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Hamilton air quality hot-spot monitoring and modelling – 2024 baseline study

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Waikato Regional Council

Hamilton Air Quality Hot-Spot Monitoring and Modelling – 2024 Baseline Study

22 October 2025

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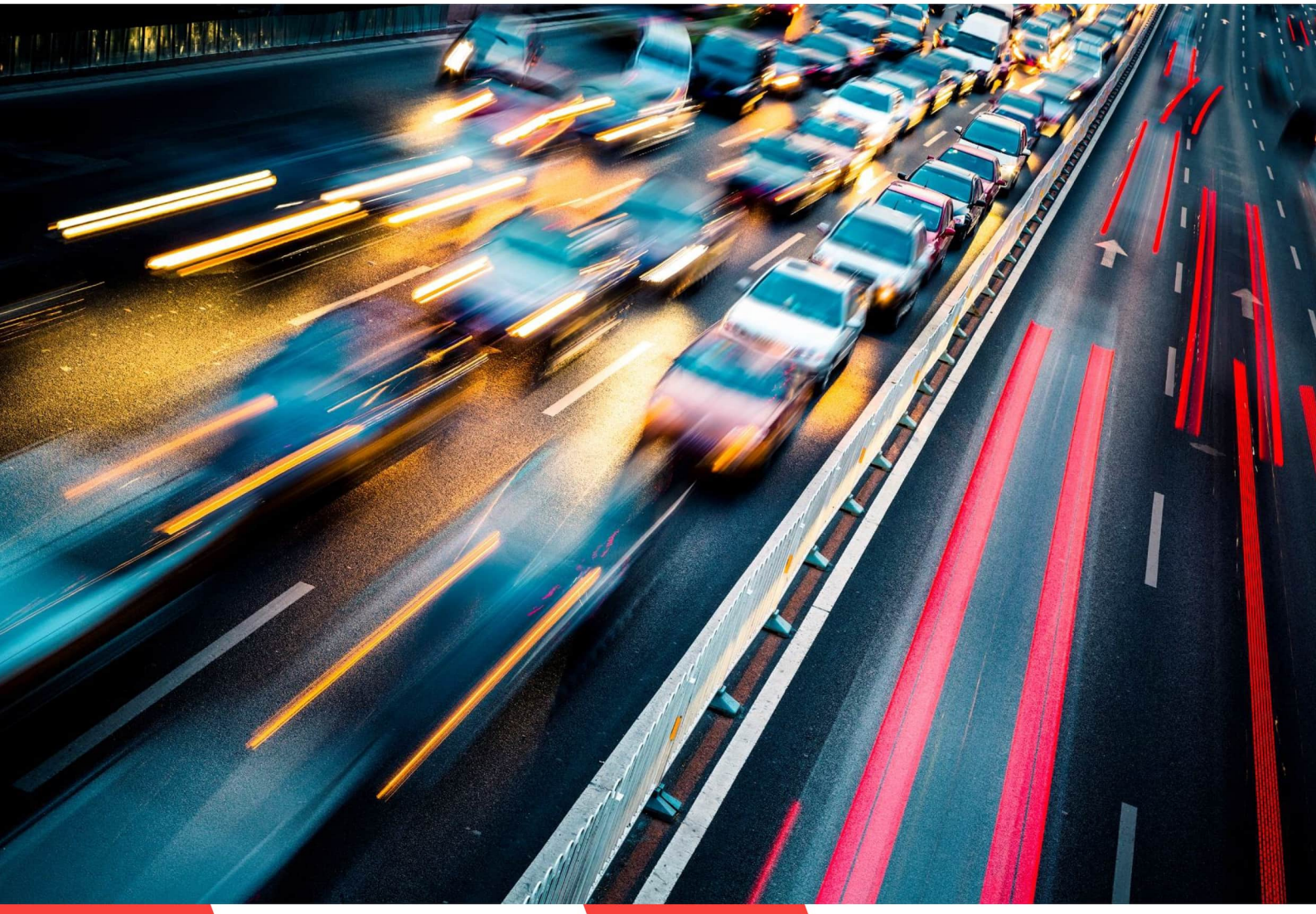

Hamilton Air Quality Monitoring and Modelling

Waikato Regional Council

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A	22/05/2025	Draft for client comment.
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C	22/10/2025	Final following peer review.

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Prepared By:	Swathi Arivalagan	22/05/2025
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ABBREVIATIONS/ACRONYMS

$\mu g/m^3$	Microgram per cubic metre
AADT	Annual average daily traffic
AAQG	Ambient Air Quality Guideline
ADMS-Roads	Atmospheric dispersion modelling system for roads
AM	Ante meridiem
CERC	Cambridge Environmental Research Consultants
CO	Carbon monoxide
CV	Coefficient of variation
GIS	Geographic information system
GPG	Good practice guide
HCV	Heavy commercial vehicle
IP	Inter-peak
HTM	Hamilton Transport Model
LCV	Light commercial vehicle
LINZ	Land Information New Zealand
NESAQ	National Environmental Standards for Air Quality
NO_2	Nitrogen dioxide
OP	Off-peak
PM	Post meridiem
PM_{10}	Fine particulate matter
$PM_{2.5}$	Very fine particulate matter
RMSE	Root mean square error
VOC	Volatile organic compounds
WHO	World Health Organization
WRC	Waikato Regional Council
WRTM	Waikato Regional Transport Model

EXECUTIVE SUMMARY

This report presents the outcomes of a detailed dispersion modelling assessment of road traffic emissions for five key areas in Hamilton. These areas were identified through WSP's previous review of monitoring and traffic data (WSP, 2024a) as being likely areas of elevated pollutant concentrations resulting from traffic emissions. These areas include:

- Mangaharakeke Drive
- Victoria Street/Te Rapa Road;
- Wairere Road/Ruakura Road;
- Cambridge Road/Thermal Explorer Highway Roundabout; and
- Normandy/State Highway 3.

Project-specific nitrogen dioxide diffusion tube monitoring was deployed at roadside and background locations representative of the study area to gain an appropriate dataset to allow model verification during the quantitative assessment of pollutant concentrations for 2024. The dispersion model ADMS-Roads was used to predict annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations at selected receptors across the wider study area.

The model predicted no exceedances of the relevant annual mean health guidelines applied in New Zealand and the Waikato Region, for NO_2, PM_{10} or $PM_{2.5}$.

Of the 112 sensitive receptors modelled, the highest annual mean concentration for NO_2 (29.5 $\mu g/m^3$) was predicted at Receptor 103 (a residential property on Te Rapa Road, Beerescourt, Hamilton 3200, 3.3 m from the modelled road edge). The highest predicted concentrations for annual mean PM_{10} (17.8 $\mu g/m^3$) and $PM_{2.5}$ (9.7 $\mu g/m^3$) were both at Receptor 108 (a residential property at 4 Lugton Street, Nawton, Hamilton 3200, 9.6 m from the modelled road edge).

1 PROJECT BACKGROUND

1.1 OVERVIEW

Regional councils and unitary authorities are responsible for managing air quality under the Resource Management Act, including the statutory requirement to monitor areas where air quality is likely to, or known to, exceed the standards. The National Environmental Standards for Air Quality (NESAQ) set out a guaranteed minimum level of health protection for people living in New Zealand. These, along with the Ambient Air Quality Guidelines (AAQG) are health-based air quality standards and guidelines used to facilitate this monitoring.

The release of the Health and Air Pollution in New Zealand (HAPINZ) 3.0 study (Kuschel et al., 2022) highlighted the importance of developing a better understanding of air pollution from road traffic sources in New Zealand. This is important for the protection of the public from exposure to unsafe levels of harmful air pollutants, in particular, to high concentrations of nitrogen dioxide (NO_2). The study highlighted that the main anthropogenic contributors to air pollution were caused by motor vehicles and domestic fires. Most of the motor vehicle related deaths and health implications were associated with long term exposure to NO_2, followed by a smaller number related to levels of very fine particulate matter ($PM_{2.5}$). As noted in the study, road traffic emissions are the dominant source of NO_2 in urban areas such as Hamilton. In addition to nitrogen dioxide (NO_2), road traffic emissions include pollutants from fuel combustion such as particulates (PM_{10}, $PM_{2.5}$), gases such as carbon monoxide (CO) and volatile organic compounds (VOCs), in addition to particulates from non-combustion processes such as brake, tyre and road-wear. Studies such as HAPINZ highlight that traffic related air pollution contributes significantly to adverse human health and economic impacts in New Zealand.

In 2024 WSP were commissioned by Waikato Regional Council (WRC) to assist in the identification of locations at ‘higher-risk’ of elevated road traffic emissions in Hamilton, for consideration using detailed assessment methods as part of a future scope of work (WSP, 2024a).This report identified eleven ‘higher-risk’ locations in Hamilton where public exposure occurs near congested or busy roads.

These eleven initial locations were ranked based on their risk of elevated pollutant concentrations, and the top five were selected for further consideration, termed ‘Hot-Spots’. This report presents the findings of that further consideration using a detailed dispersion modelling exercise that has been completed to make predictions of pollutant concentrations resulting from road traffic emissions around these five ’Hot-Spots’ in Hamilton.

The purpose of this project is to evaluate the performance of a road traffic emissions dispersion model within the Hamilton City environment when compared to monitoring data, and to provide baseline scenario predictions of pollutant concentrations at key sensitive receptors. Having confirmed that the modelling provides acceptable performance within this environment, the model can subsequently be used to provide future scenario testing and be expanded to other areas as described further within the Conclusions of this report.

1.2 STUDY AREA

Five key congested or high traffic flow areas of interest were modelled in this assessment to better understand their risk of exposure to elevated pollutant concentrations. These locations are shown in Figure 1-1 (the wider study area) and correspond to previously designated ‘higher risk’ areas outlined in the earlier WSP report (WSP, 2024a). Traffic data has been provided to cover each of the five areas as below:

- Mangaharakeke Drive study area (defined as the highest risk rating (1) in the previous report) is covered by the Mangaharakeke traffic dataset;

- Victoria Street/Te Rapa Road (defined as risk rating 1 in the previous report) is covered by the Te Rapa traffic dataset;
- Wairere Road/Ruakura Road (defined as risk rating 1 in the previous report) is covered by the Ruakura traffic dataset;
- Cambridge Road/Thermal Explorer Highway Roundabout (defined as risk rating 1 in the previous report) is covered by the Cambridge traffic dataset; and
- Normandy/State Highway 3 (defined as risk rating 2 in the previous report) is covered by the Ohaupo traffic dataset.

1.3 POLLUTANTS OF CONCERN

The main pollutants of concern associated with road traffic emissions are NO_2, PM_{10} and $PM_{2.5}$. These are the pollutants most likely to be at risk of exceeding their health-based guidelines at sensitive receptor locations adjacent to road sources. As such, this assessment has focused on these three pollutants.

There are a range of criteria available for assessing the impact of discharges to air. The Ministry for the Environment (Ministry for the Environment, 2016) Good Practice Guide (GPG) provides recommendations as to which assessment criteria take precedence. In the absence of a New Zealand standard (in the NESAQ) (for example annual mean NO_2 concentrations), the Ministry for the Environment recommends a hierarchy whereby the New Zealand NESAQ are used first and then the AAQG (Ministry for the Environment and the Ministry of Health, 2002) are used if the NESAQ do not give guidance on a given contaminant. If neither document provides guidance, then regional ambient air quality guidelines (RAAQG), WHO guidelines (World Health Organization, 2021) and California Office of Environmental Health Hazard Assessment (OEHHA) reference exposure levels should be referred to in turn.

In 2021 the WHO updated its guideline value concentrations for pollutants (World Health Organization, 2021). Although not formally adopted in New Zealand, in the case of NO_2, the WHO update included a substantial reduction in the recommended annual mean concentration from 40 µg/m^3 (microgram per cubic metre) to 10 µg/m^3. To work towards the longer-term NO_2 guideline of 10 µg/m^3 there are recommended WHO interim targets of 30 µg/m^3 and 20 µg/m^3. WRC has set a Waikato Region Level (Waikato Regional Council, 2012)) in line with the WHO's interim target 2 (30 µg/m^3). Following the hierarchy outlined above, as there are no NESAQ or AAQG annual mean NO_2 guidelines, the NO_2 concentrations in this report will be compared against the WRC RAAQG target of 30 µg/m^3.

There is no annual mean PM_{10} standard in the NESAQ and therefore the annual mean guideline of 20 µg/m^3 will be used in this review as per the AAQG and WRC Regional Plan.

The Ministry for the Environment has proposed an amendment to the existing NESAQ to include 24-hour and annual mean $PM_{2.5}$ criteria. The proposed annual mean $PM_{2.5}$ standard is 10 µg/m^3. In line with good practice, and in the anticipation of these amendments being approved in the future, WSP has considered the annual mean $PM_{2.5}$ concentrations against the proposed NESAQ standard.

As such, this report compares the monitoring results against the following annual mean guidelines:

- 30 µg/m^3 for NO_2 (RAAQG).
- 20 µg/m^3 for PM_{10} (AAQG); and
- 10 µg/m^3 for $PM_{2.5}$ (proposed NESAQ).

1.4 MONITORING DATA

The previous WSP review of existing air quality monitoring locations in Hamilton (WSP, 2024a), was undertaken to consider whether the NO_2 monitoring sites operated by WRC and Waka Kotahi (New Zealand Transport Agency) were suitable for use in dispersion modelling verification. The review identified that only three of the eleven 'higher-risk' locations had monitoring data nearby from a recent year that would be suitable and it was therefore recommended to gather further monitoring data beside road links in the 'higher-risk' areas for this purpose. In addition, background monitoring sites were identified as being required for use in the modelling exercise, and as such, a project-specific monitoring campaign has been undertaken for this assessment. Details are provided in Section 2. Full details of the monitoring review and existing sites operational across the Hamilton region can be found in the previous WSP report (WSP, 2024a).

1.5 DETAILED MODELLING METHODOLOGY

The previous WSP review (WSP, 2024a) proposed a detailed modelling methodology to further consider the 'higher risk' areas identified. In developing this approach, WSP considered the traffic data available and how dispersion model verification could be completed.

1.5.1 TRAFFIC DATA:

For the previous review, traffic data from the Waikato Regional Transport Model (WRTM) was reviewed, and a staged approach for developing suitable input data for dispersion modelling was set out. However, during the subsequent discussions on development of traffic data for this study, it was identified that more detailed traffic data than anticipated was available from the Hamilton Transport Model (HTM). This data was then provided by Stantec on behalf of WRC, to use in undertaking the detailed dispersion modelling for this study.

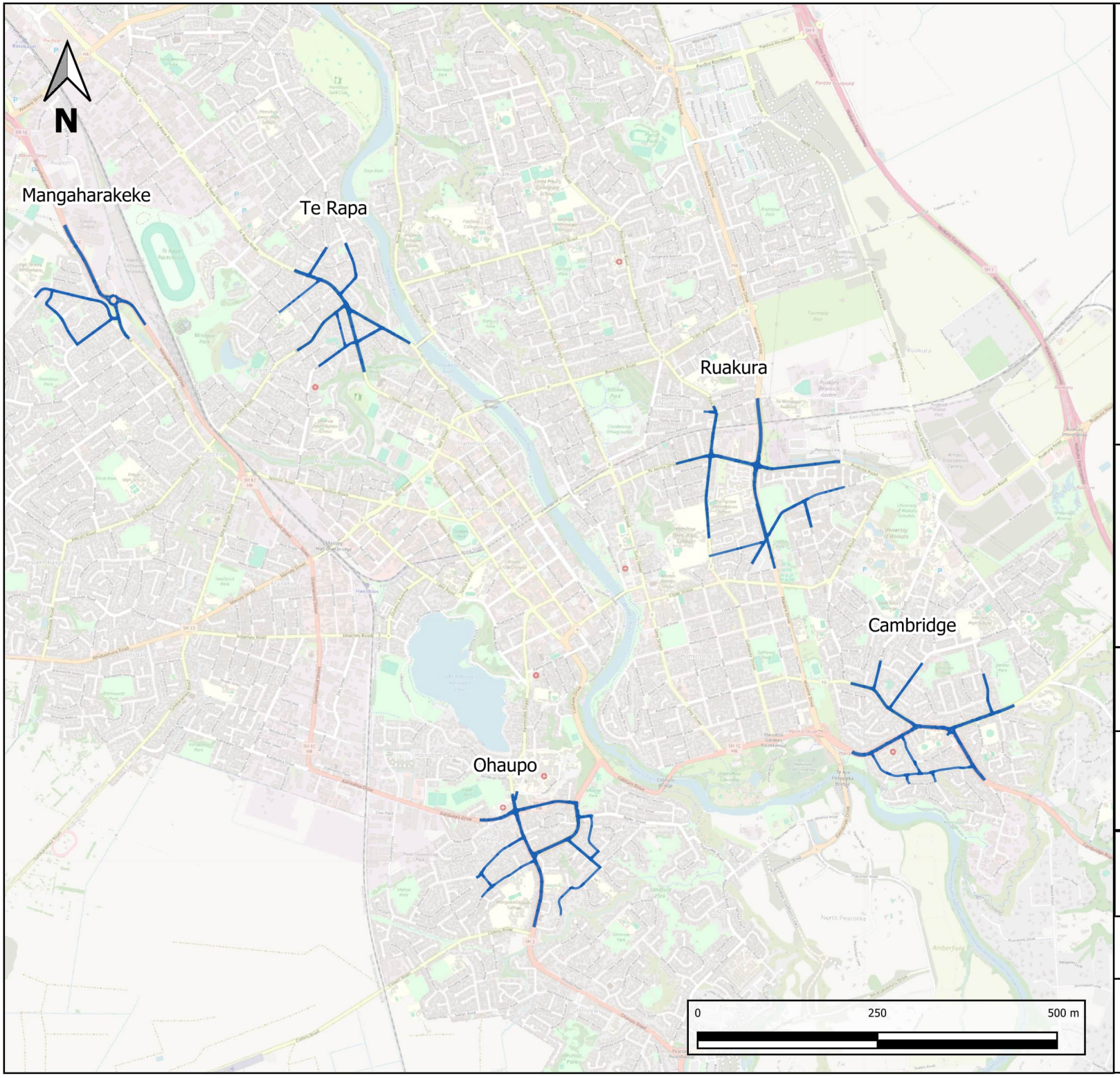
1.5.2 MODEL VERIFICATION

At the time of the initial review, there was no consistent approach within Australian or New Zealand's technical guidance documents for completing model verification of road traffic dispersion models. Since then, WSP has developed a methodology for dispersion model verification on behalf of NZ Transport Agency Waka Kotahi. This has been published on the NZTA website, alongside accompanying tools to use during detailed modelling exercises (WSP, 2025a). This newly released guidance and the associated tools have therefore been applied for this study.

1.6 STRUCTURE OF THIS REPORT

This detailed dispersion modelling study of five key areas in Hamilton has the following structure:

- Section 2: details of the project-specific NO_2 monitoring deployed for this assessment
- Section 3: details of the dispersion modelling assessment undertaken to assess the road traffic impacts
- Section 4: details of the comparison of modelled concentrations with local monitored concentrations
- Section 5: predicted NO_2, PM_{10} and $PM_{2.5}$ concentrations from the road traffic emissions dispersion modelling assessment
- Section 6: summary of the monitoring and modelling assessment



Legend

Modelled Road Network

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Wider Air Quality Study Area

FIGURE No.:	REV:
1-1	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB

2 PROJECT-SPECIFIC MONITORING

Diffusion tubes (also known as Palmes type tubes) were used for gathering the data for use in the dispersion model verification. They are a tried and tested method of monitoring NO_2, and consist of a small plastic tube containing a chemical reagent which absorbs the pollutant to be measured directly from the air.

2.1 MONITORING LOCATIONS

Twenty sites were established across the larger study area to gather sufficient monitoring data to use in the model verification. The diffusion tubes were attached to appropriate street furniture at each location. Triplicate tubes were exposed at each site for approximately one calendar month at a time, for six months from 27th/28th August 2024 to 3rd March 2025. A travel blank was used every month to identify any possible contamination of the diffusion tubes while in transit and storage.

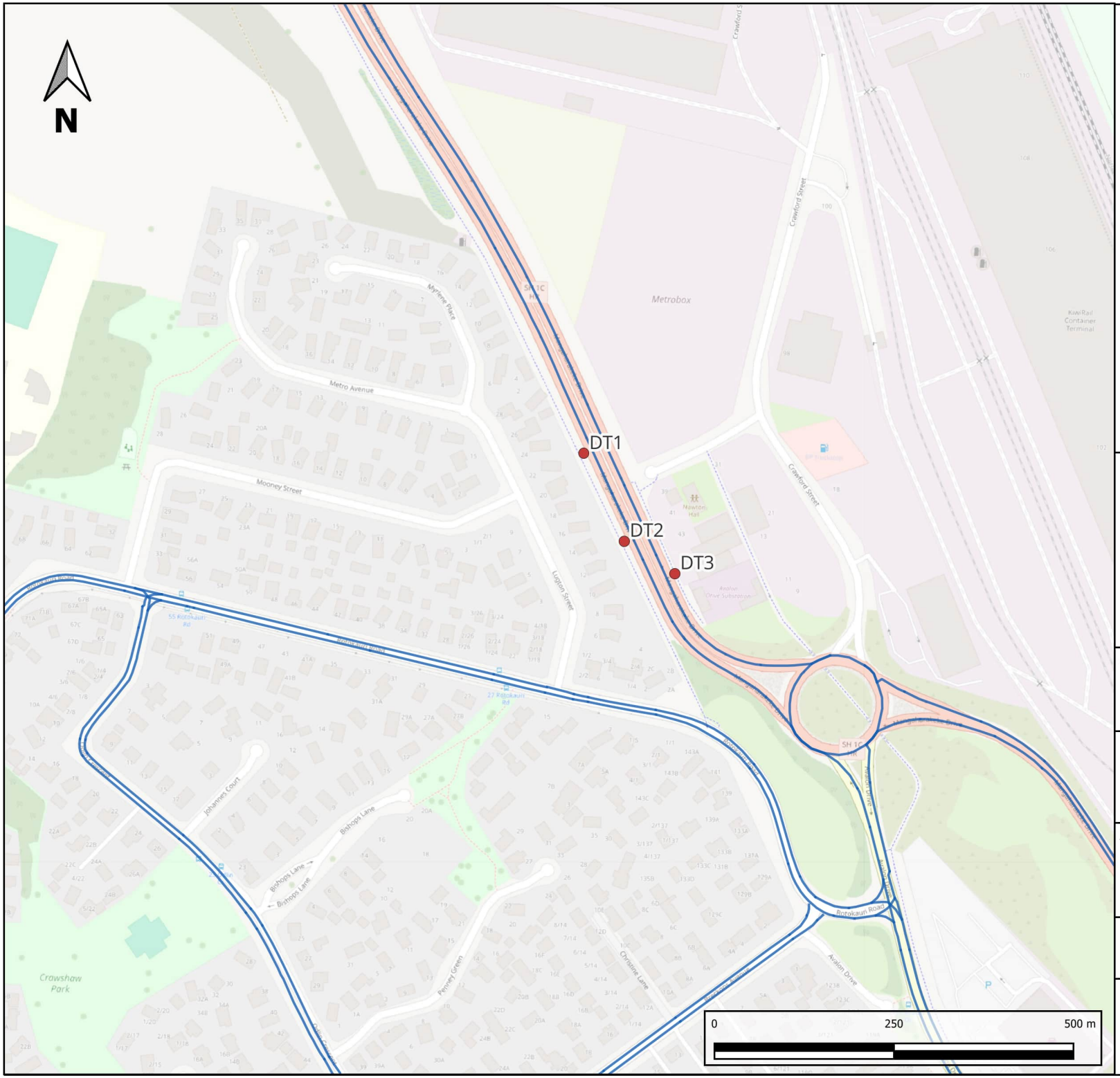
WRC maintains one NESAQ compliant continuous monitoring site that monitors NO_2. This site is located at the Bloodbank centre on Ohaupo Road (south of the city centre). NO_2 is monitored using a Teledyne API 200 oxides of nitrogen analyser. One of the WSP operated diffusion tube sites was established at the Bloodbank monitoring site. Validated NO_2 monitoring data from this continuous monitoring site was then able to be used to derive a local bias adjustment factor through comparison with the co-location diffusion tube results. The site also monitors PM_{10} and $PM_{2.5}$, this has been undertaken using a Teledyne API T640x since 6th October 2023, prior to which a FH 62 BAM was used.

