Grey Lynn Tunnel - Air Quality Assessment

1. EXECUTIVE SUMMARY

This report assesses the potential air quality effects associated with the Grey Lynn Tunnel, in particular the construction and operation of the Tawariki Street Shaft Site. In the absence of mitigation there is potential for dust and to a lesser extent odour to result in nuisance effects beyond the Tawariki Street Shaft Site. A range of 'Best Practice' mitigation measures are recommended to reduce the potential for adverse dust and odour nuisance effects.

A FIDOL assessment has been undertaken in accordance with the relevant Ministry for the Environment ("**MfE**") good practice guides. That assessment determined that, provided the proposed mitigation measures are implemented, there is limited potential for adverse effects beyond the site boundary.

To assess the potential odour effects from the operation of the Tawariki Street Shaft Site, atmospheric dispersion modelling was undertaken to determine the concentration of odour at or beyond the designation boundary. Based on the results of the modelling it has been determined that a stack height of a minimum of 5 metres (m) above ground level is required to ensure that odour at and beyond the boundary is below the prescribed odour assessment criteria.

Provided that the mitigation measures presented in this report are implemented for both the construction and operational phases, AECOM consider the effects of the Grey Lynn Tunnel will be less than minor.

1.1 Recommendations

It is recommended that a 5 m vent stack is incorporated into the control building at the Tawariki Street Shaft Site and odour is discharged vertically. The roof vent should be designed so that an extension of up to 3 m could be easily retrofitted, in the unlikely event that odour nuisance were to occur with the lower height stack.

2. INTRODUCTION

Watercare Services Limited ("**Watercare**") is the water and wastewater service provider for Auckland. Watercare is proposing to construct a wastewater interceptor from Tawariki Street, Grey Lynn to Western Springs Reserve ("**Grey Lynn Tunnel**"). The Grey Lynn Tunnel will connect to the Central Interceptor ("**CI"**) at Western Springs.

This report and assessment is submitted to accompany an application for resource consents and a notice of requirement by Watercare for the construction, operation and maintenance of the Grey Lynn Tunnel.

2.1 Project Overview

The Grey Lynn Tunnel involves the elements shown in the drawings and outlined in the reports which form part of the application.

Grey Lynn Tunnel

The Grey Lynn Tunnel involves the construction, operation and maintenance of a 1.6 km gravity tunnel from Western Springs to Tawariki Street, Grey Lynn with a 4.5 m internal diameter, at an approximate depth of between 15 to 62 m below ground surface, depending on local topography. The tunnel will be constructed northwards from Western Springs using a Tunnel Boring Machine ("**TBM**"). The Grey Lynn Tunnel will connect to the Central Interceptor at Western Springs via the Western Springs shaft site.

Tawariki Street Shaft Site

The Grey Lynn Tunnel also involves the construction, operation and maintenance of two shafts and associated structures at Tawariki Street, Grey Lynn ("**Tawariki Street Shaft Site**").

The Tawariki Street Shaft Site will be located at 44-48 Tawariki Street, where the majority of the construction works will take place. Construction works will also take place within the road reserve at the eastern end of Tawariki Street and a small area of school land (St Paul's College) bordering the end of Tawariki Street (approximately 150 m^2).

The Tawariki Street Shaft Site will involve the following components:

Main Shaft

- A 25 m deep shaft, with an internal diameter of approximately 10.8 m, to drop flow from the existing sewers into the Grey Lynn Tunnel;
- Diversion of the Tawariki Local Sewer to a chamber to the north of the shaft. This chamber will be approximately 12 m long, 5 m wide and 5 m deep below ground, and will connect to the shaft via a trenched sewer;
- Diversion of the Orakei Main Sewer to a chamber to the south of the shaft. This chamber will be approximately 10 m long, 5m wide and 11 m deep below ground and connected to the shaft via a trenched sewer;
- Construction of a stub pipe on the western edge of the shaft to enable future connection to the Tawariki Connection sewer shaft.
- Construction of a grit trap within the property at 48 Tawariki Street to replace the existing grit trap on the Orakei Main Sewer located within the Tawariki Street road reserve. The replacement grit trap will be approximately 16 m long, 5 m wide and 13 m deep below ground;

- Permanent retaining of the bank at the end of Tawariki Street to enable the construction of the chamber for the Orakei Main Sewer. The area of the bank requiring retaining will be approximately 44 m long, 3 m wide and 2 m high; and

- An above ground plant and control building that is approximately 14 m long, 6 m wide and 4 m high. An air vent in a form of a stack of approximately 1 m internal diameter and 5 m height will be incorporated into the plant and control building and discharge air vertically via a roof vent. The vent stack will be designed with a flange to allow future extension of up to 8 m in total height and approximately 1 m in diameter in the unexpected event of odour issues with the lower height stack.

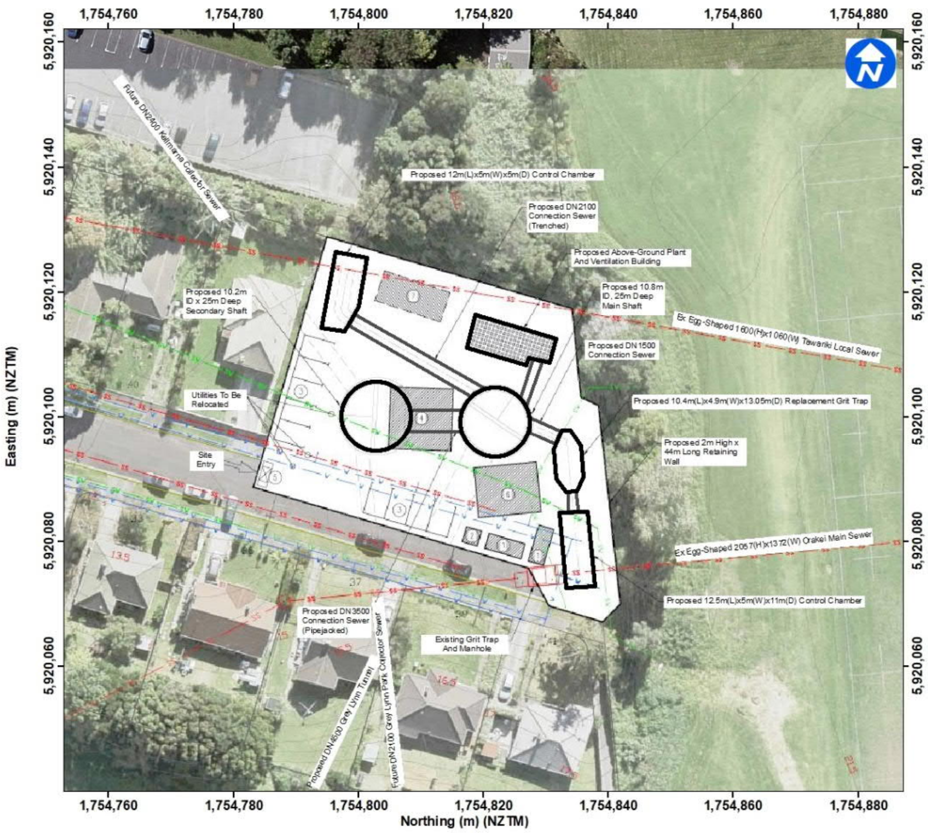
Tawariki Connection Sewer Shaft – Secondary Shaft

A secondary shaft will be constructed at the Tawariki Street Shaft Site to enable the connection of future sewers (that are not part of this proposal) from the Combined Sewers Overflows ("**CSO**") network. This will involve the following components:

- A 25 m deep drop shaft with an internal diameter of approximately 10.2 m; and
- A sewer pipe constructed by pipe-jacking to connect the secondary shaft to the main shaft.

Figure 1 shows the key components of the Project.

Figure 1 Overview of study area.



The Grey Lynn Tunnel represents a key component for the upgrading and reorganisation of Auckland's metropolitan wastewater network, as it will:

a. increase the capacity of the metropolitan wastewater network, thereby supporting the intensification of the Auckland urban area;

b. assist in reducing the frequency of storm-related overflow events from the combined wastewater / stormwater network; and

c. improve network reliability and enable future upgrades and improvements to the network.

2.2 Assessment Overview

This report contains an assessment of the potential air quality impacts at the nearest identified receptors resulting from the discharges to air from the Tawariki shafts. The assessment has been undertaken in accordance with the following MfE Good Practice Guides ("**GPG**"):

- Good Practice Guide for Assessing and Managing Dust[1] ("**GPG Dust**");
- Good Practice Guide for Assessing and Managing Odour[2] ("**GPG Odour**");
- Good Practice Guide for Assessing Discharges to Air from Industry[3] ("**GPG ID**"); and,
- Good Practice Guide for Atmospheric Dispersion Modelling[4] ("**GPG ADM**").

The assessment involved modelling the dispersion of odour from the Tawariki Street Shaft Site to predict the level of impact that may be experienced in the surrounding environment.

This assessment is set out as follows:

Section 3	The Proposal
Section 4	Existing Environment
Section 5	Assessment Criteria
Section 6	Assessment Methodology
Section 7	Mitigation Methods
Section 8	Results of Construction Effects Assessment
Section 9	Results of Operational Effects Assessment
Section 10	Summary and Conclusions
Section 11	Limitations

Key inputs into the assessment of odour were taken from information provided in the following documents:

- Draft Project Description and Construction Methodology dated 12 December 2018;
- Pneumatic Analysis of the CI Tunnel During Wet Weather, dated February 2019 (DSCIN-DEL-MEM-AI-J-100038); and,
- Odour Assessment of the Western Springs Odour Discharge, dated 7 April 2016 (DSCIN009-DEL-MEM-AI-J-100215). (Western Springs Odour Assessment)

[1] Ministry for the Environment, Good Practice Guide for Assessing and Managing Dust, November 2016
[2] Ministry for the Environment, Good Practice Guide for Assessing and Managing Odour, November 2016
[3] Ministry for the Environment, Good Practice Guide for Assessing Discharges to Air from Industry, 2008
[4] Ministry for the Environment, Good Practice Guide for Atmospheric Dispersion Modelling, 2004

3. THE PROPOSAL

3.1 Construction

The Grey Lynn Tunnel will be constructed using a TBM. The tunnel spoil will be removed at the CI May Road shaft site (which already has all necessary resource consents), and will not have any local impacts.

The main shaft at the Tawariki Street Shaft Site will be large in diameter (12 m external diameter) to allow for the removal of the TBM. The shaft will be constructed using excavators, with material being transferred to trucks for off-site disposal. Construction of other shafts and connections will be undertaken using methodologies which minimise air discharges.

There is the potential that making the connection to the Orakei Main Sewer may generate some odour, and appropriate mitigation methodologies will be employed to minimise this as set out in Section 7. Once construction is complete material will be brought in to reinstate the Site.

3.2 CI Ventilation

While CI is already consented, and does not form part of this application, the Grey Lynn Tunnel will connect to CI once it is constructed. It is therefore important from an air quality point of view, to understand the CI ventilation philosophy, as the same general philosophy is proposed as the primary odour control for the Grey Lynn Tunnel.

