Report

Assessment of Air Quality Effects - Transmission Gully Project: Technical Report 13

Prepared for the NZ Transport Agency (NZTA) and Porirua City Council (Client)

By Beca Infrastructure Ltd (Beca)

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Document Acceptance

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Executive Summary

In relation to the notices of requirement for designations, and applications for resource consents (for discharges to air from concrete batching and rock crushing) under the Resource Management Act 1991 (RMA), the NZ Transport Agency (NZTA) has commissioned Beca Infrastructure Limited (Beca) to assess the potential air quality effects associated with the Transmission Gully Project (the Project). The NZTA proposes to construct, operate and maintain an inland State highway between Wellington at Linden and the Kapiti Coast at MacKays Crossing (the Main Alignment). In addition, the Project involves the construction and operation of two local roads connecting the Main Alignment to the existing eastern Porirua road network (the Porirua Link Roads) and the existing western Porirua road network (the Kenepuru Link Road).

The existing SH1 coastal route between Linden and MacKays Crossing is likely to become a local road. The Main Alignment is part of the Wellington Northern Corridor (Wellington to Levin) road of national significance (RoNS).

In undertaking this assessment, Beca has followed the procedures outlined in the Ministry for the Environment's Good Practice Guide for Assessing Discharges to Air from Land Transport (2008) and the draft NZTA Standard for Producing Air Quality Assessments for State Highway Projects (2010).

Dispersion modelling has been used as the primary tool to quantitatively assess pollutant concentrations associated with the Project and changes in the existing roading network as a result of the Project. The dispersion model inputs of vehicle emission rates and traffic volumes have been derived using traffic modelling and the Vehicle Emissions Prediction Model v3 (VEPM) emission factors. Potential effects have been assessed by comparing predictions against relevant health-based National Environmental Standards for Air Quality (AQNES), and the New Zealand Ambient Air Quality Guidelines (NZAAQG) and the Greater Wellington Regional Council (GWRC) Regional Ambient Air Quality Guidelines (RAAQG). These air quality criteria are designed to protect the health of the most vulnerable individuals in the community. The AQNES is currently under review and undergoing consultation following proposed amendments. The currently proposed amendments are not considered to impact on the criteria used in this assessment.

In accordance with the requirements of the AQNES, the GWRC has classified eight airsheds in the Wellington region where the PM_{10} standard is regularly breached each year, or that were considered to have potential to breach the national environmental standard unless carefully managed. Parts of the Project and wider regional impacts of the Project will affect one of these gazetted airsheds which is the Porirua airshed.

The potential air quality impacts have been predicted for a 'base year' of 2006 and for two future years, 2026, and 2031. For the years 2026 and 2031, the emission scenarios have considered both 'do minimum' (ie the Project not being undertaken) and the 'with Project' scenario (ie the NZTA's proposed development option). The dispersion modelling assessment has focused on the relative impacts that the 2031 emission scenarios will have on local air quality, as this scenario provides an estimate of the worst case effects, when compared to the existing baseline as modelled in the 2006 emission scenario.

The potential effects of carbon monoxide (CO), fine particles (PM_{10}), nitrogen dioxide (NO_2) and benzene have been considered in the assessment. Conservative existing (background) levels of CO, PM_{10} and NO_2 have been derived using ambient air quality data collected at the GWRC monitoring station at Tawa and through a project specific passive NO_2 sampling programme. Background benzene concentrations have been derived from the results of the NZTA passive sampling programme conducted in Auckland.

Dust will also be generated during the construction phase of the Project. At the locations where construction occurs in close proximity to sensitive receptors, including residential premises and childcare facilities, a high standard of emissions control and management will be employed to adequately avoid or mitigate the effects of discharges of construction dust. A Construction Air Quality Management Plan (CAQMP) has been prepared, which is designed to form the basis for specific management plans to be prepared by contractors. The CAQMP and the specific management plans prepared by contractors will detail methods to be used to mitigate discharges of contaminants into air from the construction of the Project.

The key conclusions of this air quality assessment are as follows:

- The existing ambient air quality in the vicinity of the majority of the Main Alignment and link roads is rural by nature and therefore has very low existing levels of air quality pollutants. The main exception to this is the southernmost part of the route through Linden (including the Kenepuru Link Road), which based on GWRC monitoring data, is impacted by PM_{10} emissions from home heating during winter time.
- The operation of the Project will improve air quality in many parts of the Project area, due to the vehicle emissions being taken off the existing congested SH1 coastal route and arterial roads and being dispersed in a rural location. Moving the traffic from the existing congested urban road network means better air quality than would exist with the same traffic volumes using local roads.
- Some locations are predicted to slightly increase the exposure of people living, working or spending time in the Project area to vehicle related contaminants above the ‘do minimum’ scenario (ie without the Project), due to the location of new link roads, and increased volume of traffic accessing the Main Alignment at Linden and via the Kenepuru Interchange. However, predicted increases are comparatively small and exposure levels in all areas will comply with the AQNES which are designed to protect the health of the most vulnerable individuals in the community.
- In terms of regional effects and impacts on the Porirua airshed, the Project is expected to have an insignificant effect on Wellington’s regional air quality, despite a slight increase in vehicle kilometres travelled overall, due to improvements in traffic flow through the Project area, combined with the continuing improvements in vehicle emissions generally. The Project is not predicted to impact the GWRC’s ability to issue future resource consents within the airshed.
- The route for the Project was selected based on a prioritisation of a route option for a new State highway that avoids increasing the exposure of sensitive receivers to poor air quality. The relocation of traffic from the existing SH1 coastal route to the Project will result in significantly reduced exposure to vehicle emissions for the coastal communities between Linden and MacKays Crossing. The route selection and improvements in efficient traffic flow expected to be brought about as a result of the Project are considered to adequately mitigate the potential adverse effects of vehicle emissions from the Project.

1 Introduction

1.1 Purpose

The purpose of this technical assessment is to assess the effects of exhaust emissions from vehicles using the proposed motorway and connecting roads on air quality and the environment, and also to assess the likely effects of discharges of dust and other contaminants to air from the construction stages of the Transmission Gully Project (the Project). An assessment of the effects of the proposed concrete batching and crushing plants required during the construction stages of the project is included in Section 10 and Section 11. This report is part of a suite of documents in support of the notices of requirement for designations and applications for resource consent for the Project.

1.2 Report scope

In summary, this assessment report provides information on the following:

- Description of the Project (Section 1)
- Statutory matters for consideration in assessing air quality impacts of the Project (Section 0)
- Methods used for determining pollutant emissions and assessing the impacts (Section 1)
- Air quality standards and guidelines relevant to this Project (Section 4.3)
- Review of existing land use and meteorological conditions and existing air quality in the area (Section 1 and Section 1)
- Vehicle emissions modelling used to predict future vehicle related emissions and used as inputs to the dispersion modelling assessment (Section 7.4)
- Use of dispersion modelling to predict exposure levels to vehicle related contaminants (Section 8)
- Interpretation and analysis of predicted air quality impacts (Section 1)
- Description of potential impacts of dust generated during Project construction stages (Section 10 and Section 11)
- Mitigation measures that were considered during the development of the Project concept design (Section 12)

2 Overview of the Project

2.1 Overview

The Transmission Gully Project (the Project) consists of the following components:

- The Transmission Gully Main Alignment (the Main Alignment) involves the construction and operation of a road formed to expressway standard between Linden to MacKays Crossing. The NZ Transport Agency is responsible for the Main Alignment.
- The Kenepuru Link Road will connect the Main Alignment to western Porirua road network. The Kenepuru Link Road will provide access from Kenepuru Drive to the Kenepuru Interchange. The NZ Transport Agency is responsible for the Kenepuru Link Road.
- The Porirua Link Roads involves the construction and operation of two local roads connecting the Main Alignment to the existing eastern Porirua road network. The Porirua City Council (PCC) is responsible for the Porirua Link Roads.

2.2 Transmission Gully Main Alignment

The Transmission Gully Main Alignment will provide an inland State highway between Kapiti Coast at MacKays Crossing and Wellington at Linden.

Once completed, the Main Alignment will likely become part of State Highway 1 (SH1). The existing SH1 coastal route between Linden and MacKays Crossing will likely become a local road. The Main Alignment is part of the Wellington Northern Corridor (Wellington to Levin) road of national significance (RoNS).

The Wellington Northern Corridor is one of the seven RoNS that were announced as part of the Government Policy Statement on Road Transport Funding (GPS2) in May 2009. The focus of the RoNS is on improved route security, freight movement and tourism routes.

The Main Alignment is approximately 27 kilometres in length and involves land in four districts: Wellington City, Porirua City, Upper Hutt City, and Kapiti Coast District. In accordance with the Wellington Northern Corridor RoNS, the Main Alignment will be a road to an expressway standard.

The key design features of the Main Alignment are:

- Four lanes (two lanes in each direction with median barrier separation)
- Rigid access control
- Grade separated interchanges
- Minimum horizontal and vertical design speeds of 100 km/h and 110 km/h respectively
- Maximum gradient of 8%
- Crawler lanes in some high gradient sections to account for the high speed differences between heavy and light vehicles

2.3 Kenepuru Link Road

The Kenepuru Link Road will connect the Main Alignment to western Porirua. The Kenepuru Link Road will provide access from Kenepuru Drive to the Kenepuru Interchange. This road will be a State highway designed to following standards:

- Two lanes (one in each direction)
- Design speeds of 50 km/h
- Maximum gradient of 10%
- Limited side access

2.4 Porirua Link Roads

The Porirua Link Roads will connect the Main Alignment to the eastern Porirua suburbs of Whitby (Whitby Link Road) and Waitangirua (Waitangirua Link Road). The Porirua Link Roads will be local roads designed to the following standards:

- Two lanes (one in each direction)
- Design speeds of 50 km/h
- Maximum gradient of 10%
- Some side access will be permitted

2.5 Route description

The proposed Main Alignment route is an inland alternative to the coastal route of the existing State Highway 1, running from SH1 at MacKays Crossing in the north to rejoin it at Linden just south of Porirua City as illustrated on Figure 13.1. The route runs through a predominantly rural landscape passing the fringe of existing urban areas at Pauatahanui, Whitby and Porirua East.

Heading south on State Highway 1, the Main Alignment route starts just south of MacKays Crossing, curving left up the Te Puka Stream valley and over the Wainui Saddle. It follows Horokiri Stream down to Battle Hill Farm Forest Park and on past Pauatahanui Golf Course.

The route swings west to cross over State Highway 58 about 600 metres southeast of the existing Pauatahanui roundabout. It climbs to the headwaters of Duck Creek, runs above the creek, and crosses Cannons Creek near the Takapu Road electricity sub-station.

The route follows the hills above Ranui Heights before dropping down through plantation forest opposite Kenepuru Hospital to join State Highway 1 at Linden.

In more detail the key features of the route are as follows:

- State Highway 1 MacKays Crossing/Paekakariki Interchange

The Main Alignment will cross above State Highway 1 south of MacKays Crossing. Traffic from Kapiti will still be able to access the existing State Highway 1. Traffic from Paekakariki township can access the Main Alignment via MacKays Crossing.

- Te Puka Stream/Climb to Wainui Saddle

Crawler lanes for the steepest section of the route on the climb and descent between MacKays Crossing to Wainui Saddle are proposed to take into account the large difference in speeds between cars and trucks.

- Battle Hill Farm Forest Park

The route through Battle Hill Farm Forest Park is on the valley floor, which makes it less visible from the park and surrounding areas and reduces the level of road noise.

- State Highway 58 Interchange

The Main Alignment will cross above the existing State Highway 58 route. There will be on and off ramps from the Main Alignment to a new two-lane roundabout on State Highway 58.

- Combined Whitby/Waitangirua Interchange and Porirua Link Roads

The Main Alignment route runs under the proposed interchange. The Porirua Link Roads, the Whitby Link Road and the Waitangirura Link Road, will connect the roundabout with James Cook Drive and Warspite Avenue. No connections are proposed to local roads located on the eastern side of the route in line with Porirua City Council land use development policies.

Extra lanes will assist merging between State Highway 58 and the combined James Cook Interchange. This combined interchange eliminates the need for the originally proposed Warspite Interchange by providing a more efficient link to both suburbs.

- Kenepuru Interchange and Link Road

The Main Alignment will cross above a roundabout with on and off ramps, and a connecting road to Porirua. Extra lanes will assist merging where appropriate.

Porirua will be connected to the Main Alignment via a new two lane, 50km/h link road (the Kenepuru Link Road). The link road will be approximately 600m in length and connect the Main Alignment to a new roundabout on Kenepuru Drive. The link road will run under the existing State Highway 1 motorway and will be bridged over the North Island Main Trunk rail line (NIMT).

- State Highway 1 Linden Connection

The Main Alignment merges with State Highway 1 at Linden. Travelling south, the Main Alignment joins State Highway 1 as it crosses Collins Avenue bridge and along the Tawa College straight.

Travelling north, the Porirua motorway and the Main Alignment will separate at Linden with two lanes diverging to the right to travel north along the Main Alignment route. Two lanes diverge left to continue along the existing State Highway 1 to Porirua.

2.6 Development of the current design

The scheme assessment report (SAR) was undertaken between 2006 and 2008. The key objective for this phase was to identify the most advantageous route alignment which could then be further refined and used for assessment and consenting. The associated findings from the SAR investigations indicated that the proposed route provides several significant benefits over the existing designated alignment and the coastal route. The key benefits include:

- Improving route security
- Improving highway safety and function
- Managing environmental impacts
- Improving connections to local roads

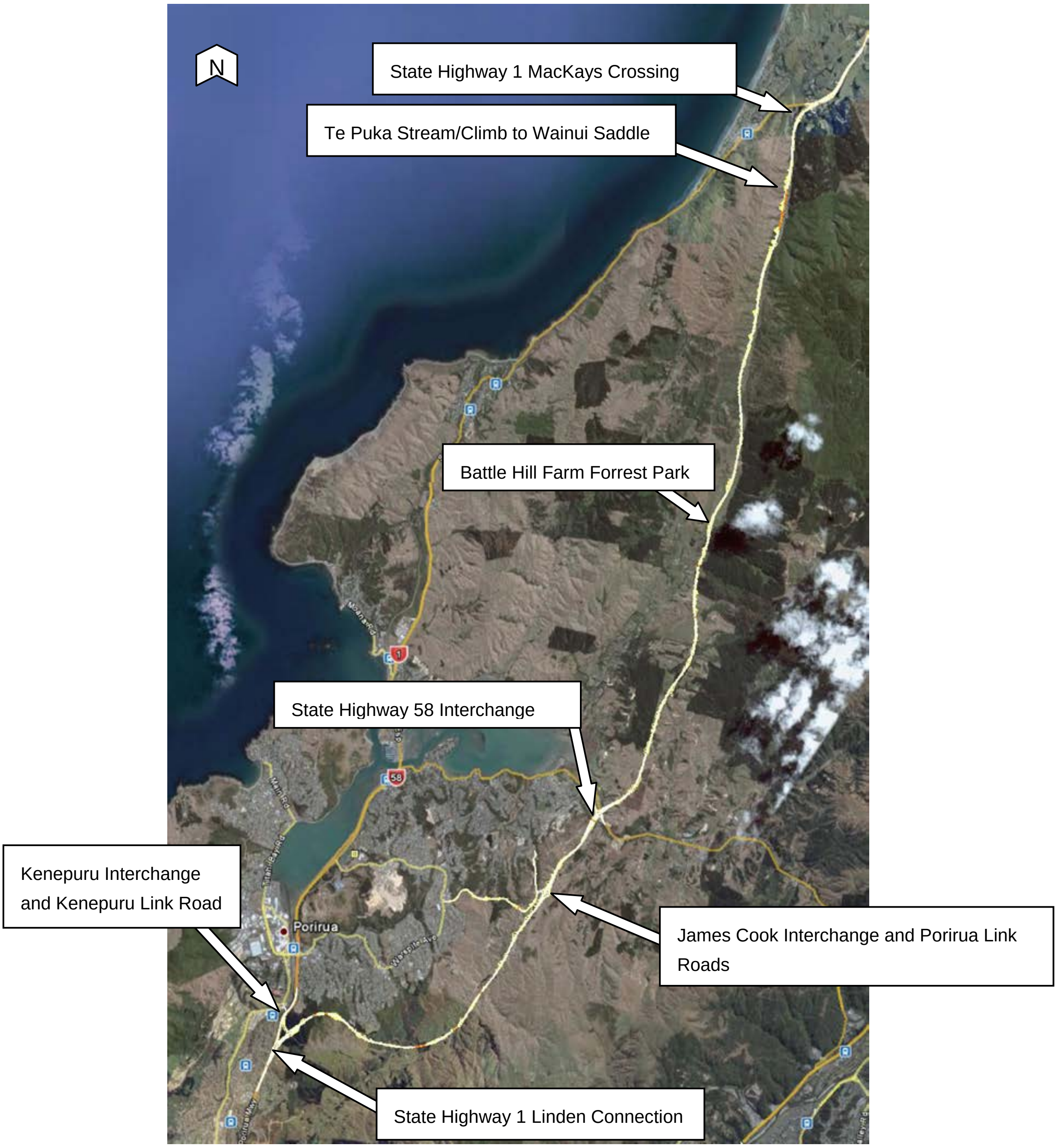

Figure 13.1: Transmission Gully Main Alignment, Kenepuru Link Roads and Porirua Link Roads

3 Assessment Matters

3.1 Introduction

The NZTA uses designations as the statutory tool for its State Highway network. In applying for a designation, the requiring authority (in this case the NZTA and Porirua City Council) submits a notice of requirement. The notice of requirement is accompanied by an assessment of environmental effects (AEE) including an assessment of potential effects on air quality.

Several pieces of legislation guide land transport planning. The statutory framework for land use planning is largely contained within the RMA. The purpose of the RMA is to promote the sustainable management of natural and physical resources. The Land Transport Management Act 2003 (LTMA) sets out requirements for the operation, development and funding of the land transport system.

In addition to the notice of requirement, resource consent will be required under the Regional Air Quality Management Plan for the Wellington Region for the discharge of contaminants into air from concrete batching and rock crushing, associated with the construction of the Project.

The following sections of this report outline some of the key statutory and non-statutory documents that must be considered in relation to the assessment of effects of discharges into air. A complete description of the statutory framework is beyond the scope of this report, but can be found in the AEE.

3.2 Resource Management Act 1991

The purpose and principles of the RMA are set out in Sections 5 to 8. Of particular relevance to the assessment of effects of discharges into air from land transport activities are Sections 5(1) and 5(2)(c), which state:

> *"(1) The purpose of this Act is to promote the sustainable management of natural and physical resources*
>
> *(2) In this Act, sustainable management means managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while – …*
>
> *(c) Avoiding, remedying or mitigating any adverse effects of activities on the environment."*

Air is one such natural resource. Section 7 of the RMA requires consent authorities to give particular regard to those matters listed in the section. In the case of discharges into air from this particular Project, the following matters are considered relevant: maintenance and enhancement of amenity values (Section 7(c)) and maintenance and enhancement of the quality of the environment (Section 7(fl).

In the context of this assessment, amenity values may be affected by discharges of construction dust, while the quality of the environment is described in the context of effects on human health. Effects on the environment that are not associated with the direct effects of vehicle exhaust emissions on human health or with discharges of dust are considered to be outside the scope of this report. Amenity values are addressed in Section 1 of this report, while other effects on human health are considered in Section 10.

Discharges of contaminants into air are specifically addressed in section 15 of the RMA. Sections 15(2) and (2A) state:

> *(2) No person may discharge a contaminant into the air, or into or onto land, from a place or any other source, whether moveable or not, in a manner that contravenes a national environmental standard unless the discharge—*
>
> *(a) is expressly allowed by other regulations; or*
>
> *(b) is expressly allowed by a resource consent; or*
>
> *(c) is an activity allowed by section 20A.*
>
> *(2A) No person may discharge a contaminant into the air, or into or onto land, from a place or any other source, whether moveable or not, in a manner that contravenes a regional rule unless the discharge—*
>
> *(a) is expressly allowed by a national environmental standard or other regulations; or*
>
> *(b) is expressly allowed by a resource consent; or*
>
> *(c) is an activity allowed by section 20A.*

The relevant regional plan requirements as they relate to air discharges are described in more detail below.

3.3 Regional Air Quality Plan for the Wellington region

The Regional Air Quality Management Plan (RAQMP) became operative on 8 May 2000. Change 1 to the RAQMP was made operative on1 September 2003.

