# Waste Futures – Green Island Landfill Closure

## Air Quality Impact Assessment – October 2024 Update

Dunedin City Council

1 March 2023

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|---|---|
| **Project name** | GILF Closure Consents |
| **Document title** | Waste Futures – Green Island Landfill Closure \| Air Quality Impact Assessment – October 2024 Update |
| **Project number** | 12547621 |
| **File name** | 12547621-REP-A_Air Quality_GILF GHD Technical assessment.docx |

| **Status Code** | **Revision** | **Author** | **Reviewer** | | **Approved for issue** | | |
|---|---|---|---|---|---|---|---|
| | | | **Name** | **Signature** | **Name** | **Signature** | **Date** |
| S3 | A | J Potgieter | D Craggs<br>P Stacey | | Stephen Douglass | | |
| S4 | Rev01 | J Potgieter | D Craggs<br>P Stacey | | Stephen Douglass | | 13/3/2023 |
| S4 | Rev02 | J Potgieter<br>C Yii Sim | P Stacey | | Nick Eldred | | 4/10/2024 |
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# 1. Introduction

As part of Dunedin's wider commitment to reducing carbon emissions and reducing waste going to landfill, the Dunedin City Council (Council) has embarked on the Waste Futures Programme to develop an improved comprehensive waste management and diverted material system for Ōtepoti Dunedin. The Waste Futures Programme includes the roll out of an enhanced kerbside recycling and waste collection service for the city from July 2024. The new service will include collection of food and green waste.

To support the implementation of the new kerbside collection service, the DCC are planning to make changes to the use of Green Island landfill site (Figure 1.1) in coming years.

The proposed changes include:

- planning for the closure of the Green Island landfill, which is coming to the end of its operational life
- developing an improved Resource Recovery Park (RRPP) to process recycling, and food and green waste
- providing new waste transfer facilities to service a new Class 1 landfill currently planned for a site south of Dunedin, at Smooth Hill.

The resource consents for the new Smooth Hill landfill were granted in May 2023. Depending on DCC decisions regarding the development of Smooth Hill, time needed to undertake baseline monitoring, preparation of management plans, landfill and supporting infrastructure design and construction, DCC anticipate that the new Class I landfill facility, won't be able to accept waste until 2027/2028 at the earliest.

In the interim, DCC therefore plans to continue to use Green Island landfill for waste disposal. Based on Dunedin's current waste disposal rates, it is likely that that the Green Island landfill can keep accepting waste for another six years (until about 2029). Between now and then, and as it continues to fill up, the landfill will be closed and capped in stages. When the landfill closes completely, there will be opportunities for environmental enhancements and public recreational use around the edge of the site. Examples could be planting restoration projects and new walking and biking tracks beside the Kaikorai Estuary. Long term use and public access to the landfill site post closure will be determined in consultation with Te Rūnanga o Ōtākou, the local community and key stakeholders.

As current Otago Regional Council resource consents needed to operate a landfill at Green Island expire in October 2023, the DCC are now applying to ORC for replacement resource consents to continue to use the landfill until it closes completely, and waste disposal can be transferred to a new landfill facility. The replacement consents relate to ground disturbance, flood defence and discharges to land, water, and air. The site is subject to an operative designation (D658) in the Proposed Second-Generation Dunedin City District Plan (2GP) for the purpose of Landfilling and Associated Refuse Processing Operations and Activities.

The development of the new RRPP and waste transfer facilities at Green Island does not form part of the replacement consent applications. Resource consents for the development and operation of the RRPP were submitted in March 2024 and are under consideration by ORC.

To allow kerb side organics collections to commence in 2024 as part of the new waste collection systems, DCC required an Organics Receivables Building (ORB) to be constructed at the landfill. The ORB was commissioned in mid-2024 and organic materials are being received, mulched and blended, and trucked to a facility near Timaru for processing. Ultimately an Organics Processing Facility will be constructed as part of the RRPP development. The operation of the ORB is authorised by the existing Green Island landfill resource consents. Therefore, the cumulative effects associated with the ORB have been assessed in this air quality study for the replacement landfill resource consents.

## 1.1 Project overview

Figure 1.1 shows the location of Green Island Landfill. A range of options for closure of Green Island have been considered by Council. The option selected for the landfill design is shown on Drawing 12547621-01-C202 in the *Green Island Landfill Closure Design Report (GHD 2023).* This option will result in landfill closure occurring by late 2029.

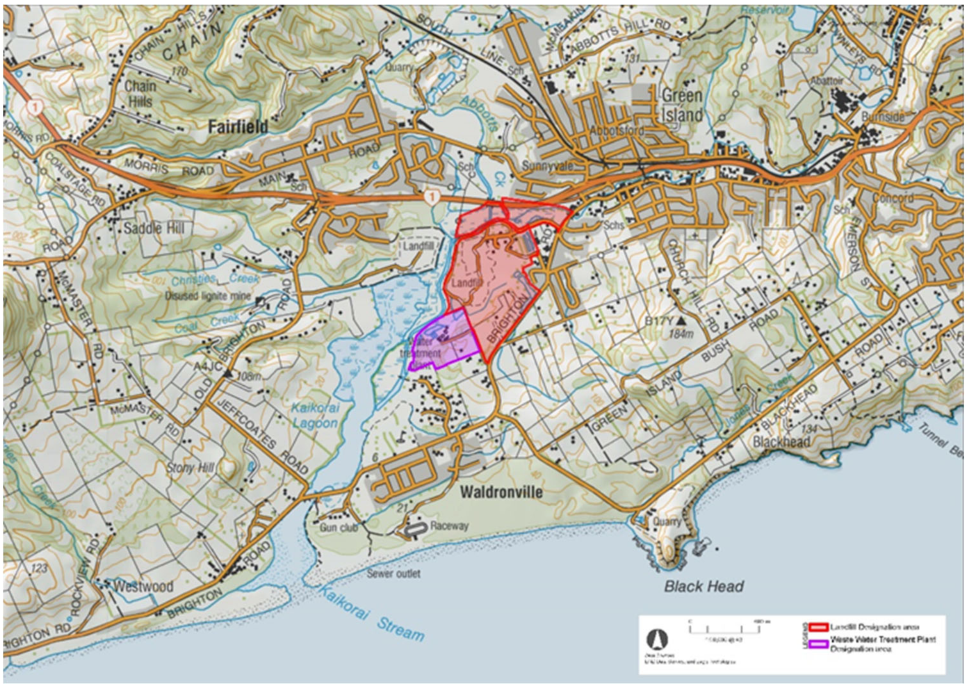


*Figure 1.1 Green Island Landfill Location*

## 1.2 Scope of assessment

The following tasks have been completed as part of the air quality assessment:

- Identification of sensitive receptors.
- Review and interpretation of the complaint data.
- Review of meteorological data.
- Review of instantaneous surface monitoring (ISM) data.
- A detailed FIDOL (frequency, intensity, duration, offensiveness, location) assessment of odour impacts from the existing operations.
- Review of current odour and dust management measures.
- Additional management measures have been proposed based on the qualitative assessment.
- A qualitative assessment of odour impacts taking into account the proposed management measures.
- A detailed FIDOL assessment of dust.
- Atmospheric dispersion modelling of flares/engines.
- Preparation of an air quality assessment report.

The assessment undertaken in this report has been carried out with consideration of the following guidance documents:

- Ministry for the Environment (MfE) Good Practice Guide for Assessing and Managing Odour (MfE, 2016) (GPG Odour)
- MfE Good Practice Guide for Assessing and Managing Dust (MfE, 2016a) (GPG Dust)

- MfE Good Practice Guide for Assessing Discharges to Air from Industry (MfE, 2016b) (GPG ID)
- MfE Good Practice Guide for Atmospheric Dispersion Modelling (MfE, 2004) (GPG ADM)
- Air Quality Management's (IAQM) guidance document on the assessment of odour for planning (IAQM, 2018) (IAQM Odour)

# 1.3 Purpose of this report

GHD has been engaged by Council to prepare an air quality assessment of the potential effects associated with air discharges from Green Island Landfill to support an application to the ORC for replacement resource consents for the landfill. The scope of works for the assessment is outlined in Section 1.2 above.

This report has been updated in October 2024 to address the cumulative effects arising from the operation of the ORB.

# 1.4 Limitations

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*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.*

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*The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

# 1.5 Assumptions

The following assumptions have been used in preparation of this report:

- Meteorological data provided by MetService and from the onsite station has been assumed to be accurate and free of errors.
- Information on the design of the landfill is based on GHD's Green Island Design Report, dated December 2022.
- Modelling of emissions from the landfill gas flare and engine has been undertaken based on the information provided in the *Landfill Gas Masterplan* prepared by Tonkin+Taylor (2021).

# 2. Site description

## 2.1 Site location

The Green Island Landfill site is located approximately 8.8 km by road from central Dunedin. The landfill site comprises a total area of 75.6 ha, being the total area of the landholding owned by Council and designated in the Proposed Dunedin City District Plan (2GP). The landfill site footprint is shown in Figure 2.1 below. Primary access to the site is via Brighton Road.

The site is generally bound by State Highway 1 to the north, the Kaikorai Stream and Estuary to the west, the Green Island Wastewater Treatment Plant (GIWWTP) to the southwest, Brighton Road to the south, and the Clariton Ave residential area and Green Island industrial area to the east. Landfill gas collected at the landfill is conveyed to the GIWWTP and combusted via a flare or an engine.

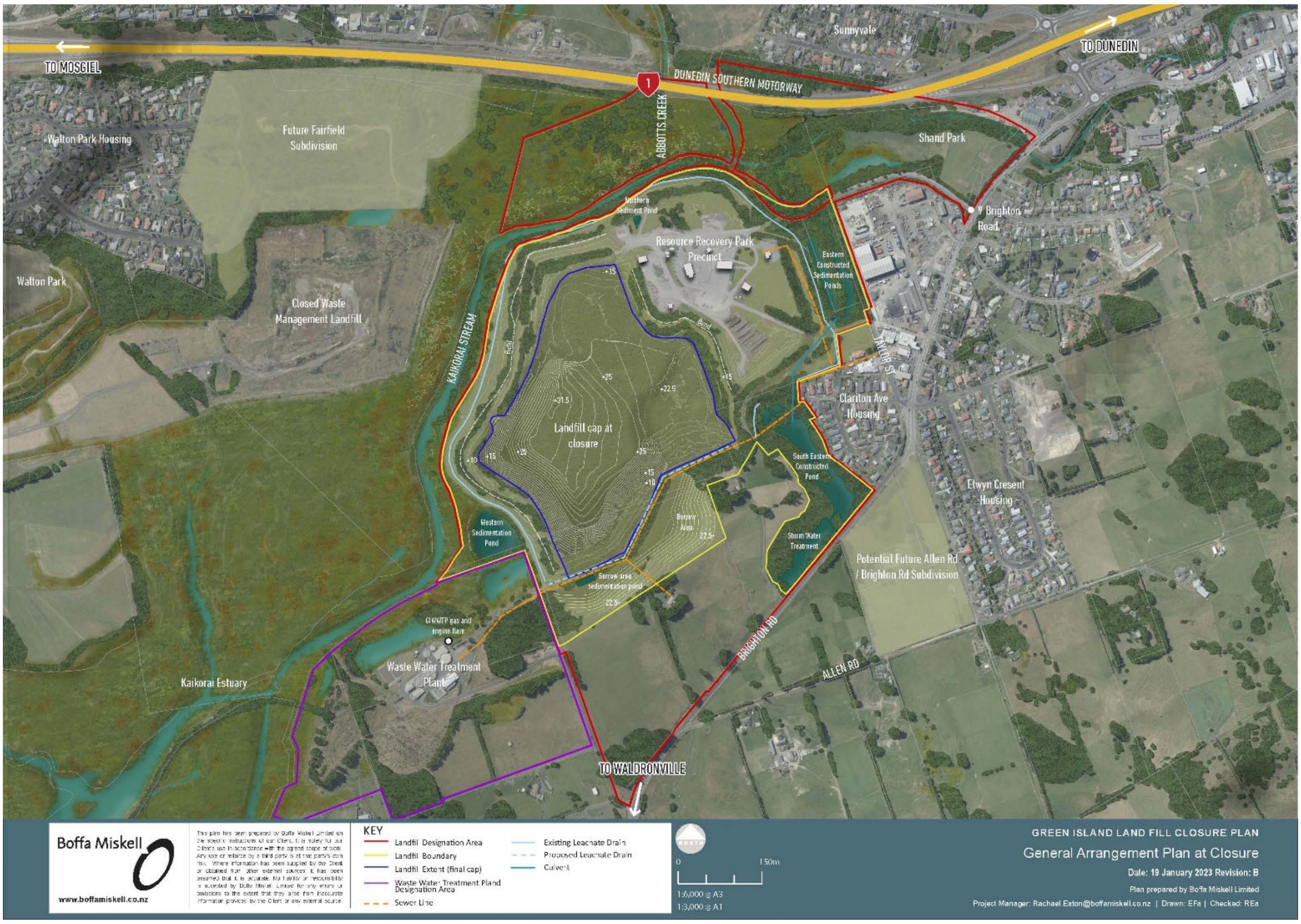


*Figure 2.1 Site location*

## 2.2 Sensitive receptors

For this assessment the term 'sensitive receptor' includes any person, location, or system that may be susceptible to changes in 'abiotic' factors as a consequence of odours from the landfill, as well as emissions of particulate matter from landfill operations, and combustion emissions from combustion of the landfill gas by engine or flare. The majority of the sensitive receptors identified are nearby residential properties.

The Clariton Ave residential area comprises the closest residential properties to the landfill, being approximately 200 m southeast of the existing waste diversion and transfer facilities, and 120 m east of the current landfill footprint. Council is also proposing to rezone a block of land between Weir Street and Brighton Road, south of Clariton Avenue, to a General Residential Zone enabling low-medium density residential living.

Other residential properties are located to the southeast at Elwyn Crescent, and to the north and west within Sunnyvale and Fairfield. Those residential properties are located at greater distances and separated from the landfill site by a combination of the State Highway 1 corridor, the Kaikorai Stream and Estuary, and rural and open space land. An area of undeveloped land zoned General Residential exists within Fairfield, accessed from Walton Park Avenue.

The margins of the Kaikorai Stream and Estuary bordering the landfill to the north and west are identified as a Regionally Significant Wetland in the Regional Plan: Water; and an Area of Significant Biodiversity Value, and a Wāhi Tupuna of cultural significance to mana whenua in the 2GP. This area is therefore considered an ecological receptor.

The nearest sensitive receptors in each direction have been reviewed. Receptors R01-R08 indicate residential areas where there are clusters of residences, as well as some recreational and commercial spaces within these areas. These have been referred to as sensitive receptor clusters and were assessed at the nearest point to the site assuming high sensitivity across the whole area. The Sunnyvale Sports Complex has been included in the R02 receptor cluster and Te Kura Kaupapa Māori o Ōtepoti primary school has been included in the R03 receptor cluster. R09 indicates the Kaikorai Stream and Estuary ecological receptor, which covers a large area around the site and similarly has been assessed at the nearest point.

Sensitive receptors and receptor clusters are shown in Table 2.1 and Figure 2.2.

***Table 2.1 Sensitive receptors***

| ID | Receptor | Receptor type | Distance and direction from landfill footprint |
|---|---|---|---|
| R01 | Green Island suburb (southeast) (nearest point along Clariton Ave) | Residential | 120 m east |
| R02 | Green Island suburb (northeast) (nearest point along Watson St) | Residential | 500 m northeast |
| R03 | Fairfield suburb (north) (nearest point along Holyport Cl) | Residential | 530 m north |
| R04 | Fairfield suburb (south) (nearest point along Blanc Ave) | Residential | 650 m northwest |
| R05 | 172-176 Brighton Rd, Waldronville | Residential | 440 m southwest |
| R06 | 45-51 Allen Rd South, Waldronville | Residential | 420 m south |
| R07 | Proposed residential area between Weir St and Brighton Rd | Proposed residential | 280 m southeast |
| R08 | Proposed residential area in Fairfield | Proposed residential | 330 m northwest |
| R09 | Abbotts Creek, Kaikori Stream and Estuary | Ecological | 120 m west, northwest and north |

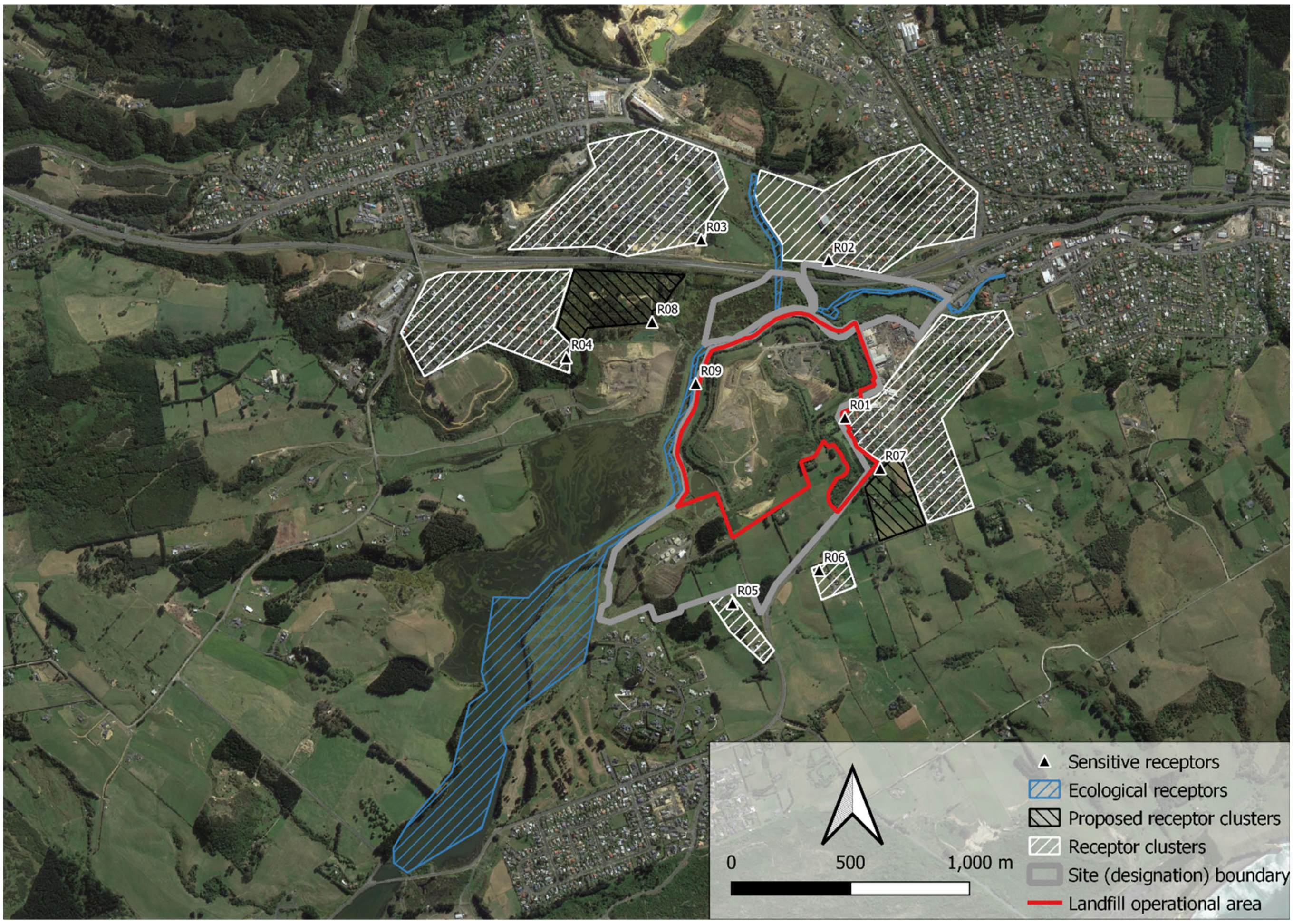


*Figure 2.2* ***Sensitive receptors***

# 2.3 Existing air quality

## 2.3.1 Air pollutants of concern

The contaminants of interest for this assessment are air pollutants associated with the combustion of landfill gas (LFG), these include:

– Particulate matter, expressed as particles with an aerodynamic diameter less than 10 ($PM_{10}$) and 2.5 ($PM_{2.5}$) micrometres in size.
– Oxides of nitrogen (NOx), particularly nitrogen dioxide ($NO_2$); sulphur dioxide ($SO_2$).
– Carbon monoxide (CO).