The general ventilation philosophy for CI is described in the Odour Assessment[5] prepared for the CI designation and consent application hearing process and the evidence of Clinton Cantrell prepared for the CI Council Hearing. While the general philosophy has remained broadly the same through the detailed design process, there has been a reduction in the number of potential discharge points. Therefore set out in this section is a brief outline of how the CI ventilation system as designed will work.

The CI is designed to operate under negative pressure with air being continuously drawn into the tunnel via air intakes located at Western Springs, and the existing sewer network. The main Ci tunnel air will be extracted and treated by the primary Air Treatment Facility ("**ATF**") located at the Mangere Pump Station ("**MPS**") (at the southern end of CI) and will ensure that as far as practical in normal dry weather conditions there are no odour discharges from CI.

During significant wet weather events there is the potential for the volume of water in the CI tunnel to prevent air from being extracted at the primary ATF. In this scenario, the air flow will reverse, pushing air back up the main tunnel and releasing it at a secondary ATF that will be installed at May Road. This may occur once or twice a year. The secondary ATF at May Road is primarily designed to ventilate Link Sewer C but has been designed to accommodate these wet weather events.

In extreme weather events there is the potential that the CI tunnel may fill to the extent that the secondary ATF at May Road is also unable to extract air. In this scenario, the air flow (now well diluted and therefore less odorous) will be discharged via a vent located at Western Springs. Discharges at this location are expected to occur less than once every ten years. These discharges are already consented under the CI consents.

The vents at May Road and at the Western Springs shaft site also act as emergency vents in extreme weather conditions to prevent an over pressure situation in the tunnel

[5] Beca Infrastructure, Central Interceptor – Odour Assessment, 30 July 2012

3.3 Operation - Tunnel Ventilation

Grey Lynn Tunnel will be connected to the CI at Western Springs, and ventilated using the same operating philosophy. The Grey Lynn Tunnel will incorporate an air inlet and exhaust which is control by air dampers to minimise fugitive emissions. This means that when the Grey Lynn Tunnel commissioned the air intake at Western Springs will be decommissioned.

(a) *Dry Weather Conditions*

During normal dry-weather flows ("**DWF"**) the Grey Lynn Tunnel will operate under negative pressure with the air extracted and treated by the primary ATF at the at the MPS. Under these conditions, no discharge (and hence no odour emission) will occur at the Tawariki Street Shaft Site.

(b) *Wet Weather Conditions*

During significant storm events, CI will fill with stormflow and air will not be able to be extracted by the ATFs at Mangere WWTP and May Road. Therefore any air that needs to be vented will discharge through the most upstream point in the system which is at Western Springs, and the CI system has been designed and consented on this basis.

Once the Grey Lynn Tunnel is constructed and connected to CI, then it will become the most upstream point in the extended system. This means that in the event that there is a significant storm event and water levels in CI reach a level where it is not possible to exhaust air at Western Springs, then as the most upstream location, air will be exhausted at the Tawariki Street Shaft Site through a vent attached to the Plant building.

It is difficult to predict how often this might occur, however based on available information (relating to CI), it is likely to be less than a 1 in 10 year event[6].

Again based on information available for CI this event could lead to an air discharge of approximately 8.8 m^3/s for a period of time[7].

3.4 Operational Maintenance

The existing Grit trap associated with Tawariki local sewer will continue to be used. This Grit trap is operated and maintained under the existing consents held by Watercare for its network operations. As the proposed operation of this Grit trap is unchanged from what exists currently, any fugitive emissions from this source will be no different from what currently occur.

A new Grit trap will be constructed within the 48 Tawariki Street site as part of this project for the Orakei Main Sewer. This Grit trap will be larger than the current one and therefore more effective at preventing grit from entering the Grey Lynn Tunnel. Relocating the Grit trap onto 48 Tawariki Street will move it further from neighbours. Therefore, any odour effects from it should be no different to those that currently occur.

Occasional maintenance activities will need to be undertaken at the Tawariki Street Shaft Site, which may result in occasional uncontrolled odours as chamber covers are opened particularly if the ATF at the MPS is offline. However, these events are not expected to occur frequently or for significant periods of time. It is therefore considered that emissions associated with maintenance activities are insignificant and have therefore not been considered any further in this report.

[6] The worst case storm event for CI has a peak rate of inflow during a 10-year storm (10 yr+CC+25% storm scenario) of 8.8 m^3/s. This assumes that all of the automated control gates on CI operate and that consequently inflows are only associated ungated sources.

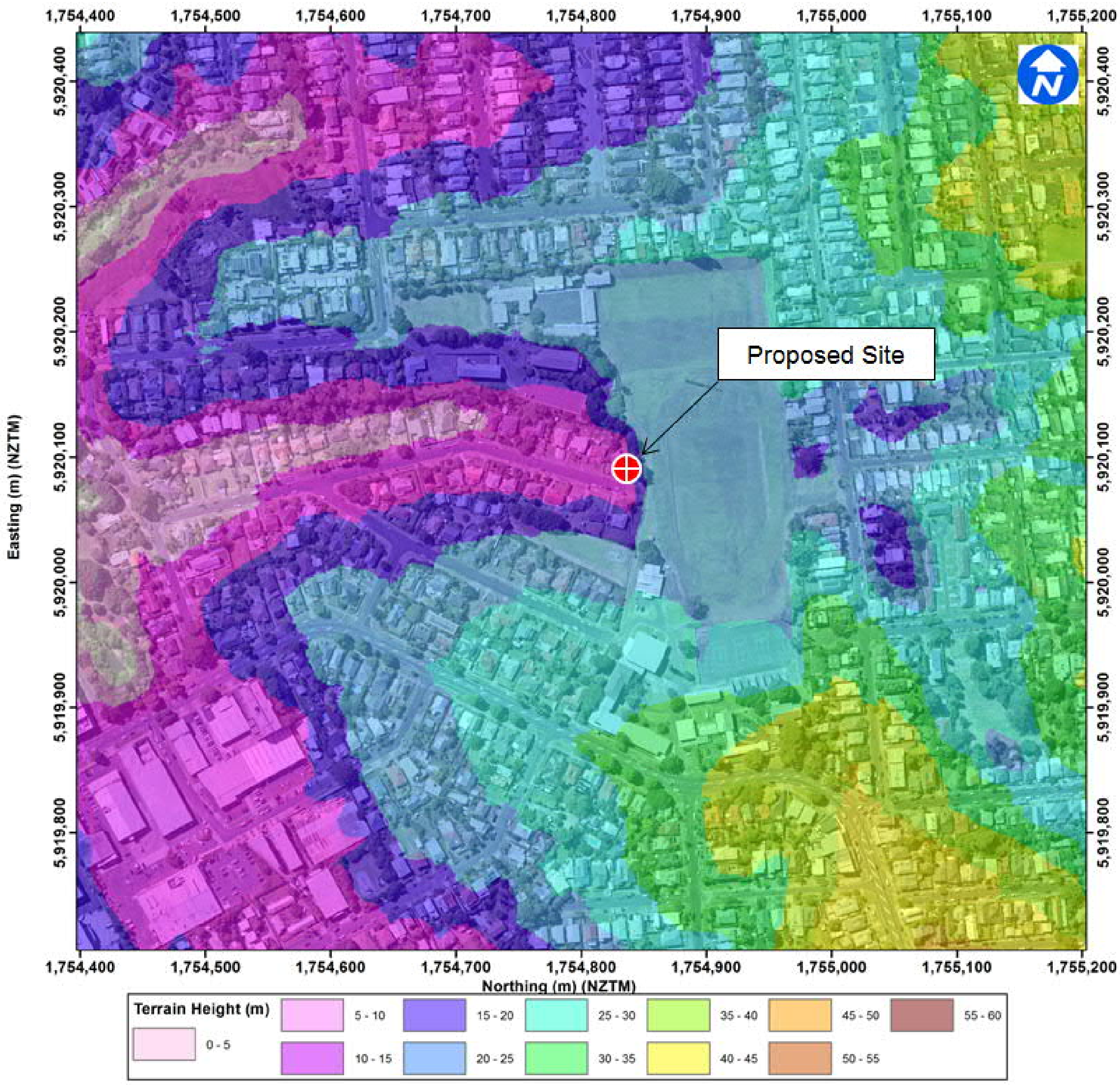
[7] It is difficult to estimate the length of these events as it is depends on the intensity of the rain event. However in most circumstances it is expected that any discharge would be less than two hours

4. EXISTING ENVIRONMENT

The Tawariki Street Shaft Site is located at the eastern end of Tawariki Street. The Site is bordered by St Paul's College playing fields to the east, Marist School to the north and residential properties to the west and south. It is located within a small valley which runs east to west. An escarpment lies approximately 20 m to the east of the Site, where the elevation increases from 15 m to 25 m over a horizontal distance of 10 m. The elevation changes to the north and south occur progressively, with a total increase in elevation of 10 m over a horizontal distance of 50 m. The surrounding terrain elevations are presented in Figure 2.

The residential properties located on Tawariki Street are zoned Residential – Mixed Housing Urban under the Auckland Unitary Plan – Operative in Part ("**AUP(OP)**"). There is a park to the south of the Site, which is zoned Open Space – Informal Recreation Zone and contains a playground. Both St Paul's College and Marist School are zoned Special Purpose – School.

Figure 2 Surrounding Terrain



5. ASSESSMENT CRITERIA

The assessment contained in this report incorporates the matters outlined in the following documents:

- Auckland Unitary Plan: Operative in Part (AUP(OP)); and,
- Ministry for the Environment Good Practice Guides listed previously.

5.1 Assessment Criteria – Auckland Unitary Plan

AECOM has reviewed the applicable air quality rules set out in Chapter E14 of the AUP (OP) and considers that the Grey Lynn Tunnel falls under Rule E14.1.1 (A166) as a permitted activity which covers:

> *"Wastewater facility that is for the primary purpose of pumping or transfer or storage of raw or partially treated wastewater"*

In order to be permitted, discharges must meet the relevant permitted activity standards, including.

E14.6.1. Permitted Standards
All activities listed as permitted in Table E14.4.1 Activity table must comply with the following general standards and specific standards where applicable.
E14.6.1.1. General Standards
The following standards apply to all permitted activities that discharge contaminants into air …

> *(1) The discharge must not contain contaminants that cause, or are likely to cause, adverse effects on human health, property or the environment beyond the boundary of the premises where the activity takes place.*
> *(2) The discharge must not cause noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash beyond the boundary of the premises where the activity takes place.*
> *(3) There must be no, dangerous, offensive or objectionable visible emissions.*

Note 1
When making a determination of adverse effects in relation to odour and dust, the FIDOL factors (frequency, intensity, duration, offensiveness and location) should be used. The use of the FIDOL factors provides a framework for making an objective and consistent assessment in relation to the degree of effects. The nature of the zone, predominant types of activities within any given area and amenity provisions for each zone, precinct or overlay will be taken into account when undertaking the assessment effects on the environment.