The RAQMP contains objectives, policies and rules relating to air quality impacts from mobile sources (policies 4.2.22 and 4.2.23 and methods 6.5.1 and 6.5.2).

Regional objectives and policies

Policy 4.2.22:

> *“ To avoid, remedy, or mitigate the adverse effects of discharges to air from mobile transport sources and to promote:*
>
> *(1) the use of transport fuels which are low or non-polluting;*
>
> *(2) the use of fuel-efficient and well maintained vehicles; and*
>
> *(3) driving habits which minimise the production of harmful emissions”*

Policy 4.2.23:

> *“To promote improved air quality in the Region through regional and district transport planning practices which:*
>
> *(1) encourage the development of an efficient and effective public transport system;*
>
> *(2) promote the use of non-motorised forms of transport such as walking and cycling; and*
>
> *(3) aim to reduce the growth in motor vehicle numbers and motor vehicle congestion in urban centres.”*

Policy 4.2.23 aims to deal with the effects of motor vehicle emissions through transport planning mechanisms. A non-regulatory approach has been adopted in the RAQMP because it is considered more appropriate that any regulations or minimum standards relating to mobile transport sources be developed at a national level.

Method 6.5.1 requires the GWRC to include appropriate policies in the Wellington Regional Land Transport Strategy aimed at reducing the discharge of contaminants for motor vehicles.

Motor vehicle congestion results in stop-start driving, which causes inefficient combustion. Reduced congestion improves most vehicle emission characteristics, and together with reduced growth in motor vehicle numbers, reduces undesirable vehicle emissions.

Therefore, resource consent is not required for the discharge of contaminants into air from the proposed new surface sections of road.

Air discharges from road construction activities

Rule 22 of the RAQMP considers discharges from a range of miscellaneous activities, including road construction and paving activities, as a permitted activity

Rule 22:

> *"Notwithstanding any provision in Rules 1-21, the discharge of contaminants into air in connection with any industrial or trade processes associated with:*
>
> *…*
>
> *(7) road construction and paving activities (including reconstruction), other than the manufacture of hot-mix asphalt paving mixes, including moveable asphalt plants, and the remediation of asphalt surfaces ("tar burning);*
>
> *…"*

Subject to the following condition:

> *The person(s) responsible for the activity shall ensure that:*
>
> *(i) there is no discharge of particulate matter, smoke, odour, gas, aerosols or vapours from the process, which is noxious, dangerous, offensive or objectionable at or beyond the boundary of the property.*

Therefore, provided compliance with condition (i) is maintained, the discharge of contaminants into air from the proposed road construction phases is *permitted* under the RAQMP.

Air discharges from the concrete batching plant

The discharge of contaminants into air in connection with pneumatic conveying of bulk materials (including cement required for concrete batching) is specifically excluded from Rule 10 of the RAQMP (see below). The air discharges from the proposed concrete batching plant therefore require consent as a discretionary activity under Rule 23:

Rule 23:

> *"The discharge of contaminants into air from:*
>
> *(1) any process or activity explicitly excluded from Rules 1-22; or*
>
> *(2) any process or activity covered by Rules 1-22, but which does not meet the conditions attached to those rules; or*
>
> *(3) any process or activity on an industrial or trade premises not covered by Rules 1-22;*
>
> *is a Discretionary Activity."*

Air discharges from mobile crushing plant

The discharge of contaminants into air in connection with a mobile crushing plant was considered under Rule 10 of the RAQMP which provides for aggregate processing as a permitted activity.

Rule 10

> *"The discharge of contaminants into air in connection with:*
>
> *(1) sorting, storage and conveying (including loading and unloading) of fertiliser, grains, berries, coal, coke, wood chips, sawdust, wood shavings, timber and logs, bark, sand, soda ash, aggregates, live animals and other bulk products (whether in solid or liquid form, other than hydrocarbons which are covered by Rule 8); and/or*
>
> *(2) the extraction, quarrying* **[***and mining of minerals and the size reduction and screening of wood products and minerals***]***;*
>
> *is a Permitted Activity, provided it complies with the conditions below, and excluding discharges of contaminants to air arising from processes involving:*
>
> *(b) the pneumatic conveying of bulk materials."*
>
> Therefore, the use of a mobile crushing plant is a Permitted Activity subject to compliance with the following condition:
>
> *"(ii) .., any discharge shall not result in dust, odour, gas or vapour, which is noxious, dangerous, offensive or objectionable at or beyond the boundary of the property."*

3.4 Land Transport Management Act

The Land Transport Management Act 2003 (LTMA) sets out requirements for the operation, development and funding of the land transport system. Section 94 of the LTMA states that the objective of the NZTA is to "*undertake its functions in a way that contributes to an affordable, integrated, safe, responsive, and sustainable land transport system.*" The functions of the NZTA in the context of this proposal are set out in Section 95(1) of the LTMA, while Section 96 sets out the operating principles of the NZTA. The specific principle that applies to this assessment is set out in Section 96(1)(a)(i), as follows:

> *"(1) In meeting its objective and undertaking its functions, the* [NZTA] *must—*
>
> > *(a) exhibit a sense of social and environmental responsibility, which includes—*
> >
> > > *(i) avoiding, to the extent reasonable in the circumstances, adverse effects on the environment; and …"*

3.5 New Zealand Transport Strategy 2008

The NZTS has established targets that support the delivery of the government’s transport objectives and provide a focus for many of the government’s actions over the life of the Strategy. The NZTS guides New Zealand transport policy at all levels to create a sustainable, affordable, integrated, safe and responsive transport system. The vision of the NZTS is that by “*2010 New Zealand will have an affordable, integrated, safe, responsive and sustainable transport system*”.

The NZTS includes a target to *'reduce the number of people exposed to health-endangering concentrations of air pollution in locations where the impact of transport emissions is significant'*.

3.6 Wellington Regional Land Transport Strategy

The Wellington Regional Land Transport Strategy 2007-2016 was adopted by Greater Wellington in 2007. The proposed RLTS 2010-2040 has been released for submission. This RLTS meets the requirements of the Land Transport Management Act 2003 and supports the vision of the New Zealand Transport Strategy 2008, that is, an affordable, integrated, safe, responsive and sustainable transport system. An objective of the RLTS is to protect and promote public health and the RLTS contains policies in relation to environment and public health which seek to avoid, to the extent reasonable in the circumstances, the adverse effects of transport on the environment and public health. These include the following:

> *8.4 (b)*
>
> *“Support continuous improvement in air quality through reduction in harmful vehicle emissions.”*

3.7 NZTA [Transit] Environmental Plan

Where the NZTA (formerly Transit New Zealand) seeks a new or altered designation, it must take into account any air quality effects and the requirements of the Ambient Air Quality Standards set out in the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and other Toxics) Regulations 2004 (hereafter referred to as AQNES).

In 2004, Transit New Zealand (the predecessor of the NZTA) issued an Environmental Plan, which set out how its obligations under the LTMA would be exercised in practice. This Environmental Plan was reissued as Version 2 in 2008. Section 2.2 of the Environmental Plan addresses air quality issues and sets out the following objectives:

> *“A1 Understand the contribution of vehicle traffic to air quality.*
>
> *A2 Ensure new State highway projects do not directly cause national environmental standards for ambient air quality to be exceeded.*
>
> *A3 Contribute to reducing emissions where the State highway network is a significant source of exceedances of national ambient air quality standards.”*

This assessment of effects considers the requirements of these objectives, in particular objective A2, in the context of the proposed Project. In support of this assessment (and related to objective A1), a network of passive nitrogen dioxide samplers has been installed to measure ambient air quality in the area of the Project.

4 Methodology

4.1 Introduction

The Ministry for Environment's (MfE) Good Practice Guide (GPG) for Assessing Discharges to Air from Land Transport (MfE, 2008) (hereafter referred to as MfE Transport GPG) and the draft NZTA Standard for Producing Air Quality Assessments for State Highway Projects (NZTA, 2010) (draft NZTA Air Quality Standard) both recommend a three tiered approach to the assessment of vehicle exhaust emissions from road projects, as follows:

- Tier 1: preliminary assessment, to identify whether there are likely to be significant air quality effects
- Tier 2: screening assessment, using straightforward dispersion modelling techniques
- Tier 3: full assessment, with increased complexity in both traffic emission and dispersion modelling and reliance on site specific data

The assessment reported here represents a Tier 3 assessment in accordance with the MfE Transport GPG and the NZTA Air Quality Standard. The Tier 3 assessment is the culmination of the previous Tier 1 and Tier 2 project assessments. The aim of this technical assessment is to assess the:

- Potential effects that emissions from vehicles using the roads affected by the Project have on human health and the environment
- The likely effects of discharges of dust from the construction of the project on the environment

The assessment has focused on the effects that the Project will have on all members of the community, particularly those considered to represent the most vulnerable eg school children and the elderly or infirm. Exposure levels are predicted through mathematical modelling and compared with the AQNES and other relevant human health based air quality criteria (refer Section 4.3) which are designed to protect the health of the most vulnerable individuals in the community.

The assessment has considered the impact of pollutant of most concern to the health of the surrounding community. These pollutants are carbon monoxide (CO), nitrogen dioxide (NO_2), inhalable particulate matter (PM_{10}) and benzene. Particulate matter emitted from vehicle exhausts and as a consequence of brake and tyre wear have both been considered in the report.

4.2 Approach to Assessment of Effects

4.2.1 Assessment of motor vehicle emissions

The effects of vehicle exhaust emissions are dependent upon a number of factors, including: the mass emission rates of various contaminants, meteorology, background pollutant concentrations and the sensitivity of the receiving environment. The mass emission rates for different contaminants are in turn dependent on a range of factors, including: traffic volumes, vehicle speed, road gradient, and vehicle type, age and fuel composition rate.

Potential air quality effect associated with vehicle emissions of NO_2 CO, PM_{10}, and benzene have been assessed using a series of mathematical models. Separate models have been used sequentially to predict 1) traffic data, 2) vehicle pollutant emissions rate, and 3) ground level pollutants concentrations. The traffic model, SATURN-TG, vehicle emission model, VEPM (Vehicle Emission Prediction Model), and the atmospheric dispersion model used to predict ground level pollutant concentrations, AUSROADS, are described respectively in Section 1 and Section 8 of the report. These are standard and accepted models in wide use throughout New Zealand.

Potential adverse effects have been assessed by comparing predicted ground level pollutant concentrations assessed against relevant health based New Zealand air quality standards, guidelines and targets (see Section 4.3). Comparisons against the air quality criteria have taken into consideration the sensitivity of the receiving environment (refer to Section 1 and existing background pollutant levels (refer to Section 1). The structure of the assessment methodology is shown in Figure 13.2.

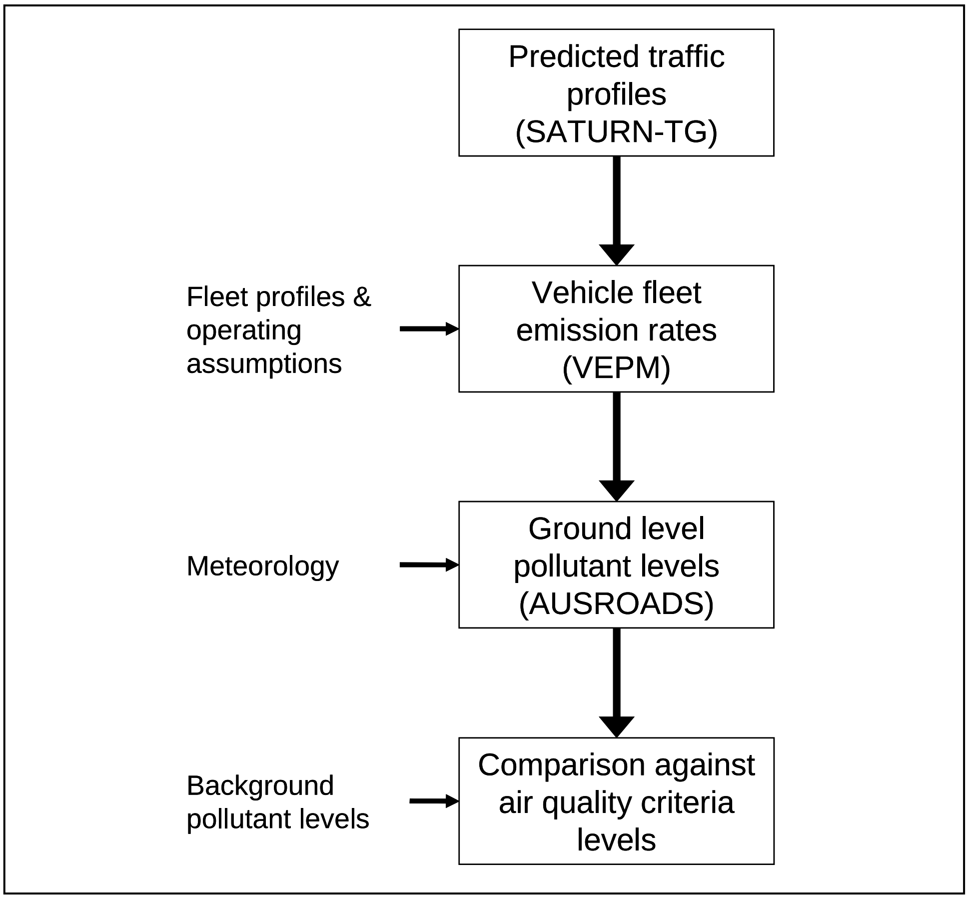

Figure 13.2: Overview of the Vehicle Emission Assessment Procedure

A total of five traffic scenarios have been assessed for the years 2006, 2026, and 2031, as follows:

- **Current base year (2006)** – used to provide a ‘baseline’ against which to compare future effects both with and without the Project.
- **2026 With Project (2026 WP)** –Traffic flows and fleet composition predicted for year 2026 assuming the Project has been completed.
- **2026 Do Minimum (2026 DM)** – For comparison with the 2026 WP scenario. Traffic flows and fleet composition are predicted for year 2026 assuming the Project has not been completed.
- **2031 With Project (2031 WP)** – Traffic flows and fleet composition predicted for year 2031 assuming the Project has been completed. Higher traffic volumes are predicted for the 2031 scenario compared to 2026 scenario. The fleet profile and emission rate varies from 2026.
- **2031 Do Minimum (2031 DM)** – For comparison with the 2031WP scenario assuming the Project has not be completed.

The projected 2026 and 2031 'do minimum' traffic scenarios assume that transportation projects which have not yet constructed (and may not been consented), but are expected to be completed in 2026 regardless of whether Transmission Gully Project goes ahead, have been completed. These projects include the following:

- The completion of other Roads of National Significance (RoNS)
- Petone (SH2)-Grenada (SH1) link Road
- SH58 upgrades
- Anticipated public transport improvements

For each of the traffic scenarios, traffic parameters and vehicle emission rates have been predicted for the Main Alignment, Project link roads, arterial roads, and major urban roads within the region (~920 links).

Pollutant levels associated with motor vehicles decrease rapidly with distance from the road they are travelling on. Therefore, predominant effects of emissions from road are generally localised to within approximately 100-200 m of the road. In the assessment, ground level pollutant concentrations have been predicted at sensitive receptors located close to roads where the air quality is expected to be most affected by the Project. This includes areas directly impacted by the traffic travelling on the Main Alignment, Link Roads and existing roads that will connect to the Main Alignment.

The wider regional air quality effects have been assessed by comparing predicted changes in traffic volumes and pollutant emissions rates on major arterial road within the region for 2026 and 2031 traffic scenarios with and without the project and against the 2006 base year. Simplified screening dispersion modelling has also been used to assess worse case pollutant levels at locations near major arterial roads affected by the Project.

Detailed dispersion models have been constructed for the most affected locations. The selection of these locations is described in Section 7.3.2 and the models are described in Section 8. Detailed modelling of the entire route was not considered necessary, for the following reasons:

- The existing air quality along most to the route is very good due to the rural environment
- The estimated traffic volumes (even with heavy duty vehicles on inclines) are insufficient to generate significant effects
- There are few or no sensitive receptors along most of the route

Simpler screening models using conservative emissions and dispersion assumptions have been used to predict worse case pollutant levels on other arterial roads. The results are presented in Appendix 13.H.

The effect of the Project on total traffic related pollutant emission rates in the region has been discussed in Section 7.3 of the report. However, it is important to note that predicted changes in regional emission rates do not necessarily correspond to changes in local air quality levels. The proposed Project will be located in a predominantly rural area. Since the Wellington region is well ventilated, regional emissions from vehicles travelling on the Project roads in these areas will not have a significant effect on pollutant levels in the more densely populated residential areas.

4.2.2 Assessment of construction dust emissions

The assessment of construction dust is based on reviewing the proposed construction methodology to identify dust generating activities and assessing the proximity of these activities to residential properties and other sensitive receptors. Having identified these locations, mitigation measures are recommended for managing and minimising the impacts of dust emissions.

4.3 Air quality standards and guidelines

Air quality standards and guidelines are used to assess the potential for ambient air quality to give rise to adverse health or nuisance effects. The MfE Transport GPG (2008) recommends the following order of precedence when selecting air quality assessment criteria:

- New Zealand National Environmental Standards
- New Zealand Ambient Air Quality Guidelines
- Regional Air Quality Targets (unless these are more stringent than the equivalent National Environmental Standards, in which case the regional targets take precedence)

For the contaminants being considered in this assessment, relevant assessment criteria are discussed in this section, while the applicability of those criteria to different receptors is discussed in Section 4.6.

The Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 (as amended) (AQNES) were prepared under Sections 43 and 44 of the RMA and are designed to protect public health and the environment of New Zealand. The AQNES came into effect in 2005 and among other things, set concentration limits for five common ‘criteria’ air pollutants including PM_{10}, CO, and NO_2. The AQNES criteria limits for PM_{10}, CO, and NO_2 are summarised in Table 13.1. For each of the contaminants the AQNES defines a criteria concentration and number of times per year they may be exceeded. Other air contaminants for which AQNES criteria limits were defined were sulphur dioxide (SO2) and ozone (O_3). The proposed project will not have effect on the ambient levels of either of these air pollutants.

The AQNES apply nationally everywhere people may be exposed in the open air, except in areas to which a resource consent applies for the discharge of that contaminant. The standards do not apply inside enclosed spaces such as houses, tunnels or vehicles.

The AQNES are not designed to be air dispersion modelling criteria. Compliance is determined by the evaluation of ambient monitoring records as opposed to the direct comparison of predicted dispersion model concentrations against the AQNES threshold concentrations. However, the “*Updated Users Guide to Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004”* (MfE, 2005) indicates that predictive air dispersion modelling is an appropriate method for estimating the contribution of defined emission sources to air pollutant level, when used in accordance with the “*Good Practice Guide to Atmospheric Dispersion Modelling*” (MfE, 2004).

MfE (2005) also provides guidance with respect to the application of the AQNES in relation to land designations, as follows:

> *“For **new** designations after 1 September 2005, territorial authorities and/or requiring authorities should consider the ambient air quality standards when weighing up whether new designations, or alterations to existing designations, meet the purposes of the RMA (eg, safeguarding the life-supporting capacity of air). Territorial authorities will need to take into account the potential impacts of a new designation on air quality in the airshed, and the subsequent impact upon their ability to issue future resource consents within that airshed.”*

Table 13.1: Relevant National Environmental Standards

Pollutant	Averaging time	Criteria level	Allowable exceedances per year
Nitrogen dioxide (NO_2)	1-hour	200 µg/m^3	9
Carbon monoxide (CO)	8-hours (rolling)	10 mg/m^3	1
Inhalable particulate (PM_{10})	24-hours	50 µg/m^3	1

In accordance with the requirements of the AQNES, the GWRC has classified eight airsheds in the Wellington region where the PM_{10} standard is regularly breached each year, or that were considered to have potential to breach the national environmental standard unless carefully managed. Parts of the Project and wider regional impacts of the Project will affect one of these gazetted airsheds which is Porirua.

MfE has published a set of Ambient Air Quality Guidelines (AAQG), which were most recently updated in 2002. The AAQG are intended to promote the sustainable The AAQG criteria limits are comparable to the AQNES, but unlike the AQES the AAQG do not specify a permitted number of time per year the guideline may be exceeded. Relevant pollutant criteria levels for average periods not prescribed in the AQNES are present in Table 13.2.

