URS

Volume 2A

RESOURCE CONSENT APPLICATION FOR THE STAGE 4 EXTENSION OF THE SOUTHERN LANDFILL, WELLINGTON

August 2013

Absolutely Positively Wellington
Me Heke ki Pōneke
Wellington City Council

Report

Assessment of Air Quality Effects Associated with the Proposed Stage 4 Extension to the Southern Landfill

AUGUST 2013

Prepared for

Wellington City Council

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Executive Summary

Wellington City Council (WCC) is in the process of obtaining new resource consents for the operation of Stage 4 of the Southern Landfill, including discharges to air. The site is located at Landfill Road, Owhiro Bay, Wellington.

This assessment of air quality environmental effects, prepared by URS New Zealand Limited (URS), concludes that the various predicted off-site emissions as a result of Stage 4 are within relevant air quality guidelines and standards. The assessment also indicates a good degree of correlation between complaints and predicted concentrations for the current operation.

Stage 4 has a number of potential discharges to air including odour, dust and methane emissions. These arise from various sources such as the landfill refuse and biosolids disposal, and gas emissions associated with refuse degradation.

In the past the frequency with which off-site odours associated with the Carey's Gully Complex (including the landfill, sludge dewatering facility and co-composting plant) has been at an unacceptable level. Since the sludge co-composting plant has been decommissioned there has been a significant reduction in nuisance complaints to the point that the remaining complaints are at a level that is considered acceptable in accordance with Good Practice Guide for Assessing and Managing Odour in New Zealand (MfE 2003). The assessment undertaken by URS demonstrates that effects from Stage 4 will be no worse than, and potentially better than those that currently occur as long as all appropriate mitigation measures continue to be utilised. Consequently URS does not consider that the operation of Stage 4 will generate an odour nuisance.

The proposed Stage 4 expansion will be provided with a landfill gas collection and connected to the current treatment system which meets the requirements of the National Environmental Standards (NES)[1].

Because of its location and the effective management of the existing operation, URS considers that it is unlikely that there will be any off-site dust effects associated with Stage 4.

The site and the processes involved and their effects can be broadly divided into the following areas:

Landfill refuse and sludge disposal

Odour can be produced from general refuse and special odorous wastes disposed of at the Southern Landfill site. It is generally accepted that odours associated with landfills are considered unpleasant by the general population. Strict management practices have been adopted to minimise the effects of odorous wastes including: acceptance and timing of prearranged odorous loads; unloading of material in designated areas; controlling mixture ratios of sludge; covering odorous loads immediately; stock pilling cover material; and placing final or intermediate cover over completed cells as soon as practicable. Even with all these methods in place, there is still the potential for odours to occur off site from time to time. However, odour modelling indicates that if managed properly, the frequency, intensity, duration and offensiveness of odours are likely to be within acceptable levels at the location of residential receptors.

There is also the potential for dust emissions to occur when disposing and compacting dusty material, and also from the placement of the cover material and rehabilitating the site. Some of the mitigation measures implemented to reduce this effect involve avoiding disturbing the stockpiles in extreme winds, restricting vehicle speeds, not accepting potentially dusty loads and planting completed

[1] Resource Management (National Environmental Standards for Air Quality) Regulations 2004

sections of the landfill. In addition to these methods, dust generated by the landfill activities is generally large (100 µm plus) and unlikely to reach the receptors as these are more than 650 m away. This has been confirmed by a lack of complaints related to dust. Therefore, dust is considered to pose a less than minor risk of causing off-site effects.

Leachate system

Leachate is produced by rainfall runoff from uncovered portions of the landfill, percolation of rainfall through refuse and from liquid released from the waste as it decomposes. When leachate is concentrated and has been left to become anaerobic, there is the potential for it to become odorous. The leachate at the Southern Landfill is controlled by a series of pipes and drains that promotes the flow within the refuse and active landfill to the leachate collection ponds. The leachate is then discharged via the trade waste and sewer network to the Moa Point wastewater treatment plant. Given that this is managed adequately, and the leachate is only stored in the collection ponds for a minimal time, the off-site odour effects associated with the leachate system is inferred to be less than minor.

Landfill Gas

Landfill gas has the potential to result in the generation of methane gas and odours. Landfill gas results from anaerobic decomposition of waste material. The most effective way to manage this is to capture and treat the gas through combustion.

The proposed Stage 4 expansion will be provided with a landfill gas collection system designed and operated in compliance with the NES. The collection system will be reticulated to a landfill gas combustion system consented to receive, treat and discharge such wastes and which meets the requirements of the NES.

The collection of landfill gas is considered to be best practice and the collection system will be designed to comply within the National Environmental Standard requirement to discharge less than 5,000 ppm of methane from the landfill surface. With effective management practices applied, such as connecting the newly completed cells to the gas collection system as soon as practicable and the placement of a cap over completed cells, the emissions released from the landfills surface should meet the National Environmental Standards, and the effects will be less than minor.

1

Introduction

Wellington City Council (WCC) has operated the Southern Landfill, located in Carey's Gully since 1975. WCC has evaluated alternatives for future waste disposal and the current preferred option is the Stage 4 extension of the existing landfill further up Carey's Gully. WCC is applying to Greater Wellington Regional Council (GWRC) for resource consents for the Stage 4 extension. URS New Zealand Limited (URS) has been engaged to prepare this assessment of the air quality effect of the proposal in support of those applications.

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Background Information

2.1 Site Location

The site is located in Carey's Gully, in rugged hill country, approximately 5 km to the southwest of Wellington City. The site has been used continuously for refuse disposal since 1975 and approximately 4.5 million tonnes of municipal solid waste has been deposited on the site, including residential, commercial and industrial waste.

The nearest residential dwellings are located approximately 650 m to the northeast of the site on Mitchell Street, in the suburb of Kowhai Park, with the nearest suburb to the east being Kingston approximately 1 km away.

The site location is shown in **Figure 2-1**. **Figure 2-2** shows the existing (Stage 3) and proposed (Stage 4) landfill footprints.

2.2 Topography

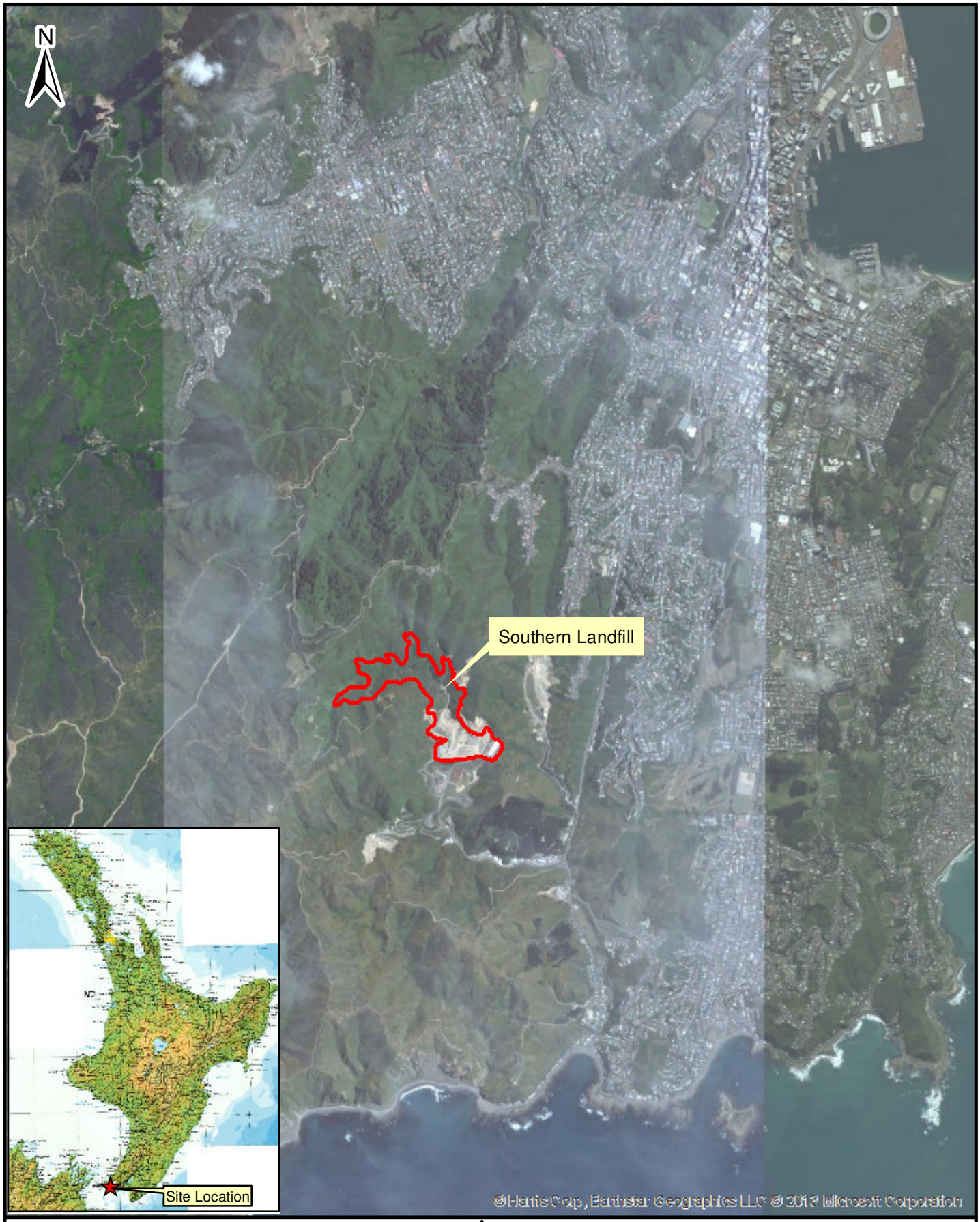
The site comprises a deeply incised valley with steep slopes and natural slope angles typically between 30° to 50°. Natural slopes steeper than 50° are present at site, typically encountered in the bottom of the main valley. There is an approximately 200 m difference in elevation between the valley floor and surrounding ridges.

The site drains to Carey's Stream, located at the bottom of the valley. The slope of the Carey's Gully stream is approximately 5° in the area above the existing Stage 3 of the landfill.

The existing stages of the landfill, Stages 1 through 3, have been constructed in the mid-section of the valley. The proposed Stage 4, extends further up Carey's Gully to the north/northwest of Stage 3.

The site is generally surrounded by a series of ridges, approximately 360 m RL to the north and 260 m RL to the east. The majority of the slopes are densely vegetated with scrub and trees that obscure the landforms. The site is generally surrounded by a ring of high scrub-covered ridges, which separate the site from most residential and commercial land uses, and generally screens the site from public view.

Access to the site is via Landfill Road, which climbs up Carey's Gully from Happy Valley Road (connecting the suburbs of Brooklyn and Owhiro Bay).



0 0.5 1 2 Km

Southern Landfill Air Quality Assessment
Site Location Plan

Absolutely Positively Wellington
Me Heke Ki Poneke Wellington City Council

URS

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Original Size: A4	Checked: JH		Figure 2-1
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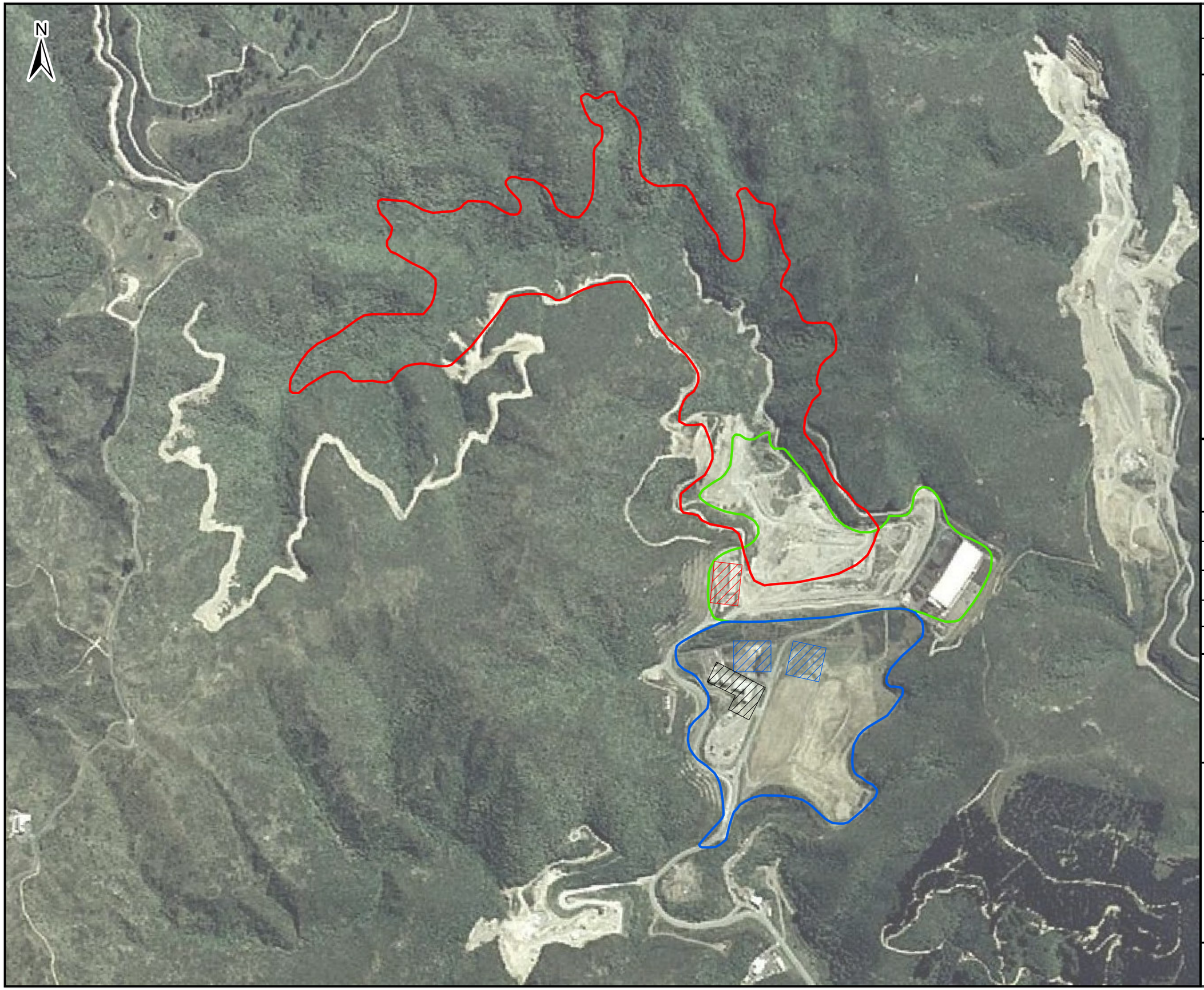

Project:
Southern Landfill Air Quality Assessment

Title:
Proposed Ultimate Landfill Footprint

Legend:

- Proposed Stage 4
- Existing Stage 3
- Closed Stage 2
- Waste Transfer Station
- Composting Operations
- Sludge Dewatering

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Status FINAL	Approved: JH

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Client:

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Me Heke Ke Ponenke
Wellington City Council