In addition to combustion emissions, nuisance dust and odour (associated with landfill gas and refuse) emissions are considered to be of potential concern.

GHD has identified the following possible additional sources of air pollutants in the area:

– Odour emissions from the GIWWTP approximately 750 m southwest of the site and natural sources such as Abbotts Creek, the Kaikorai Stream and the Estuary, particularly when parts of the creek/lagoon bed are exposed.
– Dust emissions from Blackhead Quarries approximately 2.6 km south of the site and Fulton Hogan sand quarry approximately 1.6 km north of the site.
– Motor vehicle emissions from local roads and State Highway 1 (approximately 450 m north of the landfill footprint).

– Discharges from agricultural activities, which may include burning of vegetation, aerial spraying, ground-based fertiliser application, etc.
– Possible gas and dust emissions from the industrial area adjacent to the site including Waihola Asphalt Surfacing Ltd and Otago Metal Industries Ltd.
– Possible LFG emissions from Waste Management's closed landfill on the opposite side of Kaikorai Stream approximately 500 m to the west of the site.

The presence of existing odour sources increases the risk of impact from the site by cumulative odour effects. The GIWWTP and nearby natural features are existing odour sources in close proximity to the site. Therefore, it is possible cumulative odour impacts may occur and should be taken into account.

### 2.3.2 Background air quality

ORC has defined three air zones within the region (ORC, 2009). Air Zone 1 and Air Zone 2 are identified as likely to breach National Environment Standards for Air Quality (NESAQ) standards for $PM_{10}$. The site is located in Air Zone 2 which has been identified as a polluted airshed based on monitoring observations in Mosgiel.

$PM_{10}$ monitoring is undertaken in central Dunedin approximately 9 km northeast of the site, and in Mosgiel approximately 5.8 km north of the site (LAWA, 2022). Observations recorded at these monitoring stations for the last 3 years are presented in Table 2.2 as well as the relevant assessment criteria (refer Table 4.2).

The main source of $PM_{10}$ in central Dunedin is smoke from solid fuel burners used to heat homes during winter. For the past 5 consecutive years, Dunedin has met the National Environmental Standards for Air Quality (NES-AQ). The city has relatively good air quality year-round, although emissions can accumulate in some of the valley areas. Exceedances of the maximum 24 hour criterion were observed in 2018 and 2021. No exceedances of the annual average criterion were observed.

Mosgiel can experience poor winter air quality when smoke from domestic and industrial emissions concentrates near the ground surface. The maximum 24 hour criterion was exceeded every year, however no exceedances of the annual average criterion were observed.

*Table 2.2 Background $PM_{10}$ concentrations*

| Monitoring location | Parameter | Assessment criteria (µg/m³) (refer Table 4.2) | Concentration (µg/m³) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | Average |
| Central Dunedin | 24 hour maximum | 50 | 39.1 | 40.0 | 51.5 | 41.1 | 40.3 | 52.0 | 44.0 |
| | Annual average | 20 | 16.1 | 14.2 | 15.1 | 12.1 | 12.4 | 15.4 | 14.2 |
| Mosgiel | 24 hour maximum | 50 | 116.3 | 89.1 | 94.5 | 79.6 | 70.5 | 67.9 | 86.3 |
| | Annual average | 20 | 19.2 | 18.6 | 19.2 | 16.9 | 17.9 | 17.3 | 18.2 |

Given the semi-rural surroundings and relatively small size of adjacent urban areas, GHD does not consider it appropriate to use monitoring at Dunedin or Mosgiel (much larger urban areas) to infer background concentrations at the Site. Alternatively, GHD has adopted the Waka Kotahi Background Air Quality default values for the Green Island census area, which were developed in May 2022 (Waka Kotahi, 2022). Default background values for $SO_2$, CO and $NO_2$ have been sourced from the GPG ID as there is no local monitoring of these pollutants.

A summary of the background concentrations applicable for this assessment are presented in Table 2.3.

*Table 2.3 Background air quality concentrations*

| Pollutant | Parameter | Assessment criteria (µg/m$^3$) (refer Table 4.2) | Concentration (µg/m$^3$) | Source |
|---|---|---|---|---|
| $PM_{10}$ | Average 24 hour maximum | 50 | 31.5 | Waka Kotahi Background Air Quality |
| | Annual average | 20 | 12.0 | |
| $PM_{2.5}$ | Average 24 hour maximum | 25 | 15.1 | |
| | Annual average | 10 | 6.5 | |
| $SO_2$ | 1 hour average | 350 | 20 | GPG ID (Table 8) |
| | 24 hour average | 120 | 8 | |
| | Annual average | 10 | No data (assumed to be < 4) | |
| CO | 1 hour average | 30,000 | 5,000 | |
| | 8 hour average | 10,000 | 3,000 | |
| $NO_2$ | 1 hour average | 200 | 65 | |
| | 24 hour average | 100 | 43 | |
| | Annual average | 40 (30 Ecological) | 16 | |

## 2.4 Climate and meteorology

The local climate and meteorology (weather) within the study area is of critical importance when assessing the potential for air quality impacts at sensitive receptors.

The meteorological environment relevant to a project site is best understood through review of data collected from long-running monitoring weather stations. Simulation of the meteorological environment (modelling) is a useful tool in understanding the environment where suitable meteorological observations are not available.

### 2.4.1 Onsite observations

The average wind rose representing data collected by the onsite AWS is presented in Figure 2.3. Data has been collected from 3 February 2022 to 10 January 2023, and shows the following features:

– The predominant wind direction is from the northeast.
– The average wind speed measured was 2.9 metres per second.
– Calm conditions (wind speeds less than 0.5 m/s) occurred 1.2% of the time.
– High wind speeds (winds greater than 5 m/s which are often attributed to dust lift-off) mostly occur from the northeast and southwest.

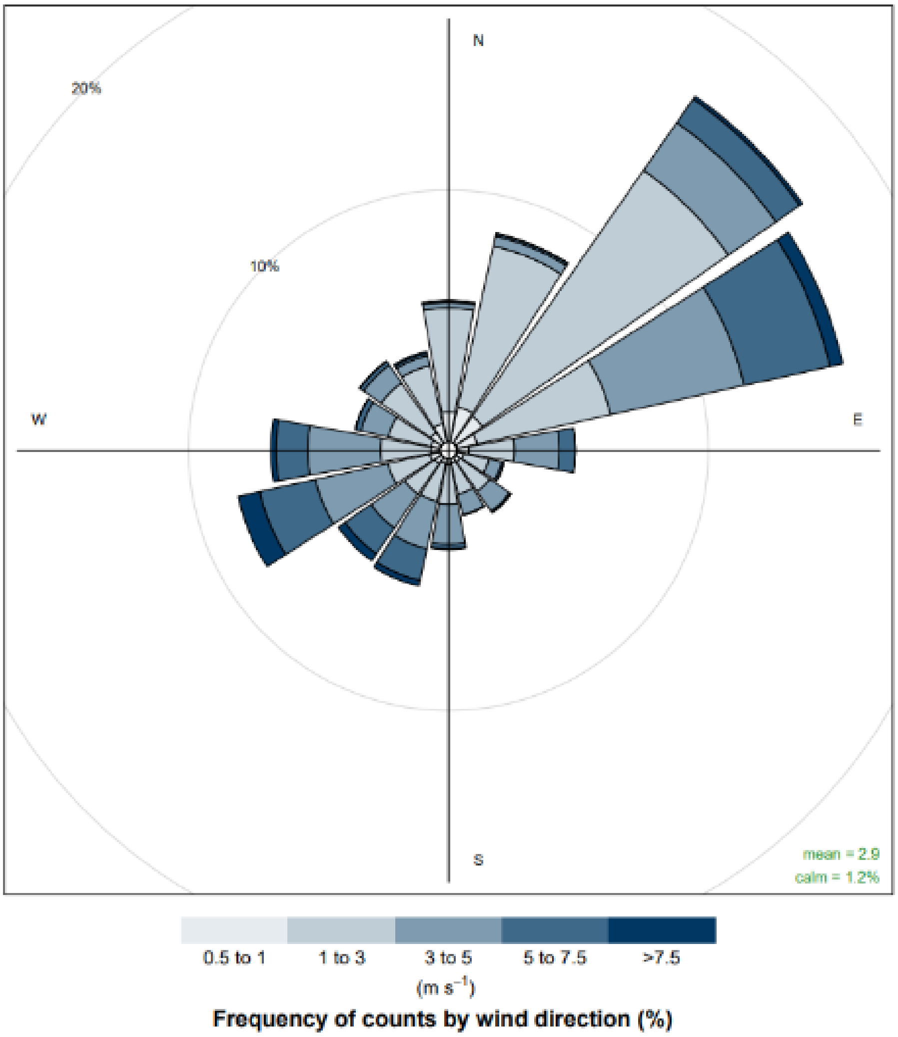


*Figure 2.3 Average wind rose collected from onsite AWS (Feb-Dec 2022)*

### 2.4.2 Nearby observations

Due to the short time period that the onsite observations are available, data from several nearby stations have been reviewed. Details of the locations and time periods of observation for each station are provided in Table 2.4. Observations from these stations are not considered wholly representative of the site due to the complex terrain between the site and the stations. However, they are useful for understanding the overall wind fields in the region. The annual wind roses are presented at the station locations in

Figure 2.4**Error! Reference source not found.**.

*Table 2.4 Details of nearby meteorological stations*

| Station | Location | Distance and direction from site | Time period of observations | Average wind speed (m/s) | Proportion of calms (<0.5 m/s) |
|---|---|---|---|---|---|
| North Taieri | -45.845591°, 170.387887° | 7.1 km north | Feb 2022 – Dec 2022 | 2.6 | 2.6% |
| Dunedin Aero | -45.916667°, 170.183333° | 17.6 km west | Jan 2020 – Dec 2022 | 3.4 | 3.7% |
| Dunedin Musselburgh | -45.901290°, 170.514700° | 8 km east | Jan 2018 – Dec 2021 | 2.9 | 2.8% |

The most similar observations to those recorded onsite are in North Taieri with the predominant wind direction from the northeast. In contrast, the predominant wind directions observed at Dunedin Musselburgh and Dunedin Aero are from the north and southwest respectively.

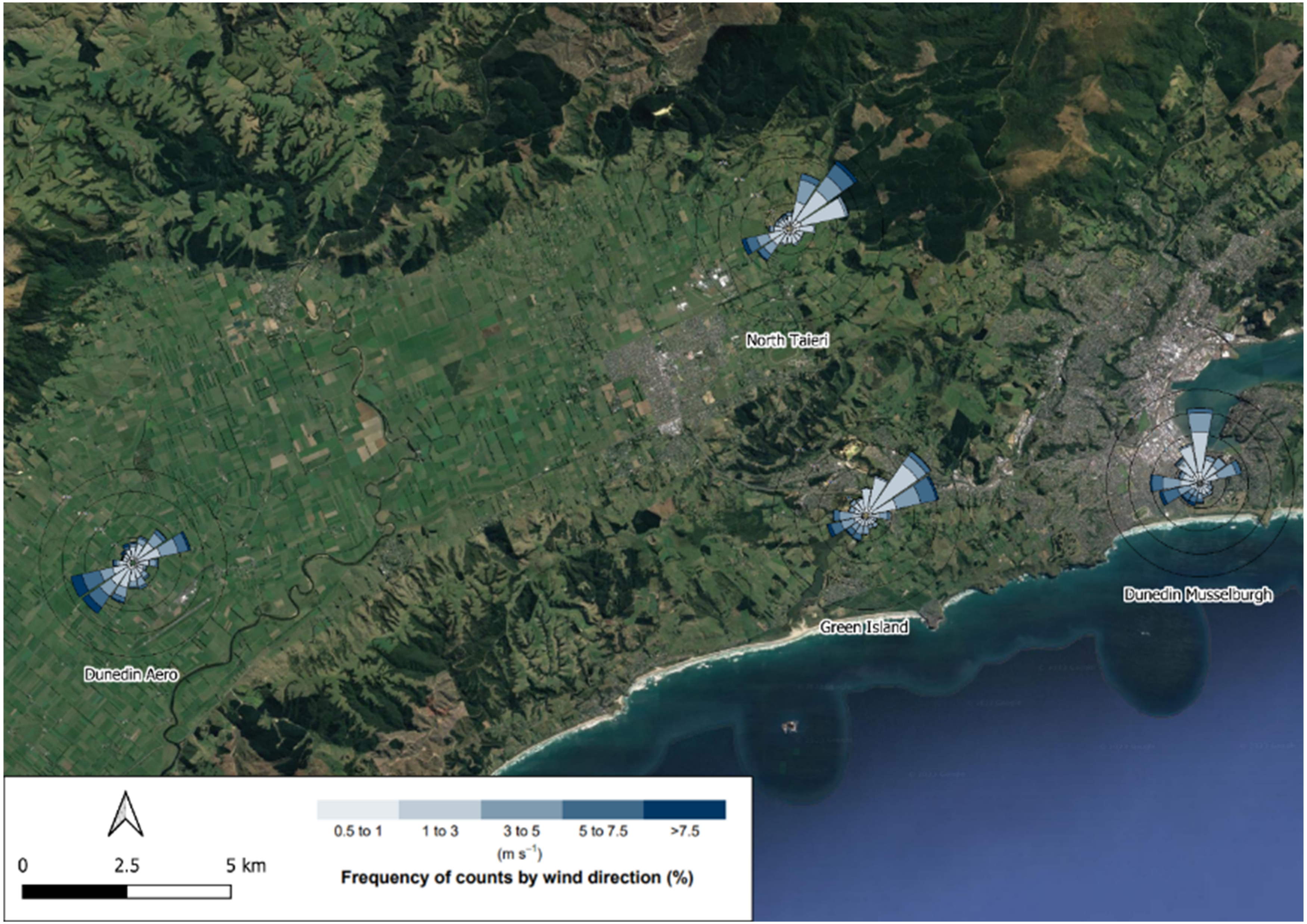


*Figure 2.4 Average wind roses collected from nearby meteorological stations*



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### 2.4.3 Meteorological data processing

Local meteorology, including long term wind speed and direction as well as atmospheric stability, can influence how pollutants are dispersed into the local environment. Meteorological modelling has been used to synthesise site-representative meteorology for the project.

Key meteorological input data for the assessment was from the Dunedin Aero AWS operated by MetService approximately 17.6 km west of the site. Data from Dunedin Aero was used as there is limited site data (< 1 year for both Green Island and North Taieri).

AERMOD, an air dispersion model, has been used for dispersion modelling of the emissions from the combustion of landfill gas. AERMET is the meteorological data pre-processor for AERMOD. The AERMET model was therefore used to develop the meteorological data file for subsequent use in dispersion modelling of combustion emissions. The model was run for 3 years from 01 January 2017 to 31 December 2019 as consistent data were available over this period. Surface characteristics were constant for all sectors. Details of albedo, Bowen ratio and surface roughness are presented in Table 2.5. The albedo describes the reflectivity of the surface, and the Bowen Ratio describes the heat transfer properties of the surface.

***Table 2.5 Surface characteristics around the site***

| | Albedo | Bowen Ratio | Surface Roughness |
|---|---|---|---|
| Summer (Dec-Feb) | 0.143 | 0.61 | 0.06 |
| Autumn (Mar-May) | 0.143 | 0.73 | 0.06 |
| Winter (Jun-Aug) | 0.149 | 0.73 | 0.06 |
| Spring (Sep-Nov) | 0.143 | 0.55 | 0.06 |

The average wind rose extracted from the AERMET model at the site is shown in Figure 2.5.

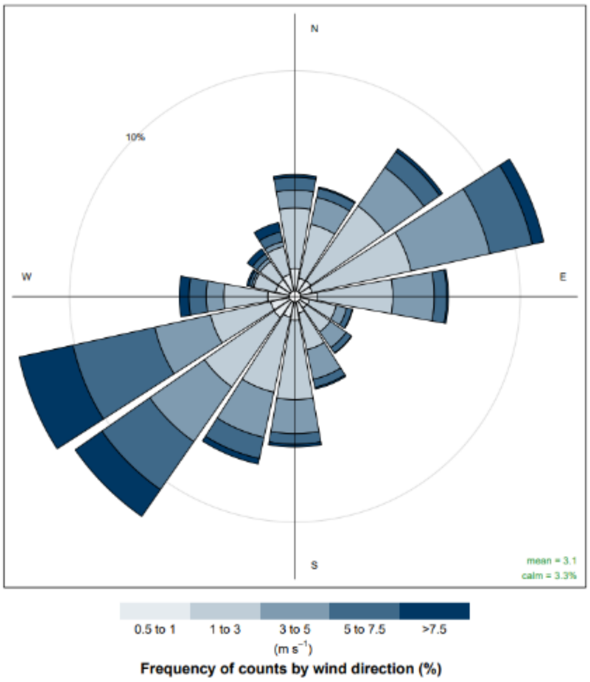


***Figure 2.5 AERMET on site wind rose***

From the above wind rose it can be seen that north-easterly winds observed at the onsite station are similarly recorded within the Dunedin Aero data set, however there is also a high proportion of winds from the south-west which are not consistent with the onsite observations. The mean wind speed is slightly higher than the observed, at 3.1 m/s compared with 2.9 m/s. The proportion of calm conditions is also slightly higher, at 3.3% compared with 1.2%. Differences between the onsite data and the Dunedin Aero data are likely due to the complex terrain around the site.  Overall, while there are differences between the two datasets, GHD considers that the 3 years of data from Dunedin Aero will likely incorporate sufficient meteorological conditions that capture worst-case onsite conditions.