Table 13.2: Relevant MfE Ambient Air Quality Guidelines (AAQG)

Pollutant	Averaging time	Criteria level
Nitrogen dioxide (NO_2)	24-hours Annual	100 µg/m^3 40 µg/m^3
Carbon monoxide (CO)	1-hour	30 mg/m^3
Inhalable particulate (PM_{10})	annual	20 µg/m^3
Benzene	annual	3.6 µg/m^3

The Greater Wellington Regional Council (GWRC) has also adopted regional ambient air quality guideline (RAAQG) values, which are set out in the Regional Air Quality Management Plan for the Wellington Region (2000). The Regional Air Quality Management Plan became operation in May 2000, before either the AQNES or AAQG were published. For CO and NO_2 the RAAQG specifies both 'maximum desirable levels' and 'maximum acceptable levels'. Only 'maximum acceptable levels' are defined for particulates. Policy 4.2.1 of the air quality plan define 'maximum desirable levels' and 'maximum acceptable levels' as follows:

- *"the **maximum acceptable levels** are defined as the level adequate to protect the health of individuals. These levels would be applied in areas where existing activities has had a significant effect on air quality; and*
- *the **maximum desirable levels** are defined as the level that will provide maximum protection to the environment, taking into account existing air quality, community expectations, economic implications, and the purpose and principles of the Act. Desirable levels are appropriate guidelines or targets in rural or residential areas, and in other areas with good air quality. These levels are based on Canadian standards and do not appear in the National Ambient Air Quality Guidelines. "*

Relevant RAAQG are presented in Table 13.3. The RAAQG maximum acceptable levels for particulates and CO are comparable to the AQNES and AAQG. However, the maximum acceptable level for 1-hour average NO_2 concentration is less stringent than either the AQNES or AAQG.

Table 13.3: Relevant GWRC Regional Ambient Air Quality Guidelines (RAAQG)

Pollutant	Averaging time	Maximum desirable levels	Maximum acceptable levels
Nitrogen dioxide (NO_2)	1-hour 24-hours	95 µg/m^3 30 µg/m^3	300 µg/m^3 100 µg/m^3
Carbon monoxide (CO)	8-hours (rolling)	6 mg/m^3	10 mg/m^3
Inhalable particulate (PM_{10})	24-hours annual	- -	50 µg/m^3 20 µg/m^3

In addition, there are a number of relevant international guidelines, particularly those promulgated by the World Health Organisation (WHO)1 that must be considered. The WHO guideline that is applicable to this assessment is summarised in Table 13.4.

Table 13.4: WHO Air Quality Guidelines

Pollutant	Averaging period	Threshold concentration
Nitrogen dioxide	Annual	40 µg/m^3

The MfE (2000) also publishes guidelines for the protection of sensitive ecosystems. The applicable critical level for vehicle emissions is presented in Table 13.5. The critical level assumes that ozone or SO_2 are also present at or near guideline levels.

Table 13.5: MfE Critical Levels

Pollutant	Averaging period	Critical level
Nitrogen dioxide	Annual	30 µg/m^3

4.4 Relevant air quality assessment criteria

Table 13.6: Relevant Assessment Criteria summarises the relevant assessment criteria that have been used in the assessment. Due to the reductions in the permissible sulphur content of vehicle fuels over recent years, vehicle exhaust emissions are no longer regarded as a significant source of SO_2 in ambient air in New Zealand. Therefore, assessment criteria for SO_2 have not been used in this report.

Table 13.6: Relevant Assessment Criteria

Pollutant	Threshold concentration	Averaging period	Rationale
Fine particles (as PM_{10})	50 µg/m^3 20 µg/m^3	24-hour Annual	AQNES NZAAQG
Carbon monoxide	30 mg/m^3 10 mg/m^3	1-hour Rolling 8-hour	NZAAQG AQNES
Nitrogen dioxide	200 µg/m^3 100 µg/m^3 40 µg/m^3	1-hour 24-hour Annual	AQNES NZAAQG WHO
Benzene	3.6 µg/m^3	Annual	NZAAQG

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[1] Air Quality Guidelines Global Update 2005, World Health Organisation Regional Office for Europe

4.5 Trigger levels for dust

Dust refers to larger airborne particles, typically more than 50µm in diameter, that have the potential to settle on surfaces. These larger particulates are not generally associated with adverse health effects, although may have the potential to cause nuisance effects from dust settling if emissions are not appropriately managed and controlled.

There are no National Environmental Standards, Air Quality Guidelines or Regional Air Quality Guidelines for dust, other than particulate matter with a diameter greater than 10µm. A number of ‘trigger levels’ are contained in the Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions (MfE, 2001) (MfE Dust GPG), which are summarised in Table 13.7. Table 13.7 presents three different trigger levels for total suspended particulate (TSP), depending on the sensitivity of the receiving environment.

Table 13.7: Recommended Trigger Levels for Deposited and Suspended Particulate (MfE, 2001)

Pollutant	Trigger level	Averaging period	Applicability
Deposited dust	4 g/m^2	30 days	All Areas
Total Suspended Particulate	80 µg/m^3	24-hours	Highly sensitive areas
	100 µg/m^3	24-hours	Moderately sensitive areas
	120 µg/m^3	24-hours	Insensitive areas

The GWRC also includes a narrative standard for dust in the RAQMP as follows:

> *“That beyond the boundary of the premise where the activity is being undertaken there shall be no noxious, dangerous, offensive or objectionable dust, particulate, smoke or ash”*

The trigger levels presented in Table 13.7 have not been used as assessment criteria in this document as no modelling has been carried out, however, as discussed in Section 10.5 of this report, the trigger values for TSP are appropriate for managing the effects of dust once construction of the Project has commenced.

4.6 Application of criteria to receptors

The MfE Transport GPG (2008, p30) indicates that the ambient air quality standards should apply where people would reasonably be exposed for the standard’s averaging period. Specific guidance on the applicability of the AQNES is provided in the Good Practice Guide, as summarised in Table 13.9).

Table 13.8: Applicability of the AQNES at Receptors

Averaging period	Locations where assessment against the Standards should apply
1 hour	This includes any outdoor areas where the public might reasonably be expected to spend one hour or longer, including pavements in shopping streets, as well as facades of any building where the public might reasonably be expected to spend one hour or longer.
24 hours and 8 hours	This includes all outdoor locations where members of the public might be regularly exposed (eg residential gardens) as well as facades of residential properties, schools, hospitals, libraries, etc.

5 Receiving Environment

5.1 Land use

5.1.1 Overview

The proposed Main Alignment of 27 km in length traverses a range of receiving environments with varying land use from its interchange with SH1 at Linden in the south to its interchange with SH1 at MacKays Crossing in the north.

The Main Alignment has been divided into nine sections for reference purposes. The reference sections are summarised in Table 13.9 and shown in Figure 13.3.

Table 13.9: Main Alignment Sections Description

Section N^o	Section name	Station value (m)	Length (km)
1	MacKays Crossing	00000-03500	3.5
2	Wainui Saddle	03500-06500	3.0
3	Horokiri Stream	06500-09500	3.0
4	Battle Hill	09500-12500	3.0
5	Golf Course	12500-15500	3.0
6	State Highway 58	15500-18500	3.0
7	James Cook	18500-21500	3.0
8	Cannons Creek	21500-24900	3.4
9	Linden	24900-27700	2.8

The receiving environment of the Porirua Link Roads is described in Section 5.1.6 along with the James Cook Section of the Main Alignment.

5.1.2 Section 1: MacKays Crossing

This section has an alignment length of 3.5 km from the interchange south of MacKays Crossing.

SH1 traverses a coastal plain from Paekakariki east to where the MacKays Crossing interchange is to be located at the foot of the Te Puka Stream valley and then north to MacKays Crossing. From the interchange, the alignment leads south up the Te Puka Stream valley.

The area in the vicinity of the interchange with SH1 is generally rural, predominantly used for pastoral farming. The township of Paekakariki is located to the west of the alignment. Outside of the township, in the vicinity of the alignment, rural dwellings are sparsely distributed. Commercial uses, such as market gardening and a commercial car transport business, are also located adjacent to SH1 southwest of the MacKays crossing interchange. Queen Elizabeth II Park is located to the north of the interchange area.

Outside of the sparsely located rural dwellings and commercial activities, the sensitivity to air contaminants of land use activities in this area is generally low.

Vehicle emissions from SH1 are likely to contribute to background levels of NOx, CO and PM_{10}. Domestic solid fuel heating at Paekakariki is likely to contribute to background levels of PM_{10} and CO.

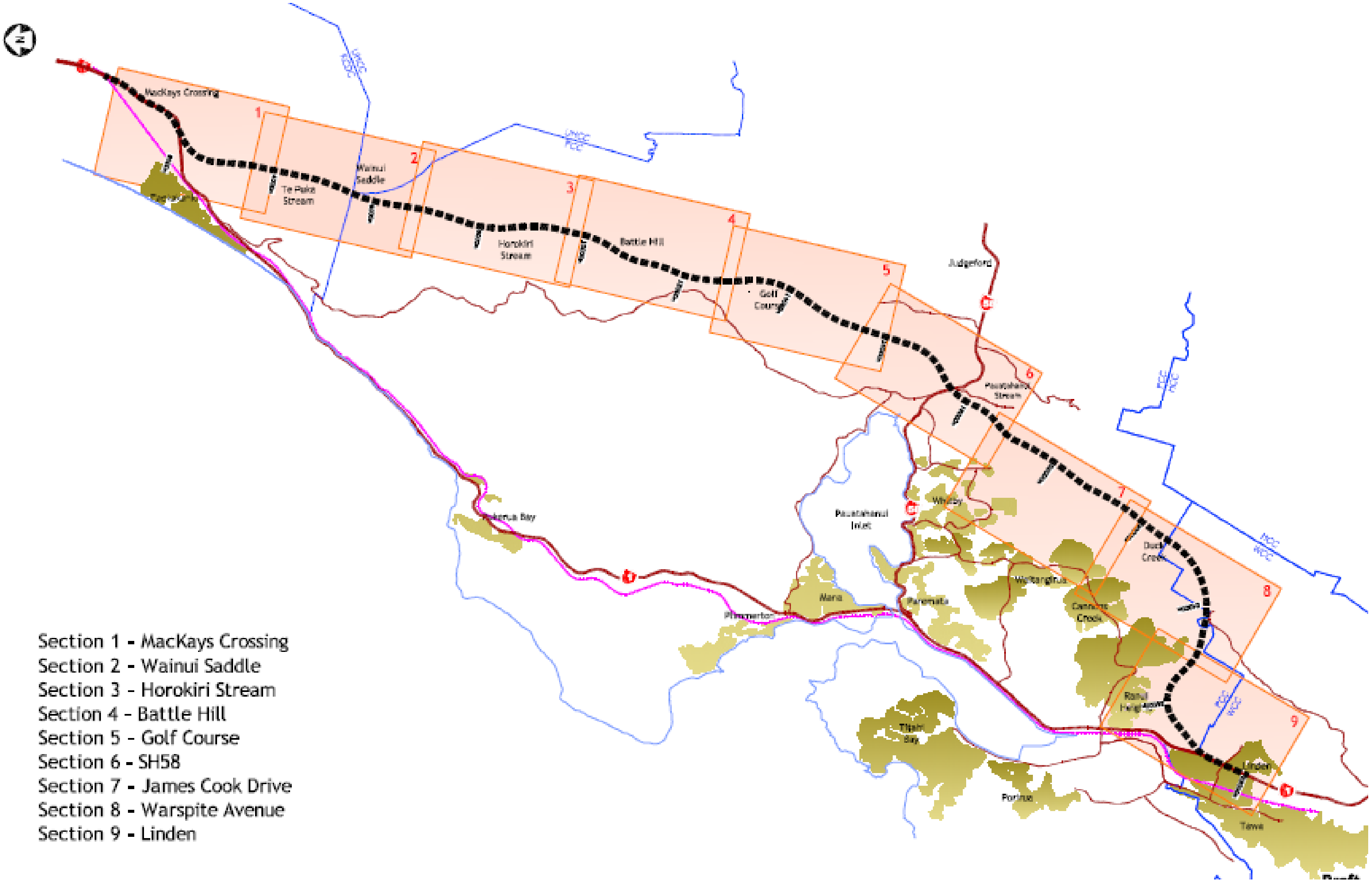


Figure 13.3: Location of main alignment sections

5.1.3 Sections 2 and 3: Wainui Saddle/Horokiri Stream

The alignment in these sections (total alignment length of 6.0 km) climbs up the Te Puka Stream valley to the Wainui Saddle and down the Horokiri Stream Valley. These sections feature rural land uses with a mixture of pasture and forest. The sensitivity to air contaminants of land use activities in this area is generally low.

5.1.4 Sections 4 and 5: Battle Hill/Golf Course

These sections (total alignment length of 6.0 km) also feature rural land uses. The Battle Hill Forest Park features pasture and forest. The park is open to the public and provides for a range of public recreational activities. The Pauatahanui Golf Course abuts the alignment to the west.

Sparsely located rural dwellings are located along Paekakariki Hill Road to the west of the alignment and along Flightys Road to the east of the alignment in the Golf Course section towards SH58.

Outside of the sparsely located rural dwellings or locations such as the clubhouse at the golf club, the sensitivity to air contaminants of land use activities in this area is generally low.

5.1.5 Section 6: State Highway 58

The alignment follows a generally rural environment in this section, through pasture and plantation forest.

The township of Pauatahanui is located to the west of the alignment on the Pauatahanui Inlet. This township features residential housing, a school, a church and commercial activities. Outside of the township there are a number of dwellings located along SH58.

There are a number of rural residential dwellings located along Bradey Road, south of SH58 and to the east of the alignment.

The residential area and recent residential subdivisions of eastern Whitby lie to the west of the alignment and feature existing and future medium density residential development.

The areas of residential development and commercial activities at Pauatahanui and Whitby and the isolated dwellings in the area are likely to be sensitive to air contaminants. Sensitivity is likely to be further increased at Pauatahanui School. Sensitivity in the remaining areas of this section is generally low.

Vehicle emissions from SH58 and suburban streets are likely to contribute to background levels of NO_x, CO and PM_{10}. Domestic solid fuel heating in the residential areas is likely to contribute to background levels of PM_{10} and CO.

5.1.6 Section 7: James Cook

As with Section 6 the main alignment follows a generally rural environment in this section, through pasture and plantation forest. The residential areas of Whitby and Waitangirua lie to the west of the main alignment.

Two Porirua Link Roads (the Whitby Link Road and the Waitangirua Link Road) are proposed that are to traverse areas of existing plantation forest and pasture to the outskirts of the residential areas at Whitby and Waitangirua. The Porirua Link Roads are shown in Figure 13.1.

The Whitby Link Road connection at James Cook Drive currently features little residential development, however much of this area is due to be developed. There is also the potential for future residential development within the existing undeveloped areas along the alignment of this link road.

The Waitangirua Link Road intersection is adjacent to Maraeroa Marae and the carpark of the Waitangirua shopping centre on Warspite Avenue. The North City Apostolic Church and commercial activities along Commerce Cr, including a bus depot lie to the north of the alignment. Otherwise the area of the intersection generally consists of medium density residential development.

Within the residential area are a number of locations of increased sensitivity, such as the marae health centre approximately 60 m south of the alignment, Natone Park School approximately 230m southwest of the interchange and Waitangirua Kindergarten and the grounds of Corrina St School approximately 350 m south of the alignment.

The residential areas and commercial activities in this area are sensitive to air contaminants. Sensitivity is likely to be further increased at the locations of health centres, schools and early childhood centres in the area. Sensitivity in the remaining areas of this section is generally low.

Vehicle emissions from suburban streets and the bus depot are likely to contribute to background levels of NO_x, CO and PM_{10}. Domestic solid fuel heating in the residential areas is likely to contribute to background levels of PM_{10} and CO.

5.1.7 Section 8: Cannons Creek

As with Section 6, the Main Alignment passes through rural pasture to the east of the eastern suburbs of Porirua in this section. The alignment runs along the eastern side of Duck Creek valley through the Belmont Regional Park. The Belmont Regional Park features pasture and forest. The park is open to the public and provides for a range of public recreational activities.

The Main Alignment passes to the east of residential areas of Waitangirua and Cannons Creek before turning west to pass to the south of upper Cannons Creek. It is this area of residential development that is likely to be most sensitive to vehicle emissions in this section. Sensitivity to emissions is likely to be increased at Glenview School in Cannons Creek but this school is located approximately 800 m north of the alignment.

Vehicle emissions from suburban streets in this area of Cannons Creek are likely to contribute to background levels of NO_x, CO and PM_{10}. Domestic solid fuel heating in Cannons Creek is likely to contribute to background levels of PM_{10} and CO.

5.1.8 Section 9: Linden

The eastern part of this section comprises rural pasture and plantation forest. The western part of this section is comprised of the residential areas of Tawa and Linden in the Tawa Valley. SH1 runs along the eastern side of this valley. Further residential development and semi-residential properties are located at Greenacres on the eastern side of SH1 to the south of the main alignment at the proposed Kenepuru link road roundabout. The residential area of Ranui Heights is located to the north of the alignment in this section.

Linden School is located adjacent to SH1 where the Main Alignment diverges. Tawa College and Tawa Intermediate, Tui Park Kindergarten and Greenacres School are also located nearby but further from the motorway.

The grounds of Kenepuru Community Hospital are located immediately northwest of the intersection of the proposed Kenepuru Link Road and Kenepuru Drive. Light industrial and commercial activities are located to the south of this intersection with further commercial activities located on Kenepuru Drive to the north.

The schools, early childhood centres and medical facilities in this area are likely to exhibit particularly high sensitivity to vehicle emissions. Sensitivity is also likely to be high in residential areas and at locations of commercial activities.

Domestic solid fuel heating in the residential areas is likely to be the main contributor to background levels of PM_{10} and CO. Vehicle emissions from SH1, Kenepuru Drive and suburban streets is also likely to contribute to background levels of NO_x, CO and PM_{10}.

5.2 Topography

Local topography can influence the transport and diffusion of emitted air pollutants. For example, hills or rough terrain can affect wind speeds, directions and turbulence characteristics, and nearby water bodies can considerably dampen turbulence levels. Significant valleys can restrict horizontal movement and dispersion and encourage the development and persistence of drainage flows.

5.3 Meteorology

The Wellington region has been classified into eight airsheds by the GWRC. These airsheds are constrained by valleys between steep hills or mountains and each has a distinct microclimate and meteorological conditions.

Wind speed and wind direction influences the dispersion of contaminants discharged and therefore the potential effects of those contaminants on the surrounding environment. Given the length of the Transmission Gully Main Alignment and the variable terrain that it traverses, local winds flows are expected to vary throughout the alignment. Wind measurements made in the area of the alignment provide an indication of wind conditions that may be experienced in different areas of the alignment.

The GWRC has recorded meteorological parameters at its Tawa ambient air quality monitoring site. Tawa is the only meteorological monitoring site within the Project area. Wind speed and wind direction are recorded at the site using a 6 m high meteorological mast. The wind fields at this site are likely to be representative of most locations within the Tawa Valley including areas surrounding the Linden interchange and the Kenepuru link road, where peak traffic volumes are predicted.

The distribution of wind speeds and wind directions recorded at the Tawa monitoring site for the year 2008 are presented in Figure 13.4. The figure shows a strong prevalence of north-northeast winds and also a high proportion of wind from the opposite south-southwest direction. Observed wind flows are consistent with topography of the area - the monitoring site is located in the Tawa valley which runs in the same direction as the predominant wind flows – and regional wind flows. Wind speeds at the site are low compared to most other locations in the Wellington area. Wind speeds greater than 5.5 m/s, when there is higher potential for adverse dust effects, occur for approximately 8% of the time and blow predominantly from the north north-east. Receptors to the south-west of dust emission sources are likely to be those most affected.