Drawing Number
Figure 2-2

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Created with ESRI ArcGIS

2 Background Information

2.3 Odour Compliant History

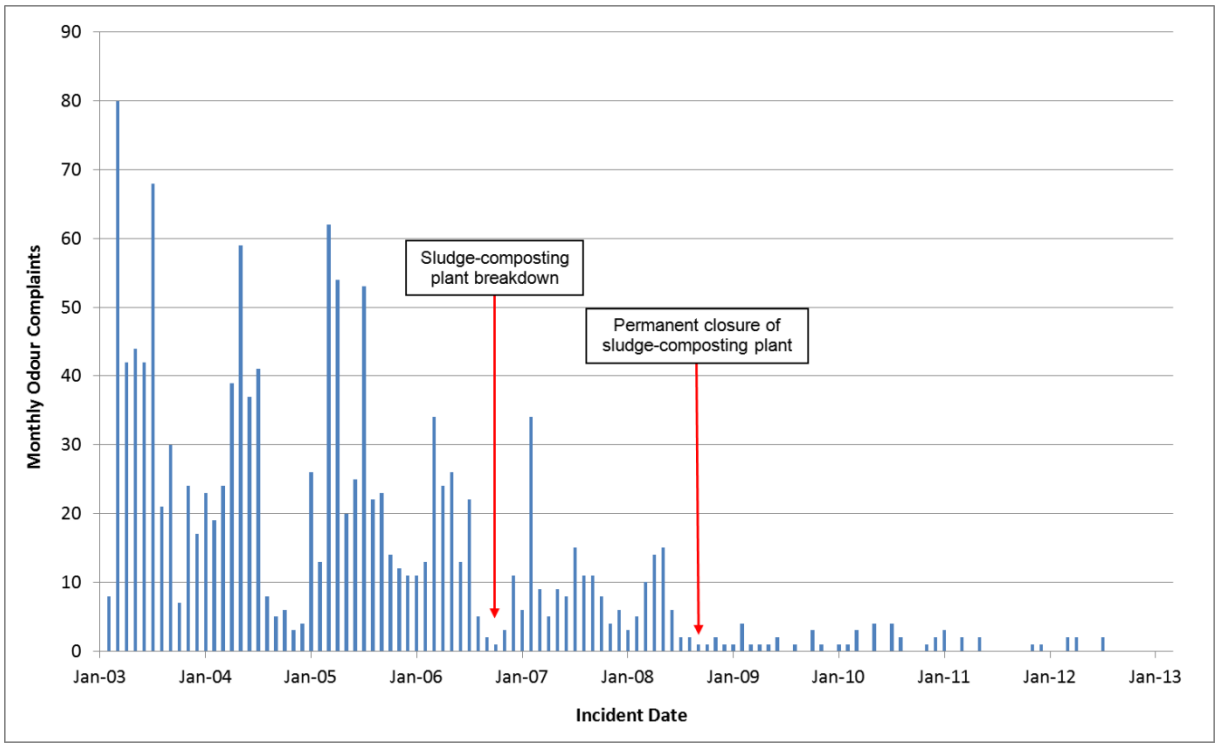
Odour complaint data is available from GWRC and WCC for the Carey's Gully complex since February 2003. This data includes all off-site complaints associated with various odour sources in Carey's Gully, including the sludge dewatering plant, the composting plant and Southern Landfill. The number of off-site complaints are summarised in **Figure 2-3** and presented in detail in **Appendix A**. Following receipt of a complaint, the GWRC call centre alerts the WCC landfill operations manager. Steps are then taken to verify the potential odour source, and if found, measures are taken to minimise odours.

Figure 2-3 shows a correlation between the number of odour complaints recorded and the operation of the sludge co-composting plant. In September 2008, the sludge co-composting plant was decommissioned, and a concomitant reduction in odour complaints was recorded. A similar reduction in odour complaints was recorded during September 2006 when there was a breakdown in the composting plant.

Since the closure of the sludge co-composting operation, the majority of the complaints received have come from residents located to the north-northeast of the Southern Landfill (**Figure 2-4**). As shown in **Figure 2-5**, approximately 85% of the odour complaints have been registered from suburbs to the northeast through east of the site, Kowhai Park, Brooklyn, Kingston and Mornington. This is also supported by the odour modelling results presented in **Appendix B**.

URS considers that the current level of odour complaints (which occur in the order of 0.1-0.2% of the time) is consistent with what might be expected for an operation as that at the Southern Landfill.

Figure 2-3 History of Odour Nuisance Complaints[2]



[2] Data provided by Greater Wellington Regional Council

2 Background Information

Figure 2-4 Orientation of the Odour Complaints in Relation to the Carey's Gully Complex (Post Closure of the Composting Plant)

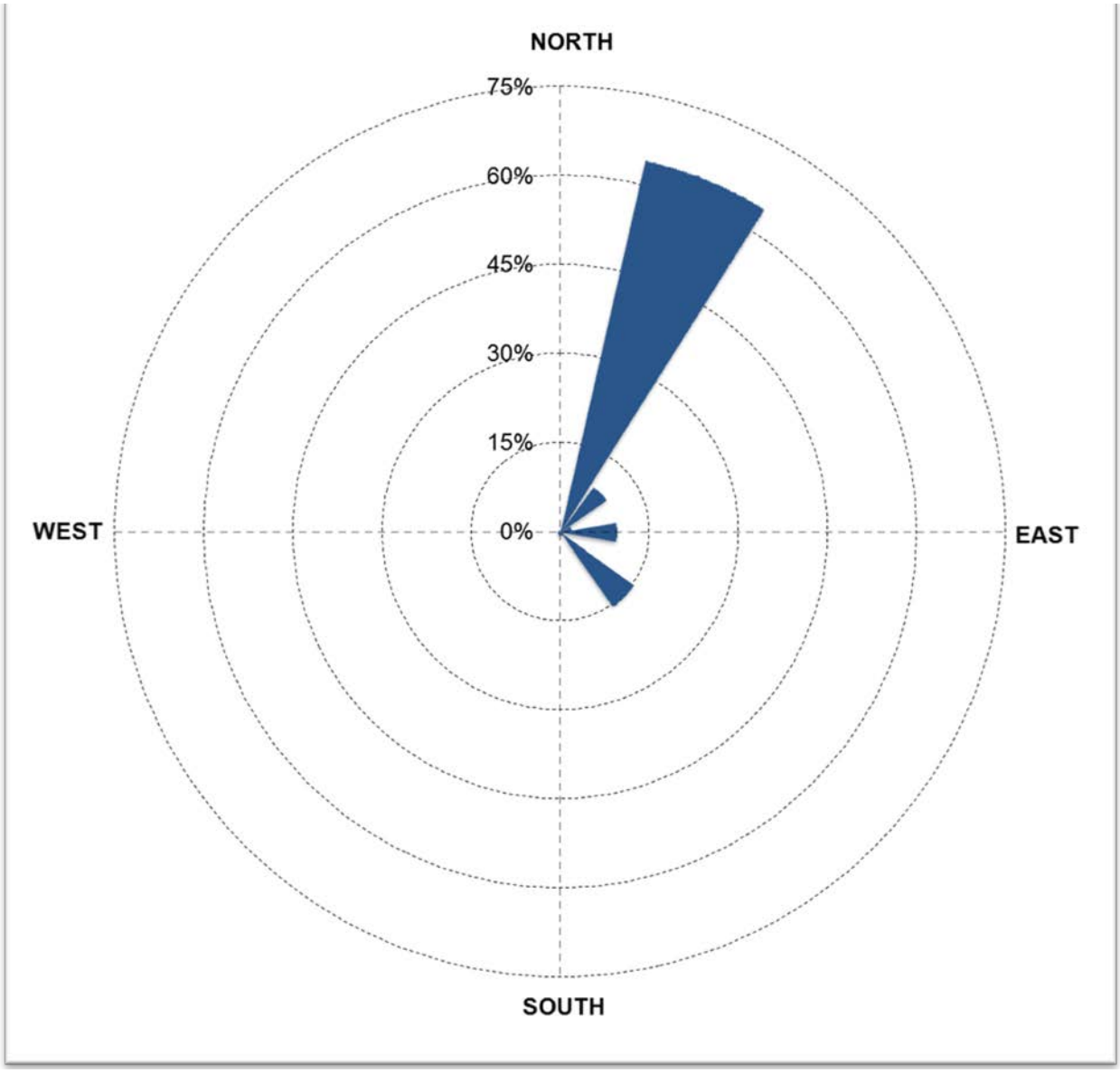
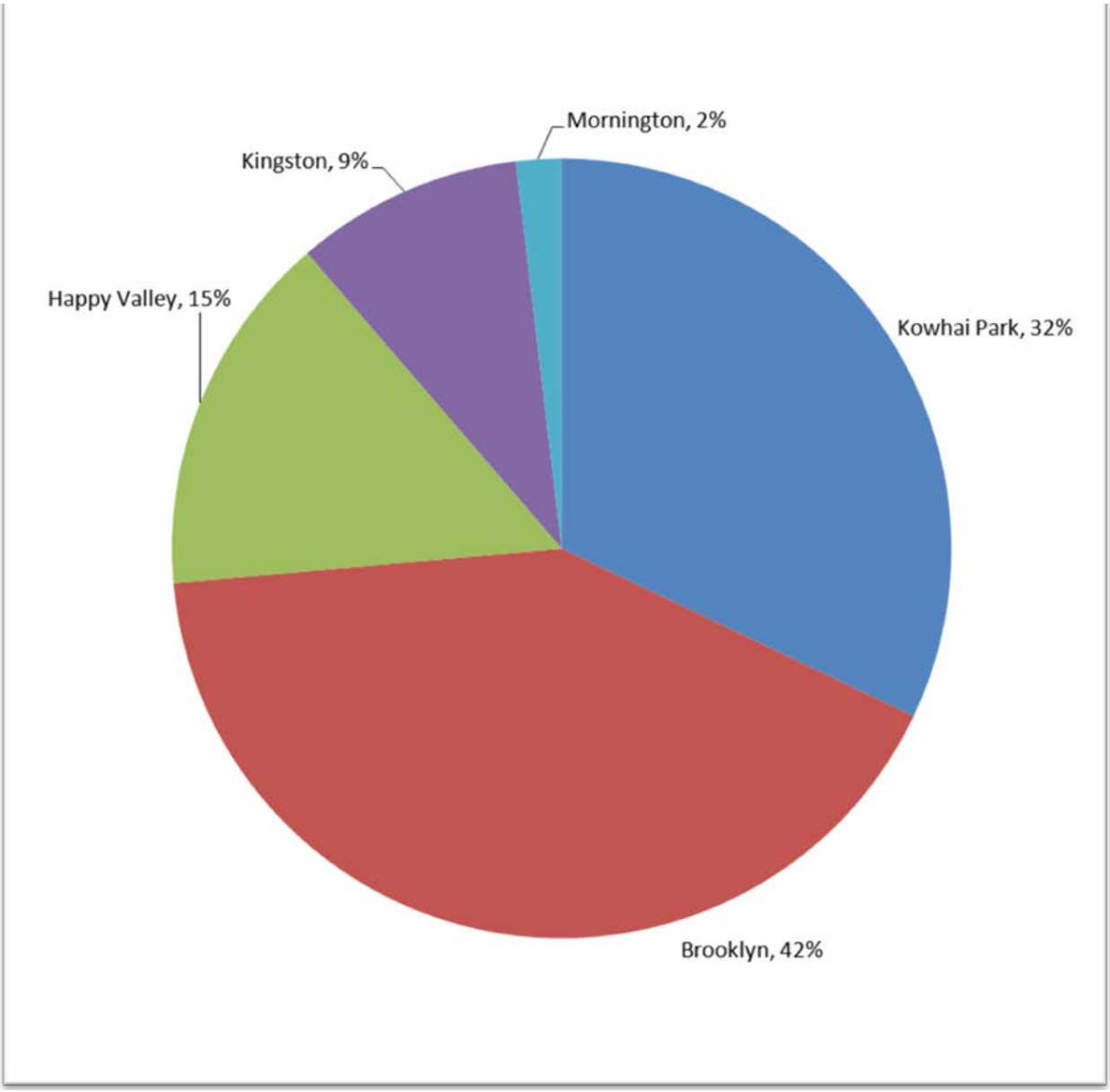


Figure 2-5 Odour Nuisance Complaints related to the Carey's Gully Complex by Suburb,(Post closure of the Composting Plant)



2.4 Local Meteorological Conditions

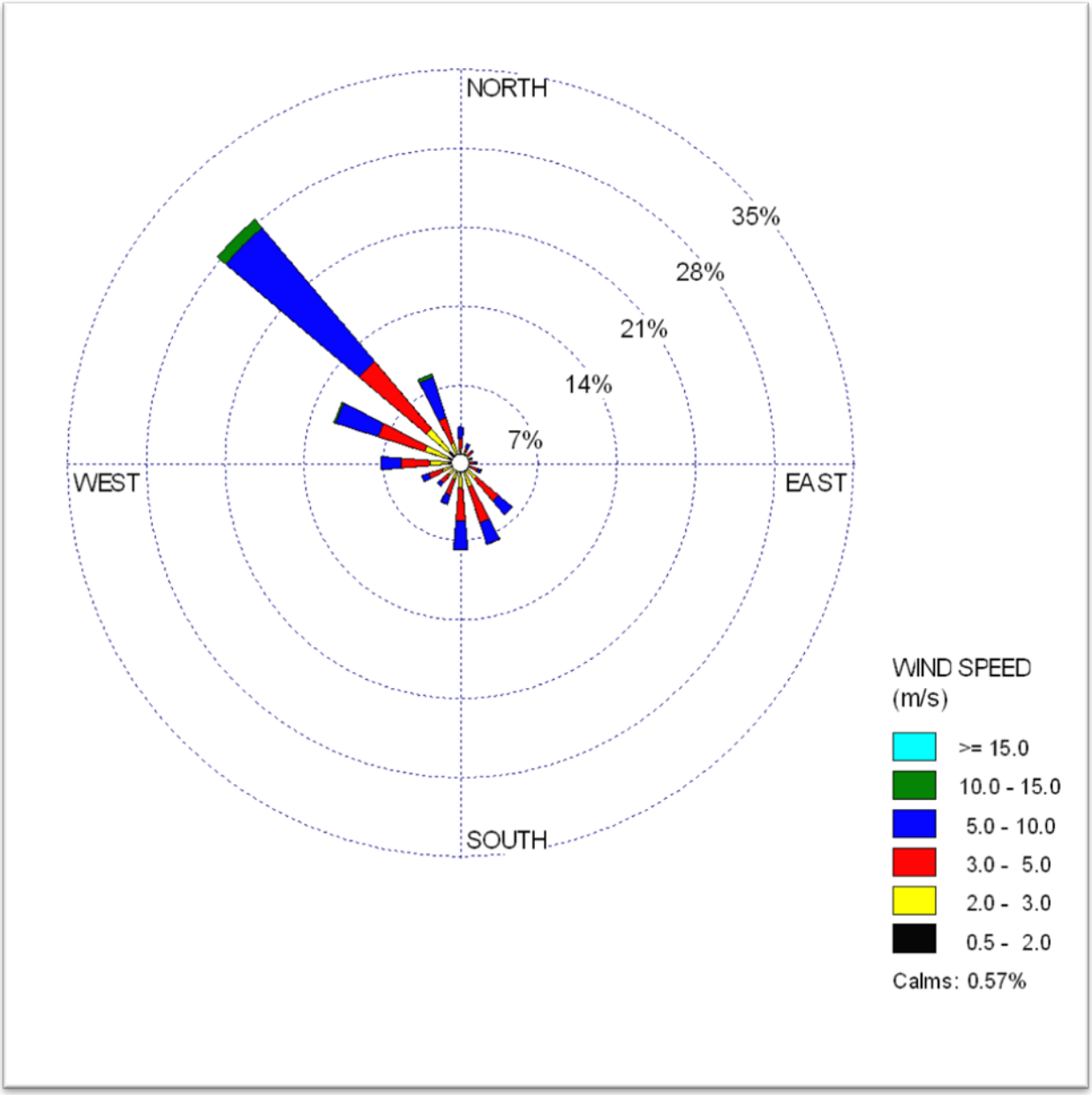
URS has developed site-specific artificial meteorological data for air quality modelling purposes as there is no on-site meteorological monitoring (refer **Section 5.2** for further discussion). This data was developed using a specialist model, The Air Pollution Model (TAPM). This model utilises synoptic weather information together with any available local data. In this case data has been obtained from the Meridian Energy wind turbine site on the ridge above Carey's Gully as well as two adjacent sites (Kelburn and the Wellington Airport) in the National Climate Database (CliFlo).