# 3. Project discharges to air

The possible discharges to air from the project include odour, dust, vehicle combustion emissions and emissions from the landfill gas extraction system and flare. Locations where these discharges may occur are shown in Figure 3.1.


*Figure 3.1 Project discharges to air locations*

## 3.1 Odour discharges

Generally, odours originating from landfills have the potential to be objectionable and have nuisance effects beyond the site boundary. The sources of odour from the site include:

– Refuse odours from tipped waste, material awaiting tipping or being transported to the tipface.
– Odour from highly malodorous specific waste.
– Excavation activities into previously placed waste.
– Landfill gas.
– Odour from public drop off to the waste transfer station.
– Organics Receivals Building (ORB) (operational mid 2024).

Up until the ORB becoming operational in mid 2024 green waste material was accepted in the concrete pad area directly opposite the Transfer Station. Greenwaste was dumped on the concrete pad where it was moved and stockpiled ready for mulching. Once the greenwaste was mulched it was stockpiled in windrows and left to compost. It was then screened and turned into a product that can be sold. A total of approximately 1,300 tonnes of greenwaste was composted in 2022. With the commissioning of the ORB and the commencement of kerb side organic waste collection all green waste is now processed through the ORB where it is mixed with the incoming kerb side collections. The composting operation has ceased operation.

### 3.1.1 Organics Receivals Building

The ORB is a newly constructed building within the RRPP where kerbside collected organic material such as household food scraps and green waste (FOGO) is received for shredding and blended with additional green waste received at the landfill before being taken offsite for composting. Operation of the ORB commenced in July 2024.The ORB is a fully enclosed structure. The southern side of the ORB has a roller door which allows a truck to enter and unload organic waste onto the concrete floor. The northern side of the ORB has two roller doors for the loader access. The doors of the ORB will be closed, when practicable, in between receivals and load-outs. Kerbside organic materials are blended with green waste on the same day it is received and transported off-site. When fully operational the ORB will be capable of handling 30,000 tpa of organic material.

The odours associated with the ORB are from green waste and organic waste from kerbside organic collection. The kerbside organic waste stream may include small quantities of meat, fish, and dairy which can be more odorous when compared to green waste. The odour from the green waste and organic waste received at the ORB is expected to be largely contained within the enclosed ORB which greatly reduces the odour intensity when compared to composting green waste in the open previously.

## 3.2 Dust discharges

Dust emissions from operation of the site (with the exception of combustion operations) are expected to predominantly consist of coarse particles. The most common concerns relating to coarse dust discharges are impacts on amenity, visibility and effects on structures (nuisance), however with mitigation these impacts are typically localised to within 100 m of the source.

Throughout operation of the landfill it is anticipated the following activities will generate dust:

- Disturbance of dry soils on internal roads as a result of wind or traffic movements.
- Earthworks, such as placing of cover material during dry periods.
- Receiving, placing and compacting dry material during windy conditions.

There is also the potential for there to be short periods of time when there are more vehicles on site as new cells are developed, or when final capping is being placed. Consequently, during these periods there will be additional dust and exhaust emissions from these vehicles.

## 3.3 Vehicle combustion emissions

Typically, adverse effects associated with vehicle/machinery emissions in New Zealand are only found in urban areas where there are particularly high traffic levels combined with traffic congestion. During the operational phase of the landfill heavy vehicles will be present delivering and transferring waste around the site, as well as light vehicles used by staff and at the public drop-off. In practice, the total number of heavy vehicles may fluctuate across any given day due to seasonality or operational requirements (including the need for water and trucks).

All incoming waste at the weigh bridge is directed to either the waste transfer station or to the tip face. Only pre-approved waste delivery operators with large trucks are permitted to the tip face. All domestic, or loads not pre-approved for disposal at the tip face, are directed to the waste transfer station where they are loaded on to the landfill operator's trucks to transfer to the tip face.

All waste deliveries are by road and most will exit SH1 at the Green Island SH1 Interchange, to access the 50 km/hr Brighton Road, entering the site at 9 Brighton Road that leads directly to the landfill weighbridge and kiosk. All public roads and internal access to the weighbridge and waste transfer station are sealed.

Overall, the expected traffic volumes along the access roads at any given time will be very low. Consequently, the potential for adverse effects is considered to be negligible and no further consideration has been given in this assessment to vehicle emissions.

## 3.4 Landfill gas extraction system and flare

LFG is a complex mixture of different gases produced by the degradation of biodegradable waste materials deposited within landfill sites. The emission rate and chemical composition of LFG varies depending on many factors including waste type, time, moisture content, temperature, etc. during the anaerobic phase, when decomposition of biodegradable waste materials occurs in the absence of oxygen.

LFG is comprised primarily of methane, carbon dioxide, oxygen and nitrogen with trace amounts of reduced sulphur compounds and volatile organic compounds.

The timescale for the evolution of significant quantities of LFG typically varies from three to twelve months following waste deposition and can continue for well over 30 years following the termination of waste landfilling activities.

A Landfill Gas Masterplan was prepared by Tonkin+Taylor in 2021 (updated in September 2023) in which a review of the existing LFG extraction system was undertaken and detailed the design work and gas collection wellfield expansion required to maximise gas collection and destruction at the site.

The LFG extraction system comprises:

- 38 vertical LFG collection wells installed and connected to the network.
- A series of 110 mm and 225 mm lateral connector pipes that connect to a header or ring main pipes to convey the LFG to the destruction systems installed at the GIWWTP.
- A LFG engine that uses LFG gas as a fuel, in conjunction with gas produced from the adjacent GIWWTP, with its associated blower, power, and alarm systems, to generate electricity which is fed back into the grid. The LFG engine has a 600 kW capacity and operates at an LFG flowrate of approximately 350 $m^3$/hr.
- A 450 $m^3$/hr candlestick flare, with its associated blower, power and alarm systems, to serve as a back-up for the LFG engine and destroy the residual LFG that cannot be used by the engine.

In addition to the above, a small mobile solar powered flare is used on the landfill to control LFG emissions from LFG wells that are not connected to the reticulated system. This typically occurs where wells are located close to the active tip face and reticulation pipework cannot be installed due to vehicle movements. A second mobile solar powered flare is intended to be acquired and utilised at the site.

Based on LFG generation modelling completed as part of the Masterplan, the maximum possible collected LFG at the site was within the combined capacity of the LFG engine and candlestick flare. However, with the increased LFG to be collected at the landfill, discussion was included on other destruction or utilisation operations for the future. Based on the recommendations provided in the Masterplan, a replacement flare will be installed to manage the predicted increase in excess LFG generated. This flare will be an enclosed flare.

For the purposes of this assessment, GHD has assessed emissions based on the maximum amount of LFG that is predicted to be collected from the landfill. As of 1 July 2024, Council has commenced collecting kerbside organic waste which will reduce the organics being disposed to the landfill and subsequently reduce LFG generation at the landfill. Therefore, the utilised LFG collection rate provides a conservative assessment of impacts. This approach provides for a worst-case assessment of emissions and therefore allows sufficient flexibility for the flare/engine to be upgraded in the future as required without needing to amend the resource consent.

Emissions from the flare associated with combustion of LFG include nitrogen dioxide, carbon monoxide, particulate matter ($PM_{2.5}$ and $PM_{10}$) and sulphur dioxide. Specific emission rates for each of these pollutants are described in Section 7.3.1.

# 4. Assessment criteria

## 4.1 Regulatory requirements

### 4.1.1 Consideration of Resource Management Act 1991

There are a number of sections within the Resource Management Act 1991 (RMA) which are relevant to the assessment of odour and dust from the site.

Given that odour and dust are considered to cause effects on amenity values, people and communities, the RMA requires that they are appropriately managed. As the compounds that have the potential to cause effects are mobilised as air contaminants, these discharges are controlled by section 15 of the RMA.

Section 15(1) of the RMA states that discharges from industrial or trade premises are only allowed if they are authorised by a regional plan, a resource consent or by New Zealand regulations.

Section 17 of the Act imposes a general duty on every person to avoid, remedy or mitigate any adverse effect on the environment arising from any activities the individual may conduct or have carried out on their behalf.

### 4.1.2 Consideration of separation distances

The consideration of separation distance between sensitive neighbours, particularly residential dwellings, and odour/dust-generating activities is important when assessing the likely impacts of an activity, as a suitable separation can help to mitigate nuisance effects on occasions when standard mitigation measures cannot be entirely effective (for example when strong dry winds occur). By having a suitable separation distance, odour/dust emissions can be dispersed, diluted and deposited to such an extent that their effects at sensitive locations should be minimised to an acceptable level.

The Auckland Council (AC) discussion document on Separation Distances for Industry (Wickham, L. , 2012) prepared by Emission Impossible recommends a separation distance of 1,000 m for landfills, and the Environment Protection Authority Victoria (EPA Victoria) separation distance guidelines recommend a distance of 500 m for Type 2 landfills, which Green Island is classified as. GHD has identified several receptors within 500 m of the landfill as per Section 2.2. While receptors have been identified within the recommended buffers by the respective regulators, the AC document states that "*Separation distances are indicative, not absolute criteria, and may be adjusted having regard to specific site circumstances."*

Furthermore, GPG Industry states that *"…the EPA Victoria guidelines (and other similar guidance) are generic. Most of the separation distance guidelines are based on the protection of amenity values at sensitive locations. They do not generally consider risk, or potential health effects. It is also important to note that they do not take into account site specific factors which may influence discharge rates and how they are dispersed (e.g., the specific processes and emission controls used on site). They are also applied in all directions and so do not take into account the effects of local topography and meteorology.*"

Overall, GHD considers that careful consideration must be given when applying generic buffer distances for landfills, as in some instances this buffer may be either, insufficient or too conservative. For this GHD has undertaken detailed analysis of odour discharges as part of this assessment to better understand the potential for odour nuisance, particularly for those receptors within 1,000 m of the landfill. This is discussed further in Section 5.5.

## 4.2 Odour and dust emission assessment criteria

The primary concern with odour and dust is its ability to cause an effect that could be considered 'offensive or objectionable' as these impacts can contribute to a reduced quality of life. In order to assess whether an odour or dust event has the potential to be offensive or objectionable MfE recommends that the FIDOL factors are considered using the guidance provided in GPG Odour and GPG Dust. The FIDOL factors concerning odour and dust are summarised in Table 4.1.

*Table 4.1 FIDOL factors*

| FIDOL Factor | Description |
|---|---|
| Frequency | The frequency of odour or dust discharges relates to how often an individual is exposed. |
| Intensity | The intensity relates to the concentration of odour or dust. |
| Duration | The duration relates to the length of time that an individual is exposed. |
| Offensiveness | Offensiveness relates to the 'hedonic tone' of the odour, which may be pleasant, neutral or unpleasant.<br>In terms of dust, offensiveness relates to the type of dust. |
| Location | The sensitivity of locations in the receiving environment, which is characterised by land uses surrounding the site. |

## 4.3 Landfill gas combustion emissions assessment criteria

### 4.3.1 The national environmental standards for air quality (NESAQ) regulations 2004

The NESAQ are regulations made under the RMA. These regulations aim to set a guaranteed minimum level of health protection for all New Zealanders. This includes controlling greenhouse gas emissions at landfills. The relevant regulations to LFG combustion emissions are Regulations 26 and 27.

Regulations 26 and 27 set the requirement that large landfills (as set out in Regulation 25) collect LFG and meet a maximum surface methane concentration of 5,000 ppm. In addition, the NESAQ requires the collected gas to be flared, or used as a fuel or to generate electricity. The current system for gas destruction at the site complies with the regulations (Tonkin+Taylor, 2021).

### 4.3.2 Health-effects based assessment criteria

GPG ID recommends an order of priority when determining the most appropriate assessment criteria to be used for air quality assessments. The documents provided below set out the minimum requirements that ambient air quality should meet in order to protect human health and the environment. The order of priority in which documents should be reviewed to identify the minimum requirements for the pollutants of concern is as follows:

- Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (Parliamentary Counsel Office, 2020) (NESAQ).
- Ambient Air Quality Guidelines (2002 update) (MfE, 2002) (NZAAQG).
- Regional Air Quality Targets (RAQT) – Otago Ambient Air Quality Targets (OAQT).
- World Health Organisation air quality guideline (WHO AQG) Global Update 2021 (WHO, 2021).

The air quality assessment criteria relevant to this project are presented in Table 4.2.

In September 2021, the WHO published new guidelines for $PM_{2.5}$ of 15 µg/m³ and 5 µg/m³ as a 24-hour and annual average, respectively. However, MfE has not reviewed these values to determine if they are appropriate for use in New Zealand. Furthermore, the new guidelines have very low thresholds and adopting these values in urban/industrial areas would likely require the removal of combustion sources such as wood-fired home heaters and petrol/diesel vehicles. Consequently, GHD has not compared predicted off-site concentrations against these values; instead, predicted concentrations have been compared with the previous 2005 WHO guidance.

*Table 4.2 Health-effects based air quality assessment criteria*

| Pollutant | Threshold Concentration (µg/m³) | Averaging Period | Source of Assessment Criteria |
|---|---|---|---|
| $NO_2$ | 200 | 1-hour | NESAQ |
| | 100 | 24-hour | NZAAQG |
| | 40 | Annual | WHO AQG |
| CO | 30,000 | 1-hour | NZAAQG |
| | 10,000 | 8-hour | NESAQ |
| $SO_2$ | 570 | 1-hour | NESAQ |
| | 350 | 1-hour | NESAQ |
| | 120 | 24-hour | NZAAQG |
| $PM_{10}$ | 50 | 24-hour | NESAQ |
| | 20 | Annual | NZAAQG |
| $PM_{2.5}$ | 25 | 24-hr | WHO AQG (2005) |
| | 10 | Annual | WHO AQG (2005) |

### 4.3.3 Ecological guidelines

MfE also provides guidelines for the protection of ecosystems. Table 4.3 presents the guidelines applicable to this assessment.

*Table 4.3 Ecological based air quality assessment criteria*

| Pollutant | Threshold Concentration (µg/m³) | Averaging Period |
|---|---|---|
| $SO_2$<br>– Agricultural crops<br>– Forest and natural vegetation<br>– lichen | <br>30<br>20<br>10 | <br>Annual and winter average<br>Annual and winter average<br>Annual |
| $NO_2$ | 30 | Annual |

### 4.3.4 Regulation 17 of the NESAQ

In addition to the standards in the NESAQ, there are also regulations which limit the ability of consent authorities to grant consent in airsheds that do not meet the standards. For $PM_{10}$ the relevant regulations are Regulation 17 (1) – (2) which state:

"**17 Certain applications must be declined unless other $PM_{10}$ discharges reduced**

*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.*

*However, subclause (1) does not apply if—*

a. *the proposed consent is for the same activity on the same site as another resource consent (the existing consent) held by the applicant when the application was made; and*
b. *the amount and rate of $PM_{10}$ discharge to be expressly allowed by the proposed consent are the same as or less than under the existing consent; and*

c. *discharges would occur under the proposed consent only when discharges no longer occur under the existing consent."*

As well as being emitted in the form of 'dust' (e.g., from vehicles on dirt roads roads) particulate matter is a product of combustion; and therefore, operation of the flare and engine is a material source of $PM_{10}$ emissions. The site is located within the Otago 2 air shed, as shown in Figure 4.1 and while no $PM_{10}$ monitoring has been undertaken within the airshed, given that it has the same designation as the Mosgiel airshed (Otago 2), ORC consider that this airshed is also polluted. Given that the discharges from the flare and engine are not authorised by an existing resource consent, Regulation 17(1) is relevant to this application. GHD has therefore assessed $PM_{10}$ discharges against the requirement that off-site concentrations are less than 2.5 µg/m³ as a 24-hr average.


***Figure 4.1 Location of site within Otago 2 air shed (MfE Data Management, 2020)***

# 4.4 Methodology

## 4.4.1 Odour assessment

A review of the existing operations and complaint history has been undertaken to gain an understanding of and qualitatively assess the odour impacts from the site. This was undertaken with consideration to the FIDOL factors using the guidance provided in GPG Odour, as described in section 4.1. A review of the recommended separation distances has also been undertaken.

The proposed site layout and operations were assessed to understand the possible changes in impacts on receptors.

Based on the results of the FIDOL assessment of the existing operations a range of management and mitigation measures have been recommended to minimise future impacts on sensitive receptors, with consideration to the proposed changes to the site and operations. The FIDOL assessment has then been repeated to estimate future impacts on receptors, taking into account the recommended measures and proposed changes to the site.

Use of atmospheric dispersion modelling to estimate odour impacts was not considered necessary or appropriate for this assessment, as an understanding of impacts from existing operations is provided by the complaints history.

Estimated emission rates would be based on an equivalent landfill site as odour monitoring is not available and therefore would not be able to take into account the specific mitigation measures identified.

### 4.4.2 Dust assessment

A qualitative assessment of the potential effects associated with the proposed activities has been undertaken to determine the potential for the activities to generate nuisance dust that might affect the neighbouring community. This has been undertaken in accordance with GPG Dust using the FIDOL assessment tool.

### 4.4.3 Landfill gas combustion emissions assessment

Emissions associated with LFG combustion have been assessed using atmospheric dispersion modelling.

Generation and collection rates of LFG identified in the Landfill Gas Masterplan (Tonkin+Taylor, 2021) have been used to estimate emissions from the engine and flare[1]. Meteorological modelling was undertaken using AERMET based on observations recorded at the Dunedin Aero AWS, with consideration to MfE's GPG ADM (NSW OEH, 2011) (refer section 2.4.3 for a more detailed summary). Dispersion modelling has been undertaken based on the maximum estimated yearly LFG emissions. An impact assessment was undertaken by comparison of the predicted pollutant concentrations against relevant assessment criteria.