In short, air discharges associated with the Tawariki shafts are permitted providing that the discharge does not result in offensive or objectionable odour beyond the boundary of the designation. To make this assessment the AUP requires that the frequency, intensity, duration, offensiveness and location ("**FIDOL**") assessment factors are considered. This is an applicable assessment methodology for both construction odour and dust, however as this is a qualitative criterion, it is not possible to directly compare atmospheric dispersion modelling results, associated with the operational assessment, against the subjective standard set out above. Therefore the modelling results have been compared with the odour assessment criteria developed by the MfE as is normal for a project like this. This assessment criterion is presented in Table 2.

5.2 Ministry for the Environment Good Practice Guidance

(a) *Dust*

The GPG Dust sets out how dust effects are assessed in New Zealand. While it does not contain any standards, the GPG Dust provides methodologies that can be used to determine whether any emissions result in nuisance or offensive or objectionable effects. This is primarily undertaken using the FIDOL assessment tool.

The GPG Dust also contains monitoring trigger levels, which can be used to determine whether an activity is resulting in some form of effect. Those that are relevant to the Grey Lynn Tunnel are set out in Table 1.

Table 1 Dust Monitoring Trigger Levels

Trigger	Averaging Period	High Sensitivity Environment
Short term	5 min	250 µg/m^3
Short term	1 hour	200 µg/m^3
Daily	24 hours (rolling average)	60 µg/m^3
Wind warning	1 minute	10 m/s (during two consecutive 10-minute periods)
Rain warning	12 hours	There has been no rain in the previous 12 hours
Visible dust	Instantaneous Visible	Visible dust crossing the boundary

(b) *Odour*

The GPG Odour sets out in general how odours are assessed in New Zealand, but does not contain any standards. This is primarily because the odour assessment is a qualitative process and in general is assessed against the test that odours should not “result in offensive or objectionable effects” beyond the boundary of the site that the odours are generated on. For fugitive odours a FIDOL assessment is recommended, which has a similar methodology to the dust assessment.

In some instances it is possible to model odour effects, and the GPG Odour provides odour modelling assessment criteria against which the results of modelling can be compared. The values contained in the GPG Odour are set out in Table 2. For the purposes of the Grey Lynn Tunnel, an assessment criterion of 2 OU/m^3 is considered appropriate as the sensitivity of the environment is High (being a residential area) and the worst case odours occur in neutral to stable atmospheric conditions.

Table 2 MfE Odour Modelling Guidelines

Sensitivity of the Receiving Environment	Concentration	Percentile
High (worst-case impacts during unstable to semi-unstable conditions)	1 OU/m^3	0.1 and 0.5%
High (worst-case impacts during neutral to stable conditions)	2 OU/m^3	0.1 and 0.5%
Moderate (all conditions)	5 OU/m^3	0.1 and 0.5%
Low (all conditions)	5-10 OU/m^3	0.5%

6. ASSESSMENT METHODOLOGY

6.1 Meteorological Modelling

For the purposes of undertaking an atmospheric dispersion modelling assessment, the model requires a number of specific inputs. One of the key inputs is meteorological data. While some of these parameters can be obtained from automatic weather stations ("**AWS**"), including wind speed, temperature and relative humidity, the model also requires other meteorological parameters such as mixing height, vertical wind profile and temperature profile – which are not typically measured by AWS.

Therefore, to understand the local meteorological conditions, 'The Air Pollution Model' ("**TAPM**") was used together with data from a meteorological station installed at the Tawariki Street Shaft Site to develop the missing meteorological parameters. This data was then subsequently refined using CALMET, CALPUFF's meteorological pre-processing module, which takes into consideration the influence of local terrain and land use.

(a) *TAPM*

TAPM is a prognostic model used to predict three-dimensional meteorological data, with no local data inputs required. TAPM Version 4 was developed in Australia by the Commonwealth Scientific and Industrial Research Organisation ("**CSIRO**").

The TAPM modelling domain was centred at Universal Transverse Mercator ("**UTM**") 295.700 km E, 5,913.400 km N, (zone 60, south).

A three dimensional prognostic meteorological file was extracted from TAPM and was used to generate the CALMET meteorological data input file.

The parameters used in the TAPM meteorological modelling are summarised in Table 3, with the grids shown in Figure 3.

Table 3 Meteorological Parameters used in TAPM for this Study

TAPM (v 4.0)	
Number of grids (spacing)	4 (1,200 km, 400 km, 120 km, 40 km)
Number of grid points (x, y, z)	40 x 40 x 35
Year of analysis	2013
Centre of grid	Project Site UTM 295.700 km E, 5913.400 m N, zone 60 South
Meteorological data assimilation	None

Figure 3 TAPM Grids

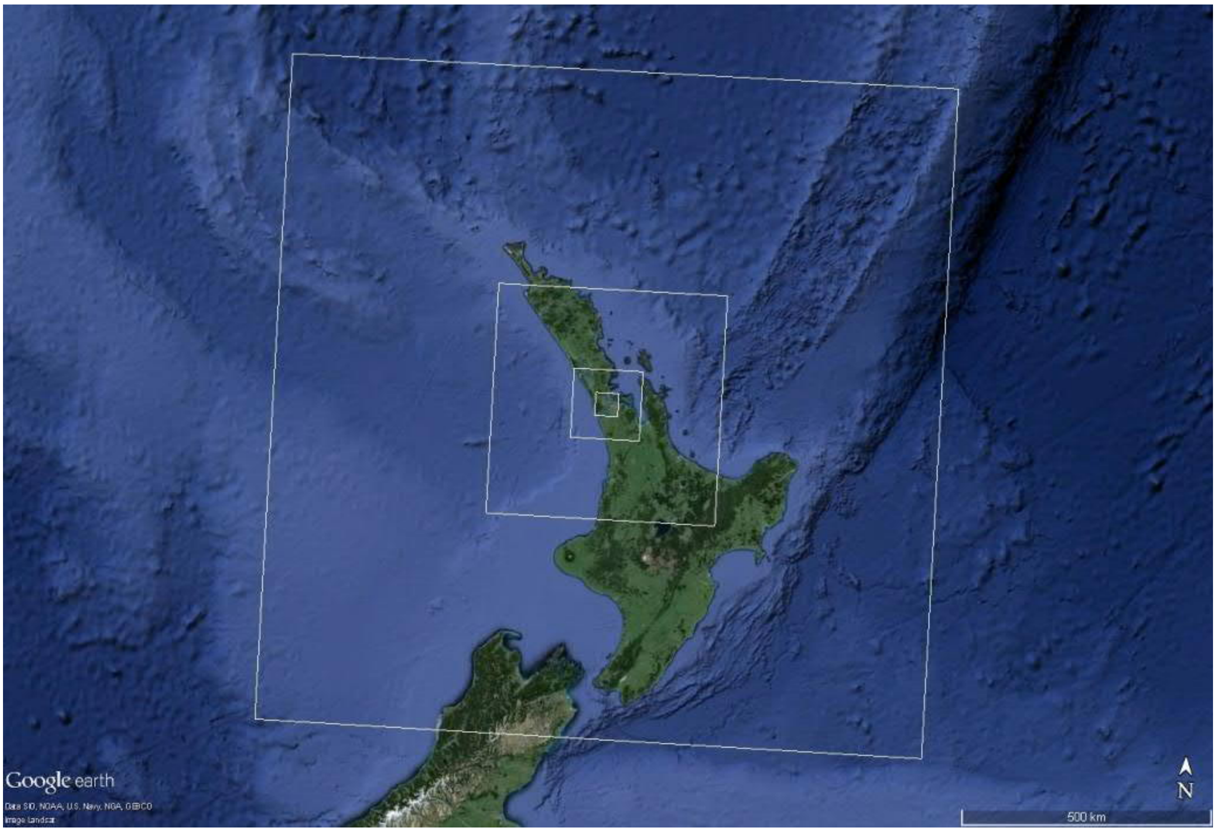


Image Source: Google Earth™ 2015

TAPM allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, and temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations. TAPM is often used where insufficient on-site meteorological data are available. Parameters not recorded by AWS (e.g. atmospheric stability class, mixing height and sigma theta) but required by the meteorological input file have been synthetically generated using TAPM. The TAPM model also allows for the assimilation of wind observations to be optionally included in a model simulation. The wind speed and direction observations are used to realign the predicted solution towards the observation values. Technical details of the model equations, parameterisations, and numerical methods are described in Hurley (2008).[8] A summary of some verification studies using TAPM is also provided in Hurley et al. (2008).[9]

[8] Hurley, P.J. (2008). TAPM V4. Part 1: Technical Description, CSIRO Marine and Atmospheric Research Paper No. 25, 59 pp.
[9] Hurley, P., Edwards, M. and Luhar, A. (2008). TAPM V4. Part 2: Summary of Some Verification Studies, CSIRO Marine and Atmospheric Research Paper No. 26, 31 pp.

(b) *CALMET*

The CALMET modelling domain was centred at UTM 295.821 km E, 5,910.964 km N (zone 60 south). A 30 km by 23 km Cartesian grid was used at a resolution of 120 m.

Wind speed and direction, temperature, relative humidity and pressure data from the following AWS were input into the model:

- Auckland Airport (MetService)
- Albany (Auckland Council)
- Lincoln Rd, Henderson
- Mangere (NIWA)
- Musick Point (Auckland Council)
- Glenfield, North Shore (Auckland Council)
- Penrose (Auckland Council)
- Whenuapai (MetService)

Wind data from these stations is presented in Appendix B as a series of windroses which show diurnal and seasonal variations in wind patterns.

Geophysical (terrain and land use) data were input into the CALMET model at a resolution of 120 m.

The surface elevation (terrain) data were taken from Lakes Environmental Software's website (www.webGIS.com), which was based on the Shuttle Radar Topography Mission ("**SRTM-3**") digital elevation model (90 m resolution) data (Version 2) originally produced by the National Aeronautics and Space Administration ("**NASA**").

The parameters used in the CALMET meteorological modelling are summarised in Table 4.

Table 4 Meteorological Parameters used in CALMET for this Study

CALMET (v 5.8)	
Meteorological grid size	30 km x 23 km
Meteorological grid coordinates	Southwest: UTM 280.8210 km E, 5,899.5640 km N (zone 60 south)
Meteorological grid resolution	120 m
Number of grid points (x, y, z)	250 x 190 x 11
Year of analysis	2013
TAPM-generated meteorological data	TAPM 3D Prognostic file – Grid 4
Surface Stations	– Auckland Airport (MetService) – Albany (Auckland Council) – Lincoln Rd, Henderson – Mangere (NIWA) – Musick Point (Auckland Council) – Glenfield, North Shore (Auckland Council) – Penrose (Auckland Council) – Whenuapai (MetService)

CALMET (v 5.8)	
Terrain Data	Auckland Council 1 m Lidar data.
Land Use Data	Data were developed based on USGS land use and land cover classification scheme

(c) *CALMET Windrose*

Figure 4 presents a windrose generated from the CALMET data centred on the Tawariki Street Shaft Site. Figure 5 shows how the wind changes between day time and night time hours. As can be seen in Figure 5, the stronger winds (which improve dispersion) primarily occur during the day, with lighter winds predominating at night time.