The wind speed and direction data for the period January 2007 to 31 December 2009 are presented in the wind rose, **Figure 2-6**. The data indicates that the predominant wind directions at the Southern Landfill site are from the northwestern quarter.

2 Background Information

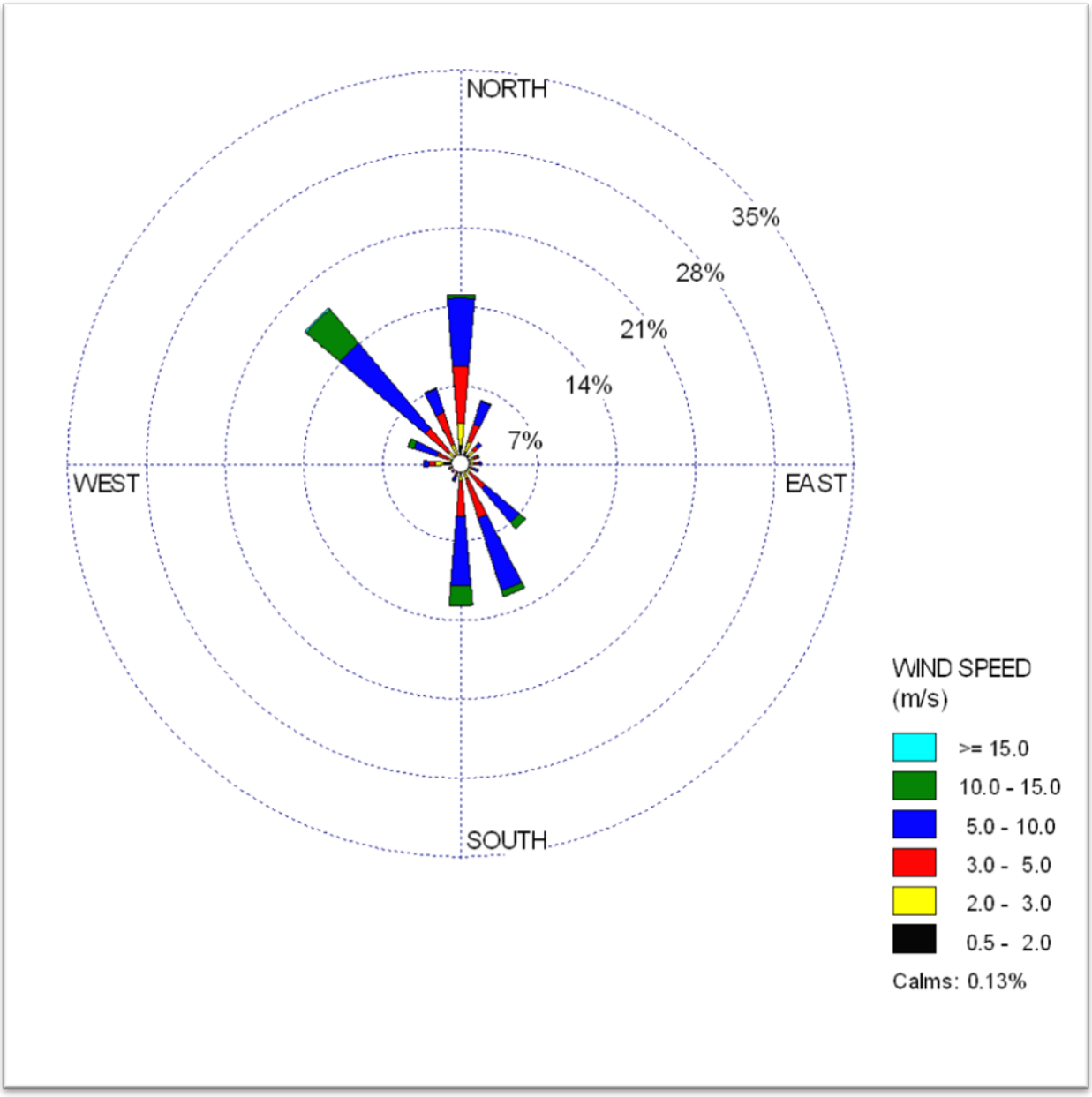
For comparison the data for Kelburn and Wellington Aero meteorological stations for the same period is presented in **Figures 2-7 and 2-8**, respectively. These figures indicate that the prevailing wind directions at the Southern Landfill are similar to those evident at the Kelburn and Wellington Airport stations; however, the Southern Landfill has more pronounced northwesterly winds. The wind data at the Wellington Aero site shows a distinct north and south direction, relating to the obvious headland and local terrain layout. The differences between the various sites are likely due to the effects of the local topography. The Southern Landfill is situated within a deep valley surrounded by high ridge lines with an obvious southeast to northwest orientation. Therefore, the TAPM generated wind data is considered to be representative for the Southern Landfill site.

Figure 2-6 Wind Rose for Southern Landfill



2 Background Information

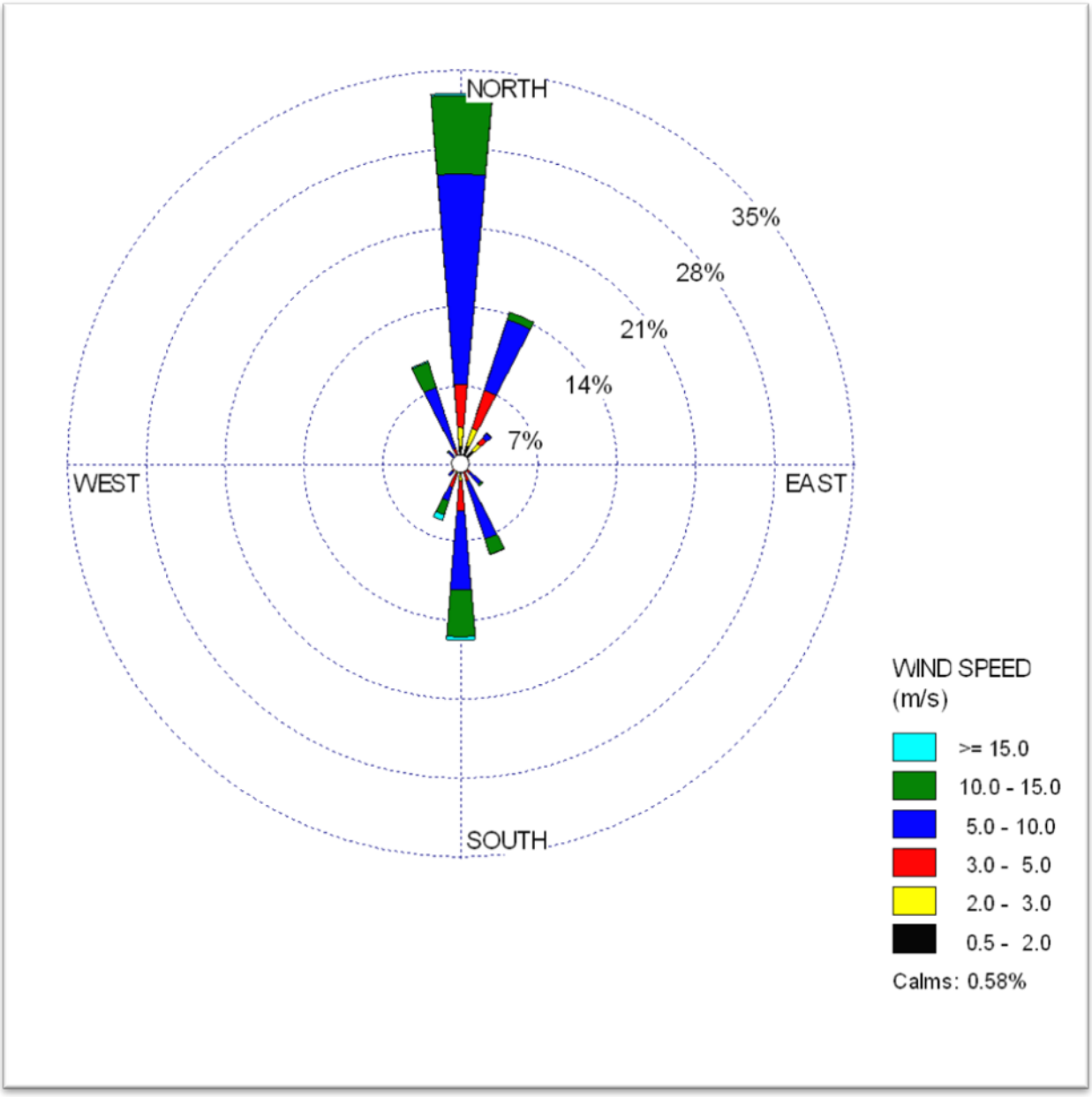
Figure 2-7 Wind Rose for Kelburn[3]



[3] Meteorological data provided by the national climate database

2 Background Information

Figure 2-8 Wind Rose for Wellington Airport[4]



[4] Meteorological data provided by the national climate database

3

Proposed Operation and Potential Emissions

The operations proposed for Stage 4 are similar to current site operations, with similar processes proposed for operation of the tip working face, rehabilitation of the site, and treatment of landfill gas. The greenwaste composting operations, not included as part of the Stage 4 consent, will continue to occur on Stage 2.

Wellington City Council has provided estimated historic and projected annual waste disposal volumes which are summarised in **Appendix C**. The projections indicate a general decrease in waste acceptance rates between 2011 and 2040. Beginning 2041 the waste acceptance rate increases to allow for projected closure of other regional landfills. Between 2011 and 2015 elevated waste acceptance rates are indicated as a result of disposal of biosolids at the landfill. In 2016 it is projected that an alternate biosolids disposal method will be implemented; however, for the purpose of this assessment URS has assumed that such disposal will continue to occur at the Southern Landfill.

The main differences between current operation of Stage 3 and the proposed Stage 4 include the following:

- progressive changes in location of the landfill tipping face and the fill areas;
- temporary increases in vehicle and equipment associated with construction and development of new cells and related infrastructure;
- increase in the number of vehicles that might enter the site associated with projected increases in waste acceptance;
- nominal increase in the amount of equipment required to operate the site associated with projected increases in waste acceptance;
- longer waste transit times between the weighbridge and the tipping face; and
- an increase in the transit time for sludge to the proposed tip face.

There are a number of sources related to Stage 4 that have the potential to discharge contaminants to air. These include landfill refuse disposal (including sludge discharged to landfill), earthworks, leachate, and landfill gas.

There are also a number of ancillary and adjacent activities, not proposed to be covered by the Stage 4 consent, that have the potential to discharge contaminants to air, including the following:

- Stage 1 through 3 of Southern Landfill
- Existing Transfer Station
- Sludge dewatering and disposal operations
- Composting operations

Provided below is a summary of the proposed Stage 4 operations as well as other activities that may result in the discharge of contaminants to air.

3 Proposed Operation and Potential Emissions

3.1 Landfill Development

3.1.1 Operational Activities

The continued development of the landfill will require a range of earthmoving activities, including removal of topsoil, contouring of the landform, and eventual rehabilitation of the site.

3.1.2 Potential Discharges

The landfill construction and operational activities that will occur progressively throughout the life of the landfill (as it is developed) involve:

- Establishment of erosion and sediment control management.
- Provision of perimeter access roads
- Provide temporary access for cell construction
- Establishment of cut-off drainage and diversion of the Carey's Stream
- Clearing of vegetation
- Trimming of the valley side walls of loose rock and colluvium and removal of topsoil
- Provision of the sub-liner drainage system
- Provision of the liner system
- Provision and operation of a leachate collection and conveyance system
- Provision of earthen bunds at the toe of the cell
- Establishment and operation of leachate/stormwater attenuation ponds
- Provision and use of roads to the landfill tip face
- Placement and compaction of refuse
- Provision of daily cover
- Provision of a permeable drainage layer at the interface with rock slopes to promote drainage to the leachate collection system
- Provision and operation of a landfill gas collection system
- Provision of intermediate cover
- Provision of final cover
- Quarrying for cover materials

The majority of these activities are similar to those that occur for earthworks projects (for example subdivision development), and have the potential to generate dust, both from vehicle movement over unsealed surfaces, and from material either being stockpiled or excavated.

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. While the number of vehicles will be greater than when normal filling activities occur, the incremental off-site effect is likely to be less than minor and these emissions are not considered further in this assessment.

3.2 Refuse Disposal

3.2.1 Operational Practice

General Refuse

Refuse trucks arrive on-site and after passing over the weighbridge are directed via the road system to the current location of the tip face. At the tip face the operator directs the truck to the correct location to unload and once unloaded the refuse is compacted. This occurs progressively throughout the day. Depending on the nature of the refuse received cover, comprising soil or non-objectionable waste, is provided shortly after disposal of the waste and daily cover is provided as necessary at the end of each day.

Odorous Special Wastes

Odorous special wastes include but are not limited to abattoir wastes and sludge, sewage sludge, fish waste, putrid material and contaminated fill.

The current practice is for odorous special waste to be placed at the tip face and immediately covered with other refuse.

The methods for disposing sewage sludge involves mixing the de-watered sludge with bulking agents, such as quarried fill and general refuse at a ratio of 1:4 (sludge to refuse). This is to avoid creating boggy areas and to reduce the odours. As with other odorous refuse, this is also promptly covered and compacted.

Asbestos

The site also accepts wrapped asbestos, which is handled at a separate tip area to that of general or other special wastes. Asbestos waste is covered with 1 m of soil within 2 hours of disposal.

3.2.2 Potential Discharges

There are two potential discharges of significance associated with refuse placement, these are odour and dust.

Odours can occur from the refuse being deposited, which may have begun to decompose prior to placement. There is also the potential, from time to time, that especially odorous material can be deposited. In addition, there is the potential for the discharge of landfill gas from the working face, which also has the potential to be odorous due to the presence of a range of decomposition products.

Dust emissions can occur either when particularly dusty material is being deposited or compacted or from the placement of cover material.

If some of the smaller regional landfills are closed and the waste diverted to the Southern Landfill there may be an increase in the number of vehicles entering Stage 4 compared to the existing operation. As a result, increased discharges associated with on-site vehicle traffic and equipment associated with refuse disposal may occur. These discharges are not considered to be significant due to the small number of vehicles currently involved in this activity and the likely small incremental increase in these emissions anticipated for Stage 4. Therefore, they have not been considered any further in the assessment.

The operational procedures associated with Stage 4 are proposed to be similar or better than those for Stage 3. Therefore, it is anticipated that the nature and intensity of dust and odours associated with refuse placement will be similar or better to that which currently occurs. However, it is noted that the location of the dust and odour sources will change as Stage 4 is progressively filled.

3.3 Leachate

3.3.1 Operational emission

Landfill leachate, a potential odour source, is generated as a result of decomposition of waste combined with precipitation and stormwater run-on to the landfill.

For Stage 4 it is proposed that leachate flow within the landfill be facilitated by the construction of drains that direct leachate to the basal leachate collection system. Gas extraction wells and the associated collection system will also provide a conduit for transport of leachate and condensate to the leachate collection system.

Leachate is discharged to the trade waste system and conveyed off-site for treatment at the Moa Point Waste Water Treatment Plant (WWTP).

3.3.2 Potential Discharge

As is the current practice with Stage 3, it is proposed that landfill leachate be temporarily stored in attenuation pond(s) located at the toe of the active landfill cell prior to discharge to the leachate conveyance system. The location of these ponds will move progressively with the filling of the landfill. It is not expected that nature or intensity of odours associated with leachate storage will be significantly different from that of Stage 3.