[1] Note the T+T Masterplan has been updated in Sept 2023. However, the assessment has continued to use the 2021 data which is a conservative approach as the 2021 rates are higher than the 2023 rates.

# 5. Odour assessment of existing operations

## 5.1 Annual environmental monitoring

Condition 11 of the discharge permit consent no. 3839A_V1 requires that the Consent Holder (Council) provide the Consent Authority (ORC) with a Landfill Monitoring report by 1st October each year. The report is to contain all of the results obtained for all leachate, groundwater, surface water and leachate pumping system monitoring undertaken to meet the requirements of this consent for the previous year. GHD has compiled these reports for the years 2017-2018, 2018-2019, 2019-2020, 2020-2021 and 2021-2022.

Monitoring of the LFG collection system indicated that installation of four new gas wells in mid-2018 reduced the amount of gas escaping from the landfill. LFG collection rates increased each year with a maximum average rate of destruction of 7,154 $m^3$/day over the 2020-2021 monitoring period. This is a result of bringing additional wells onto the main network as quickly as possible after placement of waste, as well as a focus on reliability and maximising destruction at the engine / flare.[2]

## 5.2 Complaint history

The odour complaint history from July 2017 to August 2022 has been reviewed. Causes of the complaints were divided into four categories:

- Landfill – regular operations
- Landfill – other operations
- Landfill – delivery from wastewater plant
- Unknown

'Other operations' at the landfill included site works and irregular events such as digging a new asbestos pit (excavation of old waste), digging out soft areas due to large volumes of liquid waste, engine and flare operation issues, drainage work, etc. Fifty of the 142 received complaints were attributed to 'other operations' at the landfill.

Regular deliveries of sludge and grit screenings from wastewater treatment plants are received. These are particularly odorous and were identified as the possible source of emissions for 15 complaints.

The number of complaints per year, shaded by category, are shown in Figure 5.1.

[2] Note – these values are for the 2021 period. Additional wells continue to be added to the system as the landfill is developed.

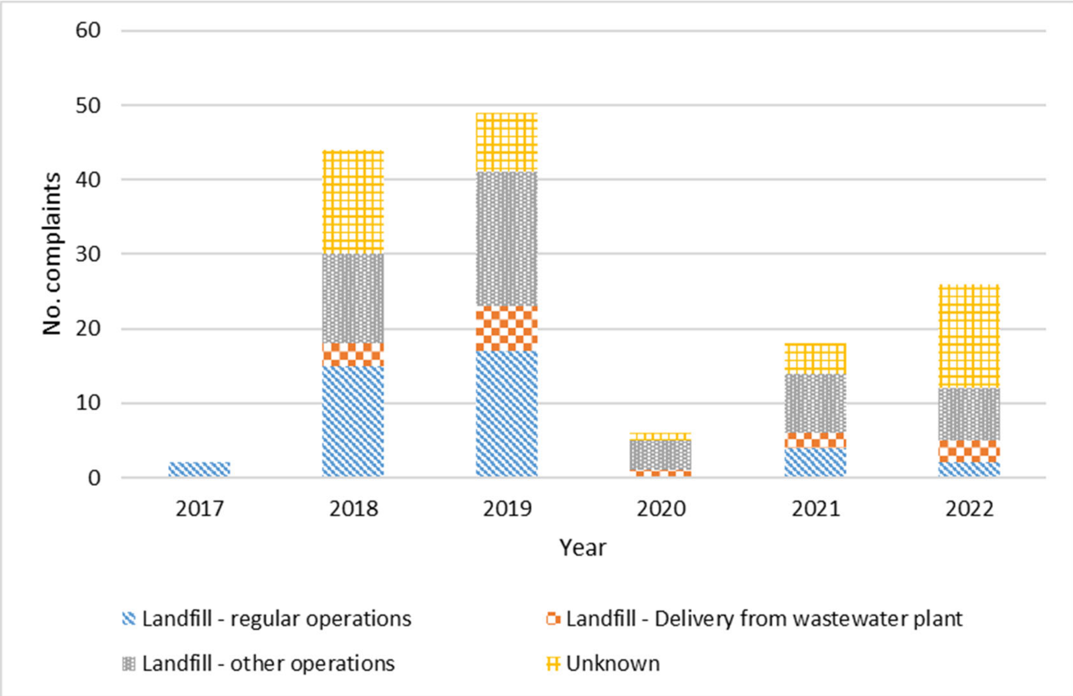


***Figure 5.1*** ***Number of odour complaints per year***

The number of complaints per year varies from 2 complaints in 2017 to 49 complaints in 2019. 2018 and 2019 had the highest number of complaints with 44 and 49 respectively. In general, most complaints were attributed to either regular or other operations at the landfill, while a maximum of 6 complaints per year (in 2019) were attributed to odorous deliveries from wastewater treatment plants. 41 of the total 145 complaints did not have an identified source. For many of the complaints, investigations by Council identified a possible source of the odour emission. These sources included turning of the compost, activities at the tip face, the sludge pit, particularly odorous deliveries, LFG, or shut down of the flare and engine.

Figure 5.2 shows the total number of complaints per each category across the time period 2017-22, shaded by the believed source of the odour emission. These are also divided into the direction from the site from which the complaint originated. There are instances where sources are included in multiple categories, for example complaints attributed to turning of the compost were split between ‘landfill – regular operations’ and ‘landfill – other operations’. Of the six complaints attributed to turning of the compost, two were attributed to the compost being very wet at the time of turning which was deemed ‘other operations’, while the remaining four were deemed ‘regular operations’ as no differences to regular operations which may have led to the complaint were identified.

Most of the complaints (91 of 112 complaints with provided location) originated from southeast of the site. 54 of these originated from Clariton Avenue, the nearest residential street to the site. Other complaints from this direction came from Brighton Road (16 complaints), Allen Road (17 complaints), and other streets (4 complaints) within the nearby Green Island suburb.

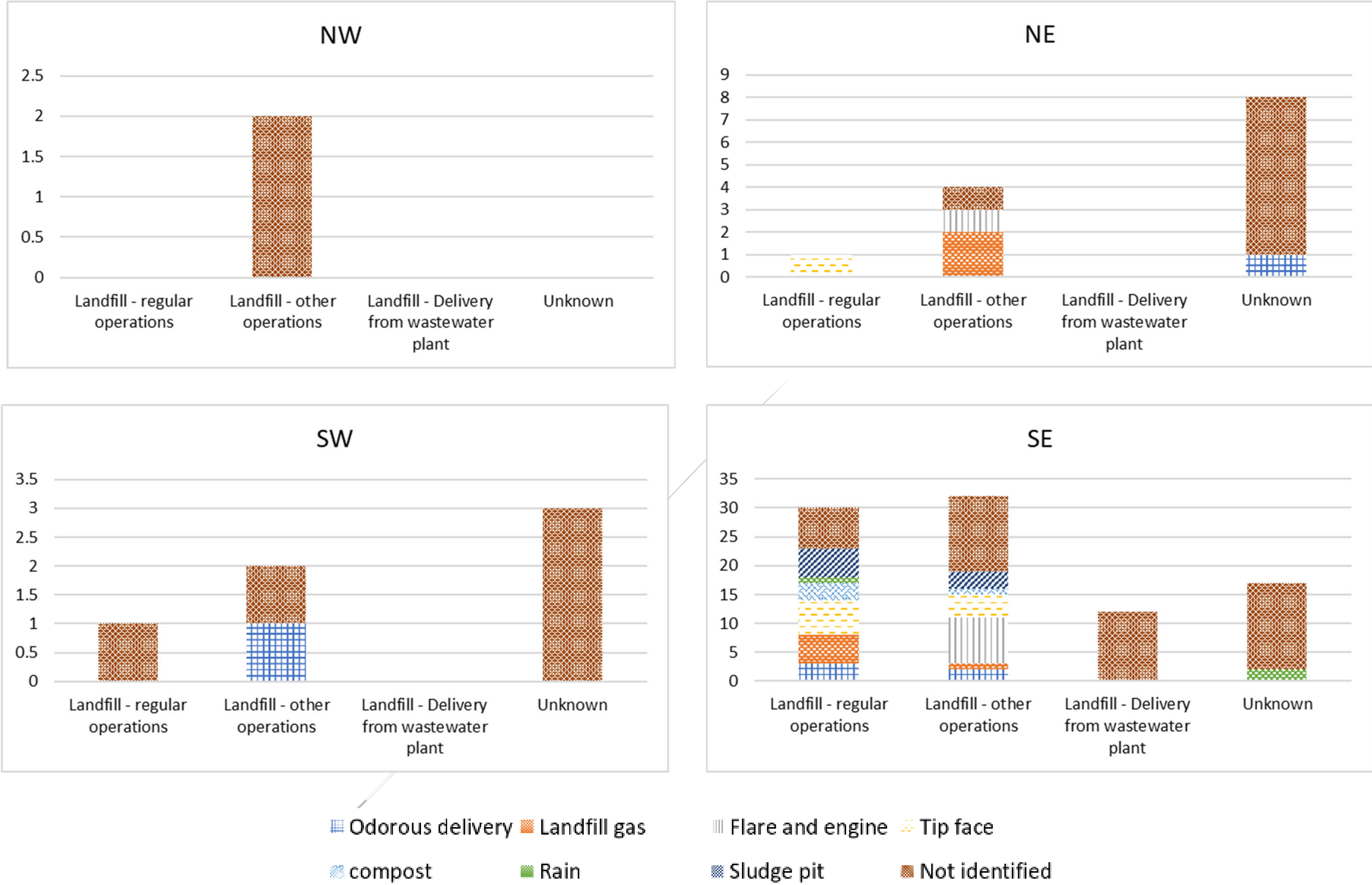


*Figure 5.2 Odour complaint categories and sources*

## 5.3 Green Island Wastewater Treatment Plant odour surveys

Community odour surveys are regularly undertaken around the GIWWTP to assess the impact of odour discharges. These surveys are carried out by an independent party engaged by DCC. The survey area is within 1 km of the GIWWTP and uses a standard questionnaire to determine the extent of odour impacts.

The most recent survey was undertaken in November 2022 and received a total of 145 responses (72 from the Clariton survey area and 73 from the Wavy Knowes survey area). The GIWWTP was not regarded as a significant or noteworthy source of odour. 49%±12% of respondents from the Clariton survey area were 'at least annoyed' by industrial odours, with 43%±11% of the respondents attributing the source to the landfill. The landfill appears to be the main source contributor to odour annoyance in both survey areas, and in 2022 recorded the highest level of annoyance to date. The predominant odour description used by respondents in this survey was 'rubbish/rotten/putrid' which is consistent with landfill odours.

It is noted that the findings of the November 2022 community odour survey are generally consistent with the GILF complaint history, indicating an existing level of odour nuisance attributed to GILF operations.

## 5.4 Environmental effects assessment of odour

To gain an understanding of impacts of the existing operations on site, the qualitative FIDOL assessment tool (as described in Section 4.2) has been used in conjunction with the odour complaint history, to determine the potential for odours to be considered offensive or objectionable by off-site receptors.

### 5.4.1 Frequency

Wind observations from an onsite meteorological station have been used to understand the frequency in which receptors may experience nuisance odours from the site. Onsite observations were considered the most relevant for this assessment rather than nearby observations or modelling results, despite the limited time period (less than a full year). This data is presented in Table 5.1. Figure 5.3 presents the onsite data as a wind rose which has been overlayed on a figure of the site with the closest receptors in view.

*Table 5.1 Wind speed frequency distribution – onsite meteorological station (Feb-Dec 2022)*

| Direction (blowing from) | Wind speed categories (m/s) | | | | | |
|---|---|---|---|---|---|---|
| | 0.5-1.0 | 1.0-3.0 | 3.0-5.0 | 5.0-7.5 | 7.5-25 | Total |
| N | 1.3% | 4.0% | 0.2% | 0.1% | 0.0% | 5.6% |
| NNE | 1.5% | 6.4% | 0.4% | 0.1% | 0.0% | 8.4% |
| NE | 1.4% | 11.8% | 2.3% | 1.1% | 0.1% | 16.8% |
| ENE | 0.9% | 5.4% | 5.4% | 3.4% | 0.5% | 15.7% |
| E | 0.5% | 1.8% | 1.8% | 0.6% | 0.0% | 4.7% |
| ESE | 0.3% | 1.0% | 0.5% | 0.1% | 0.0% | 1.9% |
| SE | 0.2% | 1.4% | 0.9% | 0.1% | 0.0% | 2.7% |
| SSE | 0.2% | 1.3% | 0.8% | 0.0% | 0.0% | 2.3% |
| S | 0.2% | 1.6% | 1.6% | 0.2% | 0.0% | 3.6% |
| SSW | 0.2% | 1.5% | 1.9% | 1.3% | 0.2% | 5.2% |
| SW | 0.3% | 1.5% | 1.6% | 1.2% | 0.3% | 5.0% |
| WSW | 0.4% | 1.7% | 3.0% | 2.2% | 0.9% | 8.2% |
| W | 0.4% | 2.0% | 2.9% | 1.2% | 0.2% | 6.7% |
| WNW | 0.4% | 1.7% | 1.1% | 0.2% | 0.0% | 3.4% |
| NW | 0.5% | 2.4% | 0.8% | 0.2% | 0.0% | 4.0% |

| Direction (blowing from) | Wind speed categories (m/s) | | | | | |
|---|---|---|---|---|---|---|
| | 0.5-1.0 | 1.0-3.0 | 3.0-5.0 | 5.0-7.5 | 7.5-25 | Total |
| **NNW** | 0.8% | 2.3% | 0.4% | 0.1% | 0.1% | 3.7% |
| **Sub-total** | 9.6% | 48.1% | 25.6% | 12.1% | 2.4% | 97.8% |
| | | | | | **Calms** | 2.2% |
| | | | | | **Missing** | 0 |
| | | | | | **Total** | 100% |

GHD consider that light winds with speeds less than 3 m/s have the greatest potential to cause odour impacts off-site. Stronger winds disperse odour more widely, reducing the impact on the local area. Analysis of low wind speeds from the site is presented in Table 5.2.

Data presented in Table 5.2 show that some receptors may experience wind conditions which have the potential to cause odour nuisance for a moderate amount of time. The following classification, in accordance with the *Guidance for assessing odour* (EPA Victoria, 2022), has been used to determine how likely the receptors could be impacted:

- 0-2% = Low (green),
- 2-6% = Moderate (yellow),
- >6% = High (orange).

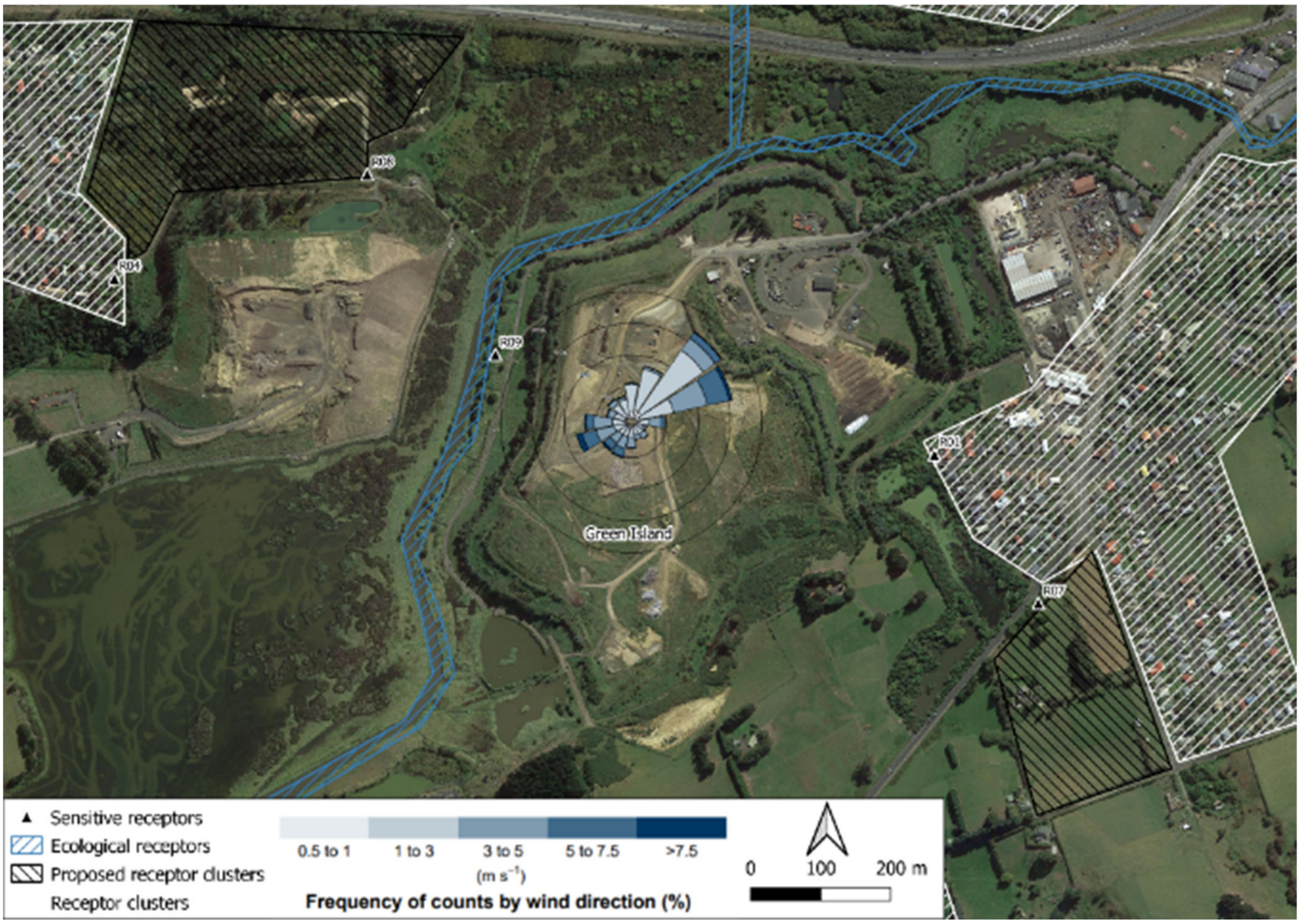


*Figure 5.3 Onsite meteorological station wind data (Feb-Dec 2022) presented as a wind rose*

*Table 5.2 Frequency of low speed winds (<3 m/s)*

| Receptor ID | Worst-case wind direction | % of low speed winds |
|---|---|---|
| R01 | W | 2% |
| R02 | SSW | 2% |
| R03 | SSE | 1% |
| R04 | E | 2% |
| R05 | N | 5% |
| R06 | NNW | 3% |
| R07 | WNW | 2% |
| R08 | SE | 2% |
| R09 | SE | 2% |

Based on the data provided in Table 5.2, it is expected that sensitive receptor cluster R05 will experience light winds coming from the direction of the site for approximately 5% of the year, and the nearest receptor cluster R01 and ecological receptor R09 are expected to receive light winds from the site 2% of the year.

