Whangārei WWTP Consent Application

Air Quality (Odour) Assessment

Whangārei District Council

12 August 2021

The Power of Commitment

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Abbreviations

Abbreviation	Term
AEE	Assessment of Effects on the Environment
AWS	Automatic Weather Station
FIDOL	Frequency, Intensity, Duration, Offensiveness and Location
GPG	Good practice guide
IAQM Odour	Institute of Air Quality Management's (IAQM) guidance document on the assessment of odour for planning, July 2018
MfE	Ministry for the Environment
MfE Odour	Ministry for the Environment, Good Practice Guide for Assessing and Managing Odour in New Zealand, 2016
NES	National Environmental Standards for Air Quality, 2004
NIWA	National Institute of Water and Atmospheric Science
NRC	Northland Regional Council
RMA	Resource Management Act 1991
UTM	Universal Transverse Mercator
UV	Ultraviolet
WDC	Whangārei District Council
WWTP	Wastewater treatment plant
m asl	Metres above sea level
km	Length scale or distance (as 'kilometres')
m	Length scale or distance (as 'metres')
NZTM	New Zealand Transverse Mercator

1. Introduction

1.1 Purpose of this report

Whangārei District Council (WDC) currently hold a resource consent (AUT.004352.04.01) for the discharge of contaminants (primarily odours) into the air from the Whangārei Wastewater Treatment Plant (Whangārei WWTP) located at on Kioreroa Rd, Whangārei (the Site). The consent was granted in 2004 and will expire in April 2022 and WDC are seeking a long-term renewal of this consent.

GHD New Zealand Limited (GHD) has been engaged by WDC to prepare an assessment of the potential odour nuisance effects from the Whangārei WWTP on the surrounding community which will support the resource consent application. This report is not a stand-alone report and should not be read separately from the Whangārei WWTP – Resource Consent Application documentation. This report also links to the Master Plan Report[1], which outlines the Adaptive Pathway Planning philosophy for implementing upgrades in relation to wider issues including odour.

1.2 Background

The Whangārei WWTP, located at Kioreroa Road, Whangārei, services an area extending from Dairy Flat in the north, Maunu in the west, Raumanga in the south and Onerahi / Whangārei Heads in the east with a current population of approximately 65,000 people.

Wastewater from Whangārei undergoes advanced secondary and tertiary treatment at the Whangārei WWTP before discharging via a wetland system into Limeburners Creek and ultimately the Hātea River (also referred to as the "Upper Whangārei Harbour").

The plant was constructed in 1968 and has been progressively developed as the surrounding population has increased. The Whangārei WWTP features a number of open treatment vessels/processes which discharge odour to air. These sources require careful management to ensure that odour from the plant does not cause nuisance effects within the surrounding community, particularly for residential receptors located to the north of the plant.

A map showing the location of the Site is presented in Figure 2.1.

Plant Location:	Kioreroa Road, Whangārei
Map Reference:	NZTM 258,556 m E 6,014,007 m S
Legal Description:	Lot DP 65,087 Pt Lot 1 DP 50540

1.3 Scope

The scope of works to undertake an air quality assessment for the Whangārei WWTP includes the following:

- A review of NRC and WDC odour complaint records.
- An assessment of local topography and meteorology.
- Review of community surveys undertaken by WDC.
- Field investigations to identify the existing odour sources and their potential to cause nuisance beyond the Whangārei WWTP's site boundary.
- Interpretation of the community odour interviews.
- The completion of a qualitative odour assessment.

The assessment undertaken in this report was carried out in accordance with the Ministry for the Environment's (MfE) *Good Practice Guide for Assessing and Managing Odour in New Zealand* (2016)[2] (MfE Odour) and the

[1] GHD (2021), "Whāngarei WWTP Consenting – Master Plan Report", Draft version, prepared for Whāngarei District Council, dated July 2021.
[2] Ministry for the Environment, Good Practice Guide for Assessing and Managing Odour in New Zealand, 2016

Institute of Air Quality Management's (IAQM) guidance document on the assessment of odour for planning[3] (IAQM Odour).

The report is set out as follows:

- Section 1: Introduction
- Section 2: Existing environment
- Section 3: Statutory consideration
- Section 4: Existing plant process
- Section 5: Sources of odour from the wastewater treatment plant (Whangārei WWTP)
- Section 6: Odour mitigation and management
- Section 7: Assessment methodology
- Section 8: Odour assessment
- Section 9: Qualitative assessment of odour (FIDOL)
- Section 10 Conclusion

1.4 Limitations

This report: has been prepared by GHD for WDC and may only be used and relied on by WDC for the purpose agreed between GHD and WDC as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than WDC arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

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 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

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.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has prepared this report on the basis of information provided by WDC and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

[3] Institute of Air Quality Management's (IAQM) guidance document on the assessment of odour for planning, July 2018

1.5 Assumptions

The following assumptions have been made as part of this assessment.

- The information obtained from third parties is correct and free from significant error or omission. GHD has accepted in good faith the veracity of this data.
- The observed and inferred conditions are representative of the actual conditions associated with the Whangārei WWTP.

2. Existing environment

2.1 Site location

The Site is located at 79 Kioreroa Road, Whangārei at approximately 258,556 m E 6,014,007 m S New Zealand Transverse Mercator (NZTM), as shown in Figure 2.1. The Site is approximately 2 km south-southeast of Whangārei Township, and 3.5 km northwest of Whangārei Airport.

The Site comprises of the wastewater treatment facility which is designated for wastewater treatment and disposal land use (WD7) and the associated wetland which provides the final filtration for the treated water from the adjacent facility. The land surrounding the Site includes rural production, open space and business /heavy industrial land uses, Figure 2.2 shows the WDC land use zones for the area. Overall, the location of the Whangārei WWTP is considered to be commensurate with the surrounding land use which is predominantly industrial/or rural.

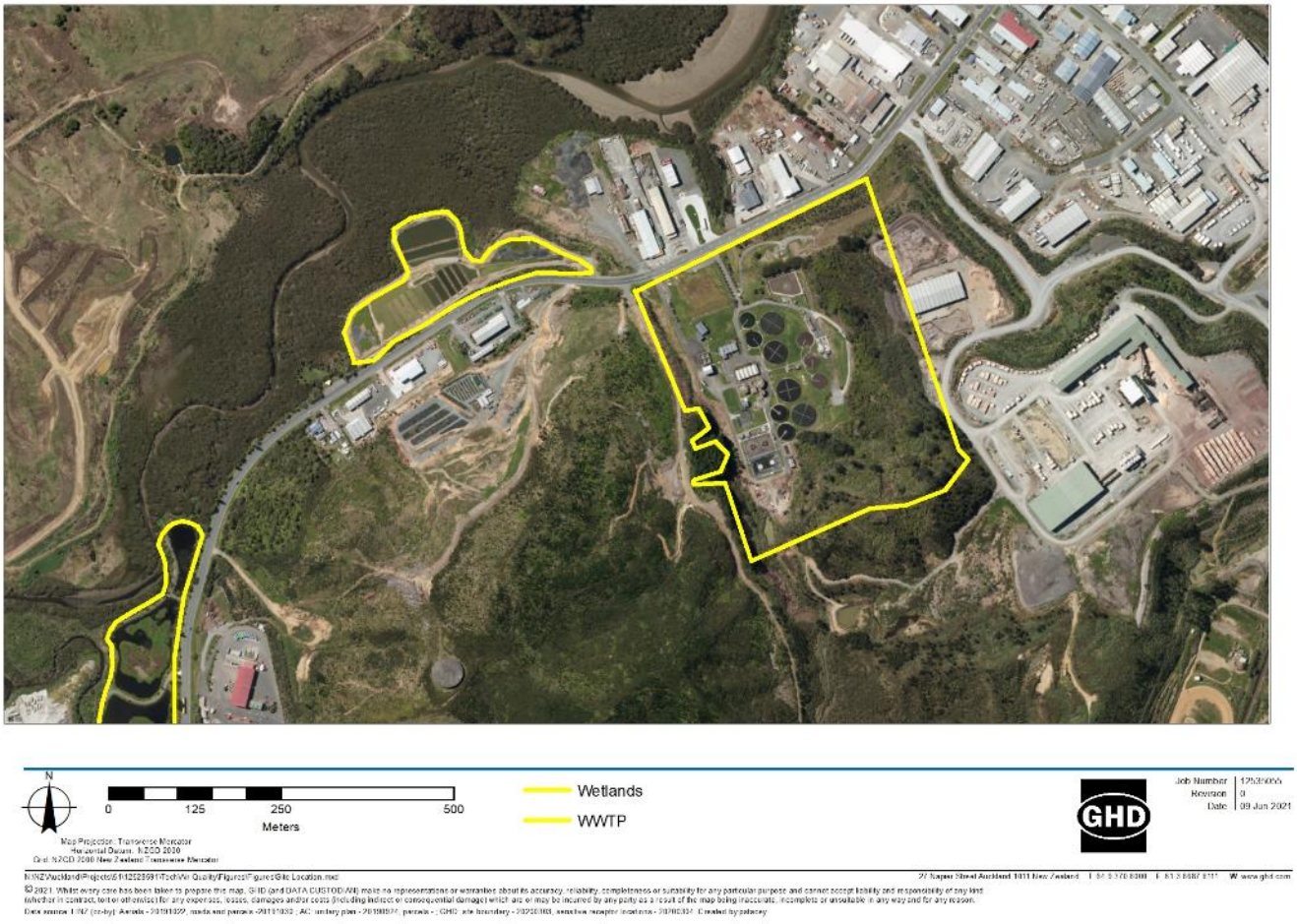


Figure 2.1 Site Location

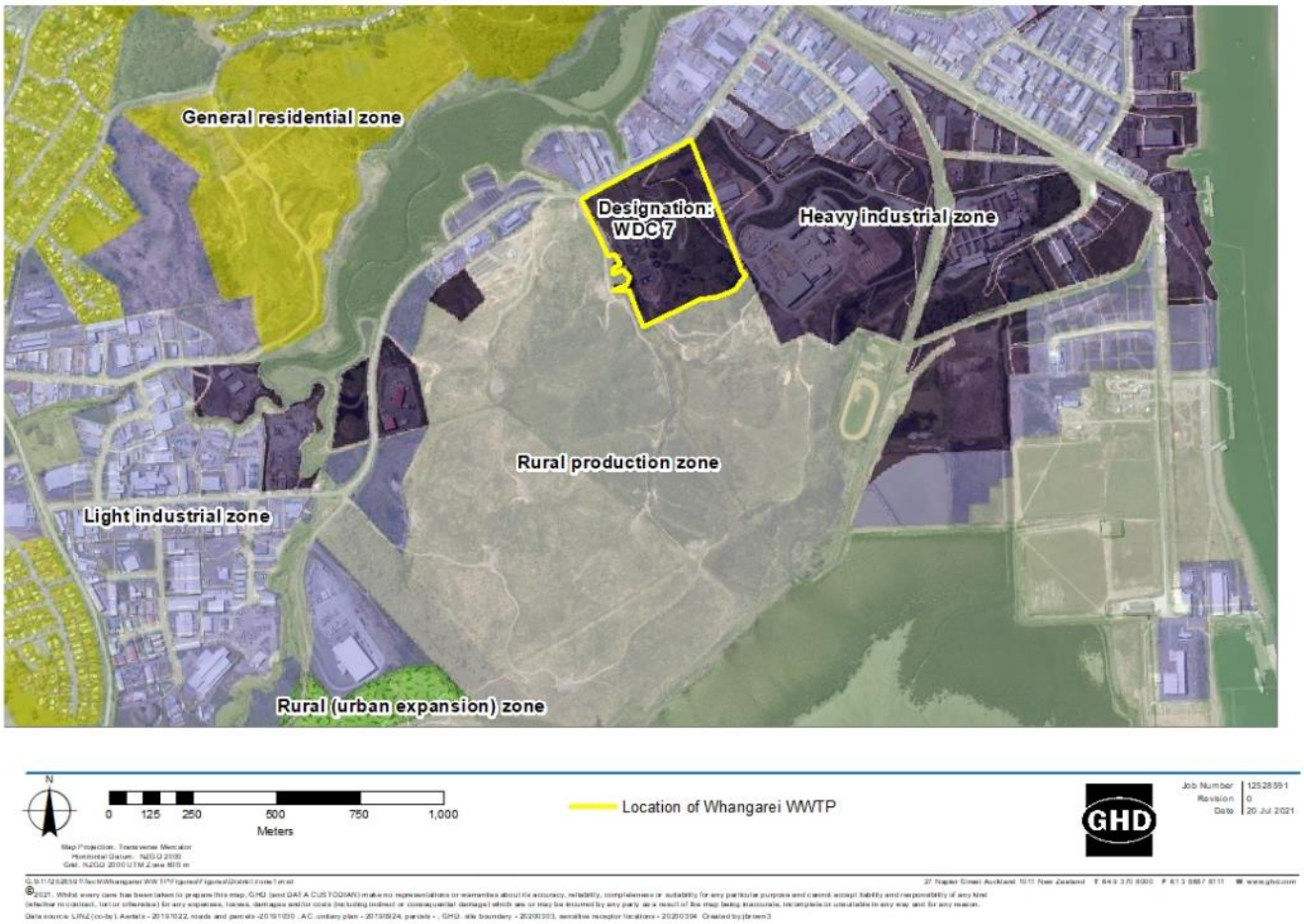


Figure 2.2 Whangārei District Council land use zones

In addition to the Whangārei WWTP, WDC own a number of other properties which surround the Site. These properties are shown on Figure 2.3 as the blue shaded areas. Furthermore, some of the adjacent properties include a covenant on their land title which restricts the property owner from making odour complaints (these locations are shown in Figure 2.3 as orange shaded areas).

Consequently, properties owned by WDC, or those which include an odour covenant have not been considered to be sensitive receptor locations in this assessment.

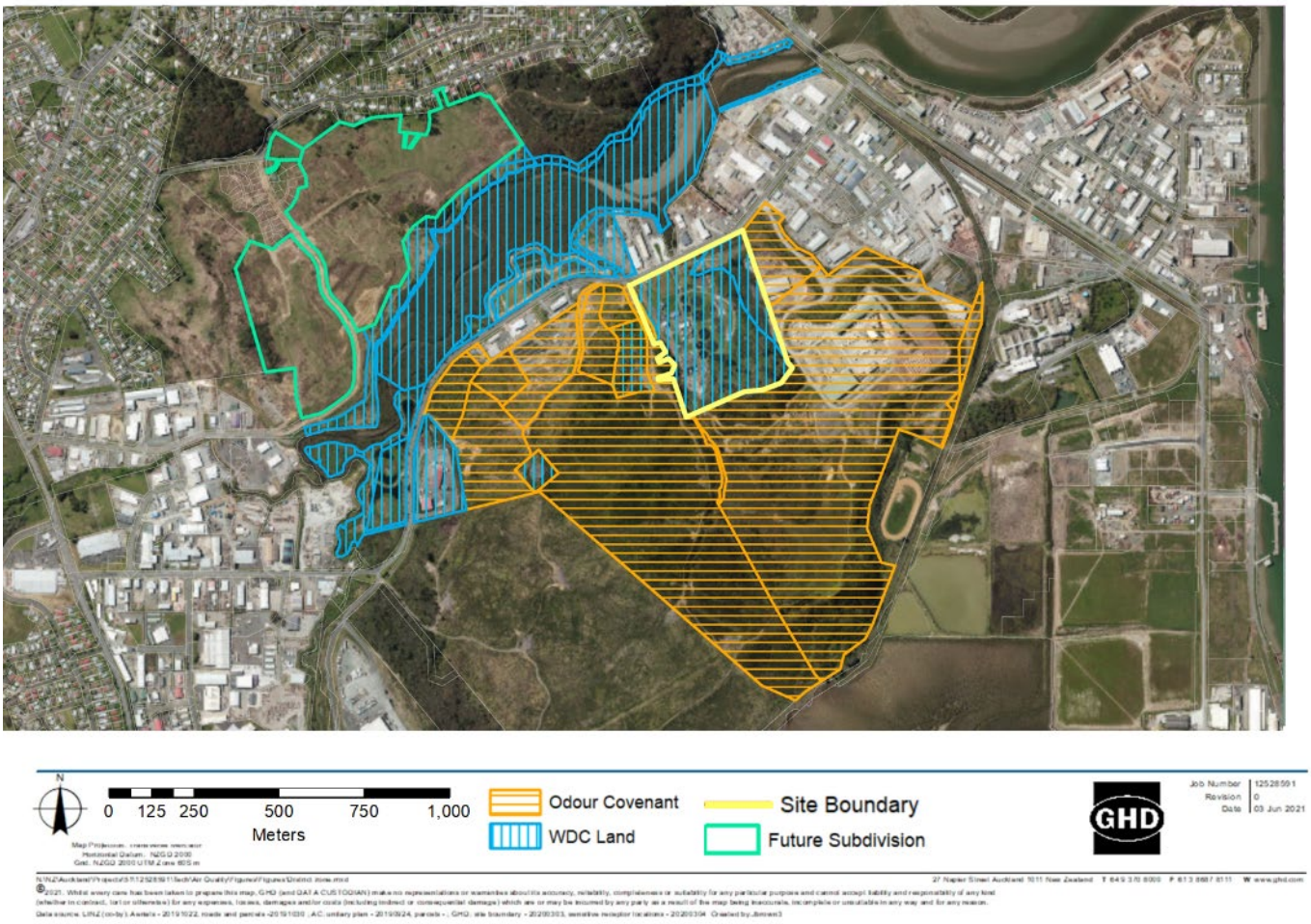


Figure 2.3 WDC owned property and properties with an odour covenant

2.2 Receiving environment

Given the Industrial zoning adjacent to the north and east of the site boundary it would be generally accepted that there should be a higher tolerance to odour at these locations. This is supported by the guidance provided in MfE GPG Odour given for industrial zones, which states the following:

- *Adverse amenity effects tend to be tolerated, as long as the effects are not severe.*
- *Many sources discharge into air, so there is often a mix of effects.*
- *People who occupy these areas tend to be adult and in good physical condition, so are more likely to tolerate adverse effects, particularly if the source is associated with their employment.*
- *Note: Need to consider the time of day, nature of activity, and likelihood of exposure (people are typically present less than 24 hours per day).*

The residential zone (~750 m from the centre of the Site) has a higher sensitivity to odour. For these locations the MfE GPG Odour states the following:

- *People of high sensitivity (including children and the elderly) are exposed.*
- *People expect a high level of amenity in their home and immediate environs (ie, curtilage).*
- *People may be present all times of the day and night, both indoors and outdoors.*
- *Visitors to the area are unfamiliar with any discharges and are more likely to be adversely affected (which can cause embarrassment to residents and raise awareness of the problem)*

The rural production area to the south of the Site has a moderate to high sensitivity to odours which are not typically associated with rural activities. For rural locations MfE GPG Odour states the following:

- *A low population density means there is a decreased risk of people being adversely affected. People living in and visiting rural areas generally have a high tolerance for rural activities and their associated effects.*
- *Although these people can be desensitised to rural activities, they may still be sensitive to other types of activities (eg. industrial activities).*

Overall, GHD considers that based on the varying land uses surrounding the Site any assessment should take into consideration the sensitivity of that location (as defined above) when making such determinations as to whether odour could be at a level considered to be "offensive and objectionable". For example, some level of odour experienced within industrial areas may be appropriate, however if these odours were experienced within residential areas, they may have the potential to cause nuisance effects.

2.3 Site topography and meteorology

2.3.1 Terrain

The Site is located within a valley with hills close to the Site boundary on the east and west and more distantly in the south. The Site is largely flat terrain with a hilly range elevating the land to the south-eastern side as presented in Figure 2.4. Kioreroa Road is at a similar elevation to the Site and gently slopes downhill towards the northeast where Limeburners Creek meets the Hātea River.

With respect to odour effects and the immediate topography it is expected that low speed winds carrying odour from the Site will typically follow valley contours. In this instance, valley drainage is likely to follow Limeburners Creek down towards Hātea River to the east.

Figure 2.4 Terrain around the Site

2.3.2 Meteorology

GHD obtained meteorological data from the Automated Weather Station (AWS) operated and maintained by the National Institute of Water and Atmospheric Research (NIWA) for the period between 1 September 2015 to 31 December 2019. As presented in Figure 2.5 the AWS is located directly north-east of the Site, approximately 10 metres from the Site boundary. Considering the proximity of the AWS to the Site and the data capture rate (>99%), GHD considers that the data recorded at the AWS is representative of wind conditions experienced at the Site.

A wind rose of the data collected between 1 September 2015 to 31 December 2019 is presented in Figure 2.5 and monthly and yearly wind roses are presented in Figure 2.6 and Figure 2.7, respectively. Figure 2.8 presents windroses for day-time and night-time periods and a breakdown of wind distribution frequency is presented in Table 2.1. The hourly wind data indicates that the Site receives winds from all directions, however the predominant winds originate from the south southeast, south southwest and southwest directions with low windspeeds occurring most frequently.

Light winds (typically defined as being less than 3 m/s) provide the worst-case scenario for ground-based odour sources as mechanical mixing (vertical air movements due to the energy of the wind dispersing pollutants through a greater depth of the atmosphere) is limited. Light winds are usually associated with more stable atmospheric conditions (night-time when light winds allow ground-based temperature inversions to develop or light breezes on cloudy days). With a stable or light-breeze neutral atmosphere, ground-based odour sources stay close to the ground (a shallow boundary layer) with less mixing resulting in higher odour concentrations downwind. With less energy due to the light winds, ground-based odours stay close to the ground and will follow contour lines in valleys and are unable to rise up the slopes of valley walls. Hence, worst-case odour dispersion occurs along valleys (especially down-slope when temperature inversions exist at night) and will follow contour lines of the release height and/or to lower elevations.

Based on the meteorological data presented in Table 2.1 and Figure 2.5 light winds (<3 m/s) occur approximately 64% of the time.

Based on the data presented in Figure 2.6, calm conditions (when the windspeed is less than 0.5 m/s) are most common in autumn (15% of the time) and winter (17% of the time). The dominant wind directions observed at the Site does not change substantially throughout the year, with winds most commonly occurring from the southern quarter for the majority of the year, however winds from the northwest can be common in the cooler months.

As presented in Figure 2.7 it appears that there is little inter-annual variation during the period reviewed. During the period of data that was reviewed calm conditions were observed at the Site between 9 and 14% of the time. The predominant wind direction was from the south southeast, south southwest and southwest with windspeeds typically less than 3 m/s. Winds from these direction with a speed of less than 3 m/s occurred 24% of the time.

Given the prevailing winds any odours associated with the Site are likely to migrate downslope to the northeast of the plant, following Limeburners Creek towards the Hātea River. Consequently, the industrial properties located on the northern side of Kioreroa Road are the most likely locations to experience odour from the Whangārei WWTP, especially during calm, or low wind speed conditions where very little dilution of odour occurs.