3.4 Landfill Gas

3.4.1 Operational Emissions

The decomposition of organic waste material results in the generation of landfill gas as a by-product of bacterial activity. The composition of this gas will vary according to a number of factors; in particular, whether the gas results from aerobic or anaerobic decomposition. At landfills, decomposition primarily occurs in anaerobic conditions and generated gas which consists of methane (in the order of 50% to 60%) and carbon dioxide (CO_2) (around 30% to 40%). Both methane and carbon dioxide are odourless gases. However, there are small quantities of Non-Methane Organic Compounds (NMOC) present in the landfill gas that can give rise to the characteristic landfill gas odour associated with these potential emissions. NMOC are also considered hazardous air pollutants, which can cause human health and vegetation effects.

An appropriate and site-specific design for the landfill gas collection system is the key factor in the control of odours from this source. In this case the collection system will be developed progressively for Stage 4, with extraction commencing:

- Once it is safe to do so, without the risk of introducing air into the landfill and creating the potential for a fire.
- When required to manage gas hazards for site workers (based on instantaneous surface monitoring) and odours.
- Once sufficient mass has been accumulated in the landfill to practically recover and combust methane
- Notwithstanding the above, at a cumulative mass of biodegradable/putrescible waste no greater than 200,000 tonnes, in compliance with the NES.

The extracted landfill gas will be reticulated to a landfill gas combustion system, consented to receive, treat and discharge such wastes. It is noted that there will always be some landfill odour detectable around the working face when this is open because it is not practical to extract landfill gas in this area due to the potential for fires to occur.

The landfill gas collection system for Stage 4 will be designed to ensure that when intermediate or final capping is in place, the surface emissions of methane will be less than the NES requirement of 5,000 parts per million (ppm).

Effects related to and discharges from the landfill gas treatment system will not be consented under this application; therefore, they have not been considered in this assessment.

3.4.2 Methane Emissions

URS has predicted methane gas production rates using LandGEM[5] the landfill gas emission model, version 3.02. All predicted landfill gas values mentioned in this report have been calculated using this model. Stage 4 future waste acceptance rates were supplied by WCC, refer **Appendix C**. The model has been designed by the United States Environmental Protection Agency (USEPA) as a screening tool to give a best estimate for landfill gas emissions.

The base equation that is used in this model is:

$$Q = L_o R(e^{-kc} - e^{-kt})$$

where,

Q	=	methane gas generation at time t, m3.yr-1
Lo	=	potential methane generation capacity of the refuse, m3 per tonne refuse
R	=	average annual refuse acceptance rate during active life, tonne.yr-1
k	=	methane generation rate constant, yr-1
c	=	time since landfill closure, year (c=0 for active landfill)
t	=	time since the initial refuse placement, year

The difficulty in using this model, as with any model, is in selecting appropriate parameters. In particular selection of the parameters L_o and k requires careful consideration and discussion of these parameters is provided in the following sections.

[5] LandGEM Landfill Gas Emissions Model Version 3.02 a model developed by the USEPA, which has been commonly used in New Zealand

3 Proposed Operation and Potential Emissions

Typical emissions were modelled to demonstrate the likely gas generation and recovery rates. A summary of the setup parameters is provided in **Table 3-1**. This model only considers the gas generation for the proposed Stage 4 of the Southern Landfill.

Estimation of Methane Generation Potential

The methane generation potential, L_o, is primarily influenced by the refuse composition, moisture content, and permeability of cover material. Based on values obtained from other landfills located in New Zealand a L_o value of 100 m^3/tonne has been selected as a typical methane generation potential for this assessment.

Estimation of Methane Generation Rate Constant, k

The methane generation rate, called *k*, is influenced by a number of factors including refuse type, moisture, pH, temperature, and landfill operating conditions. For dry sites, *k* values of 0.02/year or lower may be appropriate and alternatively, where a site is predominantly wet, *k* values in excess of 0.3/year have been recorded. Based on the rainfall data collected for the Wellington region for the years 2006 – 2010 (approximately 1440 mm/annum)[6] a *k* value of 0.2/year has been used for a typical methane generation rate.

Gas Capture Efficiency

The capture efficiency for a gas collection system is dependent on the design and operation of the system, capping permeability, condensate management, capping integrity, refuse depth, and many other factors. For modelling purposes, a constant gas capture efficiency of 60% has been selected.

System Coverage

The gas extraction system is designed to cover 85% of the landfill. However, for the first 3 years of the Stage 4 expansion, the gas extraction system will not be operational as it will take this long for the first cells to be completed and capped. Therefore to undertake a conservative assessment, URS has assumed that the system coverage will be 0% for these first years and as the landfill progressively expands and cells are completed this will increase to a 85% system coverage.

Table 3-1 Methane Generation

	Typical Methane Emission Variables
Methane Generation Potential, L_o	100 m^3/tonne
Methane Generation Rate, k	0.2/year
Capture Efficiency	60 %
System Coverage	85 %

[6] CLIFLO database

3 Proposed Operation and Potential Emissions

Figure 3-1 Predicted Methane Generation and Recovery for Stage 4

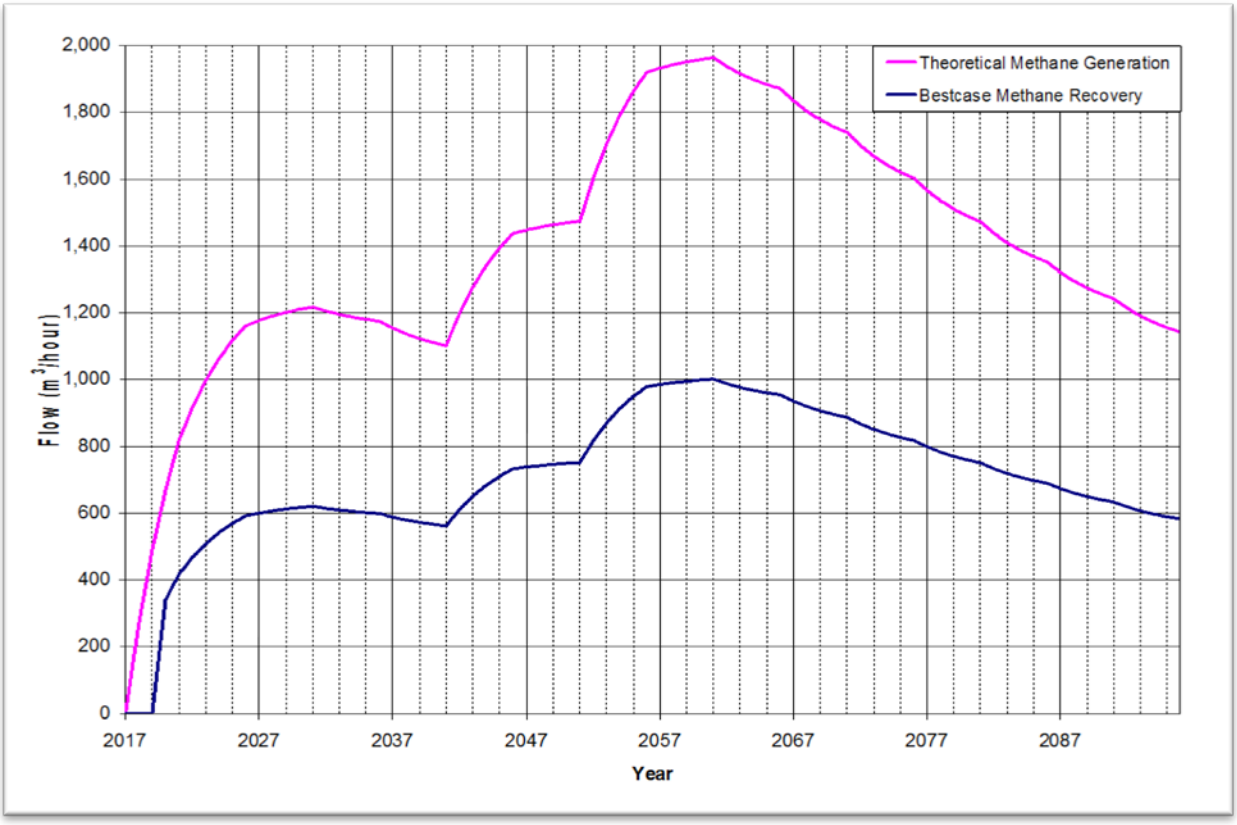


Figure 3-1 shows the typical generated and recoverable methane yields for the proposed Stage 4 of the Southern Landfill. The maximum generated curve is the methane that will be produced from the landfill based on the refuse acceptance rates presented in **Appendix C**. The maximum recoverable flow is the portion of the methane generated that has the potential to be recovered using best practice for capture efficiency and system coverage as discussed in **Section 3.4.2**.

There is a steep increase in methane emissions from the opening year of the Stage 4 landfill, which is is typical of a new landfill. Even though waste acceptance rates decrease from 2020, methane emissions increase for a period of time after this due to a time lag where methane emission levels are still being generated by the existing refuse. The refuse acceptance rates are expected to increase in 2041 and 2051 by approximately 65% when there is the potential for additional sources of waste to be diverted to the Southern Landfill as other local landfills close. This is apparent in **Figure 3-1**, where the additional waste has results in an increase in methane emissions. The steady decline from 2061 is due to the expected gradual decrease (approximately 10% decrease per 5 year period) in refuse acceptance rates as Stage 4 is progressively rehabilitated and completed.

3.4.3 Potential Discharges

With the collected and combusted portions of the landfill gas the discharges are reduced primarily to CO_2, water and combustion emissions such as carbon monoxide and oxides of nitrogen (NOx), as well as extremely small amounts of unburned gas (typically less than 1%). The majority of the uncollected portion of the landfill gas is reduced to carbon dioxide as the gas is decomposed by bacteria in upper

aerobic portions of the landfill including the capping. A small percentage of the landfill gas (which will be less than the NES limit of 5,000 ppm) will potentially discharge to atmosphere; although, based on measurements that URS has undertaken on other landfills this potential emission is negligible.

3.4.4 Landfill Gas Migration

There is also the potential for landfill gas migration to occur. This is an issue primarily for older landfills but it can also occur in modern landfills if the liner becomes compromised. There are two potential effects that can be experienced. The first is that there can be effects on vegetation if exposed to high concentrations of methane, and secondly there is the potential for landfill gas to accumulate in enclosed spaces (such as under buildings) and potentially result in fires or harm to individuals (while not toxic, methane is an asphyxiant if present in sufficient quantities) and carbon dioxide can also cause issues.

The design for Stage 4 will incorporate features such as a liner over the colluvial material in the valley floor, and a drainage layer along the side walls which will minimise the potential for landfill gas migration to occur.

3.5 Greenwaste Composting

Green waste composting will continue to be processed in the Stage 2 area, which is remote from Stage 4; and as a result these composting activities are not covered by the Stage 4 consent. A discussion of green waste air quality emissions is provided below because there is the potential for these emissions to be confused with those that might occur from Stage 4.

3.5.1 Operational emission

WCC composts up to 5,000 tonnes of greenwaste and small amounts of household food waste per year in an effort to reduce the volume of refuse to landfill. The location of composting activities is shown **in Figure 2-2**. This location and level of this activity is not expected to change with the development of Stage 4.

Composting activities consist of shredding collected greenwaste, and placing the shredded material in windrows. Each windrow is between 1.8 and 4 m wide, 2 to 3 m high and between 20 and 60 m in length. The total area utilised by composting operations is approximately 1 ha. The material is then broken down by bacterial action to form compost. These windrows are regularly turned to improve porosity and oxygen content, add/or remove moisture, and redistribute temperature in the pile. At the completion of the composting cycle the compost is used as cover material for the landfill. The composting area is isolated from the surrounding land by edge drains with leachate from the operation fed back to the landfill or leachate ponds.

3.5.2 Potential Discharge

Discharges arising from composting activities mainly consist of nuisance odour and dust emissions. These emissions primarily occur when the windrows are either being formed or turned and will only generate off-site nuisance in adverse wind conditions.

Odour

The potential for odour arises from two sources. The first is from the raw materials that are used in the composting process and the second from the degradation of compost.

This type of composting activity is less likely to produce odorous emissions when compared to those that involve other materials such as animal waste.

The type and intensity of odour produced by the compost depends on bacterial activities occurring in the compost. Research suggests that anaerobic decomposition is generally more odorous as the bacteria that prefer these conditions tend to generate a range of reduced sulphur compounds such as hydrogen sulphide and dimethyl sulphide, which have low odour thresholds and are invariably considered to be offensive. Therefore, in terms of odour generation from composting, there is a need to make a trade off between turning the windrows to maintain aerobic conditions, and the fact that each turning event has the potential, albeit for a short period of time, to generate some odour that could cause off-site nuisance.

Dust

The shredding and preparation of raw compost materials can give rise to dust emissions that can create nuisance effects. There is also potential for dust to be generated during the turning of the windrows.

3.6 Sludge De-watering Operation

As mentioned earlier the sludge de-watering plant has its own air discharge consent, which permits emissions from the dewatering operation and disposal of the sludge at the Southern Landfill. Consequently the odours associated with the operation do not need to be assessed as part of this application. However, URS has included the odours from this operation as part of the odour modelling, as the model needs to consider the cumulative impact of all sources. The following is therefore included for information purposes only.

3.6.1 Operational emission

The sludge de-watering plant is located to the southwest of the active Stage 3 landfill, as shown in **Figure 2-2**. The sludge is produced as a by-product of sewage treatment at regional WWTPs. Sludge from the Moa Point WWTP is pumped through an underground pipeline to the dewatering plant at the Southern Landfill. The sludge from the Western WWTP is transported by truck, in covered bins, to the de-watering plant. Sludge is dewatered using centrifuges to 28% solids in an enclosed and ventilated building. Currently the plant produces approximately 50 tonnes of de-watered sludge per day, which is then disposed of to the landfill. Until September 2008, de-watered sludge was processed at the co-composting site, where it was mixed with greenwaste compost.

The centrate (water) that has been removed from the sludge passes into a wet well and is then treated and returned back to Moa Point via the same sewer that returns the leachate to the WWTP.

3 Proposed Operation and Potential Emissions

3.6.2 Potential Discharge

During the Sludge de-watering operation, there is potential for odour to be discharged. These sources include leaks from the sludge storage building, odours whilst the sludge is transported to the facility and to the landfill face, discharges from the wet well and centrate treatment system and the ventilation biofilter system.

4

Regulatory Framework

4.1 Resource Management Act

Section 15(1)(c) of the Resource Management Act 1991 (RMA) states that any discharge from an industrial or trade premise into air requires a Resource Consent unless that discharge is expressly allowed by a rule in a Proposed Regional Plan and Regional Plan, or a regulation.

4.2 Wellington Regional Air Quality Management Plan

The relevant regional policies and rules covering discharges of contaminants to air are set out in Sections 4.2 and 5.2 of the GWRC Air Quality Management Plan (AQMP). The plan has been operative since May 2000.

The policies in the AQMP relating to the discharge to air of operations associated with the Southern Landfill operations are addressed below and further explained in **Section 8** of this report.

Policy 4.2.4 specifically addresses odour issues and aims to avoid, remedy or mitigate any adverse effect of the discharge of contaminants to air that is noxious, dangerous, offensive, or objectionable. The explanation note attached to the policy is as follows:

"This policy reflects the general duty under section 5 of the Act to promote the sustainable management of natural and physical resources by avoiding, remedying or mitigating adverse effects. It also reflects the general duty placed on all persons under section 17 of the Act to "avoid, remedy or mitigate any adverse effect on the environment from an activity carried on, by or on behalf of that person". It applies to all individuals or groups carrying out an activity which involves the discharge of a contaminant to air".