The day/night wind roses in Figure 5.4 show that the frequency of light winds during waking hours (05:00-22:00) is significantly lower (approximately half) than during the night-time as is expected due to solar radiation (convective heating of the air column) during the day period. This is important, as people are more susceptive to experiencing odour effects during these hours (i.e. times when they are working outside and not indoors asleep). The values presented in Table 5.1 are therefore considered to provide a worst-case assessment of those periods of time that people would likely experience odour.

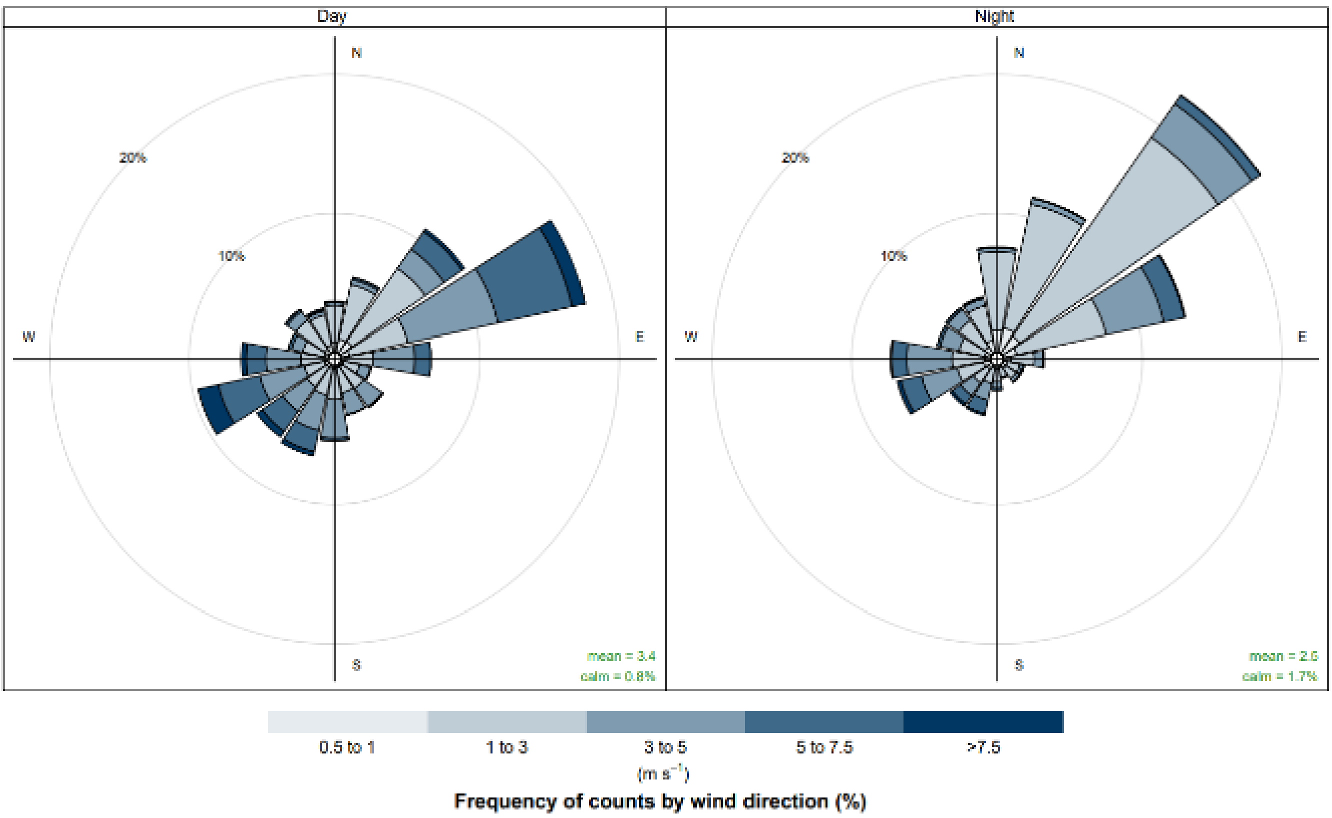


*Figure 5.4 Wind rose of daytime (5am-10pm)/night-time (10pm-5am) hours*

While one of the sensitive receptor clusters is at a location where low winds (<3 m/s) occur for a moderate amount of time, these wind conditions would have to coincide with significant odour being generated by the landfill for adverse effects to occur.

## 5.4.2 Intensity

Odour associated with landfill operations can have a strong intensity and can be considered offensive and objectionable, particularly if an undisclosed malodourous load is deposited or if the LFG collection system is not operating efficiently.

Based on GHD's experience under normal operations, a distinct sweet odour is usually only detected in close proximity to the source and a weak to distinct odour might be detected out to 500 m from the boundary. This is supported when looking at complaint records for other landfills. However, review of the odour complaint history at the existing site indicates the odour intensity is causing impacts at the nearby sensitive receptors. Most of the odour complaints are due to impacts at the nearest residential cluster, Green Island suburb (southeast) (R01), which is approximately 120 m east of the site.

## 5.4.3 Duration

The frequency and intensity factors are dependent on the strength of emissions and meteorological conditions. While this can also be stated for duration (i.e., how long wind conditions are experienced), it is primarily the response time of operation staff to significant odour events which has the greatest impact on the duration of off-site odours.

The duration of odour impacts from the existing facility has been reviewed based on comments provided in the complaint history, as shown in Figure 5.5. Duration of the event was only specified in 20 of the 145 complaints. 13 of the 20 complaints specified an odour duration of 1 day or less and these complaints were mainly attributed to regular operations at the site or unknown sources. Complaints which specified an odour duration of 1 week or more are believed to be related to intermittent odour rather than continuous odour impacts over the whole period, however the complaint history had insufficient detail to confirm this.

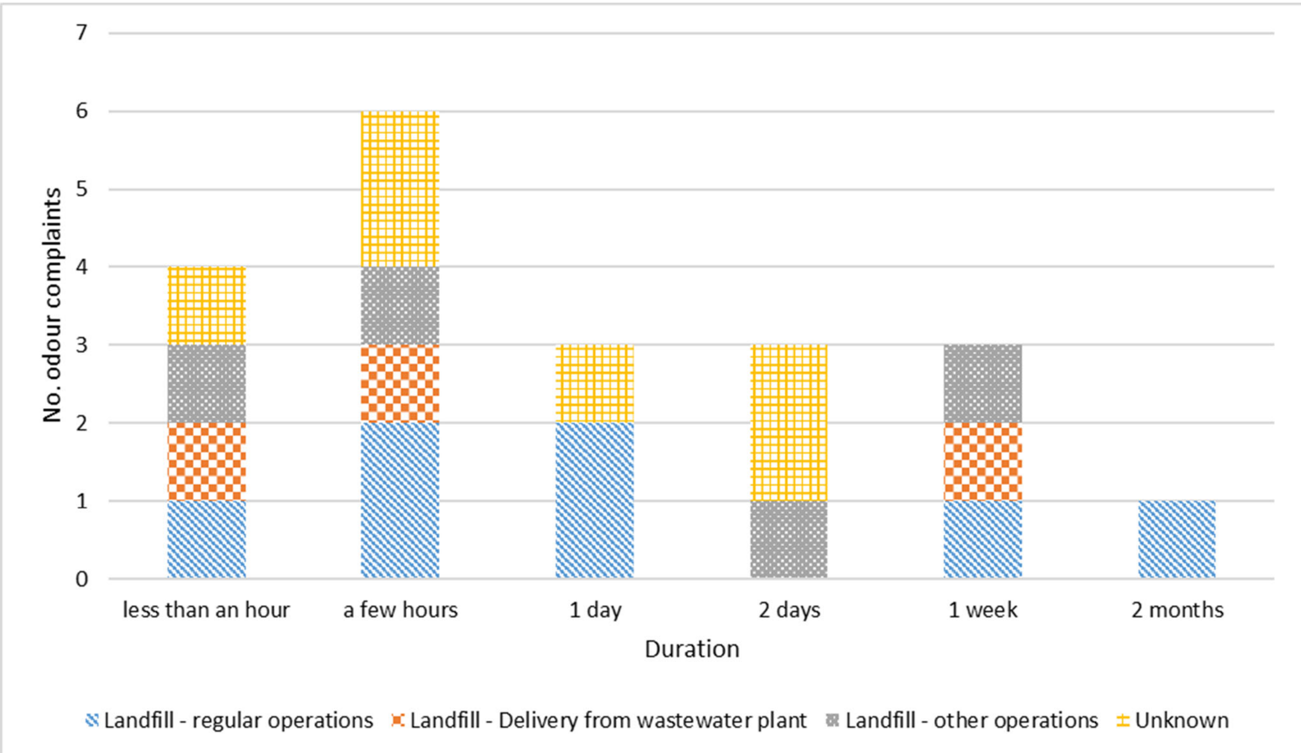


***Figure 5.5 Complaint history – odour duration***

### 5.4.4 Offensiveness

The complaint history from July 2017 to August 2022 was reviewed and based on the comments provided with the complaint, the odour offensiveness at the time of each complaint was categorised as 'offensive', 'strong', or 'identifiable'. Those which did not have enough detail to classify the offensiveness were identified as 'not specified'.

The number of complaints in each category is shown in Figure 5.6.

Seventy seven of the 145 complaints were categorised as 'strong', while only 15 were categorised as 'offensive' and 8 were categorised as 'identifiable'. Forty-five of the complaints were categorised as 'not specified'. This assessment provides an understanding of the variability in the complaints received; however, it is important to recognise that generally any odour impact which leads to a complaint is usually considered 'offensive'.

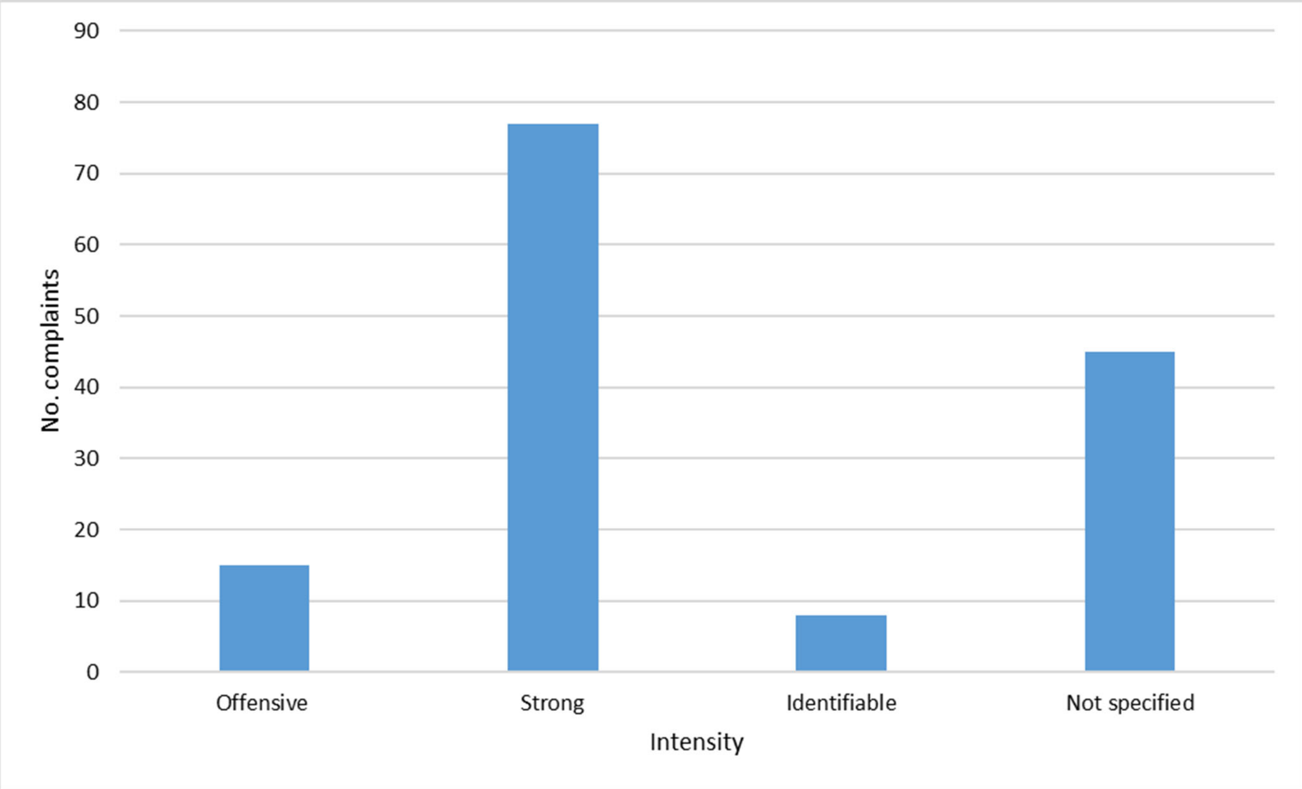


*Figure 5.6 Complaint history – odour offensiveness*

### 5.4.5 Location

To a large extent the location of the source in proximity to sensitive receptors is possibly the most important of the FIDOL factors. With increased distance, odours have more time to disperse and become lower in intensity through dilution or chemical changes in the atmosphere as they travel from source to receptor.

Complaint locations were recorded for 112 of the 145 complaints, with 27 distinct locations. The complaint locations are shown in Figure 5.7 along with a 1 km buffer. The majority of the complaints originated from within 1 km of the site, mostly from east of the site likely due to the proximity of these receptors.


*Figure 5.7 Complaint locations*

### 5.4.6 FIDOL conclusion

In general, undiluted odours associated with landfills (refuse, leachate and LFG) are considered to be offensive in nature when experienced by off-site receptors.

Based on a review of the odour complaint history, it is apparent that odour from the existing operations is leading to impacts at the nearby sensitive receptors. The following summarises the findings of the FIDOL assessment based on this review:

- One of the sensitive receptor clusters (R05) is located in an area where low winds occur a moderate amount of the time.
- The duration of odour impacts ranged from less than an hour to more extended periods, however more than half of the complaints where duration was specified were due to odours which lasted for 1 day or less. Where the specified duration was 1 week or more, this was believed to be due to intermittent odour impacts.
- Generally any odour impact which leads to a complaint is considered offensive, however based on the comments provided with each complaint a range of odour offensiveness was observed
- The most impacted area (based on complainant locations) was the Green Island suburb (southeast) residential cluster likely due to the close proximity of these receptors.

To manage these impacts in the future, a range of mitigation measures (existing and new) are recommended to be implemented (see Section 6.0).

## 5.5 Separation distances

As discussed in section 4.1.2 AC recommend a buffer distance of 1 km for landfills. MfE suggests that separation distances are indicative, not absolute criteria, and may be adjusted having regard to specific site circumstances.

A range of best practice mitigation measures (outlined in the Section 6.0 of this report) to reduce off-site odour have been recommended to reduce impacts at receptors. Implementation of these measures would aid in reducing impacts within the 1 km separation distance.

Review of the complaints register indicates that odour impacts are occurring in spite of the mitigation controls already in place. Further measures are therefore recommended to reduce the chance of nuisance at offsite receptor locations.

In relation to the site, there is currently one receptor cluster (R01), located 120 m from the landfill footprint, this cluster is the source of the majority of odour complaints. The following assessment will provide a more detailed understanding of the future odour potential at R01 and all other identified receptor locations.

# 6. Mitigation measures

## 6.1 Odour mitigation measures

This section of the report presents the odour management measures that will be implemented to minimise offsite odours from the operation of the landfill. It is important to note that even with best practice management measures it is not possible to completely eliminate odours at a landfill or internalise odour within the site boundary. Operational practices at the site will be based on those currently used, and amended where necessary to represent best practice operation standards for landfills in New Zealand.

Site investigations after receipt of complaints identified a number of sources of odour emissions as discussed in Section 5. Where possible, mitigation measures specific to these sources have been identified.

### 6.1.1 Existing mitigation measures

Mitigation measures which are already in place as described in Landfill Operations Plan (LOP) prepared by Waste Management are described here to gain an understanding of how the site is currently operating, and where mitigation measures are effective or ineffective.

The following methods are employed at the site to minimise odour emissions from general operations:

– Implementing and maintaining good housekeeping standards on the site.
– Keeping the size of the working face to a minimum. The *Design Report (GHD 2023)* proposes to keep the active tip face no larger than 900m$^2$ unless special circumstances prevail that necessitate its expansion to 1200m$^2$. In addition, it is proposed to reduce the size to 300m$^2$ during very high or extreme fire days.
– The use of a waste transfer station to minimise the number of vehicles accessing the working face helps to minimise the working face size.
– Covering work areas at the end of each working day and ensuring that no refuse remains exposed overnight.
– Mowing and/or maintaining landfill surfaces that are grassed to allow effective surface emission monitoring.
– Scheduling activities such as extensive excavations into old waste (an activity that is only undertaken under exceptional circumstances) that have increased potential to generate odour to days when wind direction is away from sensitive receptors.
– Note any damage to the cover system and effectiveness of the implemented mitigation measures during weekly walk gas-round monitoring.
– Implementing systems for identifying areas for improvement and recording corrective actions.
– Training landfill operators to identify and recognise activities that have the potential to cause odours to leave the site, and implement measures to minimise the effects.
– Training weighbridge staff to identify potentially odorous or unexpected highly odorous deliveries, and to hold such deliveries until such time as tip face operators have measures in place to place and cover the waste quickly and mitigate emissions that occur.
– Operating and maintaining the existing odour control systems on the site, and implementing improvements as opportunities arise.
– Inspecting and maintaining the landfill gas extraction system to optimise extraction and minimise fugitive surface emissions.
– Repairing any damage to the extraction system promptly.
– Identifying leachate breakouts and working with Council to remediate.
– Maintaining a log of all odour complaints, including; investigations by site management to identify the source, actions taken to minimise odour emissions, and feedback to the complainant.
– Deploying (if required) a trailer mounted odour cannon upwind of the odour source to provide improved distribution and mixing of odour neutralisers towards receptors. The particular conditions under which odour sprays will be used, are as set out in the LOP.