The 20 project-specific diffusion tube monitoring locations (including one co-location and four background sites) are shown in Figure 2-1 to Figure 2-6, with the details of each site presented in Table 2-1.

Table 2-1 Project-specific monitoring locations

Key area monitoring relates to	Site name	X co-ordinate (NZTM)	Y co-ordinate (NZTM)	Height (m)	Distance to modelled road source (m)
Mangaharakeke Three lampposts along Mangaharekeke Drive	DT1	1797081	5817612	2.3	3.6
	DT2	1797112	5817544	2.3	3.6
	DT3	1797151	5817522	2.2	3.6
Te Rapa Three lampposts on Forest Lake Road, Victoria Street and Te Rapa Road	DT4	1799281	5817402	2.5	3.7
	DT5	1799212	5817344	2.4	6.1
	DT6	1799390	5817303	2.5	4.0
Ruakura Three lampposts on Ruakura Road and Wairere Drive	DT7	1802613	5816031	2.7	3.9
	DT8	1803052	5815969	3.60	6.2
	DT9	1802813	5815656	2.6	2.9
Cambridge Three lampposts on Cambridge Road and Morrinsville Road	DT10	1804038	5813835	2.5	4.0
	DT11	1804133	5813773	2.6	3.5
	DT12	1804553	5813744	2.3	4.4
Ohaupo Two lampposts and one overhead street sign on State Highway 3 and Normandy Avenue	DT13	1800852	5812669	2.4	6.2
	DT14	1800980	5812678	2.4	1.5
	DT15	1800885	5812614	2.6	2.8
Bloodbank	CoLoc	1800746	5813072	4.4	12.1

Key area monitoring relates to	Site name	X co-ordinate (NZTM)	Y co-ordinate (NZTM)	Height (m)	Distance to modelled road source (m)
Co-location with continuous monitor					
Dominion Road Reserve	BGD1	1796722	5816594	3.0	502.0
Swarbrick Park	BGD2	1798268	5815101	2.5	1,924.4
Claudelands	BGD3	1801600	5816500	2.6	712.0
Hamilton Gardens	BGD4	1802799	5813206	2.7	889.5



Legend

- Modelled Road Network
- Monitoring Sites

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Monitoring Sites for the Mangaharakeke Study Area

FIGURE No.:	REV:
2-1	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB

Legend

- Modelled Road Network
- Monitoring Sites

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

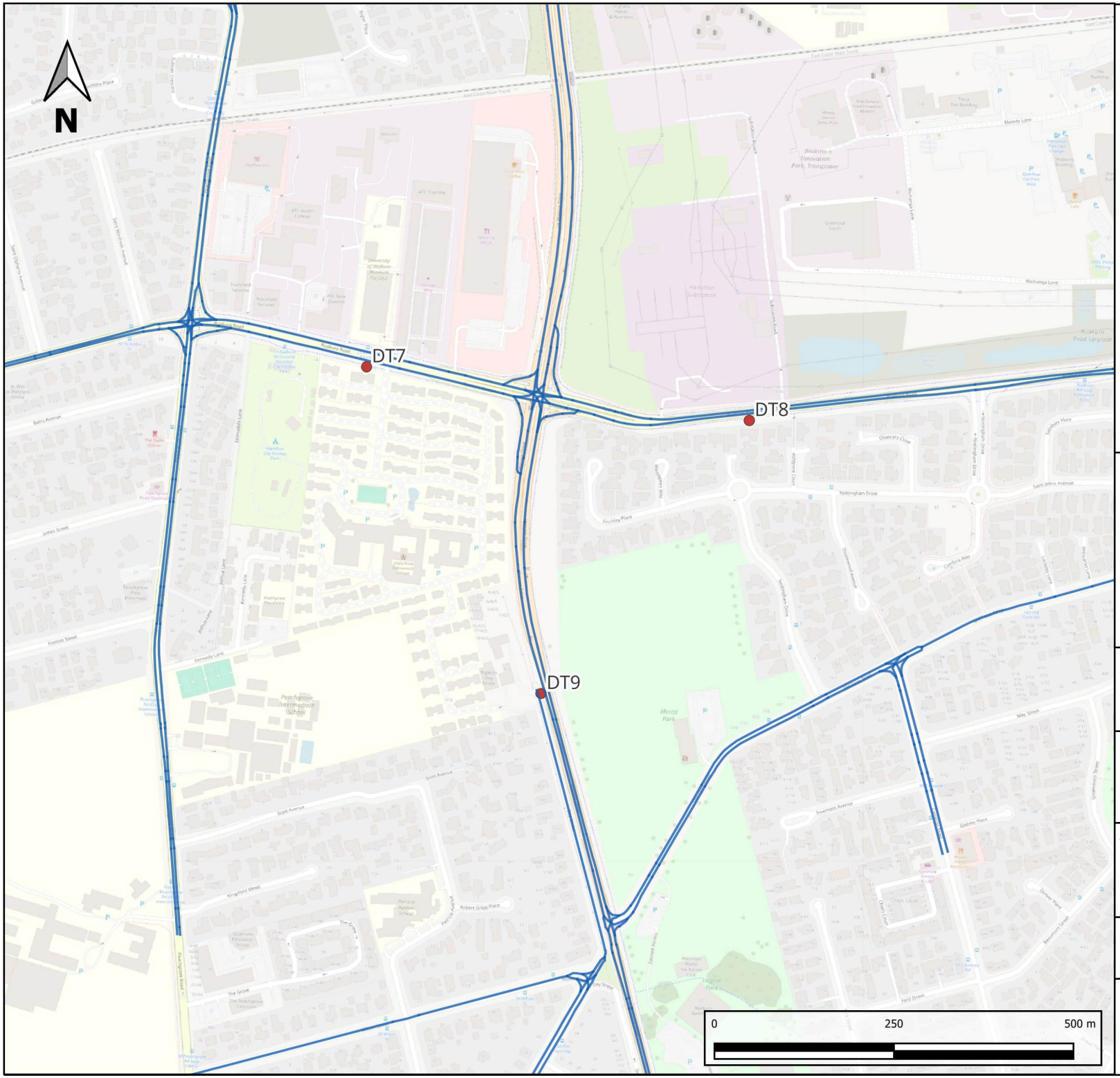
Hamilton Air Quality Monitoring and Modelling

TITLE:

Monitoring Sites for the Te Rapa Study Area

FIGURE No.:	REV:
2-2	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB



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- Modelled Road Network
- Monitoring Sites

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PROJECT:

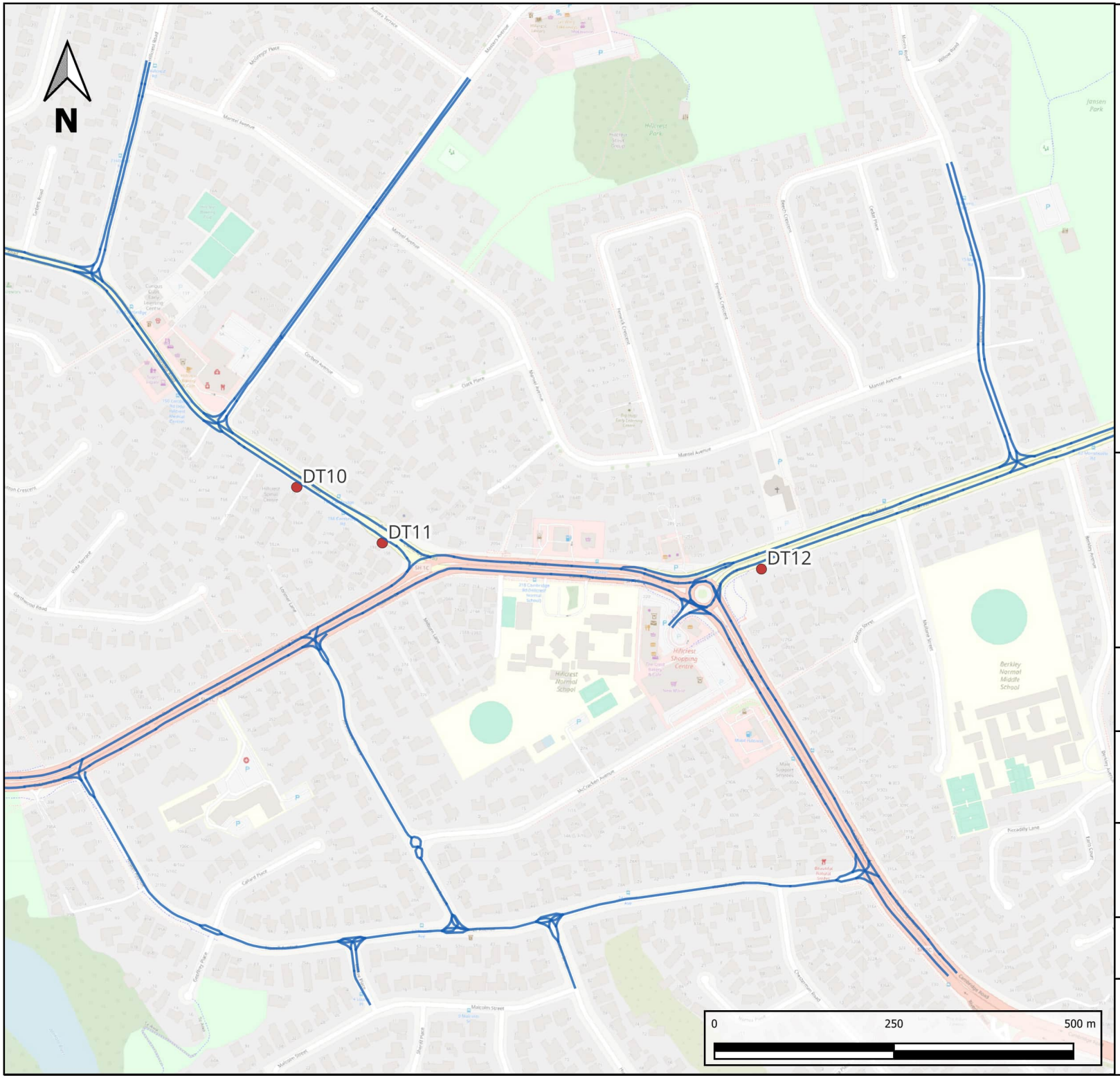
Hamilton Air Quality Monitoring and Modelling

TITLE:

Monitoring Sites for the Ruakura Study Area

FIGURE No.:	REV:
2-3	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB



Legend

- Modelled Road Network
- Monitoring Sites

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Monitoring Sites for the Cambridge Study Area

FIGURE No.:	REV:
2-4	1.0

REV DATE: 24-04-2025	
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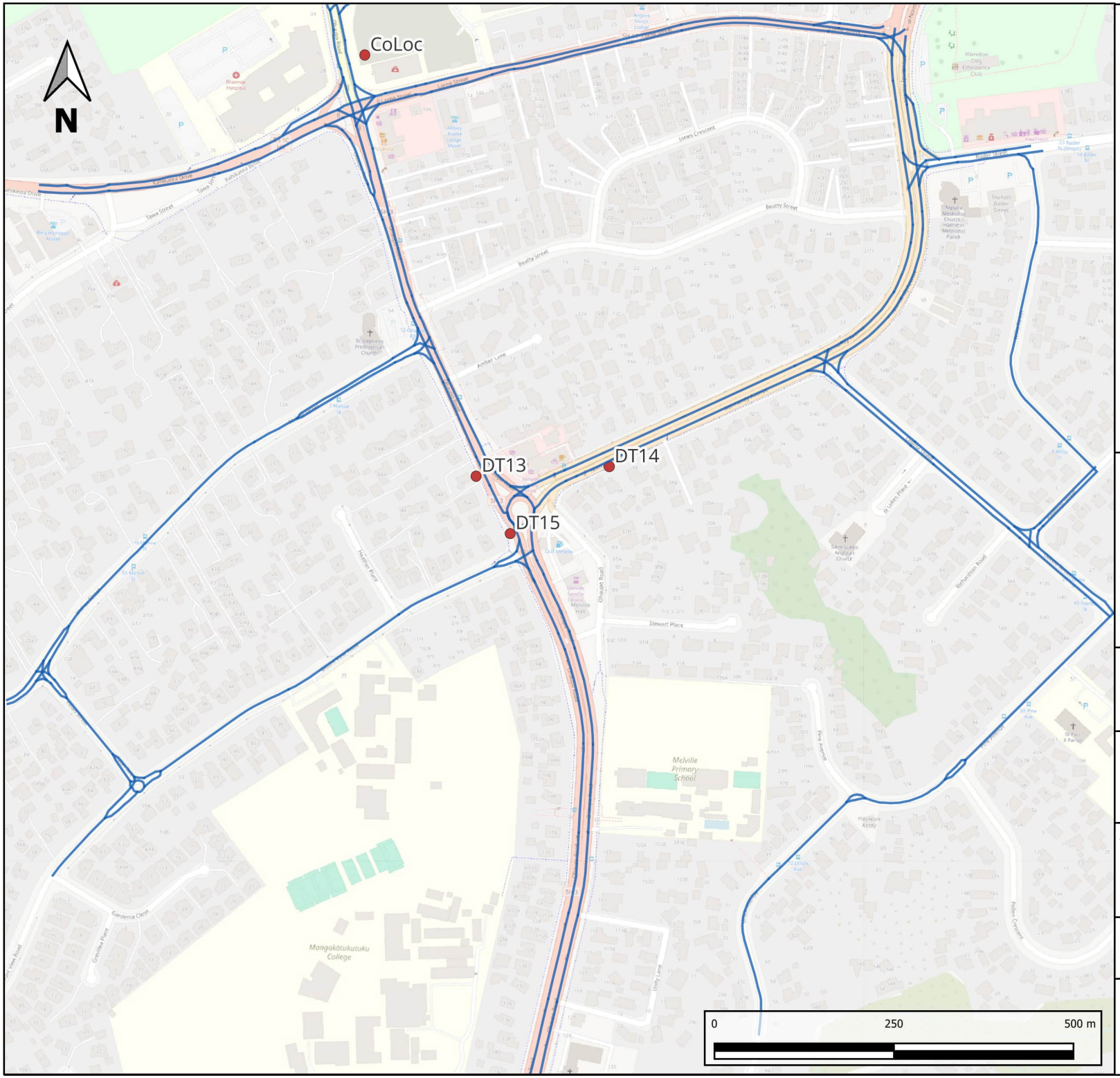
APPROVED BY:	FB



Legend

- Modelled Road Network
- Monitoring Sites

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

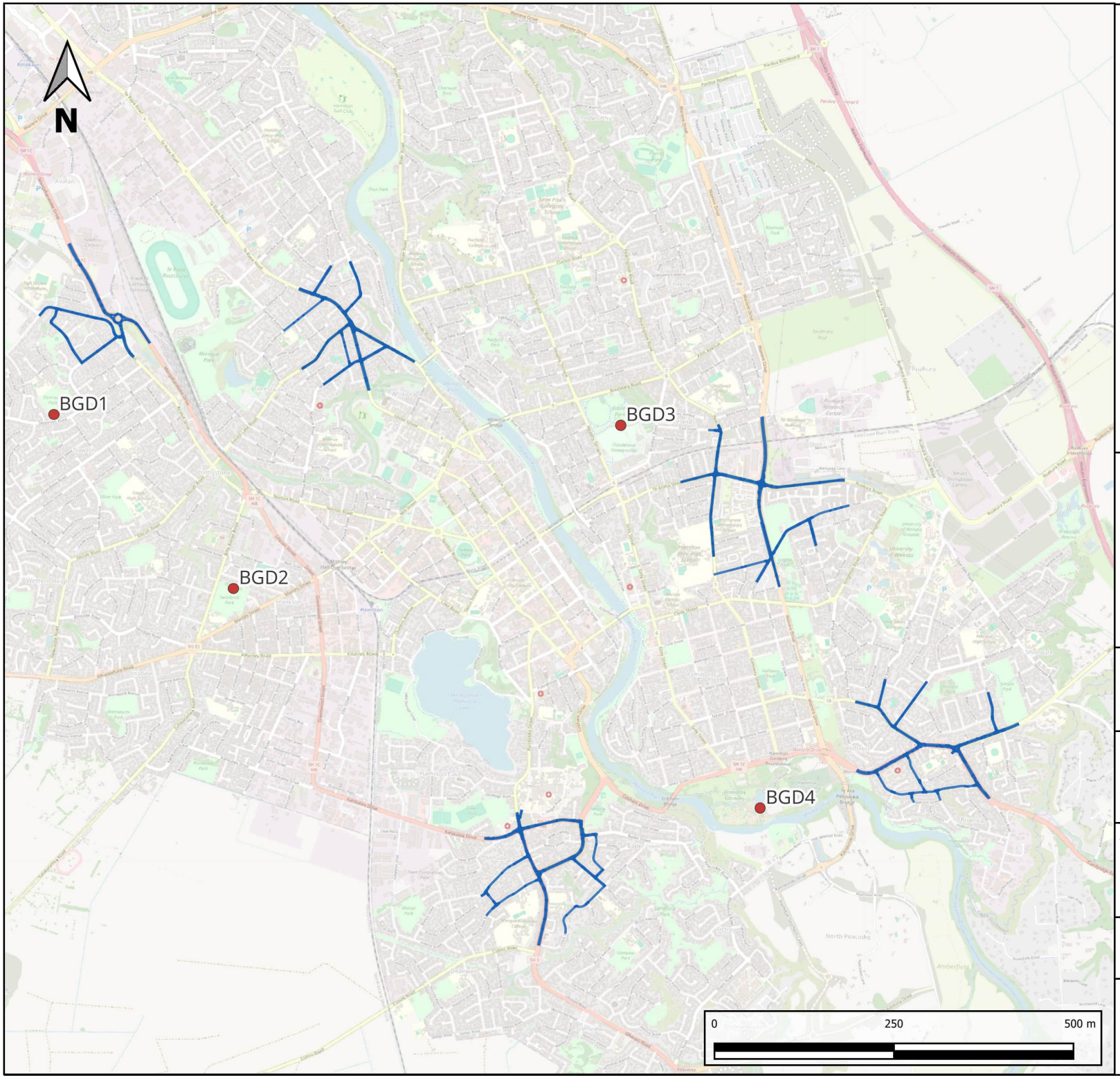
Hamilton Air Quality Monitoring and Modelling

TITLE:

Monitoring Sites for the Ohaupo Study Area

FIGURE No.:	REV:
2-5	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB



Legend

- Modelled Road Network
- Background Monitoring Sites

NOTES:

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Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Background Monitoring Sites for Wider Study Area

FIGURE No.:	REV:
2-6	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB

2.2 DATA ANALYSIS

The diffusion tubes were exposed across Hamilton for a month at a time and sent to Staffordshire Highways Laboratory, a UKAS accredited laboratory, for analysis.

The preparation method for the diffusion tubes supplied by Staffordshire Highways Laboratory was 20% triethanolamine (TEA) in water.

2.2.1 PRECISION

Precision refers to the ability to consistently reproduce a measurement, i.e. how similar the results of the triplicate tubes are to one another. The precision is calculated using the coefficient of variation (CV) and is categorised as 'good' or 'poor'. As per Defra's technical guidance (Department for Environment, Food and Rural Affairs, 2022) "*Good precision applies where the coefficient of variation (CV) of triplicate diffusion tubes for eight or more periods during the year is less than 20%, and the average CV of all monitoring periods is less than 10%. Poor precision applies where the CV of four or more periods is greater than 20% and/or the average CV is greater than 10%*".

For this monitoring survey, as it was not undertaken for a full calendar year, the CV for each site and each period was calculated and used to identify outlying results, to aid in any decision to remove outlying monitoring results prior to calculation of 6-month means. Where the CV was 20% or above for a triplicate site during any period, the monitoring notes were checked for instances of tubes being contaminated or tampered with and removed from the calculation of 6-month means where appropriate. Monitoring results removed from further calculations are underlined in Table 2-2.

Table 2-2 presents the raw NO_2 monitoring data for the triplicate sites across the 6-month period. Diffusion tubes 1, 2 and 3, colocation and background sites 1 and 2 were deployed on 28th August 2024, all other sites were deployed from 27th August 2024.

Table 2-2 Project-specific monitoring exposure dates/times, raw NO_2 results and CV for each tube for each period

Site Name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
	27th or 28th August to 27th September	27th September to 25th October	25th October to 22nd November	22nd November to 19th December	19th December to 24th January	24th January to 3rd March
DT1	26.0	26.9	26.3	16.9	16.0	21.2
	26.2	28.3	25.1	17.8	15.1	17.6
	25.3	28.2	23.3	19.8	15.3	18.4
CV	2 %	3 %	6 %	8 %	3 %	10 %
DT2	29.6	31.7	27.2	19.8	16.8	22.3
	27.8	30.6	24.6	19.4	13.7	17.6
	28.7	29.3	27.9	20.0	16.9	21.4
CV	3 %	4 %	7 %	2 %	12 %	12 %
DT3	26.9	21.5	21.3	16.5	12.2	17.6
	28.2	20.9	21.9	16.7	10.9	18.4
	25.6	22.5	21.1	16.6	13.1	16.8
CV	5 %	4 %	2 %	1 %	9 %	5 %
DT4	26.2	23.8	23.7	18.6	14.6	21.0
	25.8	24.0	21.5	19.3	14.7	*N/A*
	25.5	24.0	21.9	18.4	15.3	*N/A*
CV	1 %	0 %	5 %	3 %	3 %	-
DT5	11.7	13.7	11.4	8.9	8.4	11.4
	11.6	13.0	11.8	8.2	7.8	11.6
	11.8	12.4	11.4	8.1	7.9	11.6
CV	1 %	5 %	2 %	5 %	4 %	1 %
DT6	16.9	14.8	14.2	11.6	9.0	12.5
	16.9	15.0	14.1	*N/A*	9.2	11.5
	17.9	14.6	14.1	11.1	9.2	12.8
CV	3 %	1 %	0 %	3 %	1 %	6 %
DT7	12.1	12.0	11.2	*N/A*	6.5	10.1
	13.6	11.4	10.7	*N/A*	6.3	10.1
	13.2	12.4	*N/A*	*N/A*	6.6	9.7
CV	6 %	4 %	3 %	-	2 %	2 %
DT8	2.7	11.6	1.0	8.6	6.1	*N/A*
	12.8	11.0	6.4	8.5	6.0	10
	12.8	6.1	7.2	8.1	7.5	9.7
CV	62 %	32 %	69 %	3 %	13 %	2 %
DT9	13.2	12.2	11.1	8.0	7.1	10.5

Site Name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
	27th or 28th August to 27th September	27th September to 25th October	25th October to 22nd November	22nd November to 19th December	19th December to 24th January	24th January to 3rd March
	11.6	11.6	11.4	7.2	5.0	10.8
	12.1	11.8	11.1	8.8	6.8	10.5
CV	7 %	3 %	2 %	10 %	18 %	2 %
DT10	11.4	9.9	9.4	7.1	6.0	*N/A*
	10.4	10.5	9.0	7.8	5.9	10.0
	10.7	9.4	8.5	7.5	5.7	9.3
CV	5 %	6 %	5 %	5 %	3 %	5 %
DT11	12.0	10.7	10.0	*N/A*	6.5	10.1
	11.7	11.5	9.7	*N/A*	6.7	10.5
	11.8	11.2	10.0	8.1	6.5	10.2
CV	1 %	4 %	2 %	-	2 %	2 %
DT12	18.4	15.4	17.9	13.4	*N/A*	14.2
	18.6	14.8	17.1	14.0	8.8	13.3
	18.3	15.2	17.5	13.6	9.5	13.4
CV	1 %	2 %	2 %	2 %	5 %	4 %
DT13	15.7	15.4	13.7	8.7	8.8	12.9
	15.4	*N/A*	13.3	9.9	8.6	13.0
	15.2	15.5	13.9	9.9	8.2	12.5
CV	2 %	0 %	2 %	7 %	4 %	2 %
DT14	*N/A*	13.9	13.9	13.7	7.3	12.1
	17.8	13.7	12.7	10.6	7.5	11.3
	17.2	14.8	12.6	11.0	8.3	12.3
CV	2 %	4 %	6 %	14 %	7 %	4 %
DT15	18.4	20.2	18.9	13.6	9.8	16.0
	19.7	20.1	19.3	12.5	10.6	16.8
	20.3	20.3	19.2	13.3	11.0	15.7
CV	5 %	0 %	1 %	4 %	6 %	4 %
CoLoc	16.8	14.2	12.6	11.0	9.0	12.5
	16.6	14.5	13.3	11.3	8.0	12.2
	16.8	14.1	13.4	10.6	8.5	12.5
CV	1 %	1 %	3 %	3 %	6 %	1 %
BGD1	*N/A*	6.9	7.0	4.8	4.8	7.2
	N/A	6.8	6.5	4.7	5.0	7.5
	N/A	7.4	7.3	5.1	4.7	7.4

Site Name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
	27th or 28th August to 27th September	27th September to 25th October	25th October to 22nd November	22nd November to 19th December	19th December to 24th January	24th January to 3rd March
CV	-	5 %	6 %	4 %	3 %	2 %
BGD2	10.5	8.7	9.4	*N/A*	5.3	7.9
	9.3	9.1	8.1	6.4	5.5	8.3
	10.0	8.5	8.2	6.4	5.3	8.4
CV	6 %	3 %	8 %	0 %	2 %	3 %
BGD3	8.4	7.2	6.8	6.2	4.5	7.5
	6.9	7.1	7.4	5.3	*N/A*	7.8
	N/A	8.0	7.1	5.7	5.0	7.6
CV	14 %	7 %	4 %	8 %	7 %	2 %
BGD4	*N/A*	5.5	5.8	11.8	3.3	6.4
	N/A	6.0	6.1	4.5	3.5	6.3
	N/A	6.2	6.3	5.0	3.9	11.7
CV	-	6 %	4 %	57 %	9 %	38 %

Table notes: Underlined denotes either something in the tube when collecting e.g. spider's web/spider etc. or interference with tube that may have affected the monitoring result from that tube. These results have therefore been removed from further calculations.