Policy 4.2.14 introduces the Frequency, Intensity, Duration, Offensiveness and Location (FIDOL) factors and indicates the GWRC approach to control odour. The policy states that the council aims to avoid, remedy or mitigate any adverse effects which arise as a result of the frequency, intensity, duration, offensiveness, time and location of odorous contaminants that are discharged to air. The explanation note attached to the policy is as follows:

"The Council will require, through rules in this plan, through conditions on resource consents and through its enforcement responsibilities under the Act, that the effects of odorous activities be avoided, remedied or mitigated. The effects of odour include nuisance effects, effects on cultural and amenity values and human health effects. Frequency, intensity, duration, offensiveness and Location (FIDOL factors) are the five properties of odorous discharges which contribute to odour nuisance or objectionable discharges will depend upon the specific circumstances. In responding to a complaint relating to a breach of a condition concerning odour, what may be "offensive or objectionable" will generally be determined initially by a council officer, or officers, who have experience in odour assessment. In such assessments, officers will generally follow relevant case law principles and take into account the FIDOL factors, as well as time".

This approach aims to promote consistency in the assessment of odour. However, as the odours that arise from the Southern Landfill do not have a single discharge point, good management practices may be the best means of controlling odour.

These policies have been put in place to maintain the integrity of the existing Wellington airshed, and promote the best practicable option for preventing or minimising the adverse effects associated with the operations at the Southern Landfill on the environment.

4 Regulatory Framework

Due to the number and size of the operations, there are several rules from the Regional AQMP that apply for the activities at the Southern Landfill. The rules that are relevant to the Southern Landfill operation are presented in **Table 4-1**.

Table 4-1 Wellington Regional AQMP Rules

Rule No.	Type of Discharge	Rule conditions
20	Landfilling and composting (Permitted Activity)	The discharge of contaminants into air in connection with any: (1) landfilling and composting; (2) sites which have been used in the past for landfilling (closed landfills); is a Permitted Activity, provided it complies with the conditions below, and excluding any discharges or contaminants to air arising from: (a) sites where waste materials are accepted from sources other than the property on which the landfilling or composting takes place; and/or (b) waste transfer stations.
23	General rule (Discretionary Activities)	The discharge of contaminants into air from: (1) any process or activity explicitly excluded from Rules 1-22; or (2) any process or activity covered by Rules 1-22, but which does not meet the conditions attached to those rules; or (3) any process or activity on an industrial or trade premises not covered by Rules 1-22

Rule 20 under the Wellington Regional AQMP includes landfilling and composting as a permitted activity, providing it complies with the rule conditions as shown in **Table 4-1**. However, the operations at the Southern Landfill do not comply with these conditions as the Southern Landfill accepts refuse from other sources. Therefore Stage 4 of the Southern Landfill will require consent under Rule 23 (Discretionary Activity). These rules have been assessed throughout this assessment and are detailed in **Section 8** of this report.

4.3 National Environmental Standards

The Ministry for the Environment (MfE) promulgated the National Environmental Standards (NES)[7] on 6 September 2004 as regulations under the Resource Management Act 1991. The NES standards identify specific requirements for gas collection and treatment for landfills.

Regulations 26 and 27 for the control of gas emissions at landfills apply. Regulation 26 refers to the control of landfill gas and specifies that the landfill must have an appropriate gas collection system and the gas discharged to air must not exceed 5,000 ppm methane. The collected gas is flared in accordance with regulation 27 or used as a fuel for generating electricity.

The assessment of discharges in relation to the NES is contained in **Section 8** of this report.

[7] Resource Management (National Environmental Standards for Air Quality) Regulations 2004

5

Assessment Methodology

This section describes the CALPUFF dispersion model used to assess the potential environmental effects of discharges from the Southern Landfill site. URS have also used this model to provide an indication of the likely impact of odours from Stage 4 on surrounding landowners.

5.1 The CALPUFF Dispersion Model

For this assessment the puff model CALPUFF version 6.4.0 has been used. CALPUFF has been accepted by the USEPA as a guideline model to be used in all regulatory applications involving the long-range (>50km) transport of pollutants, and can also be used on a case-by-case basis in situations involving complex flow and non-steady state cases from fence-line impacts to 50 km.

CALPUFF is recommended by the MfE as one of the most commonly used advanced dispersion models in New Zealand[8].

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model, which is able to simulate the effects of time- and space-varying meteorological conditions on pollutant transport. This enables the model to account for a variety of effects such as spatial variability of meteorological conditions, causality effects, dry deposition and dispersion over a variety of spatially varying land surfaces, plume fumigation, low wind-speed dispersion, pollutant transformation and wet removal.

Like all dispersion models, CALPUFF has requirements for a number of inputs in order to make it function. The following sections describe the inputs used in this assessment.

5.2 Meteorological Data

The CALPUFF model uses meteorological data for any length of time from one hour to many years. As there was no local wind data to use for the Southern Landfill site, an artificial meteorological data set was developed using the meteorological component of TAPM. This model takes the synoptic weather patterns for New Zealand and applies them over the terrain of the area to be modelled and applies corrections to the wind flows based on real meteorological data for locations within the area. In this assessment URS has used surface meteorological data collected from the Kelburn and Wellington Airport meteorological stations for the years 2007, 2008 and 2009, and wind data from local stations set up by Meridian Energy as part of a power generation scheme on the ridge line to the west of the landfill.

CALPUFF requires complex meteorological data in order to be able to predict the potential effects associated with emissions from the proposed expansion.

This data, together with the topographical data discussed in the following section, is pre-processed using TAPM to produce multi-dimensional hourly varying wind fields.

5.3 Terrain

URS prepared terrain and land use data from the GIS product NZ TOPO 1:50,000 produced by Eagle Technology and the New Zealand Digital Elevation Model with 50 m resolution.

[8] Ministry for the Environment, Good Practice Guide for Atmospheric Dispersion Modelling, 2004

5.4 Model Options

There are a large number of options that need to be considered when setting up CALPUFF. In this section the decisions regarding some of the more important options are discussed.

5.4.1 Building Downwash

URS has selected the transitional plume rise, partial plume penetration, and prime stack downwash options.

5.4.2 Boundary Conditions

CALPUFF can incorporate concentrations of pollutants from areas outside the specific area being modelled. In this case it has been assumed that there are no other significant sources of pollutants, and therefore no external concentrations have been incorporated.

5.5 Specific Model Inputs

The specific inputs to the CALPUFF model developed for the site discharges include meteorological data, the various sources and discharge rates as described in **Section 3**. The inputs and parameters are summarised in **Table 5-1**.

5.5.1 Odour Modelling

The odour monitoring data that was used for this modelling was collected by Watercare Services Ltd and carried out in February and March 2005. The data is summarised in **Table 5-1** and has been used as input into the CALPUFF model.

These values are likely to be an over estimate of potential past emissions, particularly from the landfill face, given that some of the procedures and operations have changed since the time that the monitoring took place.

Table 5-1 Odour Emissions from various Southern Landfill Sources

Source	Average Concentration OU/m^3	Odour Flux Certainty $OU/m^2/s$	Source Area m^2	Odour Emissions from Source OU/s
UW Biofilter	277	0.03	600	11.7
Landfill face	9,350	0.99	625	620.1
Leachate face	6,750	0.72	64	45.8
Turned Compost	2,300	0.24	400	97.6
Unturned Compost	523	0.06	1,600	88.9

6

Assessment Criteria

This section sets out the criteria considered relevant for the assessment of effects of emissions from Stage 4.

As well as the NES, the MfE has produced National Ambient Air Quality Guidelines (NZAAQG) for air contaminants. While the NES were not intended to be assessment criteria, the fact that consent authorities have to determine whether emissions from a site will cause an exceedance of the standard or not means that they are in fact de facto assessment criteria. With respect to the NES only those contaminants relating to emissions from Southern Landfill have been considered in the assessment.

The NES standards for pollutants were primarily designed to ensure that air quality within a defined airshed is maintained at acceptable levels and consequently are not particularly relevant to the operations at Southern Landfill, as the emissions are primarily those associated with emissions in urban areas from high concentrations of vehicles and domestic fires. The concentrations of these compounds from the landfill operations relate primarily to the operation of the flares, engines and vehicles on-site.

In this assessment the odour modelling has been compared to the Ministry for the Environment[9] guideline for sensitive locations of 2 OU/m^3 which is applicable for the residential areas surrounding the site.

[9] Ministry for the Environment, 'Good Practice Guide for Assessing and Managing Odour in New Zealand'

7

Current Mitigation Measures

The existing landfill operates under a comprehensive operations and management plan that sets out how the site will be operated and all aspects of the procedures that are used to minimise potential effects from the site. Due to the sensitivity that surrounds landfills, it is important that the operations that have potential to generate discharges to air have strict management practices in place. As a result a complaint register has been implemented at the Southern Landfill to assist in the management of odours associated with landfilling operations. This is accomplished through review of complaint histories and identifying operations that are potentially responsible for creating adverse off-site effects and implementing appropriate mitigation measures.

A summary of air quality and odour mitigation measures currently utilised at the Southern Landfill is provided below. Similar measures are proposed for Stage 4.

7.1 Odour

Mitigation measures for the off-site discharge of objectionable odours from Stage 4 are summarised below.

7.1.1 Refuse Placement

Odours associated with refuse placement are generally localised at the landfill working face. Therefore, the following mitigation measures are currently used:

- Strict time frames for accepting odorous loads and sewage sludge
  - Not accepting significantly odorous loads after 4.00 pm and without prior arrangement.
  - Disposing of sewage sludge to the landfill between the hours 7.30 and 11.30 am
- Direct vehicle drivers to the appropriate unloading areas.
- Landfill operator available to oversee special waste disposal.
- Control mixture ratios and placement of sewage sludge.
- Spread and compact of refuse material in layers.
- Compaction of refuse in accordance with accepted good practice for sanitary landfilling.
- Covering planned odorous loads immediately with at least 100 mm of compacted cover material.
- Stock-pile cover material, including soil, silt, mixed aggregate, sawdust, demolition spoil and other like materials.
- Landfill staff to check and record that no residual or offensive odours are discharged after the completion of the odorous waste procedure.
- Placing final cover on completed areas of the landfill as soon as practicable.
- Permanent fence mounted odour neutralising spray and mobile odour spray units, to spray odour minimising chemicals in the event that there are strong odours on-site.

7.1.2 Leachate Storage

There is also the potential for there to be some odour associated with the storage of leachate collected from the landfill, prior to it being disposed of to the WWTP at Moa Point. The Southern Landfill has put in place measures to minimise this including:

- Leachate control system, comprising of a series of pipes and drains constructed to collect leachate at the base of the landfill and discharge it to the sewer.
- Ensuring that leachate is stored for a minimum time.

7 Current Mitigation Measures

7.1.3 Landfill Gas

The most effective means of controlling odour from landfill gas is to collect it and utilise it, either in engines to generate electricity or flaring it, which has been implemented at the site. Other measures implemented at the site that further reduce the potential for odours include:

- Connecting newly completed cells to the gas collection system as soon as practicable;
- Maintaining / monitoring the capping over intermediate / final areas to ensure that gas is being collected; and
- Progressively increasing the capacity of the treatment systems to keep pace with the growth in landfill gas generation.

Additional Recommended Mitigation

One of the most effective tools for the identification of odour sources on completed section of the landfill is Instantaneous Surface Monitoring (ISM). This is a technique, which is internationally recognised, and involves walking over the surface of the landfill using a Flame Ionisation Detector (FID). The FID is an instrument that detects the presence of methane, and consequently can be used to identify locations requiring remedial works, where methane, and any odour associated with the other decomposition gases, may be escaping. It is proposed that this monitoring would be carried out on a six-monthly basis.

7.2 Dust

There is the potential for nuisance dust to be generated from activities associated with landfills. Presented below are the mitigation methods currently in place to minimise the generation of dust from the various operations at the Southern Landfill.

7.2.1 Construction

There is the potential for dust to be generated by earthmoving activities, in particular the removal of topsoil and operation of machinery over surfaces, in dry conditions. While the location of the landfill is such that dust is unlikely to result in off-site effects, the following measures are nevertheless used:

- Restricting vehicle speeds on dry unsealed roads or surfaces to 20 kph; and,
- Avoiding removing topsoil or stockpiling in extremely windy conditions.

7.2.2 Landfill Operations

There is also the potential for dust to be generated from landfill operations. In this case, the distance to receptors means that it is unlikely that dust would result in off-site effects. However, there are measures, such as the following, set in place to ensure that the potential for effects is minimised:

- Not intentionally accepting potentially dusty loads;
- If dusty loads are detected during placement, they are covered or watered as soon as practicable;
- Sealing of permanent roads;
- Restricting vehicle speeds to 20 kph on the active cell and haul roads; and
- Rehabilitating completed sections of the landfill as soon as practical to minimise the potential for dust.

8

Assessment of Environmental Effects

This section of the report sets out the assessment of the effects associated with the potential discharges for Stage 4. It is noted that the landfill operates under a comprehensive operations and management plan (OMP) that sets out how the site will be operated and all aspects of the procedures that are used to minimise potential effects from the site.

8.1 Odour

There are a number of potential odour sources associated with landfilling, which include the landfill disposal activities, leachate, and landfill gas. In addition, there are ancillary and adjacent activities that have the potential to generate odours, such as the sludge de-watering process, composting, and the transfer station.

Odour modelling has been undertaken to provide a basis for comparing the effects of the current site and future extension of the landfill. This modelling also provides a basis for validating the assessment of the FIDOL of odours and odour complaints. The results from the odour modelling assessment are provided in **Appendix B**. The odour and emissions associated with landfill gas are discussed in **Section 8.1.2**.

8.1.1 Potential for Odour Effects

It is generally accepted that odours associated with refuse are considered unpleasant by the general population. Therefore, appropriate measures are required to minimise the potential effects. The proposed mitigation measures are outlined in **Section 7**. These are consistent with best practice for the control of odour on landfills.

Even with all appropriate mitigation measures in place there is the potential, that from time to time, odours may be detectable off-site. Consequently, the FIDOL assessment tool, referred to in **Section 4.2**, has been used to determine whether an odour is “offensive or objectionable”. This tool involves assessment against the FIDOL factors: frequency, intensity, duration, offensiveness and location.

Frequency

The sludge co-composting facility is no longer active, and will not be in use for any future operations at the Southern Landfill. Therefore, data prior to the September 2008 decommissioning of the co-composting facility has been excluded from this assessment. Since closure of the co-composting facility, there have been a relatively small number of occasions that odours have been verified by GWRC to have resulted in off-site effects; therefore, it is considered that the frequency is moderate.

The potential frequency will also be affected by the coincidence of low wind speeds and activities on-site that have the potential to generate odour.

At times, there will be strong odours discharged from the landfill face when special odorous wastes are being disposed of, and it is probable that odour from the working face is detectable on-site whenever the working face is open. It has been considered that only odours associated with the special wastes are likely to be detected off-site, and this will be managed as discussed in **Section 7**. The timing of these activities are important, and the Southern Landfill have set out in the management plan that sewage sludge is to be transferred to the landfill at the beginning of the day. The wind frequency distributions, presented in **Table 8-1**, for these times (7:00am – 9:00am) show that the wind speeds are very consistent with the yearly average wind speeds. Other special odorous wastes are

only to be accepted by a prearranged agreement. This is to make sure management measures and appropriate staff are able to minimise the nuisance effect of the odour.

This conclusion is supported by the odour modelling comparison between Stage 4 and the existing portions of the landfill.

Figures B-1 and **B-2** (**Appendix B**) present frequency plots for off-site odour for the current operation and Stage 4, respectively. These figures show the frequency at which odours with a strength of 2 OU/m^3 occur. As shown in the figures the model predicts that the frequency of odours with a strength of 2 OU/m^3 will decrease from the levels associated with current operation when Stage 4 begins to operate. As discussed in **Appendix B** this modelling is intended to show only the relative change, reliance should not be placed on the absolute values presented.