Several complaints were found to be caused by deliveries of highly odorous waste. When highly odorous waste such as biosolids or offal is found to have caused nuisance effects, the following control measures are implemented:

- Working with customers and Council to identify the source of highly odorous waste and identify measures that can be implemented to minimise odour emissions by treatment prior to delivery, during the transport of waste to the landfill, off-loading and placement activities.
- Implementing protocols to forewarn of the arrival of odorous waste (examples include non-stabilised biosolids and offal, and deliveries from the wastewater treatment plants) at the landfill so that proper preparations can be made to mitigate odour emissions once the waste is received at the tip face i.e. to cover as soon as the waste is placed.
- Training weighbridge staff to identify potentially odorous or unexpected highly odorous deliveries, and to hold such deliveries until such time as tip face operators have measures in place to place and cover the waste quickly and mitigate emissions that occur.

In addition to the above mitigation measures, the following measures are believed to have been implemented however are not currently formalised in the Waste Management LOP. It is recommended that these measures are formalised in the LOP. These include:

- Locating the refuse tip head close to the refuse placement area to avoid pushing the refuse a long distance that would otherwise increase the odour potential. As the refuse placement area changes, the tip head will closely follow that placement area.
- Undertaking instantaneous surface monitoring (ISM) on a minimum annual basis to identify any areas of capping that need to be remediated.
- Constructing litter fences around the landfill face area, and placing of odour neutralising misting devices to the top of the litter fences (This is an automated system which is utilised during operating hours as needed and when a westerly wind is blowing).
- When highly odorous waste is found to have caused nuisance effects, the following control measures are implemented:
  - Transportation routes to the landfill are optimised to minimise the amount of time spent on local roads and waiting at intersections.
  - A dedicated disposal area has been developed for biosolids within the active landfill face and this waste is placed directly into a prepared hole and immediately covered.
  - Placement areas are located as far as practicable from the nearest sensitive receptors.
  - A stockpile of suitable cover material is located near to the disposal area to allow the waste to be immediately covered.
  - The bins are completely emptied as far as practicable to minimise the amount of residual material retained in the bin which can cause odour nuisance as the truck leaves the site and travels back to its next pick-up point.

## 6.1.2 Proposed Mitigation Measures

The complaints history indicates that emissions from operation of the landfill are still an issue, therefore additional mitigation measures are described in this section. This includes controlling emissions from odorous waste deliveries, the tip face, landfill gas and leachate management, the sludge pit and upset conditions (such as shutdown of the engine and flare).

### 6.1.2.1 Waste acceptance controls

Odour control begins with careful management of odorous waste receipt and delivery. Activities that are typically utilised to successfully control odour include:

- Placing of refuse in sealed truck and trailer units or bins while transported to site (no open bin trucks).
- Treating of the majority of wastewater biosolids (stabilised with lime) prior to arriving at the site.

In addition to the above proposed mitigation measures, there will be a significant reduction in putrescible content that will enter the landfill once the kerbside food and organic waste collection is implemented (from July 2024). This will likely result in a reduction in odour impacts by reducing odour intensity and offensiveness at the tip face.

#### 6.1.2.2 Organic Receivals Building waste management

The primary purpose of the ORB is to control odour from this activity through containment within a building, the main odours from the newly constructed ORB are odours from green waste and kerbside organic waste. Odour from the green waste and organic waste can be minimised by implementing the following odour mitigation measures:

– Any food waste spillages that occur outside the building whilst organic material is being tipped-off will be cleaned up immediately;
– The doors to the ORB will be closed, and when practicable, only one door will be open at any one time, in between the receival and load-out of waste to avoid cross winds through the facility;
– Any kerbside organic material will be blended with green waste on the same day it is received to reduce odour and then removed off-site; and
– Green waste will remain at the ORB for no more than 72 hours unshredded, or 48 hours if shredded.

This replaces the previous practice of composting green waste (not kerbside organic waste) outside on an area in the open air where there was the potential for odour generation.

#### 6.1.2.3 Landfill gas management

Shutdowns of the flare and engine, and the subsequent LFG emissions, have been identified as the cause of several odour complaints. To minimise these impacts, the following measures are recommended:

– Establishing 24 hour emergency maintenance agreements with equipment manufacturers (particularly for the flare and engine) to limit the impact of equipment failures.
– instantaneous surface monitoring (ISM) on a quarterly basis until closure (increased regularity to existing operations) to identify any areas of capping that need to be remediated.
– monitoring of landfill gas concentrations at perimeter wells every two months.
– Replacing the existing candlestick flare with an enclosed flare to handle the total volume of LFG predicted to be collected in the future, so that ‘shut downs’ at GIWWTP do not lead to interruptions in processing, as per the updated Landfill Gas Masterplan prepared by Tonkin+Taylor (2023).
– Monthly walk-over inspection of the landfill cap/cover to identify any damage to the cover system and to monitor the effectiveness of the mitigation measures

#### 6.1.2.4 Leachate management

The Green Island landfill has been progressively developed since the 1950s and does not include a base liner. In the early years of operation the landfill did not have an engineered approach to managing leachate. However, in the mid-1990’s a leachate collection system was installed. Leachate management is achieved through a leachate interception trench along the full estuary boundary (excluding the southern section adjacent to the rising ground to the east and around PS9).

Perched leachate water tables have developed occasionally since 1994 and have been managed by construction of gravel drains on the face of the bund to direct the leachate to the perimeter leachate trench. Given that leachate is collected underground and conveyed directly to the GIWWTP for treatment the potential for odour discharges from this source is low. Consequently, no additional odour management measures are necessary.

#### 6.1.2.5 Highly odorous waste disposal control procedures

Disposing of highly odorous waste such as biosolids or offal has the greatest potential to cause odour nuisance. If this type of waste is being found to cause odour nuisance effects, the following control measures could be implemented:

– Deliveries are arranged so that trucks are not waiting outside the gate prior to the landfill opening for the day.

- Transport to the landfill shall be arranged so that deliveries arrive between the hours of 10 am and 4 pm, as this time of day generally provides better odour dispersion conditions. Waste originating from Council contracts shall stipulate this condition.
- Deliveries of highly odorous waste shall be prioritised and allowed to be taken directly to the tip-head.
- If practicable, the bins shall be washed out to remove residue after emptying to minimise odour nuisance as the truck leaves the site and travels back to its next pick-up point.
- Whilst receiving highly odorous waste, during low wind speed conditions (winds less than 3 m/s) an odour cannon shall be setup and operated downwind of the disposal area.
- Investigation of odour complaints shall be undertaken to determine the contributing factors and identification of improvements to odour control procedures. Where delivery of a particular odorous material remains a consistent driver of complaints despite full employment of the recommended mitigation measures, further investigation should be carried out, including re-assessment of the suitability of receiving this waste at the landfill in the future.

#### 6.1.2.6 Irregular activities

For irregular activities with high potential to lead to off-site impacts, including digging through old waste (e.g. construction of new asbestos cells and planned leachate trench construction – as described in the *Green Island Landfill Closure – Design Report (GHD 2023)*, then the following mitigation would apply:

- An activity specific management plan should be developed which considers the specific construction plan.
- Minimise open areas.
- Have suitable material to cover excavation if significant odour is observed that could cause complaints.
- Use of the odour cannon to minimise odour nuisance while excavating old waste.
- Regular odour scouting.

## 6.2 Dust mitigation measures

Adverse effects of dust depend on the size of the particles emitted, while the below mitigation measures are targeted at nuisance dust, they will also assist managing emissions of smaller size fractions, such as $PM_{10}$ and $PM_{2.5}$ which have the potential to cause adverse health effects.

The following mitigation measures will be implemented at all times on site to minimise the potential for off-site dust emissions, as far as practicable.

The site access road is sealed as far as the wheel wash. Other measures in order to minimise dust emissions from the landfill include:

- A maximum speed limit of 30 km/hr will apply in all areas of the site.
- Permanent roads on the site and used as part of the day-to-day operations should be sealed and well maintained.
- Water-carts will be used on both sealed and unsealed roads as required during dry periods. Generally visual observation is used to judge the need for water carts.
- Temporary roads on the landfill will be properly maintained and graded.
- Dust generating waste will be treated as a special waste. The customer will be required to dampen down the load prior to delivery to site, and special controls will be implemented at the disposal point, (e.g. water sprays, waste pit, etc.).

# 7. Assessment of effects on the environment

## 7.1 Odour assessment

### 7.1.1 FIDOL assessment

For each source of odour identified based on the complaint history, the mitigation measures which will aid in reducing emissions and impacts are specified in Table 7.1. The FIDOL parameter by which the impact will be reduced has also been specified (i.e. reduced frequency or intensity, shorter duration, etc.).

The frequency of low winds for the proposed extension of the site is unchanged compared with the existing operations. Therefore, as per Section 5.4.1, while two of the sensitive receptors are at locations where low winds (<3 m/s) occur a moderate amount of time, these wind conditions would have to coincide with significant odour being generated by the landfill for adverse effects to occur.

*Table 7.1 Source-specific mitigation measures*

| Source | Existing mitigation | Additional mitigation measures | FIDOL parameter |
|---|---|---|---|
| Flare and engine<br>Landfill gas | – As part of weekly gas monitoring program identify any damage to the cover system and to monitor the effectiveness of the mitigation measures employed.<br>– Mowing and/or maintaining landfill surfaces that are grassed to allow effective surface emission monitoring.<br>– Undertaking instantaneous surface monitoring (ISM) on (at minimum) an annual basis to identify any areas of capping that need to be remediated. | – Establishing 24 hour emergency maintenance agreements with equipment manufacturers (particularly for the flare and engine) to limit the impact of equipment failures.<br>– Continuing instantaneous surface monitoring (ISM) on a monthly basis until closure (increased regularity to existing operations) to identify any areas of capping that need to be remediated.<br>– Monitoring of landfill gas concentrations at perimeter wells on a bi-monthly basis.<br>– Replacing the existing candlestick flare with an enclosed flare to handle the total volume of LFG predicted to be collected in the future, so that 'shut downs' at GIWWTP do not lead to interruptions in processing.<br>– Monthly walk over of entire cap/cover area to monitor the effectiveness of the mitigation measures employed | Duration, Frequency, Intensity |
| Odorous deliveries, including<br>deliveries from wastewater treatment plants. | – A stockpile of suitable cover material shall be located near to the disposal area to allow the waste to be immediately covered.<br>– The bins shall be completely emptied as far as practicable to minimise the amount of residual material retained in the bin which can cause odour nuisance as the truck leaves the site and travels back to its next pick-up point.<br>– A dedicated temporary disposal area shall be developed for biosolids within the active landfill face and this waste shall be placed directly into a prepared hole and immediately covered.<br>– Transportation routes to the landfill can be optimised to minimise the amount | – Refuse will be placed in sealed truck and trailer units or bins while transported to site (no open bin trucks). | Intensity |
| | | – Deliveries of highly odorous waste shall be prioritised and allowed to proceed directly to the tip-head. | Duration, Frequency |
| | | – Majority of wastewater biosolids will be treated (stabilised with lime) prior to arriving at the site.<br>– Investigation of odour complaints shall be undertaken to determine the contributing factors and identification of improvements to odour control procedures.<br>– Where delivery of a particular odorous material remains a consistent driver of complaints despite full employment of | Offensiveness |

| Source | Existing mitigation | Additional mitigation measures | FIDOL parameter |
|---|---|---|---|
| | of time spent on local roads and waiting at intersections.<br>– Placement areas shall be located as far as practicable from the nearest sensitive receptors.<br>– Implementing protocols to forewarn of the arrival of odorous waste (examples include non-stabilised biosolids and offal, and deliveries from the wastewater treatment plants) at the landfill so that proper preparations can be made to mitigate odour emissions once the waste is received at the tip face i.e. to cover as soon as the waste is placed.<br>– Training weighbridge staff to identify potentially odorous or unexpected highly odorous deliveries, and to hold such deliveries until such time as tip face operators have measures in place to place and cover the waste quickly and mitigate emissions that occur. | the recommended mitigation measures, further investigation should be carried out, including re-assessment of the suitability of receiving this waste at the landfill into the future. | |
| Sludge pit | | – Nearly all wastewater biosolids will be treated (stabilised with lime) prior to arriving at the site. | Offensiveness |
| Tip face | – Keeping the size of the working face to a minimum.<br>– The refuse tip head will be located close to the refuse placement area to avoid pushing the refuse a long distance that would otherwise increase the odour potential. As the refuse placement area changes, the tip head will closely follow that placement area.<br>– Works areas shall be covered at the end of each working day and no refuse shall remain exposed overnight. | – Based on the proposed site layout (shown in **Error! Reference source not found.**), the active tip face will be located further away from the nearest receptors (R01). | Location |
| | | – Significantly reduced putrescible content (from July 2024).<br>– Tip face size will be limited to a width of 30 m | Intensity, offensiveness |
| Irregular activities | | – An activity specific management plan should be developed which considers the specific construction plan;<br>– Minimise open areas;<br>– Have suitable material to cover excavation if significant odour is observed that could cause complaints;<br>– Use of the odour cannon to minimise odour nuisance while excavating old waste; and<br>– Regular odour scouting. | Intensity, duration, offensiveness |
| Unfavourable meteorological conditions | – Scheduling activities such as extensive excavations into old waste (an activity that is only undertaken under exceptional circumstances) that have increased potential to generate odour to days when wind direction is away from sensitive receptors. | – Transport to the landfill shall be arranged so that deliveries arrive between the hours of 10 am and 4 pm, as this time of day generally provide better odour dispersion conditions.<br>– During low wind speed conditions (winds less than 3 m/s) an odour cannon shall be setup and operated downwind of the disposal area. | Intensity |

| Source | Existing mitigation | Additional mitigation measures | FIDOL parameter |
|---|---|---|---|
| General odour emission sources | – Implementing and maintaining good housekeeping standards on the site.<br>– If required the supply of a trailer mounted odour cannon can be deployed upwind of the odour source to provide improved distribution and mixing of odour neutralisers towards receptors. The particular conditions under which odour sprays will be used, will be set out in the Landfill Operations Plan (LOP).<br>– Implementing systems for identifying areas for improvement and recording corrective actions.<br>– Maintaining a log of all odour complaints, including investigations by Site Management to identify the source, actions taken to minimise odour emissions, and feedback to the complainant. | – Deliveries to be arranged so that trucks are not waiting outside the gate prior to the landfill opening for the day. | Duration |

### 7.1.2 FIDOL assessment for Organic Receival Building

**Frequency**

Based on the data provided in Table 7.2, it is expected that sensitive receptor cluster R05 will experience light winds coming from the direction of the ORB for approximately 8% of the year, and the nearest receptor cluster R01 and ecological receptor R09 are expected to receive light winds from the direction of the site, 3% and 6% of the year, respectively.

R05 and R09 sensitive receptor clusters are at locations where low winds (<3 m/s) occur for a moderate amount of time, and these wind conditions would have to coincide with significant odour being generated by the ORB for adverse effects to occur. The remaining receptor clusters are predicted to be downwind of the ORB during low winds at a lower frequency.

*Table 7.2 Frequency of low winds (< 3 m/s) which will place receptor downwind of the ORB*

| Receptor ID | Worst-case wind direction | % of low speed winds |
|---|---|---|
| R01 | NW | 3% |
| R02 | SSW | 2% |
| R03 | SSE | 1% |
| R04 | E | 2% |
| R05 | NNE | 8% |
| R06 | NNW | 3% |
| R07 | NW | 3% |
| R08 | SE | 2% |
| R09 | ENE | 6% |

**Intensity and Offensiveness**

The amount of odour that could be associated with the ORB is dependent on the content of the raw materials received and the control of the waste receival process. The ORB only consolidates, shreds and blends green waste and organic waste. The kerbside organic waste (which includes small quantities of meat, fish, and dairy) can be more odorous than green waste. It is understood that:

- the consolidating and shredding of accepted waste are undertaken within the enclosed ORB which is not mechanically ventilated;
- organic waste is to be blended with green waste on the same day it is received and taken offsite; and
- green waste is to be taken offsite within 48 hours if shredded, or within 72 hours if unshredded.

Based on the above, odour from the green waste and organic waste received at the ORB is largely contained within the ORB. Moreover, organic waste is blended with green waste on the same day it is received, therefore reducing its odour potential, and taken offsite for composting which will reduce the intensity of the odour from the ORB. Given the short duration of time waste will be present at the ORB, the odours from the ORB are unlikely to have a high intensity at offsite locations.

**Duration**

It is understood that green waste and organic waste are accepted on a daily basis at the ORB. Consolidation, shredding and blending of waste at the ORB are undertaken within the enclosed ORB in which odour is largely contained within the ORB. Therefore, the odour emissions from the ORB are likely to occur intermittently when the odorous loads are being transported in and out of the ORB.

Additionally, the ORB typically operates Monday to Friday, and occasionally on Saturdays due to public holidays. In the evening the doors are closed. Therefore, the duration of any odour event is typically limited to between normal working hours.

**Location**

As shown in the frequency assessment, R05 and R09 sensitive receptor clusters are more likely to be downwind of the ORB than other identified receptors and experience odour from the ORB. These receptors are approximately 300 m and 1 km, respectively, from the ORB. The nearest receptor cluster to the Green Island Landfill site is R01 which is located at least 370 m from the ORB.

Based on GHD's experience with odours from this type of activity, while the receival of organics has the potential to generate moderate to strong odours within the building, once blended with green waste the odour intensity is greatly reduced, with significant odour unlikely to be detected beyond a few metres from the building. Consequently, it is unlikely that offensive or objectionable odours would be detected more than 50 m from the ORB.

Based on the above, given the nearest sensitive receptors are at least 300 m from the ORB and the limited odour potential from this activity, it is unlikely that odours from the ORB will be experienced at these off-site locations, let alone odours that could cause nuisance effects.

**FIDOL conclusion for ORB**

In conclusion, odours associated with the ORB are unlikely to be experienced at off-site locations at a frequency, intensity and duration that will result in nuisance effects.

### 7.1.3 Environmental effects assessment of odour

As per the FIDOL assessment of the existing operations, emissions of odour from activities at the landfill are known to have caused impacts in the surrounding areas leading to complaints. Investigation into the odour complaint history identified seven main sources of emissions: odorous deliveries, landfill gas, the flare and engine, the tip face, turning of the compost, impacts of rain, and the sludge pit. To effectively reduce future emissions, mitigation measures targeted to each of the identified odour sources have been recommended.

A range of additional measures will be used at the landfill to reduce odour, with the most important measures being:

- Preparation for odorous waste deliveries including forewarning of deliveries, pre-treatment of biosolids, and minimising exposure time.
- Minimising interruptions to the landfill gas flare by reducing wait times for maintenance equipment and installing an additional flare.