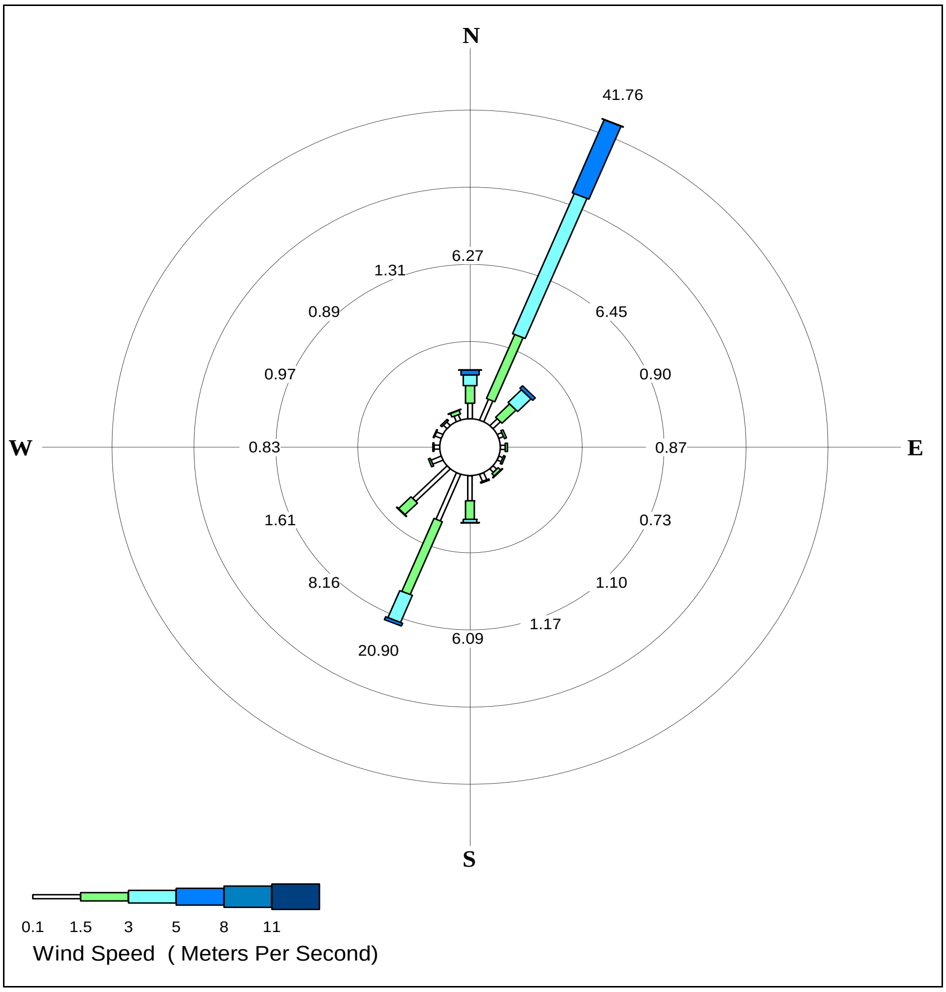


Figure 13.4: Tawa Ambient Air Monitoring Station Distribution of Wind Speed and Wind Direction 2008 (1-hour averages)

Wind speed and wind direction is also recorded at the Paraparaumu airport meteorological station (station number 8567), located on the Kapiti Coast. Although the monitoring station's location is 7km north of the MacKays Crossing interchange along the coastal plain, recorded wind flows are expected to be indicative of wind conditions in the area of this interchange at the northern end of the alignment.

Wind speed and wind direction are recorded at site using a 10m meteorological mast. The distribution of wind flows for the year 2008 is shown in Figure 13.5. The figure shows the prevalence of northerly and north-easterly winds.

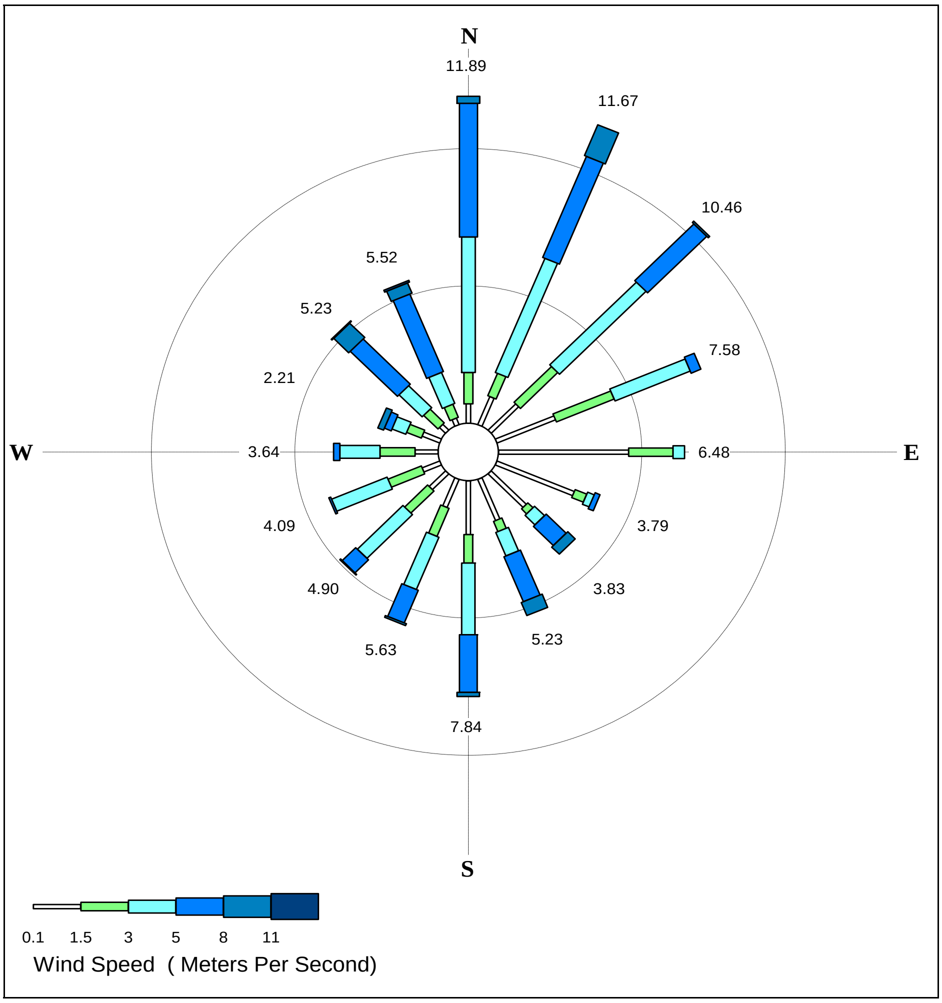


Figure 13.5: Paraparaumu Meteorological Monitoring Station Distribution of Wind Speed and Wind Direction 2008 (1-hour averages)

5.4 Sensitive receptors

5.4.1 What is a sensitive receptor?

The MfE Transport GPG recommends assessing the air quality effects of a proposed road on identified sensitive receptors. In this context, sensitive individuals include children and those whose health is already compromised, such as elderly persons.

Therefore, sensitive receptors include residential areas, childcare and early learning facilities, schools, hospitals and residential care homes.

These people are generally regarded as likely to be more sensitive than the general population to the effects of vehicle exhaust emissions. The identification of specific sensitive receptors is based on both the presence of vulnerable individuals and their exposure time (the period when people might reasonably be expected to be exposed to pollutants at a specific site). The frequency and duration of exposure is related to the averaging periods used for the various assessment standards and guidelines (refer Table 13.6).

5.4.2 Selection of sensitive receptors

Concentrations of air pollutants from vehicles on surface roads tend to decrease fairly rapidly with increasing distance from the road. For example, in 2006 the ARC undertook passive monitoring of NO_2 at a number of sites at varying distances from SH20 in Mangere and SH1 in Penrose (ARC, 2008). The results of this monitoring indicated that elevated concentrations of NO_2 arising from motor vehicle emissions could be detected only within a few hundred metres from the motorway.

Therefore, for the purposes of this assessment, sensitive receptors have only been identified if they are located within 200 m of a major surface road.

In addition to residential areas, other high sensitivity receptors include locations where people with a higher than average susceptibility to the effects of air pollution are likely to be found for an hour or more. In practice such ‘sensitive receptors’ are generally considered to include the following (MfE, 2008; NZTA, 2010):

- Early childhood education centres
- Schools
- Hospitals
- Medical clinics
- Residential care homes

Residential receptors have also been included, selected on the basis of their proximity to the roads most affected by the Project.

In addition, areas of open space or parks used for recreational activities are classified in the MfE Transport GPG as being receiving environments of high sensitivity. Sports fields have therefore also been identified as sensitive receptors. This assessment does not include any possible effects of vehicle exhaust emissions on vehicle occupants (which are excluded from consideration under the AQNES).

A list of the sensitive and other discrete receptors are presented in Table 13.10. Grid references (New Zealand Transverse Mercator) for each receptor have been included. Maps showing their individual location are presented in Appendix 13.C.

Table 13.10: Sensitive and Other Discrete Receptors

Detailed Model Area	Detailed Model Receptor N^o	Description	NZTM X	NZTM Y
L1	R4	Kapi Mana School	1754632	5443702
	R5	Kenepuru Community Health Hospital	1754369	5443234
	Various	Residential receptors	Various	Various
L2	R5	Linden School Sports ground	1754097	5441941
	R6	Linden School	1754052	5441884
	R13	Arthur Carman Park	1754170	5442136
	R14	Tui Park Kindergarten	1753970	5442228
	Various	Residential receptors	Various	Various
L3	R1	6 Kokiri Cres (Natone Park School)	1757760	5445022
	R2	Maraeroa Marae Health Centre	1757880	5445143
	R3	Maraeroa Marae	1757891	5445209
	Various	Residential receptors	Various	Various
L4	Various	Residential receptors	Various	Various
L5	Various	Residential receptors	Various	Various

5.5 Identification of affected locations for detailed assessment

The Main Alignment will extend for approximately 27 km and will also involve the development of large interchanges and link roads. For the majority of the Main Alignment however, the route travels through rural areas with very low population density and therefore are considered to be of low sensitivity to the potential air quality effects of the Project. Despite this, the proposed Project will potentially have a significant effect on traffic flows over a large area.

These changes in regional traffic flows will have a greater impact on ambient air pollutant level in areas where traffic flows are high and where high levels of vehicle congestion or queuing may occur, for instance busy intersections, and roads with volumes of high heavy vehicle traffic.

In order to identify the key air quality issues and affected locations on which to focus the detailed air quality assessment, the guidance in the GPG for Assessing Discharges to Air from Land Transport (MfE GPG Transport) has been used. During the preliminary assessment phase of road transport projects, the GPG Transport Tier 1, recommends the use of the criteria in Table 13.11 to identity potential areas where further investigation is required. In other areas it is assumed that emissions from vehicles are highly unlikely to result in any of the air quality criteria being exceeded, even if worse case background pollutant and dispersion conditions were to occur.

Table 13.11: MfE (2008) Tier 1: Screening Threshold Criteria

Road type	Screening threshold criteria
Busy roads	Identify links where traffic is likely to be greater than 7000 vehicles per day.
Congested roads	Identify any links that may be congested, where traffic is likely to be greater than 3000 vehicles per day.
Busy intersections	Identify any busy intersections with more than 7000 vehicles per day, regardless of level of congestion.
Roads with a high flow of buses and/or heavy vehicles	Identify any links where the flow of heavy vehicles (> 3.5 tonnes) is likely to be more than 500 vehicles per day

Comparable screening criteria are also incorporated in the Tier 1 screening assessment phase of the draft NZTA standard. The draft standard also indicates a more detailed assessment may be required if any of the following apply:

- Sensitive receptors or residents are located within 200 m of the proposed development
- Part of the development is in an area likely to be in a valley, in a built up area, an urban canyon or other sheltered spot
- Whether the Project will cause traffic volumes, level of service (LoS), or average speeds on other roads in built up areas of the 'wider project' to change by more than 10%

The air quality assessment of the proposed Project has focused on locations within the Project area where the MfE and NZTA initial screening criteria are predicted to be exceeded as a consequence of the proposed Project and where ambient air pollutant concentrations may also increase. In general these areas have been identified as roads or intersections where traffic volumes are greater than 7000 vehicles per day. The proposed Project is predicted to increase traffic volumes by more than 10%, and where sensitive receptors or residents are located within 200 m of the road.

Although average daily traffic volumes along the entire length of the Main Alignment are predicted to be greater than 7000 vehicles per day, a high proportion of the motorway will be located in sparsely populated rural areas and residential dwellings are typically located some distance from the motorway. In these areas emissions from the road are unlikely to have an impact on the surrounding community.

Detailed dispersion models have been constructed for the most affected areas. The models are described in Section 1 of this report. Simpler screening models using conservative emissions and dispersion assumptions have been used to predict worse case pollutant levels on other arterial roads. The results are presented in Appendix 13.I.

6 Existing ambient air quality

6.1 Sources of data

In order to assess the impacts of the Project on future air quality, an estimate needs to be made of the state of current air quality, or 'background' air pollutant levels. This section provides an assessment of air quality in the urban areas affected by the Project. Currently no monitoring data is available from the rural areas through which the majority of the Main Alignment will travel. An estimate of air quality in these areas is therefore based on typical conservative estimates for rural areas, provided in the MfE GPG Transport.

GWRC currently monitors air quality at six locations in the Wellington Region. The closest monitoring station to the proposed Project is at Duncan Park, Tawa. This site is located approximately 550 m west of SH1 where the existing motorway is joined by the proposed Main Alignment and approximately 1km southwest of the proposed Kenepuru interchange. The monitoring station is located within a recreational park in the Tawa/Linden residential area and the main contaminant sources are likely to be domestic solid fuel combustion and traffic emissions. Monitoring of PM_{10}, NO_x and CO concentrations commenced at the site in 2007 along with meteorological monitoring.

The Tawa site is located at the bottom of valley. Pollutant concentrations monitored at the site are likely to be influenced by drainage flows during cold winter nights which would transport pollutants emitted from residential sources located on the surrounding hills down into the valley. Concentrations recorded at the site are expected to provide a conservative assessment of background levels in the Linden area.

Of the other GWRC monitoring locations, those at Lower Hutt and Upper Hutt are considered to have similarities in topography and similar composition of emission sources to residential areas. Monitoring sites at Wellington Central (Victoria St), Melling and Ngauranga are peak traffic sites and may give some indication of concentrations in close proximity to SH1, SH58 and major arterial routes in the area. A comparison of the data collected by GWRC at these regional monitoring sites is presented in Appendix 13.A.

The NZTA has also implemented a passive NO_2 sampling programme at four locations in the Wellington region since 2007. This was expanded in March 2010 to include a further 14 sampling locations in the area of the Main Alignment.

Although no benzene monitoring has been conducted in the area, passive monitoring of benzene in the Auckland region may give a conservatively high indication of the ambient benzene concentrations that may exist in the area of the Main Alignment.

6.2 PM_{10} Concentrations

A summary of the ambient PM_{10} concentrations measured at Tawa from 2007 to 2009 are presented in Table 13.12.

Table 13.12: Summary of Ambient PM_{10} Concentrations Measured at Tawa, 2007-2009

Statistical value	2007*	2008	2009	Average
Highest 24-hr Average	54*	32	32	39
2nd Highest 24-hr Average	40*	30	30	33
Annual Average	NA*	16	13	14

*Partial year (PM_{10} monitoring commenced May 2007). There is insufficient data available for calculation of average values.

Measurements at this location are likely to be representative of the area of the Linden/Kenepuru interchange described in section 5.1.8 and, given the residential development in the surrounding area, potentially the eastern suburbs of Porirua described in sections 5.1.6 and 5.1.7 that are proposed to be linked to the Main Alignment. Given the domestic heating emissions likely to be generated from the residential development in the area of the monitoring station, the PM_{10} concentrations measured at this site are likely to be in excess of ambient concentrations in other areas of the proposed alignment, particularly rural areas.

As can be seen from Table 13.12, the highest concentrations were measured in the partial monitoring year of 2007. The highest 24-hour average PM_{10} concentration (measured on 28 June 2007) was higher than any of the concentrations measured in 2007 at the similarly located residential sites at Lower Hutt and Upper Hutt and the peak traffic sites at Victoria Street, Melling and Ngauranga Gorge. The highest 24-hour average PM_{10} concentration measured in the Wellington region in 2007 occurred on the same day (28 June 2007) in Wainuiomata. Topographical and meteorological differences between that site and the area of the Main Alignment mean that that concentrations measured in Wainuiomata are unlikely to be representative of contaminants concentrations along the alignment.

The peak concentration measured at Tawa on 28 June 2007 may have been over stated since during the day 1-hour average concentrations were not recorded between 12:00 and 17:00, when measured CO concentrations and trends in diurnal PM_{10} concentrations from the receding and following days would indicate that 1-hour average PM_{10} concentrations were likely to have dipped and reduced the 24-hour average for the day. Furthermore, 24-hour average PM_{10} concentrations measured in late June 2007 (when the highest concentrations were recorded) were influenced by peaks in hourly PM_{10} concentration averages that occurred in the late morning. The presence of peaks at this time rather than in the evening, night or earlier in the morning would indicate the potential presence of extraneous PM_{10} sources over this period.

The highest concentrations measured in 2008 and 2009 were more consistent than those measured in the partial 2007 year, with highest concentrations of 32 $\mu g/m^3$ and second highest concentrations of 30 $\mu g/m^3$ measured in each year. The highest concentrations measured in 2008 and 2009 are therefore considered more representative of concentrations likely to occur in the future.

6.3 Nitrogen Oxide concentrations

6.3.1 Instrumental Nitrogen Oxides monitoring

A summary of the continuous ambient NO_2 and NO_x ($NO + NO_2$) concentrations measured at Tawa monitoring station from 2007 to 2009 are presented in Table 13.13.

Table 13.13: Summary of Ambient NO_2 Concentrations Measured at Tawa, 2007-2009

Statistical Value	2007		2008		2009		Average	
	NO_2	NO_x	NO_2	NO_x	NO_2	NO_x	NO_2	NO_x
99.9th Percentile 1-hr Average	47	484	44	430	43	362	45	425
Highest 24-hr Average	34	278	26	186	26	176	29	213
Annual Average	-	-	9.9	27.1	9.7	24.8	11.3	30.6

As with the highest PM_{10} and CO measurements, the NO_x and NO_2 concentrations measured in the truncated 2007 period were higher than in the two subsequent full calendar years. In relation to annual average measurements, there was insufficient data available for the calculation of an annual average for 2007 (representative of the entire year).

6.3.2 Passive NO_2 monitoring results

The NZTA operates a NO_2 passive monitoring programme at a number of sites within the Wellington Region. Passive monitoring is undertaken using ‘diffusion tubes’, which are exposed for approximately a month at a time.

Four long term passive monitoring sites are located near busy State highways (SH1, SH2, and SH58). Monitoring of NO_2 levels at these sites began in 2007. A summary of annual average NO_2 concentrations recorded at the four NZTA peak traffic monitoring sites for the years 2007 to 2009 are presented in Table 13.14. The monitoring data shows annual average NO_2 concentrations are highest at monitoring sites located near SH1 and SH2 (WEL002, WEL004 and WEL005). The lower annual average NO_2 concentrations are recorded at the WEL006 monitoring site can be attributed to the lower traffic volumes on SH58 compared to those that occur on SH1 and SH2. The highest annual average NO_2 concentrations recorded at any of the long term sites is approximately24 µg/m^3.

Thirteen additional monitoring sites have been established at locations within the Project area. These passive sites have been used to help quantify existing NO_2 levels in areas that may be affected by the Project, particularly at sites located near sensitive receptors. These monitoring sites were commissioned in March 2010. Average NO_2 concentrations recorded at these sites between March and November 2010 are shown in Table 13.15. Typically higher NO_2 concentrations are predicted during the winter months compared to the summer months. The location of the passive monitoring site is shown in Appendix 13.E.

For comparison purposes the table also presents NO_2 concentrations recorded at the long term monitoring sites of WEL005 and WEL006 during the same monitoring period. The average NO_2 concentration shown for WEL042 sites is therefore calculated for the reduced period of March-June 2010. The monitoring sitesWEL034, WEL034 and WEL036 are co-located at the Duncan Park site. The variation in recorded NO_2 concentrations at the sampling site provides an indication of the precision of passive sampling methodology.

Table 13.14: Annual Average NO_2 Concentrations Measured through Passive Sampling at Peak Traffic Locations in the Wellington Region, 2007-2009

Site ID	Location	Suburb	Annual Concentration (µg/m^3)			
			2007	2008	2009	Average
WEL002	SH2/Manor Park Rd	Manor Park	22.1	21.5	23.5	22.4
WEL004	SH1/Rimutaka St	Paraparaumu	17.9	17.3	18.4	17.9
WEL005	SH1/Titahi Bay Rd	Porirua	20.1	16.8	20.2	19.0
WEL006	SH58/Paekakariki Hill Rd	Pauatahanui	11.0	11.4	14.4	12.3

Table 13.15 shows that the highest average NO_2 concentrations recorded during the nine month monitoring period were typically recorded at monitoring sites located in close proximity to SH1 (WEL005, WEL027, WEL038, WEL039, WEL040, WEL046)At these sites average NO_2 concentrations ranged between 19-27 µg/m^3.