Based on the complaint data discussed in **Section 2**, the actual frequency of complaint since the decommissioning of the sludge composting plant is in the order of 0.15% (compared to approximately 4% when that plant was operating). This frequency is less than that indicated in the Ministry for the Environment Good Practice Guide for Assessing and Managing Odour in New Zealand (MfE 2003) of odours being acceptable for 99.5% of the time; and therefore, the current frequency of odours is considered acceptable.

Table 8-1 Wind Frequency Distribution, Speed 0.5 to 3.0 m/s, at the Southern Landfill

Wind Direction	All Hours Frequency (%)	7-9 AM Frequency (%)
N	**1.3**	1.4
NNE	**1.1**	1.3
NE	**1.0**	1.1
ENE	**0.8**	0.8
E	**0.8**	0.6
ESE	**1.0**	1.0
SE	**2.0**	2.1
SSE	**2.3**	1.6
S	**2.2**	2.0
SSW	**1.6**	1.7
SW	**1.5**	1.6
WSW	**1.8**	2.6
W	**2.8**	2.9
WNW	**3.4**	3.2
NW	**4.1**	3.8
NNW	**2.0**	2.2
Sub-Total:	**29.8**	**30.0**
Calm Wind Frequency:	**0.57%**	**0.61%**
Average Wind Speed:	**4.4 m/s**	**4.33 m/s**

8 Assessment of Environmental Effects

Intensity

Odour associated with the landfill can fall into two categories depending on the source. There will generally be low intensity odours associated with the working landfill face and composting site and these are unlikely to be detectable at any of the closest residences. Also as the sludge de-watering emissions are passed through the biofilter, the odour intensities are likely to be low. However, there is the potential for there to be concentrated odours from time to time from the placement of special odorous wastes such as abattoir waste and biosolids. Provided that the mitigation measures presented in **Section 7** are followed there is limited potential for off-site odorous effects.

The intensity is also affected by the wind conditions and the resulting level of dilution that occurs between the source and the receptor. In essence the stronger the wind, the more dilution will occur, and the lower the intensity. It is generally accepted that odour nuisance typically occurs when wind speeds are less than 3 m/s.

Table 8-1 provides directional data on the frequency of wind speeds for the Southern Landfill wind rose shown in **Figure 2-5**. As the residential suburbs are all located to the east of the landfill (**Figure 8-1**), it is important to analyse the wind conditions and its potential odour transportation capability. The table indicates that approximately 65% of the time, the wind is blowing from the westerly sectors (SSW – NNW); however, only a quarter of these westerly winds have velocities low enough to carry odour in a relatively undiluted manner towards neighbouring residences. Based on this data, the risk of intense off-site odour from Stage 4 due to low wind speeds is considered to be moderate.

To compare the potential odour intensity effects from the existing landfill and Stage 4, URS has conducted odour modelling presented in **Appendix B**. As discussed in **Appendix B** the model value concentrations should be used for comparison purposes and reliance should not be placed on the numerical values due to uncertainties associated with the representativeness of the emission data.

What the modelling is able to present is a comparison between the predicted off-site odours for Stage 3 and Stage 4. These results, presented in **Figures B-3** and **B-4** (**Appendix B**) indicate that Stage 4 will not result in any significant increase in the intensity of odour experienced at these locations.

Duration

Based on experience at other sites and on discussions with staff at the Southern Landfill, the duration of intense odour events are generally short, typically less than 1 hour, with mitigation measures being implemented as soon as practicable to deal with odour. This duration is not expected to change during operation of Stage 4.

The duration associated with the strong offensive odours produced from the special wastes at the landfill tipping site will be minimised by appropriate management procedures as explained in **Section 7**.

Offensiveness

When landfill odours are detected off site they are generally considered to be offensive. Odours from the Stage 4 operations are unlikely to be significantly different to those that occur from the currently operating stages of the Southern Landfill or from other landfills.

8 Assessment of Environmental Effects

Special odorous waste materials are disposed of to the landfill that have the potential to produce odours that would be considered offensive if they were detected off site; however, as discussed, these are likely to be discharged for only short durations due to the management practices adopted by staff on site and generally will not be detected off site.

Location

The change in location of the odour source is likely to have the greatest impact to off-site odour effects associated with the proposed Stage 4 when compared to current operations.

As discussed in **Section 2.4** and shown in **Figure 2-5**, the predominant wind direction at the Southern Landfill is from the northwest. Based on wind direction alone the properties most likely to be effected by off-site odours would be those suburbs located to the southeast of the landfill. However, these suburbs are approximately 2 km from the landfill. Currently, as shown in **Figure 2-4**, the southeastern suburbs comprise approximately 20% of the odour complaints.

Figure 8-1 identifies Kingston and Kowhai Park as the nearest suburbs to the east and northeast, respectively. The Kowhai Park residents are the nearest neighbours and are situated 650 m to the northeast of the current landfill extent. As presented in **Table 8-1**, less than 10% of the total winds, are from both the southwest quarter and less than 3 m/s. Currently, as shown in **Figure 2-4**, the eastern and northeastern suburbs comprise approximately 85% of the odour complaints.

The extent of the Stage 4 filling will be further to the north and further to the west from the current Stage 3 operations. Stage 4 landfilling in the lower portions of the valley are likely to be a similar distance away from the eastern and northeastern neighbours but further away from the southeastern neighbours. Stage 4 landfilling in the upper portion of the valley will be further away from eastern, northeastern and southeastern neighbours. Stage 4 landfilling operations will be generally from the northwest to the southwest of the Kowhai Park neighbourhood. Current (Stage 3) operations are generally from the southwest to the south-southwest of the neighbourhood. As indicated in **Table 8-1**, the frequency of light winds in the direction of Kowhai Park may increase by a maximum of 2.5% during Stage 4 operations when compared to current operations.

In summary, the source of the odours will generally be further away from the receptors but in locations slightly more up wind in the light prevailing wind from the receptors. As a result the Stage 4 landfilling location is not likely to result in a significant change to off-site odours when compared to current operations. The odour modelling presented in **Appendix B** support this prediction. **Figure B-3** modelled from the existing operations show elevated odour concentrations in the south of the Kowhai Park suburb. The Stage 4 model results presented in **Figure B-4** show that the level of odour experienced at these close residences will reduce slightly when compared to current operations.

FIDOL Conclusion

Based on the qualitative analysis of the FIDOL factors presented above, the model results provided in **Appendix B**, and proposed similar or improved mitigation measures when compared to current operations, URS considers that the effect of off-site odours will be similar to or better than current operations (post closure of the co-composting operations). It is anticipated that further improvements associated with on-going analysis of the complaints register will be implemented.

0 0.25 0.5 1 Km

Southern Landfill Air Quality Assessment
Location of Residential Properties

Absolutely Positively Wellington
Me Heke Ki Poneke
Wellington City Council

URS

File:	42775090\ FIGURE8_1.MXD	Designed:	SS
Scale:	1:20,000	Drawn:	SS
Original Size:	A4	Checked:	JH
Date Created:	26 Aug 2011	Approved:	JH

Status: **FINAL**

Figure 8-1

8.1.2 Landfill Gas

The NES requires that landfill gas be collected and combusted through a cogeneration system or flared to minimise its greenhouse potential. As described in **Section 3.4.1** the Stage 4 extension landfill gas extraction system will be developed progressively with gas extraction commencing:

- Once it is safe to do so, without the risk of introducing air into the landfill and creating the potential for a fire.
- When required to manage gas hazards for site workers (based on instantaneous surface monitoring) and odours.
- Once sufficient mass has been accumulated in the landfill to practically recover and combust methane
- Notwithstanding the above, at a cumulative mass of biodegradable/putrescible waste no greater than 200,000 tonnes, in compliance with the NES.

The landfill gas collection system will be designed and operated to meet NES surface emission requirements for methane of 5,000 ppm, and would include the following:

- Landfill gas collection wells
- Landfill gas conveyance system including headers, laterals and ring mains
- Condensate drainage and traps
- A low permeability capping system underlain by a landfill gas collection layer

Landfill gas from Stage 4 will be reticulated to a landfill gas combustion system, consented to receive, treat and discharge such gas in accordance with the NES. Consent for effects related to discharges to air from the landfill gas treatment system is not sought under this application; therefore, those effects have not been considered in this assessment.

Landfill gas collection and combustion are considered to be best practice and are consistent with the NES. It is considered that the proposed landfill gas collection system, together with the separately consented combustion system, would meet the requirements of the NES with respect to landfill gas, and consequently has minimised as far as practicable the potential effects of landfill gas.

8.2 Dust

As detailed in **Section 3**, there is the potential for dust to be generated from the various activities associated with Stage 4 construction and operation.

8.2.1 Potential for Dust Effects

As mentioned earlier, dust emissions can occur as a result of a number of activities on-site. These emissions are currently being minimised through the use of appropriate mitigation measures, such as restricting vehicle speeds, not intentionally accepting dusty loads and rehabilitating completed sections of the landfill as soon as practical as addressed in **Section 7**. In addition, the fact that there is a significant distance to any potentially affected parties means that there is little potential for off-site dust nuisance. The effectiveness of the dust control measures are also supported by the fact that no complaints have been received relating to dust.

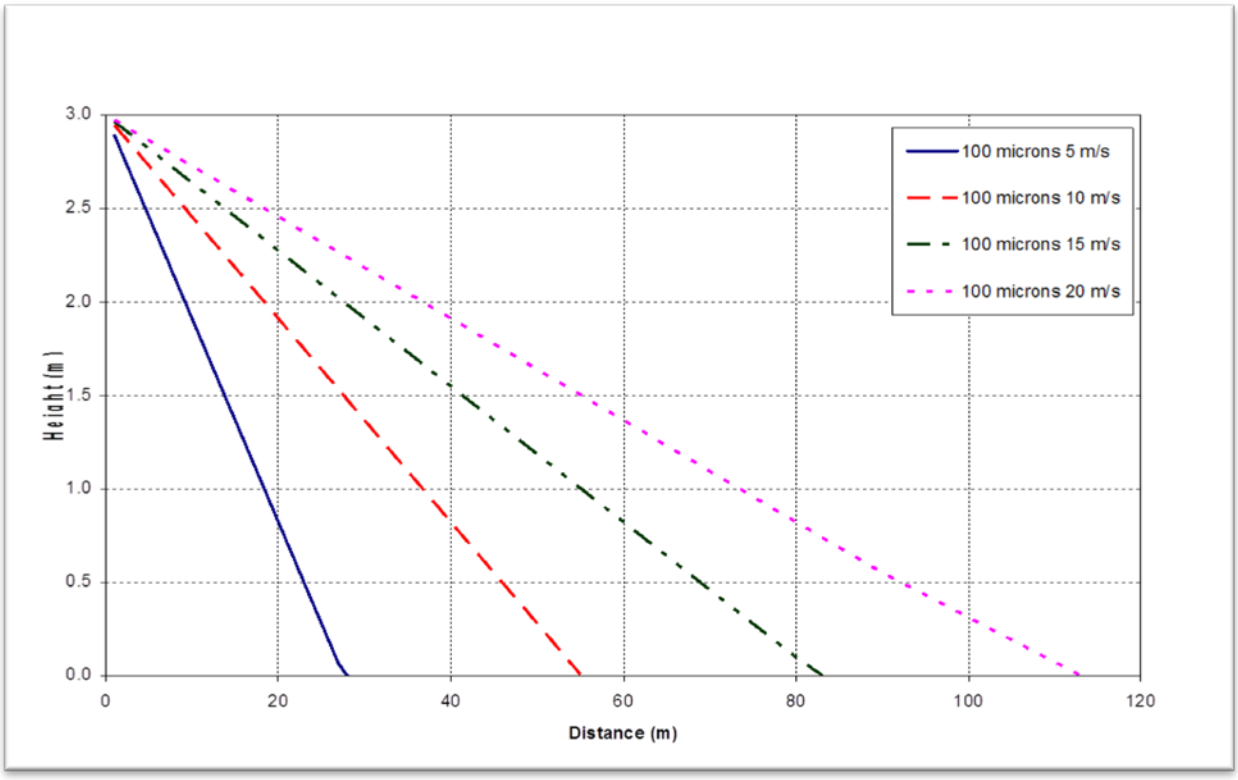
These same measures are proposed to control the potential nuisance dust for Stage 4.

8 Assessment of Environmental Effects

Dust that is generated by landfill activities is generally large (100 µm plus) and typically greater than 200 µm, and consequently as presented in **Figure 8-2**, the particles settle very quickly with distance from the source. The 3 m height used represents the height that general wind borne dust disturbance occurs from the resulting operations and machinery movements on-site. Given this and the location of the nearest residential dwelling being greater than 650m, the potential for dust to be transported off-site and cause nuisance effects is minor.

Taking these details into consideration, it is likely that off-site dust effects for the proposed Stage 4 will be similar to current operations and therefore negligible.

Figure 8-2 Dust Settling Rates



9

Conclusions

WCC is seeking consent for the Stage 4 expansion of the Southern Landfill at Carey's Gully. URS has assessed the air quality related effects of Stage 4 of the landfill.

The principal potential effect is odour, which will be generated to some extent despite the use of "best practicable option" in respect to processing and odour control technology, and management.

In the past the frequency with which off-site odours have been detected and ascribed to the landfill has been at an unacceptable level, despite the fact that not all of these odours have been generated by the landfill. Since the sludge co-composting plant has been decommissioned there has been a significant reduction in nuisance complaints to the point that the remaining complaints are at a level that is considered acceptable in accordance with Good Practice Guide for Assessing and Managing Odour in New Zealand (MfE 2003). The assessment undertaken by URS demonstrates that effects from Stage 4 will be no worse than, and potentially better than those that currently occur as long as all appropriate mitigation measures continue to be utilised. Consequently URS does not consider that the operation of Stage 4 will generate an odour nuisance.

The proposed Stage 4 expansion will be provided with a landfill gas collection system designed and operated in compliance with the NES. The collection system would be reticulated to a landfill gas combustion system consented to receive, treat and discharge such wastes and which meets the requirements of the NES.

Because of its location and the effective management of the existing operation, URS considers that it is unlikely that there will be any off-site dust effects associated with Stage 4.

The landfill currently operates under a comprehensive operation and management plan that sets out how the site will be operated and all aspects of the procedures that are used to minimise potential effects from the site. An operation and management plan will be developed for Stage 4 operation, which will include similar mitigation and control measures. URS considers that these mitigation methods are adequate and consistent with other landfill operations in New Zealand.