Figure 4 CALMET Windrose centred on the Tawariki Street Shaft Site

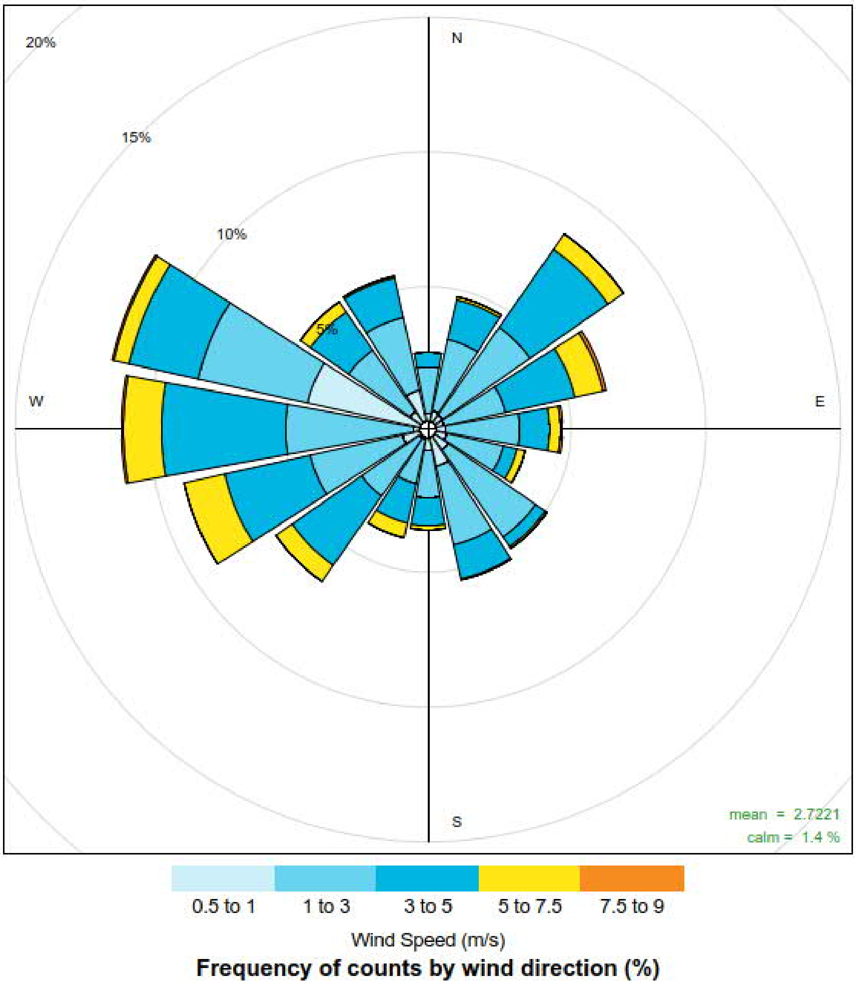
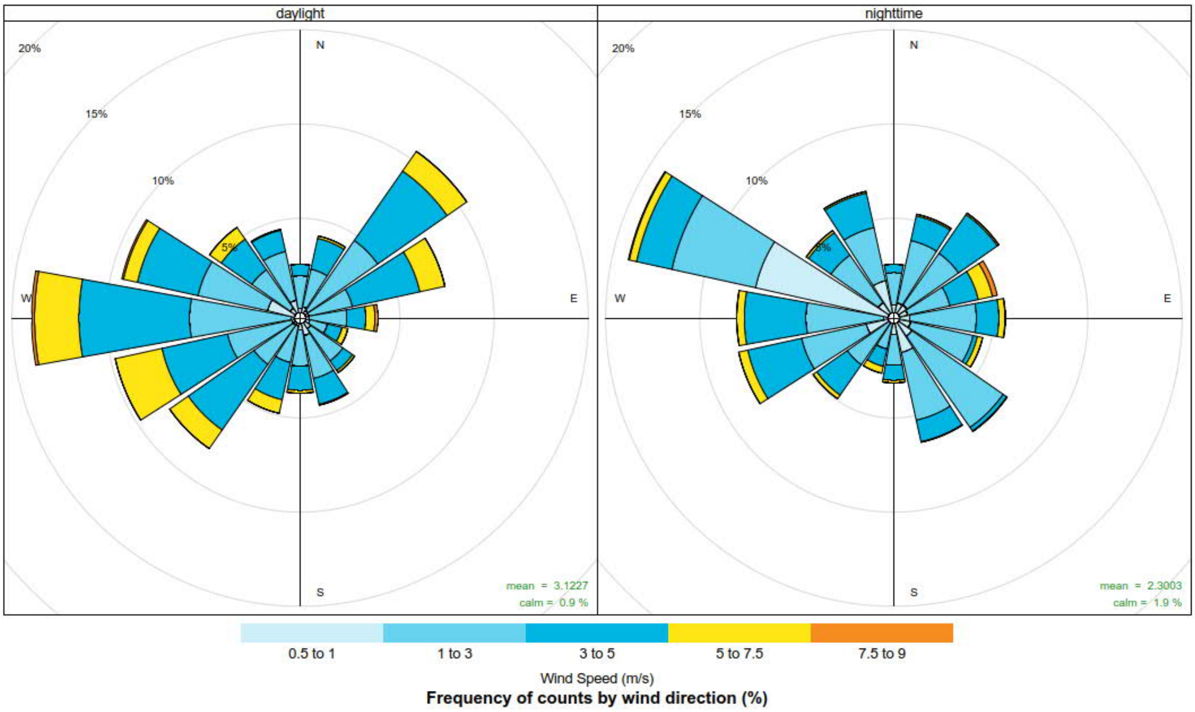


Figure 5 CALMET Windrose centred on the Tawariki Street Shaft Site (Daytime and Night-time hours)



(d) *Mixing height and Stability classes*

Figure 6 presents the mixing heights for the Tawariki Street Shaft Site. The data shows that between the hours of 2000 and 0700 a relatively high frequency of low mixing heights is predicted. During periods of low mixing height the ability of a plume to disperse vertically is limited, which can result in poor dispersive conditions. The relatively high frequency of low mixing heights, generally calm or low wind speed conditions measured at the site, along with the high frequency of extremely stable conditions predicted (refer to Figure 7), indicate the prevalence of inversion conditions at the Site (conditions where a warm layer of air traps cooler air at ground level), which can result in poor dispersion.

Figure 6 CALMET Extract Mixing Heights

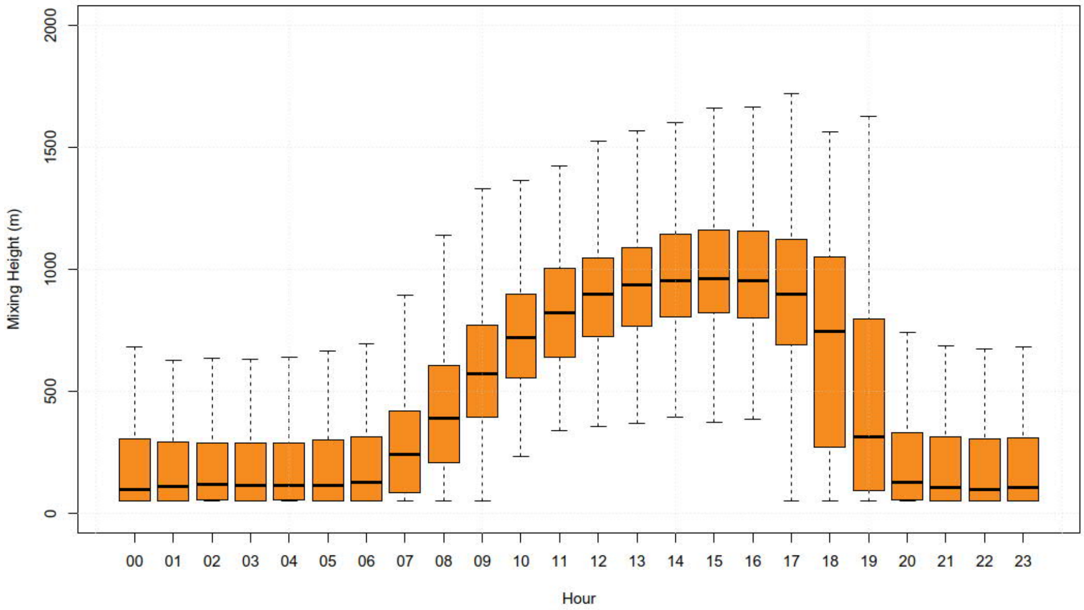
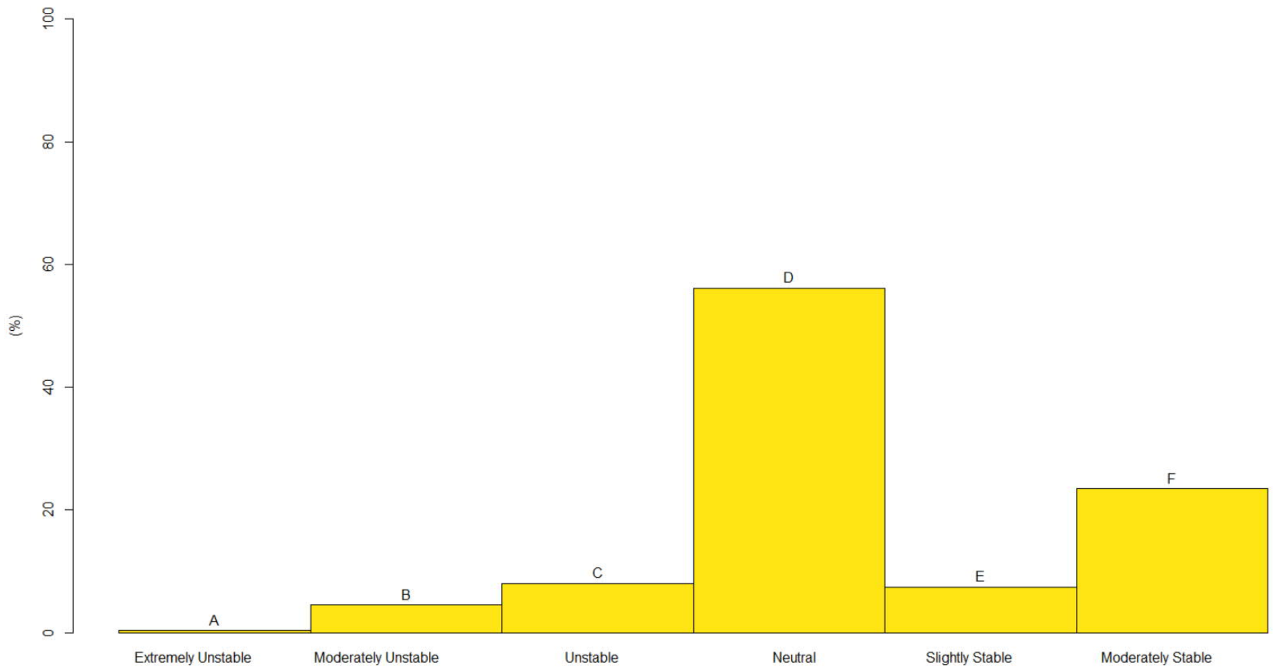


Figure 7 CALMET Stability Classes



(e) *Model Validation*

On 5 April 2018, a metrological station was installed at 44 Tawariki Street to better understand the winds experienced at the Site. The station was installed with a Vaisala ultrasonic anemometer to measure winds; a combined Harvest Electronics temperature/humidity sensor; and a Hydrological Services rain gauge. The station was mounted approximately 6 m above ground level. Figure 8 shows a picture of the station installed on the roof of 44 Tawariki Street.