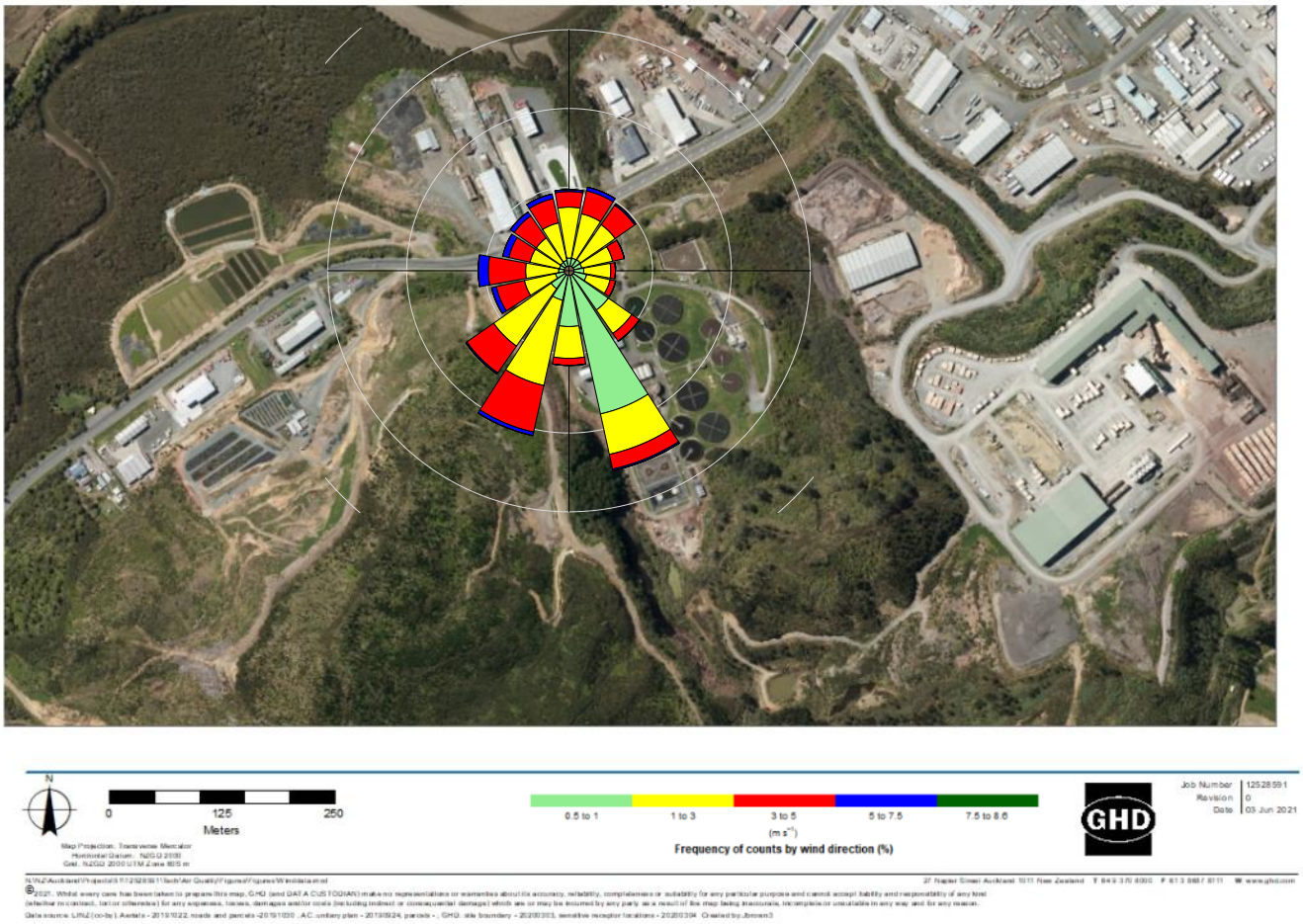


Figure 2.5 Windrose from Whangārei WWTP (September 2015 – December 2019)

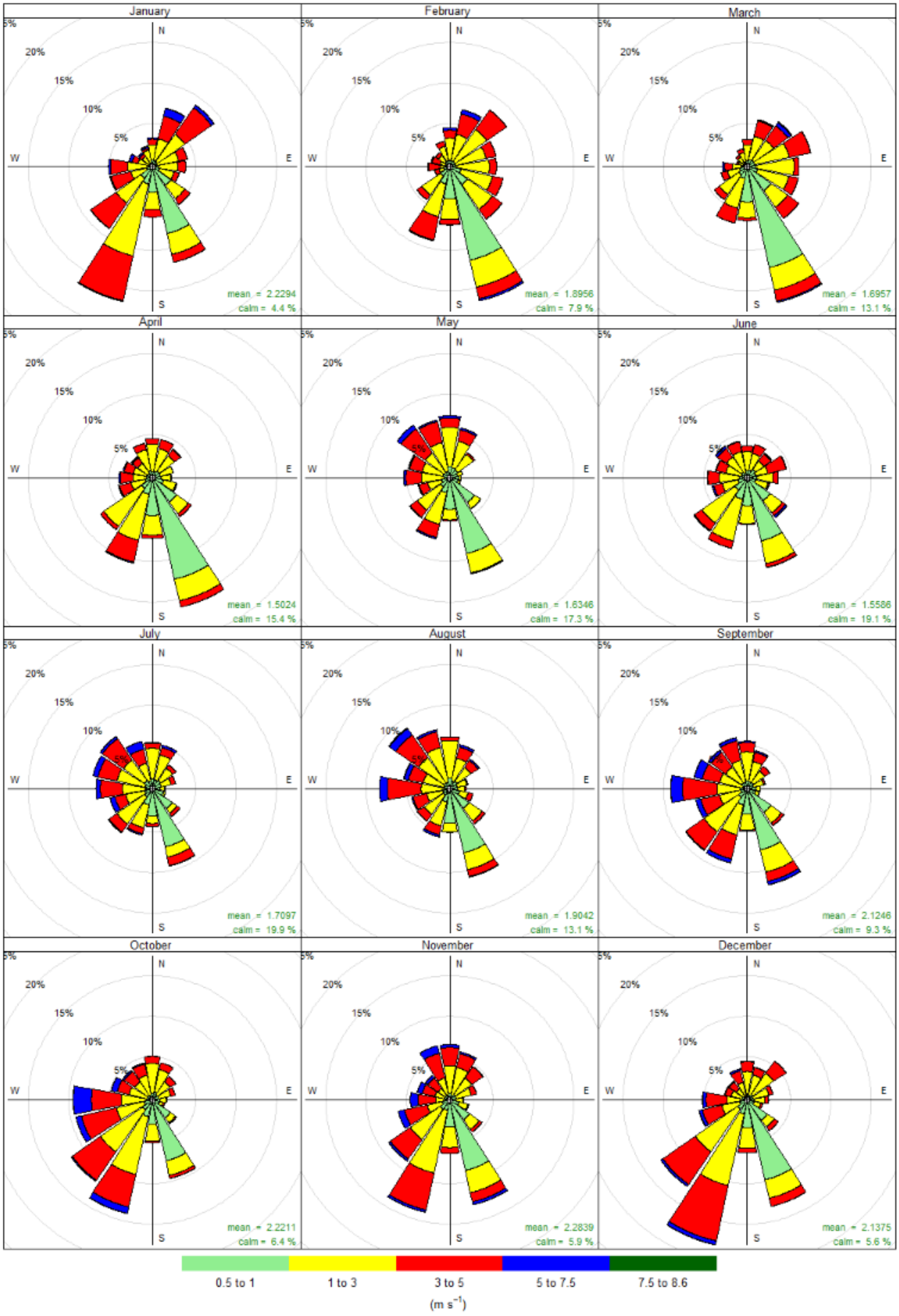


Figure 2.6 Monthly wind rose for the period from September 2015 – December 2019

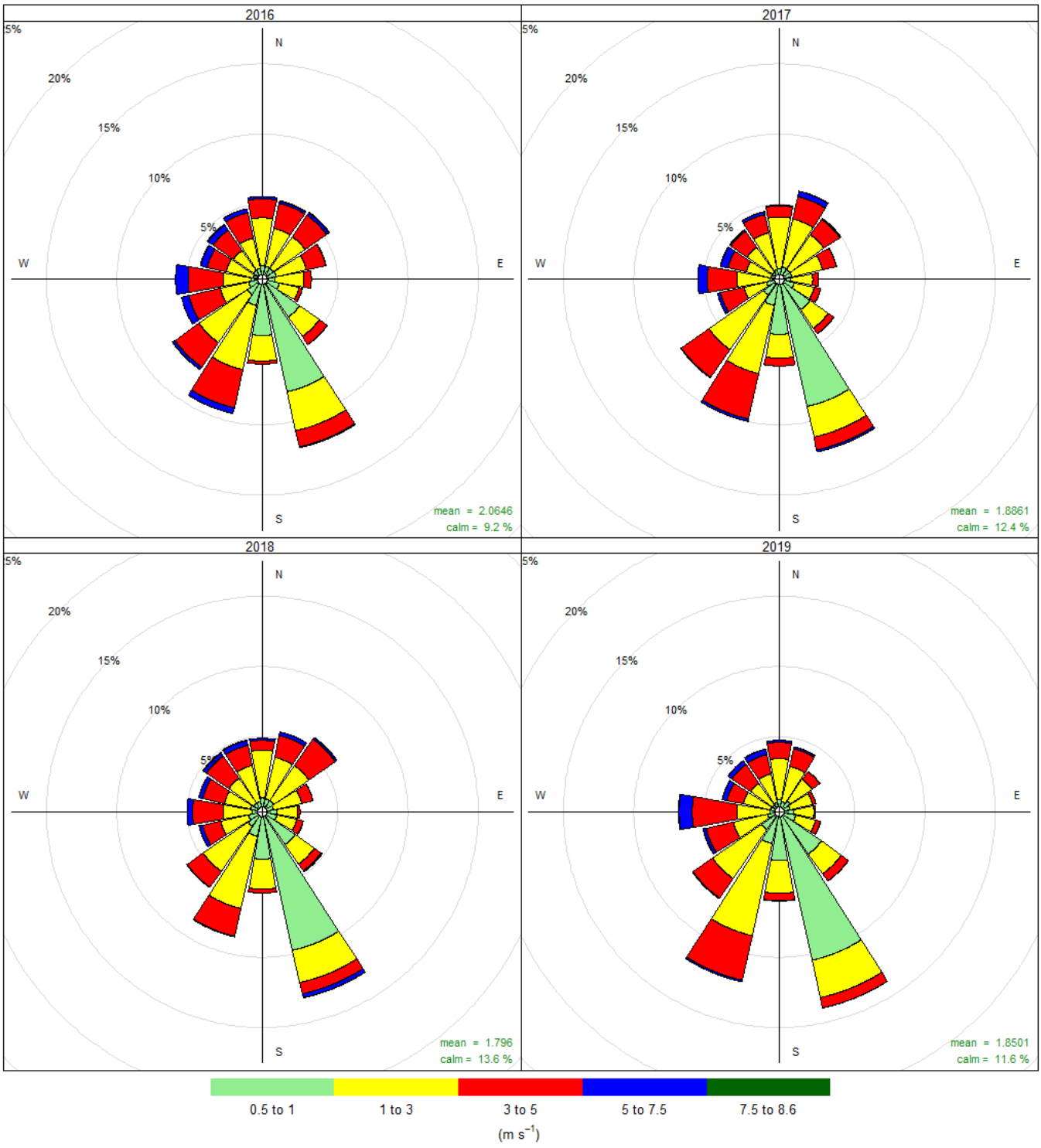


Figure 2.7 *Annual wind rose for 2016, 2017, 2018 and 2019*

Table 2.1 Average wind speed frequency distribution (%) between 1 September 2015 to 31 December 2019

Wind Direction	Wind Classes (m/s)					
	0.5 -1.0	1.0 – 3.0	3.0 – 5.0	5.0 – 7.5	7.5– 25.0	Total (%)
N	0.5	3.3	1.0	0.1	0	5.0
NNE	0.6	2.9	1.5	0.2	0.01	5.2
NE	0.6	2.6	1.5	0.1	0.01	4.8
ENE	0.5	2.0	0.8	0.01	0	3.3
E	0.6	1.6	0.3	0	0	2.5
ESE	0.8	1.4	0.4	0.01	0	2.6
SE	2.8	1.6	0.6	0.02	0	5.1
SSE	9.0	2.5	0.9	0.12	0	12.6
S	3.3	2.0	0.4	0.01	0	5.7
SSW	1.6	5.6	3.2	0.3	0.01	10.7
SW	1.0	4.6	2.2	0.1	0	7.9
WSW	0.6	2.1	2.0	0.4	0.01	5.0
W	0.4	2.2	2.5	0.7	0.01	5.7
WNW	0.3	1.9	1.4	0.4	0.01	4.0
NW	0.34	2.0	1.7	0.3	0.02	4.3
NNW	0.4	2.4	1.6	0.3	0.01	4.7
Sub-Total	23.3	40.6	21.9	3.1	0.09	88.9
Calms	-	-	-			11.1
Total	-	-	-	-	-	100.0

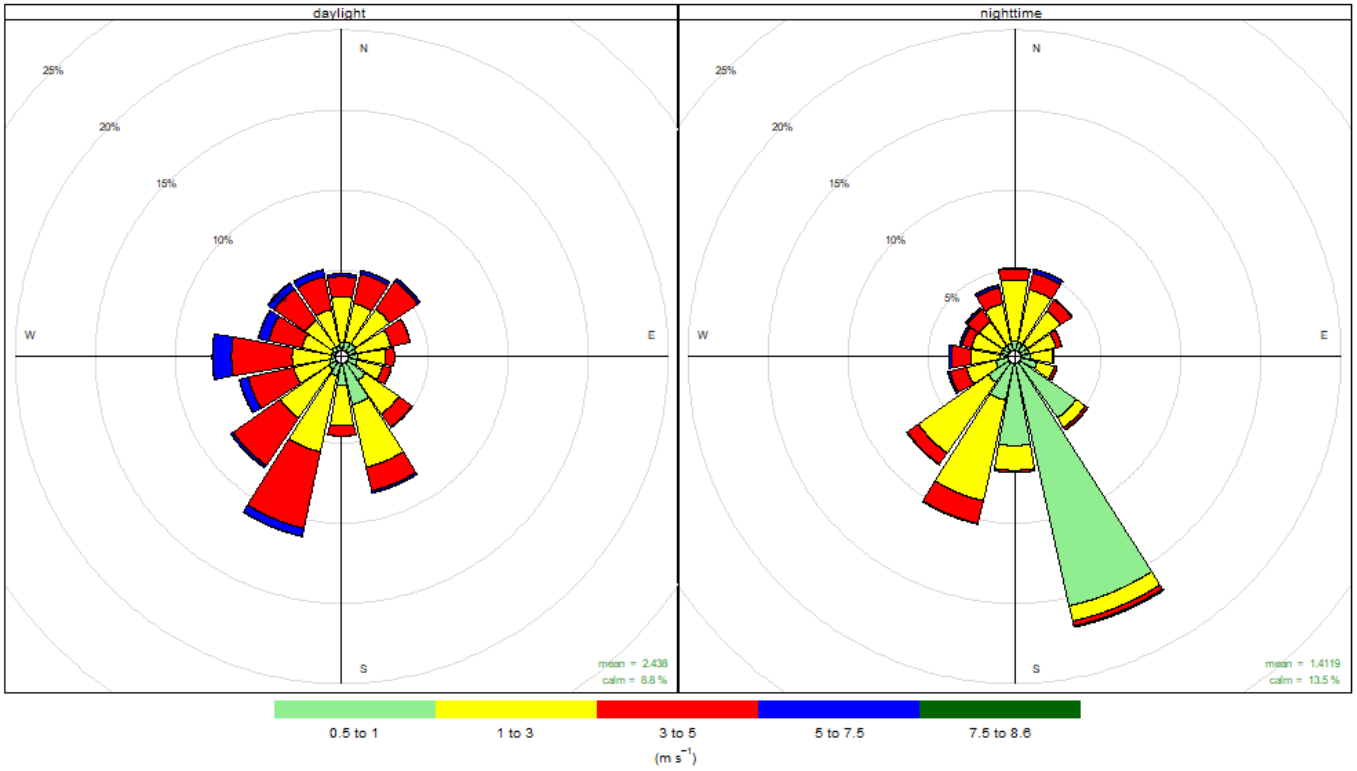


Figure 2.8 Wind rose of daytime/night-time hours for period from 1 September 2015 – 31 December 2019

3. Statutory consideration

The odour assessment presented in this report has considered the requirements outlined in the following statutory documents and recommended guidelines:

- Resource Management Act 1991 (RMA)
- Proposed Northland Regional Air Plan
- District Plan

The following Section summarises the assessment requirements of key regulations and planning documents relevant to discharges to air from the Site. A full statutory assessment of the proposal is set out in the AEE Report.

3.1 Resource management act 1991

There are a number of sections within the RMA[4] which are relevant to this odour assessment. These include:

Purpose

- Section 5(1) sets out the purpose of the RMA, which is *"to promote the sustainable management of natural and physical resources".*
- Section 5(2)(c) provides for this to occur while *"avoiding, remedying, or mitigating any adverse effects of activities on the environment".*

Section 7 Other matters

"In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to:

(c) the maintenance and enhancement of amenity values

(f) maintenance and enhancement of the quality of the environment:"

Amenity values are defined in the RMA as "*those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes*."

Given that offensive odours 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 odour 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. If the activity is prohibited under the plan then a resource consent cannot be obtained.

Section 17 of the Act is also relevant to this assessment:

Section 17 Duty to avoid, remedy, or mitigate adverse effects

"(1) *Every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of the person, whether or not the activity is carried on in accordance with—*

(a) any of sections 10, 10A, 10B, and 20A; or

(b) a national environmental standard, a rule, a resource consent, or a designation.

[4] Ministry for the Environment (1991) Resource Management Act (2018 update)

(2) The duty referred to in subsection (1) is not of itself enforceable against any person, and no person is liable to any other person for a breach of that duty.

(3) Notwithstanding subsection (2), an enforcement order or abatement notice may be made or served under Part 12 to—

(a) require a person to cease, or prohibit a person from commencing, anything that, in the opinion of the Environment Court or an enforcement officer, is or is likely to be noxious, dangerous, offensive, or objectionable to such an extent that it has or is likely to have an adverse effect on the environment; or

(b) require a person to do something that, in the opinion of the Environment Court or an enforcement officer, is necessary in order to avoid, remedy, or mitigate any actual or likely adverse effect on the environment caused by, or on behalf of, that person."

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.

Section 17(3)(a) allows an enforcement order to be made or served that can be made or served by the Environment Court or and Enforcement Officer. These require a person to cease doing something that is, or is likely to be, noxious, dangerous, offensive or objectionable to such an extent that it has or is likely to have an adverse effect on the environment.

In the opinion of the Environment Court or an enforcement officer, 'offensive' or 'objectionable' odour is determined if it has, or is likely to have an adverse effect on the environment.

3.2 Proposed Northland regional plan

Northland Regional Council (NRC) are currently in the process of introducing the Proposed Northland Regional Plan – Operative in Part (PNRP) which has the following discretionary activity rule in relation to air discharges from wastewater treatment facilities.

Rule C.6.2.2 Wastewater treatment plant discharge – discretionary activity

"The discharge of treated wastewater from a wastewater treatment plant into water or onto or into land, and any associated discharge of odour into air resulting from the discharge, are discretionary activities.

For the avoidance of doubt this rule covers the following RMA activities:

- Discharge of treated wastewater from a wastewater treatment plant into water or onto or into land where it may enter water and any associated discharge of odour into air (s15(1)).
- Discharge of treated wastewater from a wastewater treatment plant onto or into land and any associated discharge of odour into air (s15(2)(A))".

Odour discharges from the Site are considered to be a discretionary activity.

The policies contained within the PNRP that are relevant to air discharges from the Whangārei WWTP are provided in the following table:

D.3.1 General approach to managing air quality	**When considering resource consent applications for discharges to air:**
	1. ensure that discharges of contaminants to air do not occur in a manner that causes, or is likely to cause, a hazardous, noxious, dangerous or toxic effect on human or animal health or ecosystems, and
	2. apply the best practicable option when managing the discharge of contaminants listed in the National Environmental Standards Air Quality, and
	3. H.1 Stack height requirements when assessing height requirements for fuel burning devices of more than 40KW capacity, and
	4. consider the use of air dispersion modelling where the effects of a discharge are likely to be significant on sensitive areas, and

	5. take into account the Ambient Air Quality Guidelines (Ministry for the Environment, 2002) when assessing the effects of the discharge on ambient air quality, and
	6. take into account the cumulative effects of air discharges and any constraints that may occur from the granting of the consent on the operation of existing activities, and
	7. recognise that discharges to air may have adverse effects across the property boundary (including reverse sensitivity effects) and adverse effects on natural character, and
	8. take into account the current environment and surrounding zoning in the relevant district plan including existing amenity values, and
	9. consider the following factors when determining consent duration: a. scale of the discharge including effects, and b. regional and local benefits arising from the discharge, and c. location of the discharge including its proximity to sensitive areas, and d. alternatives available, and
	10. use national guidance produced by the Ministry for the Environment, including: a. the Good Practice Guide for Assessing and Managing Odour (Ministry of the Environment, 2016), and b. the Good Practice Guide for Assessing and Managing Dust (Ministry of the Environment, 2016), and c. the Good Practice Guide for Assessing Discharges to Air from Industry (Ministry for the Environment, 2016), or d. any subsequent update or revision of these national guidance documents, and
	11. generally enable discharges of contaminants to air from industrial and trade premises provided the best practicable option for preventing or minimising the adverse effects of the discharge is adopted and significant adverse effects on human health, amenity values and ecosystems are avoided.
D.3.4 Dust and odour generating activities	**When considering resource consent applications for discharges to air from dust or odour generating activities:**
	1. require a dust or odour management plan to be produced where there is a likelihood that there will be objectionable or offensive discharges of dust or odour at the boundary of the site where the activity is to take place. The dust or odour management plan must include a. a description of dust or odour generating activities, and b. potentially affected dust sensitive areas or odour sensitive areas, and c. details of good management practices that will be used to control dust or odour to the extent that adverse effects from dust or odour at the boundary of the site are avoided, remedied or mitigated, and
	2. take into account any proposed use of low dust generating blasting mediums when assessing the effects of fixed or mobile outdoor dry abrasive blasting or wet abrasive blasting. *Note: Policy D.3.3 does not apply to odour associated with the controlled discharge of gas containing an odorant (such as mercaptan) from pipelines and ancillary equipment.*

GHD notes that Section H.7 of the PNPR provides the following definition of "Offensiveness and Objectionable".

"OFFENSIVE, OBJECTIONABLE – 'Offensive' is defined as "giving or meant to give offence; disgusting, foul-smelling, nauseous, repulsive". 'Objectionable' is defined as "open to objection, unpleasant, offensive".

Case law has established that what may be offensive or objectionable under the RMA cannot be defined or prescribed except in the most general of terms. Each case will depend upon its own circumstances. Key considerations include:

i. location of an activity and sensitivity of the receiving environment – for example, what may be considered offensive or objectionable in an urban area, may not necessarily be considered offensive or objectionable in a rural area;

ii. *reasonableness – whether or not an activity is offensive or objectionable should be determined by an ordinary person who is representative of the community at large and neither hypersensitive nor insensitive; and*

iii. *existing uses – it is important to consider what lawfully established activities exist in an area, that is, if a new activity requires a permit, the effect of existing discharges of contaminants into air should be considered."*

3.3 District air plan

There are no specific rules contained within the Whangārei District Plan[5] that are relevant to this air quality assessment. The Whangarei WWTP has been designated as WDC-7 in the District Plan which denotes that the purpose of this designation is for "wastewater treatment and disposal".

[5] Whangarei District Council. Operative District Plan (operative on 3 May 2007). Sourced from Operative District Plan - Whangarei District Council (wdc.govt.nz).

4. Existing plant process

4.1 Operation

A brief description supported by a treatment process diagram (refer to Figure 4.1) and a figure showing the location of various process equipment (Figure 4.2) has been provided below to assist with understanding the parts of the plant which have the potential to generate odour.