10

Limitations

URS New Zealand Limited (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Wellington City Council and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between November 2010 and August 2013 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

A

Appendix A Complaints History

Appendix A - Complaints History

Table A-1 Odour Complaints History since September 2008 (Post Sludge Co-Composting Closure)

Complaint Date	Road Location	Suburb	Orientation	TAPM		Kelburn Met Station	
				Wind Dir	Wind Sp	Wind Dir	Wind Sp
30/09/2008 11:29	ASHTON FITCHETT DR	Brooklyn	NNE	SW	> 5.0	S	> 5.0
2/10/2008 8:28	ASHTON FITCHETT DR	Kowhai Park	NNE	SW	< 3.0	S	< 3.0
7/11/2008 8:58	ASHTON FITCHETT DR	Kowhai Park	NNE	SW	3.0 - 5.0	SE	< 3.0
26/11/2008 8:49	ASHTON FITCHETT DR	Kowhai Park	NNE	E	< 3.0	S	> 5.0
4/12/2008 15:00	QUEBEC ST	Kingston	E	NW	> 5.0	NW	> 5.0
27/01/2009 12:30	QUEBEC ST	Kingston	E	S	> 5.0	S	> 5.0
11/02/2009 9:50	THE RIDGEWAY	Mornington	ENE	SE	3.0 - 5.0	SE	< 3.0
13/02/2009 10:22	ASHTON FITCHETT DR	Kowhai Park	NNE	S	3.0 - 5.0	S	3.0 - 5.0
14/02/2009 10:46	ASHTON FITCHETT DR	Brooklyn	NNE	SE	> 5.0	S	> 5.0
15/02/2009 12:24		Brooklyn	NNE	NW	3.0 - 5.0	N	3.0 - 5.0
12/03/2009 11:01	HAPPY VALLEY RD	Happy Valley	SSE	W	> 5.0	NW	3.0 - 5.0
14/04/2009 9:00	VIRGINIA GR	Kowhai Park	NNE	S	3.0 - 5.0	SW	3.0 - 5.0
5/05/2009 13:23	HAPPY VALLEY RD	Happy Valley	SSE	NW	3.0 - 5.0	NW	3.0 - 5.0
16/06/2009 7:50	HAPPY VALLEY RD	Happy Valley	SSE	SW	3.0 - 5.0	SW	< 3.0
28/06/2009 13:00	ASHTON FITCHETT DR	Kowhai Park	NNE	E	> 5.0	SE	> 5.0
17/08/2009 12:13	ASHTON FITCHETT DR	Brooklyn	NNE	W	> 5.0	S	> 5.0
9/10/2009 10:38	ASHTON FITCHETT DR	Kowhai Park	NNE	S	< 3.0	S	> 5.0
16/10/2009 9:37	WASHINGTON AVE	Brooklyn	NNE	NW	> 5.0	NW	> 5.0
29/10/2009 9:43	ASHTON FITCHETT DR	Kowhai Park	NNE	S	> 5.0	S	> 5.0
18/11/2009 7:52	ASHTON FITCHETT DR	Kowhai Park	NNE	SE	3.0 - 5.0	SE	< 3.0

Appendix A - Complaints History

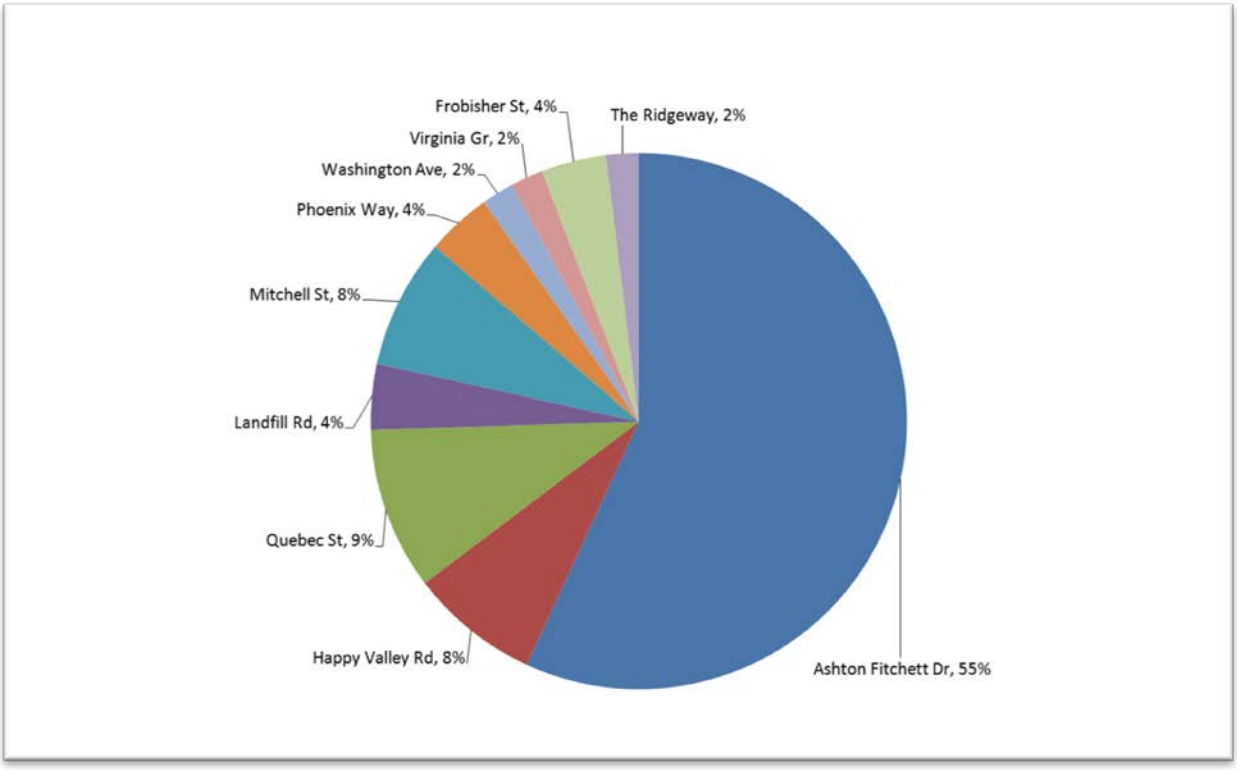
Complaint Date	Road Location	Suburb	Orientation	TAPM		Kelburn Met Station	
				Wind Dir	Wind Sp	Wind Dir	Wind Dir
13/01/2010 19:13	ASHTON FITCHETT DR	Brooklyn	NNE	Data not available		S	< 3.0
19/02/2010 20:40	LANDFILL RD	Happy Valley	SSE			N	< 3.0
6/03/2010 11:15	ASHTON FITCHETT DR	Kowhai Park	NNE			SE	> 5.0
8/03/2010 8:53	ASHTON FITCHETT DR	Kowhai Park	NNE			SE	< 3.0
17/03/2010 11:04	LANDFILL RD	Happy Valley	SSE			SE	> 5.0
17/05/2010 10:59		Brooklyn	NNE			NW	< 3.0
17/05/2010	ASHTON FITCHETT DR	Brooklyn	NNE			NW	< 3.0
24/05/2010 11:11	QUEBEC ST	Kingston	E			SE	< 3.0
24/05/2010 11:18		Brooklyn	NNE			SE	< 3.0
5/07/2010 9:30	ASHTON FITCHETT DR	Brooklyn	NNE			SE	< 3.0
8/07/2010 11:10	PHOENIX WAY	Kowhai Park	NNE			S	> 5.0
16/07/2010 11:37	PHOENIX WAY	Kowhai Park	NNE			E	< 3.0
16/07/2010 11:37	MITCHELL ST	Brooklyn	NNE			E	< 3.0
25/08/2010 15:42	ASHTON FITCHETT DR	Brooklyn	NNE			SE	< 3.0
26/08/2010 12:50		Happy Valley	SSE			S	3.0 - 5.0
28/11/2010 8:25	ASHTON FITCHETT DR	Brooklyn	NNE			E	< 3.0
3/12/2010 8:24	ASHTON FITCHETT DR	Kowhai Park	NNE			E	< 3.0
12/12/2010 10:30	ASHTON FITCHETT DR	Brooklyn	NNE			S	< 3.0
13/01/2011 8:19	ASHTON FITCHETT DR	Kowhai Park	NNE			SE	> 5.0
14/01/2011 0:30	FROBISHER ST	Happy Valley	SSE			NW	< 3.0
14/01/2011 8:15	ASHTON FITCHETT DR	Kowhai Park	NNE			E	< 3.0
8/03/2011 19:27	MITCHELL ST	Brooklyn	NNE			S	< 3.0
28/03/2011 16:04	ASHTON FITCHETT DR	Kowhai Park	NNE			NW	< 3.0

Appendix A - Complaints History

Complaint Date	Road Location	Suburb	Orientation	TAPM		Kelburn Met Station	
				Wind Dir	Wind Sp	Wind Dir	Wind Dir
10/05/2011 15:38	ASHTON FITCHETT DR	Brooklyn	NNE	Data not available		SE	< 3.0
10/05/2011 18:57	HAPPY VALLEY RD	Happy Valley	SSE			S	< 3.0
1/11/2011	QUEBEC ST	Kingston	E			S	< 3.0
9/12/2011 10:00	MITCHELL ST	Brooklyn	NNE			E	< 3.0
9/03/2012 19:30	ASHTON FITCHETT DR	Brooklyn	NNE			SE	3.0 – 5.0
16/03/2012	WATERHOUSE DR	Brooklyn	NNE			S	< 3.0
7/04/2012 9:30	MITCHELL ST	Brooklyn	NNE			E	< 3.0
7/04/2012 19:10	QUEBEC ST	Kingston	E			SW	< 3.0
9/07/2012 15:11	WATERHOUSE DR	Brooklyn	NNE			S	< 3.0
27/07/2012 16:00	ASHTON FITCHETT DR	Brooklyn	NNE			SE	< 3.0

Appendix A - Complaints History

Figure A-1 Street Location of Odour Nuisance Complaints since September 2008



B

Appendix B Odour Modelling

Appendix B - Odour Modelling

Firstly odour modelling can be limited by the variability in odour emission rates, which may not be adequately characterised by 'one-off' odour measurements. It was noted that at the time of the odour survey, the samples collected at the landfill face represented worst case emissions and consisted of odorous material such as abattoir wastes. Under the current management plan, it is highly unlikely that odorous material will remain at high odour intensities for very long consequently it is not considered that the available data is sufficiently representative of odours that are generally occurring from the operation.

Secondly, the model predicts hourly averages; however, in practice odorous peaks will only occur for short durations. The model also assumes that the wind speed and direction remains constant throughout that hour but real-life scenarios suggest that this is not the case and the wind speed and direction may fluctuate. While the models can be run using data with smaller time steps, that data is not available in this instance.

Thirdly, the dispersion model predicts odour concentrations from multiple sources, and according to MfE the concentrations tend to be overly conservative and unrealistic. The model cannot predict whether or not one source is likely to mask another, which is a common phenomenon and therefore assumes that the off-site odours are cumulative.

Therefore, the model results should be considered as one of the indicators to identify the potential adverse effects. Recommendation 17, of the MfE Good Practice Guide[10], it states that "*Modelling should be given less weighting in situations where reliable community assessment data are available"*. This has been considered within this AEE, and there has been a particular emphasis placed on the extensive odour complaints (**Appendix A**).

The Calpuff model was set up with the working face source for Stage 3 in a similar location to where it currently is but at a height equivalent to the almost finished levels for that stage. For Stage 4, the working face was located at the head of the valley at a height equivalent to the almost finished levels for that stage. These locations were selected as it was considered that these were the most exposed locations and therefore the locations that were likely to give rise to the highest off-site concentrations.

The Calpuff model can be used to provide information on the frequency with which a particular parameter can be exceeded. In this case URS has presented some data on the frequency with which 2 OU/m^3 is exceeded, with **Figure B-1** presenting the data for the current operation and **Figure B-2** presenting the data for Stage 4. These values are based on the total number of times the threshold has been exceeded over the entire modelling period, 3 January 2007–31 December 2009 (26,232 hours). Because of the concerns expressed above regarding the modelling data used, the actual quantum of the values is not considered important, what is important is the change that can be observed when Stage 4 is operational. In other words the modelling demonstrates that Stage 4 has less potential to cause off-site nuisance odour than the current operation.

The modelling results presented in **Figures B-3** (existing operations) – **Figure B-4** (Stage 4), indicate that there will also be a potential for the concentration of the odours that do travel off-site to reduce. Any off-site odour travel is likely to occur during calm periods, or when winds are less than 3 m/s and blowing from the western quarters. There is evidence that the modelling correlates with the complaints, as the concentrations that are predicted in Kowhai Park and Brooklyn, which contribute to

[10] Ministry for the Environment, 'Good Practice Guide for Assessing and Managing Odour in New Zealand

Appendix B - Odour Modelling

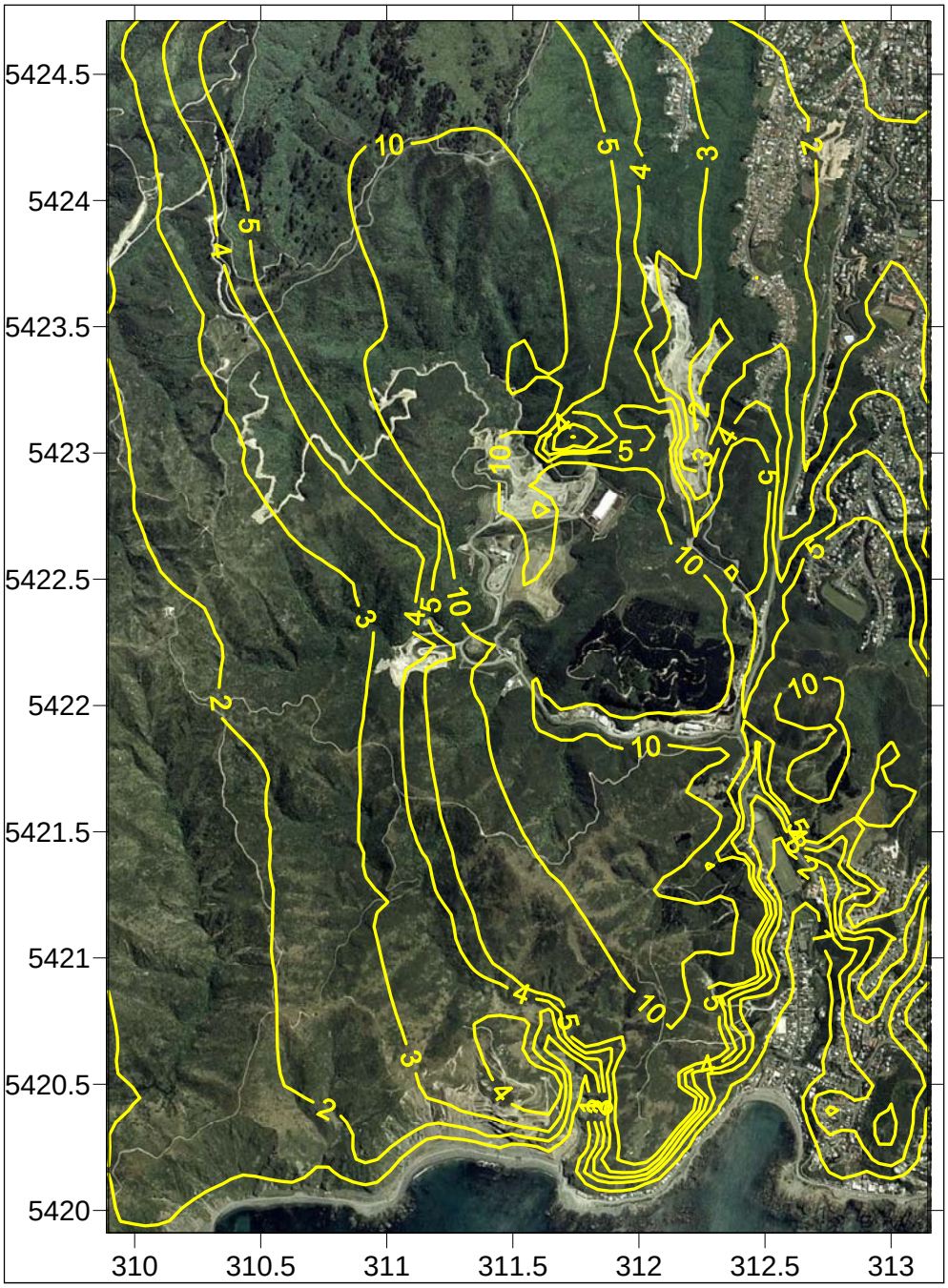
nearly three quarters of the total odour complaints[11], are potentially at a level which is greater than the MfE modelling guideline for odour nuisance on occasions.

According to the MfE[12], odour-modelling values should not be interpreted as a 'pass or fail' test. The evaluation of the potential for objectionable or offensive effects must be on the basis of probability.