The Linden School 1 (WEL038) monitoring site is located on the school’s eastern fence line approximately 5 m from the edge of SH1. Due to the proximity of the motorway, NO_2 concentrations recorded at this site are expected to provide an indication of the highest NO_2 concentrations that are likely to occur at the school.

Table 13.15: Summary of Average Ambient NO_2 Concentrations Measured through Passive Sampling along Main Alignment, March-November2010

Site ID	Location	Suburb	Average Concentration
WEL005	SH1/Titahi Bay Rd	Johnsonville	22.8
WEL006	SH58/Paekakariki Hill Rd	Pauatahanui	17.6
WEL027	SH1/Helston Rd	Johnsonville	26.7
WEL034	GWRC Duncan Park	Linden	11.5
WEL035	GWRC Duncan Park	Linden	12.4
WEL036	GWRC Duncan Park	Linden	11.9
WEL037	Tui Park Kindergarten	Linden	14.4
WEL038	Linden School 1	Linden	23.3
WEL039	Linden School 2	Linden	19.4
WEL040	Opposite Linden School	Linden	18.7
WEL041	Kenepuru Link Rd Intersection	Ranui Heights	19.4
WEL042	Natone Park School	Waitangirua	10.7*
WEL043	Maraeroa Marae Health Centre	Waitangirua	11.2
WEL044	Waitangirua Link Rd Intersection	Waitangirua	14.3
WEL045	Whitby Link Rd Intersection	Whitby	4.7
WEL046	SH1/Station Rd	Paremata	23.6

* Four month average April – June 2010

Lower average NO_2 concentrations were recorded at the residential monitoring sites of WEL034, WEL035, WEL036, WEL037 WEL042, WEL043, and WEL044. Average concentration recorded at these sites range between 12-14 $\mu g/m^3$. None of these monitoring sites are located near a major arterial road. Concentrations recorded at these sites are expected to be indicative of existing background NO_2 levels in the areas of residential development along the alignment. Average concentrations at these sites are comparable to the average annual NO_2 concentrations recorded at the GWRC Tawa instrumental ambient air quality monitoring site (refer to Table 13.13).

The lowest average NO_2 concentration of 4.7$\mu g/m^3$ was recorded at the Whitby Link Rd site (WEL045). The Whitby site located at the end of James Cook Drive in what is currently a largely empty residential subdivision. Concentrations measured there are likely to be indicative of those in the rural and sparsely populated areas along the alignment.

The monthly average concentrations recorded at the passive sampler monitoring sites cannot be directly compared against the short term 1-hour average NO_2 AQNES and the 24-hour average AAQG. However, analysis of the NO_2 data recorded at the GWRC's ambient air monitoring network suggest an approximately linear relationship between 99.9 percentile 1-hour average NO_2 concentration and annual average NO_2 concentration. Figure 13.6 shows the recorded annual average and 99.9 percentile concentration at GWRC monitoring sites for the years 2005 to 2009. A linear regression model trend line is shown in the figure as a solid line (R^2=0.84).

The analysis of the Auckland Regional Council ambient air monitoring network datasets (Longley et al, 2008) shows a similar linear relationship between annual average and 99.9 percentile 1-hour average NO_2 concentrations. In both Wellington and Auckland the ambient monitoring data provide good statistical evidence to indicate that the 99.9 percentile 1-hour average NO_2 concentration is unlikely to exceed the AQNES ambient air quality standard (200 µg/m^3) if the annual average NO_2 concentration is less than 40 µg/m^3.

A comparable analysis of UK monitoring data recorded at kerbside and roadside monitoring stations also indicated that hourly NO_2 concentrations are unlikely to exceed 200 µg/m^3 when annual average NO_2 concentrations remained less than 40 µg/m^3 (Laxen and Marner, 2003).

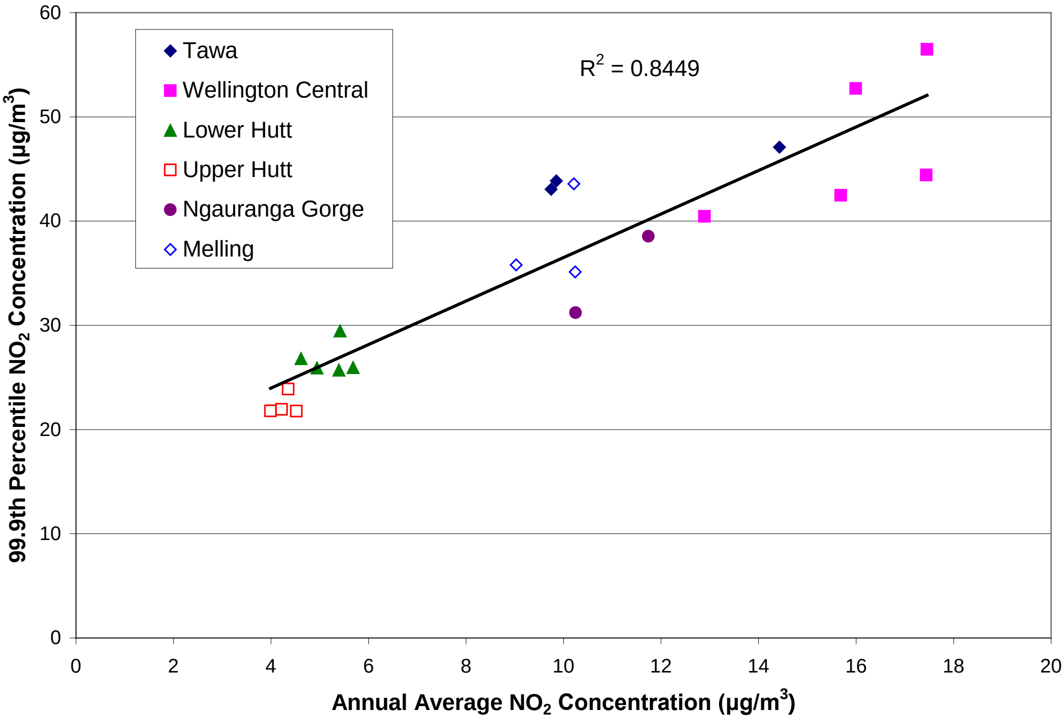


Figure 13.6: Relationship Between Yearly 99.9 percentile 1-hour Average and Annual Average NO_2 Concentrations at Wellington Monitoring Sites 2005-2009 (Data courtesy of GWRC)

The average NO_2 concentrations recorded at all of the passive monitoring sites are significantly lower than 40 µg/m^3. The results of monitoring therefore indicate that the 99.9 percentile 1-hour average NO_2 concentrations at these sites are unlikely to exceed the AQNES. The long term monitoring at sites WEL004, WEL005 and WEL006 where NO_2 levels have been recorded over a three year period provide the best indication of annual average concentrations at locations near SH1 and SH58. Maximum annual average NO_2 concentrations recorded near SH1 and SH58 are respectively 20 µg/m^3 and 14 µg/m^3. For these annual average concentrations the regression model predicts average 99.9 percentile 1-hour concentrations of 58 µg/m^3 and 45 µg/m^3, or 29% and 23% of the AQNES of 200 µg/m^3.

The highest average NO_2 concentrations at any of the monitoring sites of 23.6 µg/m^3, was recorded at the Helston Rd located near SH1 (WEL046) between April-November 2010. However, due to seasonal variations the average concentration recorded over the monitoring period is expected to be different from the average annual concentration (as used in the regression analysis). The Tawa monitoring data indicates that the average NO_2 concentrations for the month of April and November are on average approximately 13% higher than the annual average concentration. Based on the Tawa monitoring data, an annual average concentration at this Helston Road can be estimated to be 20.9 µg/m^3, which is comparable to annual average NO_2 levels recorded at the long term monitoring sites located near SH1. Figure 13.6 indicates that the 99.9 percentile 1-hour average concentration is also likely to be similar.

The comparable annual average concentration recorded at the GWRC Tawa instrumental site monitoring to those recorded at the residential sites where passive sampler are located indicates that 99.9 percentile 1-hour NO_2 concentrations recorded at the Tawa site are likely to be comparable to those in other residential areas along the Main Alignment. The average NO_2 concentration measured at the Whitby Link Rd site (WEL045) of 4.7 µg/m^3 would suggest that the 99.9 percentile concentration is unlikely to exceed 30 µg/m^3 in the rural areas away from arterial roads.

Figure 13.7 shows the predicted annual average concentration against maximum 24-hour average NO_2 at GWRC ambient air quality monitoring sites between 2005 and 2009. The figure also suggests a linear relationship between annual average and maximum 24-hour concentrations. A linear regression model trend line is shown in the figure as a solid line (R^2=0.886).

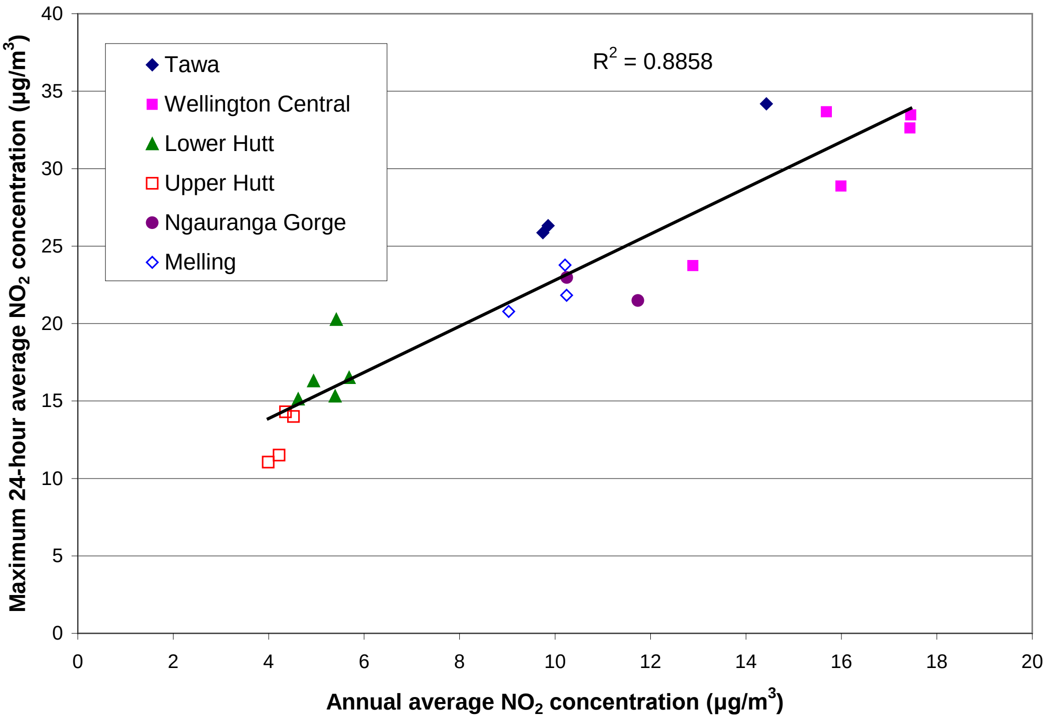


Figure 13.7: Relationship between Yearly 24-hour Average and Annual Average NO_2 Concentrations at Wellington Monitoring Sites 2005-2009 (Data courtesy of GWRC)

The observed relationship also indicates that the 24-hour average AAGT of 100 µg/m^3 is statistically unlikely to be exceeded at locations where the annual average NO_2 concentrations remain less than 40 µg/m^3. A similar trend is observed in the Auckland monitoring data. The maximum annual average concentration of 20 µg/m^3 reported at any of the monitoring sites located close to SH1 or SH58 indicates that maximum 24-hour average NO_2 levels are unlikely to exceed the AAQG at locations near the motorway. For an annual average NO_2 concentration of 20 µg/m^3, the regression model predicts a mean maximum 24-hour average concentration of 38 µg/m^3, (38% of the AAQG).

6.4 CO concentrations

Maximum 8-hour average and 99.9 percentile 1-hour average CO concentrations recorded at the Tawa monitoring site for the years 2007-2009 are presented in Table 13.16. The monitoring data shows that recorded 99.9 percentile 1-hour averages and the maximum 8-hour average CO concentrations are significantly lower than the AQNES 8-hour average standard of 10 mg/m^3. The maximum 8-hour CO recorded during the 2007-2009 monitoring period is 4.3 mg/m^3, or 43% of the AQNES. The monitoring data clearly indicates that current CO concentrations are significantly lower than air quality criteria levels.

Table 13.16: Summary of Ambient CO Concentrations Measured at Tawa, 2007-2009 (mg/m³)

Statistical Value	2007	2008	2009	Average
99.9 percentile 1-hour Average	4.2	2.8	3.2	3.4
Maximum 8-hr Average	4.3	2.2	2.9	3.1
Annual Average	-	0.2	0.2	0.2

6.5 Benzene

Ambient benzene concentrations have not been monitored in the Wellington region. Compared to the other pollutants discussed above, monitoring data for benzene is limited. Long term semi-continuous monitoring has been conducted by the ARC at Khyber Pass Road in Auckland. This monitoring has indicated major reductions in benzene concentrations over the last ten years. Similarly to carbon monoxide, this is consistent with the technological changes and new fuel standards which are contributing to reduced emissions from vehicles.

The NZTA operates a BTEX (benzene, toluene, ethylbenzene, and xylenes) passive monitoring programme at a limited number of sites across Auckland in the vicinity of the SH16 and the proposed Waterview Connection project. Passive monitoring is undertaken using 'diffusion tubes', which are exposed for approximately a month at a time. Although these measurements were made in areas generally subject to higher traffic volumes, it is considered that they give a conservatively high estimate of benzene concentrations in the urban areas of the Project.

A summary of the passive sampling for benzene near SH16 are presented in Table 13.17. For a number of the monthly samples, benzene concentrations were lower than the limit of detection for passive samplers. To provide an indication of the level of uncertainty, in Table 13.17 average concentrations have been reported in two ways; column 5 of Table 13.17 shows monthly benzene concentrations less than the level of detection (LOD) as zero; while column 6 of Table 13.17 shows monthly benzene concentration less than the level of detection (LOD) as equal to the LOD.

The monitoring data indicates that benzene levels near the motorway are currently significantly less than ambient air quality criteria levels.

Table 13.17: Passive Benzene Monitoring Results

Site Nº	Site location	Distance from SH16	Date monitoring commenced	Average Benzene Concentration ($\mu g/m^3$)	
				ND=0	ND=LOD
AUC112	Helga Cres	630	July 2009	0.7	1.0
AUC115	Titoki St	75	July 2009	0.9	0.9
AUC119	Milich Tce	40	July 2009	0.8	1.1
AUC124	Pomelo Rd	725	July 2009	0.7	1.0
AUC134	Mescal St	540	Oct 2009	0.0	0.8
AUC137	Cedar Heights Av Sth	80	Oct 2009	0.4	0.8
AUC138	Kasia Cl	80	Oct 2009	0.0	0.8
AUC141	Glenbervie Cres	590	Oct 2009	0.0	0.8

ND – Measured concentration below the limit of detection

LOD – Limit of detection for the method

6.6 Summary of estimated worst-case background concentrations

For the assessment of this project, cumulative CO and PM_{10} concentrations for the urban areas of the Project (Linden, Kenepuru Interchange and Waitangirua) have been estimated based on the Tawa monitoring data. In the assessment it has conservatively been assumed that worst case background pollutant levels occur during the same period when the maximum contribution from the Project is predicted to occur. This approach is expected to overestimate actual pollutant levels near the Project. Based on the results of relevant ambient monitoring, the worst-case background concentrations estimated for the receiving environment throughout the Main Alignment (spatially constant) are presented in Table 13.18.

Table 13.18: Summary of Estimated Worst-Case Background PM_{10}, NO_2, NO_x CO, and Benzene Concentrations – Urban Areas

Pollutant	Averaging period	Background contaminant concentration
PM_{10}	24-hour	39 $\mu g/m^3$
	Annual	16 $\mu g/m^3$
NO_2	1-hour	45 $\mu g/m^3$
	24 hour	29 $\mu g/m^3$
NO_x	1-hour	425 $\mu g/m^3$
	24 hour	213 $\mu g/m^3$
CO	1-hour	3.4 mg/m^3
	8-hour	3.1 mg/m^3
Benzene	Annual	1.0 $\mu g/m^3$

The background data presented in Table 13.18 are based on ambient concentrations measured to date (average of the highest concentrations). Given the improvements in the efficiency and cleanliness of both domestic heating and vehicle emission sources ambient concentrations may reduce over time in the developed areas of the alignment.

The MfE GPG Transport provides examples of typical existing ambient air quality concentrations for rural areas (refer Table 13.19). These concentrations are considered more representative of the air quality in the near areas near MacKays Crossing and SH58 interchange. In the assessment cumulative pollutant levels CO and PM_{10} concentrations near these areas have been calculated using the background levels the background levels shown in Table 13.19.

Table 13.19: Typical Background PM_{10}, NO_2 and CO Concentrations for Rural Areas

Area	NO_2 1 hr µg/m³	PM_{10} 24 hr µg/m³	CO 8hr mg/m³
Rural area, or urban area that is very open with low population density	15	15	0

However, at all locations included in the dispersion modelling assessment, cumulative NO_2 concentrations have assumed that background NO_2 concentrations are comparable to those recorded at the Tawa monitoring site. This approach is expected to overestimate cumulative NO_2 concentrations in the vicinity of MacKay's crossing and the SH58 interchange. In these predominantly rural areas background NO_2 emissions are expected to be minor.

7 Traffic modelling and vehicle emission rates

7.1 Approach

The effects of vehicle exhaust emissions are dependent upon a number of factors, including: mass emission rates of various contaminants, meteorology, background concentrations and the sensitivity of the receiving environment. The mass emission rates for different contaminants are in turn dependent on a range of factors, including: traffic volumes, vehicle speed, vehicle type and age and fuel composition.

Figure 13.8 shows the linkages between the inputs and outputs of the traffic model, vehicle emission model, and atmospheric dispersion model used to estimate ground level pollutant concentration in the vicinity of the Project.

This section of the report summarises the approach used to estimate pollutant emissions from the roads based on traffic volumes predicted by the traffic model.

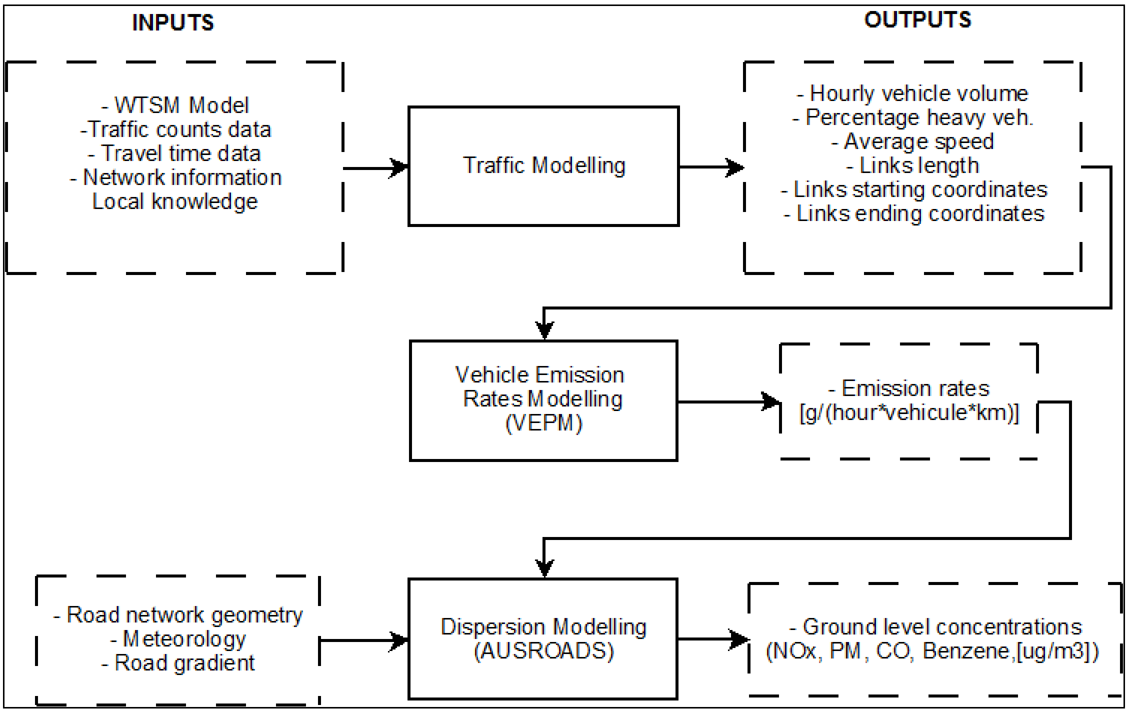


Figure 13.8: Traffic Emissions and Dispersion Modelling Process Overview

7.2 Traffic modelling

7.2.1 Methodology

Traffic patterns were assessed using the Project traffic model (SATURN-TG), which was developed for the Project by Sinclair Knight Merz (SKM). Predicted traffic volumes and associated traffic parameters were provided to Beca, from which pollutant emission rates were estimated. A detailed description of the traffic model and predicted traffic volumes is provided in the "*Traffic and Transportation Assessment Report*", SKM 2011. Beca has not independently verified any of the traffic data provided.