4.2 Process description

Inlet works

Raw sewage is pumped to the Whangārei WWTP from several terminal pump stations in the network. The inlets works consists of two sets of screening systems. The normal flow passes through the band screens, followed by a grit trap. The high flows are treated by high-flow screens. All inlet works components are uncovered. Screenings, rags and grits are captured and transferred into uncovered skip bins which are replaced twice a week.

Tanker waste trucks deliver liquid waste into a septage receiving station which also feed into the inlet screens.

Following recent discussions with WDC, GHD understands that the equalisation basin is used as a buffer to smooth out the flow to the remaining wastewater treatment process. The equalisation basin is uncovered and fitted with a surface aerator to provide supplementary oxygen into the wastewater to prevent it from going septic.

Primary and secondary treatment

Screened wastewater is first treated by three primary clarifiers, which removes organics and suspended solids in the wastewater before the primary clarifier effluent is transferred to the trickling filters for secondary treatment. Settled sludge in the primary clarifiers are pumped to the gravity thickeners for thickening and further processing. The circular primary clarifier tanks are uncovered.

There are four trickling filters on site, and they are fed by a flow splitter. Effluent from trickling filters 1 to 3 is collected and returned to the flow splitter via an Archimedes screw pump. This forms an internal recycle stream which improves the trickling filter performance, and this recycle flow is reduced when the plant experiences high flow events.

Effluent from trickling filter 4 flows into the activated sludge basin via gravity. A snail removal facility (i.e. a screen) is installed to remove snails which grow on the rock media on the trickling filters. The removed snails are transferred into an uncovered skip bin for off-site disposal, and the bin is understood to be replaced every 2 – 3 weeks.

Downstream of the snail removal facility, effluent from trickling filter 4 passes through an anoxic selector followed by an aeration basin. The aeration basin is currently serviced by two surface aerators to maintain a target dissolved oxygen set point. This practice is used to maintain aerobic condition and supply sufficient oxygen for organic and ammonia oxidation. Dissolved oxygen is continuously monitored in the aeration basin.

The mixed liquor (the content inside the aeration basin) is pumped to two secondary clarifiers which clear supernatant (secondary effluent) flows to the tertiary filter area (not decommissioned). Settled sludge in the secondary clarifiers is returned to the anoxic selector then to the aeration basin. Excess secondary sludge is pumped to a gravity belt thickener for thickening and further processing.

Tertiary treatment, wetlands and discharge

Secondary clarifier effluent passes through the filter structure, before it flows into the UV system. There are two UV systems on site, one for normal flow condition, and one for high flow condition. The high flow UV system is initiated when the flow exceeds the capacity of the normal flow UV.

The UV treated effluent is then transferred to an outlet chamber at the site boundary, of which up to 10 ML/d of incoming flow is pumped to Wetland 2. The remainder flows into Wetland 1 via gravity. Wetland 1 has been desludged and is planted with floating wetlands.

Both Wetland 1 and 2 have cascade structures which the final effluent is discharged from into the Limeburners Creek through a dense mangrove forest.

Biosolids processing

Primary sludge is pumped from the primary clarifiers to two gravity thickener tanks for thickening. A rag screen is installed upstream of the gravity thickener tanks to remove rags and clumps from the primary sludge stream. The thickened primary sludge is then pumped into one of the two sludge mesophilic digesters for treatment. The rag screen bin and the circular gravity thickener tanks do not have any cover.

Secondary sludge is pumped from the aeration basin to a gravity belt thickener, which is located within a building adjacent to the gravity thickener tanks. Thickened secondary sludge is pumped to the sludge holding tank, near the sludge dewatering building. The sludge holding tank also receives digested primary sludge from the sludge digesters.

The sludge holding tank blends the digested primary sludge and the thickened secondary sludge before feeding into one of the two dewatering centrifuges, which are located inside the sludge dewatering building. Dewatered sludge from the centrifuges are transferred/dropped into the uncovered sludge bins directly below the building. Liquid from the dewatering process is called centrate, and this is pumped back to the treatment plant's inlet works. Sludge skip bins and the rag screen bin are removed offsite for disposal to the Purewa landfill every 2 – 3 days.

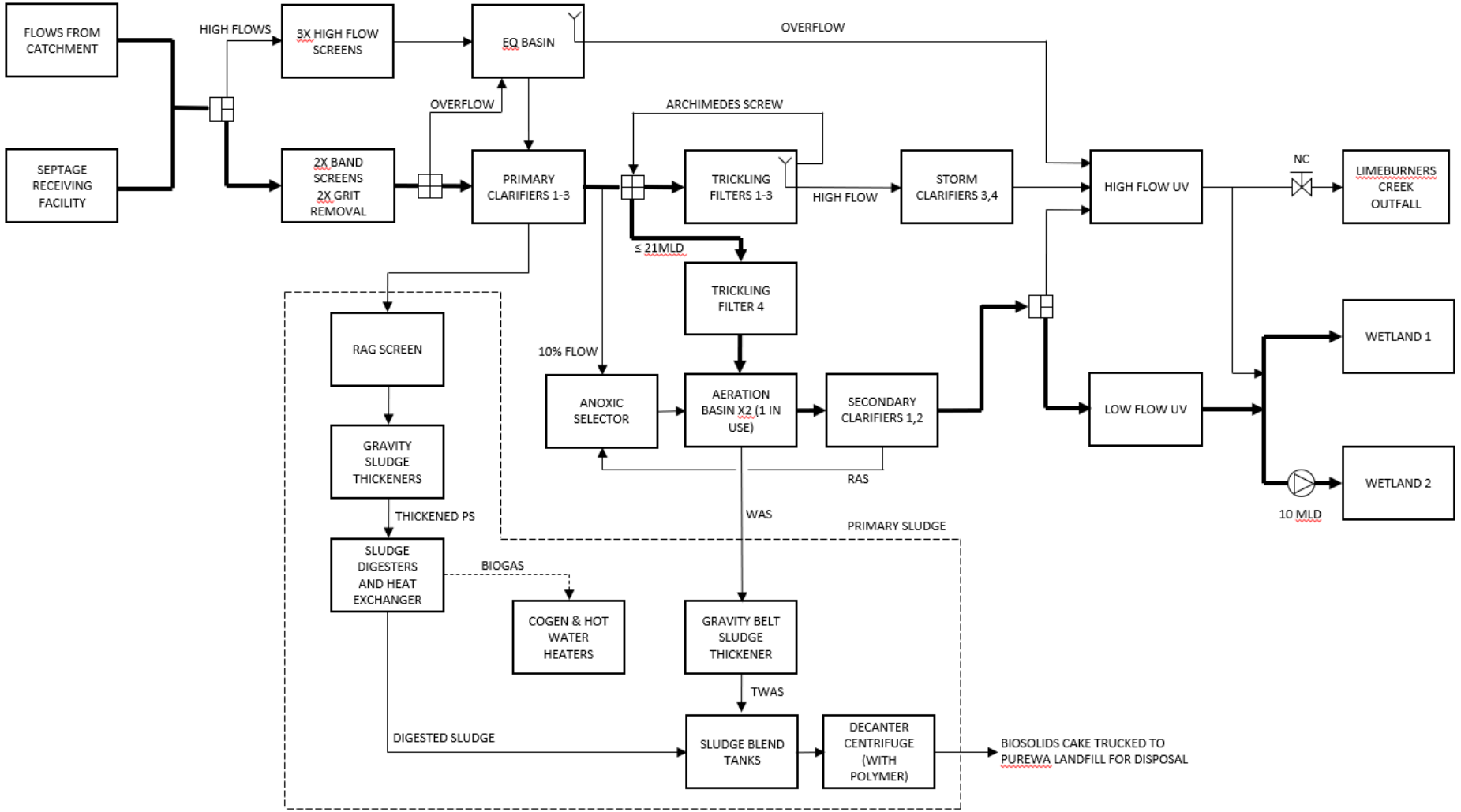


Figure 4.1 Process diagram of Whangārei WWTP

Figure 4.2 Location of treatment units

5. Sources of odour from the Whangārei WWTP

5.1 Odours associated with normal operation

Odours associated with the Whangārei WWTP will always be present around the boundary of the Site, however these will nearly always be of relatively low intensity and not be considered by members of the public to be offensive or objectionable.

Due to warmer temperatures in late spring, summer and autumn months odour associated with the plant operation is expected to be higher. This is largely contributed to two factors, the first being that warm temperatures increase the temperature of wastewater and as a result aerobic bacteria become more active and begin digesting Biological Oxygen Demand (BOD)[6] and other nutrients at a faster rate. The second reason for increased odour is due to low dissolved oxygen coupled with rising temperatures which can lead to an increase in anoxic zones at the bottom of wastewater aeration basins. Anaerobic digestion releases hydrogen sulphide, along with a variety of other gases that are the causes of wastewater odour. These warmer periods are likely to have the greatest potential to cause off-site nuisance effects, particularly if these periods coincide with calm or low wind speed conditions.

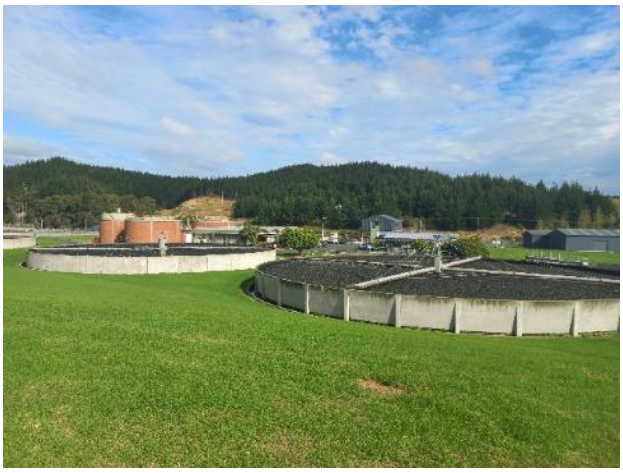
To better understand the potential for the plant to generate odour which can cause off-site nuisance effects, GHD has identified and summarised in Table 5.1 the various parts of the treatment process which have the potential to generate odour. The information contained in Table 5.1 is informed by numerous visits to the site undertaken by GHD staff. The assessment of odours from plant operations is based on normal operation. Plant upsets or periods of significant maintenance may increase the odour potential, these are discussed further is Section 5.2.

Table 5.1 Onsite Whangārei WWTP treatment activities and potential odour sources

Odour source and description	Location image
Inlets works The inlets works removes rags and large solids from the incoming wastewater and facilitates the reception of septic waste from tanker trucks. Because of the high solids loading, the septic tank trucks can temporarily reduce the inlet screen capacity. The inlet works are located near the eastern boundary and are elevated with respect to the rest of the stie. The inlet works are in constant operation and based on site observations odours from this source have a low/moderate level intensity with a dank musty character (neutral to slightly unpleasant).	
Septage receival area While trucks are unloading septage, odour has been observed to be detected occasionally with an associated unpleasant 'faecal' character. Odours associated with this area of the Site were not observed to travel far before dispersing and consequently are considered to have a low potential to directly affect offsite receptors. While odours from this source are relatively minor they can contribute to the overall level of odour associated with the Site and are therefore expected to be managed appropriately.	

[6] BOD is a measure of the amount of oxygen required to remove waste organic matter from water in the process of decomposition by aerobic bacteria.

Odour source and description	Location image
Odours from this source can be expected intermittently while trucks are unloading. Deliveries are variable but in general 50 trucks deliver wastewater per week to the Site.	
Inlets works – bins Located next to the inlet works are two bins which hold the screenings removed from the wastewater. Based on site observations odours from the bins are high in intensity and would be at a level generally considered to be offensive by members of the public. The character of the odour was described as pungent, sharp and putrid (very unpleasant). However, odour was not found to be detected more than 50 m from the bins. The inlet bins are regularly used and are filled throughout the day. These bins are emptied on twice a week. Under poor dispersive conditions odours from the bins have the potential to mix with odours from other operations of the plant which could produce off-site odour nuisance. GHD has recommended that these bins are covered to mitigate odour from this source.	
Equalisation basin The equalisation basin is located in the north-eastern corner of the site. Odour from the equalisation basin is variable, ranging from very low to distinct at an approximate distance of 50 m, or even strong odour at locations adjacent to and downwind of the source. The odour was of an unpleasant musty-dank character. The equalisation basin typically retains a minimal volume of wastewater, however the level varies depending on incoming flows and plant capacity. An aerator has been installed in the equalisation basin to reduce the potential for the wastewater to become anaerobic which will reduce fugitive odour from this source. GHD has recommended a review of the operation of the equalisation basin as there is the potential that raw wastewater is being stored over the day to balance flows during the night, which can cause odour nuisance particularly during early evening periods when poor dispersive conditions occur. Due to the proximity of the equalisation basin relative to the site boundary (~20 m to the north) there is the potential for odour from this source to be detected at off-site locations.	

Odour source and description	Location image
Primary clarifiers The primary clarifiers are generally considered to have a low level of odour potential as they have a relatively low intensity. Odours from these sources are likely to have a neutral to slightly unpleasant musty-dank character. Historically increased odour from the primary clarifiers has been attributed to two occurrences: 1. Excess sludge build up in the clarifier tanks. Sludge removal from the primary clarifiers are automated based on a preset timer, adjusted by the plant operator. However, in the event of mechanical failure, settled primary sludge can accumulate in the clarifier tanks and undergo further degradation resulting in higher odour generation; and 2. High rainfall events may result in an increase of solids from the wastewater network into the plant. This could cause a short-term surge of solids into the primary clarifiers and may generate an increase in odour.	
Trickling filters The trickling filters are constantly in use with two of the arms used to discharge water into the basin. The secondary treatment reactors have the potential to be an odour source, with odours from these sources likely to be of low intensity with a neutral to slightly unpleasant musty-dank character. Odours from this source are likely to be fairly constant.	

Odour source and description	Location image
Archimedes Screw Pump Located downslope from the inlets works, the Archimedes screw pump lifts the effluent from trickling filters #1 - #3 to the flow splitter, facilitating an internal recirculation loop. The archimedes screw pump is used constantly but was not observed to have any noticeable odour associated with it. This process is unlikely to contribute to off-site odour considering the process is located in the centre of the Site and the low level of odour observed from this process.	
Snails bin Located adjacent to the aeration basin is the snails bins which holds snails and other dewatered screenings from the primary clarifiers. The character of the odour can be described as fishy. The snails bin is constantly in use and is filled and disturbed periodically when required. This bin is emptied every 2 – 3 weeks. Odours from the bin were found to be highly offensive, particularly when the contents of the bin have been recently disturbed (i.e. when redistributing its contents with a rake). However, odours from the snails bin were not observed more than 50 m away and consequently is unlikely to be the sole source which could contribute significantly to offsite odour. While odour directly from this source is unlikely to cause off-site odour nuisance, GHD has recommended that this bin is covered to reduce the overall amount of odour being generated from the Site.	

Odour source and description	Location image
Anoxic Selector Located adjacent to the aeration basin, the anoxic selector provides a contact basin for the microbes to reach wastewater prior to the aeration basin to improve sludge settling. The character of the odour can be described as slightly unpleasant musty-dank character. This source was not found to be especially odorous and consequently has a low potential to cause offsite odour.	
Aeration basin Located near to the southern boundary of the Site, the aeration basin is used to aerate wastewater to complete the secondary treatment process. The aeration basin has earthy odours associated with the treatment process however, this source has a low/moderate potential to cause offsite odour, especially as it is located ~ 300 m from Kioreroa Road. The aeration basin is constantly in operation so odours from this source are also expected to be constant.	
Sludge Digesters and Gravity Thickeners Located on the western side to middle of the site. The gravity thickeners (foreground of the photo) thickens primary sludge before feeding it to the anaerobic digester (the tanks in the background). The anaerobic digesters convert sludge into biogas (64% methane, balance is water and carbon dioxide), containing relatively high levels of hydrogen sulphide which gives off a rotten egg type odour. The biogas is sent to either a flare and or/boiler, or used for on-site generation. Any residual odour from these sources is likely to be very low as the majority of the odour is destroyed through combustion. GHD notes that some biogas may leak through the gap between the digester lid and the digester internal wall which could contribute to off-site odour. However, based on our observations this source is considered to have a relatively low potential to cause off-site odour nuisance.	

Odour source and description	Location image
Rag Screen Sludge bin Located adjacent to the gravity thickener, the Rags Screen Sludge bin holds rags removed from the primary sludge. Odours from the bin can be offensive, however given the relatively small size of this source it is unlikely to be a sole contributor to significant offsite odour. Odour was not found to be noticeable more that 50 from this source. The character of the odour from this source can be described as pungent, sharp and putrid. The rag screen sludge bin is constantly in use and is filled as required. This bin is emptied every 2 – 3 days. Similar to the inlet bins, under poor dispersive conditions odours from the bins have the potential to mix with odours from other parts of the plant and therefore have the potential to contribute to off-site odour nuisance. For this reason, GHD has recommended that these bins are covered to mitigate this potential.	
Sludge Holding Tanks Located on the northern side of the building shown in the photo the sludge holding tanks hold sludge prior to the dewatering and disposal into the dewatered sludge bins. In general, the odour from this source isn't noticeable most of the time, however when detected there is a musty, dank odour. The sludge holding tanks will always retain sludge to buffer the demands from the centrifuge operation, which typically operates 8 to 8.5 hrs per day.	

5.2 Odours associated with abnormal operation

Abnormal operation of the plant has the potential to generate odours above the levels typically expected during normal operation. Table 5.2 provides information on a number of abnormal operation events that could generate odour and cause nuisance effects. GHD has estimated the duration, frequency and character of the odour along with information on how the event would occur and what mitigation measures are used to minimise the effects from this event.

Table 5.2 Odour discharges from abnormal plant operation

	Digester Upset	Septic tank spill	Equipment failure	Extended Power outage (>2 hours)
Duration – how many hours or days could the odour last.	A few days to a week.	Typically spills will be cleaned up within 30 minutes to an hour.	This could vary from hours to days.	Worst-case scenario up to 6 hours.
Frequency – how often could the odour be reasonably expected to occur	Very infrequent – typically caused by unauthorised trade discharges (Has occurred once in the past 10 years).	Seldom.	Seldom.	Very rare (1-4 times per year).
What happens	Sludge turns sour and requires the digester to be emptied and re-seeded.	Tanker truck operators could accidently cause a spill. However, they have the responsibility and capability to clean up the spill.	Equipment failures such as mixer or aerator fails and anerobic conditions may develop – causing elevated levels of odour.	No emergency power – everything stops – aerators and pumps stop – anaerobic conditions in aeration basin develop. There is also the potential for spillage.
Odour Character – some indication of the odour character and intensity.	Very high intensity odour with very unpleasant character.	Moderate to high unpleasant 'faecal' character.	High intensity of odour with a hydrogen sulphide (or rotten egg) character that can be considered nauseating.	
What **mitigation measures** are implemented to minimise the likelihood of this event/activity occurring.	Monitor the digester health through regular sampling. Undertake investigation to find cause of digester poisoning.	Ability to clean up spills quickly – inspected by operator.	Suitable spares are kept onsite to minimise downtime.	EQ basin can provide temporary storage during power outages (typically 2-3 hours).

6. Odour mitigation and management

6.1 Odour management

A key component of the Adaptive Pathway Planning philosophy for the Site is to develop methods for monitoring the operations at the plant to identify whether particular indicators are triggered which may then require a series of actions/improvements over time (pathways).

Methods for managing odour are recommended, including providing site staff with a comprehensive odour management plan that sets out the methods/procedures for minimising odours, the adoption of a robust “odour upset” log/incorporated into a site-wide ”Incident” Log, investigation of any odour complaints, undertaking regular independent odour surveys, and an adaptive management plan which will prescribe the monitoring methods, triggers and decision making processes for implementing the Adaptive Pathway Planning approach. These are described in further detail below.

6.1.1 Odour Management Plan

Development of a robust Odour management plan (OMP) for the Site. The OMP should ensure that the Site is operated and managed in a manner which will: ·

- Avoid, remedy or mitigate potential odours arising from the plant; and ·
- Assure compliance with the conditions of the resource consent.

Based on experience and guidance prescribed in Appendix 1 of the MfE Odour, the OMP for Whangārei WWTP should include (at a minimum) the following:

- Key personnel contact details, including management personnel and employees responsible for the implementation of the OMP.
- Identification of employee responsibilities for the implementation of the OMP.
- Employee training (in relation to odour remediation or mitigation procedures).
- Identification of potential sources of odour.
- Plant operational parameters/ controls required to control odour.
- Odour management, remediation and mitigation measures, including inspection, monitoring, maintenance and housekeeping procedures.
- Contingency/ emergency planning and procedures (including identification of risks and incidences) and remedial actions (including waste product removal).
- Management review and reporting procedures.
- Complaint response, investigation resolution and reporting procedures.

6.1.2 Odour Upset / Complaint Logs:

At a minimum, GHD recommends that the following information is recorded at the time of a complaint and/or odour event:

- Time of day;
- Wind speed and wind direction;
- Location at time of complaint (relevant for complaint log only):
- Cause of odour event; and
- Time to resolve odour event.

It is intended that these logs can be used to better understand the cause of odour complaints and consequently facilitate updates to the odour management plan or identify deficiencies in plant operation and therefore trigger the need for site upgrades through the adaptive management plan. It is GHD’s recommendation that these logs are reviewed on a six-monthly basis to identify any recuring causes.

6.1.3 Independent Odour Surveys:

Based on similar sites with diffuse odour sources, independent surveys are proposed to be undertaken on a six monthly basis ensuring that one of these surveys is conducted in the summer months. The surveys would be reviewed on an annual basis (including any trend analysis) with recommendations made on whether further investigation is warranted, updates to the OMP are required and/or upgrades (as outlined in Section 6.2). It is envisaged that the results of the review would be shared on a regular basis with an established liaison group, with feedback sought. Decision making on the actions necessary to address the recommendations made in the annual reporting, particularly around plant upgrades would be guided by the procedures/methods set out in a proposed Adaptive Management Plan (discussed in Section 6.3 below).

6.2 Proposed plant upgrades

Table 6.1 provides a summary of the various upgrades that have been proposed in the short-term along with an overall assessment of the potential effect on odourous discharges.

GHD understands that the various waste storage bins discussed in Section 5 will be covered within the next 12 months and has based the assessment provided in Section 8.3 on the assumption that these odour mitigation measures will be in place.

The upgrades proposed in the Master Plan are to either improve capacity and/or water quality. None of these upgrades are expected to have a significant impact on odour in terms of increasing the overall odour potential from the plant, upgrades will consider potential improvements that can be made to minimise odour discharges.

If odour from the plant is found to increase and create significant odour nuisance within the local community, this is proposed to be identified via routine independent odour surveys which will trigger further investigation and review of management procedure and if necessary, plant upgrades. An assessment of these potential improvements is outside the scope of this assessment and an updated version of this assessment would need to be undertaken to better understand the benefit of additional odour mitigation.