Continued planning and preparation of the site and operations is expected to maintain the low intensity of odour impacts from general operations, for example maintaining good housekeeping standards onsite, having cover available in case of unexpected odorous deliveries, and minimising activities where possible on days with unfavourable meteorological conditions.

Duration of impacts has generally been reduced by implementation of procedures which will identify odour sources as soon as possible, and therefore apply mitigation measures such as cover to minimise emissions. For odorous deliveries including those from wastewater treatment plants, planning for receival will also reduce the duration of emissions as processing of the odorous waste can be prioritised over less odorous waste. Several complaints were attributed to interruptions in operation of the flare and engine. Establishing maintenance agreements and providing an additional flare as a backup will therefore minimise the duration of the interruptions, which will reduce the duration of impacts.

Offensiveness of impacts from odorous deliveries is mitigated by identifying when the existing mitigation measures are not expected to sufficiently minimise odour emissions, and requiring the load to be treated prior to delivery (for example by requiring the wastewater biosolids to be stabilised with lime). Where offensive emissions are unavoidable, implementing an odour cannon upwind of the odour source to minimise impacts at receptors will aid in minimising impacts.

The volume of putrescible waste entering the landfill will also be reduced from July 2024 when kerbside food and organic waste collection commenced. This material collected at the kerbside together with garden greenwaste previously composted is consolidated in a newly constructed Organic Receival Building (ORB) and transported off-site. The existing garden greenwaste composting operation has ceased. This will reduce offensiveness of the waste received and processed on the site. Ultimately it is intended that a new composting operation for organic waste is established on the site as part of the wider RRPP development, replacing the transport and composting of material off site. The Council has separately applied for consents which authorise the development of the proposed RRPP, including onsite composting.

The Green Island (southeast) residential area, particularly Clariton Ave, is expected to be the most likely receptor cluster to encounter odour due to the proximity to the site and the odour complaint history. A range of contingency measures have been recommended should odour be observed in this area, including minimising truck waiting times outside the site, operation of an odour cannon during low wind speed conditions. In addition, the location of the active tip face will progress further west than previously and will therefore be further from this receptor cluster.

The potential for cumulative effects considering odours from both the landfill and the ORB are expected to be negligible. Based on the mitigation measures proposed for the ORB and the location of the activity relative to receptors (>300 m) it is unlikely that odours from the ORB will be experienced at these locations, let alone result in cumulative effects.

Overall, GHD considers that based on the implementation of the proposed mitigation measures, odour discharges will reduce in terms of both intensity, frequency and duration.

While odours may still be detectable on occasions at or near the site boundary, providing the proposed mitigation measures are rigorously implemented, the likelihood of off-site odours being considered offensive and objectionable is low. Consequently, odour discharges are unlikely to cause more than a minor effect.

## 7.2 Dust assessment

### 7.2.1 FIDOL assessment

A qualitative assessment of the potential effects associated with the proposed activities is required to determine the potential for the activities to generate nuisance dust that might affect the neighbouring community. This is undertaken in accordance with GPG Dust using the FIDOL assessment tool. A summary of the FIDOL assessment is presented in Table 7.3. Further discussion regarding specific factors during operation of the site is discussed in section 7.2.2.

*Table 7.3 Dust FIDOL factors*

| FIDOL | |
|---|---|
| **F**requency | Typically nuisance dust requires winds greater than 5 m/s for it to travel more than 300 m from the source.<br>Based on Table 5.1 winds greater than 5 m/s are only expected 14% of the year from all directions, with the majority of these from ENE and WSW. The likelihood therefore of the nearest sensitive receptors being downwind of the site during periods of high wind speeds for significant periods of time is considered to be low. |
| **I**ntensity | Based on experience at other landfills and the current site operations, there is the potential for dust concentrations to be high. However, assuming the range of recommended mitigation measures are implemented, off-site dust concentrations are expected to continue to be low. |
| **D**uration | Dust events correlating with dust issues are exacerbated under dry, windy conditions – this is discussed further in Section 7.2.2.<br>The duration of dust effects is dependent on mitigation measures not being implemented and the wind conditions at the time of the dust event.<br>Assuming on-site mitigation is implemented, off-site dust effects are typically expected to be of short duration as the time taken to implement mitigation measures is a short duration (< 1 hour). |
| **O**ffensiveness | Dust can lead to amenity issues such as visual amenity (dust clouds) and dust deposition on property, including vehicles, washing lines and rooftops. While these events can lead to nuisance over extended and frequent exposure, the nature of a standalone event is not considered highly offensive.<br>Given the existing mitigation measures in place to minimise dust effects (such as on-site vehicle speed limits and the use of water carts), it is expected that the offensive nature of the dust will continue to be low. |
| **L**ocation | The predominant land use around the site is residential which generally has high sensitivity to dust impacts. The nearest receptors are located in the Green Island (southeast) cluster (R01). Based on impacts at this location from existing operations, future concentrations are expected to continue to be low. Proposed residential developments near the site (R09 and R10) are further from the site boundary than R01, therefore significant impacts are not expected in these areas. |

### 7.2.2 Environmental effects assessment of dust

The greatest potential for nuisance dust to occur from the operation of the landfill is from the acceptance of dusty waste and vehicle movements on unpaved roads, particularly the perimeter road which circuits the landfill.

Based on the information provided in Table 5.1, winds blowing towards sensitive receptors with a speed >5 m/s are expected to occur at most 2% of the time (westerly winds towards R01). MfE states that nuisance dust effects are generally only experienced within 300 m of unmitigated dust sources. Assuming that the strict onsite protocols for containing dust are followed, dust may travel up to 100 m from the source. As the nearest receptor (where sensitivity to dust is increased) is greater than 100 m from the landfill, it is not expected that there will be any significant dust deposited at these locations.

Based on the operational activities of the landfill, impacts from the existing site, and considering the FIDOL factors, it is unlikely that operational dust emissions will cause any adverse effects beyond the site boundary.

Lastly, GHD is not aware of any historic complaints in relation to dust, further suggesting that fugitive dust discharges are unlikely to cause adverse effects on the surrounding community.

# 7.3 Landfill gas combustion assessment

## 7.3.1 Emissions inventory

### 7.3.1.1 Landfill gas modelling

In order to develop an understanding of the potential magnitude of LFG emissions from the site over time, the Landfill Gas Masterplan completed by Tonkin+Taylor (2021) has been reviewed[3]. The final year of waste placement used in this assessment is 2026. While this is not consistent with the end date for the current assessment, use of the data is expected to be suitable for the purposes of estimating peak LFG production and therefore destruction rates. It is also noted that the LFG data is collected and summarised in the Green Island Landfill Annual Monitoring Reports, as discussed in Section 5.1. A copy of the latest version is appended to the Design Report (GHD 2023).

The estimated LFG emission rates at approximately 50%v/v methane for the model are shown in Figure 7.1. Results of previous modelling as part of the UEF applications for the site are also shown in this figure. These results were generated using the input parameters required by the UEF Regulations, which may not be representative of actual conditions at the site. Operational model results, which were generated based on the onsite conditions, are therefore considered more reflective of actual site conditions.

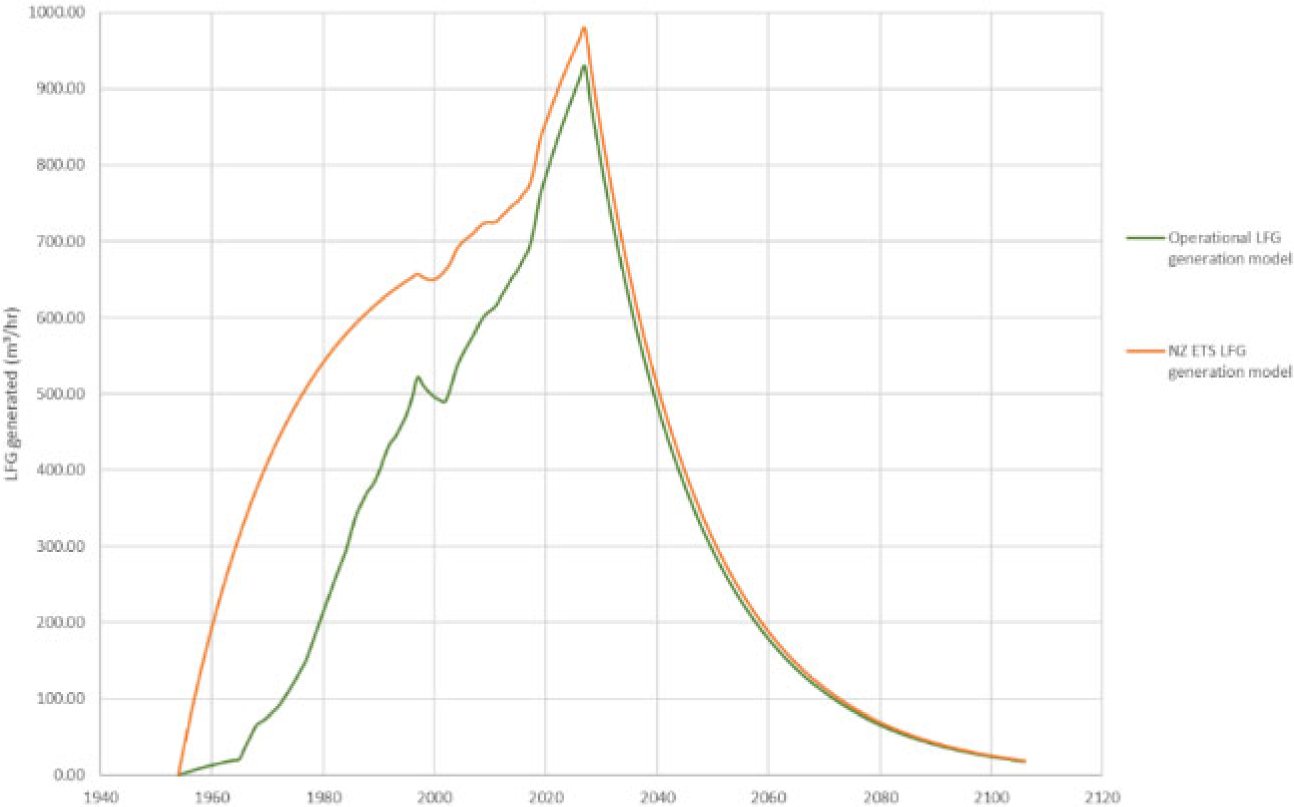


*Figure 7.1 LFG generation curves for Green Island Landfill (Tonkin+Taylor, 2021)*

Figure 7.1 shows the following:

– The total LFG emission rate at the site will peak in 2027 at 930 $m^3$/LFG/h and will steadily decrease every year post 2030.

[3] Note the T+T Masterplan has now been updated (2023). However, the values in the 2021 plan are higher and have been conservatively used in this assessment.

– The maximum LFG collection rate at the site will peak in 2027 at 745 $m^3$/LFG/h based on an assumed collection rate of 80% (Tonkin+Taylor, 2021).

The pattern, peak and fall of LFG production would be similar for an extended landfill life, however the peak would occur some years after that shown in the figure. Based on the magnitude and longevity of the estimated emission rates, it is considered that active LFG management using flares and/or engines will likely be required at the site for many decades to appropriately manage the LFG emitted.

#### 7.3.1.2 Emissions from the landfill gas flare and engine

LFG will be managed through the use of an engine and either existing candlestick flare or larger enclosed flare from 2024 onwards. The combustion of LFG in the engine and flares will generate a variety of air discharges. The principal air pollutants include $NO_X$, CO, $SO_2$, $PM_{10}$ and $PM_{2.5}$ and small amounts of volatile organic compounds (VOCs).

The capacities of the existing flare and engine are 450 $m^3$/hr and 350 $m^3$/hr respectively, providing an overall LFG processing rate of 800 $m^3$/hr, which is greater than the maximum estimated LFG collection rate of 745 $m^3$/hr. A replacement enclosed flare will be installed which will further increase the capacity of the system. Emissions have been estimated for one flare and the engine operating at capacity (a total processing rate of 800 $m^3$/hr) for all hours of the day. This provides a conservative assessment for the maximum estimated LFG collection rate.

Emissions of $NO_X$, CO and particulate matter have been calculated using USEPA AP-42 emission factors, specifically Chapter 2.4, Municipal Solid Waste Landfills (draft, October 2008) (AP42).

For the purposes of this assessment $PM_{10}$ and $PM_{2.5}$ emissions were conservatively assumed to comprise 100% of the total particulate emission.

$NO_2$ emissions have been conservatively assumed to comprise 100% of the $NO_X$ emission.

$SO_2$ emissions have been based on a mass balance approach in accordance with the guidance contained in AP42. This assumes that 100% of the sulphur in the LFG is converted to $SO_2$ as it is combusted in the flare.

$H_2S$ is the main source of sulphur with other reduced sulphides typically found at trace levels. The trace amounts of reduced sulphur compounds are negligible when compared to the concentration of $H_2S$ in LFG and therefore contributions from these compounds have been assumed to be zero.

The concentration of $H_2S$ varies greatly depending on the type of waste accepted, with higher concentrations associated with landfills that accept large amounts of gypsum, industrial waste and biosolids from municipal wastewater treatment plants. The concentration of $H_2S$ in the gas at Green Island is typically between 400 and 500 ppm, which is consistent with other landfills around New Zealand.

For this assessment $SO_2$ emissions have been based on the maximum $H_2S$ concentration measured at Green Island of 500 ppm (761 mg/$m^3$). Based on a $SO_2$ concentration of 1,429 mg/$m^3$ (761 mg/$m^3$ x 1.88 (molecular weight conversion from $H_2S$ to $SO_2$)), and a maximum LFG flow rate of 450 $m^3$/LFG/h for the flare and 350 $m^3$/LFG/h for the engine, the emission rates of $SO_2$ have been estimated to be 0.6 kg/h and 0.5 kg/h respectively.

Calculated emission rates from the flare and engine are presented in Table 7.4.

No testing of the destruction efficiency of either the engine or the flare has been carried out. Therefore, under UEF Regulations, default destruction efficiencies of 90% and 50% are assumed for the engine and flare respectively.

Given the relatively low VOC discharge rate combined with the distance to the nearest sensitive receptors the potential for effects from these compounds is considered to be negligible and therefore atmospheric dispersion modelling of these compounds is not considered necessary.

The flare is 6 m tall and 0.3 m in diameter, located at the WWTP as shown in Figure 3.1. The engine stack is 5 m tall and 0.3 m in diameter, located adjacent to the flare. The replacement flare will be designed and built to achieve a destruction efficiency of 99% for UEF purposes.

Note the landfill is a potential source of LFG to the atmosphere. However, this will be controlled by:

– Installation of daily and intermediate cover material.
– Permanent capping of the landfill and installation of permanent LFG wells as soon as practicable.

– Installation of intermediate horizontal and vertical LFG wells as the landfill is developed and prior to permanent capping to capture LFG.

*Table 7.4 Flare and engine emissions*

| Pollutant | Typical rate kg/$10^6$ dscm $CH_4$ | Typical rate kg/$10^6$ dscm of landfill gas | Emission rate (kg/hr) |
|---|---|---|---|
| **Flare** | | | |
| Nitrogen dioxide | 631 | 315.5 | 0.14 |
| Carbon monoxide | 737 | 368.5 | 0.17 |
| $PM_{10}$ | 238 | 119 | 0.05 |
| $PM_{2.5}$ | 238 | 119 | 0.05 |
| Sulphur dioxide | - | - | 0.64 |
| **Engine** | | | |
| Nitrogen dioxide | 11620 | 5810 | 2.03 |
| Carbon monoxide | 8462 | 4231 | 1.48 |
| $PM_{10}$ | 232 | 116 | 0.04 |
| $PM_{2.5}$ | 232 | 116 | 0.04 |
| Sulphur dioxide | - | - | 0.50 |

### 7.3.2 AERMOD model settings

The AERMET data described in section 2.4.3 has been incorporated into the atmospheric dispersion modelling assessment to determine the potential effects associated with the operation of the flares.

Ground-level air concentrations were predicted over a Cartesian receptor grid covering an 2 km by 2 km domain which was centred on the project site. The resolution of the modelling grid was 100 m. Four onsite buildings were included in the model using the Building Profile Input Program (BPIP) to take into account building wake effects.

The emission data input into the model is presented in Table 7.5.

*Table 7.5 Modelled emission data*

| Parameter | Flare | Engine stack |
|---|---|---|
| Source Coordinates (x) | 409716 | 409719 |
| Source Coordinates (y) | 794300 | 794291 |
| Elevation AMSL (m) | 4 | 4 |
| Stack/Flare Diameter (m) | 0.3 | 0.3 |
| Stack/Flare Height (m) | 6 | 5 |
| Exit Gas Temperature (°C) | 700 | 500 |
| Gas Exit Velocity (m/s) | 10 | 10 |
| Pollutant Emission Rates | Refer to Table 7.4 | Refer to Table 7.4 |

### 7.3.3 Environmental effects assessment of landfill gas combustion

This section of the report presents the results of the assessment to determine the effects associated with emissions from the flare.

#### 7.3.3.1 Nitrogen dioxide

The predicted 99.9%ile 1-hour and 24-hour average $NO_2$ concentrations are presented in Table 7.6. A graphical presentation of the 1-hour 99.9%ile $NO_2$ concentrations associated with the flare are presented in Figure 7.2.

Predicted 1 and 24-hour average $NO_2$ concentrations, including background, are predicted to be well below the relevant health-effect based assessment criteria at all off-site locations. The potential for adverse health effects associated with $NO_2$ emissions is expected to be very low. The maximum off-site annual average $NO_2$ concentration, including background, was 19 µg/m³ which is less than the ecological guideline of 30 µg/m³. Consequently, there is limited potential for adverse effects on the environment.

*Table 7.6 Predicted ground-level concentrations of $NO_2$*

| Receptor ID | 1-hour 99.9%ile $NO_2$ concentration (µg/m³) | | 24-hour 99.9%ile $NO_2$ concentration (µg/m³) | |
|---|---|---|---|---|
| | Site contribution | Site contribution + background | Site contribution | Site contribution + background |
| *Assessment criteria* | *200* | | *100* | |
| Maximum offsite | 102 | 167 | 29.0 | 72 |
| R01 | 20 | 85 | 4.6 | 47.6 |
| R02 | 19 | 84 | 3.1 | 46.1 |
| R03 | 16 | 81 | 2.5 | 45.5 |
| R04 | 30 | 95 | 2.9 | 45.9 |
| R05 | 91 | 156 | 11 | 54.0 |
| R06 | 22 | 87 | 3.1 | 46.1 |
| R07 | 20 | 85 | 4.0 | 47.0 |
| R08 | 23 | 88 | 2.8 | 45.8 |
| R09 | 26 | 91 | 5.9 | 48.9 |


*Figure 7.2 1 hour 99.9th percentile $NO_2$ concentration contours ($\mu g/m^3$) (site contribution only)*

### 7.3.3.2 Carbon monoxide

The predicted 1-hour and 8-hour average CO concentrations are presented in Table 7.7. Predicted 1 and 8-hour average CO concentrations, including background, are predicted to be well below the relevant health-effect based assessment criteria at all off-site locations. The potential for adverse health effects associated with CO emissions is expected to be low.