Figure 8 Tawariki Street Meteorological Station

The monitoring data collected by the Tawariki Street station for the period 5 April 2018 to 30 October 2018 was compared with the data extracted from the CALMET model for the same time of the year (5 April 2013 to 30 October 2013). This data is presented as windroses in Figure 9.

Figure 10 presents the wind direction frequency distribution for both Tawariki Street and an extract from the CALMET data for a similar period of the year. This comparison shows that generally the CALMET model has performed reasonably well at approximating the frequency of wind directions, with the exception that it appears to have overestimated the frequency of winds from the northeast and east for the limited data set available from the on-site weather station. CALMET was also unable to replicate the high frequency of calm conditions, with Tawariki Street recording 16% calm compared with CALMET which predicted 2%.

Figure 11 presents a q-q plot, which plots the distribution of wind speeds measured at Tawariki Street (y-axis) against the CALMET extraction winds (x-axis). The 1:1 line as well as 2 x over and 2 x under prediction lines are also included. The Figure shows that for medium to low wind speeds CALMET overestimates wind speeds, however higher wind speeds are represented reasonably well. The majority of the data fits between the 2 x over and 2 x under prediction lines.

While the outputs from the CALMET model reveal that there are some differences between the model and the observational data, this is not unexpected as even complex meteorological models like CALMET are unable to account for localised wind flows, blocking effects from trees and nearby houses.

Due to the lower frequency of low wind speed and calm conditions predicted by CALMET, and to ensure that the assessment is as conservative as possible, in this assessment the results presented in Section 6.3 are the maximum odour concentrations predicted by the model rather than the 45 highest value (the 99.5%ile) recommended by GPG Odour.

Figure 9 Windrose Comparison (Tawariki Street vs CALMET Extraction)

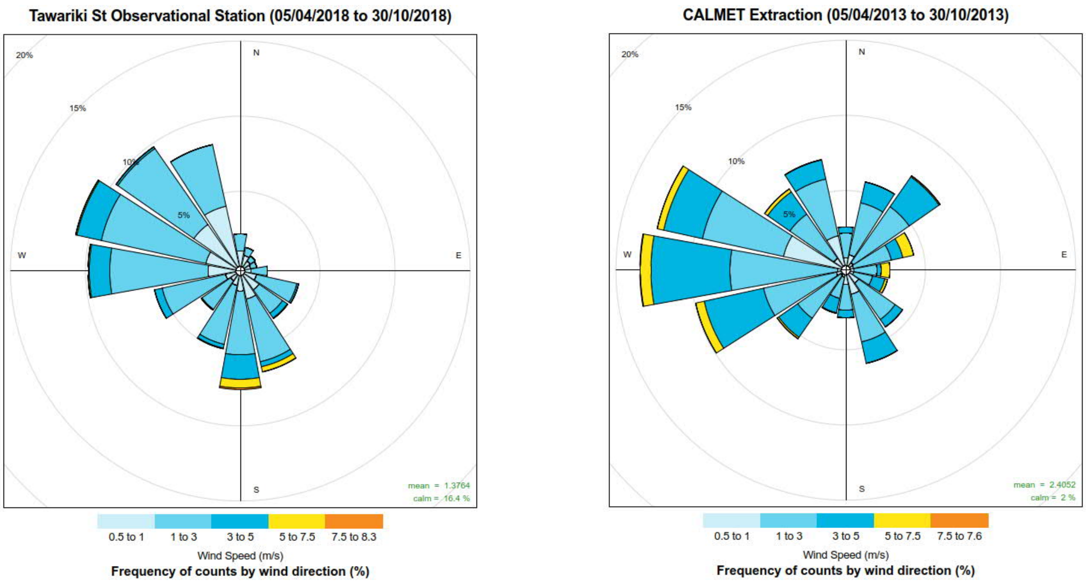


Figure 10 Wind Direction Frequency Distribution

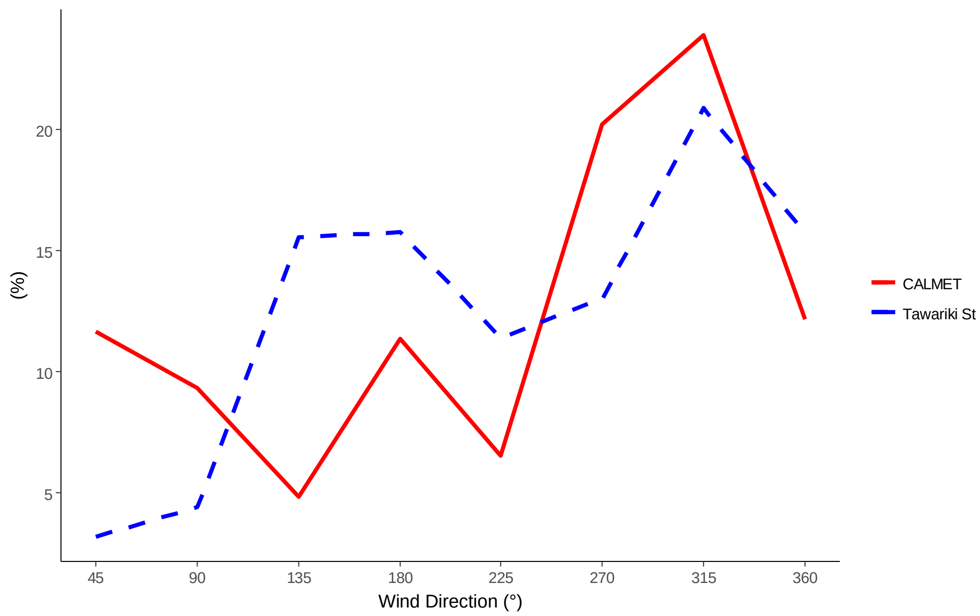
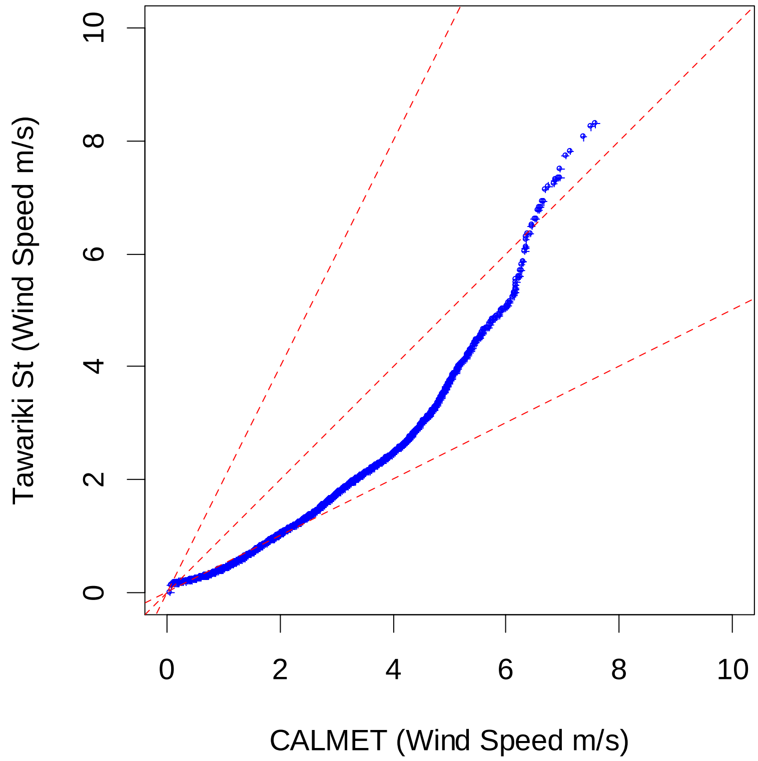


Figure 11 Q-Q Plot Wind Speed Distributions



6.2 Construction Effects Assessment Methodology

As set out in Section 5.1 in the Auckland Region, both dust and odour are assessed against the qualitative standard of "no offensive or objectionable effects" at or beyond the boundary (or designation) of a site, the FIDOL assessment tool has been used to determine the likelihood of off-site effects occurring.

In the context of this assessment, the relevant FIDOL tool considerations are set out in Table 5.

Table 5 FIDOL Factors

Factor	Odour Descriptor	Dust Descriptor
Frequency	How often an individual is exposed to the odour.	How often an individual is exposed to the dust.
Intensity	The strength of the odour.	The concentration of the dust.
Duration	The length of exposure.	The length of exposure.
Offensiveness/character	The character relates to the 'hedonic tone' of the odour, which may be pleasant, neutral or unpleasant.	The type of dust.
Location	The type of land use and nature of human activities in the vicinity of an odour source.	The type of land use and nature of human activities in the vicinity of the dust source.

These factors have been assessed based on the project description and construction methodology for the Grey Lynn Tunnel, together with information on local meteorology and experience with other similar construction processes.

6.3 Operational Effects (Atmospheric Dispersion Modelling) Methodology

The off-site concentrations of odour from the discharge vent at Tawariki Street were predicted using an atmospheric dispersion model called CALPUFF. The CALPUFF model was set up in accordance with the guidance contained in GPG ADM. No account has been made for background odour that may be present.

CALPUFF (Version 7) has been used extensively in New Zealand and Australia, and is a recommended model in the GPG ADM particularly for sites surrounded by complex terrain and where sea-breeze conditions are likely to occur. CALPUFF is a US EPA approved atmospheric dispersion model and is a recommended model in GPG ADM.

The CALPUFF model is designed to simulate the continuous discharges (characterised as a series of puffs) emitted from a source into the ambient wind flow. As wind flow changes hourly (in both speed and direction), the path each puff takes follows the new wind flow direction. Puff diffusion is Gaussian, and concentrations are based on the contributions of each puff as it passes over or near a receptor point.

The CALPUFF model containing modules for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. In other words, the model can simulate the effects of time and space-varying meteorological conditions on contaminant transport, transformation and removal.