'N/A' denotes tube missing.

'–'denotes CV unable to be calculated due to insufficient number of tubes for that period.

2.2.2 ANNUALISATION (SHORT TO LONG TERM ADJUSTMENT)

Each monitoring site should ideally be operated for one year to provide a monitored annual mean concentration accounting for seasonality. However, where this is not possible, a shorter period of monitoring can be used to provide annual mean equivalent values for use in model verification through annualisation (also known as short to long term adjustment).

Annualisation helps to make sure that seasonality has been considered in any monitoring campaign and is the process of estimating an annual average of monitored concentrations where monitoring has been completed for less than 75 % of the year (9 months). This is performed by deriving an annualisation factor from a comparison of monitoring period means and annual means from continuous monitoring sites. The monitoring period means and corresponding period means for the continuous monitoring (Bloodbank) used in this monitoring survey are presented in Table 2-3. As all sites were monitored for less than 75 % of the year, an annualisation factor was calculated and applied to every monitoring site to provide 2024 annual mean equivalent values.

The project specific diffusion tubes were exposed for 6 months (50% of the year). Different annualisation factors were calculated and applied to each site depending on the data coverage achieved. For example, most sites had data for all 6 months therefore they were compared with the same 6 months of monitoring recorded at the Bloodbank site, however DT7 had no data for period 4, and BGD1 and BGD4 had no data for period 1 therefore for these the monitoring data from Bloodbank that corresponded with the same monitoring periods (e.g. without period 4 or period 1 respectively) were used.

Each annualisation factor was calculated through comparison of the ratio of the Bloodbank 'period mean' of monitoring (excluding any months with missing tubes or data impacted by contamination) to the 2024 annual

mean from the Bloodbank continuous monitoring site (12.9 µg/m^3) as shown in Table 2-3. The calculated annualisation factors were then applied to the diffusion tube data to provide monitored annual mean equivalent concentrations for 2024 for each diffusion tube site.

Table 2-3 Project-specific monitoring exposure period means and corresponding Bloodbank means for the same exposure periods to derive annualisation factors for each diffusion tube location

Site	Monitoring survey period mean (µg/m^3)	Corresponding Bloodbank period mean (µg/m^3)	Bloodbank annual mean (µg/m^3)	Ratio of Bloodbank annual mean to the Bloodbank period mean	Estimate of the monitored annual mean equivalent for 2024 (µg/m^3)
DT1	21.9	9.46	12.9	1.36	29.7
DT2	23.6	9.46		1.36	32.1
DT3	19.4	9.46		1.36	26.3
DT4	21.1	9.44		1.36	28.8
DT5	10.7	9.44		1.36	14.6
DT6	13.2	9.44		1.36	17.9
DT7	10.5	9.73		1.32	13.8
DT8	9.3	9.44		1.36	12.6
DT9	10.2	9.44		1.36	13.8
DT10	8.8	9.44		1.36	12.0
DT11	9.6	9.44		1.36	13.1
DT12	14.6	9.44		1.36	19.9
DT13	12.6	9.44		1.36	17.1
DT14	12.7	9.44		1.36	17.3
DT15	16.4	9.44		1.36	22.4
CoLoc	12.7	9.46		1.36	17.2
BGD1	6.2	8.37		1.54	9.5
BGD2	7.9	9.46		1.36	10.7
BGD3	6.7	9.44		1.36	9.1
BGD4	5.2	8.37		1.54	8.0

Table notes: Data has been removed from the period mean if it was suspected to have impacted the monitoring result from that tube (e.g. it was identified that something was in the tube when collecting, for example a spider's web/spider etc. or there was suspected interference with the tube).

'N/A' denotes tube missing.

Following the completion of the annualisation process, bias adjustment is required to be applied to the 2024 annualised average to account for the possibility of the diffusion tubes systemically over or under-predicting the concentrations compared to continuous monitoring.

2.2.3 BIAS ADJUSTMENT AGAINST LOCAL CONTINUOUS MONITORING SITE

For monitoring surveys, the bias (possibility of the diffusion tubes systemically over or under-predicting the concentrations) is considered. A bias adjustment factor is derived from either co-location of project-specific diffusion tubes locally with a continuous monitor, or from a national database of co-location studies.

For this monitoring survey a co-location (CoLoc) with the WRC reference monitor 'Bloodbank' was undertaken so that a local bias adjustment could be derived and then applied to all monitoring site results. The local bias adjustment factor has been derived for this monitoring survey by comparing the monitoring period mean of the project-specific co-location tube site (CoLoc) with the same monitoring period mean of the Bloodbank reference monitor as shown in Table 2-4. This shows that for this monitoring survey, the diffusion tubes at the co-location overpredict concentrations when compared to the reference monitor, and a bias adjustment factor of **0.75** has been calculated.

Table 2-4 Local bias adjustment factor derived for the project-specific monitoring survey.

Site Name	Period mean (µg/m^3)						Monitoring survey mean (µg/m^3)	Ratio of Bloodbank period mean to co-location period mean
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6		
CoLoc	16.7	14.3	13.1	11.0	8.5	12.4	12.7	0.75
Bloodbank	14.9	10.4	8.3	8.0	6.2	8.9	9.5	

This bias adjustment factor was then applied to all annualised diffusion tube results to produce annualised and bias adjusted results for use in the verification of detailed dispersion modelling.

2.3 MONITORING RESULTS

The measured NO_2 concentrations are presented in Table 2-5. The table provides the unadjusted period mean, annualisation factor, bias adjustment factor and the resulting 2024 annual mean bias adjusted measurement. All 2024 measured concentrations are below the annual mean NO_2 guideline (30 µg/m^3). Measured concentrations are considerably lower at the background sites, which is in line with expectations. The highest annual mean NO_2 concentration measured was 24.0 µg/m^3, recorded at diffusion tube site DT2, which is located on Mangaharakeke Drive.

Table 2-5 NO_2 diffusion tube results

Site ID	Period mean	Annualisation factor (short to long term adjustment)	Local bias adjustment factor	2024 Annual Mean (Bias adjusted and annualised mean)
DT1	21.9	1.36	0.75	22.2
DT2	23.6	1.36		24.0
DT3	19.4	1.36		19.7
DT4	21.1	1.36		21.5
DT5	10.7	1.36		10.9
DT6	13.2	1.36		13.4
DT7	10.5	1.32		10.3
DT8	9.3	1.36		9.4
DT9	10.2	1.36		10.3
DT10	8.8	1.36		8.9
DT11	9.6	1.36		9.8
DT12	14.6	1.36		14.8
DT13	12.6	1.36		12.8

Site ID	Period mean	Annualisation factor (short to long term adjustment)	Local bias adjustment factor	2024 Annual Mean (Bias adjusted and annualised mean)
DT14	12.7	1.36		12.9
DT15	16.4	1.36		16.7
CoLoc	12.7	1.36		12.9
BGD1	6.2	1.54		7.1
BGD2	7.9	1.36		8.0
BGD3	6.7	1.36		6.8
BGD4	5.2	1.54		6.0

Table note: data has been removed from the period mean if it was suspected to have impacted the monitoring result from that tube (e.g. it was identified that something was in the tube when collecting, for example a spider's web/spider etc. or there was suspected interference with the tube).

3 DETAILED DISPERSION MODELLING

3.1 DISPERSION MODEL SET-UP

For detailed dispersion modelling of road sources, the contribution from the road source is calculated by the model, and an appropriate background concentration is added to the road contribution to derive a total predicted concentration at the modelled location, prior to comparison with the relevant air quality guidelines.

For this assessment WSP has used the advanced Gaussian dispersion model Atmospheric Dispersion Modelling System for roads (ADMS-Roads) (version 5.0.1.3) developed by Cambridge Environmental Research Consultants (CERC) Ltd to undertake the detailed dispersion modelling of NOx, PM_{10} and $PM_{2.5}$ emissions.

ADMS-Roads was developed for regulatory authorities in the United Kingdom and is used in jurisdictions around the world. This model uses detailed information regarding traffic flows on the local road network, surface roughness, and local meteorological conditions to predict pollutant concentrations at specific receptor locations, as determined by the user. ADMS-Roads also includes traffic-induced turbulence and the ability to model complex street canyons, and is optimised for street-scale (metres) resolution predictions. The ADMS models have been widely validated for both point and road sources and are accepted by the industry as being 'fit-for-purpose' for use in air quality assessment.

3.1.1 METEOROLOGICAL DATA

ADMS-Roads is an advanced Gaussian plume model which requires hourly sequential meteorological data as an input. This is a time series of weather parameters and some information on variation with height, but no horizontal variation. Meteorological requirements for ADMS-Roads include wind speed, wind direction and temperature, cloud cover and incoming solar radiation. Data from Hamilton Airport for 2024 was obtained for this assessment. Figure 3-1 presents the wind rose; it can be observed that the prevailing wind direction is from the west. The dataset contains 1.6 % of calm hours (wind speeds less than 0.5 metres per second (m/s)) and 99.9 % of usable data for the dispersion model.

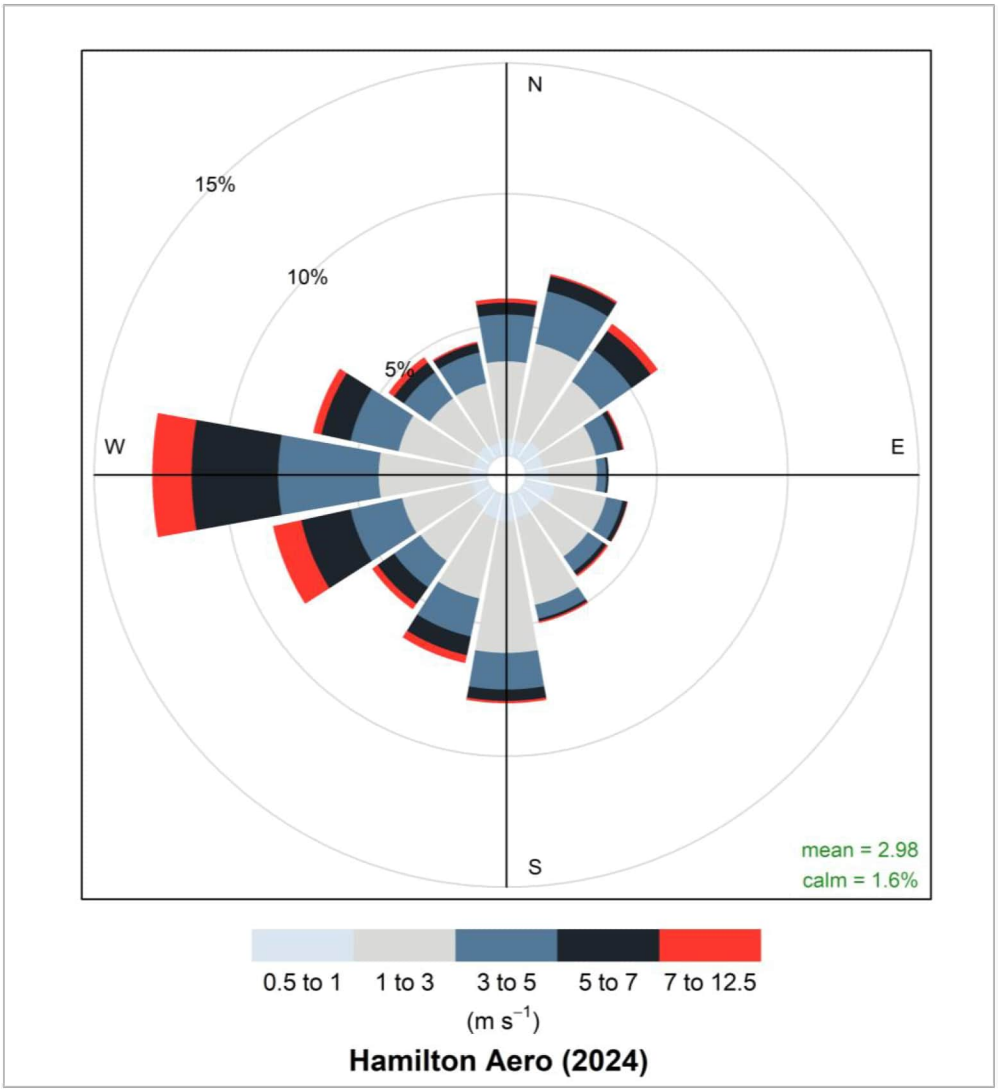


Figure 3-1: Wind rose generated from the meteorological data used for the dispersion modelling of operational phase impacts.

3.1.2 OTHER MODEL PARAMETERS

The extent of mechanical turbulence (and hence mixing) in the atmosphere is affected by the surface/ground over which the air is passing, Typical surface roughness values range from 0.0001m (for water or sandy deserts) to 1.5m (for cities, forests and industrial areas). In this assessment, a surface roughness of 1.0 m corresponding to ‘cities, woodlands’ was applied for the study area and 0.2 m for the meteorological station which corresponds to ‘agricultural areas (min)’.

Another model parameter is the minimum Monin-Obukhov length. This describes the minimum level of turbulence in the atmosphere, which is limited due to the urban heat island effect. Typical values range from 2 m to 20 m for rural and sparsely populated areas. In urban areas, where traffic and building increase the generation and/or retention of more heat, these values are higher. For this model, a minimum length of 30 m ‘cities and large towns’ was used.

Data for the topography of the study area (widths of roads, street canyons and noise barriers) was included in the model and these were calculated from mapping and satellite imagery. Following a review of the topography across the wider study area, the advanced street canyon module was used in two locations for single-sided canyons (one to represent a one-sided street canyon and the other to represent a noise barrier) in the model.

3.1.3 TRAFFIC DATA

Hourly traffic data (split into weekday and weekend) for light commercial vehicles (LCV), heavy commercial vehicles (HCV) and buses was provided by WRC for the main roads within 200 m of the roadside monitoring locations for the five study areas from the Hamilton Aimsun Model. Data was provided for 2024 to align with the project-specific monitoring undertaken.

The hourly data was consolidated into four traffic periods: Ante meridiem (AM) (7 am – 10 am), Inter-peak (IP) (10 am – 4pm), Post meridiem (PM) (4pm – 7pm), and Off-peak (OP) (7pm – 7am). The speeds were calculated as weighted averages with respect to the traffic flow for each link (a length of road which is considered to have the same flow of traffic along it) and the flows pro-rated for weekday and weekend to create four consolidated traffic datasets (one for each time period) split out by LCV, HCV and buses.

Based on WSP's experience of modelling road traffic emissions, it was expected that the use of period flows (AM, IP, PM and OP) would be sufficient to provide robust estimates of annual mean pollutant concentrations and a dispersion model that performs acceptably. Additionally, traffic speeds have been manually reduced to represent the slower moving stop-start and queuing traffic patterns experienced at junctions.

The digitized road network for the provided traffic data was georeferenced in GIS using the Land Information New Zealand (LINZ) basemap to import this network into ADMS-Roads. The modelled road network for the five key areas is shown in Figure 1-1.

3.1.4 EMISSION RATES

Emissions rates were calculated from the Vehicle Emissions Prediction Model (VEPM 7.1) (NZ Transport Agency Waka Kotahi, 2025) for each road link based on the traffic flow and speed. VEPM allows for the calculation of emission factors arising from road traffic for all years between 2001 and 2050. For the predictions of future year emissions, the toolkit takes into account factors such as anticipated advances in vehicle technology and changes in vehicle fleet composition, such that vehicle emissions are assumed to reduce over time. Emissions for the year 2024 were used to align with the monitoring data collected for this assessment and traffic data provided.

3.1.5 BACKGROUND CONCENTRATIONS

Background concentrations refer to the existing levels of pollution in the atmosphere, provided by a variety of sources such as roads, airports and industrial processes. The background concentrations used in any detailed modelling of road traffic emissions account for sources other than road traffic in the urban environment (e.g. home heating, local industry) when calculating total pollutant concentrations.

The background concentrations used in this assessment for NO_2 were from the four project-specific background monitoring sites installed across the wider study area. In the absence of PM_{10} and $PM_{2.5}$ project-specific background monitoring, the Waka Kotahi background concentrations were used (NZ Transport Agency Waka Kotahi, 2023) for the appropriate census area unit within which a receptor was located.

A comparison between the NO_2 background concentrations used from the project-specific background monitoring sites and those from the Waka Kotahi website for the same census unit area has been undertaken (Table 3-1). As shown in Table 3-1, the Waka Kotahi background concentrations for the Crawshaw and Swarbrick areas are higher than the respective project-specific sites BGD1 and BGD2 by 25% and 29%, respectively. Similarly, the background concentrations for Claudelands and Naylor are higher than BGD3 and BGD4 by 54%. The project-specific background monitoring sites were used for this assessment as the locations were chosen specifically to be set back from the modelled roads sources and therefore representative of the background concentrations without the influence of the modelled road source, to avoid double counting transportation emissions in the predictions. Each receptor considered within this project has been assigned a background value based on a combination of their locations relative to the monitoring and consideration of whether the background site is representative of other sources within the region. As such only

site BGD1, BGD3 and BGD4 have been used to represent background values at receptor locations, with BGD2 not being assigned to any receptors considered within the study area as it was not considered to be representative of the locations of receptors that were included within the modelling exercise.

Table 3-1 Comparison between the Waka Kotahi and project-specific background NO_2 concentration

Site ID	Project-specific NO_2 background concentration	Waka Kotahi census area name for the respective project-specific sites	Waka Kotahi NO_2 background concentration	Difference between the project-specific and Waka Kotahi background concentration
BGD1	7.1 µg/m^3	Crawshaw	8.9 µg/m^3	25%
BGD2	8.0 µg/m^3	Swarbrick	10.3 µg/m^3	29%
BGD3	6.8 µg/m^3	Claudelands	10.5 µg/m^3	54%
BGD4	6.1 µg/m^3	Naylor	9.4 µg/m^3	54%

3.2 SENSITIVE RECEPTORS

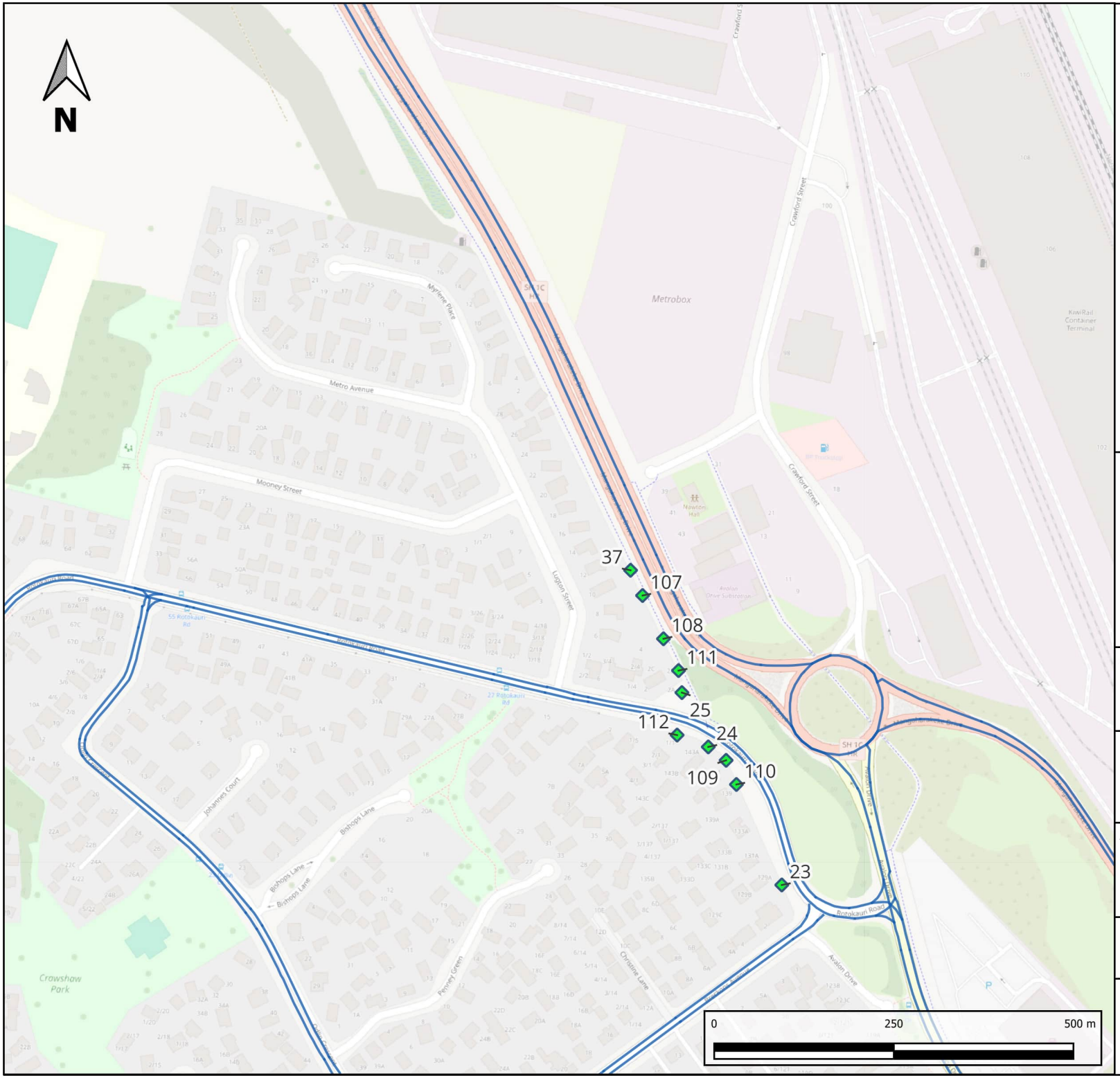
Emissions of nitrogen oxides and particulate matter from road traffic disperse quickly into the surrounding environment, with the highest concentrations being found closest to the road. Concentrations reduce quickly with distance away from the source until road contributions to total concentrations are imperceptible from general background concentrations. The largest reduction in concentration with distance from the road source occurs within the first 20 m from the road (Air Quality Consultants Ltd, 2008), after which the drop-off in concentration with distance tapers off.

It is therefore important to consider whether there is relevant exposure nearby to the ‘higher risk’ locations identified from the review of traffic data. Where those exposure locations exist, the risk of population exposure to concentrations in exceedance of objectives and guideline values is higher.

The representative sensitive receptor locations have therefore been identified based on their proximity to the road sources modelled, where members of the public could conceivably be present for time periods that align with the relevant air quality objectives and guideline values considered.

There were 112 receptor locations selected for this assessment. Their locations are shown in Figure 3-2 to Figure 3-6 with details provided in Appendix A, Table A. 1.

In addition to the selected sensitive receptors, gridded model outputs have been modelled with source orientated grid points included for each road link. These have been used in the production of contour plots for each of the 5 model areas considered.