The SATURN-TG model simulates traffic patterns within the wider Wellington region. In building the SATURN-TG model, data was collated from a wide range of sources including the Wellington Transport Strategy Model (WTSM), which is a strategic multi- modal model for the entire region.

The evaluation of scenarios has been for the years 2026, 2031 and 2041 along with 2006 to represent the current baseline. For each of the forecast years, traffic parameters have been predicted both with and without the development of the Project (refer Table 13.21).

Over 8000 separate road links are defined in the model. Each link represents a section of road between two geographic points (nodes). A single road may be represented by one or more links. Links are also used to represent small networks of suburban roads with low traffic volumes.

The traffic parameters predicted for each of the links included the total hourly traffic volumes, the percentage of heavy commercial vehicles (HCV), and the average vehicle speed.

7.2.2 Diurnal traffic profiles

For all the traffic scenarios considered the traffic model predicted traffic parameters for three time periods. These time periods were defined as:

- AM Peak: 7am to 8am
- PM Peak: 5pm to 6pm
- Interpeak: 11am to 1pm

Based on guidance provided by SKM, the AM Peak was expanded to represent traffic parameters (traffic volume, average vehicle speed, and % HCV) between 7am to 9am, and the PM Peak was expanded to represent traffic parameters between 4pm to 6pm.

For other periods average vehicle speeds and the percentage of HCVs were assumed to be the same as those predicted for the interpeak period. Hourly traffic volumes for these hours were estimated based on the weekday diurnal traffic counts recorded on SH1. It was assumed that for each link the ratio of the hourly traffic volume to the predicted interpeak traffic volume was the same as that recorded on SH1.

The average daily weekday traffic volumes for each link were calculated from the AM Peak, PM Peak and Interpeak traffic volumes using the following expression derived by SKM;

Error! Bookmark not defined. $$\mathrm{ADDT} = 2*[\mathrm{AM\ Peak}] + 2*[\mathrm{PM\ Peak}] + 12.4*[\mathrm{Interpeak}]$$

The constants of 2 and 12.4 in the above expression were derived from traffic count sites in the corridor over approximately a two year period.

7.3 Forecast traffic volumes

7.3.1 Summary of predicted volumes

Presently, road congestion in the SH1 corridor results in lengthy travel times during weekday peak periods. Travel between the Hutt Valley and SH1 (north) requires the use of routes which are indirect (SH58 and Grays Road around the Pauatahanui Inlet) or inappropriate for large volumes of traffic (Grays Road, Paekakariki Hill Road). During weekend and holiday periods severe congestion can occur as a result of increased road traffic demands. In the event of an incident, such as a crash or natural event, disruption may be magnified. Increased congestion increases travel times and the variability of travel times (SKM, 2011).

The Project is predicted to result in a significant relocation of traffic movements away from the existing SH1 route between Linden and MacKays Crossing. The existing coastal route is expected to become a local road once the Project is completed and as a result there will be a corresponding reduction in traffic volumes on the existing SH1. In addition, there will be a range of more subtle changes in traffic volumes on sections of the road network as drivers utilise routes which are more convenient.

The heavy vehicle movements are forecast to increase, with or without the Project, in response to economic activity. The growth in heavy vehicles movements are predicted to higher than that for general traffic. The Project is predicted to result in the removal of a large number of heavy vehicles from the existing SH1 and in particular the communities of Paekakariki, Pukerua Bay, Plimmerton, Mana and Paremata. This is due to the significant time saving compared to the coastal route (SKM, 2011) during the AM peak period. The shorter travelling times are expected to result in virtually all HCVs travelling between Linden to MacKays using the Transmission Gully Main Alignment route, despite the greater degree of ascent and descent required and marginally longer distance.

Under the ‘do minimum’ scenario, traffic volumes on SH1 are predicted to increase significantly compared to the existing (2006) baseline. The situation is worse in 2031 without the Project, as traffic volumes continue to increase. Increased traffic volumes are forecast to increase travel times and the variability of travel times in the network. As expected, with the operation of the Project, a large proportion of traffic is predicted to be diverted away from the existing SH1 onto the Main Alignment. The busiest area, in terms of traffic density, remains on SH1 around Linden, to the south of Porirua.

Without the Project, rising traffic demand over the period to 2026 is also expected to place a number of existing intersections in the SH1 corridor under increasing strain. This is likely to be manifested in increased delays, and queue lengths. Queuing time at these intersections are predicted to decrease when TG is constructed, resulting in operational improvements. The link road intersections are expected to have a high level of operational performance. The exception is the Warspite Avenue/Waitangirua Link Road intersection which would be predicted to be operating at near capacity during peak traffic periods if traffic signals are used for intersection control. Improved intersection performance is predicted for a roundabout intersection, however this is not the preferred option due to pedestrian and cyclist safety concerns. The assessment of expected changes in performance of existing and new intersections is discussed in the “Transmission Gully - Traffic and Transportation Assessment Report” (2011).

The Main Alignment in 2026 is forecast to carry 18-20000 vehicles/day on the south/east section, and 22300 vehicles/day/day between the SH58 intersection and MacKays Crossing. The Kenepuru Link will carry 13000 vehicles/day, with 3300-3400 vehicles/day using each of the Waitangirua and James Cook link roads.

Forecast traffic volumes on local roads connecting to the Whitby Link Road and Waitangirua Link Road are comparable to traffic volumes predicted without the Project. Any increases in traffic volumes are expected to be easily accommodated by the existing capacity of the road network (SKM, 2011).

For the purposes of the dispersion modelling assessment, it was considered appropriate to identify the areas with the most significant traffic volumes. The NZTA definition of an urban arterial road is “arterial and collector roads within urban areas carrying traffic volumes greater than 7000 vehicles/ day”. An overall picture of all the links with predicted traffic volume greater than 7000 vehicles per day is presented in Appendix 13.D.

The predicted traffic volumes for the different scenarios on selected arterial roads and main roads are presented in Table 13.20 for links related to the Main Alignment and link roads and Table 13.21 for SH1. The location of these links in the Project area is shown in Figure 13.9. Table 13.20 shows traffic volumes on the Main Alignment are predicted to be similar for 2026 and 2031, with traffic volume being slightly higher in 2031.

The effect of the Project on predicted SH1 north bound traffic volumes for the five traffic scenarios is shown Figure 13.10. The figure clearly shows the predicted decrease in traffic volumes between Linden Interchange and MacKays Crossing Interchange with the development of the Project.

A detailed description of the forecast changes in the road network's traffic patterns is provided in the "*Transmission Gully - Traffic and Transportation Assessment Report*" (2011).

Table 13.20: Average Annual Daily Traffic (vehicles/day) Volumes for an Average Weekday

Map identifier	Description	2026 with Project	2031 with Project
		AADT [vehicles/day]	
TG2	**Main alignment - connection to SH1**		
	Northbound traffic	8600	8800
	Southbound traffic	9700	9900
	Total traffic	18300	18700
TG3	**Main alignment between Linden and Kenepuru Interchanges**		
	Northbound traffic	8900	9000
	Southbound traffic	10000	10100
	Total traffic	18900	19100
TG4	**Main Alignment between SH58 and MacKays Interchanges**		
	Northbound traffic	10900	11000
	Southbound traffic	11300	11400
	Total traffic	22300	22400
TG1	TG feeder – Proposed Kenepuru Link Road	12900	13000
TG5	TG feeder – Proposed Link Road to James Cook Dr	3300	3400
TG6	TG feeder – Proposed Link Road to Warspite Rd	3400	3400
TG7	TG feeder - Paremata Heywood Rd (SH58 East)	14800	15200
TG8	Paekakariki Hill Road	5	5

Table 13.21: Average Annual Daily Traffic (vehicles/day) Volumes for an Average Weekday

Map identifier	Description	2006 Baseline	2026 Do Minimum	2026 With Project	2031 Do Minimum	2031 With Project
		AADT [vehicles/day]				
	State Highway 1 (SH1)					
SH1-2	SH1-Tawa	43900	58100	62400	53300	65600
SH1-13	SH1-Porirua Harbour	51800	60400	43800	61100	44700
SH1-8	SH1-Mana Esp	31600	33800	19200	33800	19600
SH1-11	SH1-North of Plimmerton	23100	23700	5400	23800	5600
	SH1 arterial roads and feeders					
SH1-1	Takapu Rd	19400	24900	21800	25700	22500
SH1-3	Parumoana St	20200	22900	20400	23600	21100
SH1-4	Titahi Bay Rd	22100	24700	21700	24800	22000
SH1-5	Mungavin Ave	12100	13700	13500	14100	13900
SH1-6	Whitford Browne Ave	11200	16500	16400	16900	16800
SH1-7	SH58-Paremata Rd West	18000	16700	12500	16600	12500
SH1-9	Grays Rd	5600	5100	1900	5600	2000
SH1-10	Steyene Ave	6400	6600	6900	6700	7000
SH1-12	SH58-Paremata Rd East	6700	5000	2700	5200	2800

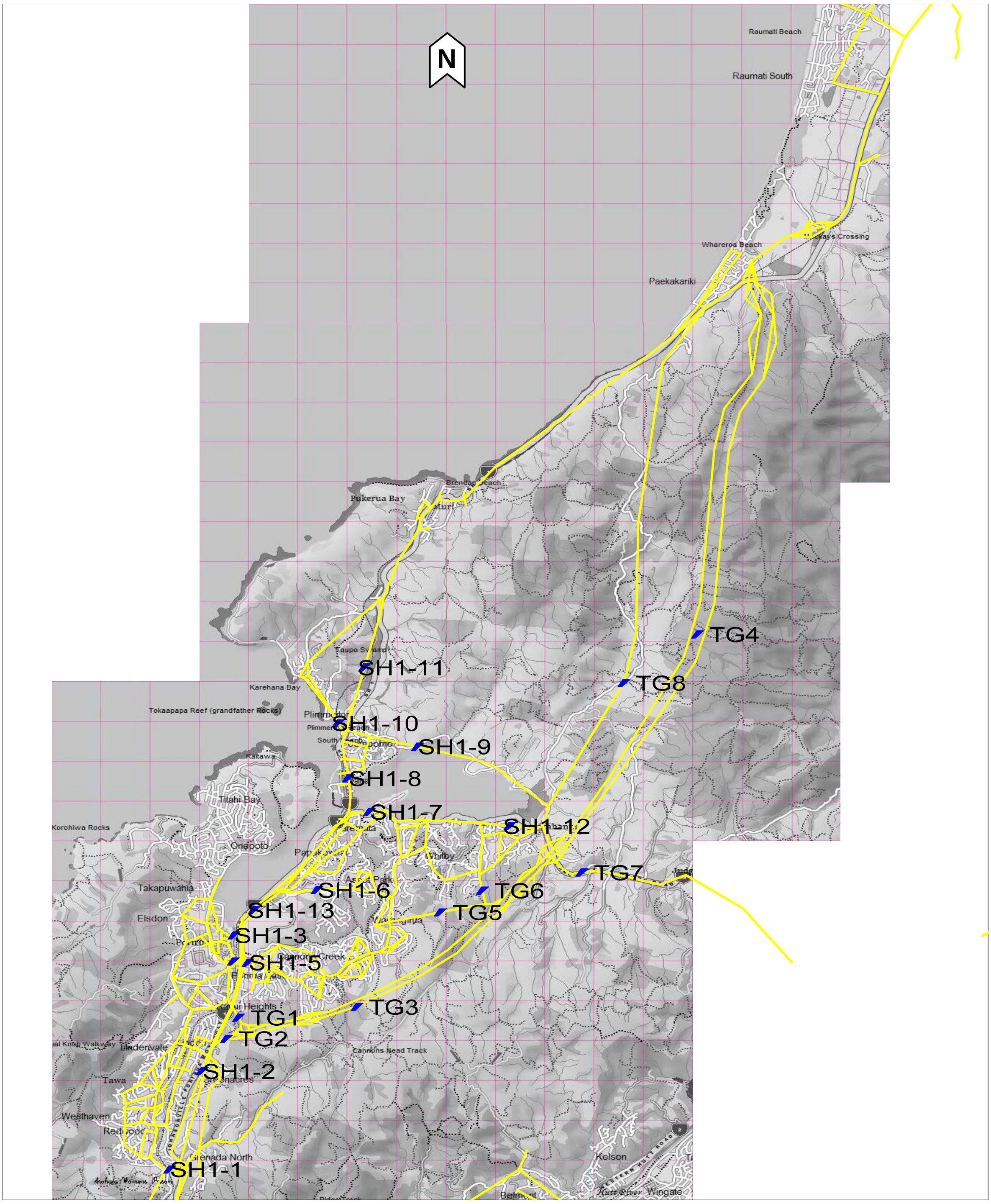


Figure 13.9: Location of Road Links

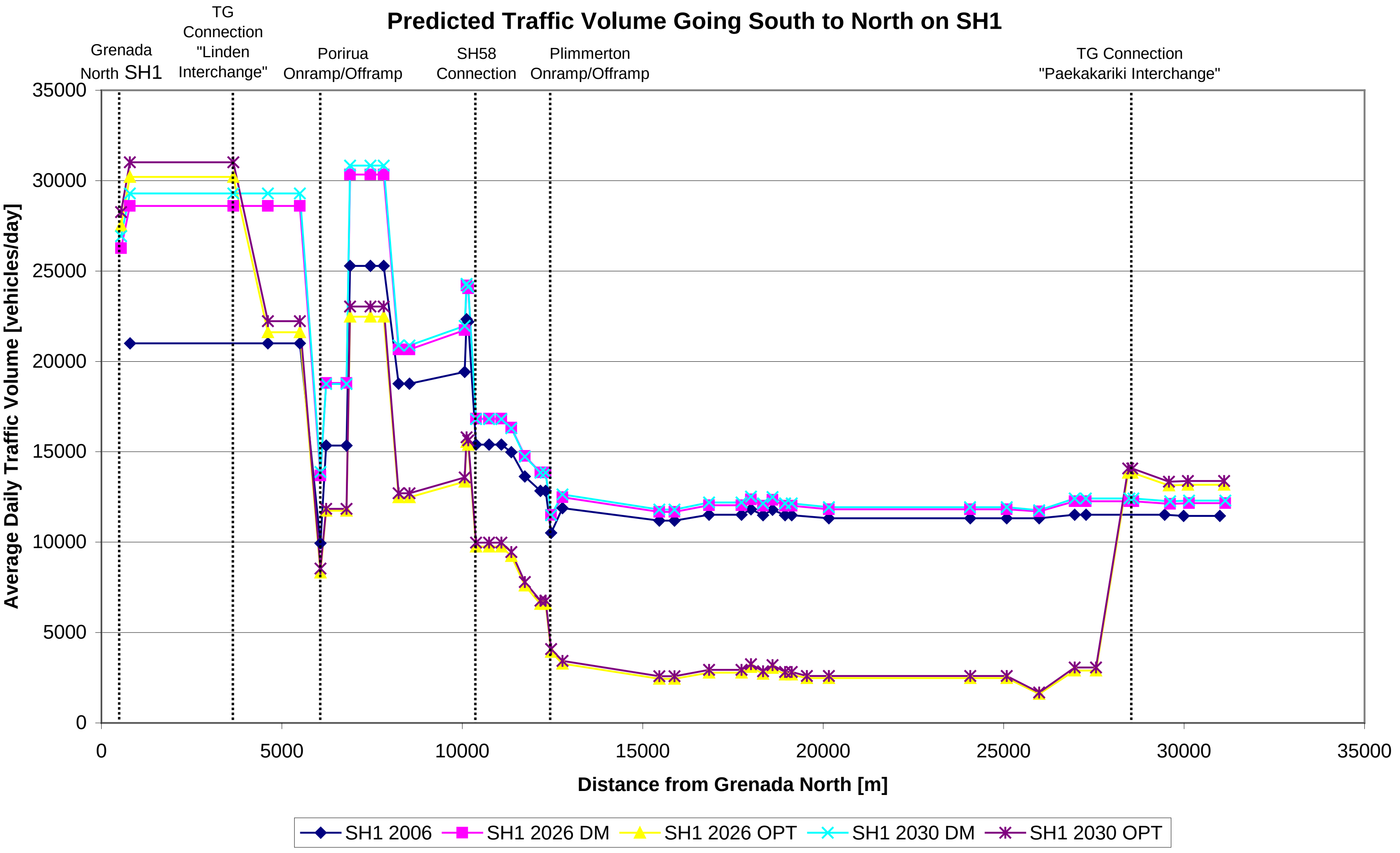


Figure 13.10: Predicted Traffic Volume on SH1 with Different Scenarios

7.3.2 Identification of potentially affected locations

Figure 13.11 shows predicted differences in traffic volumes within the Project area between the 2031 DM (‘do-minimum’) and 2031 WP(‘with project’) traffic scenarios. The red lines and triangles show roads and intersections where traffic volumes are predicted to be greater than 7000 vehicles per day and predicted daily traffic volumes are more than 10% higher for 2031 WP traffic scenario compared to the 2031 DM traffic scenario. The green lines and triangles shows road and intersections where traffic volumes are predicted to be greater than 7000 vehicles per day and predicted daily traffic volumes are less than 10% higher for 2031 DM traffic scenario compared to the 2031 WP traffic scenario. These criteria have been used to identify areas where air quality may be significantly affected by the Project (refer Section 5.5).

The figure clearly shows the decrease in predicted traffic volumes along the length of SH1 and also Main Road (Tawa) and SH58 west of the Main Alignment. In these areas vehicle emission rates on these roads are likely to be lower as a consequence of the Project. Most of these areas are heavily urbanised.

The figure shows high traffic volumes (>7000 vehicles per day) are predicted along the length of Transmission Gully. Increases in traffic volumes of more than 10% are also predicted on SH58 to the east of the Transmission Gully (Pauatahanui), Kenepuru Drive (Porirua), and the intersection of Warspite Avenue and Niagara Street (Waitangirua). At each of these locations a new link road or ramp connects to the proposed motorway.

The yellow circles shown in Figure 13.11 indicate areas where detailed dispersion models have been constructed. The five modelling domains are shown in greater detail in Section 8.2.