(a) *Limitations of Meteorological Modelling*

It is acknowledged that the meteorological files compiled for this assessment used directly measured and indirectly generated parameters. It is considered that the CALMET data file will appropriately reflect the range of meteorological conditions expected to be experienced at the Tawariki Street Shaft Site and is therefore appropriate for a statistical modelling exercise such as this. However, it is not possible to generate the extremely fine scale meteorological effects caused by factors such as street canyon winds, turbulent eddies at building edges. These effects are minimised as far as practicable by the incorporation of local meteorological data into the model.

(b) *Modelling Scenarios*

To determine an appropriate stack height that will mitigate the effects from odour discharges, three heights have been assessed. These are presented below.

- **Scenario 1:** Vent stack height at ground Level;
- **Scenario 2:** Vent stack height at 5 m; and,
- **Scenario 3:** Vent stack height at 8 m.

The inputs provided in Table 6 have been incorporated into the modelling assessment.

The concentration of odour in the tunnel during a storm event has been based on the analysis presented in the Western Springs Odour Assessment in 2016, which predicted the concentration of odour discharged at Western Springs during storm events of 350 OU/m^3. For this assessment, it can be reasonably assumed that the concentration of the odour discharge will be similar at Tawariki Street, if not lower, due to the level of dilution that will occur in the tunnel due to the stormwater inflows that will occur from May Road to Western Springs.

Table 6 Odour Emission Parameters

Parameter	Scenario 1	Scenario 2	Scenario 3
Odour Concentration (OU/m^3)	350	350	350
Air Flow Rate (m^3/s)	8.8	8.8	8.8
Odour Emission Rate (OU/s)	3,080	3,080	3,080
Stack Height (m)	0.1	5	8
Stack Diameter (m)	1.74	1.06	1.06
Stack Exit Velocity (m/s)	5	10	10
Assumed Stack Exit Temperature °C (K)	15 (288)	15 (288)	15 (288)

(c) *Sensitive Receptors*

A ‘sensitive receptor’ is defined in the AUP(OP)[10] as a location where people or surroundings may be particularly sensitive to the effects of air pollution. This type of receptor includes residential houses, hospitals, schools, early childhood education centres, childcare facilities, rest homes, residential properties, premises used primarily as temporary accommodation (such as hotels, motels, and camping grounds), open space used for recreation, the conservation estate, marae and other similar cultural facilities.

There are a number of residential properties, early childcare facilities and schools that have the potential to be sensitive to the effects of the Grey Lynn Tunnel. During the preliminary stages of the assessment, AECOM identified areas where there was the potential for air quality impacts, and a number of representative sensitive receptors selected in each of those areas. While it is not typically identified as a sensitive location, odours have also been assessed at the local supermarket because it

[10] Appendix 3.45.2, Air Quality Separation Distances for Industry.

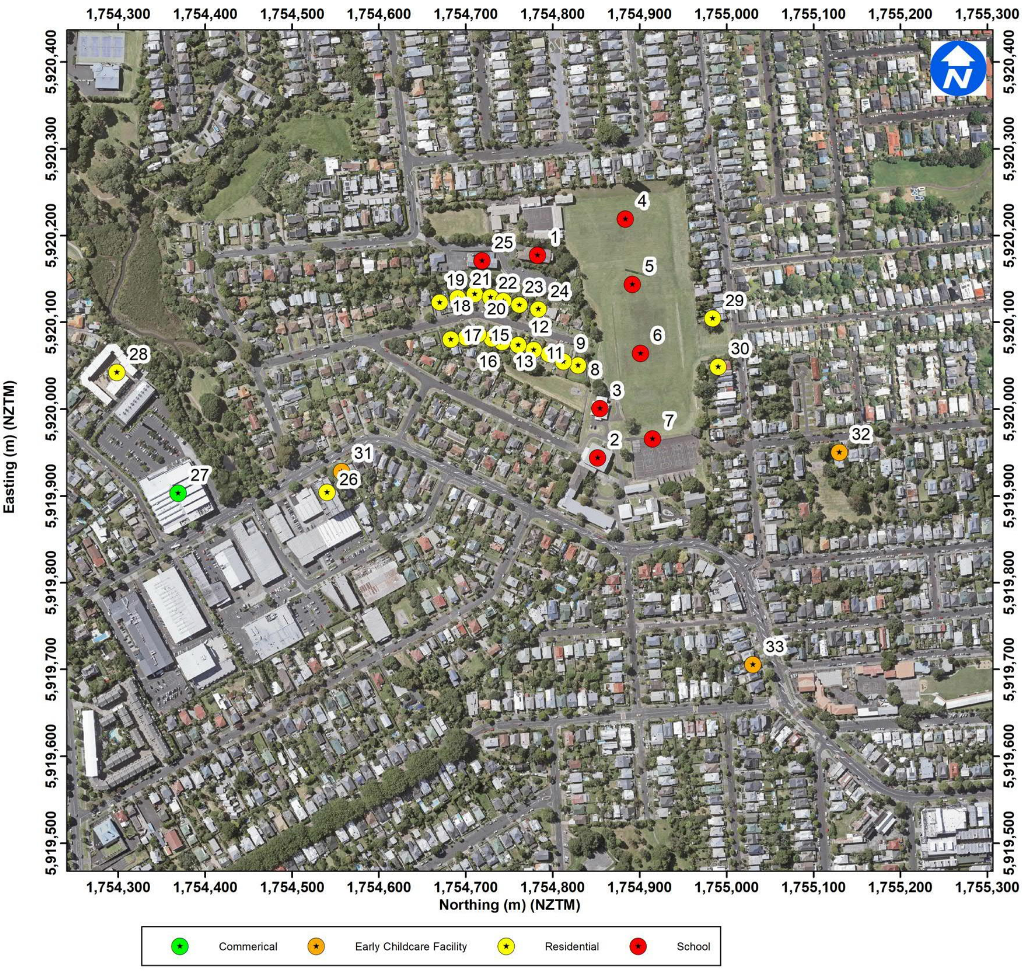
is a location where a lot of people will be present. These receptors are presented in Table 7 and shown in Figure 12.

For practical purposes, not all of the residential locations have been included as discrete receptors but instead a number of locations considered to be representative have been selected. This approach is common practice for projects like the Grey Lynn Tunnel. Effects on the other sensitive receptors are likely to be less than those at the selected locations.

Table 7 Sensitive Receptors

Receptor Number	NZTM (m)		Description	Category
	X	Y		
1	1,754,783	5,920,178	Marist School	School
2	1,754,852	5,919,944	St Pauls College - Main Hall	School
3	1,754,855	5,920,001	St Pauls College - Class Rooms	School
4	1,754,884	5,920,219	St Pauls College - Playing Fields	School
5	1,754,892	5,920,144	St Pauls College - Playing Fields	School
6	1,754,901	5,920,064	St Pauls College - Playing Fields	School
7	1,754,915	5,919,966	St Pauls College - Tennis Courts	School
8	1,754,830	5,920,050	41 Tawariki Street	Residential
9	1,754,813	5,920,055	39 Tawariki Street	Residential
10	1,754,796	5,920,063	37 Tawariki Street	Residential
11	1,754,778	5,920,068	35 Tawariki Street	Residential
12	1,754,760	5,920,074	33 Tawariki Street	Residential
13	1,754,742	5,920,077	29 Tawariki Street	Residential
14	1,754,730	5,920,081	27 Tawariki Street	Residential
15	1,754,714	5,920,086	25 Tawariki Street	Residential
16	1,754,701	5,920,082	23 Tawariki Street	Residential
17	1,754,683	5,920,080	21 Tawariki Street	Residential
18	1,754,670	5,920,123	28 Tawariki Street	Residential
19	1,754,691	5,920,128	30 Tawariki Street	Residential
20	1,754,710	5,920,133	32 Tawariki Street	Residential
21	1,754,729	5,920,129	34 Tawariki Street	Residential
22	1,754,743	5,920,125	36 Tawariki Street	Residential
23	1,754,762	5,920,120	38 Tawariki Street	Residential
24	1,754,784	5,920,115	42 Tawariki Street	Residential
25	1,754,719	5,920,171	Marist School	School
26	1,754,541	5,919,904	250 Richmond Rd - Apartments	Residential
27	1,754,369	5,919,903	Countdown Grey Lynn	Commercial
28	1,754,299	5,920,042	50 Livingstone Street	Residential
29	1,754,985	5,920,105	117 John Street	Residential
30	1,754,991	5,920,049	125 John Street	Residential
31	1,754,557	5,919,928	244 Richmond Rd - Kindergarten	Early Childcare Facility
32	1,755,130	5,919,950	94 Vermont Street - The Learning Centre	Early Childcare Facility
33	1,755,031	5,919,705	136 Richmond Rd - First Steps Ponsonby Childcare	Early Childcare Facility

Figure 12 Sensitive Receptors



(d) *Gridded Receptors*

In addition to the sensitive receptors discussed above, a large number of gridded receptors were included in the CALPUFF model to understand the extent of the air quality impact around the Tawariki Street Shaft Site. The gridded receptor grids analysed were centred on the Tawariki Street Shaft Site, and are presented below.

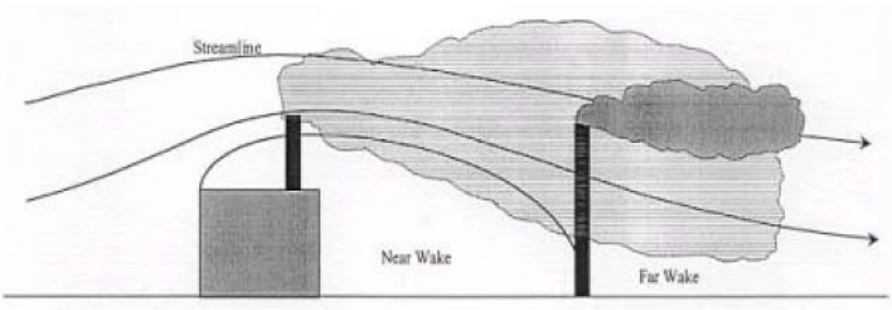
- 1 km x 1 km inner cartesian grid with a spacing of 20 m;
- 2 km x 2 km middle cartesian grid with a spacing of 50 m; and,
- 3 km x 3 km outer cartesian grid with a spacing of 100 m.

(e) *Building Downwash*

Another of the inputs required in the dispersion model is an assessment of any building downwash, which can have a significant impact on how a discharge is dispersed. Building downwash is defined in the GPG ADM as follows:

"Airflow around buildings is often very complicated and may create zones of strong turbulence and downwind mixing on the lee side of a building (Figure 14). This effect is known as building downwash. In such cases, the entrainment of exhaust gases released by short stacks in the wake of a building can result in much higher ground-level concentrations close to the source than the model would otherwise predict."

Figure 13 Building Downwash Turbulence Zones



Source: Schulman et al., 2000

To determine the effects of building downwash on air discharges associated with the Tawariki Street shafts, building dimensions were input into the Building Profile Input Program ("**BPIP**") Plume Rise Model Enhancements (PRIME) model incorporated within CALPUFF. BPIP-PRIME was used to simulate the building downwash effects in accordance with the requirements of the GPG ADM.

A 4 m high control building was incorporated into the CALPUFF model.