Legend

- Modelled Road Network
- Sensitive Receptors

NOTES:

1. Aerial image: Contains data sourced from the LINZ Data Service and licensed for reuse under CC BY 4.0
2. Projection: EPSG:2193 - NZGD2000/ New Zealand Map Grid

CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Sensitive Receptors for the Mangaharakeke Study Area

FIGURE No.:	REV:
3-2	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

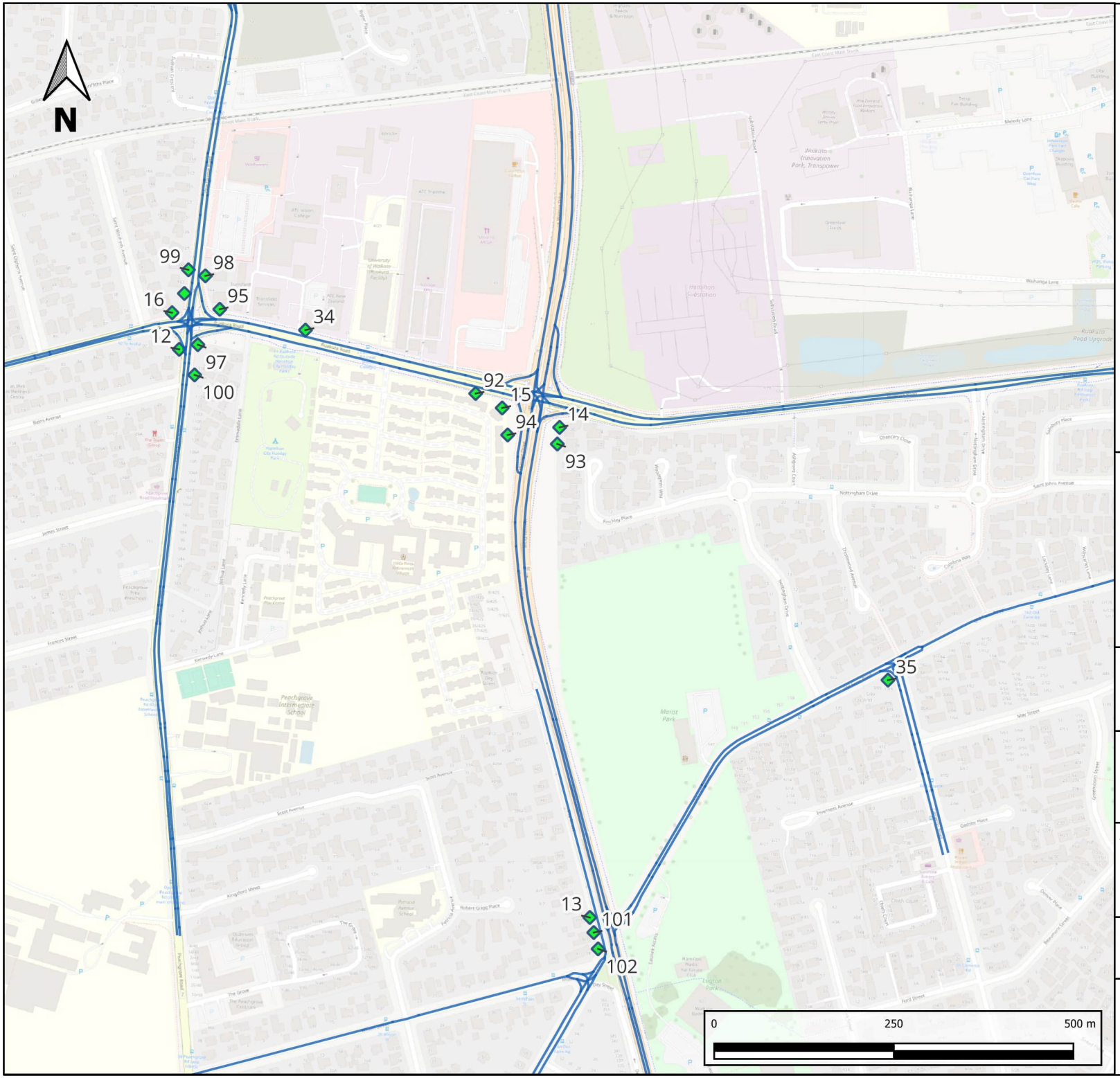
Hamilton Air Quality Monitoring and Modelling

TITLE:

Sensitive Receptors for the Te Rapa Study Area

FIGURE No.:	REV:
3-3	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB



Legend

- Modelled Road Network
- Sensitive Receptors

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CLIENT:

Waikato Regional Council

PROJECT:

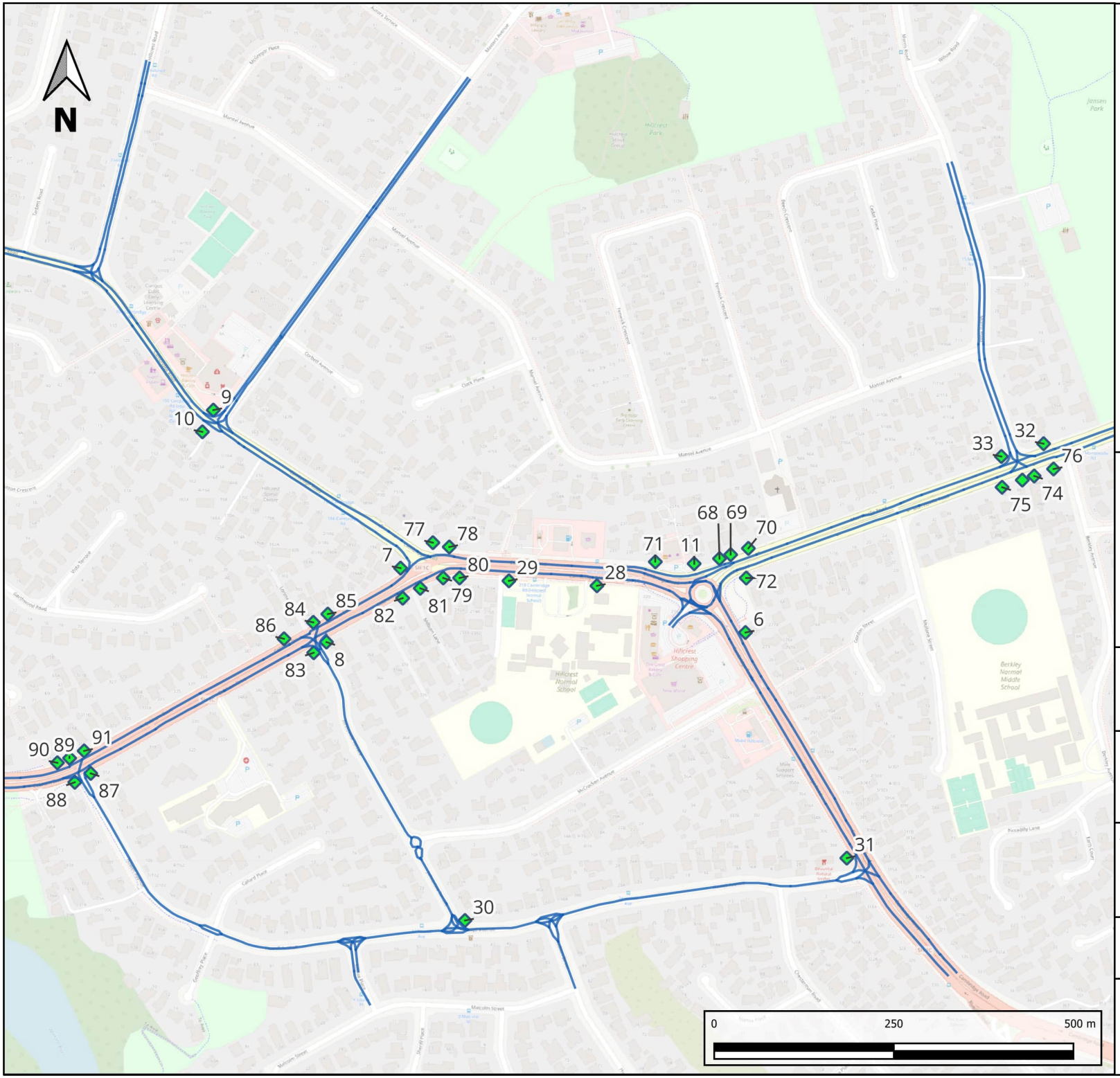
Hamilton Air Quality Monitoring and Modelling

TITLE:

Sensitive Receptors for the Ruakura Study Area

FIGURE No.:	REV:
3-4	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB



Legend

- Modelled Road Network
- Sensitive Receptors

NOTES:

1. Aerial image: Contains data sourced from the LINZ Data Service and licensed for reuse under CC BY 4.0
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CLIENT:

Waikato Regional Council

PROJECT:

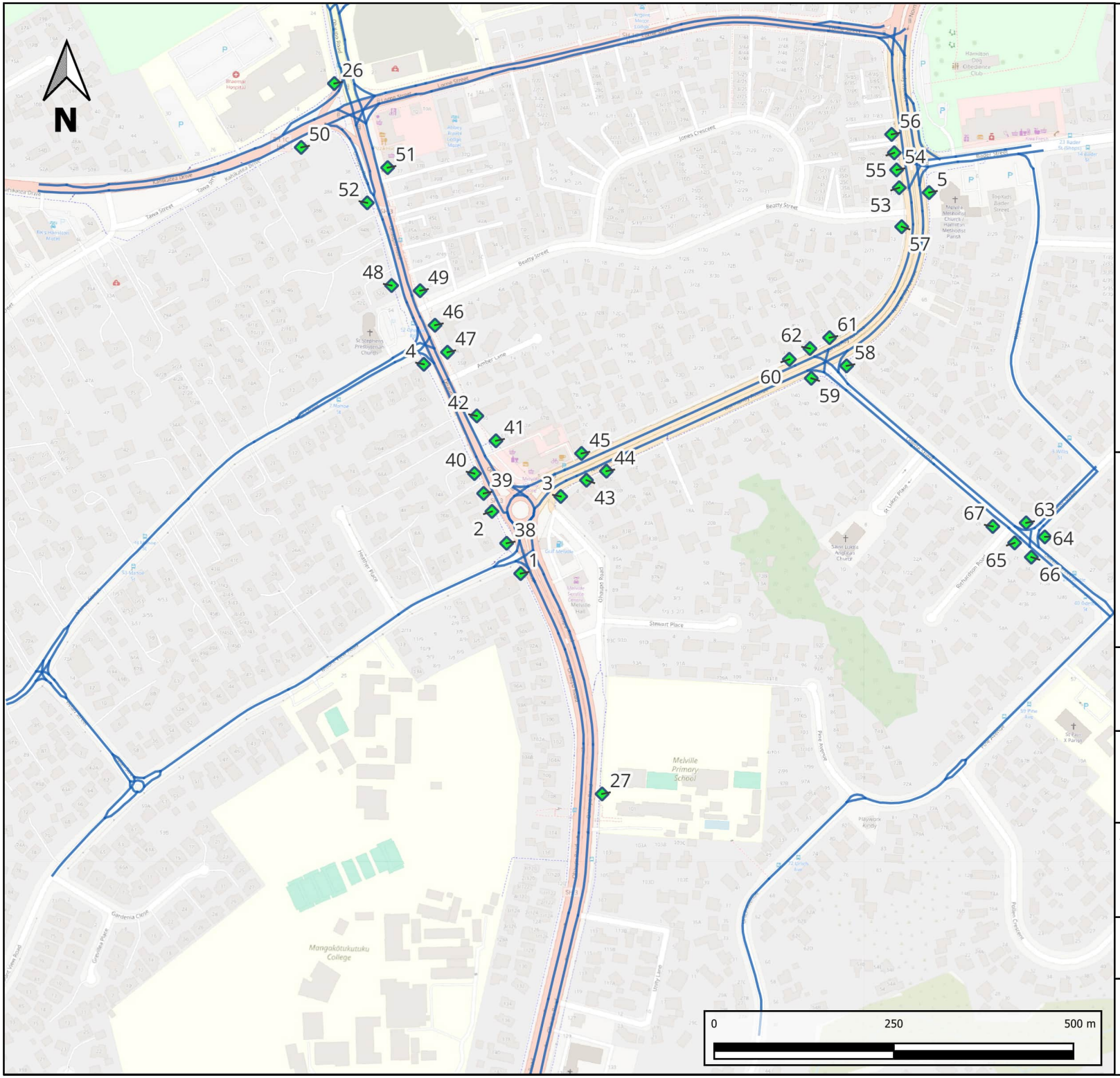
Hamilton Air Quality Monitoring and Modelling

TITLE:

Sensitive Receptors for the Cambridge Study Area

FIGURE No.:	REV:
3-5	1.0

REV DATE: 24-04-2025	
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB



Legend

- Modelled Road Network
- Sensitive Receptors

NOTES:

1. Aerial image: Contains data sourced from the LINZ Data Service and licensed for reuse under CC BY 4.0
2. Projection: EPSG:2193 - NZGD2000/ New Zealand Map Grid

CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Sensitive Receptors for the Ohaupo Study Area

FIGURE No.:	REV:
3-6	1.0

REV DATE:	24-04-2025
PREPARED BY:	SA
REVIEWED BY:	RD
APPROVED BY:	FB

3.3 NO_X TO NO_2 CONVERSION

The model predicts roadside NOx contributions, which comprise principally nitric oxide (NO and primary NO_2 (i.e. NO_2 that is emitted directly from the vehicle exhaust). The emitted NO reacts with oxidants in the air (mainly ozone) to form more NO_2 (known as secondary NO_2). Since the air quality standards/guidelines for the protection of human health are based on NO_2 rather than NOx or NO, a suitable NOx to NO_2 conversion needs to be applied to the modelled NOx concentrations.

The NOx to NO_2 conversion has been completed using the NOx to NO_2 tool (version 1.02) developed by WSP on behalf of NZ Transport Agency Waka Kotahi (WSP, 2025c)). Details of the calculations behind this tool can be found in the associated user guide (WSP, 2024b).

3.4 MODEL ASSUMPTIONS

There are uncertainties associated with both measured and predicted concentrations. The model (ADMS-Roads) used in this assessment relied on input data (including predicted traffic flows), which also have uncertainties associated with them. The model itself simplifies complex physical systems into a range of algorithms. In addition, local micro-climatic conditions may affect the concentrations of pollutants that the ADMS-Roads model does not consider.

In order to assess the uncertainty associated with predicted concentrations, model verification has been completed using the project specific NO_2 monitoring data (and adjusted where necessary) to confirm that the model is performing acceptably.

Receptor heights have been assumed at average head height (1.5 m) above the ground height, and locations of receptors and roads within the model have been determined based on georeferenced basemaps.

4 MODEL VERIFICATION

4.1 OVERVIEW

The comparison of modelled concentrations with local monitored concentrations is a process termed '*verification*'. As stated in the Model Verification Guidance (WSP, 2025a):

"*where road traffic emissions factors are estimated, and dispersion models used to simulate the dispersion of those emissions to air, it is important that errors and uncertainty are minimised as much as possible; model verification is a process by which this can be achieved*".

Model verification is the process by which estimates of pollutant concentrations are compared with measurements taken within the study area over the same period modelled. Ideally, the concentrations predicted to occur at the measurement sites should match or be close to the measured concentrations. By systematically comparing a number of paired measured-predicted concentrations, the modelling can be assessed for accuracy, precision and biases that may be caused by the quality or choice of input data or model options, and the model predictions adjusted if needed.

As noted in Section 1.5, the model verification undertaken for this assessment followed the methodology set out in the Model Verification Guidance for detailed assessment of air quality impacts from road transport projects (WSP, 2025a), and used the following associated tools available from the Waka Kotahi NZTA website:

- Verification template (WSP, 2025b);
- NO_x to NO_2 tool (WSP, 2025c); and
- Adjustment template (WSP, 2025d).

4.2 BEFORE ADJUSTMENT

The ADMS-Roads dispersion model was used to predict 2024 annual mean road-NO_X contribution at the 15 project specific diffusion tube monitoring sites located within the modelled road network. The model outputs of road-NO_X were compared with the 'measured' road-NO_x, which was determined from the NO_2 concentrations measured using diffusion tubes at the monitoring locations. NO_X has been converted to NO_2 as explained in Section 3.3, using the NO_2 background concentrations from the four project-specific background monitoring sites. Table 4-1 shows the comparison between total monitored and total modelled NO_2 concentrations before any model adjustment.

Two zones have been defined for the model verification: one for dual carriageway (including DT1 and DT2) and one for all remaining areas modelled. DT11 was removed from the model verification calculations due to a new road development which had been implemented since 2024 near to the monitoring site, which was not reflected in the 2024 traffic modelling network and data, and therefore is not comparable to the monitoring data gathered in 2025.

4.2.1 STATISTICAL PARAMETERS – BEFORE ADJUSTMENT

The Model Verification Guidance (WSP, 2025a) identifies statistical parameters to evaluate model performance and assess the uncertainty of a modelling exercise, to establish the level of confidence in model predictions.

To assess the uncertainty of a model, the Root Mean Square Error (RMSE) is used to provide an estimate of the average error of the model in the same units as the modelled predictions. Ideally an RMSE within 10% of

the air quality guideline or criteria being considered would be derived, which in this instance equates to 3.0 µg/m^3 for the annual mean NO_2 objective for this assessment.

Additionally, the factional bias helps to determine whether the model under- or over-predicts; the ideal value is zero. The correlation coefficient evaluates the linearity in the relationship between predicted and observed data; the ideal correlation value is 1. Table 4-1 provides the statistical parameters before adjustment for the modelling completed.

Table 4-1 Comparison between total monitored and total modelled NO_2 concentrations before adjustment.

Site ID	Monitored total NO_2 concentration ($\mu g/m^3$)	Non-adjusted total modelled NO_2 concentration ($\mu g/m^3$)	Percentage difference before adjustment ([modelled – monitored] / monitored)	Root mean square error (RMSE)	Fractional Bias	Correlation Coefficient
Zone 1						
DT1	22.2	18.7	-15.8 %	4.31	0.20	1.00
DT2	24.0	19.0	-20.8 %			
Zone 2						
DT3	19.7	23.7	20.5 %	1.92	-0.09	0.98
DT4	21.5	24.6	14.4 %			
DT5	10.9	12.1	11.0 %			
DT6	13.4	13.3	-0.7 %			
DT7	10.3	11.0	6.5 %			
DT8	9.4	10.0	5.9 %			
DT9	10.3	11.1	7.4 %			
DT10	8.9	8.9	-0.5 %			
DT12	14.8	15.5	4.4 %			
DT13	12.8	15.5	21.3 %			
DT14	12.9	13.2	2.3 %			
DT15	16.7	20.1	20.2 %			
CoLoc	12.9	12.9	0.4 %			

Figure 4-1 and Figure 4-2 provide the graphical comparison between modelled and monitored concentrations for both zones, based on the data in Table 4-1. Figure 4-1 shows that for DT1 and DT2, the model is underpredicting compared to the monitoring, for all other sites (Figure 4-2) there is a good agreement or the model is slightly overpredicting compared to the monitoring.

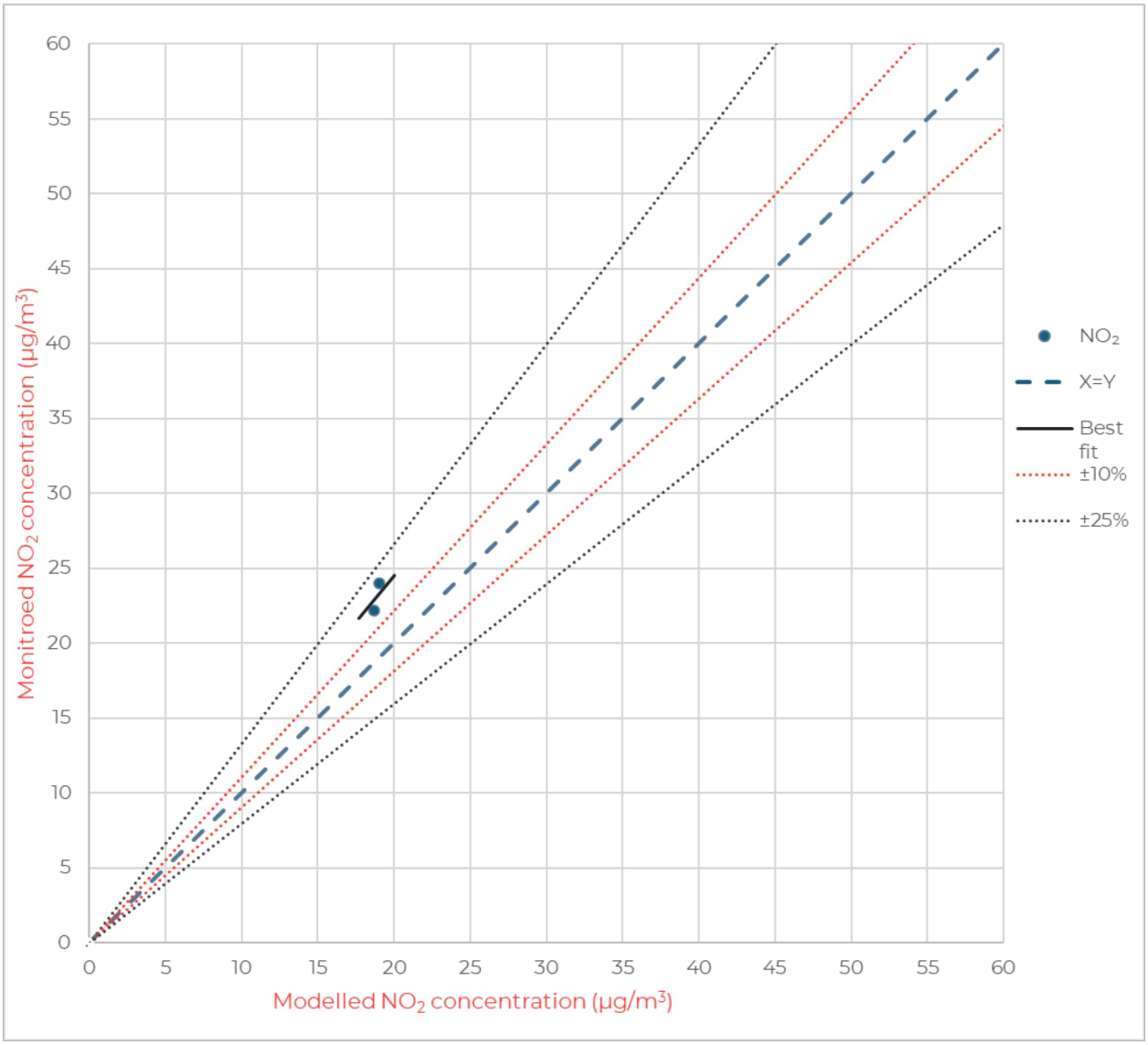


Figure 4-1: Graphical comparison between total monitored and total modelled NO_2 concentrations before adjustment (Zone 1).

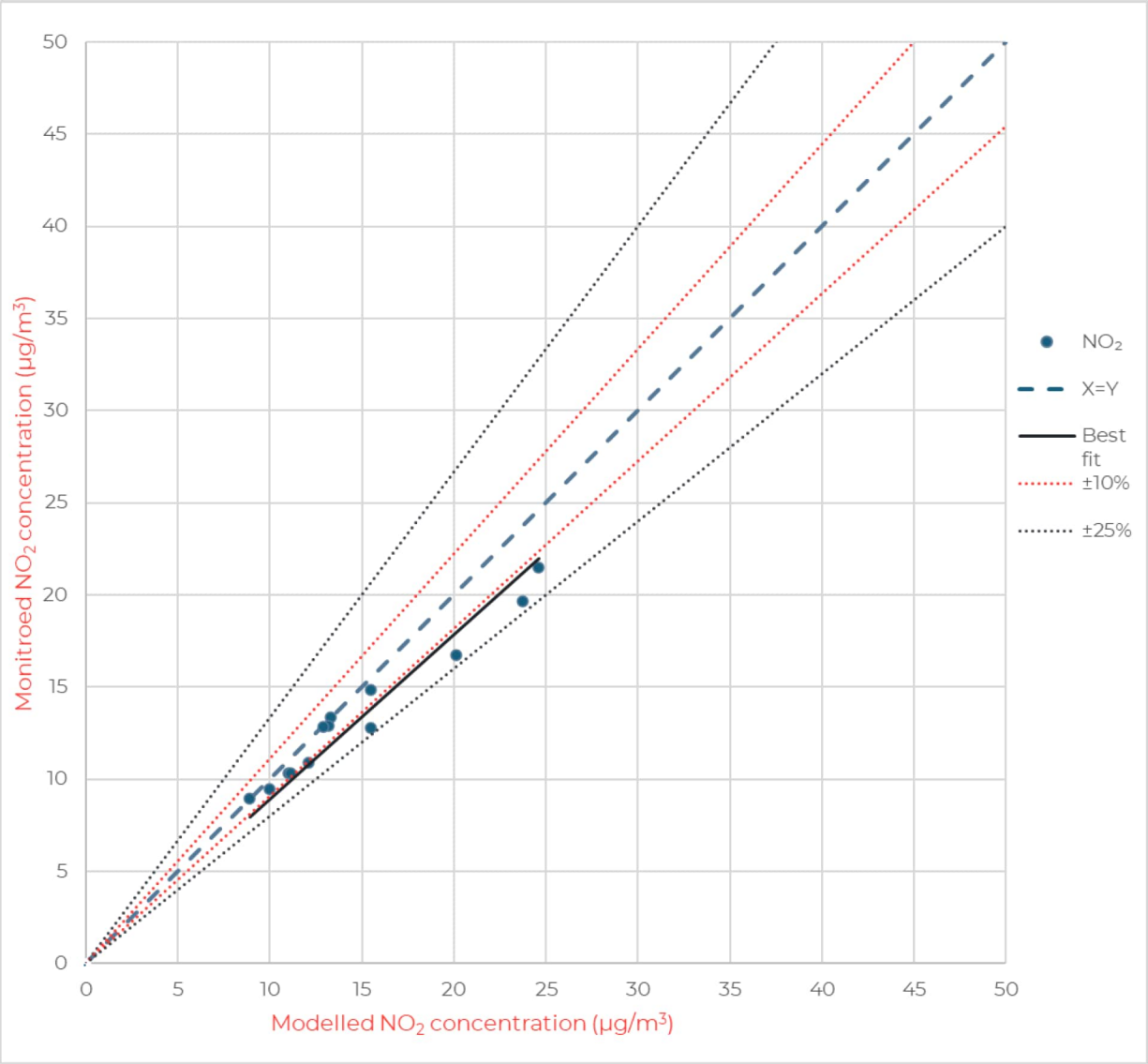


Figure 4-2: Graphical comparison between total monitored and total modelled NO_2 concentrations before adjustment (Zone 2).