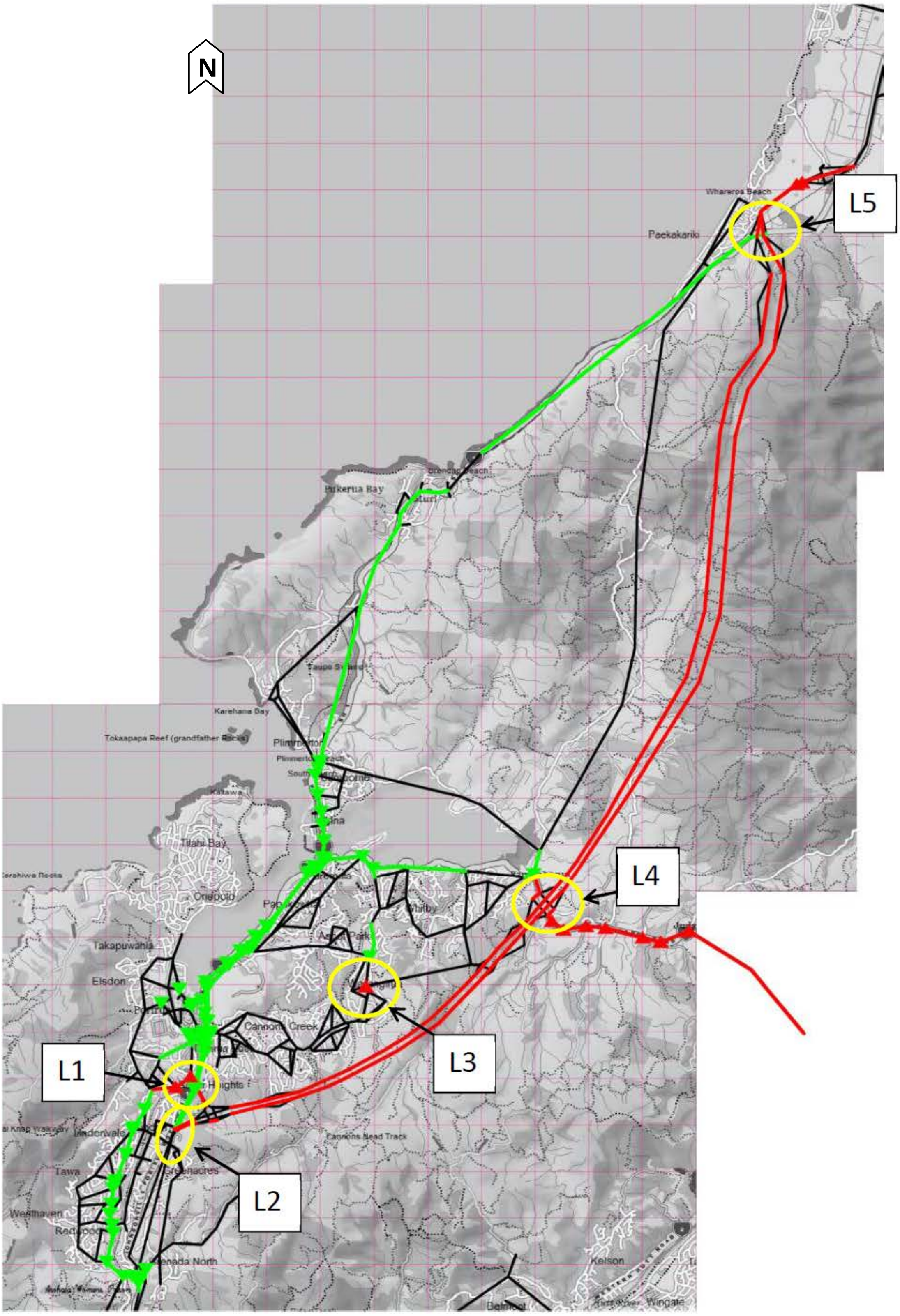


Figure 13.11: Predicted Increase (shown in red) or Decrease (shown in green) in Traffic Volumes by more than 10% at Roads and Intersections in the Project Area between the 2031 DM and 2031 WP Traffic Scenarios

7.4 Vehicle emission modelling

7.4.1 Methodology

Detailed emissions factors for CO, PM_{10}, VOC, and NO_X have been derived from the Vehicle emissions Prediction Model (VEPM v3.0). This emissions model has been developed by the ARC after considerable research and validation since 2004. The VEPM database calculates emissions factors for European origin vehicles and also draws on emissions data from New Zealand, the Japan Clean Air Programme, the European Environment Agency (COPERT III), and the European Programme on Emissions, Fuels and Engine Technologies (EPEFE). The model provides a comprehensive emissions database covering the range of vehicle types available in the New Zealand fleet. A summary of VEPMs inputs and outputs are detailed in Figure 13.12.

Until recently, only the Ministry of Transport's NZTER model was recommended in the MfE Transport GPG for use in the assessment of vehicle emissions from roading projects. NZTER has now been superseded by the publication of the VEPM model. For this assessment the VEPM model (v. 3.0) was used. The benefits of using VEPM over NZTER are that VEPM has been developed much more recently (2008 vs. 1996), and it contains a much more detailed breakdown of fleet components (especially HCV).

In general the model was run using VEPM's defaults values including cold starts, and emission degradation, although a higher ambient air temperature of 20°C was assumed. Vehicles volumes, vehicle speeds, and the percentage of heavy vehicle predicted by the SATURN-TG traffic model were used as input to VEPM. For each of the five traffic scenarios modelled vehicle emission rates were calculated for all of the links defined in the traffic model and each time period (ie AM Peak, PM Peak and Interpeak).

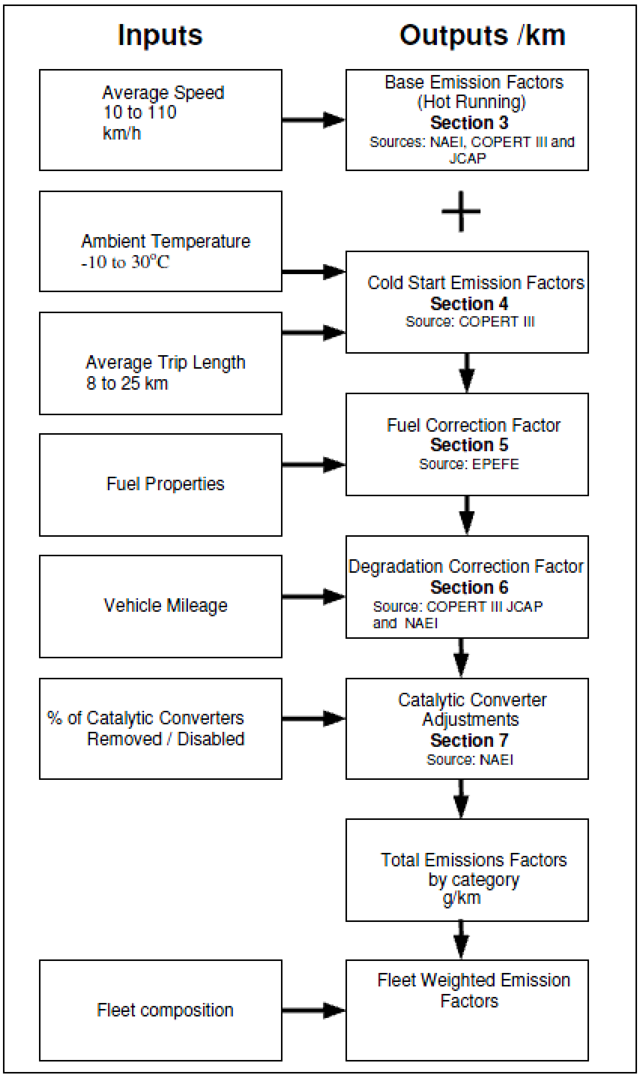


Figure 13.12: VEPM Inputs and Calculations, source: VEPM Technical Report Dec 2008, The University of Auckland, 2008

7.4.2 Vehicle fleet profile

Predicted vehicles emission rates were calculated using VEPM's default vehicle fleet composition for the base year of 2006, and the projected years of 2026 and 2031. However, VEPM is designed to estimate vehicle emission up to the year 2030. Therefore, in the analysis it is assumed that the fleet composition and vehicle emission rates for the year 2030 are comparable to those in 2031.

The percentage of light and heavy vehicles on each link was varied according to the traffic model outputs. The relative distribution of sub-categories of light and heavy vehicles within two classifications were assume to be the same as those predicted by VEPM. The percentage of buses is assumed to be constant and equal to 0.6% for the entire network.

7.4.3 Non-exhaust emission factors

The MfE Transport GPG recommends that brake and tyre wear emissions be considered, since for busy roads these can be a significant source of PM_{10}. Brake and tyre wear emission calculated by VEPM increases the PM_{10} emissions by 20-50% depending on the average speed of vehicle.

VEPM provides the option to calculate brake and tyre wear particulate emissions based on the average number of wheels for each vehicle class. In this case the model default settings were used for the purposes of the assessment. There is however a high level of uncertainty associated with these emission factors.

7.4.4 Diurnal emission profiles

Diurnal emission profiles have been constructed for each of the road sections included in the dispersion model. The method used to estimate diurnal traffic volumes for each of the links is detailed in 7.2.2. Vehicle emission rates between 7am-9am were estimated using the AM peak traffic parameters. Emission rates between 4pm-6pm were estimated using the PM peak traffic parameters. Emission rates for other hours were calculated based on interpeak traffic parameters and derived traffic volumes.

7.4.5 Benzene emission rates

The VEPM emission factors do not directly calculate motor vehicle benzene emission rates, only the emission rate of total tail pipe hydrocarbon emissions. In this analysis, benzene emission rates have been estimated using the method detailed in the MfE Transport GPG (2008), by assuming that approximately 5.9% of total hydrocarbon emitted by vehicle exhausts is in the form of benzene. Since emissions of benzene are primarily associated with exhaust emissions from petrol engines, this approach is likely to overestimate actual benzene emission rates. The small contribution from evaporative losses has not been incorporated into the emission estimates.

7.4.6 Road gradients

Road gradients can increase or decrease vehicle fuel consumption depending on whether vehicles are travelling uphill or downhill. The rate of fuel consumption changes with weight of the vehicle and vehicle load. The Transmission Gully motorway includes section of the road where significant gradients are present. These gradients are expected to have an effect on the vehicle emission rates.

VEPM does not model the effect of road gradients on vehicle emissions. VEPM emission factors assume that vehicles are travelling on a relatively flat plain. In the assessment the effect of road gradients on vehicle emissions has been estimated using gradient factors derived from the ARTEMIS (Assessment and Reliability of Transport Emission Models and Inventory Systems) project emission factor model. ARTEMIS is funded by European Commission.

Gradient factors derived from ARTEMIS have been used to estimate the proportional increase or decrease in vehicle emissions predicted by VEPM. ARTEMIS defines separate gradient were defined for light vehicle and heavy vehicles, and pollutant type.

ARTEMIS defines light vehicle gradient factors with respect to fuel type (petrol and diesel), road type (urban, standard road, and motorway), road gradient (0%, +/-2%, +/-4% and +/-6%), and European vehicle emission standards (Euro 1 to 4). The gradient factors published for Euro 4 standard vehicles travelling on motorways is the most applicable to light vehicles using the Main Alignment in 2026 and 2031. These gradient factors are shown in Table 13.22.

Table 13.22: ARTEMIS Light Vehicles Gradient Factors (Euro 4)

Gradient	Petrol Vehicles				Diesel Vehicles				
	CO	VOC	NO_X	FC	CO	VOC	NO_X	PM	FC
-6%	0.325	0.376	0.584	0.299	0.013	0.381	0.045	0.429	0.277
-4%	0.435	0.543	0.898	0.483	0.040	0.736	0.192	0.554	0.434
-2%	0.722	0.737	0.989	0.740	0.104	0.922	0.527	0.762	0.706
0%	1	1	1	1	1	1	1	1	1
2%	1.235	1.415	0.922	1.281	3.223	1.124	1.715	1.287	1.315
4%	1.364	1.902	1.030	1.530	5.862	1.232	2.428	1.548	1.602
6%	1.785	2.763	1.006	1.923	6.940	1.458	3.335	1.905	1.919

FC = Fuel consumption; VOC = volatile organic compound; PM = particulate matter; CO = carbon monoxide; NO_X = nitrogen oxides

The gradient factors presented in Table 13.22 show that for roads where a similar number of vehicles are travelling in both directions the effect of the road's gradient on total light vehicle emissions rates is comparatively small. For example, on roads where an equal volume of traffic is assumed to be travelling in both directions, for gradients of 2%, 4% and 6% the total PM_{10} emission rates for light diesel vehicles are predicted increase by respectively 2%, 5% and 17% compared with emissions from a road with no gradient. The table shows that road gradients are predicted to have the greatest effect on CO emissions from light diesel vehicle.

The determination of gradient factors for heavy vehicles is more complex. The effect of road gradients on heavy vehicle emissions are not directly modelled by ARTEMIS using gradient factors as is done for light vehicles. Emissions from heavy vehicles are predicted by ARTEMIS using derived mathematical equations where emission rates are assumed to be dependent on vehicle speed. A separate mathematical equation is defined for each heavy vehicle type (vehicle weight class), European emission standard (Euro 1 to 5), truck load (0%, 50%, and 100%), gradient (0%, +/-2%, +/-4% and +/-6%), and pollutant type (CO, HC, NO_X, PM) or fuel consumption rate. For pollutant species HCV emission rates are defined in ARTEMIS by over 2000 separate speed dependent equations. The equations correspond to the different combinations of vehicle type, gradient, truck loading, and vehicle emission standard.

The effect of road gradient on heavy vehicle tail pipe emission rates of PM_{10}, NO_X, CO and VOCs were characterised using the ARTEMIS equations. Due to the complexity of the calculation procedure it was only practical to incorporate slope factors for sections of the Main Alignment (and associated on and off ramps) defined in the dispersion modelling assessments. Due to the significantly high traffic volumes on the proposed motorway compared to the surrounding roads, modelling this simplified approach will simulate the most significant effects of slope on vehicle emissions.

For the assessment a gradient factor for each of the four VEPM HCV classifications (i.e. <7.5t, 7.5-14t, 14-32t, >32t) was derived for each link by dividing the emission rates predicted by ARTEMIS for the link's gradient by the emission rates predicted by ARTEMIS assuming no gradient. The calculated ratio provides a measure of the relative change in vehicle emissions with changes in road gradient compared to vehicles travelling on the flat. Only vehicles achieving the Euro 4 and Euro 5 emission standards were considered. For each heavy vehicle class it was assumed that an equal proportion of the vehicles had loads of 0%, 50% and 100%. The formula used to estimate the gradient factor for each HCV classification for a specific vehicle speed and pollutant species is shown below:

$$GF_{ix} = 1/3(GF_{0\%i} + GF_{50\%i} + GF_{100\%i})$$

Where:

GF_{ix} = the average gradient factor for HCV classification *i* (i.e. <7.5t, 7.5-14t, 14-32t, >32t) and gradient slope *x* (+/-2%, +/-4% and +/-6%)

$GF_{0\%ix}$ = the average gradient factor for HCV classification *i*, gradient slope *x*, and 0% load

$GF_{50\%ix}$ = the average gradient factor for HCV classification *i*, gradient slope *x*, and 50% load

$GF_{100\%ix}$ = the average gradient factor for HCV classification *i*, gradient slope *x*, and 100% load

For each link a gradient modified emission factor was calculated separately for each of the VEPM light and heavy vehicle classifications. An average vehicle fleet emission rate (g/km-vehicle) for the link then was calculated as the weighted average of each of the gradient modified vehicle emission factors. The formula used is shown below:

$$EM_y = \Sigma(GF_{iyx} \text{ x } EM_{yi} \text{ x } PV_i)$$

Where:

EM_y = the average vehicle fleet emission rate per vehicle for pollutant y (g/km-vehicle)

GF_{iyx} = ARTEMIS derived gradient factor for vehicle classification *i*, gradient slope *x*, and pollutant *y*

EM_{yi} = the predicted VEPM emission factor for vehicle classification *i*, and pollutant *y* (g/km-vehicle)

PV_i = the proportion of total traffic associated with vehicle classification *i*

The average vehicle fleet emission rate for PM_{10} also incorporated the contribution from brake and tyre wear. No gradient factor was applied to brake and tyre wear emissions.

The average fleet emission rate per vehicle (g/km-vehicle), which was used as an input in the AUSROADS dispersion model, was calculated by dividing the total vehicle emission rate for each link by the total traffic volume.

7.5 Forecast vehicle emission rates

7.5.1 Predicted Nitrogen Oxide emission rates

Table 13.23 and Table 13.24 show the average daily NO_x emission rates predicted for selected sections the Main Alignment, SH1 and associated feeder roads. The location of each of the road sections is shown in Figure 13.9 on Page 44 The emission rates presented in the tables do not incorporate the effects of road gradients.

Table 13.23: Predicted Average Weekday NO_X Emission Rates (g/km/day) for the Main Alignment and Associated Link Roads

ID	Description	2026 WP	2031 WP
		[g/km/day]	
TG2	**Main Alignment**: connection to SH1	7790	8140
TG3	**Main Alignment**: Linden to Kenepuru Interchanges	8750	9030
TG4	**Main Alignment**: SH58 to MacKays Interchanges	10420	10730
TG1	Kenepuru Link Road	4470	4630
TG5	Whitby Link Road	1760	1890
TG6	Waitangirua Link Road	1400	1440
TG7	Paremata Heywood Rd (SH58 East)	6970	7410
TG8	Paekakariki Hill Road	6	6

Table 13.24: Predicted Average Weekday NO_X Emission Rates (g/km/day) for SH1 and Associated Link Roads

ID	Description	2006	2026 DM	2026 WP	2031 DM	2031 WP
		[g/km/day]				
SH1-2	**SH1** - Tawa	48340	25660	27610	26740	28570
SH1-13	**SH1** - Porirua Harbour	58400	26820	19660	27780	20470
SH1-8	**SH1** - Mana Esp	30310	16870	8760	17740	9280
SH1-11	**SH1** - North of Plimmerton	27240	11630	2710	12060	2910
SH1-1	Takapu Rd	19360	10670	10000	11400	10620
SH1-3	Parumoana St	17290	8430	7540	8920	7990
SH1-4	Titahi Bay Rd	18590	9320	7710	9680	8080
SH1-5	Mungavin Ave	10440	5410	5160	5840	5510
SH1-6	Whitford Browne Ave	9890	6570	6290	6970	6670
SH1-7	Paremata Rd West (SH58)	15720	6300	6300	6490	4680
SH1-9	Grays Rd	5810	2310	990	2590	1050
SH1-10	Steyene Ave	5700	2690	2780	2830	2920
SH1-12	Paremata Rd East (SH58)	6870	2450	1280	2640	1350

7.5.2 Predicted Carbon Monoxide Emission Rates

Table 13.25 and Table 13.26 show the average daily CO emission rates predicted for selected sections of the Main Alignment, SH1 and associated feeder roads. The location of each of the road sections is shown in Table 13.9 on Page 44. The emission rates presented in the tables do not incorporate the effects of road gradients.

Table 13.25: Predicted Average Weekday CO Emission Rates (g/km/day) for the Main Alignment and Associated Link Roads

ID	Description	2026 WP	2031 WP
		[g/km/day]	
TG2	**Main Alignment**: connection to SH1	10580	11260
TG3	**Main Alignment**: Linden to Kenepuru Interchanges	11430	12070
TG4	**Main Alignment**: SH58 to MacKays Interchanges	13420	14090
TG1	Kenepuru Link Road	8920	9330
TG5	Whitby Link Road	2220	2350
TG6	Waitangirua Link Road	2290	2360
TG7	Paremata Heywood Rd (SH58 East)	10190	10820
TG8	Paekakariki Hill Road	3	3

Table 13.26: Predicted Average Weekday CO Emission Rates (g/km/day) for SH1 and Associated Link Roads

ID	Description	2006	2026 DM	2026 WP	2031 DM	2031 WP
		[g/km/day]				
SH1-2	**SH1** - Tawa	157210	33970	36720	36040	39430
SH1-13	**SH1** - Porirua Harbour	194490	35710	26140	37720	27850
SH1-8	**SH1** - Mana Esp	137320	34780	17070	36950	18120
SH1-11	**SH1** - North of Plimmerton	88130	14040	3010	14710	3210
SH1-1	Takapu Rd	58220	16490	16290	17600	16880
SH1-3	Parumoana St	67820	16170	14400	17300	15430
SH1-4	Titahi Bay Rd	77730	23680	17160	24970	18500
SH1-5	Mungavin Ave	52400	13630	13060	15630	14570
SH1-6	Whitford Browne Ave	34780	11040	10930	11700	11640
SH1-7	Paremata Rd West (SH58)	55350	11030	11030	11400	8580
SH1-9	Grays Rd	16230	2800	1080	3150	1150
SH1-10	Steyene Ave	24330	5250	5450	5530	5760
SH1-12	Paremata Rd East (SH58)	19890	3300	1820	3570	1900

7.5.3 Predicted Particulate Emission Rates

Table 13.27 and Table 13.28 show the average daily PM10 emission rates predicted for selected sections of the Main Alignment, SH1 and associated feeder roads. The location of each of the road sections is shown in Table 13.9 on Page 44. The emission rates presented in the tables do not incorporate the effects of road gradients.