Table 6.1 Proposed Whangārei WWTP upgrades

Proposed Upgrades	Influence on Odour	Timeline for implementation
Activated Sludge Basin	No impact on odour	Over the course of the consent
UV system upgrade	No impact on odour	Within the next three years
Covering of inlet works bins	Minor reduction in odour	Within the next 12 months
Covering of rag screen bin	Minor reduction in odour	Within the next 18 months
Covering/treatment of odour from Sludge Storage bins	Minor reduction in odour	Within the next 12 months
New Tertiary Filters	Minor reduction in odour	Within the next three years
New Septage Receival	Minor reduction in odour as odour discharges are minimised.	Within the next three years
Upgrade of Centrifuge	No impact on odour	Within the next three to five years
Investigation into the optimisation of the EQ basin to reduce odour – e.g. instead of sending excess screened wastewater to EQ basin, divert after primary clarifiers (which has less solids and organics, lower odour generation potential)	Potentially significant improvements in the level of off-site odour	Within the next 18 months
Biofilter to treat odour from inlet works	Minor reduction in odour	Triggered depending on the findings of independent odour surveys undertaken on a three-

Proposed Upgrades	Influence on Odour	Timeline for implementation
Covering and treatment of various parts of the plant process	Potentially significant improvements in the level of off-site odour	monthly basis. If independent odour surveys find odour to be offensive and objectionable at off-site locations where people could be affected, an additional round of surveys would be undertaken to confirm the results. If off-site odour is confirmed to be at unacceptable levels further action/upgrades to the plant to reduce odour would be implemented.

6.3 Adaptive Management Implementation

The key feature of the Adaptive Pathway Planning approach is the continuous loop of ongoing monitoring of triggers and review of solutions as understanding of the activity and its effects is improved and as drivers change or as new drivers emerge. As noted above in Section 6.2, if odour from the plant is found to increase and create significant odour nuisance, identified via independent odour surveys, this will trigger WDC to undertake further investigation and review management/operational procedures, and may result in the need for plant upgrades specifically to address odour management.

It is proposed that an Adaptive Management Plan is developed that would detail the methodology to be applied by the independent odour surveyor, define the trigger(s) that would drive the need for action, procedures for decision making (including response times), and process for updating the Master Plan and/or OMP. Figure 6.1 presents the continuous loop of ongoing monitoring/review and refining the solution for an optimal outcome to the community.

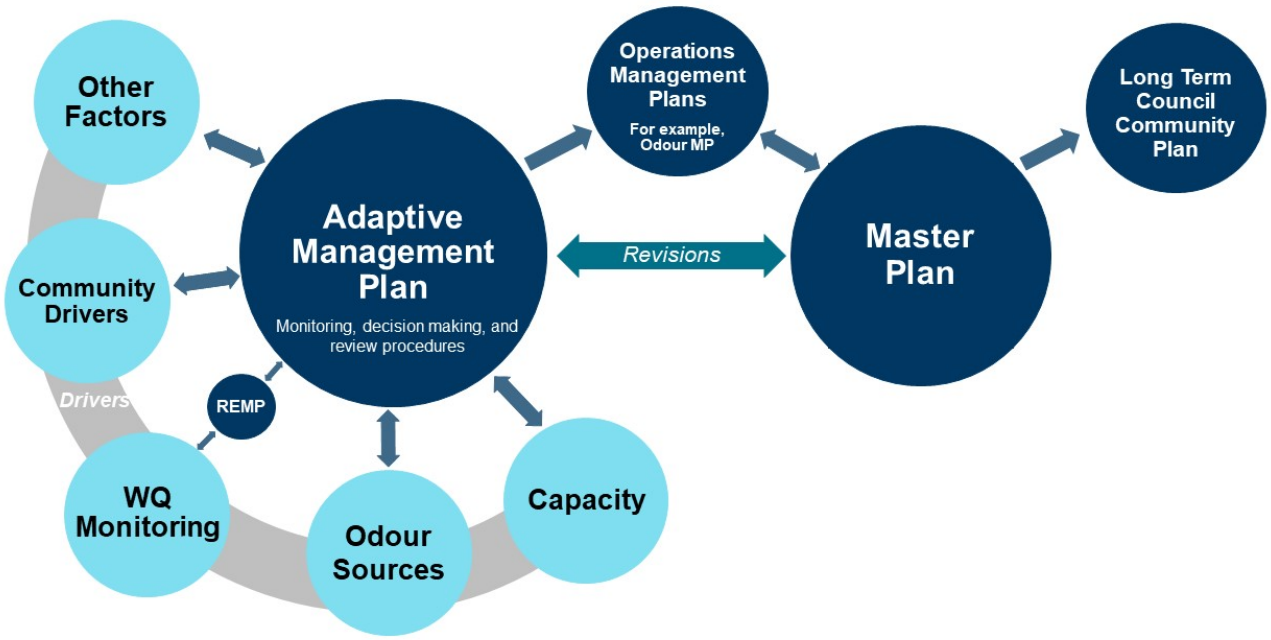


Figure 6.1 Schematic of the implementation of adaptive management approach proposed

7. Assessment methodology

Complaints are likely to occur when odours become detectable and recognisable at off-site locations. However, there are many situations when the release of a potentially odorous compound does not result in an odour nuisance effect. It is the subjective judgement of an odour's hedonic tone that enables the decision to be made as to whether it is a nuisance or not. The factors that contribute to an odour nuisance effect include the **frequency (F)** of odour impact, the **intensity (I)**, the **duration of exposure (D)**, the **offensiveness (O)** and the **location (L)**.

"Under the Resource Management Act, the primary concern with odour is its ability to cause an effect that could be considered 'offensive or objectionable'. Whether an odour has an offensive or objectionable effect requires an overall judgement that considers the frequency, intensity, duration, offensiveness/character, and location of the odour event" (MfE Odour). These are known as the FIDOL factors which are also supported in H7 of the PNRP, as discussed in Section 3.2. These factors are explained in greater detail in the Table 7.1

Table 7.1 Explanation of FIDOL factors

FIDOL Factors	Description
Frequency	How often a receptor is exposed to odour. Factors determining this include the frequency that the source discharges odour, prevailing meteorological conditions; and the topography.
Intensity	Intensity is the perceived strength of the odour. An increase in intensity of odour will increase the potential for odour complaints.
Duration	The overall duration that individuals are exposed to an odour over time.
Offensiveness	Offensiveness/character: is a subjective rating of an odour's pleasantness and relates closely to hedonic tone, which is essentially the character of the odour. Offensiveness is related to the sensitivity of the 'receptors' to the odour emission, i.e. whether the odorous compound is more likely to cause nuisance, such as the sick or elderly, who may be more sensitive.
Location	The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The 'Location' factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors. *It is also important to note that in some locations some odours may be more acceptable than in others (e.g. there is the expectation that rural odours will occur as part of the rural environment and industrial odours will occur in industrial areas).*

Figure 7.1 (reproduced from IAQM Odour) shows how a receptor will appraise the FIDOL factors along with the social and psychological factors determined whether an odour has an adverse odour impact and an objectionable effect.

Different exposures of the FIDOL factors can result in varying effects at a given receptor location. For example, odour may occur as a one-off event of frequent short-bursts, or for longer less frequent events and may be considered to provide an 'acute' or 'chronic exposure', respectively.

GHD has assessed each of the individual FIDOL factors and using this information has made a determination on whether the odour from the Site is likely to be considered offensive or objectionable. FIDOL factors have been assessed using the results from odour surveys, review of complaint logs and outcomes from community interviews, which are discussed in Section 8, along with analysis of local meteorology and site operations.

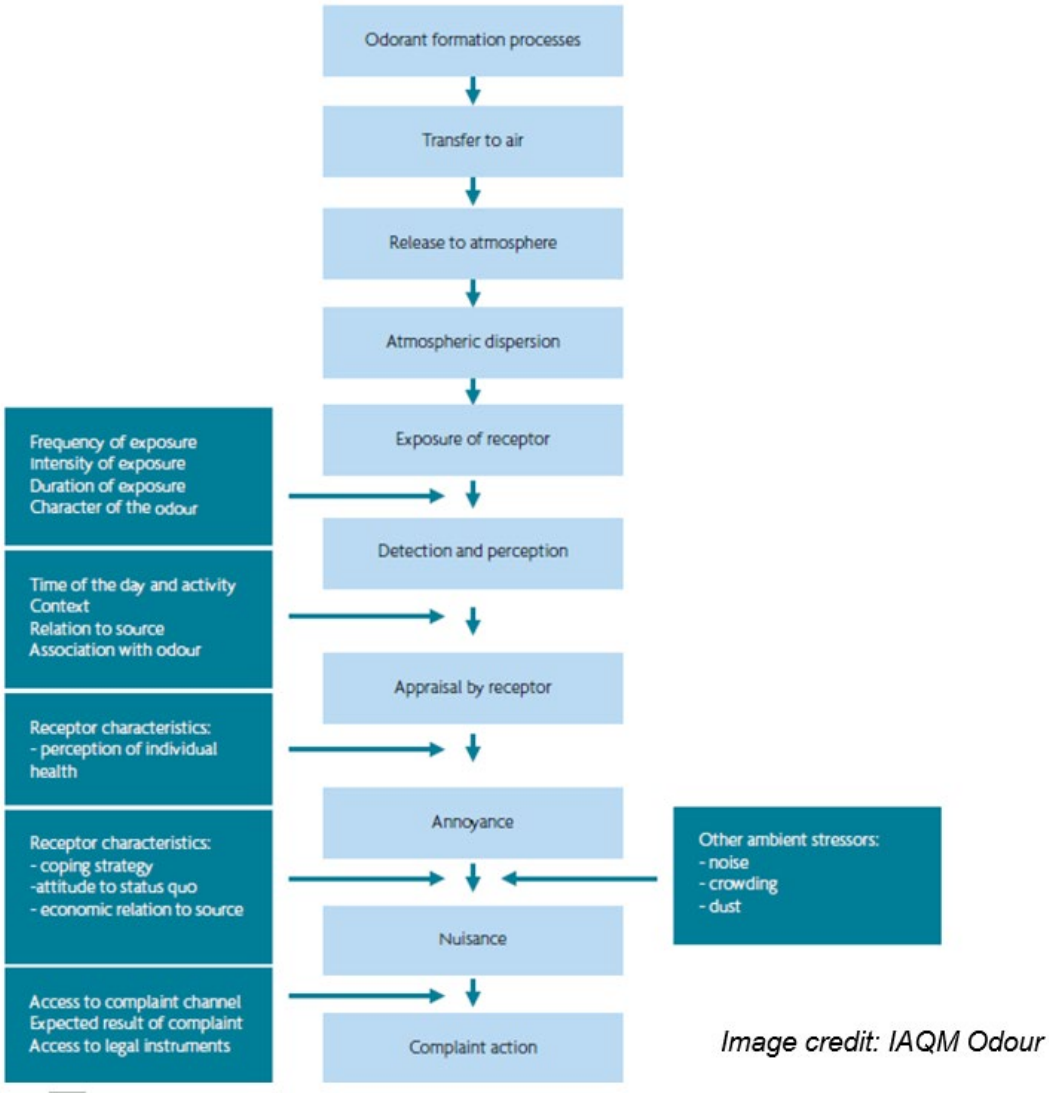


Figure 7.1 How an odour complaint occurs

7.1 Receptor locations

Based on GHD's experience receptors located within approximately 1 km of the Site may have the potential to be affected by odour discharges. GHD has not included all of the residential locations as discrete receptors in the assessment for practical purposes. Rather, a selected number of receptor locations have been identified which cover sufficient spatial variability to assess potential air quality impacts from the Site. These receptors are presented in Table 7.2 and shown on Figure 7.2.

As discussed in Section 2.2 various locations around the plant have a sensitivity rating ranging from "low" to "high" depending on the susceptibility of being affected by odour. The sensitivity rating of each receptor is shown in Table 7.2.

Table 7.2 Table of Sensitive receptors

Receptor ID	Type of receptor	Coordinates NZTM		Sensitivity rating	Distance from site boundary (m)	Direction from site boundary
		X (m)	Y (m)			
R1	Residential	257,519	6,040,952	High	950	W
R2	Residential	256,923	6,041,397	High	~ 1,000	WNW
R3	Residential	257,361	6,041,619	High	~ 1,000	NW
R4	Residential	257,864	6,041,675	High	750	NNW
R5	Residential	258,349	6,041,804	High	630	N
R6	Recreational	258,664	6,042,146	High	860	NNE
R7	Recreational	258,486	6,042,261	High	950	NNE
R8	Recreational/Walking Track	258,109	6,041,138	Moderate	240	NW
R9	Industrial	257,971	6,040,986	Low	400	W
R10	Industrial	258,486	6,041,204	Low	50	N
R11	Industrial	258,816	6,041,517	Low	330	NE
R12	Industrial	259,268	6,041,385	Low	600	E

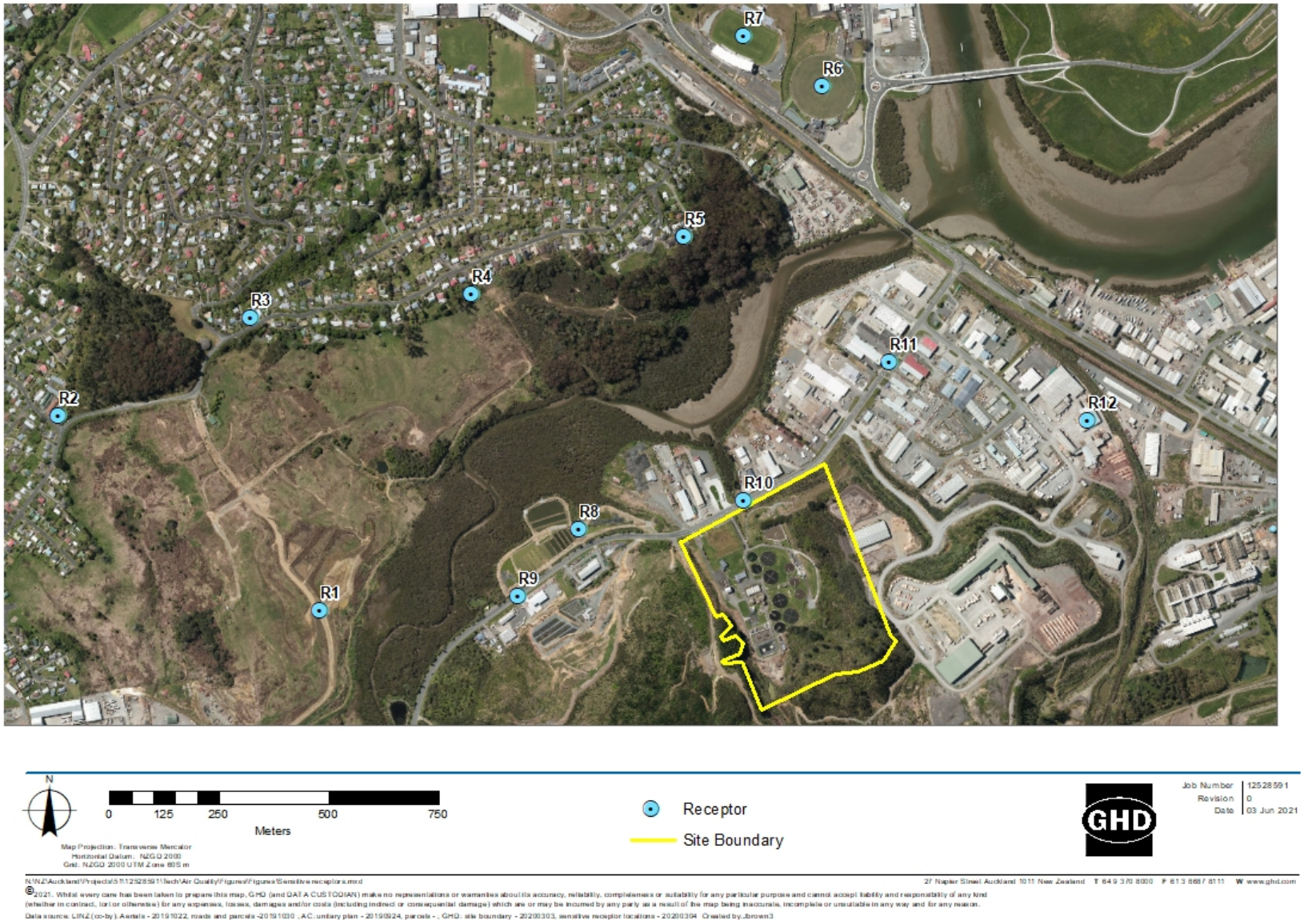


Figure 7.2 ***Receptor locations***

8. Odour assessment

This section of the report presents an assessment of odour from the plant and the potential to cause odour nuisance effects. The assessment includes the following:

- Analysis of odour complaint records (Section 8.1).
- Results from a field odour investigation (Section 8.2).
- Results from interviews with members of the surrounding community (Section 8.3).

8.1 Complaint records

Complaints made by the public are either received and lodged by site operators or are made directly to the NRC. Using information provided by NRC and WDC, GHD has prepared the complaints register presented in Table 8.1. In total 13 complaints have been received between October 2006 through to May 2021 (~14 year period).

GHD notes that the exact location of the complainants and time of the complaint is often not disclosed, so for the purposes of this analysis we have assumed that complaints noted as being recorded on Kioreroa Road occurred at properties located within 200 m of the Site and that the complaint occurred at some point during the day that was recorded in the complaint log.

Table 8.1 Odour complaints record

Logged date	Description
26 October 2006	Significant odour from STP
16 July 2008	Offensive odour
21 February 2010	Offensive odour from Whangārei WWTP
09 February 2014	Offensive odour at Whangārei WWTP
09 August 2015	Sewage odour at Gumdigger Pl, Whangārei
26 October 2016	Collingwood Street
17 November 2016	Odour nuisance from Whangārei WWTP at Kioreora Road, Whangārei
25 June 2017	Odour complaint at Kioreroa Road, Whangārei
03 May 2018	Odour complaint at Kioreroa Road, Whangārei
10 April 2019	Odour complaint at Kioreroa Road, Whangārei
02 May 2019	Odour complaint at Kioreroa Road, Whangārei
09 May 2019	Odour complaint at Kioreroa Road, Whangārei
07 May 2021	Odour complaint at Kioreroa Road, Whangārei

GHD has analysed the meteorological data for all complaints which occurred in the last 5-years using wind data from the Site. Only the daylight hours for the day of the complaint have been included in our analysis, as it is assumed that odour nuisance is not occurring during night-time hours when the majority of people are asleep. Windroses for the days in which an odour complaint occurred are shown in Appendix A, along with our analysis of the likely odour source. The following summary of the odour analysis is as follows: The following provides summary of the odour analysis:

- Of the most recent seven complaints, two of the days did not correlate with winds where the Whangārei WWTP was upwind of the complainant. For the remaining five complaints which potentially originated from the Site, it was found that the location of the complainant was downwind of the Whangārei WWTP between 12% and 70% of the time.
- During days that coincided with complaints at downwind receptor locations calm wind conditions occurred between 0% - 23% (average 15%) of the time.

Further to the recorded odour complaints, GHD has received anecdotal accounts from various stakeholders that odours from the plant can on occasions have a high level of intensity, particularly at locations along Kioreroa Road directly north or east of the Whāngarei WWTP and areas around Te Matau A Pohe bridge. GHD has received anecdotal accounts from various stakeholders that odours from the plant can on occasions have a high level of intensity, particularly at locations along Kioreroa Road and areas around Te Matau A Pohe bridge.

Overall GHD considers that the small number of odour complaints received for the Site suggests that offensive and objectionable odour from the plant is not experienced with any significant frequency within the community and/or the existing level of odour is generally considered to be acceptable by the local community.

While complaints are not always the best indicator of whether an effect is occurring within the community, in this instance the low number of complaints suggests the frequency of receptors experiencing **objectionable and offensive** odour is low and the number of potentially affected people (to the point where complaint is warranted) is also low i.e. isolated to a relatively small area near to the plant.

Table 8.2 Wind direction during complaint periods.

Date of complaint	Summary
26 October 2016	Complaint unlikely to be attributed to the Site as wind direction was not consistent with the plant being upwind of the complainant.
17 November 2016	Complaint unlikely to be attributed to the Site as wind direction was not consistent with the plant being upwind of the complainant.
25 June 2017	Whangārei WWTP possible source of odour: Low windspeeds from the south eastern quadrant occurred 70% of the time on the day of the complaint. These winds had the potential to carry odour from the plant to the complainant on Kioreroa Road.
03 May 2018	Whangārei WWTP possible source of odour: Low windspeeds from the south eastern quadrant occurred 20% of the time on the day of the complaint. These winds had the potential to carry odour from the plant to the complainant on Kioreroa Road.
10 April 2019	Whangārei WWTP possible source of odour: Low windspeeds from the southerly quadrant occurred 25% of the time on the day of the complaint. These winds had the potential to carry odour from the plant to the complainant on Kioreroa Road.
02 May 2019	Whangārei WWTP possible source of odour: Low windspeeds from the southerly quadrant occurred 45% of the time on the day of the complaint. These winds had the potential to carry odour from the plant to the complainant on Kioreroa Road.
09 May 2019	Whangārei WWTP possible source of odour: Low windspeeds from the southerly quadrant occurred 20% of the time on the day of the complaint. These winds had the potential to carry odour from the plant to the complainant on Kioreroa Road.
07 May 2021	Complaint unlikely to be attributed to the Site as wind direction was not consistent with the plant being upwind of the complainant.

8.2 Field odour survey

To inform the FIDOL assessment an odour field study was undertaken using a modified version of the German Standard VDI 3882 Part 1, “Olfactometry Determination of Odour Intensity”. This methodology is similar to that used by council enforcement officers and independent assessors who are Investigating odour complaints.

The odour survey involved a GHD staff member with a calibrated nose spending two 5-day periods (10 days in total) (15 – 19 March and 10 – 14 May) surveying odour within the Site, around the Site boundary and within the local community. Odour surveys within the site boundary were undertaken to better understand the various sources of odour associated with Site.

At the time of the odour surveys, the Whangārei WWTP was operational and there were no reported issues with the plant.

Multipoint odour observations were undertaken at each location to assess the odour character and intensity based on the categories identified in Appendix B.

For each location surveyed an overall summary of the odour experienced was defined as follows:

- No odour.
- Whangārei WWTP odour (offensive odour relating to the Whangārei WWTP).
- Offensive Whangārei WWTP odour (potentially offensive odour relating to the Whangārei WWTP).
- Other odour (Whangārei WWTP odour but unlikely to be considered offensive).
- Other offensive odour (not from Whangārei WWTP).

The results from the odour survey are presented in Section 8.2.3.

8.2.1 Background odour sources

It was noted that while undertaking the odour surveys there were other significant odour sources in the area which including a composting facility northwest of the Site and a landscaping yard, located northeast of the Site. Both of these sites hold varying quantities of compost in open air piles which can generate odour. These sources were found to have an organic or musty/earthy odour. In addition, transient odours were also observed from vehicles travelling along Kioreroa Road.

The cumulative effect of these sources resulted in a near constant level of detectable odour in the industrial area which was often not associated with the Whangārei WWTP.

8.2.2 Analysis of meteorology

As discussed in Section 2.3.2, meteorology plays an important part as it determines the level of odour dispersion that occurs between odour sources and receptor locations, with low winds speeds providing worst-case conditions.

A review of the wind data for the site shows that the months of March and May are characterised by a high frequency of low windspeeds and calm conditions, with winds blowing from a southerly direction towards Kioreroa Road. GHD therefore concludes that the monitoring period represented a relatively ideal time of year to assess worst-case odour from the Site.

The meteorological data for the period of the two weeks of odour surveys is presented in Figure 8.1.

This shows the wind direction during the first monitoring period included a high frequency of winds from the south which are typical of the prevailing winds experienced at the Site.

In general wind speeds tended to be greater during this period than the average but the majority of winds were less than 3 m/s.

Similarly, during the second monitoring period winds also tended to be less than 3 m/s, however during this period the prevailing wind direction was from the northern quadrant.

Temperature and rainfall data for the survey period is provided in Appendix C, however in general the monitoring period was characterised by warm dry periods. Monitoring was typically completed between the hours of 08:00 and 19:00.