4.3 ADJUSTMENT PROCESS

Table 4-2 shows the data used to compare and adjust the Road NO_X contribution. The Road NO_X adjustment factor has been determined by applying a trend line to the plotted results, using the slope of the best fit line between the 'measured' road contribution and the model derived road contribution before adjustment, forced through zero (as shown in Figure 4-3 for Zone 1 and Figure 4-4 for Zone 2).

As for the receptors (noted in Section 3.1.5) Table 4-2 the most representative monitored background concentration (second column in Table 4-2) has been assigned to each diffusion tube site for this assessment's model verification calculations.

Table 4-2 Data used to undertake verification calculations for Road NOx adjustment.

Site ID	Background NO_2 concentration ($\mu g/m^3$)	Non-adjusted modelled road NO_x concentration ($\mu g/m^3$)	Non-adjusted monitored road NO_x concentration ($\mu g/m^3$)	Ratio of monitored road NO_x to modelled road NO_x	Road NO_X Adjustment Factor
Zone 1					
DT1	7.1	35.3	49.3	1.4	1.49
DT2	7.1	36.3	57.3	1.6	
Zone 2					
DT3	7.1	56.0	38.9	0.7	0.76
DT4	6.8	60.7	47.0	0.8	
DT5	6.8	14.0	10.5	0.7	
DT6	6.8	17.6	17.8	1.0	
DT7	6.8	10.9	9.0	0.8	
DT8	6.8	8.0	6.6	0.8	
DT9	6.8	11.0	9.0	0.8	
DT10	6.1	6.8	7.0	1.0	
DT12	6.1	26.3	24.1	0.9	
DT13	6.1	26.2	17.7	0.7	
DT14	6.1	19.1	18.1	0.9	
DT15	6.1	42.9	30.4	0.7	
CoLoc	6.1	18.2	17.9	1.0	

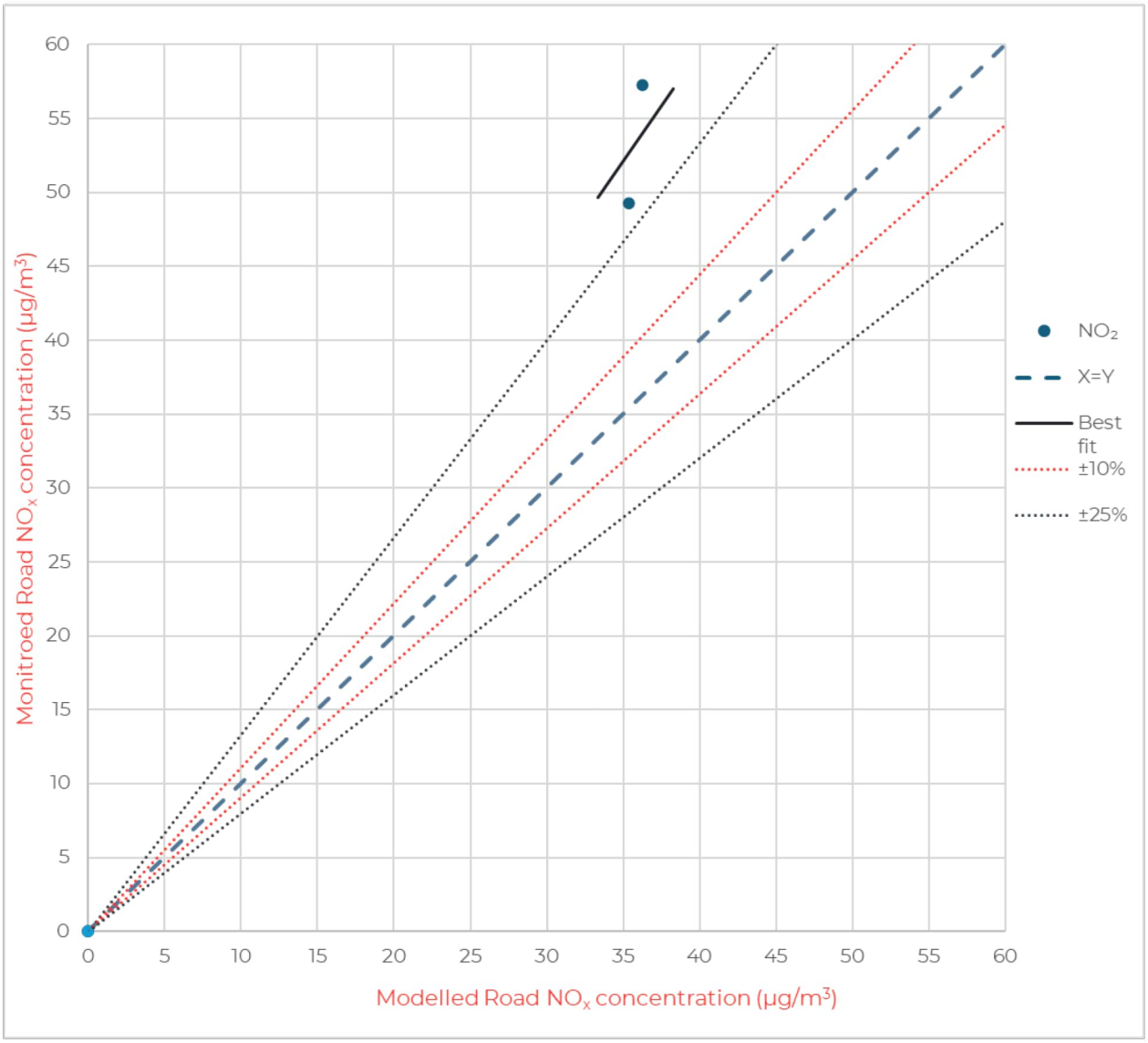


Figure 4-3: Graphical comparison between monitored Road NOx and modelled Road NOx before adjustment (Zone 1).

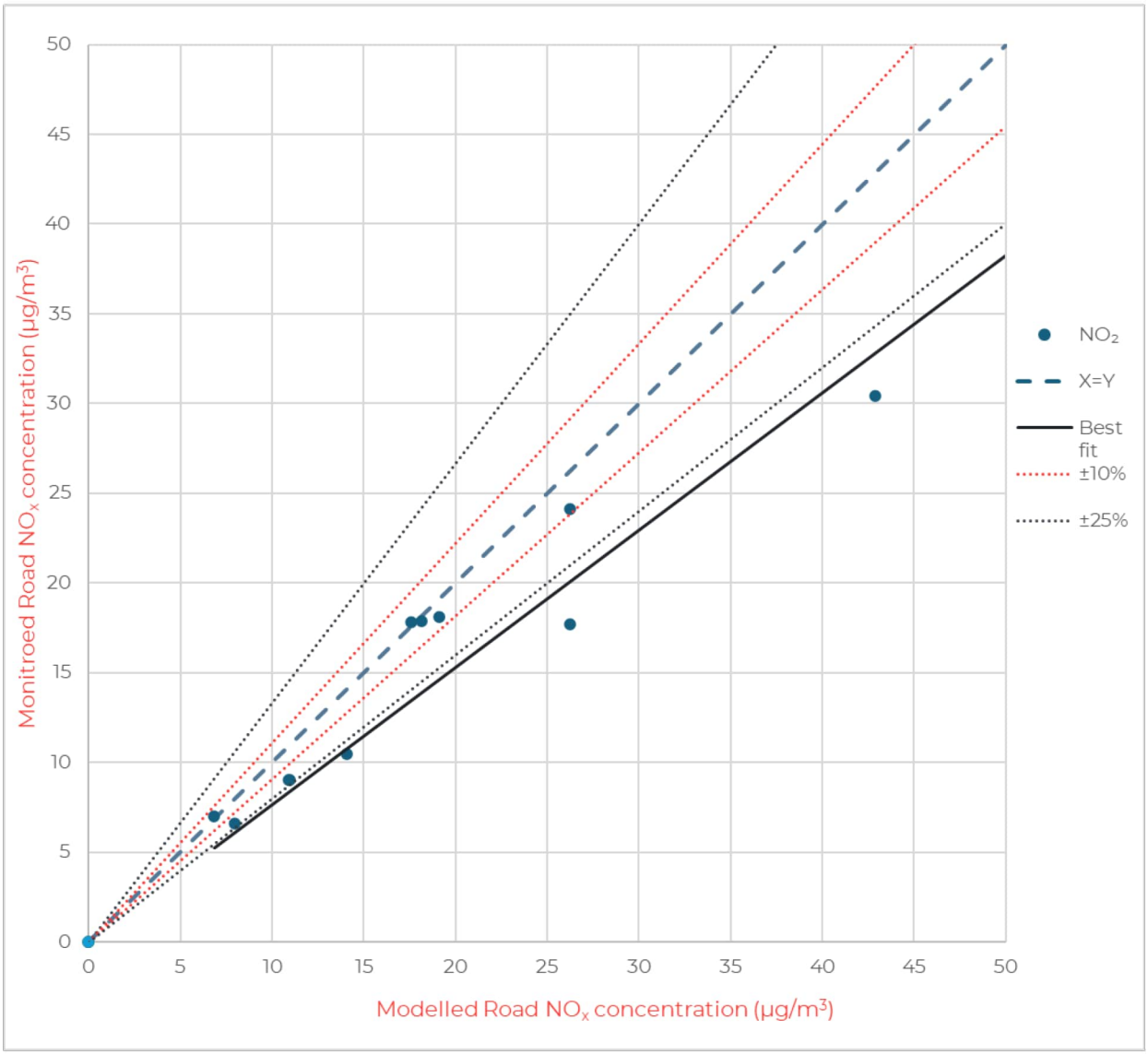


Figure 4-4: Graphical comparison between monitored Road NOx and modelled Road NOx before adjustment (Zone 2).

These factors have been applied to the modelled Road NO_X concentration for each monitoring site within each zone, to provide adjusted modelled Road NO_X concentrations. The total nitrogen dioxide concentrations have been determined by inputting the adjusted modelled Road NO_X concentrations and the background NO_2 concentration to the NO_X to NO_2 tool (WSP, 2025c)).

As sufficient local roadside monitoring data are not available for PM_{10} or $PM_{2.5}$, the modelled road-PM_{10} and road-$PM_{2.5}$ components have been adjusted using the verification factors determined for adjusting the Road NO_X contribution, before adding to the appropriate background concentrations. This follows advice from Defra's technical guidance (Department for Environment, Food and Rural Affairs, 2022), and the Model Verification Guidance (WSP, 2025a) which states that "*In the absence of sufficient monitoring data, the adjustment factor for modelled road NOx can be applied to modelled road contributions of particulate matter*".

4.4 AFTER ADJUSTMENT

Once the adjustment factors have been applied to the modelled Road NO_X contributions, the values and statistical parameters are recalculated (as presented in Table 4-3, Figure 4-5 and Figure 4-6).

Table 4-3 Comparison between total monitored and adjusted total modelled NO_2 concentrations.

Site ID	Monitored total NO_2 concentration ($\mu g/m^3$)	Non-adjusted modelled road NO_x concentration ($\mu g/m^3$)	Adjusted modelled road NO_x concentration ($\mu g/m^3$)	Adjusted total modelled NO_2 concentration ($\mu g/m^3$)	Percentage difference after adjustment ([modelled – monitored] / monitored)	Root mean square error (RMSE)	Fractional Bias	Correlation Coefficient
Zone 1								
DT1	22.2	35.3	52.6	23.0	3.6 %	0.74	0.00	1.00
DT2	24.0	36.3	54.0	23.3	-2.9 %			
Zone 2								
DT3	19.7	56.0	42.8	20.6	4.8 %	0.86	0.02	0.98
DT4	21.5	60.7	46.4	21.4	-0.5 %			
DT5	10.9	14.0	10.7	11.0	0.9 %			
DT6	13.4	17.6	13.4	11.9	-11.1 %			
DT7	10.3	10.9	8.3	10.1	-2.2 %			
DT8	9.4	8.0	6.1	9.3	-1.6 %			
DT9	10.3	11.0	8.4	10.1	-2.3 %			
DT10	8.9	6.8	5.2	8.3	-7.2 %			
DT12	14.8	26.3	20.1	13.6	-8.4 %			
DT13	12.8	26.2	20.1	13.6	6.4 %			
DT14	12.9	19.1	14.6	11.7	-9.3 %			
DT15	16.7	42.9	32.8	17.4	4.1 %			
CoLoc	12.9	18.2	13.9	11.5	-10.5 %			

Figure 4-5 and Figure 4-6 provide the graphical comparison between modelled and monitored concentrations for both zones, based on the data in Table 4-3.

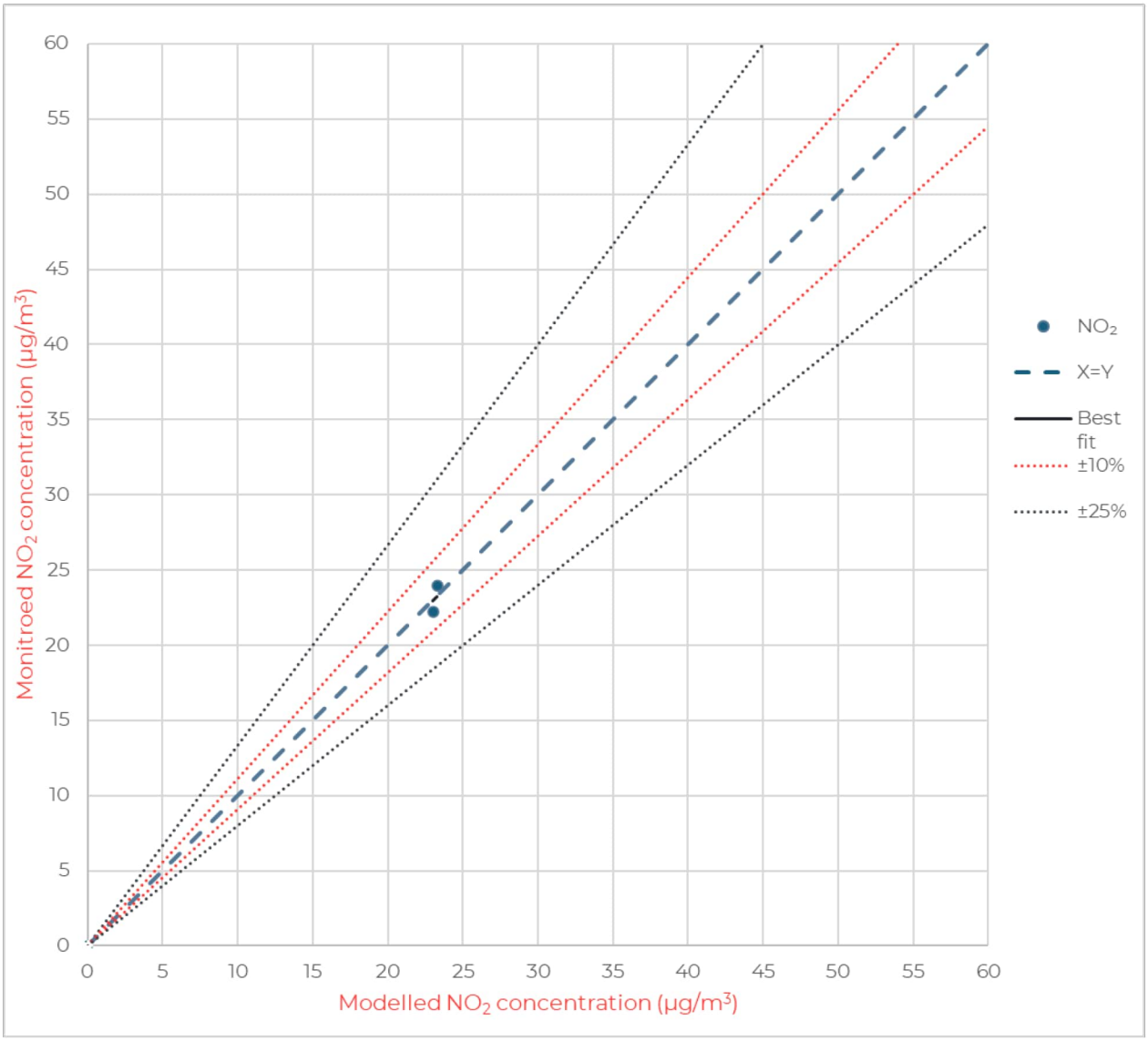


Figure 4-5: Graphical comparison between total monitored and adjusted total modelled NO_2 concentrations (Zone 1).

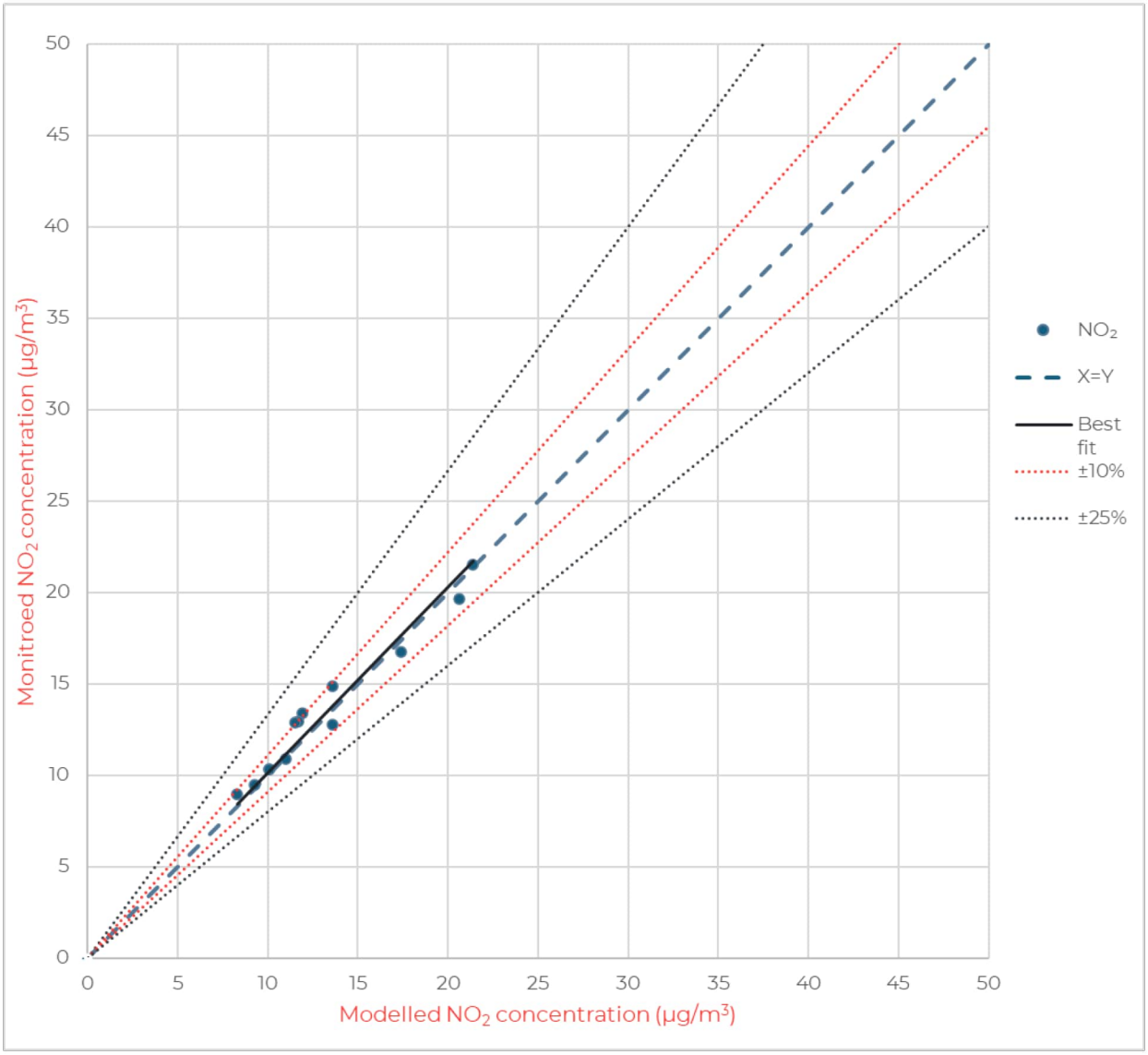


Figure 4-6: Graphical comparison between total monitored and adjusted total modelled NO_2 concentrations (Zone 2).

4.4.1 STATISTICAL PARAMETERS – AFTER ADJUSTMENT

The RMSE values calculated after verification and adjustment are 0.74 µg/m^3 for Zone 1 and 0.86 µg/m^3 for Zone 2. Both RMSE values are less than 3 µg/m^3, and all but two data points are within +/- 10 % with no systematic under-/over prediction.

The factional bias calculated after verification and adjustment is 0.00 for Zone 1 and 0.02 for Zone 2 (ideal value is zero) and the correlation coefficient is 1.00 for Zone 1 and 0.98 for Zone 2 (ideal value is 1). Therefore, the final predictions are considered to be robust.

The adjustment factors derived (1.49 for Zone 1 and 0.76 for Zone 2) would normally then be applied to all modelled NO_x concentrations in each zone before using the NO_x to NO_2 Tool (WSP, 2025c) to predict total NO_2 concentrations for modelled receptor locations. However, given the analysis shows that there are both slight under- and slight over- predictions when comparing the modelled to the monitored values, to provide conservative estimates of total concentrations within Zone 2 (where the calculated adjustment factor of 0.76 would reduce the predicted total concentration) no factor has been applied.

5 PREDICTED POLLUTANT CONCENTRATIONS

5.1 NITROGEN DIOXIDE CONCENTRATIONS

The predicted NO_2 concentrations at each of the selected sensitive receptors are presented in Appendix B, Table B.1. The percentage comparison against the annual mean guideline value (30 µg/m^3) is shown in the last column. Figures 5-1 through 5-8 are shown in Appendix C.

5.1.1 MANGAHARAKEKE STUDY AREA

Of the 10 sensitive receptors modelled in the Mangaharakeke study area, there are no predicted exceedances of the annual mean NO_2 guideline value of 30 µg/m^3. The highest NO_2 concentration (29.0 µg/m^3, 21.9 µg/m^3 of which is attributed to the road source) is predicted at Receptor 108 a residential property at 4 Lugton Street, Nawton, Hamilton 3200 (9.6 m from the modelled road edge). The annual average daily traffic (AADT) flow on Mangaharakeke drive alongside this receptor is 44,514 with a HCV proportion of 14 %. A one-sided street canyon was used to represent the noise barrier in this location, to account for the effect the barrier would have on dispersion.

Figure 5-1 shows the predicted annual average NO_2 concentrations for the Mangaharakeke study area.