A 3D representation of the building and a 5 m high stack are shown in Figure 14.

Figure 14 3D Representation of the Control Building and a Vent Stack.

Image Source: Google Earth™ 2015

(f) *Model Run time*

While the potential duration of any discharges are typically short (less than 1 hour) based on the hydraulic modelling[11], it is necessary to run the model for an entire year to ensure that all possible meteorological conditions that may be associated with the discharge are captured.

[11] Pneumatic Analysis of the CI Tunnel During Wet Weather, dated February 2019 (DSCIN-DEL-MEM-AI-J-100038)

This conservative approach to modelling potentially over predicts odours, however as the CALMET data has a lower percentage of the conditions that typically lead to odours, this approach is considered appropriate, and is consistent with best practice for this type of modelling.

6.4 Conclusions

The scenarios set out in Section 6.3 (a) have been assessed using the methodology set out above, with the results presented in Section 9.

7. MITIGATION MEASURES

Given the nature of the construction work being undertaken during the construction of the Tawariki Street shafts and related structures, and the proximity of these works to neighbouring properties, it is inevitable that there will be some construction related effects. Therefore it is appropriate to consider what measures will be implemented to mitigate these effects.

7.1 Construction Mitigation Measures

There are a range of mitigation measures that are routinely used to control the potential for effects from construction activities. The mitigation measures to be used will depend on the contractors who undertake the work. However, this section sets out typical mitigation measures which could be used to control effects, and are representative of the measures that may be utilised. The construction effects assessment detailed in Section 8 is based on the assumption that following mitigation measures are being implemented on site.

(a) *Dust Mitigation*

The GPG Dust sets out a range of mitigation measures which are considered appropriate with those set out in Table 8 most likely to be implemented for this project.

Table 8 Dust Mitigation Measures

Area	Mitigation Measures
Paved Surfaces	• Controlling the movement and handling of fine materials to prevent spillages onto paved surfaces • Minimising mud and dust track-out from unpaved areas by using rumble strips or wheel and vehicle wash facilities • Regularly cleaning paved surfaces, using a mobile vacuum sweeper or a water flushing system • Covering dusty loads to prevent spillage onto paved surfaces
Unpaved Surfaces	• Using water suppression on surfaces • Revegetating areas
Vehicles	• Limiting load size to avoid spillages • Covering loads with tarpaulins or the use of enclosed bins (to prevent dust re-entrainment from trucks)
Stockpiles	• Limiting height • Using windbreaks or enclosures around fine materials

(b) *Odour Mitigation*

The greatest potential for odour emissions during construction will occur during the break-in to the existing sewers. Given that these activities will occur below ground level in shafts, the most effective mitigation will be the use of an odour suppression chemical spray such as Biox, extraction and discharge via an appropriately designed temporary vent, or extraction and treatment of the odours using a small portable carbon filter or similar. Part of the odour mitigation will be the proactive use of a person on site who undertakes odour monitoring whenever works are occurring which could give rise to odours.

7.2 Operational Mitigation Measures

The most practical measure to mitigate operational odour from the vent stack, given the constrained nature of the site, is to ensure that the vent stack is of a sufficient height to disperse odour (i.e. the taller the stack the better odour is diluted and dispersed). The assessment has assessed a range of vent stack heights to determine the most appropriate value. Refer to Section 9 for the results of this assessment.

For the existing Grit traps, Watercare will use the same mitigation measures (vacuum loading and off-site disposal) as currently used, to ensure that odour does not cause nuisance effects when the Grit traps are open and being cleaned out.

As the new Orakei grit trap is deeper, Watercare will use the same procedure they use elsewhere for deep Grit traps which involves using a clamshell grab to remove the grit, which is then deposited into a skip at the ground surface and immediately vacuum loaded into a truck and removed from the site.

8. RESULTS OF CONSTRUCTION EFFECTS ASSESSMENT

8.1 Construction Dust Assessment

Set out in this section is the FIDOL assessment for dust emissions associated with the various structures at the Tawariki Street Shaft Site. This assessment is made on the basis that the mitigation measures set out in Section 7 will be implemented.

(a) *Frequency*

As discussed in Section 6, frequency relates to how often an off-site effect might be experienced. Dust effects generally only occur when activities are near or at the surface and in the absence of appropriate mitigation.

Dust effects also typically occur when wind speeds are greater than 5 m/s as this is the ground level wind speed that has the potential to lift dust from surfaces.

Based on the wind rose presented in Figure 4 it could be expected that approximately 8.5% of time winds could be strong enough to carry dust off-site. However, this does not account for whether activities are occurring that could give rise to dust, or whether it is raining. In addition, it does not account for the mitigation measures that will be implemented.

Taking all of these factors into account, it is considered that the percentage of time when dust could be carried off-site will be considerably less than 8.5%.

(b) *Intensity*

This relates to how much dust is present. Given the nature of the activities being undertaken and the level of mitigation that will be implemented, it is not considered that there will be large quantities of dust generated by the activity. This is also consistent with the results of dust monitoring that has been undertaken around large earth moving projects such as the City Rail Link.

(c) *Duration*

This relates to the how long dust might be present in the air. Given the constrained nature of the Site and the mitigation which is going to be implemented, it is considered that the longest duration for when dust could be being generated by a particular activity is likely to be less than 10 minutes, and most likely associated with a truck being loaded with surface materials, or truck movements as they leave the Site.

(d) *Offensiveness*

The bulk of the excavated materials will be no different in nature to the dust that will occur from normal residential activities such as lawn mowing or gardening. Therefore there are no special characteristics associated with the dust which would cause particular offense. In addition, based on our experience with other similar projects using similar mitigation, the concentrations of any dust that might be generated will be low and well less than the monitoring trigger levels set out in Table 1.

(e) *Location*

In this case the Site is extremely close (less than 50 m) to a number of residences, and therefore there is significant potential for dust to travel off-site. Even with the use of mitigation the potential remains for some dust to travel off-site on occasion, but not at a level which triggers an adverse effect.

(f) *Construction Dust Conclusion*

Based on the above, it is our opinion that any dust associated with the construction of the shafts and various sewer connections at the Tawariki Street Shaft Site will not result in offensive or objectionable dust as long as all appropriate mitigation is implemented.

8.2 Construction Odour Assessment

For the Grey Lynn Tunnel, the main potential for odour effects is associated with the tie-in of the Orakei Main Sewer and Tawariki Local Sewer to the Tawariki shaft. These activities will be discrete events and, because of this, they will be subject to greater levels of control than other portions of the works.

(a) *Frequency*

At this stage there is little information available regarding exactly how long the construction tie-ins to the existing sewers will take. However, it is expected that it will take approximately two months to complete the tie-in for each of the connections. Given the level of mitigation that will be employed, and the fact that the works will be carried out below ground level, it is considered that the frequency with which odours might be observed is extremely low.

(b) *Intensity*

Given the intrinsically odorous nature of sewerage, it is considered that if odours were observed in the absence of the mitigation they would be intense, given the proximity of residents to the works. With the mitigation measures proposed the intensity of any odours should be reduced to a very low level.

(c) *Duration*

Based on our understanding of the construction methodology, if odours were to occur in the absence of mitigation they would be likely to be present for up to eight hours a day when the tie-in works are being undertaken. If all appropriate mitigation is used then the odours, if detected, should be fleeting, as the person undertaking the odour monitoring will immediately be able to raise the alert if odour is detected.

(d) *Offensiveness*

It is generally accepted that wastewater and sewerage odours are considered offensive if detected by members of the public. Through the use of appropriate mitigation, the character of any odours observed should be less offensive.

(e) *Location*

The location of the works is dictated by the location of the existing sewers. Unfortunately, this means that there are residential receptors in close proximity that are sufficiently close to the work that they are likely to experience any odours that might occur in the absence of mitigation. Through the use of appropriate mitigation the effects should be minimised to the point that location is not a critical factor.

(f) *Construction Odour Conclusion*

Based on the above it is considered that there should be no offensive or objectionable odours, due to the level of mitigation measures to be implemented including odour monitoring which will reduce odour risks.

9. RESULTS OF OPERATIONAL EFFECTS ASSESSMENT

9.1 Vent Odour Assessment

The effects of the odour discharges from the vent stack for the three scenarios assessed are presented and discussed in the following section. These scenarios are:

- **Scenario 1:** Vent stack height at ground Level;
- **Scenario 2:** Vent stack height at 5 m; and,
- **Scenario 3:** Vent stack height at 8 m.

The maximum 1-hr average off-site odour concentrations predicted by CALPUFF for the three scenarios are compared with the assessment criteria of 2 OU/m³. The 99.5%ile values are also presented in Table 9. Graphical presentations of the maximum 1-hr average odour concentrations associated with the scenarios are presented in Table 9 and Figures 15 to Figure 17. As it is not possible to predict when these discharges might occur, normal air quality practice is to assess the potential effect for every hour of the year to ensure that all potential ambient conditions are assessed. The practice has been used for this assessment and ensures that the worst case odour risk has been determined.