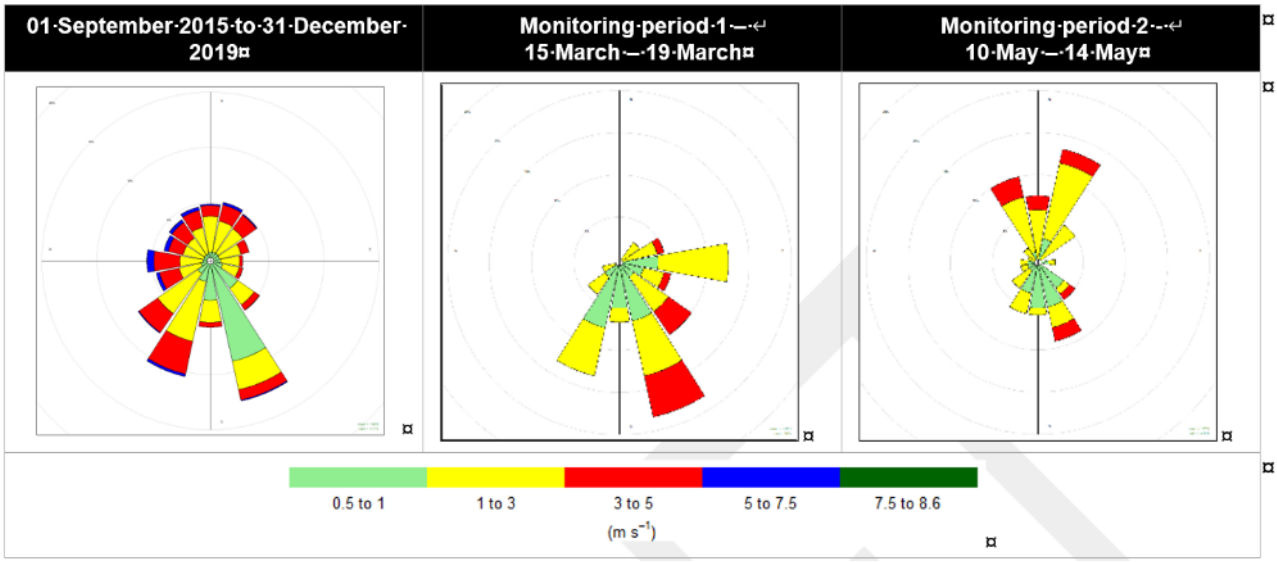


Figure 8.1 Meteorological data summary during odour surveys

8.2.3 Summary of results

Detailed analysis of the odour surveys is provided in Appendix D, however a summary of the results is presented in Figure 8.2.

Odour detected on-site generally ranged from 'very weak' odour to 'very strong' odour, with occasions where 'no' odour was identified near to the northern site boundary. 'Extremely strong' odour was observed around the bins – namely the inlet works bins and rag screen sludge bin (as discussed in Section 5).

The main findings from surveys at off-site locations were as follows:

- Odour detected offsite generally ranged from 'no' odour to 'distinct' odour.
- Odour attributed to the Whangārei WWTP was only detected within 150 m of the Site boundary.
- No significant odours were detected near the residential areas along Morningside Road and South End Road.
- Odour associated with the composting plant was detected along Kioreroa Road.
- A range of different odours were detected in the area around the Site which had a similar character to Whangārei WWTP odour, however the odour could not be attributed to the Site due to unsuited wind directions i.e., the Whangārei WWTP was downwind of the survey point and therefore could not contribute odour at the location, or an alternate odour source was identified upwind of the sampling point, for example the composting facility.

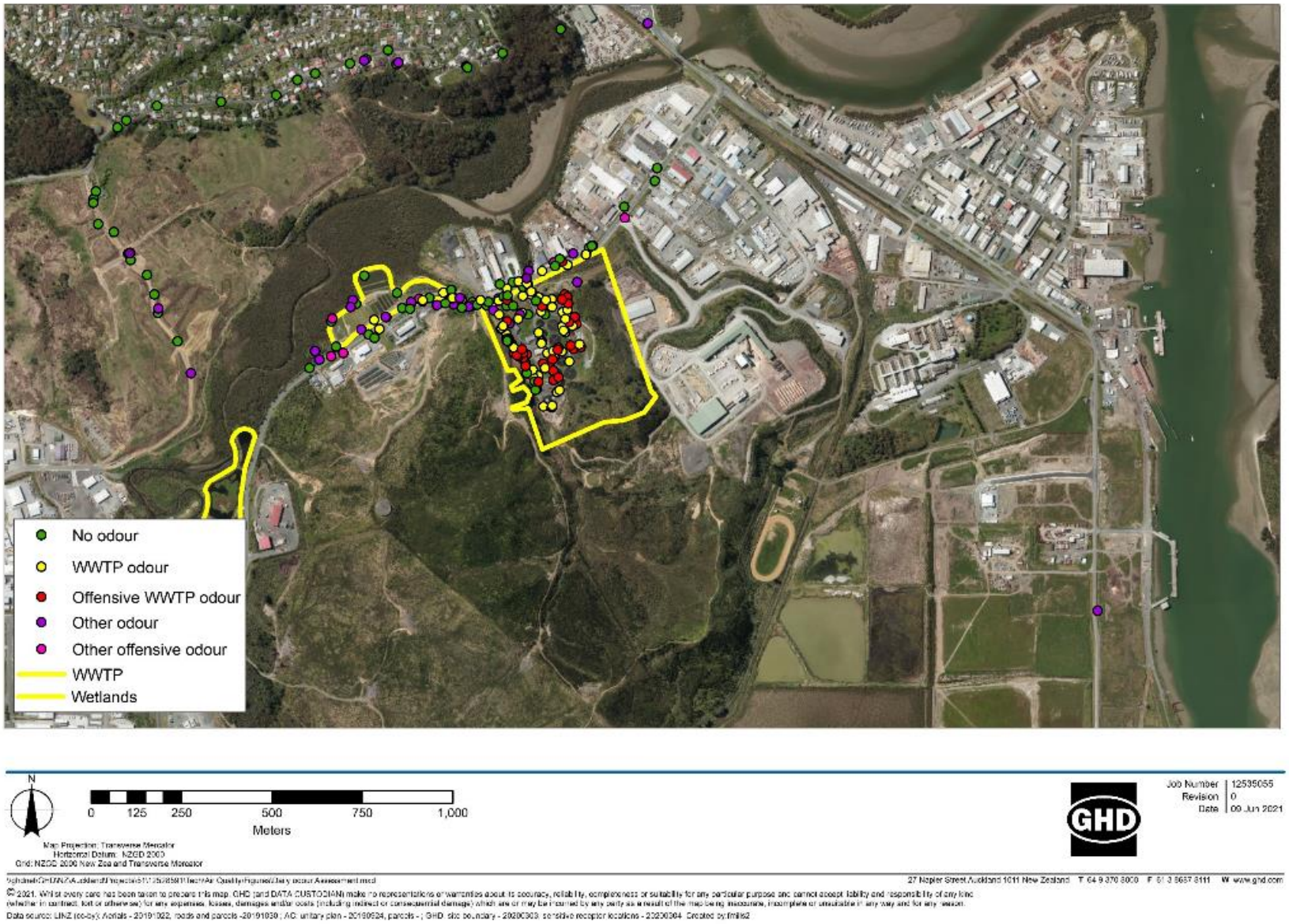


Figure 8.2 Odour Survey Results

8.3 Community interviews

While the odour survey provided information on off-site odours from the plant during normal operation and for a range of different wind conditions, there is also the potential for off-site odours to be experienced due to either abnormal operation of the plant, seasonal effects, or specific meteorological conditions, which were not captured by the survey.

To provide a better understanding of the odour potential during these conditions, GHD developed a community odour study in which GHD prepared a questionnaire as the basis of for targeted community face to face interviews in the area. The interview questions are presented in Table 8.3 and was undertaken by WDC staff over 2 days (14/07/2021 to 16/07/2021). The location of the properties surveyed is shown in Figure 8.3 and includes a collection of industrial, commercial and residential sites. The results from the interviews are graphically presented in Figure 8.4 and are summarised below, raw results are presented in Appendix E:

- Odour was not identified beyond 1 km from the Site boundary (Figure 8.3).
- Eleven of the twenty-eight locations (40%) interviewed stated that no odour was experienced.
- Of the 17 locations that identified odour, the following observations were recorded:
    - Seven locations indicated that the odour was improving (25%).
    - Eight locations indicated that the odour was not changing (30%).
    - Two indicated that the odour was getting worse (7%).
- Respondents were asked to indicate the frequency that odours were observed (Figure 8.4). The following was noted regarding the frequency of odour:
    - Two of the twenty-eight respondents indicated that odour was observed daily. Respondents who could detect odour daily were limited to locations withing 200 metres of the site boundary.
    - Six locations indicated that odour was observed once or twice per week.
    - Nine locations indicated odour was observed once or twice per month. One business located less than 50 metres from the site, downwind of the predominant wind direction indicated that odour was generally observed once or twice a month.
- Odours which had the potential to affect the daily activities of respondents (defined as yellow, orange or red on the intensity section of Table 8.3 or Figure 8.4), were limited to locations within 400 metres of the site boundary, with the exception of location 8 (940 m from the site boundary).
- Two properties, located within 200 m to the northwest of the plant, experienced odour on a frequent basis (at least 1 -2 times a week) and with a moderately high level of odour intensity.

Figure 8.3 Locations of people who participated in the community interviews

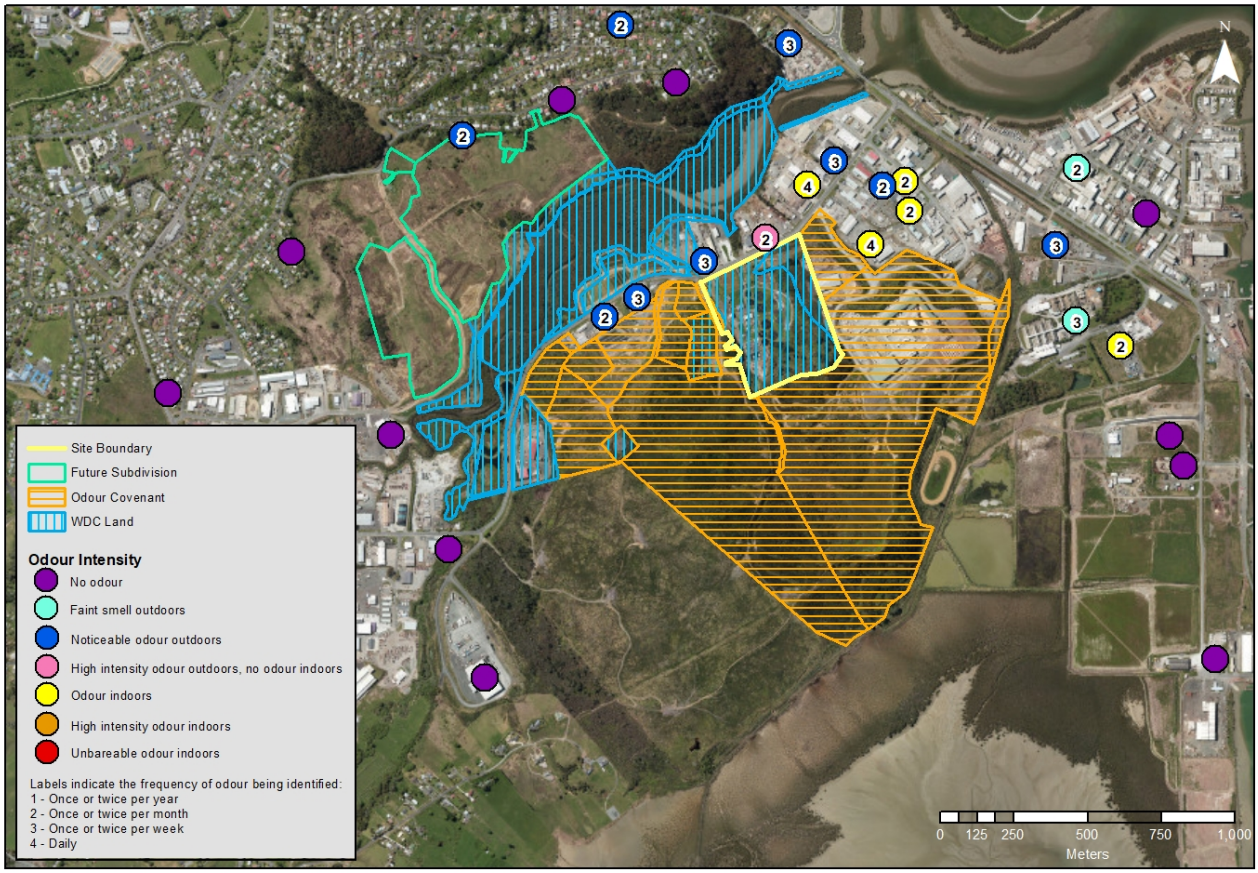


Figure 8.4 Odour identified by interview respondents - odour intensity is indicated by the colour of the point and the frequency is identified by the numerical value indicated on the point as defined by Table 8.3.

Table 8.3 Interview questions

Presence	Frequency	Intensity	Duration
Do you smell odour in the area? (1) Yes (2) No	How often do you smell odour? (1) Once or twice a year (2) Once or twice a month (3) Once or twice a week (4) Daily	Generally, how strong is the odour that you smell? (1) I notice a faint odour outside (2) I notice a smell outside, but it doesn't change what I do (3) I can't spend time outside my residence/building because of the odour, but if I keep the windows and doors closed the smell is OK inside (4) I can smell odour inside my house/the building (5) I can't use my house/business for certain activities because of the smell (6) I don't want to be here because of the odour	How long does the odour typically last? (1) Less than 30 mins (2) Up to 1 hour (3) 1 – 3 hours (4) More than 3 hours

8.3.1 Conclusions from Community Interviews

Based on the information collected through the community interviews it appears that properties in the residential areas to the northwest of the Site are seldomly affected by odours, as respondents in these locations either did not observe odour, or selected *"I notice a smell outside, but it doesn't change what I do".* Due to the infrequent nature that odour is observed, and the low intensity of odour identified at these residential properties, GHD consider that any odour generated from the Site is unlikely to be considered as offensive or objectionable at these locations.

Odour was noted by a number of occupants in the industrial area. Based on the community interviews, the majority of respondents in the industrial area either; frequently experience a low intensity of odour which is not considered to affect activities, or, infrequently experienced odours which may be considered to be at an intensity to affect daily activities. Two locations within 400 m of the Site reported odour at an intensity which may be detected indoors more frequently than twice per month. These locations are in close proximity of the Site boundary and consequently on-site odour management and the proposed plant upgrades are important to manage and minimise odour at these locations. Although odour has been noted in close proximity to the Site at indoor locations it is not considered to occur at a high frequency (ie more than 1-2 time /week).

The interview results indicate that distinct odour (higher intensity or more frequently) is limited to 400 m of the Site. These locations remain within the industrial area where a greater level of industrial type odour is expected to be tolerated, therefore GHD consider that the odour observed at these locations are commensurate with the land use zoning.

9. Qualitative assessment of odour (FIDOL)

It is generally accepted that odour associated with wastewater treatment plants is considered unpleasant by the general population, and therefore odour from the plant needs to be appropriately managed and controlled.

A range of staged improvements will be implemented to reduce the level of odour which include a review of various site operation, such as the operation of the equalisation basin and covering the various bins around the Site. These reviews and changes to operation will provide some improvement in the level of off-site odour which has been taken into consideration in the qualitative assessment below.

As discussed in Section 7, GHD considers that it is appropriate to use the FIDOL assessment tool to determine whether the odours have the potential to be offensive and objectionable. The findings from GHD's FIDOL assessment are presented in Table 9.1.

Table 9.1 FIDOL Odour Assessment

Assessment of odour FIDOL factors	
Frequency	The frequency that off-site receptors may experience odour is dependent on a range of factors which need to coincide. These factors include, calm/low speed winds, increased temperature and the type of activities being undertaken on-site i.e. activities that can generate odour. Based on the odour scouts and various site visits, odour within the Site boundary was found to be at a relatively low level, with particular sources (discussed in Section 5) noted as discharging a more intense odour at close proximity. Background odours (as discussed in Section 8.2.1) is observed along Kioreroa Road at low levels. These odours are exacerbated by the calm and low wind speed conditions which are predominant at this location. **Analysis of frequency data:** GHD considers that wind speeds less than 3 m/s have the greatest potential to cause odour nuisance. The frequency of low wind speeds required to carry undiluted odour from the Site to receptors (as presented in Section 7.1 and Table 7.2) has been summarised and categorised in terms of 'likelihood' below: 0-5% = Low, 5-10% = Moderate, 10% = High. • R1 (Residential): 2.2% • R2 (Residential): 2.2% • R3 (Residential): 4.5% • R4 (Residential): 11.5% • R5 (Residential): 5.3% • R6 (Recreational): 7.2 • R7 (Recreational): 7.2% • R8 (Recreational):4.5% • R9 (Industrial): 2.2% • R10 (Industrial): 24% (due to the close proximity of this receptor a larger wind angle has been assumed) • R11 (Industrial): 2.6% • R12 (Industrial): 2.5% The frequency analysis presented above indicates that some receptors could experience wind conditions which have the potential to cause odour nuisance for substantial periods of time. The frequency presented above are considered worst-case, as a large proportion of these low wind speeds occur during night-time hours when the majority of people are asleep or indoors (as presented in Figure 2.8).

Assessment of odour FIDOL factors
Residential/ Recreational Receptors (high or moderate sensitivity): The high frequency of low-speed winds blowing towards residential locations is mitigated to some extent by the relatively large distance from the Site to these locations (> 500 metres). At these distances it is likely that odours from the Site will undergo a considerable amount of dilution. With respect to R4, R5, R6 and R7 low wind speeds required to carry undiluted odour will typically follow the valley contour downslope toward the east and is considered unlikely that undiluted odour from the Site will travel up to the height of the ridge where these receptors are located. Consequently, the frequency of winds which can carry odour from the Site towards these receptors is likely to be overrepresented. Additionally, the community interview results of the residential sites (which include locations close to R4, R5, R6 and R7) noted that odour was either not observed or seldomly observed outdoors. Based on the odour scout and community interviews and the topography, it is expected that residential receptors will be rarely affected by odour from the Whangārei WWTP. **Industrial Receptors (low sensitivity):** Industrial receptors located along Kioreroa Road (immediately adjacent to the plant boundary) are likely to be downwind of the plant for longer periods of time and may observe occasional odour from the plant. Based on the results of GHD's odour scout, odour at industrial locations were either not observed or noted to be from other sources. Where odour was observed it was reported at low levels at intermittent frequencies to a distance to 150 m from the source. Based on the community interviews, industrial sites reported either a high frequency (more than once or twice a week) of low intensity of odour which is not considered to affect activities, or, infrequently observing odours at an intensity to affect daily activities. Industrial sites in the vicinity of R10 were noted as experiencing a high intensity of odour once or twice a month (low frequency). Based on the wind data and both the odour scout and community interviews, it is expected that any significant odour that may be attributed to the Whangārei WWTP in the industrial area is likely to be infrequent. **Abnormal Operations:** While the prevalence of low-speed winds blowing in the direction of the receptor is an important factor, these winds have to coincide with periods where odour from the plant is elevated above normal levels. Based on the information presented in Table 5.2 abnormal operations are a rare occurrence at the Site. The Site has developed responsive measures to minimise potential odour effects during these incidents such as: responsiveness to spills (less than 30 minutes) and keeping spare parts on-site to reduce repair time. With the exception of a digester upset, abnormal operations are expected to occur for a relatively short duration of time (less than 3 hours). Given the infrequent nature and the short duration of these events it is unlikely that low speed winds will coincide with abnormal activities for any prolonged length of time. In the event of a digestor upset or significant equipment failure increased odour generation from the Site may last for days. While these occurrences are very rare, the Site has developed new mitigation procedure to reduce the likelihood of prolonged effects, for instance regular monitoring and sampling of the digester is completed to ensure the health of the system before an issue arises. Since adopting this monitoring regime, the Site has only had an occurrence with the digester once in 10 years. Events of this nature are considered to be a very rare occurrence at the Site and continual improvements to an OMP will aid in reducing these occurrences further. GHD understands that Site activities which typically produce the greatest amount of odour are during the filling of sludge bins which typically occurs during the late afternoon and through the night. As these are periods where people are typically indoors and it is unlikely that odour will be observed at sensitive receptor locations. **Overall, the frequency that the majority of residential receptors could experience odour is likely to be low to moderate, especially considering that a high proportion of low speed winds occur at night and odours from the plant have to be elevated during these periods. Industrial receptors located along Kioreroa Road have the greatest potential to experience odours from the plant, however their sensitivity to odours is low based on the land use zoning.**

Assessment of odour FIDOL factors	
Intensity	GHD's odour survey noted that off-site odour associated with the Whangārei WWTP was typically observed within 150 m of the boundary and odours of high intensity were seldomly observed. This was also supported in the community interviews which observed odour of high intensities limited approximately 400 m of the Site boundary. Wastewater odour was detected near to the Site boundary by GHD in the odour surveys and through the community interviews, it was rarely noted to be at a level which would be considered offensive or objectionable. Based on the results from the odour survey and community interviews, odours associated with the normal operation of the plant are expected to be at a relatively low intensity. A review of the past 14 years of odour complaints indicates that off-site odour is often at low-levels, however GHD understands, based on the description provided by some of the complainants and accounts from various stakeholders, that odours from the plant can on occasions have a high level of intensity particularly at locations along Kioreroa Road. It has been assumed that the majority of these complaints could have been attributed to plant upset conditions, some specific issue with the plant at the time, or a specific process not identified as being a significant cause of odour. This is supported by GHD's odour survey results where no significant odours from Site operations were observed 150 m beyond the source. GHD considers that abnormal plant operation has the greatest potential to cause odours with high intensity off-site that could cause odour nuisance. However, these are not expected to occur regularly and, in most instances, can be remedied within a relatively short timeframe (12 hours). Overall, GHD considered that the intensity of any odour discharged from the plant should be relatively low and it will be further reduced with the implementation of the mitigation measures presented in Section 6. GHD notes that WDC propose to adopt an adaptive management plan whereby if significant odour is detected at locations where odour nuisance can occur then further improvements will be implemented to control odour. **For the majority of the time, any odours generated by the Site are expected to be relatively weak, particularly at nearby residential receptor locations.**
Duration	Low level odours associated with the Whangārei WWTP are likely to be present near the boundary of the Site, however these are expected to be of relatively low intensity. Given the relatively short duration that members of the public will be in close proximity to the Site it is not be considered that members of the public will find odour at the boundary to be offensive or objectionable. During instances of abnormal operations there is the potential for significant odour to occur for longer than usual. Failures at the Whangārei WWTP are rare, with most issues generally resolved within relatively short periods of time (typically 12 hours or less). As these events are largely unforeseen, it is imperative that the Site operators are responsive to any occurrences to reduce the potential for odour generation for long periods of time. **Overall, the duration of any odour discharged from the normal operation of the plant should be short. In the event of abnormal activities, there may be the potential for an extended duration of odours to be discharged until these conditions are remedied.**
Offensiveness	The normal operation of the plant should not produce offensive odours, as by the time any fugitive odours reach the plant boundary, they will be low in intensity and unlikely to be considered offensive. This was confirmed based on the findings of GHD's 10 day odour survey. Wastewater odours that are considered offensive typically arise if wastewater is allowed to become anaerobic. During normal operations the Site monitor several stages of the process to limit the occurrence of anaerobic digestion. Dissolved oxygen in the effluent is constantly maintained at an appropriate level, depending on the relevant part of the process, and therefore there is limited potential for anaerobic digestion to occur. The Whangārei WWTP is located in an industrial area where a degree of odour exists and is generally accepted. Based on the observations from GHD's site visit the odours at the boundary of the Whangārei WWTP are consistent with those experienced in the area. During abnormal operations there is the potential for adverse odour to be generated above normal levels for the Site. Generally, these events can last for up to 12 hours although there have been rare occurrences (once in ten year events) that have transpired in longer periods of elevated odour generation. These events have the potential to cause offensive odour to be detected at off-site locations. Through a combination of plant design and extensive plant instrumentation, if the treatment process was to fail, plant operators will be notified and can then take appropriate action. This could include adjustments to the process or repair of components.