5.1.2 TE RAPA STUDY AREA

Of the 11 sensitive receptors modelled in the Te Rapa study area, there are no predicted exceedances of the annual mean NO_2 guideline value of 30 µg/m^3. The highest NO_2 concentration (29.5 µg/m^3, of which 22.7 µg/m^3 is attributed to the road source) is predicted at Receptor 103, a residential property at 150 Te Rapa Road, Beerescourt, Hamilton 3200 (3.3 m from the modelled road edge). Te Rapa Road alongside this receptor has an AADT flow of 27,663 and a HCV proportion of 7 %. A one-sided street canyon was used in this location to account for the effect that the nearby residential buildings would have on dispersion.

Figure 5-2 shows the predicted annual average NO_2 concentrations for the Te Rapa study area.

5.1.3 RUAKURA STUDY AREA

Of the 18 sensitive receptors modelled in the Ruakura study area, there are no predicted exceedances of the annual mean NO_2 guideline value of 30 µg/m^3. The highest NO_2 concentration (12.0 µg/m^3, 5.2 µg/m^3 of which is attributed to the road source) is predicted at Receptor 34 (Vision College at 21 Ruakura Road Hamilton East, Hamilton 3216) (4.1 m from the modelled road edge). Ruakura road, which is closest to this receptor, has a total AADT flow of 14,007 with a HCV proportion of 5 %.

Figure 5-3 and Figure 5-4 shows the predicted annual average NO_2 concentration for the Ruakura study area.

5.1.4 CAMBRIDGE STUDY AREA

Of the 36 sensitive receptors modelled in the Cambridge study area, there are no predicted exceedances of the annual mean NO_2 guideline value of 30 µg/m^3. The highest NO_2 concentration (21.3 µg/m^3, of which 15.2 µg/m^3 is attributed to the road source) is predicted at Receptor 84, a residential property at 365A Cobham Drive, Hillcrest, Hamilton 3216 (3.7 m from the modelled road edge). Cobham drive, which is closest to this receptor, has a total flow of 27,795 with a HCV proportion of 12 %.

Figure 5-5 and Figure 5-6 shows the predicted annual average NO_2 concentration for the Cambridge study area.

5.1.5 OHAUPO STUDY AREA

Of the 37 sensitive receptors modelled in the Ohaupo study area, there are no predicted exceedances of the annual mean NO_2 guideline value of 30 µg/m^3. The highest NO_2 concentration (19.8 µg/m^3, of which 13.7 µg/m^3 is attributed to the road source) is predicted at Receptor 50, a residential property at 10 Kahikatea Drive, Kinloch, Hamilton 3377 (6.2 m from the modelled road edge). Kahikatea drive, which is closest to this receptor, has a total AADT flow of 29,583 with a HCV proportion of 15 %.

Figure 5-7 and Figure 5-8 shows the predicted annual average NO_2 concentration for the Ohaupo study area.

5.2 PARTICULATE MATTER (PM_{10}) CONCENTRATIONS

The predicted PM_{10} concentrations at each of the selected sensitive receptors are presented in Appendix B, Table B.2. The percentage comparison against the annual mean guideline value (20 µg/m^3) is shown in the last column. Figures 5-9 through 5-16 are shown in Appendix C.

5.2.1 MANGAHARAKEKE STUDY AREA

Of the 10 sensitive receptors modelled in the Mangaharakeke study area, there are no predicted exceedances of the annual mean PM_{10} guideline value of 20 µg/m^3. The highest PM_{10} concentration (17.8 µg/m^3, of which 5.0 µg/m^3 is attributed to the road source) is predicted at Receptor 108, a residential property at 4 Lugton Street, Nawton, Hamilton 3200 (9.6 m from the modelled road edge). The annual average daily traffic (AADT) flow on Mangaharakeke drive alongside this receptor is 44,514 with a HCV proportion of 14 %. A one-sided street canyon was used to represent the noise barrier in this location, to account for the effect the barrier would have on dispersion.

Figure 5-9 shows the predicted annual average PM_{10} concentration for the Mangaharakeke study area.

5.2.2 TE RAPA STUDY AREA

Of the 11 sensitive receptors modelled in the Te Rapa study area, there are no predicted exceedances of the annual mean PM_{10} guideline value of 20 µg/m^3. The highest PM_{10} concentration (16.8 µg/m^3, of which 4.0 µg/m^3 is attributed to the road source) is predicted at Receptor 103 and Receptor 104, residential properties at 150 Te Rapa Road, Beerescourt, Hamilton 3200 (3.3 m and 4.0 m respectively from the modelled road edge). Te Rapa Road alongside this receptor has an AADT of 27,663 and a HCV proportion of 7 %. A one-sided street canyon was used in this location to account for the effect that the nearby residential buildings would have on dispersion.

Figure 5-10 shows the predicted annual average PM_{10} concentration for the Te Rapa study area.

5.2.3 RUAKURA STUDY AREA

Of the 18 sensitive receptors modelled in the Ruakura study area, there are no predicted exceedances of the annual mean PM_{10} guideline value of 20 µg/m^3. The highest PM_{10} concentration (13.8 µg/m^3, of which 1.1 µg/m^3 is attributed to the road source) is predicted at Receptor 34 (Vision College at 21 Ruakura Road Hamilton East, Hamilton 3216, 4.1 m from the modelled road edge) and Receptor 92 (a residential property on Ruakura Road, Hamilton East, Hamilton 3216, 4.6 m from the modelled road edge). Ruakura road, which is closest to Receptor 34, has a total AADT flow of 14,007 with a HCV proportion of 5 %, and there is a total flow of 15,021 with a HCV proportion of 5 % on Ruakura road, which is closest to Receptor 92.

Figure 5-11 and Figure 5-12 shows the predicted annual average PM_{10} concentration for the Ruakura study area.

5.2.4 CAMBRIDGE STUDY AREA

Of the 36 sensitive receptors modelled in the Cambridge study area, there are no predicted exceedances of the annual mean PM_{10} guideline value of 20 µg/m^3. The highest PM_{10} concentration (15.2 µg/m^3, of which 2.6 µg/m^3 is attributed to the road source) is predicted at Receptor 84 (a residential property at 365A Cobham Drive, Hillcrest, Hamilton 3216, 3.7 m from the modelled road edge) and Receptor 85 (a residential property at 369 Cobham Drive, Hillcrest, Hamilton 3216, 4.1 m from the modelled road edge). Cobham drive, which is closest to Receptor 84 and 85, has a total flow of 27,795 with a HCV proportion of 12 %.

Figure 5-13 and Figure 5-14 shows the predicted annual average PM_{10} concentration for the Cambridge study area.

5.2.5 OHAUPO STUDY AREA

Of the 37 sensitive receptors modelled in the Ohaupo study area, there are no predicted exceedances of the annual mean PM_{10} guideline value of 20 µg/m^3. The highest PM_{10} concentration (15.3 µg/m^3, of which 2.6 µg/m^3 is attributed to the road source) is predicted at Receptor 50, a residential property at 10 Kahikatea Drive, Kinloch, Hamilton 3377 (6.2 m from the modelled road edge). Kahikatea drive, which is closest to this receptor, has a total AADT flow of 29,583 with a HCV proportion of 15 %.

Figure 5-15 and Figure 5-16 shows the predicted annual average PM_{10} concentration for the Ohaupo study area.

5.3 FINE PARTICULATE MATTER ($PM_{2.5}$) CONCENTRATIONS

The predicted $PM_{2.5}$ concentrations at each of the selected sensitive receptors is presented in Appendix B, Table B.3. The percentage comparison against the annual mean guideline value (10 µg/m^3) is shown in the last column. Figures 5-17 through 5-24 are shown in Appendix C.

5.3.1 MANGAHARAKEKE STUDY AREA

Of the 10 sensitive receptors modelled in the Mangaharakeke study area, there are no predicted exceedances of the annual mean $PM_{2.5}$ guideline value of 10 µg/m^3. The highest $PM_{2.5}$ concentration (9.7 µg/m^3, of which 3.3 µg/m^3 is attributed to the road source) is predicted at Receptor 108, a residential property at 4 Lugton Street, Nawton, Hamilton 3200 (9.6 m from the modelled road edge). The annual average daily traffic (AADT) flow on Mangaharakeke drive road, which is closest to this receptor is 44,514 with a HCV proportion of 14 %. A one-sided street canyon was used to represent the noise barrier in this location, to account for the effect the barrier would have on dispersion.

Figure 5-17 shows the predicted annual average $PM_{2.5}$ concentration for the Mangaharakeke study area.

5.3.2 TE RAPA STUDY AREA

Of the 11 sensitive receptors modelled in the Te Rapa study area, there are no predicted exceedances of the annual mean $PM_{2.5}$ guideline value of 10 µg/m^3. The highest $PM_{2.5}$ concentration (9.1 µg/m^3, of which 2.7 µg/m^3 is attributed to the road source) is predicted at Receptor 103 and Receptor 104, residential properties at 150 Te Rapa Road, Beerescourt, Hamilton 3200 (3.3 m and 4.0 m respectively from the modelled road edge). The AADT flow on the Te Rapa Road alongside this receptor is 27,663 and a HCV proportion of 7 %. A one-sided street canyon was used in this location to account for the effect that the nearby residential buildings would have on dispersion.

Figure 5-18 shows the predicted annual average $PM_{2.5}$ concentration for the Te Rapa study area.

5.3.3 RUAKURA STUDY AREA

Of the 18 sensitive receptors modelled in the Ruakura study area, there are no predicted exceedances of the annual mean $PM_{2.5}$ guideline value of 10 µg/m^3. The highest $PM_{2.5}$ concentration (7.1 µg/m^3, of which 0.7 µg/m^3 is attributed to the road source) is predicted at Receptor 34 (Vision College at 21 Ruakura Road Hamilton East, Hamilton 3216 (4.1 m from the modelled road edge). Ruakura road, which is closest to this receptor, has a total flow of 14,007 with a HCV proportion of 5 %.

Figure 5-19 and Figure 5-20 shows the predicted annual average $PM_{2.5}$ concentration for the Ruakura study area.

5.3.4 CAMBRIDGE STUDY AREA

Of the 36 sensitive receptors modelled in the Cambridge study area, there are no predicted exceedances of the annual mean $PM_{2.5}$ guideline value of 10 µg/m^3. The highest $PM_{2.5}$ concentration (8.1 µg/m^3, of which 1.7 µg/m^3 is attributed to the road source) is predicted at four receptors which are all a similar distance from the main Cobham Drive (all approximately 4 m from modelled road edge); Receptor 8 (a residential property at 1 Johnsview Terrace Hillcrest Hamilton 3216), Receptor 82 (a residential property at 384 Cobham Drive, Hillcrest, Hamilton 3216, Receptor 84 (a residential property at 365A Cobham Drive, Hillcrest, Hamilton 3216, 3.7 m from the modelled road edge) and Receptor 85 (a residential property at 369 Cobham Drive, Hillcrest, Hamilton 3216, 4.1 m from the modelled road edge). The AADT flow on Cobham drive is 27,795 with a HCV proportion of 12 %.

Figure 5-21 and Figure 5-22 shows the predicted annual average $PM_{2.5}$ concentration for the Cambridge study area.

5.3.5 OHAUPO STUDY AREA

Of the 37 sensitive receptors modelled in the Ohaupo study area, there are no predicted exceedances of the annual mean $PM_{2.5}$ guideline value of 10 µg/m^3. The highest PM_{10} concentration (8.1 µg/m^3, 1.7 µg/m^3 of which is attributed to the road source) is predicted at Receptor 50, a residential property at 10 Kahikatea Drive, Kinloch, Hamilton 3377 (6.2 m from the modelled road edge). Kahikatea drive, which is closest to this receptor, has a total flow of 29,583 with a HCV proportion of 15 %.

Figure 5-23 and Figure 5-24 shows the predicted annual average $PM_{2.5}$ concentration for the Ohaupo study area.

6 CONCLUSION

This report presents the outcomes of a detailed dispersion assessment of road traffic for five key areas in Hamilton. Project-specific nitrogen dioxide monitoring was deployed to gain an appropriate dataset with which to undertake model verification, and the ADMS-Roads detailed dispersion model was used to predict annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations at selected receptors across the wider study area.

The assessment compared the modelled results with the following annual mean guidelines:

- 30 µg/m^3 for NO_2 (RAAQG);
- 20 µg/m^3 for PM_{10} (AAQG); and
- 10 µg/m^3 for $PM_{2.5}$ (proposed NESAQ).

The model results show that there are no exceedances of current annual mean guidelines predicted to occur at representative breathing height (1.5 m above ground) within the study area.

Of the 112 sensitive receptors modelled, the highest predicted concentration for NO_2 (29.5 µg/m^3) was at Receptor 103 (a residential property on Te Rapa Road, Beerescourt, Hamilton 3200, 3.3 m from the modelled road edge). This is close to the RAAQG of 30 µg/m^3, which indicates that there is the potential for future changes in flow patterns (i.e. increased congestion) or growth in the area (i.e. increased traffic flows) to result in concentrations above the RAAQG, should improvements in emission rates over time not offset the increase in overall emissions due to growth.

The highest predicted concentrations for PM_{10} (17.8 µg/m^3) and $PM_{2.5}$ (9.7 µg/m^3) were both at Receptor 108 (a residential property at 4 Lugton Street, Nawton, Hamilton 3200, 9.6 m from the modelled road edge). These predictions are within 11% and 3% of the relevant AAQG and proposed NESAQ, highlighting again that any growth in the area or change to traffic pattens could result in concentrations above the relevant guidelines and objective values.

Section 3.2 outlined that the highest predicted concentrations are expected to be closest to the road edge, with concentrations reducing with distance away from the road source. This can be observed within the contour plots in Appendix C which generally show higher concentrations closer to the roads.

However, other local factors such as street canyons, high HCV emissions or road gradients can impact the drop off with distance that occurs, and so in some locations concentrations remain higher further from a road where dispersion is limited or emissions are elevated.

Based on the results from this study, recommendations for further work therefore include:

— Consideration of growth scenarios for future years, to understand whether the increase in flow or congestion due to growth will offset forecast rates of vehicle emissions improvements.

— Expand the modelling to the other key junctions experiencing congestion, high flows or high HCV proportions, and

— Consider the potential for improvements from any modal shift anticipated due to improvements in public transport.

— Consideration of other areas of the city where dispersion may be being impacted by street canyons, where development may lead to future canyoning, or other physical features.

— Consideration of any large proposed developments or zoning that could impact traffic through the city.

7 LIMITATIONS

This report (‘Report’) has been prepared by WSP New Zealand Limited (‘WSP’) exclusively for Waikato Regional Council (‘Client’) in relation to Hamilton monitoring and detailed dispersion traffic modelling assessment (‘Purpose’) and in accordance with the Form of Instruction for Service with the Client dated 15th July 2024 (‘Agreement’). The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

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APPENDIX A

SENSITIVE RECEPTORS

Table A. 1 Modelled sensitive receptors

Receptor ID	Site type	Closest address	X co-ordinate	Y co-ordinate	Approximate distance to modelled road edge (m)
Mangaharakeke study area					
23	Residential	2 Breckons Avenue Nawton Hamilton 3200	1797233	5817282	8.0
24	Residential	143A Avalon Drive Nawton Hamilton 3200	1797177	5817388	6.8
25	Residential	2A Rotokauri Road, Nawton, Hamilton 3200	1797157	5817429	15.6
37	Residential	10 Lugton Street Nawton Hamilton 3200	1797118	5817523	8.5
107	Residential	8 Lugton Street, Nawton, Hamilton 3200	1797127	5817504	8.3
108	Residential	4 Lugton Street, Nawton, Hamilton 3200	1797143	5817471	9.6
109	Residential	143A Avalon Drive, Nawton, Hamilton 3200	1797191	5817378	7.1
110	Residential	141 Avalon Drive, Nawton, Hamilton 3200	1797199	5817359	13.8
111	Residential	2B Rotokauri Road, Nawton, Hamilton 3200	1797154	5817446	17.1
112	Residential	Rotokauri Road, Nawton, Hamilton 3200	1797153	5817397	9.2
Te Rapa study area					
17	Residential	409 Ulster Street Beerescourt Hamilton 3200	1799357	5817040	4.2
18	Frankton Park Ltd Disability services & support organisation	1327 Victoria Street Beerescourt Hamilton 3200	1799560	5817186	4.7
19	Residential	37A Maeroa Road Beerescourt Hamilton 3200	1799380	5817046	3.7
20	Residential	1 Forest Lake Road Forest Lake Hamilton 3200	1799234	5817337	5.9
21	Residential	1368 Victoria Street Beerescourt Hamilton 3200	1799328	5817339	4.0
22	Barnardos Early Learning Centre Te Rapa	1 Storey Avenue Forest Lake Hamilton 3200	1799055	5817582	4.3

Receptor ID	Site type	Closest address	X co-ordinate	Y co-ordinate	Approximate distance to modelled road edge (m)
36	Residential	1370 Victoria Street Beerescourt Hamilton 3200	1799309	5817357	4.4
103	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	1799289	5817391	3.3
104	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	1799299	5817373	4.0
105	Residential	156 Te Rapa Road, Beerescourt, Hamilton 3200	1799273	5817416	2.6
106	Residential	457A Ulster Street, Maeroa, Hamilton 3200	1799288	5817302	3.3
Ruakura study area					
12	Residential	135 Peachgrove Road Hamilton East Hamilton 3216	1802398	5816051	3.2
13	Residential	371 Dey Street Hamilton East Hamilton 3216	1802869	5815399	5.1
14	Residential	Near to 26 Finchley Place Hamilton East Hamilton 3216	1802834	5815961	13.6
15	Residential	Ruakura Road Hamilton East Hamilton 3216	1802769	5815984	13.4
16	Green Forest Chinese Medical Centre	99 Te Aroha Street Claudelands Hamilton 3216	1802390	5816093	6.0
34	Vision College	21 Ruakura Road Hamilton East, Hamilton 3216	1802543	5816073	4.1
35	Bethel Hamilton Fellowship Church	Cameron Road Hamilton East Hamilton 3216	1803211	5815671	6.6
92	Residential	Ruakura Road, Hamilton East, Hamilton 3216	1802738	5816000	4.6
93	Residential	28 Finchley Place, Hamilton East, Hamilton 3216	1802832	5815942	21.8
94	Residential	Ruakura Road, Hamilton East, Hamilton 3216	1802775	5815953	12.8
95	Residential	144 Peachgrove Road, Hamilton East, Hamilton 3216	1802445	5816097	8.5
96	Residential	143 Peachgrove Road, Hamilton East, Hamilton 3216	1802404	5816115	5.7
97	Residential	118 Peachgrove Road, Hamilton East, Hamilton 3216	1802420	5816056	6.3
98	Residential	146 Peachgrove Road, Hamilton East, Hamilton 3216	1802428	5816135	6.2
99	Residential	145 Peachgrove Road, Hamilton East, Hamilton 3216	1802409	5816142	4.7

Receptor ID	Site type	Closest address	X co-ordinate	Y co-ordinate	Approximate distance to modelled road edge (m)
100	Residential	114 Peachgrove Road, Hamilton East, Hamilton 3216	1802416	5816021	6.5
101	Residential	369 Dey Street, Hamilton East, Hamilton 3216	1802874	5815382	5.0
102	Residential	73 Old Farm Road, Hamilton East, Hamilton 3216	1802879	5815363	4.7
Cambridge study area					
6	Residential	277 Cambridge Road Hillcrest Hamilton 3216	1804535	5813674	4.1
7	Residential	198 Cambridge Road Hillcrest Hamilton 3216	1804153	5813745	4.5
8	Residential	1 Johnsview Terrace Hillcrest Hamilton 3216	1804071	5813663	3.8
9	Aro Manawa heart health	153 Cambridge Road Hillcrest Hamilton 3216	1803945	5813920	5.0
10	Residential	158A Cambridge Road Hillcrest Hamilton 3216	1803933	5813896	9.6
11	Residential	257 Cambridge Road Hillcrest Hamilton 3216	1804478	5813750	10.4
28	Riverlea Kindergarten/Hillcrest Normal School	218 Cambridge Road Hillcrest Hamilton 3216	1804370	5813725	4.1
29	Grace Church Hamilton	Hillcrest Normal School 218 Cambridge Road Hillcrest Hamilton 3216	1804273	5813731	6.6
30	Residential	48A Howell Avenue Riverlea Hamilton 3216	1804224	5813354	4.4
31	Bella Dental	310 Cambridge Road Hillcrest Hamilton 3216	1804647	5813424	6.3
32	Swift Horse Cram School	53 Morrinsville Road Hillcrest Hamilton 3216	1804865	5813883	6.7
33	Residential	1 Morris Road Hillcrest Hamilton 3216	1804818	5813869	5.5
68	Residential	1 Morrinsville Road, Hillcrest, Hamilton 3216	1804506	5813756	6.4
69	Residential	3 Morrinsville Road, Hillcrest, Hamilton 3216	1804518	5813760	7.1
70	Residential	5 Morrinsville Road, Hillcrest, Hamilton 3216	1804538	5813767	7.0
71	Residential	243 Cambridge Road, Hillcrest, Hamilton 3216	1804435	5813752	9.6
72	Residential	4 Morrinsville Road, Hillcrest, Hamilton 3216	1804536	5813734	8.2

Receptor ID	Site type	Closest address	X co-ordinate	Y co-ordinate	Approximate distance to modelled road edge (m)
73	Residential	46 Morrinsville Road, Hillcrest, Hamilton 3216	1804842	5813843	9.7
74	Residential	48A Morrinsville Road, Hillcrest, Hamilton 3216	1804855	5813847	9.7
75	Residential	40 Morrinsville Road, Hillcrest, Hamilton 3216	1804819	5813835	9.3
76	Residential	2 Berkley Avenue, Hillcrest, Hamilton 3216	1804876	5813855	9.7
77	Residential	201 Cambridge Road, Hillcrest, Hamilton 3216	1804189	5813773	11.0
78	Residential	207 Cambridge Road, Hillcrest, Hamilton 3216	1804207	5813769	6.0
79	Residential	208 Cambridge Road, Hillcrest, Hamilton 3216	1804200	5813734	4.2
80	Residential	212 Cambridge Road, Hillcrest, Hamilton 3216	1804218	5813734	6.8
81	Residential	Milburn Lane, Hillcrest, Hamilton 3216	1804175	5813723	3.6
82	Residential	384 Cobham Drive, Hillcrest, Hamilton 3216	1804155	5813712	3.8
83	Residential	360 Cobham Drive, Hillcrest, Hamilton 3216	1804056	5813651	3.9
84	Residential	365A Cobham Drive, Hillcrest, Hamilton 3216	1804056	5813685	3.7
85	Residential	369 Cobham Drive, Hillcrest, Hamilton 3216	1804072	5813694	4.1
86	Residential	353 Cobham Drive, Hillcrest, Hamilton 3216	1804024	5813667	4.1
87	Residential	312 Cobham Drive, Hillcrest, Hamilton 3216	1803809	5813517	3.1
88	Residential	310 Cobham Drive, Hillcrest, Hamilton 3216	1803792	5813508	3.3
89	Residential	313 Cobham Drive, Hillcrest, Hamilton 3216	1803786	5813534	4.4
90	Residential	311 Cobham Drive, Hillcrest, Hamilton 3216	1803772	5813529	4.4
91	Residential	315 Cobham Drive, Hillcrest, Hamilton 3216	1803802	5813542	4.0
Ohaupo study area					
1	Residential	1 Mount View Road Melville Hamilton 3206	1800895	5812576	5.6

Receptor ID	Site type	Closest address	X co-ordinate	Y co-ordinate	Approximate distance to modelled road edge (m)
2	Residential	78 Ohaupo Road Melville Hamilton 3206	1800868	5812635	7.4
3	Residential	4 Normandy Avenue Melville Hamilton 3206	1800933	5812649	7.3
4	Residential	58 Ohaupo Road Melville Hamilton 3206	1800803	5812776	4.8
5	Melville Methodist Church	2 Bader Street Fitzroy Hamilton 3206	1801285	5812940	5.1
26	Braemar Hospital	28 Ohaupo Road, Hamilton Lake, Hamilton 3204	1800717	5813044	3.4
27	Melville Primary School	101 Ohaupo Road Melville Hamilton 3206	1800973	5812365	7.6
38	Residential	80 Ohaupo Road, Melville, Hamilton 3206	1800882	5812605	9.1
39	Residential	76A Ohaupo Road, Melville, Hamilton 3206	1800860	5812652	6.9
40	Residential	74 Ohaupo Road, Melville, Hamilton 3206	1800851	5812671	6.5
41	Residential	67 Ohaupo Road, Melville, Hamilton 3206	1800872	5812702	13.7
42	Residential	63 Ohaupo Road, Melville, Hamilton 3206	1800853	5812726	7.7
43	Residential	6 Normandy Avenue, Melville, Hamilton 3206	1800958	5812665	4.1
44	Residential	10 Normandy Avenue, Melville, Hamilton 3206	1800977	5812673	4.2
45	Residential	7 Normandy Avenue, Melville, Hamilton 3206	1800953	5812690	4.8
46	Residential	2C Beatty Street, Melville, Hamilton 3206	1800813	5812813	7.2
47	Residential	55A Ohaupo Road, Melville, Hamilton 3206	1800825	5812787	8.4
48	Residential	52A Ohaupo Road, Melville, Hamilton 3206	1800772	5812851	6.6
49	Residential	1 Beatty Street, Melville, Hamilton 3206	1800799	5812846	6.9
50	Residential	10 Kahikatea Drive, Kinloch, Hamilton 3377	1800686	5812983	6.2
51	Residential	37 Ohaupo Road, Melville, Hamilton 3206	1800768	5812964	6.6
52	Residential	42 Ohaupo Road, Melville, Hamilton 3206	1800749	5812930	4.3

Receptor ID	Site type	Closest address	X co-ordinate	Y co-ordinate	Approximate distance to modelled road edge (m)
53	Residential	37A Beatty Street, Melville, Hamilton 3206	1801257	5812944	4.8
54	Residential	77 Normandy Avenue, Melville, Hamilton 3206	1801254	5812961	4.6
55	Residential	79A Normandy Avenue, Melville, Hamilton 3206	1801252	5812978	4.3
56	Residential	81 Normandy Avenue, Melville, Hamilton 3206	1801250	5812995	5.2
57	Residential	73 Normandy Avenue, Melville, Hamilton 3206	1801259	5812907	6.3
58	Residential	20 Normandy Avenue, Melville, Hamilton 3206	1801207	5812774	4.1
59	Residential	2 Odette Street, Bader, Hamilton 3206	1801173	5812762	4.6
60	Residential	43 Normandy Avenue, Melville, Hamilton 3206	1801152	5812780	4.4
61	Residential	53 Normandy Avenue, Melville, Hamilton 3206	1801190	5812801	6.4
62	Residential	49 Normandy Avenue, Melville, Hamilton 3206	1801172	5812791	5.7
63	Residential	Rawlings Street, Bader, Hamilton 3206	1801378	5812624	4.2
64	Residential	23 Odette Street, Bader, Hamilton 3206	1801396	5812611	4.3
65	Residential	28 Odette Street, Bader, Hamilton 3206	1801367	5812605	4.6
66	Residential	34 Odette Street, Bader, Hamilton 3206	1801383	5812591	4.2
67	Residential	26 Odette Street, Bader, Hamilton 3206	1801346	5812621	6.0

Table note: All receptors have been modelled at a representative breathing height of 1.5 metres above ground level.