*Table 7.7 Predicted ground-level concentrations of CO*

| Receptor ID | 1-hour 99.9%ile CO concentration ($\mu g/m^3$) | | 8-hour 99.9%ile CO concentration ($\mu g/m^3$) | |
|---|---|---|---|---|
| | Site contribution | Site contribution + background | Site contribution | Site contribution + background |
| *Assessment criteria* | *30,000* | | *10,000* | |
| Maximum offsite | 76.9 | 5,080 | 22.8 | 3,020 |
| R01 | 15.1 | 5,020 | 6.83 | 3,010 |
| R02 | 14.1 | 5,010 | 5.19 | 3,010 |
| R03 | 11.8 | 5,010 | 3.95 | 3,005 |
| R04 | 22.6 | 5,020 | 5.30 | 3,010 |
| R05 | 68.5 | 5,070 | 17.4 | 3,020 |
| R06 | 16.5 | 5,020 | 4.56 | 3,010 |

| Receptor ID | 1-hour 99.9%ile CO concentration (μg/m$^3$) | | 8-hour 99.9%ile CO concentration (μg/m$^3$) | |
|---|---|---|---|---|
| | Site contribution | Site contribution + background | Site contribution | Site contribution + background |
| R07 | 14.7 | 5,020 | 6.22 | 3,010 |
| R08 | 17.4 | 5,020 | 5.00 | 3,010 |
| R09 | 19.6 | 5,020 | 8.41 | 3,010 |

#### 7.3.3.3 Particulate matter ($PM_{10}$)

The predicted 24-hour and annual average $PM_{10}$ concentrations are presented in Table 7.8. Predicted 24-hour and annual average $PM_{10}$ concentrations, including background, are predicted to be well below the relevant health-effect based assessment criteria at all off-site locations. The potential for adverse health effects associated with $PM_{10}$ emissions is expected to be low.

*Table 7.8 Predicted ground-level concentrations of $PM_{10}$*

| Receptor ID | Maximum 24-hour $PM_{10}$ concentration (μg/m$^3$) | | Annual average $PM_{10}$ concentration (μg/m$^3$) | |
|---|---|---|---|---|
| | Site contribution | Site contribution + background | Site contribution | Site contribution + background |
| *Assessment criteria* | *50* | | *20* | |
| Maximum offsite | 1.7 | 33 | 0.11 | 12 |
| R01 | 0.22 | 32 | 0.045 | 12 |
| R02 | 0.14 | 32 | 0.024 | 12 |
| R03 | 0.14 | 32 | 0.017 | 12 |
| R04 | 0.15 | 32 | 0.018 | 12 |
| R05 | 0.70 | 32 | 0.058 | 12 |
| R06 | 0.16 | 32 | 0.014 | 12 |
| R07 | 0.20 | 32 | 0.029 | 12 |
| R08 | 0.14 | 32 | 0.019 | 12 |
| R09 | 0.26 | 32 | 0.031 | 12 |

As the site is located within a polluted airshed, $PM_{10}$ impacts must comply with Regulation 17 of the NESAQ, as described in Section 4.3.4. This requires that site discharges must not '*increase the concentration of $PM_{10}$ (calculated as a 24-hour mean under Schedule 1) by more than 2.5 μg/m$^3$ in any part of a polluted airshed other than the site on which the consent would be exercised*'.

Figure 7.3 presents the maximum 24-hour average 2.5 μg/m$^3$ $PM_{10}$ contour line from the modelled site operations. The blue line indicates the site boundary. It can be seen that $PM_{10}$ concentrations outside of the site boundary are below 2.5 μg/m$^3$ and therefore the site complies with Regulation 17.

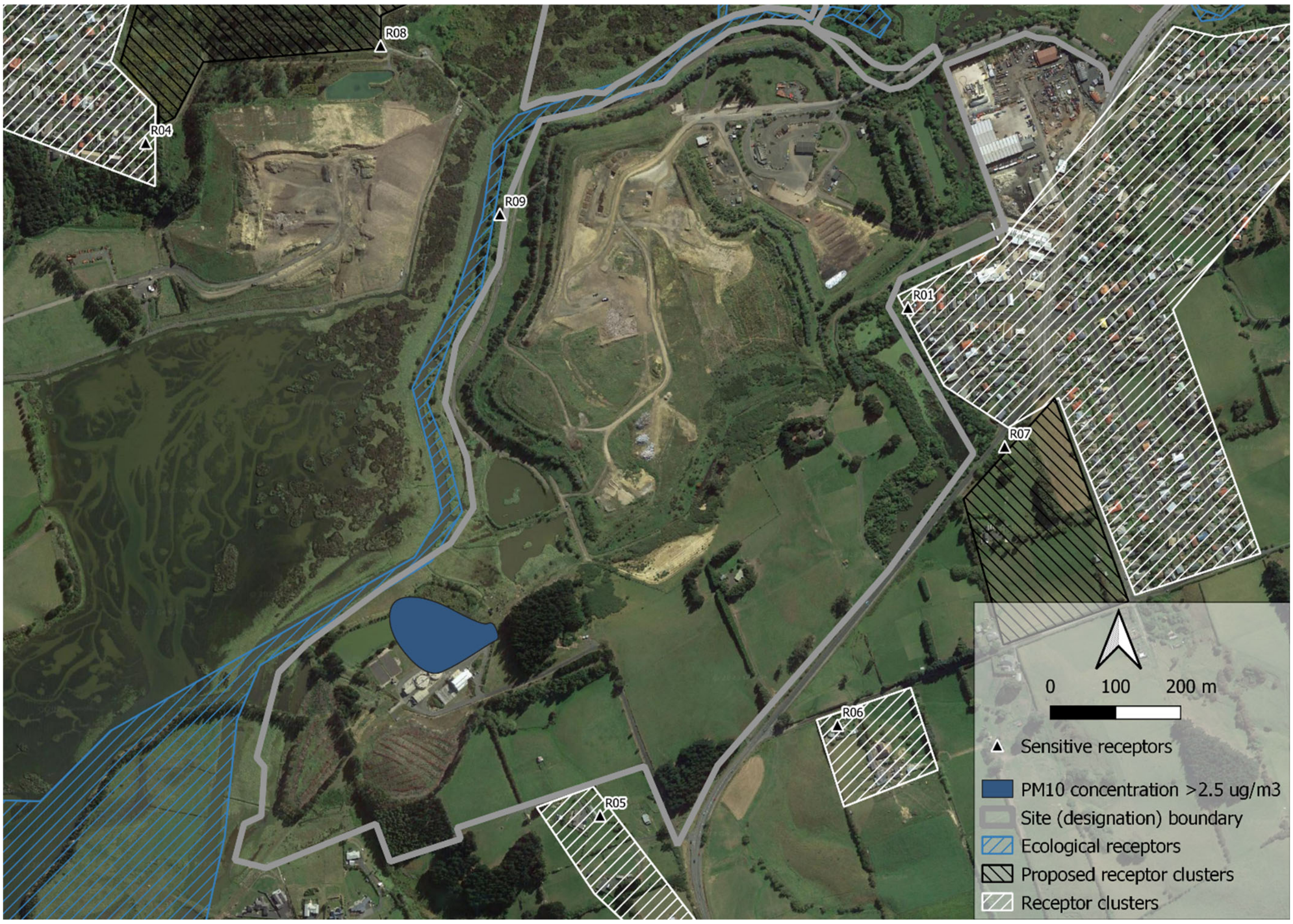


*Figure 7.3 Maximum 24 hour average $PM_{10}$ concentration (µg/m$^3$) compliance with Regulation 17 (NESAQ)*

#### 7.3.3.4 Particulate matter ($PM_{2.5}$)

The predicted 24-hour and annual average $PM_{2.5}$ concentrations are presented in Table 7.9. Predicted 24-hour and annual average $PM_{2.5}$ concentrations, including background, are predicted to be well below the relevant health-effect based assessment criteria at all off-site locations. The potential for adverse health effects associated with $PM_{2.5}$ emissions is expected to be low.

*Table 7.9 Predicted ground-level concentrations of $PM_{10}$*

| Receptor ID | Maximum 24-hour $PM_{2.5}$ concentration (µg/m$^3$) | | Annual average $PM_{2.5}$ concentration (µg/m$^3$) | |
|---|---|---|---|---|
| | Site contribution | Site contribution + background | Site contribution | Site contribution + background |
| *Assessment criteria* | *25* | | *10* | |
| Maximum offsite | 1.7 | 17 | 0.11 | 6.6 |
| R01 | 0.22 | 15 | 0.045 | 6.5 |
| R02 | 0.14 | 15 | 0.024 | 6.5 |
| R03 | 0.14 | 15 | 0.017 | 6.5 |
| R04 | 0.15 | 15 | 0.018 | 6.5 |
| R05 | 0.70 | 16 | 0.058 | 6.6 |
| R06 | 0.16 | 15 | 0.014 | 6.5 |
| R07 | 0.20 | 15 | 0.029 | 6.5 |

| Receptor ID | Maximum 24-hour $PM_{2.5}$ concentration (µg/m³) | | Annual average $PM_{2.5}$ concentration (µg/m³) | |
|---|---|---|---|---|
| | Site contribution | Site contribution + background | Site contribution | Site contribution + background |
| R08 | 0.14 | 15 | 0.019 | 6.5 |
| R09 | 0.26 | 15 | 0.031 | 6.5 |

#### 7.3.3.5 Sulphur dioxide

The predicted 99.9%ile 1-hour and 24-hour average $SO_2$ concentrations are presented in Table 7.10. A graphical presentation of the maximum 1-hour $SO_2$ concentrations associated with the flare are presented in Figure 7.4. Predicted 1 and 24-hour average $SO_2$ concentrations, including background, are predicted to be well below the relevant health-effect based assessment criteria at all off-site locations. The potential for adverse health effects associated with $SO_2$ emissions is expected to be low. The maximum off-site annual average $SO_2$ concentration (including background) was 5.3 µg/m³ which is less than the most stringent ecological guideline of 10 µg/m³. Consequently, there is limited potential for adverse effects on the environment.

*Table 7.10 Predicted ground-level concentrations of $SO_2$*

| Receptor ID | Maximum 1-hour $SO_2$ concentration (µg/m³) | | 1-hour 99.9%ile $SO_2$ concentration (µg/m³) | | 24-hour 99.9%ile $SO_2$ concentration (µg/m³) | |
|---|---|---|---|---|---|---|
| | Site contribution | Site contribution + background | Site contribution | Site contribution + background | Site contribution | Site contribution + background |
| *Assessment criteria* | *570* | | *350* | | *120* | |
| Maximum offsite | 59 | 79 | 52 | 72 | 11.0 | 19.0 |
| R01 | 11 | 31 | 10 | 30 | 2.4 | 10.0 |
| R02 | 10 | 30 | 10 | 29 | 1.6 | 10.0 |
| R03 | 8 | 28 | 8 | 28 | 1.3 | 9.3 |
| R04 | 16 | 36 | 16 | 36 | 1.5 | 9.5 |
| R05 | 50 | 70 | 47 | 67 | 5.3 | 13.0 |
| R06 | 13 | 33 | 11 | 31 | 1.6 | 10.0 |
| R07 | 11 | 31 | 10 | 30 | 2.1 | 10.0 |
| R08 | 12 | 32 | 11 | 31 | 1.4 | 9.4 |
| R09 | 14 | 34 | 13 | 33 | 3.0 | 11.0 |

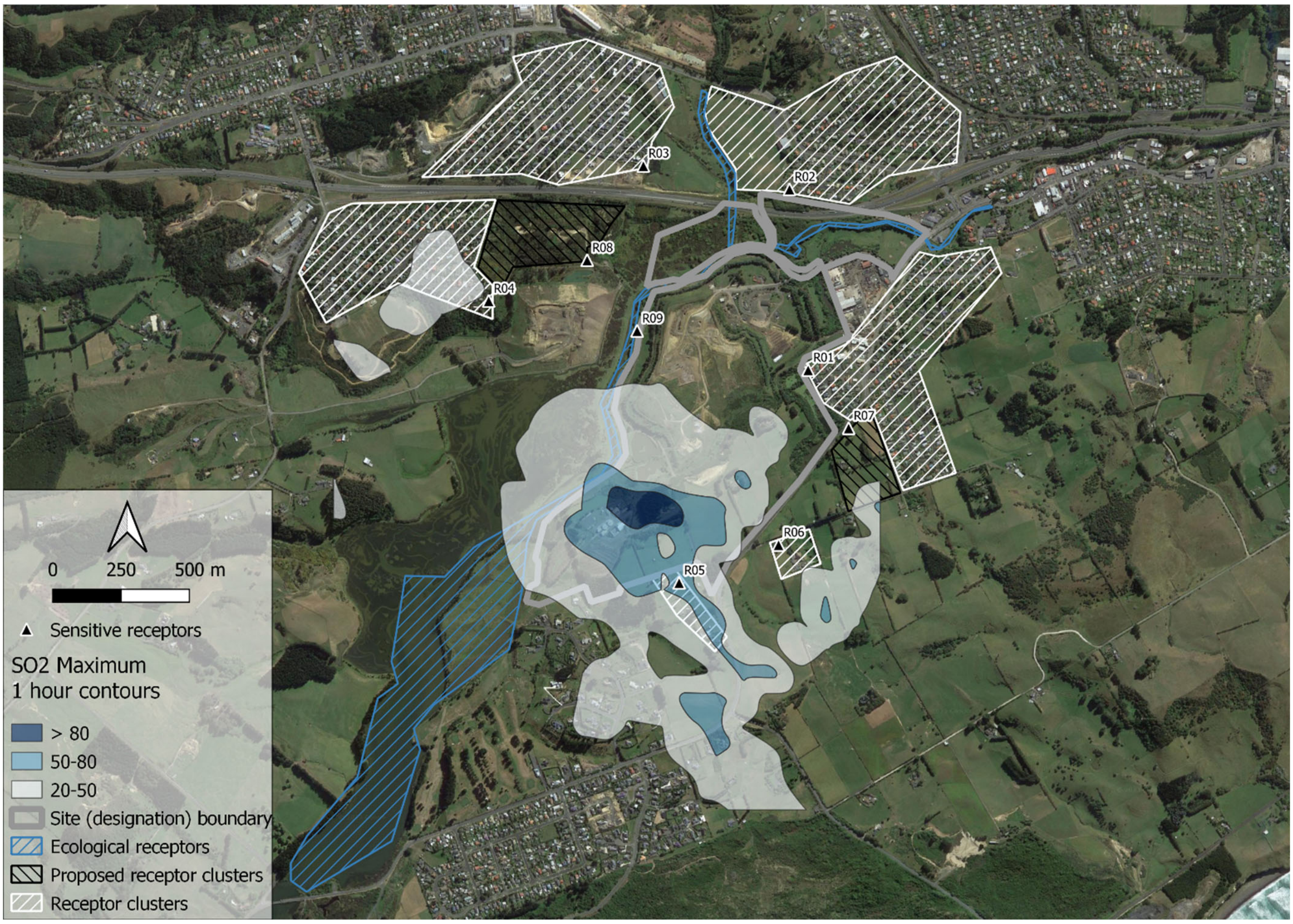


*Figure 7.4* ***Maximum 1 hour $SO_2$ concentration contours (µg/m$^3$) (site contribution only)***

# 8. Conclusions

An air quality impact assessment has been completed for the project as part of the documentation required for the application for consent for extension of operation of the Green Island landfill. This assessment was undertaken in accordance with the relevant MfE GPGs to predict the project impacts on air quality at the nearest sensitive receptors.

The primary impact to air quality from the operation of the landfill is expected to be odour. Odour impacts from the existing operations have been estimated through a review of the odour complaint history and use of the FIDOL assessment tool. Results of this assessment indicate that the nearest receptor cluster, Green Island (southeast) suburb and Clariton Ave in particular, is currently the area most affected by odour. The main sources of odour emissions which led to complaints were found to be turning of the compost, activities at the tip face, the sludge pit, particularly odorous deliveries, fugitive LFG, or shut down of the flare and engine.

Existing mitigation measures, as described in the Waste Management LOP, were reviewed and additional mitigation measures were recommended with a focus on the primary emission sources that have been identified. These included waste acceptance controls, landfill gas management, leachate management, and highly odorous waste disposal controls. The FIDOL assessment was then repeated for future operations (including the ORB which commenced operations in mid-2024), with specific reference to the proposed mitigation measures and how these will aid in reducing odour emissions and impacts. GHD considers that based on the implementation of the proposed mitigation measures, odour impacts will reduce in terms of intensity, frequency and duration.

The potential for cumulative effects considering odours from both the landfill and the ORB are expected to be negligible. The odour from the green waste and organic waste received at the ORB is expected to be largely contained within the ORB which greatly reduces the odour intensity when compared to the composting of green waste in the open previously. Based on the mitigation measures proposed for the ORB and the location of the activity relative to receptors (>300 m) it is unlikely that odours from the ORB will be experienced at these locations, let alone result in cumulative effects.

Combustion of landfill gas in the flare and engine will lead to emissions of $NO_2$, CO, $PM_{10}$, $PM_{2.5}$ and $SO_2$. Emission rates of these pollutants have been estimated based on the emission factors provided in AP-42 Chapter 2.4, and atmospheric dispersion modelling was undertaken using AERMOD. Impacts at receptors complied with the criteria specified in the GPG ID for all pollutants. In addition, as the site is located within a polluted airshed, compliance with Regulation 17 of the NESAQ is required for $PM_{10}$. The predicted $PM_{10}$ concentration increase at all points outside the site boundary is below 2.5 $\mu g/m^3$, therefore the site is predicted to comply with Regulation 17.

Emissions of dust from other operations at the landfill, such as acceptance of dusty waste and vehicle movements on unpaved roads, have been assessed using FIDOL. Based on the results of this assessment, it is unlikely that operational dust emissions will cause any adverse effects beyond the site boundary.

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