Assessment of odour FIDOL factors	
	Overall, the offensiveness of odour from the plant is high but given normal operations of the Site, the low intensity of off-site odour and that sensitive receptors, such as the residential area to the north are set back at least 500 m from the boundary, the overall likelihood of offensive odour being observed at sensitive receptor locations is considered to be low.
Location	Based on the findings of the odour investigation and community interviews it is expected that odour from the Site may be detected up to 400 m of the Site (odour scout results reported odour out to 150 m of the source). It was recorded in the odour scout survey that odours within 150 m of the source were at discernible levels, the community interviews reported these odours to be at levels noticeable within buildings. As these locations are within the industrial setting and a designated zone commensurate with waste management activities, it is not unusual to experience this level of increased odour in the area. During the odour scout, background odour in the area had a very similar odour character to that identified on-site, these included organic odours such as 'compost' and 'musty, earthy, mouldy' which are common odour characters for both the WWTP and neighbouring activities such as the adjacent compost yard. Organic type odours such as wastewater odours at low intensities are not likely to be as noticeable in this environment due to the similarities to other background odour. However, at moderate and high intensities odours associated with Whangārei WWTP which are detected off-site may be considered to be offensive. The proximity of the Whangārei WWTP to the nearby sensitive residential and recreational receptor locations is probably 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. Guidance for separation distances are not prescribed for plants of this size. Taking into account the complex terrain, landuse and local meteorology GHD consider that residential receptors located within 500 m are more likely to observe odour. For this project there are no residential properties within 500 m of the Site boundary, consequently, residential properties identified in Section 7.1 are considered unlikely to be affected by odour. This is supported by the lack of any complaints at these locations and the results of GHD's odour survey. **Overall, GHD considers the Site is located in an acceptable area due to the appropriate zoning of the site, commensurate activities surrounding the site and the distance to sensitive receptors.**

9.1 FIDOL conclusion

Taking all of the FIDOL factors into account, GHD considers that off-site odours from the Whangārei WWTP are unlikely to cause offensive or objectionable odour effects at sensitive receptors locations. This is largely due to the unlikely occurrence of highly odorous events coinciding with low wind speeds carrying undiluted odour to sensitive receptor locations. With respect to R4, it is GHD's opinion that while low speed winds from the direction of the Site are expected 11 % of the time, it is unlikely that odour will be carried to R4 as odour is expected to follow the valley downslope towards the Hātea River and away from the receptor.

Odours may be detected in the adjacent industrial area from time to time, particularly if the plant is experiencing upset conditions. However, GHD considers that the industrial zoning of locations likely to experience odour from the plant should be able to tolerate these odours. Furthermore, the results of the odour survey, community interviews and analysis of the complaint records indicate that highly odorous events are infrequent in nature and are therefore not expected to be at levels considered to be offensive or objectionable for the land use.

An overall summary of the FIDOL assessment is provided in Table 9.2.

Table 9.2 Odour FIDOL Summary

Summary of odour FIDOL factors	
Frequency	Overall, the frequency that the majority of residential receptors could experience odour is likely to be low to moderate, especially considering that a high proportion of low speed winds occur at night and odours from the plant have to be elevated during these periods. Industrial receptors located along Kioreroa Road have the greatest potential to experience odours from the plant, however their sensitivity to odours should be low based on the landuse zoning.
Intensity	For the majority of the time, any odours generated by the Site are expected to be relatively weak, particularly at nearby residential receptor locations.
Duration	Overall, the duration of any odour discharged from the plant should be short, however there is the potential for an extended duration of odours to be discharged during abnormal operating conditions.
Offensiveness	Overall, the offensiveness of odour from the plant is high but given normal operations of the Site, the low intensity of offsite odour and that sensitive receptors, such as the residential area to the north are set back at least 500 m from the site boundary, the overall likelihood of offensive odour being observed at sensitive receptor locations is considered to be low.
Location	Overall, GHD considers the Site is located in an acceptable area due to the appropriate zoning of the site, commensurate activities surrounding the site and the distance to sensitive receptors.
Overall FIDOL	**Unlikely to cause offensive or objectionable odour nuisance at sensitive receptors locations. Receptors in the neighbouring industrial area could be expected to experience odour from time to time, however GHD considers that the low sensitivity afforded by this zoning allows for some level of odour to be detected from time to time.**

10. Conclusions

GHD has assessed the potential for off-site odour nuisance associated with the operation of the Whangārei WWTP using the FIDOL assessment tool as recommended by the MfE GPG for Odour, IAQM guidance on Odour, and as required by Northland Regional Council's guidelines and policies. This assessment was supported using the results from a 10 day odour survey, where odour was evaluated in areas surrounding the plant, together with a review of the complaint logs, community interviews and stakeholder consultation.

Having assessed all of the FIDOL factors GHD considers that the plant is unlikely to cause offensive or objectionable odour effects at sensitive receptors locations – defined as either residential receptors or recreational areas. Odours may be detected in the adjacent industrial area from time to time, particularly if the plant is experiencing an abnormal operation event. However, GHD considers that the industrial zoning of locations likely to experience odour from the plant should be able to tolerate these odours, particularly if they occur infrequently - which is supported based on the results of odour surveys and analysis of complaint records. The odour interviews also agreed with the findings of the odour scout survey and the analysis of sensitive receptor locations, whereby the extent of discernible odour was reported to be localised to the industrial area. Furthermore, the outcome of the odour interviews was generally positive regarding the odour in the area, with 26 respondents (92 %) reporting that odour in the area was either "improving" or "that there was no increase in odour"[7].

In addition, this overall conclusion is supported by the minimal number of odour complaints made to NRC or WDC and the results of ten days of odour surveys undertaken during a time of the year, where it would be expected that any offensive or objectionable odours generated by the plant would be apparent.

GHD has identified a number of odour sources which can easily be mitigated and reduce the odour potential from the plant, these include covering the various bins around the site and operational review of the Equalisation basin. WDC has committed to implementing these within the next 12 months and therefore some reduction in odour should be experienced once this has been completed. It is proposed that the need for further reductions in odour will be evaluated during the term of the consent through 6 monthly odour surveys within the surrounding community.

Through the dynamic adaptive pathways planning approach being taken by WDC to improve its wastewater infrastructure if odour is found to exceed an action trigger that is to be prescribed in the proposed Adaptive Management Plan, representing unacceptable levels and occurrence of odour, WDC will investigate odour mitigation measures and progressively implement these as necessary. Further details of the adaptive plan as it relates to mitigation of odour effects is provided in the AEE.

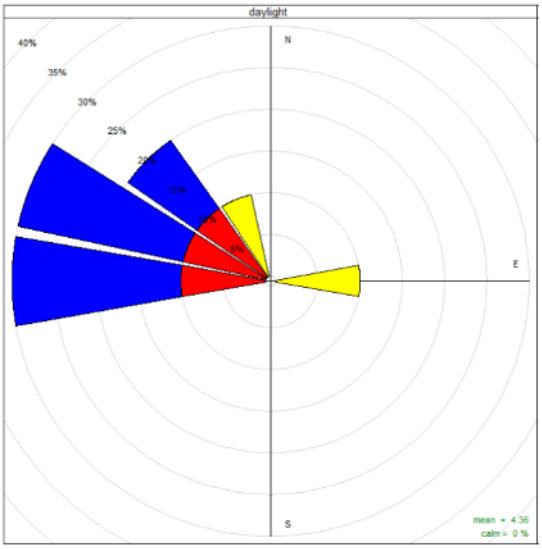
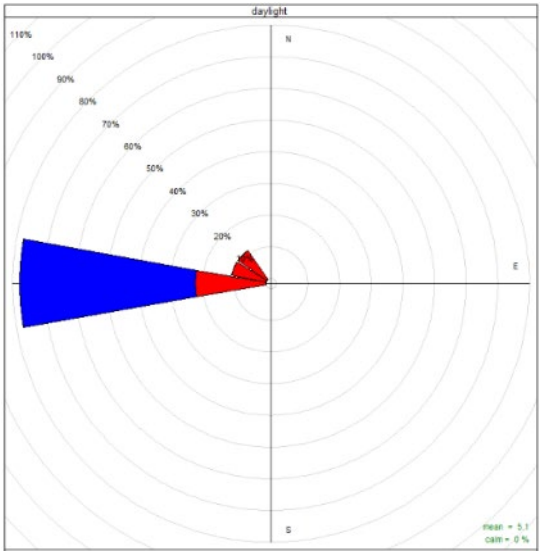
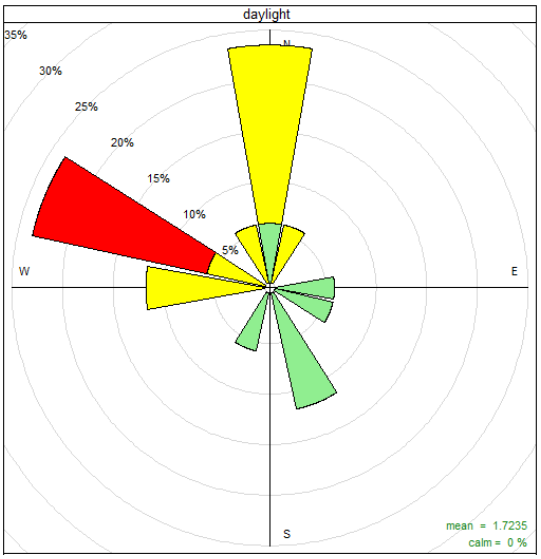
[7] This includes respondents who stated there was no odour observed

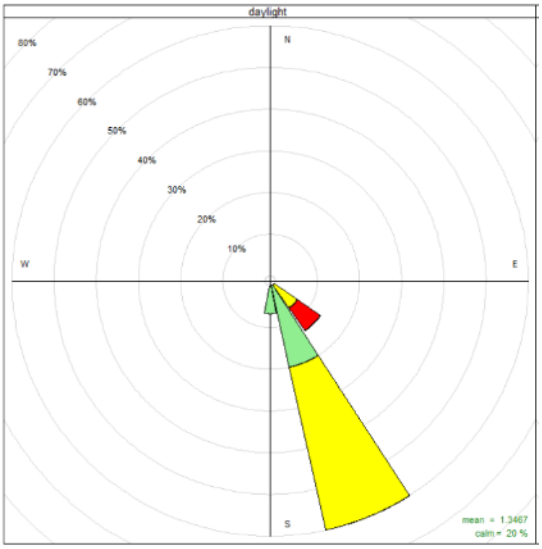
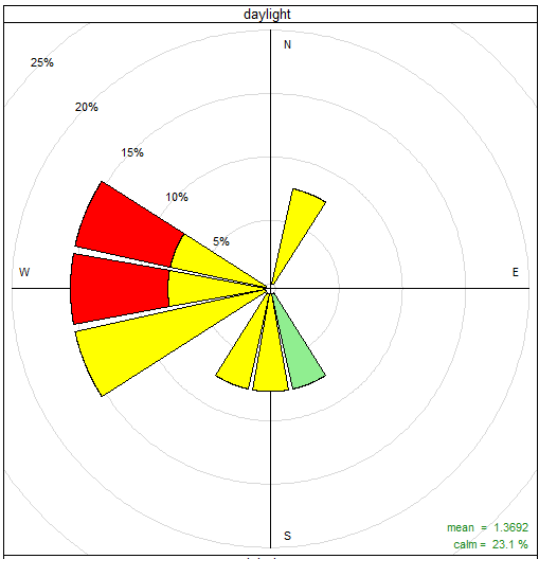
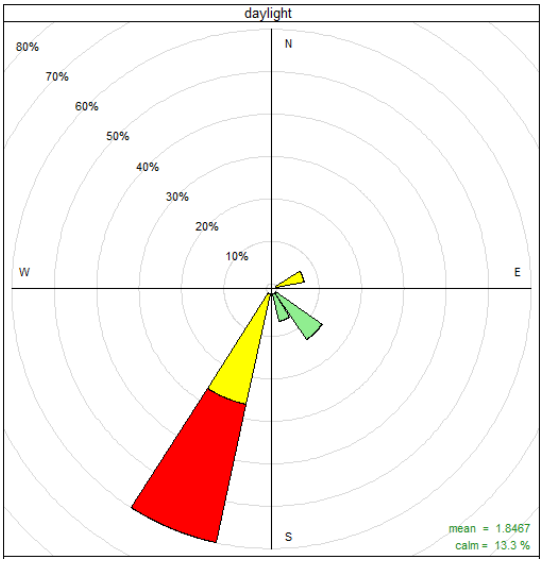
Appendices

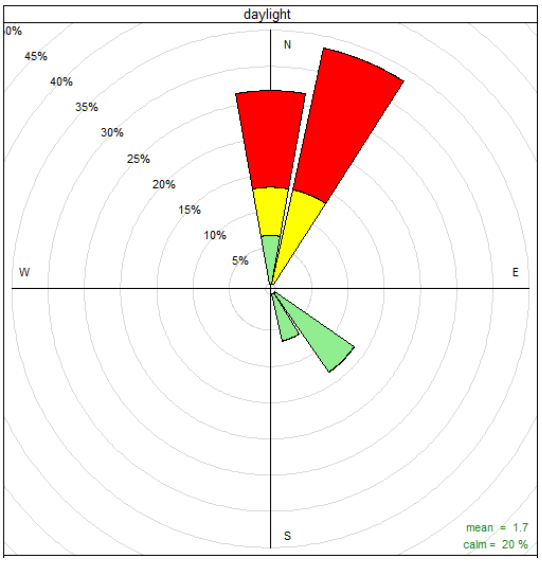
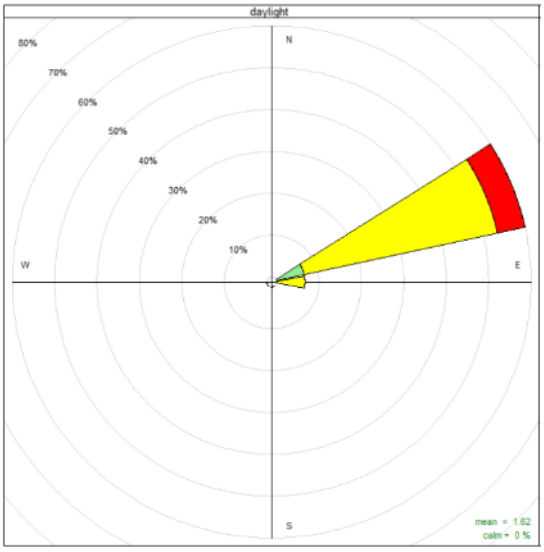
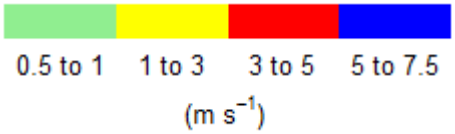
Appendix A

Odour Complaints Analysis

Table A.1 Complaints Analysis

Date	Windrose	Potential for affect
Wednesday 26th October 2016		Very low potential due to the high wind speeds from directions which would not cause odour affects to nearby industrial premises from the Site.
Thursday 17th November 2016		Very low potential due to the high wind speeds from directions which would not cause odour affects to nearby industrial premises from the Site.
Sunday 25th June 2017		During the day low wind speeds which may transport odour from the Site to nearby industrial premises occurred approximately 12% of the time from the south-southeast and 6% of the time from the south-southwest, possible impacts to the north-northwest and north-northeast of the Site.

Date	Windrose	Potential for affect
Thursday 3rd May 2018		During the day low wind speeds which may transport odour from the Site to nearby industrial premises occurred approximately 70% of the time, primarily from the south-southeast, possible impacts to the north-northwest, north and northeast of the Site.
Wednesday 10th April 2019		During the day low wind speeds which may transport odour from the Site to nearby industrial premises occurred approximately 25% of the time from the south-southwest to the south-southeast, possible impacts to the north-northeast to the north-northwest of the Site.
Thursday 2nd May 2019		During the day low wind speeds which may transport odour from the Site to nearby industrial premises occurred approximately 25% of the time from the south-southwest and 20% of the time from the south-southeast and southeast, possible impacts to the north-northeast and north-northwest of the Site.

Date	Windrose	Potential for affect
Thursday 9th May 2019		During the day low wind speeds which may transport odour from the Site to nearby industrial premises occurred approximately 20% of the time from the southeast and the south-southeast, possible impacts to the north-northwest and northwest of the Site.
Friday 7th May 2021		Very low potential due to the high wind speeds from directions which would not cause odour affects to nearby industrial premises from the Site.
Scale		

Appendix B

Odour Observation Categories

Table B.1 Odour Intensity

Odour Intensity
No Odour
Very Weak
Weak
Distinct
Strong
Very strong
Extremely Strong

Table B.2 Odour Character

Odour Character		
Fragrant	Soapy	Metallic
Perfumy	Garlic, onion	Tar-like
Sweet	Cooked vegetables	Oily, fatty
Fruity	Chemical	Like gasoline, solvent
Bakery (fresh bread)	Etherish, anaesthetic	Fishy
Coffee-like	Sour, acrid, vinegar	Putrid, foul, decayed
Spicy	Like blood, raw meat	*Paint-like*
Meaty (cooked, good)	Rubbish	Rancid
Sea/marine	Compost	Sulphidic
Herbal, green, cut grass	Silage	Dead animal
Bark-like, birch bark	Sickening	Faecal (like manure)
Woody, resinous	Musty, earthy, mouldy	Sewer odour
Medicinal	Sharp, pungent, acid	Other(record description)
Burnt, smoky		

Appendix C

Continuous Meteorological Conditions during Site visit

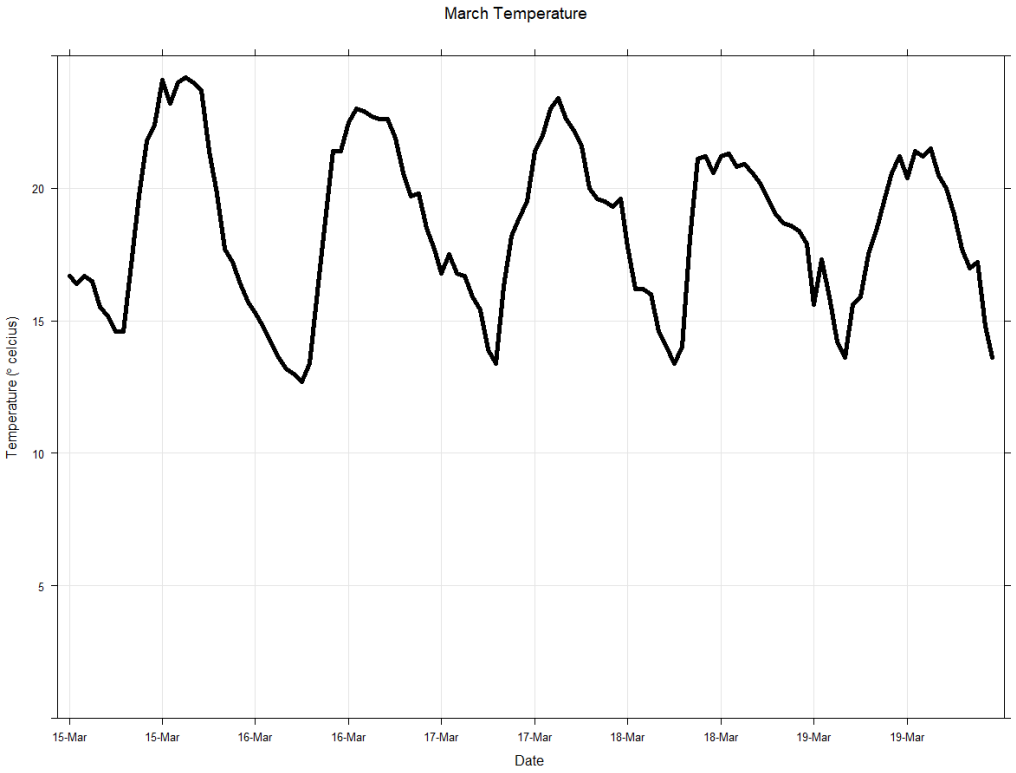


Figure C.1 Temperature for monitoring period (15 to 19 March 2021)

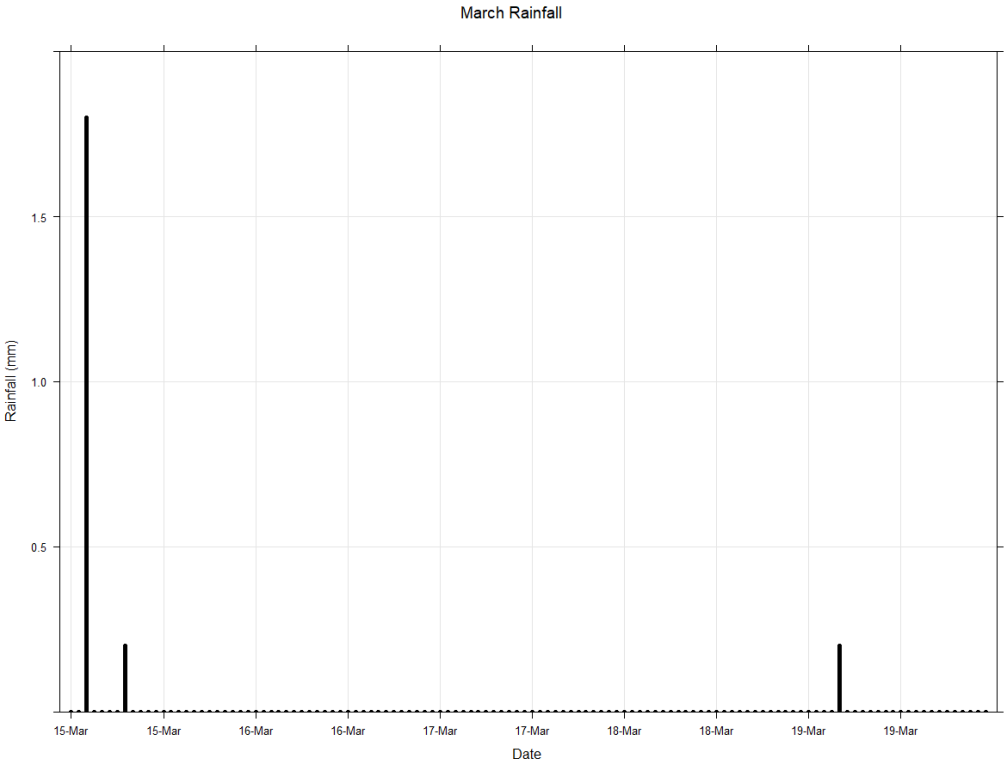


Figure C.2 Rainfall for monitoring period (15 to 19 March 2021)