APPENDIX B

PREDICTED NO_2 POLLUTANT CONCENTRATIONS

Table B.1 Predicted NO_2 concentrations at the modelled sensitive receptors.

Receptor ID	Site type	Closest address	Project background concentration ($\mu g/m^3$)	Annual mean NO_2 concentration ($\mu g/m^3$)	Percentage of guideline value (%)
Mangaharakeke study area					
23	Residential	2 Breckons Avenue Nawton Hamilton 3200	7.1	11.4	38 %
24	Residential	143A Avalon Drive Nawton Hamilton 3200	7.1	13.2	44 %
25	Residential	2A Rotokauri Road, Nawton, Hamilton 3200	7.1	14.9	50 %
37	Residential	10 Lugton Street Nawton Hamilton 3200	7.1	21.9	73 %
107	Residential	8 Lugton Street, Nawton, Hamilton 3200	7.1	23.3	78 %
108	Residential	4 Lugton Street, Nawton, Hamilton 3200	7.1	29.0	97 %
109	Residential	143A Avalon Drive, Nawton, Hamilton 3200	7.1	13.1	44 %
110	Residential	141 Avalon Drive, Nawton, Hamilton 3200	7.1	12.1	40 %
111	Residential	2B Rotokauri Road, Nawton, Hamilton 3200	7.1	17.3	58 %
112	Residential	Rotokauri Road, Nawton, Hamilton 3200	7.1	12.6	42 %
Te Rapa study area					
17	Residential	409 Ulster Street Beerescourt Hamilton 3200	6.8	12.8	43 %
18	Frankton Park Ltd Disability services & support organisation	1327 Victoria Street Beerescourt Hamilton 3200	6.8	11.6	39 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean NO_2 concentration (µg/m^3)	Percentage of guideline value (%)
19	Residential	37A Maeroa Road Beerescourt Hamilton 3200	6.8	14.7	49 %
20	Residential	1 Forest Lake Road Forest Lake Hamilton 3200	6.8	13.3	44 %
21	Residential	1368 Victoria Street Beerescourt Hamilton 3200	6.8	16.8	56 %
22	Barnardos Early Learning Centre Te Rapa	1 Storey Avenue Forest Lake Hamilton 3200	6.8	14.9	50 %
36	Residential	1370 Victoria Street Beerescourt Hamilton 3200	6.8	20.7	69 %
103	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	6.8	29.5	98 %
104	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	6.8	29.3	98 %
105	Residential	156 Te Rapa Road, Beerescourt, Hamilton 3200	6.8	22.2	74 %
106	Residential	457A Ulster Street, Maeroa, Hamilton 3200	6.8	15.6	52 %
Ruakura study area					
12	Residential	135 Peachgrove Road Hamilton East Hamilton 3216	6.8	11.0	37 %
13	Residential	371 Dey Street Hamilton East Hamilton 3216	6.8	9.4	31 %
14	Residential	Near to 26 Finchley Place Hamilton East Hamilton 3216	6.8	10.9	36 %
15	Residential	Ruakura Road Hamilton East Hamilton 3216	6.8	11.0	37 %
16	Green Forest Chinese Medical Centre	99 Te Aroha Street Claudelands Hamilton 3216	6.8	11.5	38 %
34	Vision College	21 Ruakura Road Hamilton East, Hamilton 3216	6.8	12.0	40 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean NO_2 concentration (µg/m^3)	Percentage of guideline value (%)
35	Bethel Hamilton Fellowship Church	Cameron Road Hamilton East Hamilton 3216	6.8	8.5	28 %
92	Residential	Ruakura Road, Hamilton East, Hamilton 3216	6.8	11.9	40 %
93	Residential	28 Finchley Place, Hamilton East, Hamilton 3216	6.8	10.1	34 %
94	Residential	Ruakura Road, Hamilton East, Hamilton 3216	6.8	10.0	33 %
95	Residential	144 Peachgrove Road, Hamilton East, Hamilton 3216	6.8	11.9	40 %
96	Residential	143 Peachgrove Road, Hamilton East, Hamilton 3216	6.8	11.0	37 %
97	Residential	118 Peachgrove Road, Hamilton East, Hamilton 3216	6.8	11.6	39 %
98	Residential	146 Peachgrove Road, Hamilton East, Hamilton 3216	6.8	11.3	38 %
99	Residential	145 Peachgrove Road, Hamilton East, Hamilton 3216	6.8	10.8	36 %
100	Residential	114 Peachgrove Road, Hamilton East, Hamilton 3216	6.8	10.2	34 %
101	Residential	369 Dey Street, Hamilton East, Hamilton 3216	6.8	9.4	31 %
102	Residential	73 Old Farm Road, Hamilton East, Hamilton 3216	6.8	9.3	31 %
Cambridge study area					
6	Residential	277 Cambridge Road Hillcrest Hamilton 3216	6.1	17.9	60 %
7	Residential	198 Cambridge Road Hillcrest Hamilton 3216	6.1	19.8	66 %
8	Residential	1 Johnsview Terrace Hillcrest Hamilton 3216	6.1	20.6	69 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean NO_2 concentration (µg/m^3)	Percentage of guideline value (%)
9	Aro Manawa heart health	153 Cambridge Road Hillcrest Hamilton 3216	6.1	9.8	33 %
10	Residential	158A Cambridge Road Hillcrest Hamilton 3216	6.1	8.3	28 %
11	Residential	257 Cambridge Road Hillcrest Hamilton 3216	6.1	15.7	52 %
28	Riverlea Kindergarten/Hillcrest Normal School	218 Cambridge Road Hillcrest Hamilton 3216	6.1	18.0	60 %
29	Grace Church Hamilton	Hillcrest Normal School 218 Cambridge Road Hillcrest Hamilton 3216	6.1	18.2	61 %
30	Residential	48A Howell Avenue Riverlea Hamilton 3216	6.1	10.8	36 %
31	Bella Dental	310 Cambridge Road Hillcrest Hamilton 3216	6.1	14.5	48 %
32	Swift Horse Cram School	53 Morrinsville Road Hillcrest Hamilton 3216	6.1	12.1	40 %
33	Residential	1 Morris Road Hillcrest Hamilton 3216	6.1	12.6	42 %
68	Residential	1 Morrinsville Road, Hillcrest, Hamilton 3216	6.1	16.0	53 %
69	Residential	3 Morrinsville Road, Hillcrest, Hamilton 3216	6.1	15.4	51 %
70	Residential	5 Morrinsville Road, Hillcrest, Hamilton 3216	6.1	14.7	49 %
71	Residential	243 Cambridge Road, Hillcrest, Hamilton 3216	6.1	16.2	54 %
72	Residential	4 Morrinsville Road, Hillcrest, Hamilton 3216	6.1	15.9	53 %
73	Residential	46 Morrinsville Road, Hillcrest, Hamilton 3216	6.1	11.5	38 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean NO_2 concentration (µg/m^3)	Percentage of guideline value (%)
74	Residential	48A Morrinsville Road, Hillcrest, Hamilton 3216	6.1	11.3	38 %
75	Residential	40 Morrinsville Road, Hillcrest, Hamilton 3216	6.1	11.7	39 %
76	Residential	2 Berkley Avenue, Hillcrest, Hamilton 3216	6.1	11.3	38 %
77	Residential	201 Cambridge Road, Hillcrest, Hamilton 3216	6.1	16.0	53 %
78	Residential	207 Cambridge Road, Hillcrest, Hamilton 3216	6.1	19.2	64 %
79	Residential	208 Cambridge Road, Hillcrest, Hamilton 3216	6.1	20.1	67 %
80	Residential	212 Cambridge Road, Hillcrest, Hamilton 3216	6.1	18.3	61 %
81	Residential	Milburn Lane, Hillcrest, Hamilton 3216	6.1	20.4	68 %
82	Residential	384 Cobham Drive, Hillcrest, Hamilton 3216	6.1	20.7	69 %
83	Residential	360 Cobham Drive, Hillcrest, Hamilton 3216	6.1	19.4	65 %
84	Residential	365A Cobham Drive, Hillcrest, Hamilton 3216	6.1	21.3	71 %
85	Residential	369 Cobham Drive, Hillcrest, Hamilton 3216	6.1	21.1	70 %
86	Residential	353 Cobham Drive, Hillcrest, Hamilton 3216	6.1	20.2	67 %
87	Residential	312 Cobham Drive, Hillcrest, Hamilton 3216	6.1	18.8	63 %
88	Residential	310 Cobham Drive, Hillcrest, Hamilton 3216	6.1	18.9	63 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean NO_2 concentration (µg/m^3)	Percentage of guideline value (%)
89	Residential	313 Cobham Drive, Hillcrest, Hamilton 3216	6.1	17.3	58 %
90	Residential	311 Cobham Drive, Hillcrest, Hamilton 3216	6.1	17.3	58 %
91	Residential	315 Cobham Drive, Hillcrest, Hamilton 3216	6.1	17.7	59 %
Ohaupo study area					
1	Residential	1 Mount View Road Melville Hamilton 3206	6.1	17.3	58 %
2	Residential	78 Ohaupo Road Melville Hamilton 3206	6.1	16.4	55 %
3	Residential	4 Normandy Avenue Melville Hamilton 3206	6.1	15.3	51 %
4	Residential	58 Ohaupo Road Melville Hamilton 3206	6.1	15.5	52 %
5	Melville Methodist Church	2 Bader Street Fitzroy Hamilton 3206	6.1	12.1	40 %
26	Braemar Hospital	28 Ohaupo Road, Hamilton Lake, Hamilton 3204	6.1	16.9	56 %
27	Melville Primary School	101 Ohaupo Road Melville Hamilton 3206	6.1	16.6	55 %
38	Residential	80 Ohaupo Road, Melville, Hamilton 3206	6.1	16.6	55 %
39	Residential	76A Ohaupo Road, Melville, Hamilton 3206	6.1	15.9	53 %
40	Residential	74 Ohaupo Road, Melville, Hamilton 3206	6.1	15.8	53 %
41	Residential	67 Ohaupo Road, Melville, Hamilton 3206	6.1	15.2	51 %
42	Residential	63 Ohaupo Road, Melville, Hamilton 3206	6.1	17.2	57 %

Receptor ID	Site type	Closest address	Project background concentration ($\mu g/m^3$)	Annual mean NO_2 concentration ($\mu g/m^3$)	Percentage of guideline value (%)
43	Residential	6 Normandy Avenue, Melville, Hamilton 3206	6.1	13.5	45 %
44	Residential	10 Normandy Avenue, Melville, Hamilton 3206	6.1	12.8	43 %
45	Residential	7 Normandy Avenue, Melville, Hamilton 3206	6.1	12.6	42 %
46	Residential	2C Beatty Street, Melville, Hamilton 3206	6.1	17.3	58 %
47	Residential	55A Ohaupo Road, Melville, Hamilton 3206	6.1	16.8	56 %
48	Residential	52A Ohaupo Road, Melville, Hamilton 3206	6.1	15.7	52 %
49	Residential	1 Beatty Street, Melville, Hamilton 3206	6.1	17.8	59 %
50	Residential	10 Kahikatea Drive, Kinloch, Hamilton 3377	6.1	19.8	66 %
51	Residential	37 Ohaupo Road, Melville, Hamilton 3206	6.1	18.9	63 %
52	Residential	42 Ohaupo Road, Melville, Hamilton 3206	6.1	17.0	57 %
53	Residential	37A Beatty Street, Melville, Hamilton 3206	6.1	11.0	37 %
54	Residential	77 Normandy Avenue, Melville, Hamilton 3206	6.1	11.4	38 %
55	Residential	79A Normandy Avenue, Melville, Hamilton 3206	6.1	12.0	40 %
56	Residential	81 Normandy Avenue, Melville, Hamilton 3206	6.1	12.5	42 %
57	Residential	73 Normandy Avenue, Melville, Hamilton 3206	6.1	10.4	35 %

Receptor ID	Site type	Closest address	Project background concentration ($\mu g/m^3$)	Annual mean NO_2 concentration ($\mu g/m^3$)	Percentage of guideline value (%)
58	Residential	20 Normandy Avenue, Melville, Hamilton 3206	6.1	11.0	37 %
59	Residential	2 Odette Street, Bader, Hamilton 3206	6.1	11.5	38 %
60	Residential	43 Normandy Avenue, Melville, Hamilton 3206	6.1	11.0	37 %
61	Residential	53 Normandy Avenue, Melville, Hamilton 3206	6.1	10.7	36 %
62	Residential	49 Normandy Avenue, Melville, Hamilton 3206	6.1	10.9	36 %
63	Residential	Rawlings Street, Bader, Hamilton 3206	6.1	7.8	26 %
64	Residential	23 Odette Street, Bader, Hamilton 3206	6.1	7.8	26 %
65	Residential	28 Odette Street, Bader, Hamilton 3206	6.1	7.7	26 %
66	Residential	34 Odette Street, Bader, Hamilton 3206	6.1	7.7	26 %
67	Residential	26 Odette Street, Bader, Hamilton 3206	6.1	7.6	25 %

Table note: All receptors have been modelled at a representative breathing height of 1.5 metres above ground level.

PREDICTED PM_{10} POLLUTANT CONCENTRATIONS

Table B.2 Predicted PM_{10} concentrations at the modelled sensitive receptors.

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
Mangaharakeke study area					
23	Residential	2 Breckons Avenue Nawton Hamilton 3200	12.8	13.6	68 %
24	Residential	143A Avalon Drive Nawton Hamilton 3200	12.8	13.8	69 %
25	Residential	2A Rotokauri Road, Nawton, Hamilton 3200	12.8	14.2	71 %
37	Residential	10 Lugton Street Nawton Hamilton 3200	12.8	15.6	78 %
107	Residential	8 Lugton Street, Nawton, Hamilton 3200	12.8	16.0	80 %
108	Residential	4 Lugton Street, Nawton, Hamilton 3200	12.8	17.8	89 %
109	Residential	143A Avalon Drive, Nawton, Hamilton 3200	12.8	13.8	69 %
110	Residential	141 Avalon Drive, Nawton, Hamilton 3200	12.8	13.6	68 %
111	Residential	2B Rotokauri Road, Nawton, Hamilton 3200	12.8	14.6	73 %
112	Residential	Rotokauri Road, Nawton, Hamilton 3200	12.8	13.7	69 %
Te Rapa study area					
17	Residential	409 Ulster Street Beerescourt Hamilton 3200	12.8	13.9	70 %
18	Frankton Park Ltd Disability services & support organisation	1327 Victoria Street Beerescourt Hamilton 3200	12.8	13.7	69 %
19	Residential	37A Maeroa Road Beerescourt Hamilton 3200	12.8	14.3	72 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
20	Residential	1 Forest Lake Road Forest Lake Hamilton 3200	12.8	14.0	70 %
21	Residential	1368 Victoria Street Beerescourt Hamilton 3200	12.8	14.6	73 %
22	Barnardos Early Learning Centre Te Rapa	1 Storey Avenue Forest Lake Hamilton 3200	12.8	14.3	72 %
36	Residential	1370 Victoria Street Beerescourt Hamilton 3200	12.8	15.2	76 %
103	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	12.8	16.8	84 %
104	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	12.8	16.8	84 %
105	Residential	156 Te Rapa Road, Beerescourt, Hamilton 3200	12.8	15.5	78 %
106	Residential	457A Ulster Street, Maeroa, Hamilton 3200	12.8	14.4	72 %
Ruakura study area					
12	Residential	135 Peachgrove Road Hamilton East Hamilton 3216	12.7	13.5	68 %
13	Residential	371 Dey Street Hamilton East Hamilton 3216	12.7	13.2	66 %
14	Residential	Near to 26 Finchley Place Hamilton East Hamilton 3216	12.6	13.4	67 %
15	Residential	Ruakura Road Hamilton East Hamilton 3216	12.7	13.5	68 %
16	Green Forest Chinese Medical Centre	99 Te Aroha Street Claudelands Hamilton 3216	12.7	13.6	68 %
34	Vision College	21 Ruakura Road Hamilton East, Hamilton 3216	12.7	13.8	69 %
35	Bethel Hamilton Fellowship Church	Cameron Road Hamilton East Hamilton 3216	12.6	12.9	65 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
92	Residential	Ruakura Road, Hamilton East, Hamilton 3216	12.7	13.8	69 %
93	Residential	28 Finchley Place, Hamilton East, Hamilton 3216	12.6	13.2	66 %
94	Residential	Ruakura Road, Hamilton East, Hamilton 3216	12.7	13.3	67 %
95	Residential	144 Peachgrove Road, Hamilton East, Hamilton 3216	12.7	13.7	69 %
96	Residential	143 Peachgrove Road, Hamilton East, Hamilton 3216	12.7	13.5	68 %
97	Residential	118 Peachgrove Road, Hamilton East, Hamilton 3216	12.7	13.6	68 %
98	Residential	146 Peachgrove Road, Hamilton East, Hamilton 3216	12.7	13.6	68 %
99	Residential	145 Peachgrove Road, Hamilton East, Hamilton 3216	12.7	13.5	68 %
100	Residential	114 Peachgrove Road, Hamilton East, Hamilton 3216	12.7	13.4	67 %
101	Residential	369 Dey Street, Hamilton East, Hamilton 3216	12.7	13.2	66 %
102	Residential	73 Old Farm Road, Hamilton East, Hamilton 3216	12.7	13.2	66 %
Cambridge study area					
6	Residential	277 Cambridge Road Hillcrest Hamilton 3216	12.5	14.8	74 %
7	Residential	198 Cambridge Road Hillcrest Hamilton 3216	12.6	14.9	74 %
8	Residential	1 Johnsview Terrace Hillcrest Hamilton 3216	12.5	15.1	75 %
9	Aro Manawa heart health	153 Cambridge Road Hillcrest Hamilton 3216	12.6	13.3	67 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
10	Residential	158A Cambridge Road Hillcrest Hamilton 3216	12.6	13.0	65 %
11	Residential	257 Cambridge Road Hillcrest Hamilton 3216	12.6	14.3	72 %
28	Riverlea Kindergarten/Hillcrest Normal School	218 Cambridge Road Hillcrest Hamilton 3216	12.5	14.6	73 %
29	Grace Church Hamilton	Hillcrest Normal School 218 Cambridge Road Hillcrest Hamilton 3216	12.5	14.5	73 %
30	Residential	48A Howell Avenue Riverlea Hamilton 3216	12.5	13.3	66 %
31	Bella Dental	310 Cambridge Road Hillcrest Hamilton 3216	12.5	14.0	70 %
32	Swift Horse Cram School	53 Morrinsville Road Hillcrest Hamilton 3216	12.5	13.6	68 %
33	Residential	1 Morris Road Hillcrest Hamilton 3216	12.5	13.7	69 %
68	Residential	1 Morrinsville Road, Hillcrest, Hamilton 3216	12.6	14.4	72 %
69	Residential	3 Morrinsville Road, Hillcrest, Hamilton 3216	12.6	14.3	71 %
70	Residential	5 Morrinsville Road, Hillcrest, Hamilton 3216	12.6	14.1	71 %
71	Residential	243 Cambridge Road, Hillcrest, Hamilton 3216	12.6	14.4	72 %
72	Residential	4 Morrinsville Road, Hillcrest, Hamilton 3216	12.5	14.2	71 %
73	Residential	46 Morrinsville Road, Hillcrest, Hamilton 3216	12.5	13.4	67 %
74	Residential	48A Morrinsville Road, Hillcrest, Hamilton 3216	12.5	13.4	67 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
75	Residential	40 Morrinsville Road, Hillcrest, Hamilton 3216	12.5	13.5	67 %
76	Residential	2 Berkley Avenue, Hillcrest, Hamilton 3216	12.5	13.4	67 %
77	Residential	201 Cambridge Road, Hillcrest, Hamilton 3216	12.6	14.1	71 %
78	Residential	207 Cambridge Road, Hillcrest, Hamilton 3216	12.6	14.8	74 %
79	Residential	208 Cambridge Road, Hillcrest, Hamilton 3216	12.5	14.9	75 %
80	Residential	212 Cambridge Road, Hillcrest, Hamilton 3216	12.5	14.5	73 %
81	Residential	Milburn Lane, Hillcrest, Hamilton 3216	12.5	15.0	75 %
82	Residential	384 Cobham Drive, Hillcrest, Hamilton 3216	12.5	15.1	75 %
83	Residential	360 Cobham Drive, Hillcrest, Hamilton 3216	12.5	14.8	74 %
84	Residential	365A Cobham Drive, Hillcrest, Hamilton 3216	12.6	15.2	76 %
85	Residential	369 Cobham Drive, Hillcrest, Hamilton 3216	12.6	15.2	76 %
86	Residential	353 Cobham Drive, Hillcrest, Hamilton 3216	12.6	15.0	75 %
87	Residential	312 Cobham Drive, Hillcrest, Hamilton 3216	12.5	15.0	75 %
88	Residential	310 Cobham Drive, Hillcrest, Hamilton 3216	12.5	15.0	75 %
89	Residential	313 Cobham Drive, Hillcrest, Hamilton 3216	12.6	14.7	73 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
90	Residential	311 Cobham Drive, Hillcrest, Hamilton 3216	12.6	14.7	73 %
91	Residential	315 Cobham Drive, Hillcrest, Hamilton 3216	12.6	14.8	74 %
Ohaupo study area					
1	Residential	1 Mount View Road Melville Hamilton 3206	12.7	14.9	75 %
2	Residential	78 Ohaupo Road Melville Hamilton 3206	12.7	14.7	73 %
3	Residential	4 Normandy Avenue Melville Hamilton 3206	12.7	14.5	72 %
4	Residential	58 Ohaupo Road Melville Hamilton 3206	12.7	14.5	73 %
5	Melville Methodist Church	2 Bader Street Fitzroy Hamilton 3206	12.7	14.0	70 %
26	Braemar Hospital	28 Ohaupo Road, Hamilton Lake, Hamilton 3204	12.7	14.5	73 %
27	Melville Primary School	101 Ohaupo Road Melville Hamilton 3206	12.7	14.8	74 %
38	Residential	80 Ohaupo Road, Melville, Hamilton 3206	12.7	14.7	74 %
39	Residential	76A Ohaupo Road, Melville, Hamilton 3206	12.7	14.6	73 %
40	Residential	74 Ohaupo Road, Melville, Hamilton 3206	12.7	14.6	73 %
41	Residential	67 Ohaupo Road, Melville, Hamilton 3206	12.7	14.4	72 %
42	Residential	63 Ohaupo Road, Melville, Hamilton 3206	12.7	14.8	74 %
43	Residential	6 Normandy Avenue, Melville, Hamilton 3206	12.7	14.2	71 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
44	Residential	10 Normandy Avenue, Melville, Hamilton 3206	12.7	14.1	70 %
45	Residential	7 Normandy Avenue, Melville, Hamilton 3206	12.7	14.0	70 %
46	Residential	2C Beatty Street, Melville, Hamilton 3206	12.7	14.9	75 %
47	Residential	55A Ohaupo Road, Melville, Hamilton 3206	12.7	14.8	74 %
48	Residential	52A Ohaupo Road, Melville, Hamilton 3206	12.7	14.5	73 %
49	Residential	1 Beatty Street, Melville, Hamilton 3206	12.7	15.0	75 %
50	Residential	10 Kahikatea Drive, Kinloch, Hamilton 3377	12.7	15.3	76 %
51	Residential	37 Ohaupo Road, Melville, Hamilton 3206	12.7	15.1	76 %
52	Residential	42 Ohaupo Road, Melville, Hamilton 3206	12.7	14.8	74 %
53	Residential	37A Beatty Street, Melville, Hamilton 3206	12.7	13.7	68 %
54	Residential	77 Normandy Avenue, Melville, Hamilton 3206	12.7	13.8	69 %
55	Residential	79A Normandy Avenue, Melville, Hamilton 3206	12.7	13.9	69 %
56	Residential	81 Normandy Avenue, Melville, Hamilton 3206	12.7	14.0	70 %
57	Residential	73 Normandy Avenue, Melville, Hamilton 3206	12.7	13.6	68 %
58	Residential	20 Normandy Avenue, Melville, Hamilton 3206	12.7	13.7	68 %
59	Residential	2 Odette Street, Bader, Hamilton 3206	12.7	13.8	69 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean PM_{10} concentration (µg/m^3)	Percentage of guideline value (%)
60	Residential	43 Normandy Avenue, Melville, Hamilton 3206	12.7	13.7	69 %
61	Residential	53 Normandy Avenue, Melville, Hamilton 3206	12.7	13.6	68 %
62	Residential	49 Normandy Avenue, Melville, Hamilton 3206	12.7	13.7	68 %
63	Residential	Rawlings Street, Bader, Hamilton 3206	12.7	13.0	65 %
64	Residential	23 Odette Street, Bader, Hamilton 3206	12.7	13.0	65 %
65	Residential	28 Odette Street, Bader, Hamilton 3206	12.7	13.0	65 %
66	Residential	34 Odette Street, Bader, Hamilton 3206	12.7	13.0	65 %
67	Residential	26 Odette Street, Bader, Hamilton 3206	12.7	13.0	65 %

Table note: All receptors have been modelled at a representative breathing height of 1.5 metres above ground level.