[11] See Section 2, Figure 2-5.
[12] Ministry for the Environment, 'Good Practice Guide for Assessing and Managing Odour in New Zealand'

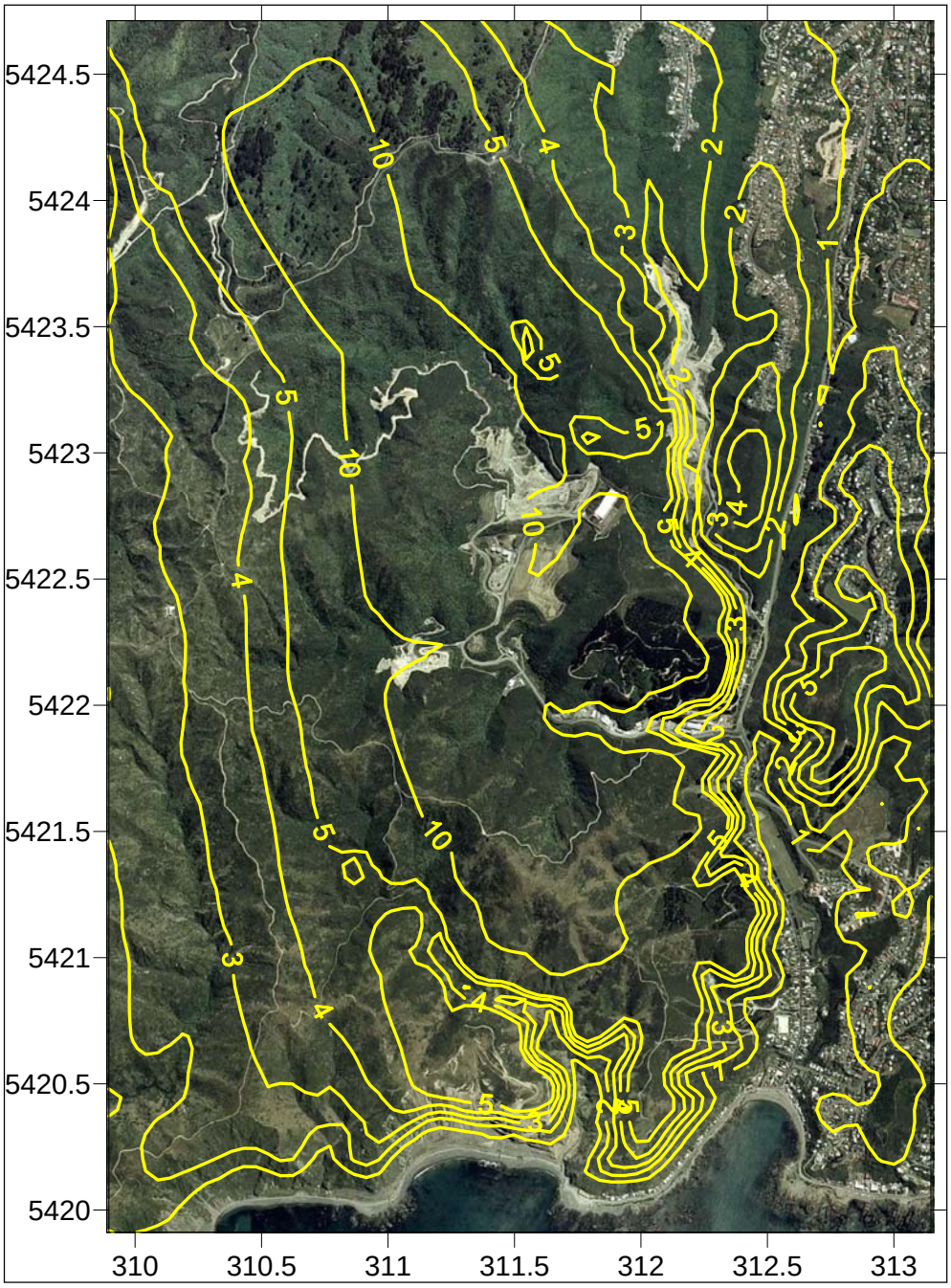
Appendix B - Odour Modelling

Figure B-1 Existing Landfill Frequency Prediction



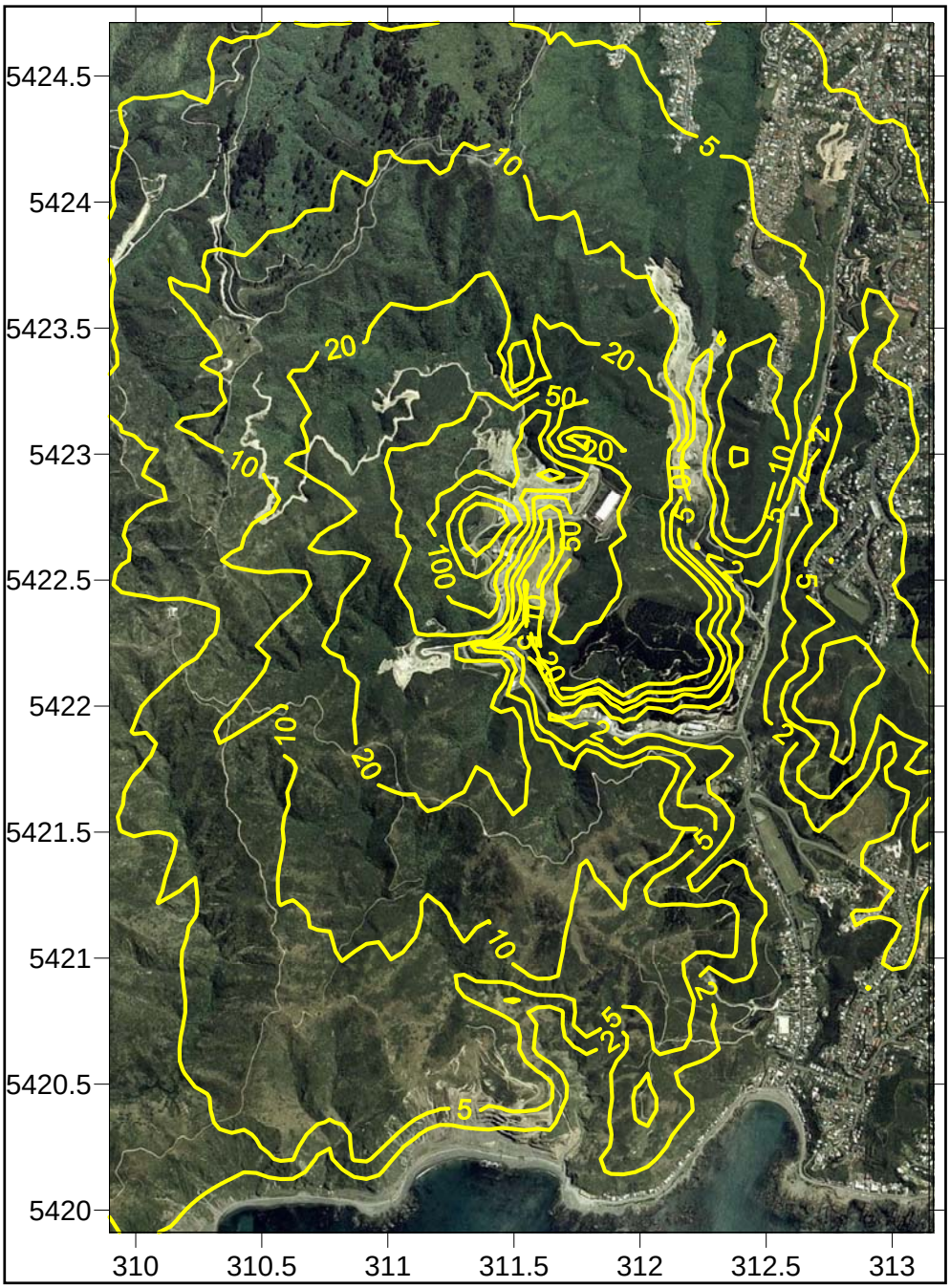
Appendix B - Odour Modelling

Figure B-2 Stage 4 Frequency Prediction



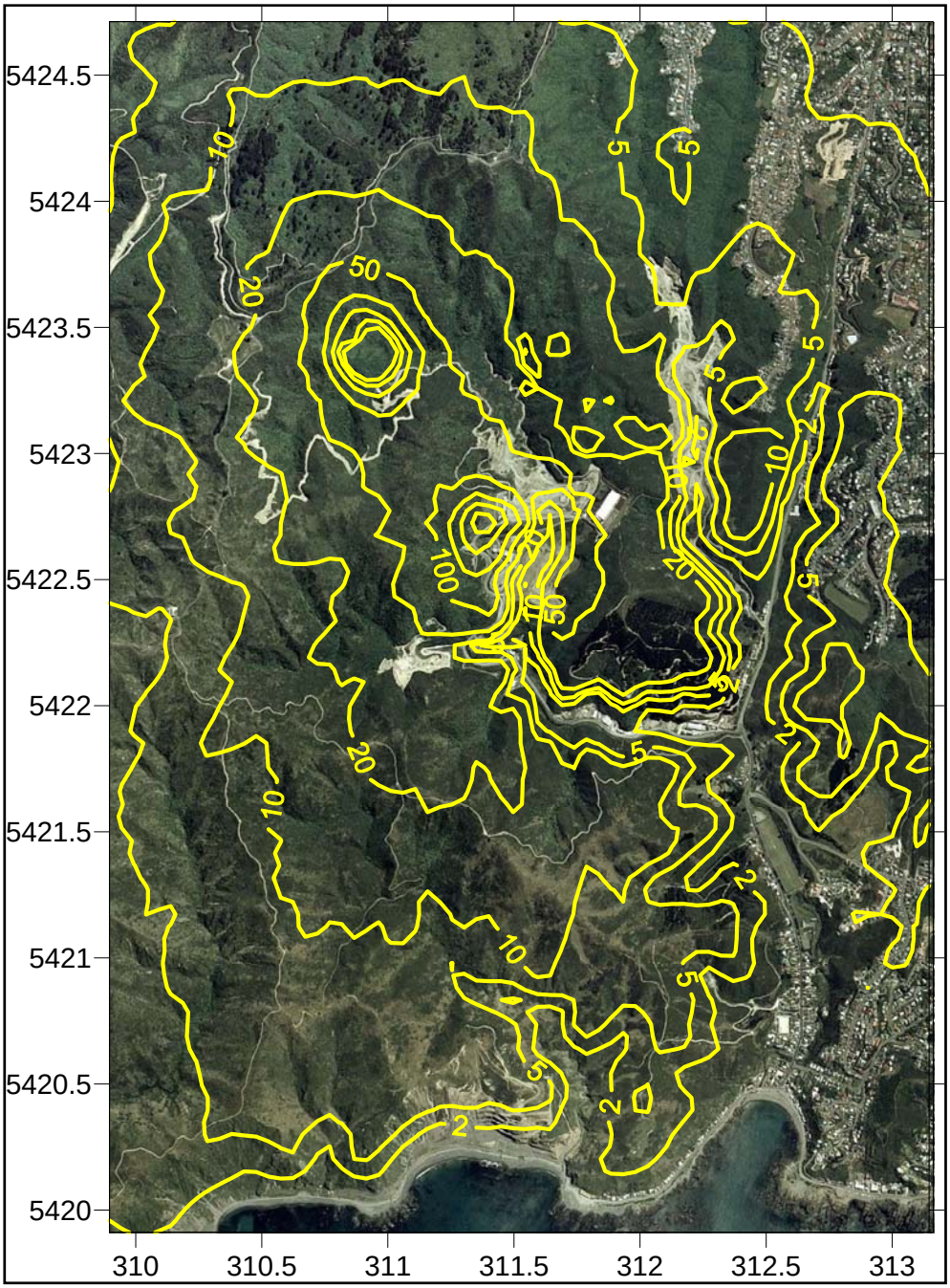
Appendix B - Odour Modelling

Figure B-3 Existing Landfill Odour Concentration Predictions



Appendix B - Odour Modelling

Figure B-4 Stage 4 Odour Concentration Predictions



C

Appendix C Refuse Acceptance Rates

Appendix C - Refuse Acceptance Rates

Table C-1 Historic and Projected Yearly Refuse Acceptance Rates

Year	Tonnes (t)
2017	128,696
2018	128,696
2019	128,696
2020	128,696
2021	118,061
2022	118,061
2023	118,061
2024	118,061
2025	118,061
2026	108,447
2027	108,447
2028	108,447
2029	108,447
2030	108,447
2031	99,757
2032	99,757
2033	99,757
2034	99,757
2035	99,757
2036	91,902
2037	91,902
2038	91,902
2039	91,902
2040	91,902
2041	141,582
2042	141,582
2043	141,582

Year	Tonnes (t)
2044	141,582
2045	141,582
2046	129,709
2047	129,709
2048	129,709
2049	129,709
2050	129,709
2051	188,976
2052	188,976
2053	188,976
2054	188,976
2055	188,976
2056	172,549
2057	172,549
2058	172,549
2059	172,549
2060	172,549
2061	157,700
2062	157,700
2063	157,700
2064	157,700
2065	157,700
2066	144,277
2067	144,277
2068	144,277
2069	144,277
2070	144,277

Data provided by WCC

D

Appendix D Operations and Management Plan

Appendix D - Operations and Management Plan

Set out below are relevant excerpts from the current operations and management plan. An Operations and Management plan will be developed for the Stage 4 expansion that includes similar controls and mitigation.

D.1 Purpose

To ensure the effective controls for the disposal of odorous waste at the Southern Landfill in order that noxious, dangerous, offensive or objectionable odours are not discharged beyond the landfill boundary as defined by the Landfill Resource Consents.

D.2 Scope

This Work Instruction covers the disposal of odorous/malodorous waste from the point at which it enters the landfill across the weighbridge to its ultimate safe burial in the landfill.

D.3 Responsibility & Control

Landfilling of particularly odorous waste shall be undertaken by the landfill operator in accordance with the methods prescribed below

D.4 Competencies

A sound working knowledge and experience in tip face operations and control.

D.5 Equipment

- Permanent fence mounted odour spray
- Mobile odour spray unit
- Excavator
- Compactor
- Sufficient stockpiles of other general waste and cover/backfill material
- Any other material or equipment which might be necessary to ensure the requirements of this instruction are met.

D.6 Definitions

Odorous waste is malodorous waste that has the potential to emit offensive and objectionable odour. Such waste includes, but is not limited to:

- Abattoir wastes and sludges.
- Other sludges, composting material, residues and associated wastes
- Fish waste
- Any putrid material
- Contaminated fill

D.7 Procedure

1. Kiosk operators, where possible, must notify the landfill operator that known odorous waste carriers are entering the landfill.
2. Kiosk operator advises driver of any specific directions in regards to tipping areas as directed by the landfill operator.
3. Landfill operator directs carrier to designated tipping area for odorous waste

4. Landfill operator must ensure that once unloading has occurred, the waste is buried by mixing it evenly with other general waste to avoid creating a water-logged area. Any shortfall of general waste bulking material must be supplemented by suitable quarried material or cleanfill and the area where odorous material was buried covered within 5 to 7 minutes with at least 100mm of compacted cover material.
5. The landfill team leader has to check and record that no residual or offensive odour is emitted from the designated site after the operation is completed in accordance with this procedure.
6. No odorous material will be accepted after 4pm.

D.8 Forms

QF 7.5 Landfilling Odorous Waste Check Sheet

701.9 References

1. QP 7 Control & Monitoring of Nuisance/Discharge - Section 7.5 Odour
2. Landfill Resource Consents
3. Landfill Health & Safety Plan

701.10 Approval

The Business Unit Manager approves this issue of WI.701 for adoption

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