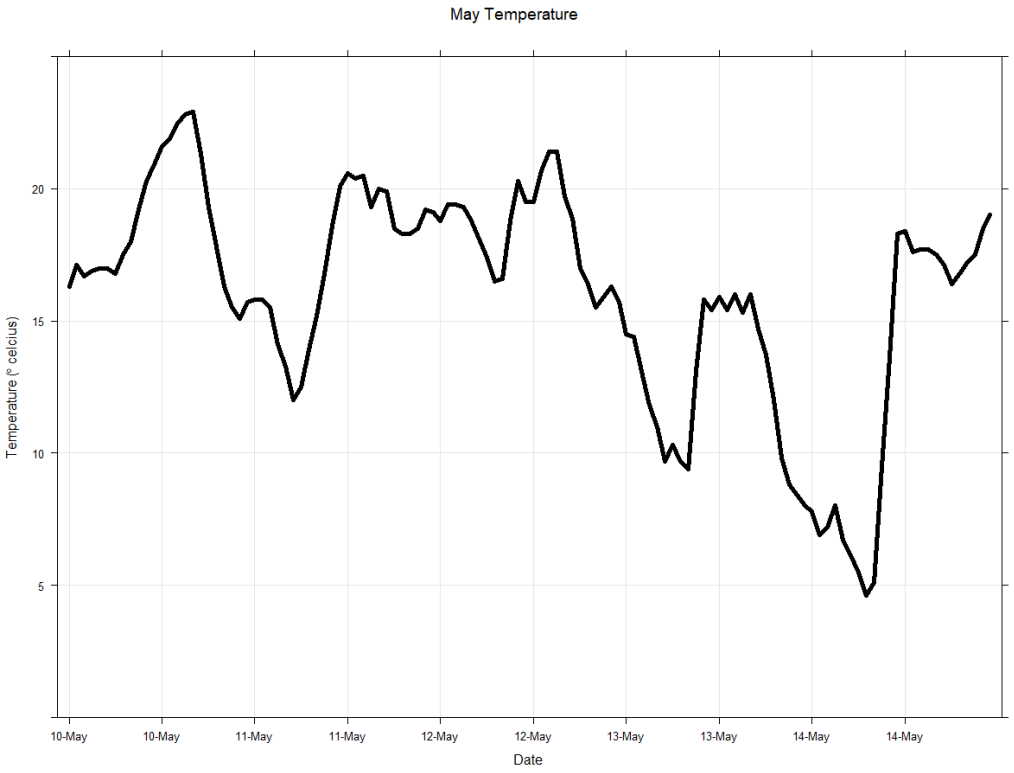


Figure C.3 Temperature for monitoring period (10 to 14 May 2021)

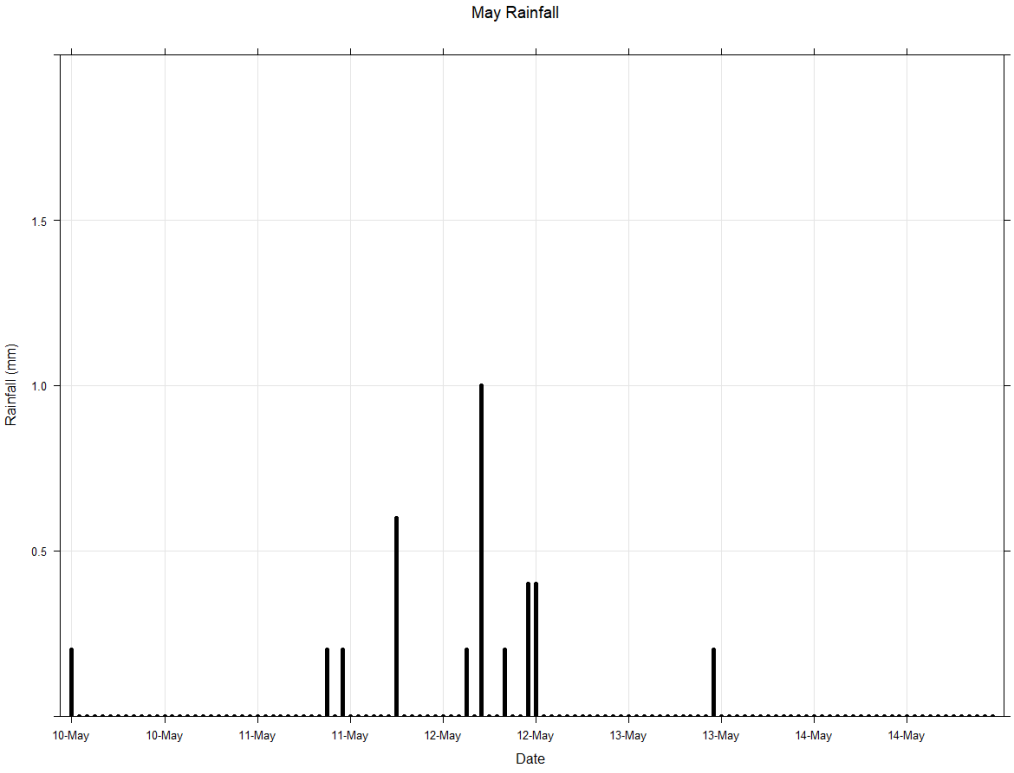


Figure C.4 Rainfall for monitoring period (10 to 14 May 2021)

Appendix D

Analysis of Meteorology for the Odour Survey period

Assessment Period 1 (Monday 15 March 2021 – Friday 19 March 2021)

During the March assessment period wind tended to prevail from the south southeast, south southwest and east with the greatest proportion of strong winds from the southeast and the greatest proportion of winds under 3 m/s from the south-southwest, south-southeast and east. Calm winds less than 0.5 m/s occurred 20% of the time (Figure D.1).

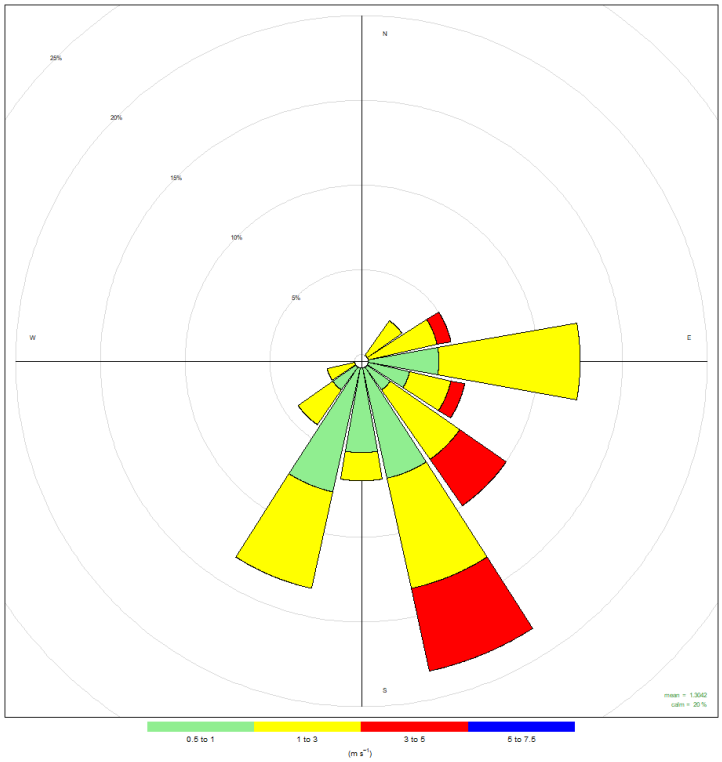


Figure D.1 Wind rose for monitoring period (15 to 19 March 2021) showing frequency of counts by wind direction (%)

Meteorology data was then broken down to the weekdays and analysed on a diurnal timescale (Table D.1). Figure D.1 shows that wind speeds during the assessment period were generally low and primarily were generated south and east of the Site. Calm conditions were experienced 20% of the time both overnight and during daylight hours, calm conditions were most common in the first half of the week during the day which reduced throughout the week. The highest wind speeds occurred on Friday 19 March but all days experienced a majority of winds under 3 m/s.

In general, the temperature over this period was relatively stable with a low of 12 °C and a high of 24 °C (Figure C.1). In addition, there was very little rainfall throughout this period with 2 mm of rainfall early in the morning of Monday 15 March and 0.2 mm of rainfall on Friday 19 March (Figure C.2).

The odour observations for the week of March monitoring is shown in Figure D.2.

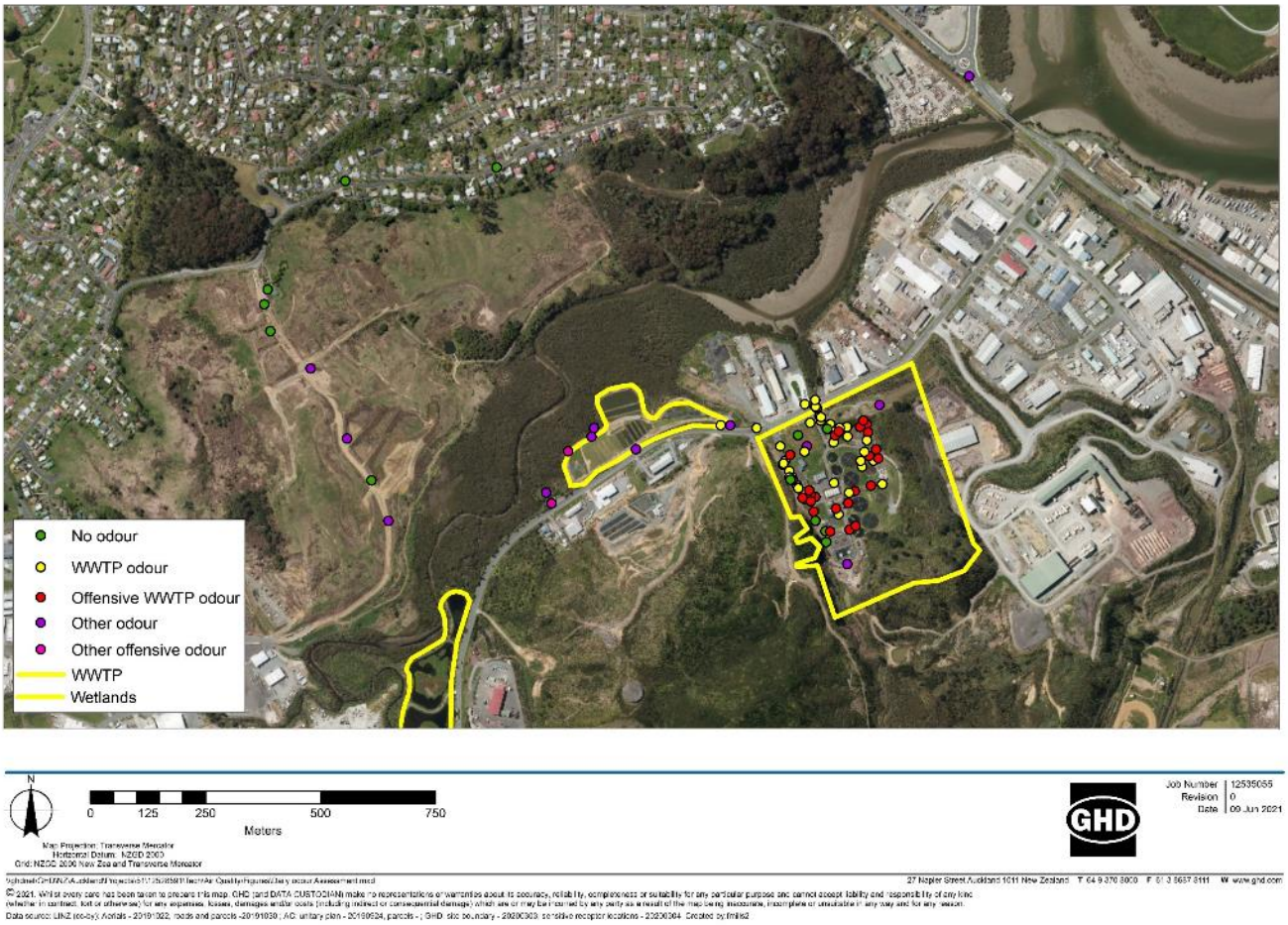
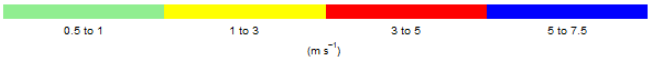
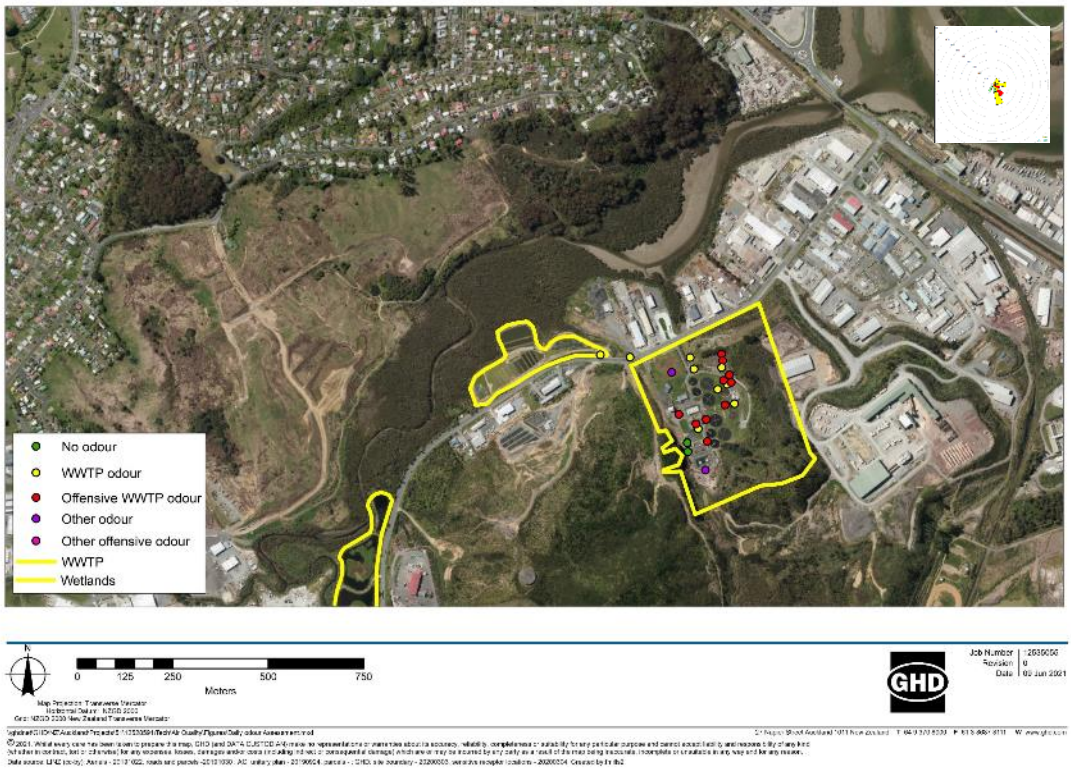
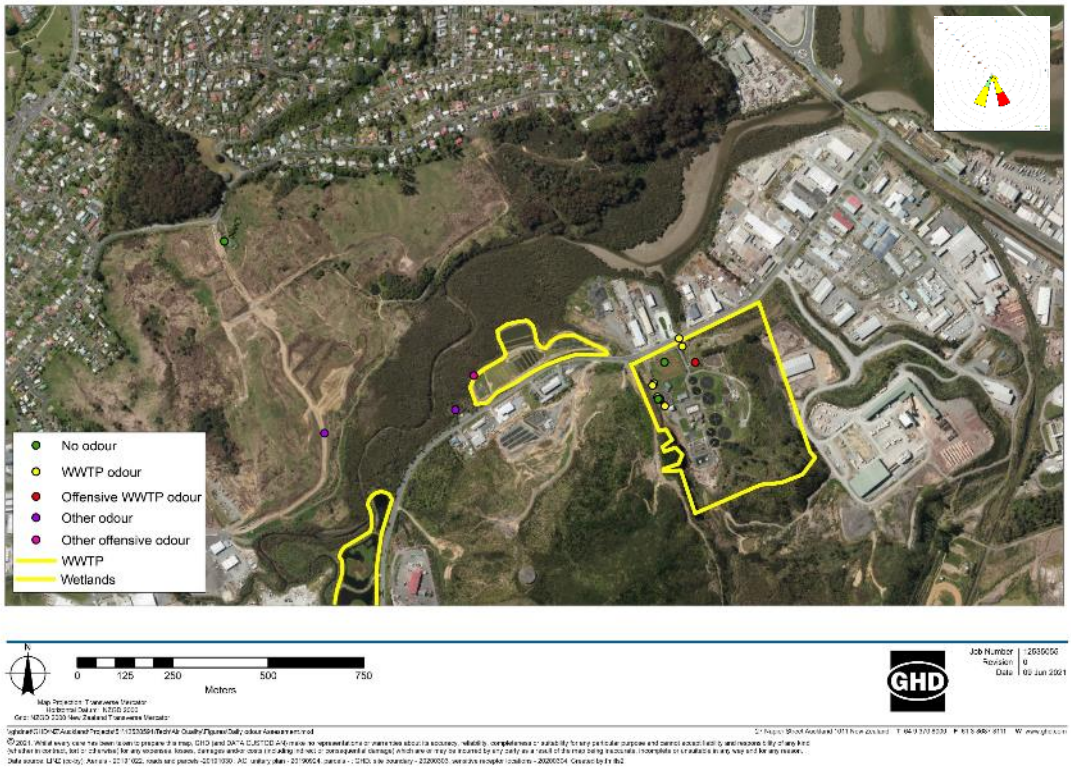
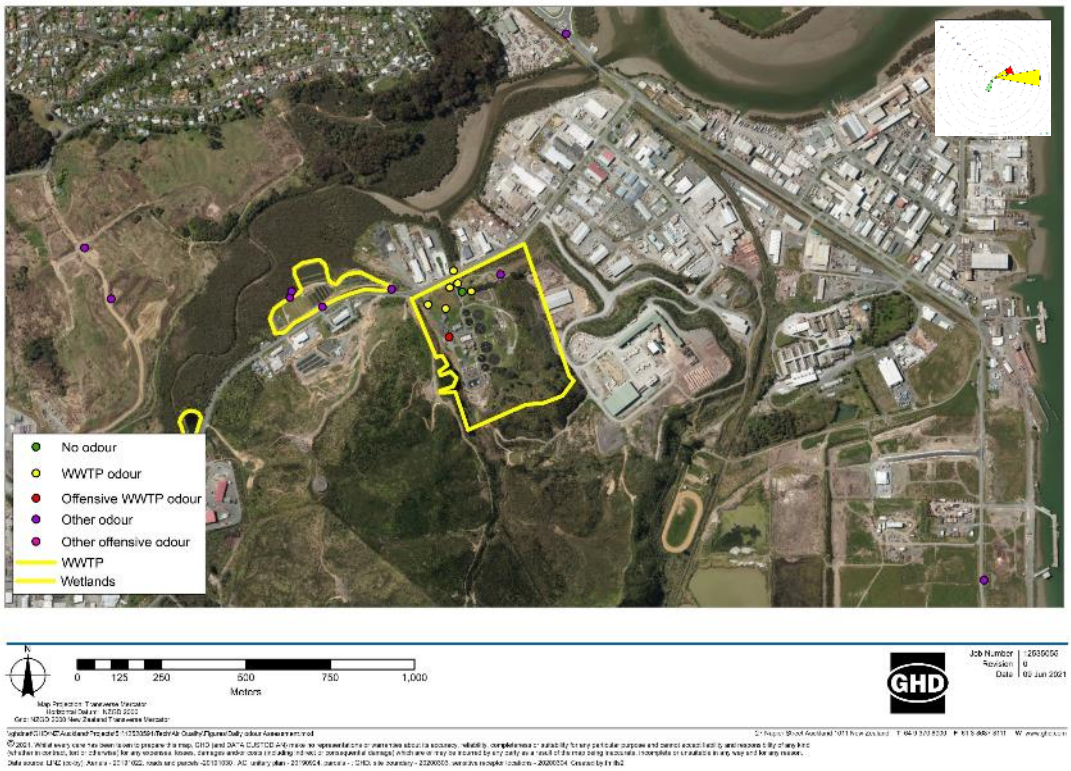
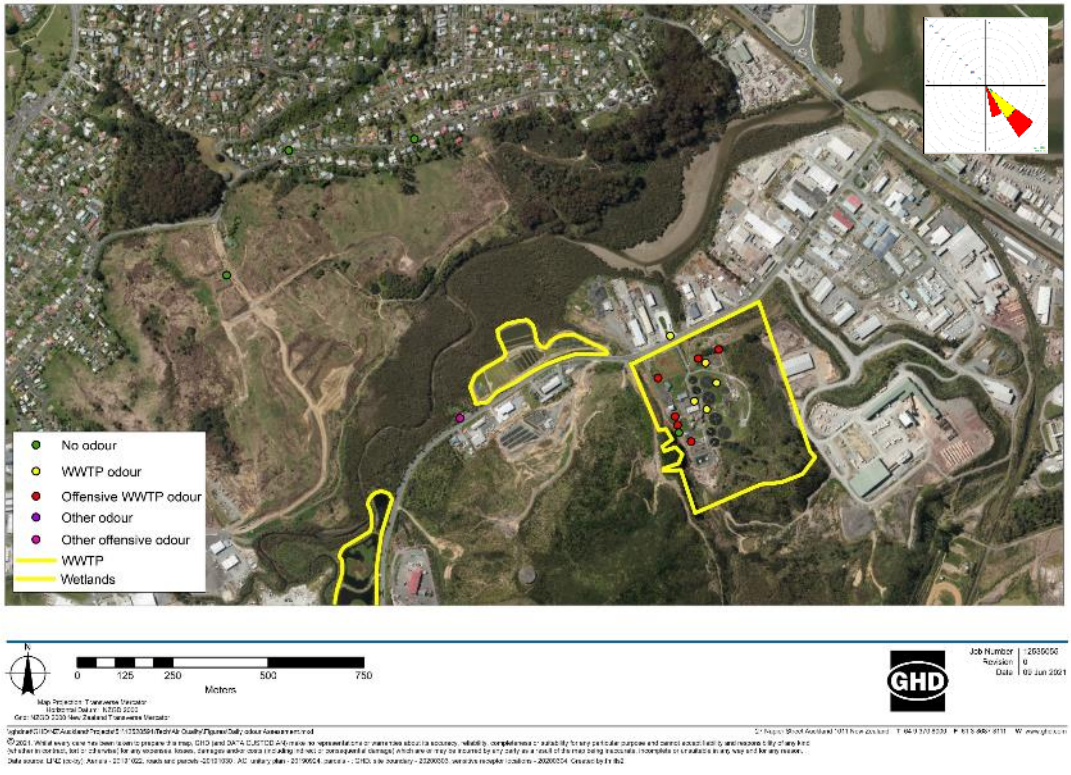


Figure D.2 March odour monitoring results

Table D.1 Daily wind rose for "daytime" hours during monitoring period (15 to 19 March 2021) showing frequency of counts by wind direction (%)

Date	Odour observations and Wind rose
	
15 March 2021 Mean = 1.9 m/s Calms = 8.3%	
16 March 2021 Mean = 0.9 m/s Calms =33.3%	 

Date	Odour observations and Wind rose
17 March 2021 Mean = 2.1 m/s Calms = 0%	
18 March 2021 Mean = 2.2 m/s Calms = 0%	

Date	Odour observations and Wind rose
19 March 2021 Mean = 2.9 m/s Calms = 0%	

Assessment Period 2 (Monday 10 May 2021 – Friday 14 May 2021)

During the May assessment period wind tended to prevail from the northern quarter, high wind speeds and wind speeds between 1 and 3 m/s were most common from these direction. During this period wind speeds between 0.5 and 1 m/s were most common from the southern quarter. Calm winds less than 0.5 m/s occurred 28% of the time (Figure D.3). Meteorology data was then broken down to the weekdays and analysed on a diurnal timescale (Table D.2). Figure D.3 shows that wind speeds during the assessment period were generally low and primarily were generated from the north and the south of the Site. Calm conditions were experienced 38% of the time overnight and 3% of the time during the daylight hours.