PREDICTED $PM_{2.5}$ POLLUTANT CONCENTRATIONS

Table B.3 Predicted $PM_{2.5}$ concentrations at the modelled sensitive receptors.

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
Mangaharakeke study area					
23	Residential	2 Breckons Avenue Nawton Hamilton 3200	6.4	6.9	69 %
24	Residential	143A Avalon Drive Nawton Hamilton 3200	6.4	7.1	71 %
25	Residential	2A Rotokauri Road, Nawton, Hamilton 3200	6.4	7.3	73 %
37	Residential	10 Lugton Street Nawton Hamilton 3200	6.4	8.3	83 %
107	Residential	8 Lugton Street, Nawton, Hamilton 3200	6.4	8.5	85 %
108	Residential	4 Lugton Street, Nawton, Hamilton 3200	6.4	9.7	97 %
109	Residential	143A Avalon Drive, Nawton, Hamilton 3200	6.4	7.1	71 %
110	Residential	141 Avalon Drive, Nawton, Hamilton 3200	6.4	6.9	69 %
111	Residential	2B Rotokauri Road, Nawton, Hamilton 3200	6.4	7.6	76 %
112	Residential	Rotokauri Road, Nawton, Hamilton 3200	6.4	7.0	70 %
Te Rapa study area					
17	Residential	409 Ulster Street Beerescourt Hamilton 3200	6.4	7.1	71 %
18	Frankton Park Ltd Disability services & support organisation	1327 Victoria Street Beerescourt Hamilton 3200	6.4	7.0	70 %
19	Residential	37A Maeroa Road Beerescourt Hamilton 3200	6.4	7.4	74 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
20	Residential	1 Forest Lake Road Forest Lake Hamilton 3200	6.4	7.2	72 %
21	Residential	1368 Victoria Street Beerescourt Hamilton 3200	6.4	7.5	75 %
22	Barnardos Early Learning Centre Te Rapa	1 Storey Avenue Forest Lake Hamilton 3200	6.4	7.4	74 %
36	Residential	1370 Victoria Street Beerescourt Hamilton 3200	6.4	7.9	79 %
103	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	6.4	9.1	91 %
104	Residential	150 Te Rapa Road, Beerescourt, Hamilton 3200	6.4	9.1	91 %
105	Residential	156 Te Rapa Road, Beerescourt, Hamilton 3200	6.4	8.2	82 %
106	Residential	457A Ulster Street, Maeroa, Hamilton 3200	6.4	7.4	74 %
Ruakura study area					
12	Residential	135 Peachgrove Road Hamilton East Hamilton 3216	6.4	6.9	69 %
13	Residential	371 Dey Street Hamilton East Hamilton 3216	6.4	6.7	67 %
14	Residential	Near to 26 Finchley Place Hamilton East Hamilton 3216	6.4	6.9	69 %
15	Residential	Ruakura Road Hamilton East Hamilton 3216	6.4	6.9	69 %
16	Green Forest Chinese Medical Centre	99 Te Aroha Street Claudelands Hamilton 3216	6.4	6.9	69 %
34	Vision College	21 Ruakura Road Hamilton East, Hamilton 3216	6.4	7.1	71 %
35	Bethel Hamilton Fellowship Church	Cameron Road Hamilton East Hamilton 3216	6.4	6.6	66 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
92	Residential	Ruakura Road, Hamilton East, Hamilton 3216	6.4	7.0	70 %
93	Residential	28 Finchley Place, Hamilton East, Hamilton 3216	6.4	6.8	68 %
94	Residential	Ruakura Road, Hamilton East, Hamilton 3216	6.4	6.8	68 %
95	Residential	144 Peachgrove Road, Hamilton East, Hamilton 3216	6.4	7.0	70 %
96	Residential	143 Peachgrove Road, Hamilton East, Hamilton 3216	6.4	6.9	69 %
97	Residential	118 Peachgrove Road, Hamilton East, Hamilton 3216	6.4	7.0	70 %
98	Residential	146 Peachgrove Road, Hamilton East, Hamilton 3216	6.4	7.0	70 %
99	Residential	145 Peachgrove Road, Hamilton East, Hamilton 3216	6.4	6.9	69 %
100	Residential	114 Peachgrove Road, Hamilton East, Hamilton 3216	6.4	6.8	68 %
101	Residential	369 Dey Street, Hamilton East, Hamilton 3216	6.4	6.7	67 %
102	Residential	73 Old Farm Road, Hamilton East, Hamilton 3216	6.4	6.7	67 %
Cambridge study area					
6	Residential	277 Cambridge Road Hillcrest Hamilton 3216	6.4	7.9	79 %
7	Residential	198 Cambridge Road Hillcrest Hamilton 3216	6.4	7.9	79 %
8	Residential	1 Johnsview Terrace Hillcrest Hamilton 3216	6.4	8.1	81 %
9	Aro Manawa heart health	153 Cambridge Road Hillcrest Hamilton 3216	6.4	6.8	68 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
10	Residential	158A Cambridge Road Hillcrest Hamilton 3216	6.4	6.6	66 %
11	Residential	257 Cambridge Road Hillcrest Hamilton 3216	6.4	7.5	75 %
28	Riverlea Kindergarten/Hillcrest Normal School	218 Cambridge Road Hillcrest Hamilton 3216	6.4	7.7	77 %
29	Grace Church Hamilton	Hillcrest Normal School 218 Cambridge Road Hillcrest Hamilton 3216	6.4	7.7	77 %
30	Residential	48A Howell Avenue Riverlea Hamilton 3216	6.4	6.9	69 %
31	Bella Dental	310 Cambridge Road Hillcrest Hamilton 3216	6.4	7.4	74 %
32	Swift Horse Cram School	53 Morrinsville Road Hillcrest Hamilton 3216	6.4	7.1	71 %
33	Residential	1 Morris Road Hillcrest Hamilton 3216	6.4	7.2	72 %
68	Residential	1 Morrinsville Road, Hillcrest, Hamilton 3216	6.4	7.6	76 %
69	Residential	3 Morrinsville Road, Hillcrest, Hamilton 3216	6.4	7.5	75 %
70	Residential	5 Morrinsville Road, Hillcrest, Hamilton 3216	6.4	7.4	74 %
71	Residential	243 Cambridge Road, Hillcrest, Hamilton 3216	6.4	7.6	76 %
72	Residential	4 Morrinsville Road, Hillcrest, Hamilton 3216	6.4	7.5	75 %
73	Residential	46 Morrinsville Road, Hillcrest, Hamilton 3216	6.4	7.0	70 %
74	Residential	48A Morrinsville Road, Hillcrest, Hamilton 3216	6.4	7.0	70 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
75	Residential	40 Morrinsville Road, Hillcrest, Hamilton 3216	6.4	7.0	70 %
76	Residential	2 Berkley Avenue, Hillcrest, Hamilton 3216	6.4	7.0	70 %
77	Residential	201 Cambridge Road, Hillcrest, Hamilton 3216	6.4	7.4	74 %
78	Residential	207 Cambridge Road, Hillcrest, Hamilton 3216	6.4	7.8	78 %
79	Residential	208 Cambridge Road, Hillcrest, Hamilton 3216	6.4	8.0	80 %
80	Residential	212 Cambridge Road, Hillcrest, Hamilton 3216	6.4	7.7	77 %
81	Residential	Milburn Lane, Hillcrest, Hamilton 3216	6.4	8.0	80 %
82	Residential	384 Cobham Drive, Hillcrest, Hamilton 3216	6.4	8.1	81 %
83	Residential	360 Cobham Drive, Hillcrest, Hamilton 3216	6.4	7.9	79 %
84	Residential	365A Cobham Drive, Hillcrest, Hamilton 3216	6.4	8.1	81 %
85	Residential	369 Cobham Drive, Hillcrest, Hamilton 3216	6.4	8.1	81 %
86	Residential	353 Cobham Drive, Hillcrest, Hamilton 3216	6.4	8.0	80 %
87	Residential	312 Cobham Drive, Hillcrest, Hamilton 3216	6.4	8.0	80 %
88	Residential	310 Cobham Drive, Hillcrest, Hamilton 3216	6.4	8.0	80 %
89	Residential	313 Cobham Drive, Hillcrest, Hamilton 3216	6.4	7.7	77 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
90	Residential	311 Cobham Drive, Hillcrest, Hamilton 3216	6.4	7.7	77 %
91	Residential	315 Cobham Drive, Hillcrest, Hamilton 3216	6.4	7.8	78 %
Ohaupo study area					
1	Residential	1 Mount View Road Melville Hamilton 3206	6.4	7.8	78 %
2	Residential	78 Ohaupo Road Melville Hamilton 3206	6.4	7.6	76 %
3	Residential	4 Normandy Avenue Melville Hamilton 3206	6.4	7.5	75 %
4	Residential	58 Ohaupo Road Melville Hamilton 3206	6.4	7.5	75 %
5	Melville Methodist Church	2 Bader Street Fitzroy Hamilton 3206	6.4	7.2	72 %
26	Braemar Hospital	28 Ohaupo Road, Hamilton Lake, Hamilton 3204	6.4	7.6	76 %
27	Melville Primary School	101 Ohaupo Road Melville Hamilton 3206	6.4	7.7	77 %
38	Residential	80 Ohaupo Road, Melville, Hamilton 3206	6.4	7.7	77 %
39	Residential	76A Ohaupo Road, Melville, Hamilton 3206	6.4	7.6	76 %
40	Residential	74 Ohaupo Road, Melville, Hamilton 3206	6.4	7.6	76 %
41	Residential	67 Ohaupo Road, Melville, Hamilton 3206	6.4	7.5	75 %
42	Residential	63 Ohaupo Road, Melville, Hamilton 3206	6.4	7.8	78 %
43	Residential	6 Normandy Avenue, Melville, Hamilton 3206	6.4	7.3	73 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
44	Residential	10 Normandy Avenue, Melville, Hamilton 3206	6.4	7.2	72 %
45	Residential	7 Normandy Avenue, Melville, Hamilton 3206	6.4	7.2	72 %
46	Residential	2C Beatty Street, Melville, Hamilton 3206	6.4	7.8	78 %
47	Residential	55A Ohaupo Road, Melville, Hamilton 3206	6.4	7.7	77 %
48	Residential	52A Ohaupo Road, Melville, Hamilton 3206	6.4	7.6	76 %
49	Residential	1 Beatty Street, Melville, Hamilton 3206	6.4	7.9	79 %
50	Residential	10 Kahikatea Drive, Kinloch, Hamilton 3377	6.4	8.1	81 %
51	Residential	37 Ohaupo Road, Melville, Hamilton 3206	6.4	8.0	80 %
52	Residential	42 Ohaupo Road, Melville, Hamilton 3206	6.4	7.7	77 %
53	Residential	37A Beatty Street, Melville, Hamilton 3206	6.4	7.0	70 %
54	Residential	77 Normandy Avenue, Melville, Hamilton 3206	6.4	7.1	71 %
55	Residential	79A Normandy Avenue, Melville, Hamilton 3206	6.4	7.1	71 %
56	Residential	81 Normandy Avenue, Melville, Hamilton 3206	6.4	7.2	72 %
57	Residential	73 Normandy Avenue, Melville, Hamilton 3206	6.4	6.9	69 %
58	Residential	20 Normandy Avenue, Melville, Hamilton 3206	6.4	7.0	70 %
59	Residential	2 Odette Street, Bader, Hamilton 3206	6.4	7.1	71 %

Receptor ID	Site type	Closest address	Project background concentration (µg/m^3)	Annual mean $PM_{2.5.}$ concentration (µg/m^3)	Percentage of guideline value (%)
60	Residential	43 Normandy Avenue, Melville, Hamilton 3206	6.4	7.0	70 %
61	Residential	53 Normandy Avenue, Melville, Hamilton 3206	6.4	7.0	70 %
62	Residential	49 Normandy Avenue, Melville, Hamilton 3206	6.4	7.0	70 %
63	Residential	Rawlings Street, Bader, Hamilton 3206	6.4	6.6	66 %
64	Residential	23 Odette Street, Bader, Hamilton 3206	6.4	6.6	66 %
65	Residential	28 Odette Street, Bader, Hamilton 3206	6.4	6.6	66 %
66	Residential	34 Odette Street, Bader, Hamilton 3206	6.4	6.6	66 %
67	Residential	26 Odette Street, Bader, Hamilton 3206	6.4	6.6	66 %

Table note: All receptors have been modelled at a representative breathing height of 1.5 metres above ground level.

APPENDIX C

CONTOUR PLOTS

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 7 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 65

NOTES:

1. Aerial image: Contains data sourced from the LINZ Data Service and licensed for reuse under CC BY 4.0
2. Projection: EPSG:2193 - NZGD2000/ New Zealand Map Grid

CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Mangaharakeke Study Area

FIGURE No.:	REV:
5-1	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 7 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45

NOTES:

1. Aerial image: Contains data sourced from the LINZ Data Service and licensed for reuse under CC BY 4.0
2. Projection: EPSG:2193 - NZGD2000/ New Zealand Map Grid

CLIENT:

Waikato Regional Council

PROJECT:

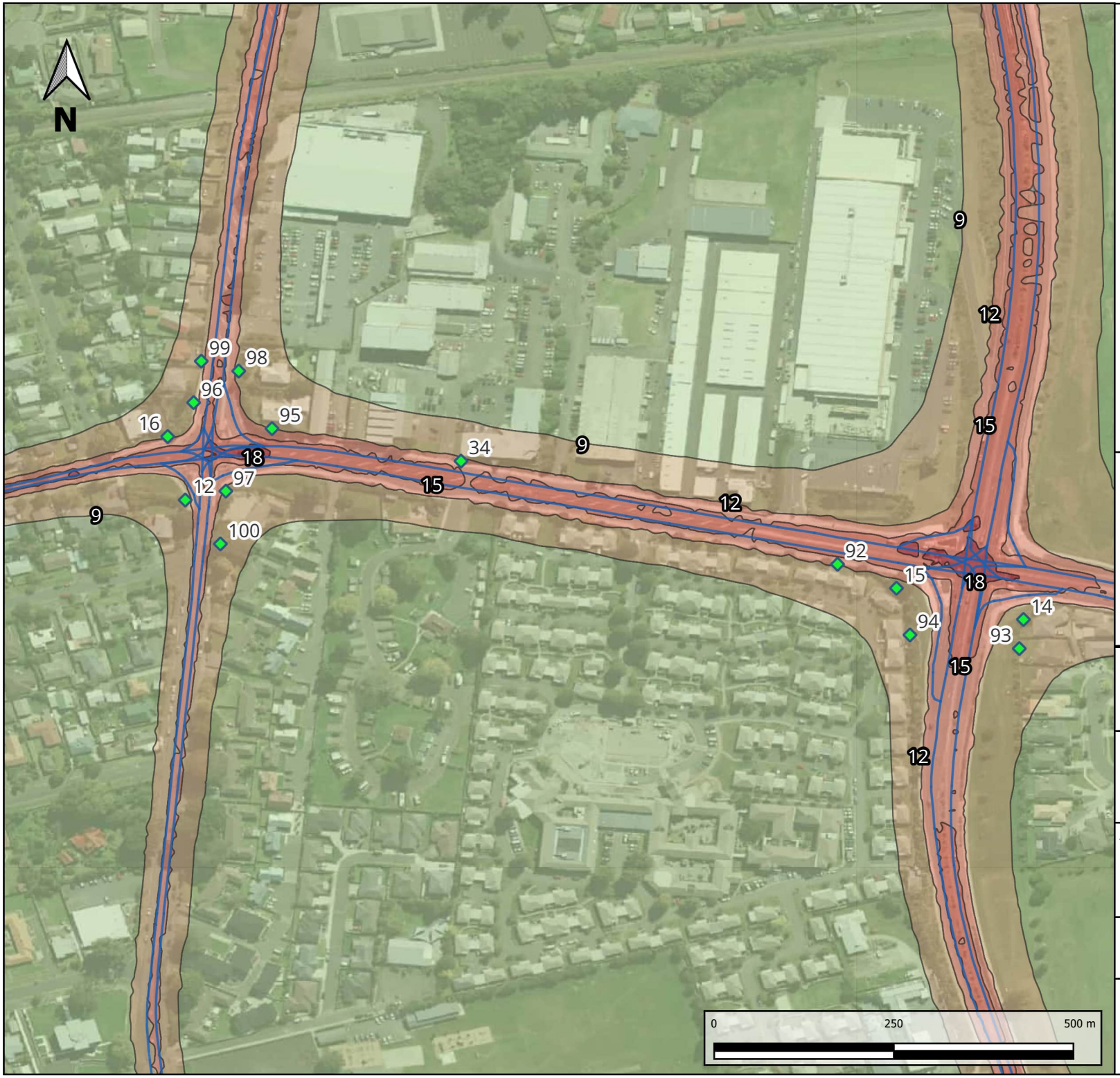
Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Te Rapa Study Area

FIGURE No.:	REV:
5-2	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB



Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 6 - 9
- 9 - 12
- 12 -15
- 15 - 18
- 18 - 24

NOTES:

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2. Projection: EPSG:2193 - NZGD2000/ New Zealand Map Grid

CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Ruakura Study Area

FIGURE No.:	REV:
5-3	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 6 - 9
- 9 - 12
- 12 -15
- 15 - 18
- 18 - 24

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Ruakura Study Area

FIGURE No.:	REV:
5-4	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- 30 - 37

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Cambridge Study Area

FIGURE No.:	REV:
5-5	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- 30 - 37

NOTES:

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Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Cambridge Study Area

FIGURE No.:	REV:
5-6	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- 30 - 36
- 36 - 42
- 42 - 58

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Ohaupo Study Area

FIGURE No.:	REV:
5-7	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean NO_2 Concentration

- 6 - 12
- 12 - 18
- 18 - 24
- 24 - 30
- 30 - 36
- 36 - 42
- 42 - 58

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean NO_2 Concentration for the Ohaupo Study Area

FIGURE No.:	REV:
5-8	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 12 - 18
- 18 - 24
- 24 - 30
- 30 - 36
- 36 - 40

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Mangaharakeke Study Area

FIGURE No.:	REV:
5-9	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- 20 - 23

NOTES:

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Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Te Rapa Study Area

FIGURE No.:	REV:
5-10	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 9 - 10
- 10 - 11
- 11 - 12
- 12 - 13
- 13 - 14
- 14 - 15
- 15 - 17

NOTES:

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Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Ruakura Study Area

FIGURE No.:	REV:
5-11	1.0

REV DATE:19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 9 - 10
- 10 - 11
- 11 - 12
- 12 - 13
- 13 - 14
- 14 - 15
- 15 - 17

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Ruakura Study Area

FIGURE No.:	REV:
5-12	1.0

REV DATE:19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 22

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Cambridge Study Area

FIGURE No.:	REV:
5-13	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 22

NOTES:

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CLIENT:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Cambridge Study Area

FIGURE No.:	REV:
5-14	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 12 - 16
- 16 - 20
- 20 - 24
- 24 - 28
- 28 - 32
- 32 - 38

NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Ohaupo Study Area

FIGURE No.:	REV:
5-15	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean PM_{10} Concentration

- 12 - 16
- 16 - 20
- 20 - 24
- 24 - 28
- 28 - 32
- 32 - 38

NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean PM_{10} Concentration for the Ohaupo Study Area

FIGURE No.:	REV:
5-16	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean $PM_{2.5}$ Concentration

- 6 - 8
- 8 - 12
- 12 - 16
- 16 - 20
- 20 - 24

NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Mangaharakeke Study Area

FIGURE No.:	REV:
5-17	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean $PM_{2.5}$ Concentration

- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10
- 10 - 11
- 11 - 13

NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Te Rapa Study Area

FIGURE No.:	REV:
5-18	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean $PM_{2.5}$ Concentration

- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9

NOTES:

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CLIENT:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Ruakura Study Area

FIGURE No.:	REV:
5-19	1.0

REV DATE:19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean $PM_{2.5}$ Concentration

- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9

NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Ruakura Study Area

FIGURE No.:	REV:
5-20	1.0

REV DATE:19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean $PM_{2.5}$ Concentration

- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10
- 10 - 11
- 11 - 13

NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Cambridge Study Area

FIGURE No.:	REV:
5-21	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
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NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Cambridge Study Area

FIGURE No.:	REV:
5-22	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean $PM_{2.5}$ Concentration

- 6 - 9
- 9 - 12
- 12 - 15
- 15 - 18
- 18 - 23

NOTES:

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CLIENT:

Waikato Regional Council

PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Ohaupo Study Area

FIGURE No.:	REV:
5-23	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
APPROVED BY:	FB

Legend

- Modelled Road Network
- Sensitive Receptors

Modelled Annual Mean $PM_{2.5}$ Concentration

- 6 - 9
- 9 - 12
- 12 - 15
- 15 - 18
- 18 - 23

NOTES:

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PROJECT:

Hamilton Air Quality Monitoring and Modelling

TITLE:

Annual Mean $PM_{2.5}$ Concentration for the Ohaupo Study Area

FIGURE No.:	REV:
5-24	1.0

REV DATE: 19-05-2025	
PREPARED BY:	SA
REVIEWED BY:	FB
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