Table 9 Predicted Ground Level Concentrations of Odour

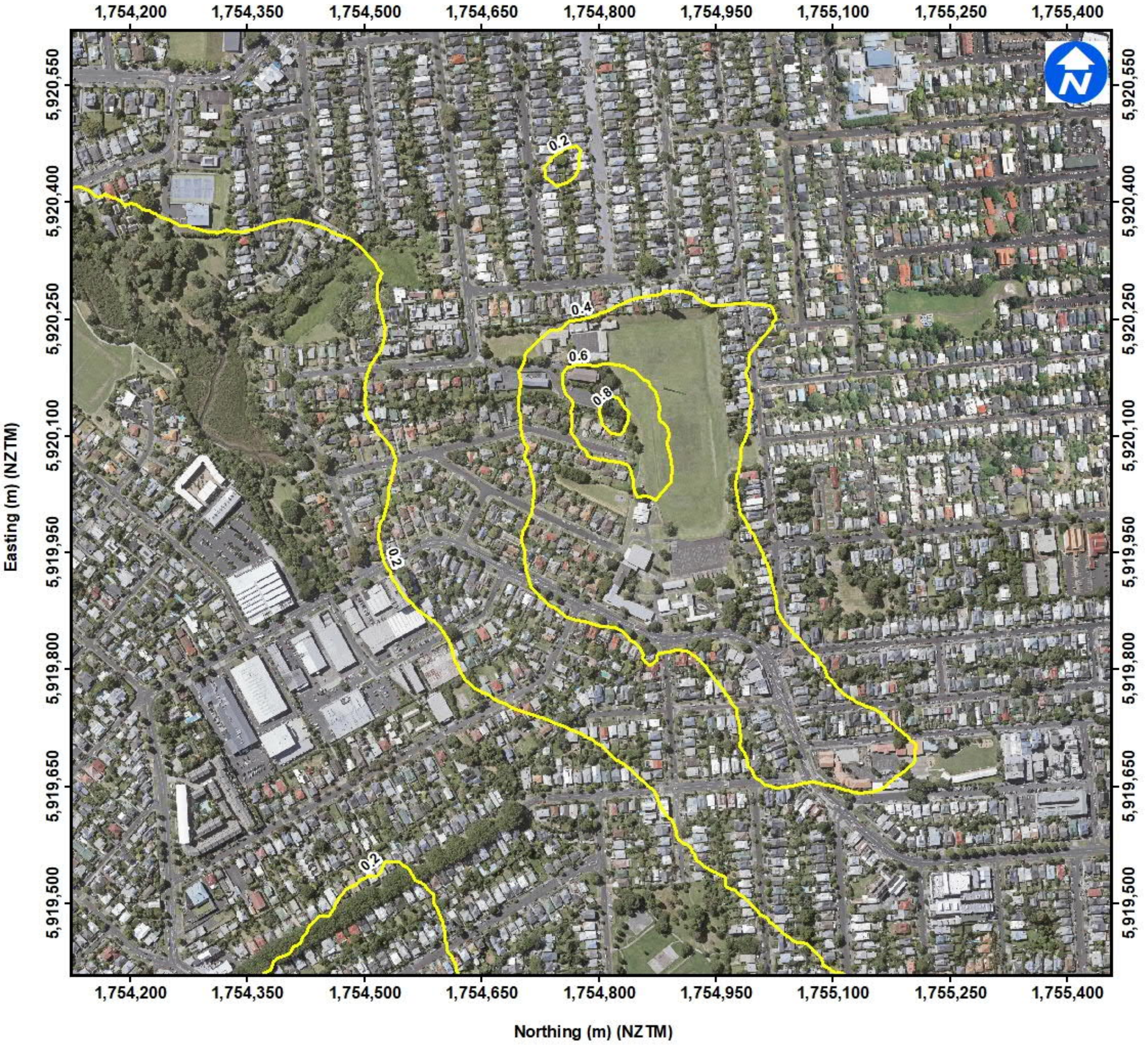
Receptor Name	1-hr average Odour Concentration (OU/m³)					
	Scenario 1		Scenario 2		Scenario 3	
	99.5%ile	Maximum	99.5%ile	Maximum	99.5%ile	Maximum
Odour Criteria	2		2		2	
Maximum Off-site	6.8	7.8	1.1	1.2	0.5	1.0
1	1.0	1.3	0.6	0.7	0.4	0.7
2	0.8	1.8	0.4	1.2	0.3	0.5
3	1.2	2.1	0.6	1.0	0.5	0.6
4	0.9	1.4	0.5	0.7	0.4	0.5
5	1.5	2.2	0.8	0.8	0.5	0.6
6	1.2	1.7	0.6	0.7	0.4	0.6
7	0.8	1.3	0.5	0.8	0.4	0.5
8	1.5	2.4	0.7	0.9	0.4	0.6
9	1.4	2.5	0.6	0.7	0.4	0.5
10	1.4	2.0	0.7	0.8	0.4	0.6
11	1.3	1.8	0.7	0.9	0.4	0.6
12	1.2	1.6	0.7	0.8	0.4	0.5
13	1.0	1.5	0.6	0.7	0.4	0.5
14	0.9	1.3	0.5	0.7	0.4	0.4
15	0.8	1.0	0.4	0.6	0.4	0.4
16	0.7	0.9	0.4	0.5	0.3	0.4
17	0.6	0.8	0.4	0.5	0.3	0.3
18	0.6	0.9	0.3	0.4	0.3	0.3
19	0.7	0.9	0.4	0.5	0.3	0.4
20	0.7	1.2	0.4	0.5	0.3	0.4
21	0.9	1.4	0.5	0.6	0.4	0.5
22	1.0	1.6	0.5	0.6	0.4	0.5

Receptor Name	1-hr average Odour Concentration (OU/m³)					
	Scenario 1		Scenario 2		Scenario 3	
	99.5%ile	Maximum	99.5%ile	Maximum	99.5%ile	Maximum
Odour Criteria	2		2		2	
23	1.3	1.7	0.6	0.7	0.4	0.5
24	1.7	2.6	0.7	0.9	0.3	0.7
25	0.8	1.1	0.4	0.5	0.3	0.5
26	0.3	0.4	0.2	0.2	0.1	0.2
27	0.2	0.3	0.1	0.1	0.1	0.1
28	0.1	0.2	0.1	0.1	0.1	0.1
29	0.7	1.1	0.4	0.5	0.3	0.4
30	0.6	1.0	0.4	0.5	0.3	0.4
31	0.3	0.4	0.2	0.2	0.2	0.2
32	0.3	0.5	0.3	0.3	0.2	0.3
33	0.2	0.5	0.2	0.5	0.2	0.4

Figure 15 Tawariki Street – Scenario 1 - Maximum 1-hr Average Odour Concentration (OU/m³)

Figure 16 Tawariki Street – Scenario 2 - Maximum 1-hr Average Odour Concentration (OU/m³)

Figure 17 Tawariki Street – Scenario 3 - Maximum 1-hr Average Odour Concentration (OU/m³)



9.2 Summary of Vent Odour Results

For Scenario 1, predicted odour concentrations were found to be above the assessment criteria of 2 OU/m³ at six of the sensitive receptor locations, with a highest predicted maximum 1-hr average of 2.6 OU/m³ predicted at Receptor 24. This means that there is a high likelihood that in the event of an odour discharge it will be detectable and found offensive by neighbouring residents if it coincides with the worst-case meteorological conditions.

The maximum 1-hr average off-site[12] odour concentration associated with Scenario 1 was 7.8 OU/m³ which is above the assessment criteria.

For Scenarios 2 and 3, the maximum 1-hr average off-site odour concentrations for the sensitive receptor locations were all well below the assessment criteria. The maximum off-site concentration for Scenario 2 and Scenario 3 were 1.2 OU/m³ and 1.0 OU/m³, respectively, which are below the odour guideline. This means that odours may be detectable, but should not be considered offensive.

[12] Defined as ground-level concentrations beyond the designation boundary.

Consequently AECOM does not consider that a ground based discharge is practicable without some form of odour mitigation. Therefore it is recommended that any discharge is via a 5 m stack incorporated into the control building. The flange around the top of the vent should be designed so that a short extension could be easily retrofitted to extend the height of the stack to 8 m above ground level) in the very unlikely event that odour nuisance occurs.

9.3 Grit Trap Odour Assessment

As the new Grit trap is larger than the existing one on the Orakei main sewer it is likely that it will capture more grit than the existing small facility. Therefore it will potentially need to be cleaned out more frequently (two to four times a year) and take longer (up to two eight hour days). However as the new grit trap is further from residences and will operate under negative pressure, it is not expected that there will be any significant odour from the chamber. Any grit removed will be immediately loaded into a vacuum truck and therefore has little potential to generate odours. If necessary odour masking sprays will be used to control residual odour.

Consequently it is considered that the activity should result in odours that are not materially different to those that currently occur, and potentially because of the negative pressure is less than that which currently occurs.

10. SUMMARY AND CONCLUSIONS

The potential effects associated with the construction and operation of the Tawariki Street Shaft Site have been assessed. For this project a range of 'Best Practice' mitigation measures will be implemented to reduce the potential for adverse dust and odour nuisance effects. FIDOL assessments of the construction effects (dust and odour) have been undertaken in accordance with the relevant MfE good practice guides and have determined that, provided the proposed mitigation measures are implemented, there is limited potential for adverse effects beyond the site boundary.

An atmospheric dispersion modelling assessment has been undertaken to assess the potential odour effects from the operation of the Site. Based on the results of the modelling it has been determined that a vent stack of at least 5 m above ground level should ensure odour emissions beyond the boundary is below the prescribed odour assessment criteria. The flange around the vent should also be designed so that a short extension of 3 m in height and approximately 1 m in internal diameter could be easily retrofitted in the unlikely event that odour nuisance occurs.

For tie-ins to the existing sewer systems at depth below ground level, provision of temporary on-site odour treatment of any ventilated air should be considered, and/or an appropriately designed temporary vent stack should be installed if odour becomes an issue. It is proposed to have on-site odour assessment personnel on site at all times work is taking place.

Provided that the mitigation measures presented in this report are implemented for both the construction and operational phases, AECOM consider the effects from the Grey Lynn Tunnel will be less than minor.

Consequently it is AECOM's opinion that air quality emissions associated with the Grey Lynn Tunnel will meet the standards in Rule E14.1.1 (A166) of Chapter E14 of the AUP (OP) and not require a resource consent for air discharges.

11. LIMITATIONS

AECOM New Zealand Limited (AECOM) has prepared this Assessment of Effects report on discharges to air in accordance with the usual care and thoroughness of the consulting profession for Watercare for use in a statutory process from the Auckland Council under the Resource Management Act 1991 for activities undertaken at Tawariki Street, Grey Lynn.

Except as specifically stated in this section, AECOM does not authorise the use of this Report by any third party except as provided for by the Resource Management Act 1991.

AECOM does not accept any liability for any loss, damage, cost or expenses suffered by any third party using this report for any purpose other than that stated above.

This report is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It was prepared in accordance with the scope of work and for the purpose outlined in the contract between Jacobs and AECOM.

Where this report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in this report. AECOM assumes no liability for any inaccuracies in or omissions to that information.

This report was prepared between October 18 and February 2019 and is based on the conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time.

Glossary Of Abbreviations

Abbreviations	Descriptions
AECOM	AECOM New Zealand Limited
ATF	Air Treatment Facility
AQNES	National Environmental Standards for Air Quality
AUP	Auckland Unitary Plan
AWS	Automatic Weather Station
BPIP	Building Profile Input Program
CI	Central Interceptor
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DWF	Dry Weather Flow
FIDOL	A qualitative assessment tool
GPG	Good Practice Guide
GPG Dust	Good Practice Guide for Assessing and Managing Dust
GPG Odour	Good Practice Guide for Assessing and Managing Odour
GPG ID	Good Practice Guide for Assessing Discharges to Air from Industry
GPG ADM	Good Practice Guide for Atmospheric Dispersion Modelling
km	Unit of distance: kilometre
MfE	Ministry for the Environment
MPS	Mangere Pump Station
NES	National Environmental Standards
NZAAQG	New Zealand Ambient Air Quality Guidelines
PRD	Pressure Relief Damper
PRIME	Plume Rise Model Enhancements
RMA	Resource Management Act 1991
RTC	Real Time Control
TAPM	The Air Pollution Model
TBM	Tunnel Boring Machine
UTM	Universal Transverse Mercator
USGS	United States Geological Survey
US EPA	United States Environmental Protection Agency
Watercare	Watercare Services Limited
WWTP	Waste Water Treatment Plant
3D	Three Dimensional
$\mu g/m^3$	Unit of concentration: microgram per cubic metre
OU/m^3	Unit of concentration: odour unit per cubic metre
%	Percentage
K	Unit of temperature: Kelvin
°C	Unit of temperature: degrees Celsius
m/s	Unit of speed: metre per second
m^3/s	Unit of flow: cubic metre per second
m	Unit of distance (metre)