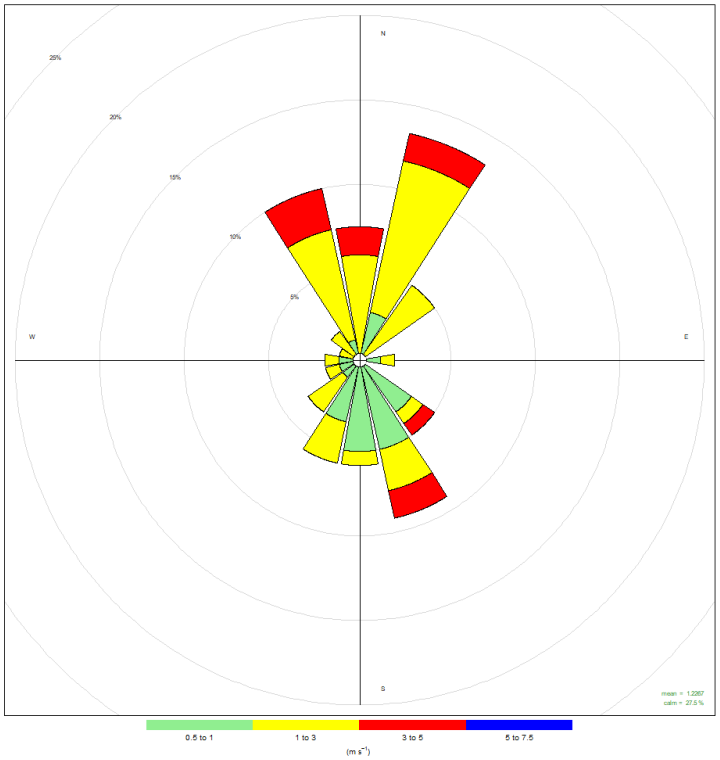


Figure D.3 Wind rose for monitoring period (10 to 14 May 2021) showing frequency of counts by wind direction (%)

In general, the temperature over this period cooled throughout the week with the coolest day reaching a low of 5 °C and a high of 16 °C and the warmest day reaching a low of 12 °C and a high of 23 °C (Figure C.3). In addition, there were scattered showers throughout the week, primarily on Tuesday 11 May and Wednesday 12 May (Figure C.4).

The odour observations for the week of May monitoring is shown in Figure D.4.

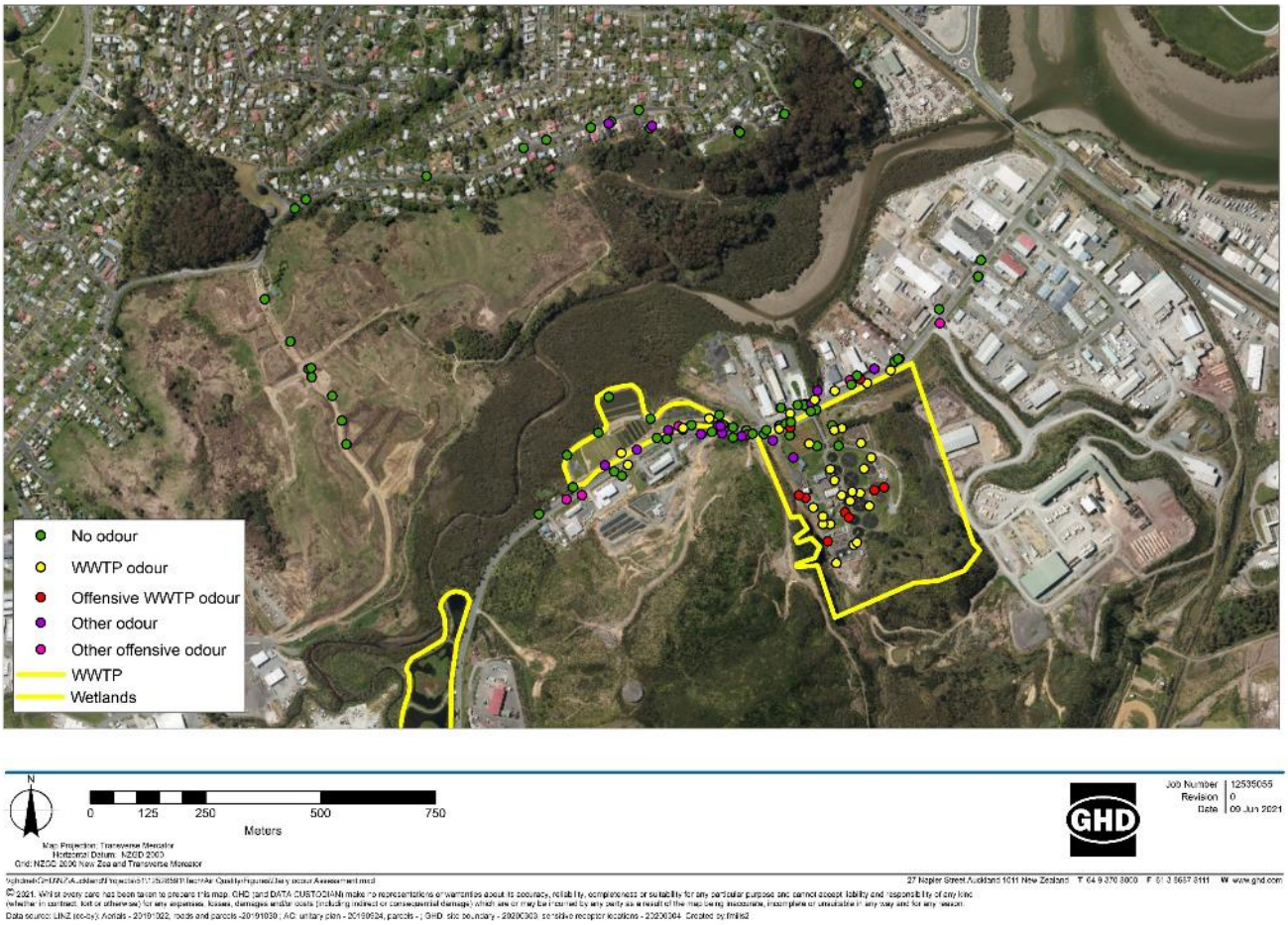
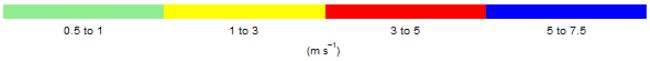
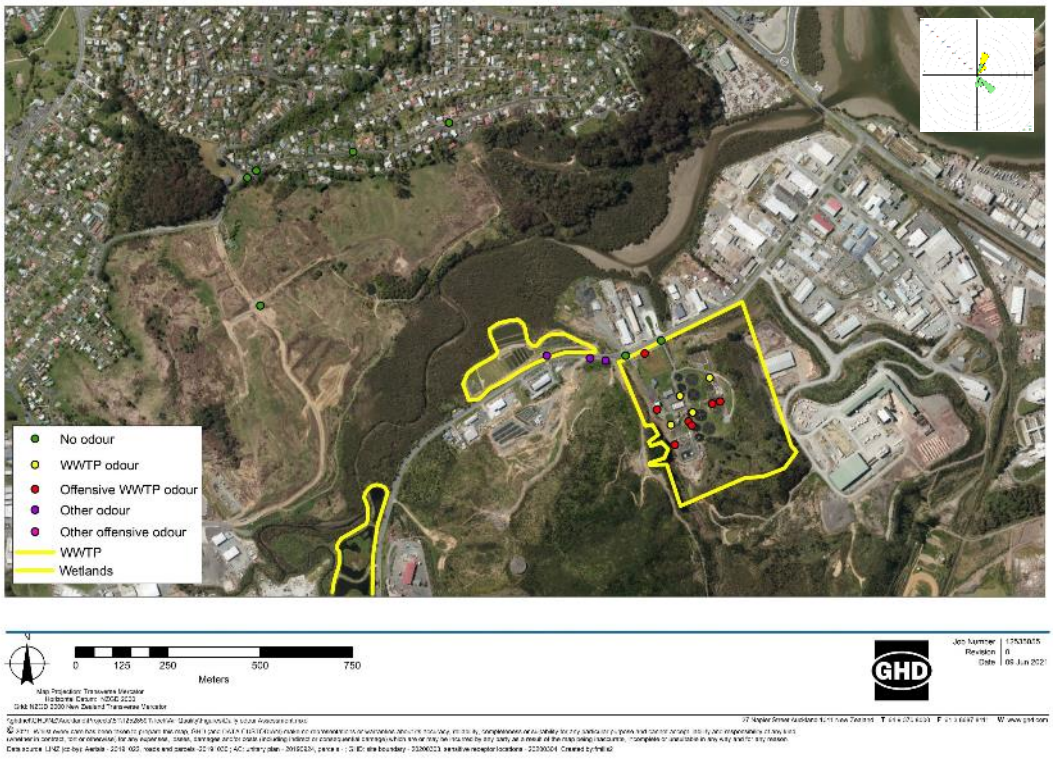
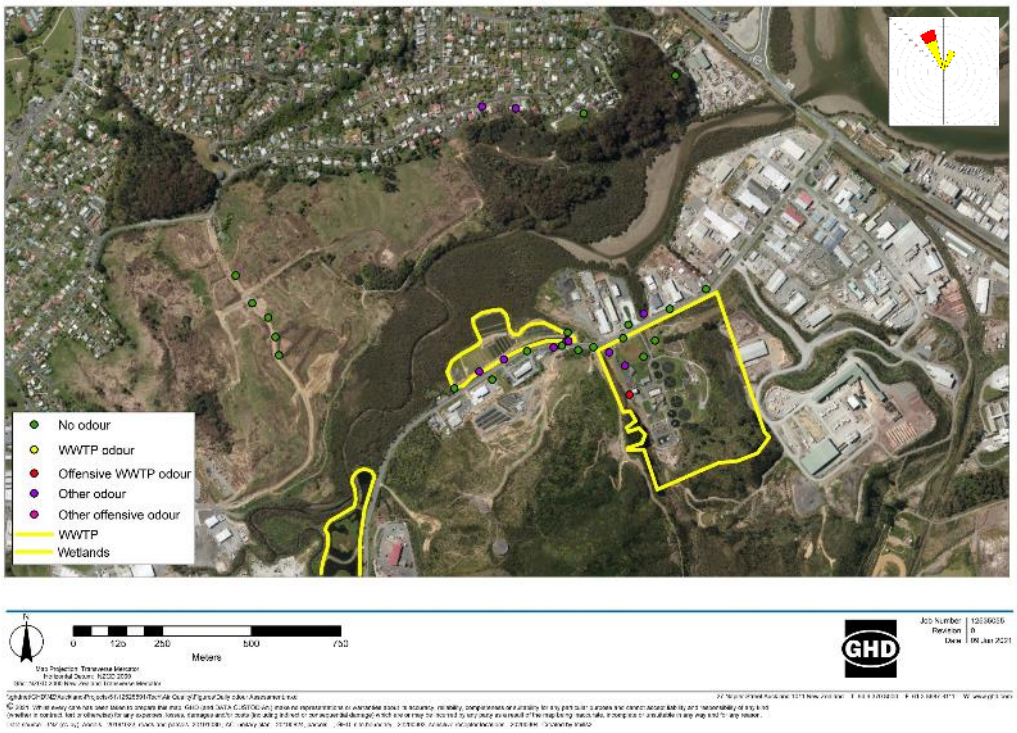
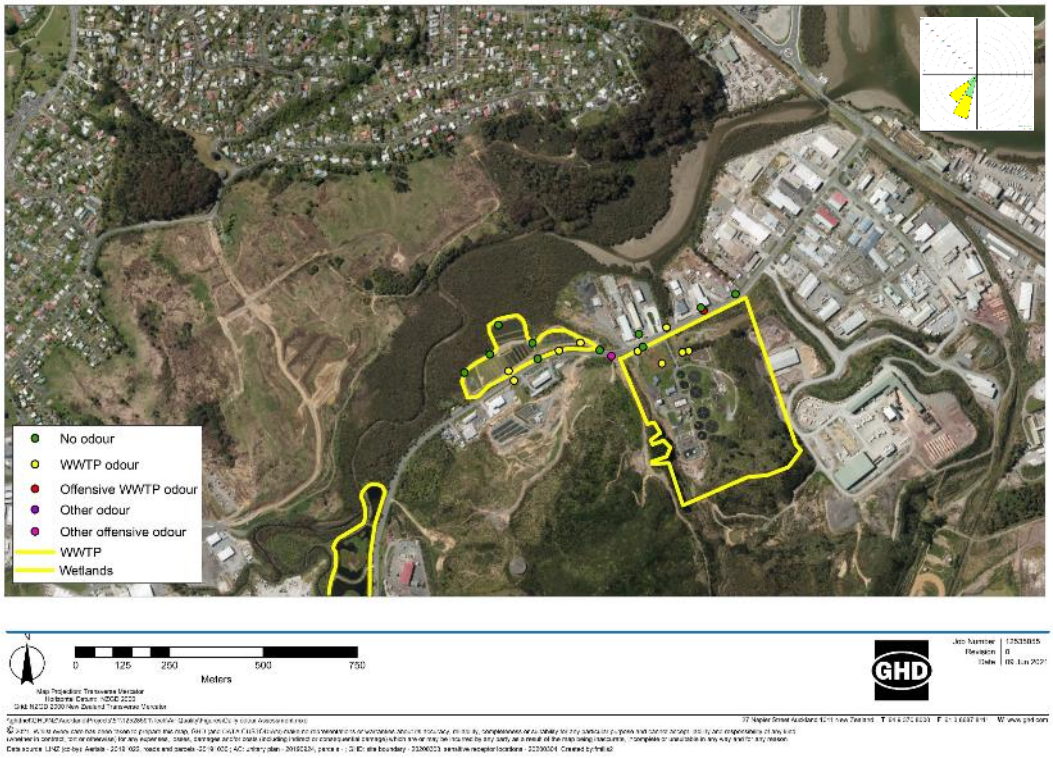
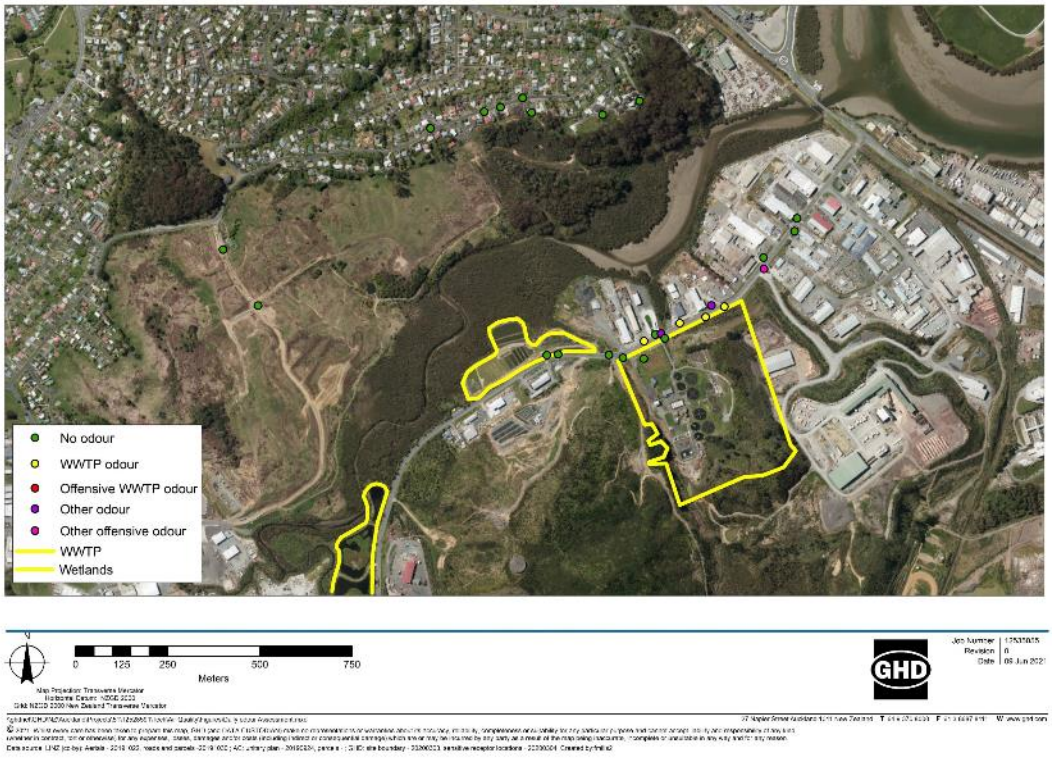
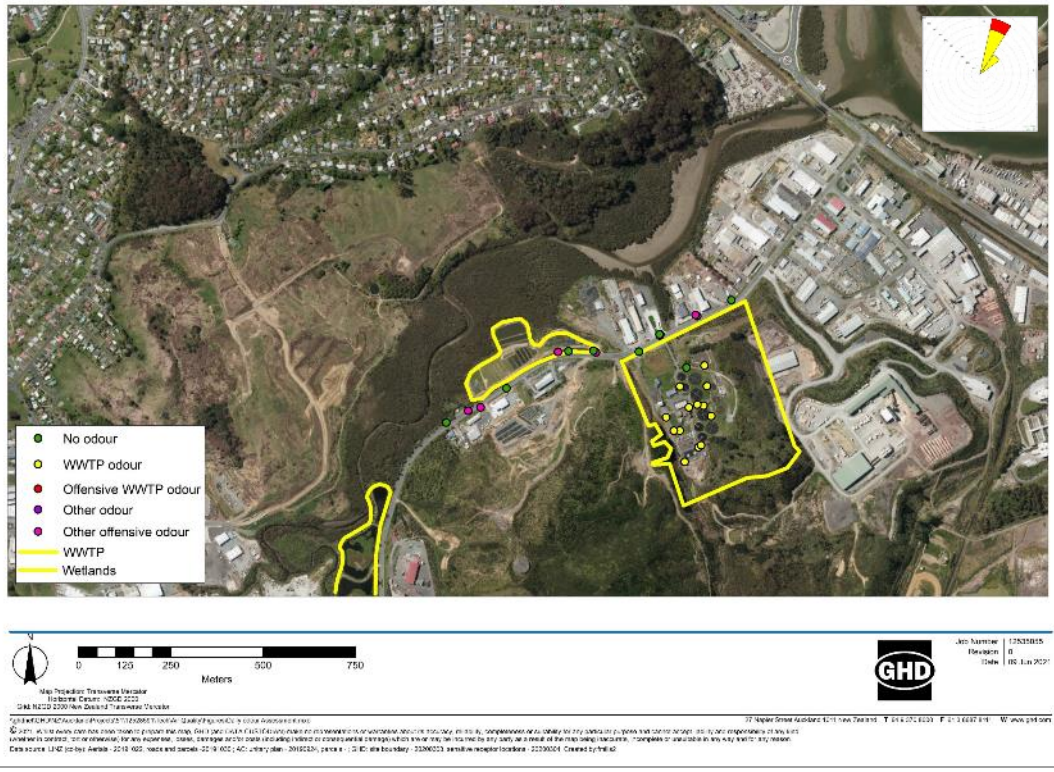


Figure D.4 May odour monitoring results

Table D.2 Daily wind rose for "daytime" hours during monitoring period (10 to 14 May 2021) showing frequency of counts by wind direction (%)

Date	Odour observations and Wind rose
	
10 May 2021 Mean = 0.9 m/s Calms = 0%	
11 May 2021 Mean = 2.4 m/s Calms = 0%	

Date	Odour observations and Wind rose
12 May 2021 Mean = 0.9 m/s Calms = 0%	
13 May 2021 Mean = 0.8 m/s Calms = 14.3%	

Date	Odour observations and Wind rose
14 May 2021 Mean = 2.0 m/s Calms = 0%	

Appendix E

Responses from the Community Odour Interview

Table E.1 Raw responses from community odour interviews

Location	Time in area	Do you experience odour in the area?	Frequency of odour	Intensity of odour	Odour character	Time of odour identification	Contributing wind conditions	Duration of odour	Possible odour source	Odour status
1	15 years	Yes	2	3	Compost, faecal		Wind	More than 3 hours	WWTP	Improving
2	15 years	Yes	3	2	Sewer odour, musty, earthy, mouldy		wind, temperature, summer, saturdays	More than 3 hours	Composting Plant, WWTP	Improving
3	3 - 4	Yes	2	2	Rotten Eggs		Summer, random, no breeze	More than 3 hours	SPCA	Improving
4	13 years	Yes	3	2	Sewer odour, rotten eggs	Mid summer, sometimes early morning	Hot days in summer	More than 3 hours	WWTP	No change
5	9 months	Yes	4	2 or 4* (open doors)	Faecal	Morning before 8, evening after 5pm	North	1-3 hours	WWTP	No change
6	1.5 years	Yes	2	2 or 4*	Sewer odour	Morning / midmorning	Warm weather	1-3 hours	WWTP	No change
7	24 years	Yes	3	2	Rotten Eggs	Mid morning	After rain, on a still day and in summer	1 - 3 hours	WWTP	Improving
8	2.5 month	Yes	2	4	Sewer odour, rotten eggs, faecal	Morning - midday all day	North	More than 3 hours	WWTP	No change
9	2 years	No								

Location	Time in area	Do you experience odour in the area?	Frequency of odour	Intensity of odour	Odour character	Time of odour identification	Contributing wind conditions	Duration of odour	Possible odour source	Odour status
10	20 Years	Yes	2	2 or 4*	Sewer odour, rotten eggs	Morning	Calm weather	1-3 hours	WWTP	Improving
11		No								
12	5 years	No								
13	6 - 7 years	No								
14	4 months	No								
15	7	Yes	4	4	Compost, faecal, musty earthy, mouldy, Ammonia	On and off - Sunny day.	Carries on the wind	More than 3 hours	WWTP, Neighbours nearby	Getting worse
16	7 years	Yes	2	2	Rotten Eggs	Morning - 5 am	Summer, still sometimes in winter	1 - 3 hours	WWTP, not sure where else	Improving
17	12	Yes	3	2	Faecal, chemical, fertiliser		Windy, or very still	More than 3 hours	"poo ponds", fert, chemicals	No change
18	4 years	No								
19	24 years	No								
20	4 years	Yes	2	2	Sewer odour	N	N	1-3 hours	WWTP	Improving
21	10 years	Yes	3	2	Sewer odour	N	Summer / heat	1 - 3 hours	WWTP	No change

Location	Time in area	Do you experience odour in the area?	Frequency of odour	Intensity of odour	Odour character	Time of odour identification	Contributing wind conditions	Duration of odour	Possible odour source	Odour status
22	2 years	Yes	3	1	Sewer odour, faecal	Morning - Faint at work, travel to work can be a strong odour - on Kioreroa Road	Calm weather	Up to 1 hour	WWTP	No change
23	20 Years	Yes	2	1	Rotten Eggs	Morning		Up to 1 hour		No change
24	"long enough"	No								
25	4.5	No								
26	2 years	No								
27	NA	No								
28	40 + years	Yes	2	2	Sewer odour	Mid morning	Wind in direction of house	1-3 hours	WWTP	Getting worse

* where two options were indicated the worse of the options was considered in the assessment

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