Table 13.27: Predicted Average Weekday PM_{10} Emission Rates (g/km/day) for the Main Alignment and Associated Link Roads

ID	Description	2026 WP	2031 WP
		[g/km/day]	
TG2	**Main Alignment**: connection to SH1	740	750
TG3	**Main Alignment**: Linden to Kenepuru Interchanges	860	870
TG4	**Main Alignment**: SH58 to MacKays Interchanges	1010	1020
TG1	Kenepuru Link Road	470	470
TG5	Whitby Link Road	140	150
TG6	Waitangirua Link Road	130	130
TG7	Paremata Heywood Rd (SH58 East)	610	620
TG8	Paekakariki Hill Road	0.3	0.3

Table 13.28: Predicted Weekday Average PM_{10} Emission Rates (g/km/day) for SH1 and Associated Link Roads

ID	Description	2006	2026 DM	2026 WP	2031 DM	2031 WP
		[g/km/day]				
SH1-2	**SH1** - Tawa	3420	2430	2650	2460	2670
SH1-13	**SH1** - Porirua Harbour	4120	2570	1930	2600	1960
SH1-8	**SH1** - Mana Esp	3090	1640	870	1650	890
SH1-11	**SH1** - North of Plimmerton	1930	1070	220	1070	220
SH1-1	Takapu Rd	1750	970	900	1000	920
SH1-3	Parumoana St	780	860	770	890	800
SH1-4	Titahi Bay Rd	1680	990	830	1000	850
SH1-5	Mungavin Ave	1030	590	570	620	590
SH1-6	Whitford Browne Ave	870	630	610	640	630
SH1-7	Paremata Rd West (SH58)	1360	620	620	620	460
SH1-9	Grays Rd	450	200	80	210	80
SH1-10	Steyene Ave	540	270	280	280	290
SH1-12	Paremata Rd East (SH58)	630	210	110	220	110

7.5.4 Predicted Benzene Emission Rates

Table 13.29 and Table 13.30 show the average daily benzene emission rates predicted for selected sections of the Main Alignment, SH1 and associated feeder roads. The location of each of the road sections is shown in Table 13.9 on Page 44. The emission rates presented in the tables do not incorporate the effects of road gradients.

Table 13.29: Predicted Average Weekday Benzene Emission Rates (g/km/day) for the Main Alignment and Associated Link Roads

ID	Description	2026 WP	2031 WP
		[g/km/day]	
TG2	**Main Alignment**: connection to SH1	87	93
TG3	**Main Alignment**: Linden to Kenepuru Interchanges	83	89
TG4	**Main Alignment**: SH58 to MacKays Interchanges	101	107
TG1	Kenepuru Link Road	77	81
TG5	Whitby Link Road	30	33
TG6	Waitangirua Link Road	24	25
TG7	Paremata Heywood Rd (SH58 East)	121	131
TG8	Paekakariki Hill Road	0.1	0.1

Table 13.30: Predicted Average Weekday Benzene Emission Rates (g/km/day) for SH1 and Associated Link Roads

ID	Description	2006	2026 DM	2026 WP	2031 DM	2031 WP
		[g/km/day]				
SH1-2	**SH1** - Tawa	455	276	286	296	317
SH1-13	**SH1** - Porirua Harbour	546	282	194	300	208
SH1-8	**SH1** - Mana Esp	688	354	172	381	185
SH1-11	**SH1** - North of Plimmerton	248	119	37	126	40
SH1-1	Takapu Rd	336	181	180	196	191
SH1-3	Parumoana St	333	147	131	158	141
SH1-4	Titahi Bay Rd	375	194	143	206	155
SH1-5	Mungavin Ave	243	113	106	128	118
SH1-6	Whitford Browne Ave	178	112	107	120	115
SH1-7	Paremata Rd West (SH58)	280	106	106	111	80
SH1-9	Grays Rd	69	30	13	34	14
SH1-10	Steyene Ave	120	50	51	53	55
SH1-12	Paremata Rd East (SH58)	119	42	22	46	23

7.5.5 Summary of Predicted Emission Rates

The results of the emission modelling shows similar daily emission rates of PM_{10}, NO_X, CO, and benzene for the Main Alignment, SH1 and the associated feeder roads for the 2026 and 2031 'with project' emission scenarios and also for the 2026 and 2031 'do-minimum' emission scenarios. Generally higher emission rates are predicted for 2031 emission scenarios compared to the 2026 emission scenarios. The higher emission rates can largely be attributed to the higher traffic volumes predicted for the projected year. However, the differences between the projected emission rates are generally small and within the uncertainty of the emission and traffic model predictions. For instance, along the Main Alignment predicted emission rates for 2026 are to 4%-7% lower than those predicted for 2031.

Since vehicle emission rates along the Main Alignment and associated feeder roads are predicted to be similar for both 2026 and 2031 the predicted contribution from the modelled road sources to ground level pollutant levels will also be similar for both of the projected years. Therefore, ground level pollutant levels have been predicted using the dispersion model only for the 2031 'with project' and 'do minimum' emission scenarios, in addition to the 2006 baseline emission scenario. Predicted ground level concentrations for 2026 will be similar but lower to those for 2031.

Pollutant emission rates from SH1 are shown to decrease at locations between the southern and northern interchanges with the Main Alignment (refer Table 13.24, Table 13.26, Table 13.28,and Table 13.30). The tables show that predicted emissions rates for the 'with project' emissions scenarios on sections of SH1 near Porirua Harbour (SH1-13), Mana Esplanade (SH1-8) and north of Plimmerton (SH1-11) are 69%-74%, 49%-54%, and 20%-32% respectively of emission rates predicted for the corresponding 'do minimum' emission scenarios. The results of the emission model indicate the contribution from vehicle emissions to ambient pollutant levels in areas near SH1 are expected to decrease with the construction of the Main Alignment. These areas are more density populated than those which surround the majority of the Main Alignment (where pollutant levels will increase). Therefore, an expected effect of the development would be a reduction in the air pollutant level where people are more likely to be exposed.

However, the development of the Main Alignment is predicted to have a lower effect on emissions from the main arterial roads feeding into the SH1. The tables show for most of the existing SH1 feeder roads comparable emission rates are predicted for the 'do minimum' and 'with project' emission scenarios, where slightly lower emission rates are predicted for the 'with project' scenarios. The Project is predicted to have the greatest effect on reducing pollutant emission rates for Grays Road (SH1-9), Paremata Road (SH1-12) and Titahi Road (SH1-4).

The tables clearly show that even though traffic vehicles are predicted to increase between the base year of 2006 and projected years of 2026 and 2031 vehicle emission rates are predicted to decrease. The lower emission rates predicted for the projected years are a consequence of the assumed improvement in the performance of the New Zealand vehicle fleet emission rates.

8 Dispersion modelling

8.1 Choice of dispersion model

Pollutant concentrations have been predicted using the AUSROADS dispersion model. AUSROADS is a simple Gaussian dispersion model developed by the Victorian Environmental Protection Agency (Vic EPA), based on the Californian Department of Transportation's CALINE4 dispersion model. Compared to CALINE4, AUSROADS allows for an increased number of road links and receptor points, and the ability to predict pollutant concentrations using a full year of meteorological data.

AUSROADS is widely used throughout Australasia and is recognised in the MfE Good Practice Guide for Atmospheric Dispersion Modelling (2004). AUSROADS has been used for the assessment of surface road emissions for the Western Ring Route: Waterview Connection project (Beca, 2010c).

The model incorporates specific algorithms designed to simulate the dispersion of pollutants from roads. The dispersion algorithms simulate the effects of vehicle induced turbulence, thermal turbulence and surface roughness. AUSROADS is a 'near road' model and is intended for the assessment of pollutant concentrations within a few hundred metres of a road source. As a consequence AUSROADS uses comparatively simple methods to account for terrain and structural effects on pollutant dispersion, eg allowing each modelled road links to be classified as either an elevated, depressed, at-grade or bridge road section. AUSROADS does not simulate the effect that local hills or gullies have on channelling wind flows. However, at sensitive receptors located near the road these effects are not expected to have a significant effect on the predicted maximum concentrations.

AUSROADS also does not model the effects that building structures have on pollutant dispersion. However, buildings on located either side of the proposed project are mostly one or two storey structures, recirculation effects typically associated with urban canyons are not expected to occur and influence ground level concentrations.

AUSROADS does not simulate the reactions of pollutant once discharged into the atmosphere. In consequence, NO_2 concentrations have been estimated from predicted NO_X concentrations using the method detailed in Section 8.6.

8.2 Modelling domains

Detailed AUSROADS dispersion models were constructed for five Project areas where emissions from the vehicles are most likely to have an effect on sensitive receptors. The five modelling domains have been labelled L1, L2, L3, L4 and L5. The modelling domains were selected using the criteria detailed in Section 5.5, and have been identified in Section 7.3.2. A brief description of each of the areas is presented in Table 13.31. The location of the modelling domain is shown in Figure 13.13.

For the roads included in the dispersion models, hourly PM_{10}, CO, NO_X and benzene emissions profiles for a typical weekday were constructed. Modelled emission rates for the proposed road have incorporated the effect of the road gradient (refer Section 7.4.6). Ground level concentrations have been predicted based on vehicle emission rates and traffic volumes for the 2006 base year, and for the projected 2031 DM and 2031 WP traffic scenarios.

Total traffic volumes and vehicle emission rates predicted for the project 2026 emission scenario were similar but lower than those predicted for the project year of 2031. Therefore, no ground concentrations were predicted for the 2026 emission scenario as the 2031 emission scenario is expected to provide an indication of worse case pollutant levels in the vicinity of the Project.

Table 13.31: Summary of Detailed Modelling Domains

ID	Modelling domain	Description
L1	Kenepuru Interchange and link road	The modelling domain is located near Porirua hospital. Kenepuru Link road will connected Kenepuru Drive to the Main Alignment. The road will extend over existing commercial areas. Sensitive receptors include the hospital and residential areas located along SH1. Vehicle volumes on Kenepuru Drive and the new on ramp are expected to be greater than 7000 vehicles per day.
L2	Linden	This location is predicted to have the highest traffic volumes in areas directly affected by the Project. Traffic volumes are predicted to be rise from less than 20000 vehicles per day in 2006 to approximately 31000 vehicles per day in 2031. Residential areas are located in the close proximity of the existing SH1 at Linden. Other sensitive receptors which may be affected included Linden School, which borders SH1, and Tui Kindergarten amongst others.
L3	Warspite Avenue / Waitangirua Link Rd intersection	This location includes the proposed intersection between Warspite Ave and the Waitangirua Link road which will feed into the Main Alignment. Traffic volumes at the intersection with the new road are predicted to be greater than 7000 vehicles per day. The area is predominantly residential and commercial. Other sensitive receptors that may be affected include a marae and a health centre.
L4	State Highway 58 interchange	The modelled area includes the proposed interchange between SH58 and the Main Alignment. The area is predominantly rural with a small number of lifestyle blocks located on SH58.
L5	MacKays Crossing	This location includes the area where the Main Alignment and SH1 reconnect. The area is predominantly rural with a small number of lifestyle blocks located along the State highway.

Modelled road sources in each of the modelling domains were divided in linked line sources. The line sources were used to define the geometry of the road and road section's model type (ie an elevated, depressed, at-grade or bridge road section). The elevation or depression of the line sources were estimated from Project plans.

North and south bound lanes of the Main Alignment and SH1 have been modelled as separate linked line sources. Smaller suburban and arterial roads have been simulated using single lines sources. In the model it has been assumed that each individual traffic lane is approximately 3.5m in width. AUSROADS input files for the five modelling domains are presented in Appendix 13.I.

Additional simpler dispersion modelling was used to predict pollutant concentrations with increasing distance from the major arterial roads (eg Grays Rd, Whitford Brown Ave and SH58) affected by the Project. Concentrations at these locations were predicted using a screening meteorological input file assuming worse case dispersion conditions.

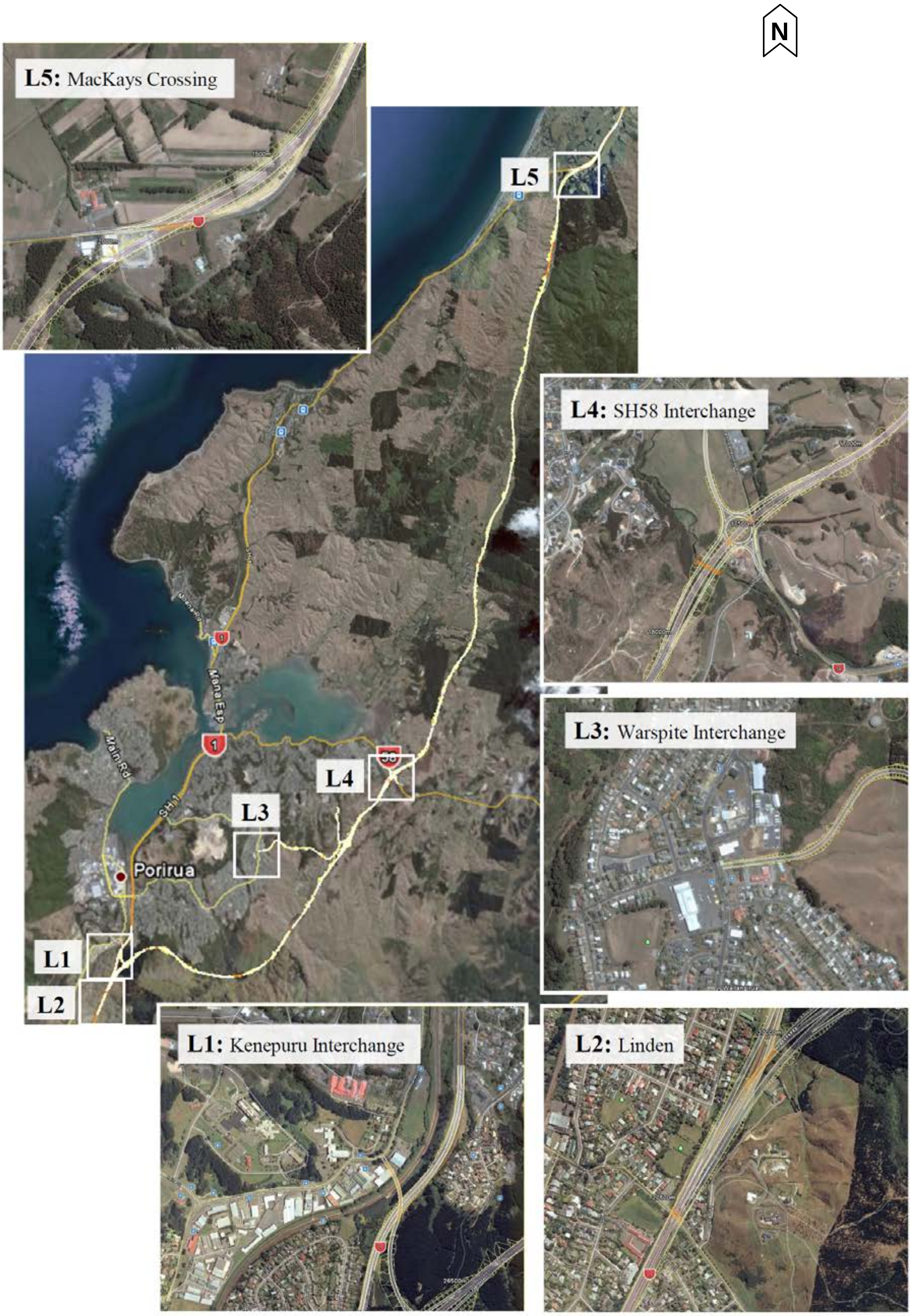


Figure 13.13: Location of the Five Detailed Modelling Domains

8.3 Configuration options

AUSROADS was configured using the following options for all of the modelled scenarios:

- Pasquill-Gifford horizontal dispersion profile
- Irwin Urban wind exponents were used for urban and residential locations and Irwin Rural wind exponents was used to model rural areas
- A surface roughness of 0.4m

The surface roughness used in the dispersion is representative of both residential areas and rolling country side.

8.4 Receptor grids

Pollutant concentrations typically decrease rapidly with distance from the roads. For each of the dispersion models, receptors were located near sensitive receptors and nearby residential properties. The location of each of the discrete receptors is shown in Appendix 13.C. Additional receptors were also defined at fixed distances from each of the modelled road sources using AUSROADS' automatic receptor gridding function.

8.5 Meteorological inputs

Accurate atmospheric dispersion modelling requires good meteorological information that is representative of the dispersion conditions near the emission source, and in a format that can be used by the dispersion model.

Due to the topography of the area wind flows are expected to vary significantly within the Project area. To help account for these spatial variations in dispersion conditions, four one-year AUSROADS (and AUSPLUME) compatible meteorological input files were developed using the TAPM v4 ('The Air Pollution Model') meteorological and dispersion model.

TAPM, developed by CSIRO, is a sophisticated computer model that predicts the three dimensional meteorology and air pollutant concentrations by solving the fundamental fluid dynamic and scalar transport equations. It consists of coupled diagnostic meteorological and air pollution components that predict the air flows important to local scale air pollution, such as sea breezes, against a background of larger scale synoptic meteorological patterns (Hurley, 1999).

One of the primary functions of the TAPM model's design is the provision of high quality meteorological data for dispersion models where suitable onsite information is not available. Using historical synoptic scale meteorological analyses in conjunction with local land use and terrain information, TAPM can produce realistic and high quality meteorological inputs for a number of air pollutant dispersion modelling systems including AUSROADS. Validation studies show that TAPM can accurately predict localised meteorological conditions.

In this instance TAPM was used to generate one-year upper air meteorological input datasets in an AUSROADS format. To help ensure that the wind fields predicted by TAPM accurately reflects the meteorological conditions, hourly wind speed and wind direction data recorded at the Tawa ambient air monitoring station and Paraparaumu aerodrome meteorological monitoring stations during 2008 were assimilated into the model. The Tawa monitoring site operates a 6m high meteorological mast, and the Paraparaumu Aerodrome a 10m high meteorological mast. However, assimilated meteorological data has only a localised effect on predicted wind flows.

Four meteorological input files were extracted from the TAPM model at the approximate location of the five dispersion modelling domains (refer Figure 13.13). The exception was that dispersion parameters for the L5 (MacKays Crossing) modelling domain were extracted from TAPM at the location of the Paraparaumu Airport meteorological monitoring station. This approach was done to ensure modelled dispersion conditions at the interchange were representative of observed wind flows on the Kapiti Coast.

The dispersion near the Kenepuru interchange (L1) and the Linden site (L2) were modelled using the same meteorological input file. Both sites are located near the Tawa monitoring site. The meteorological input file constructed for these sites is reflective of wind speeds and directions observed at the Tawa site and assimilated into TAPM.

It is important to note that there is always a degree of uncertainty in model predictions. However, TAPM is expected to provide a reasonable statistical assessment of the dispersion conditions at each of the modelled locations. Including the locations where no meteorological data could be assimilated into the model (ie L3 and L4).

TAPM was configured using nested grid spacings of 10, 3, and 1km. A 25 (east/west) x 25 (north/south) x 25m vertical layer model grid was used. Surface vegetation effects, hydrostatic pressure, rain processes and prognostic eddy dissipation options were selected in the simulation (recommended as defaults by CSIRO). The 2008 meteorological data input files were generated from the 1km spaced nested grid. The Paraparaumu meteorological input file was extracted from a separate model run to the other input files. The Paraparaumu input file was extracted from a TAPM grid centred on the approximate location of the Paraparaumu Airport. The other meteorological input files were extracted from a TAPM grid centred on the approximate location of the Tawa meteorological monitoring station. The predicted wind speed and wind direction distributions for the L1 to L5 sites are shown in Figure 13.14 and Figure 13.15

For the assessment of pollutant levels near arterial roads within the Project area a screening meteorological input file was used. Screening meteorological input files are typically used to predict the peak 1-hour average concentration that could occur at any receptor if worse case dispersion conditions were to occur. For road emissions, worst case meteorological conditions correspond to low wind speeds and highly stable atmospheric conditions (ie 0.5m/s wind speeds and Pasquil Gifford F stability). These conditions occur during the night and early morning. During the day, worse case meteorological conditions correspond to low wind speeds and neutral atmospheric conditions (ie 0.5m/s wind speeds and Pasquil Gifford D stability).

For this assessment a screening input representing worst case dispersion conditions occurring continuously over a 24-hour period with varying wind direction was developed. For the hours 6pm-8am wind speed and stability conditions were defined to be 0.5m/s and F stability, for the hours 8am-6pm they were defined to be 0.5m/s and D stability. The wind direction was assumed to be constant for each 24-hour period. For each successive 24-hour period the wind direction was increase by a 5 degree increment. A total of 72 wind directions were modelled. The results of the screening modelling are presented in Appendix 13.I. Predicted concentrations were less than the AAQNES and AAQG air quality criteria.

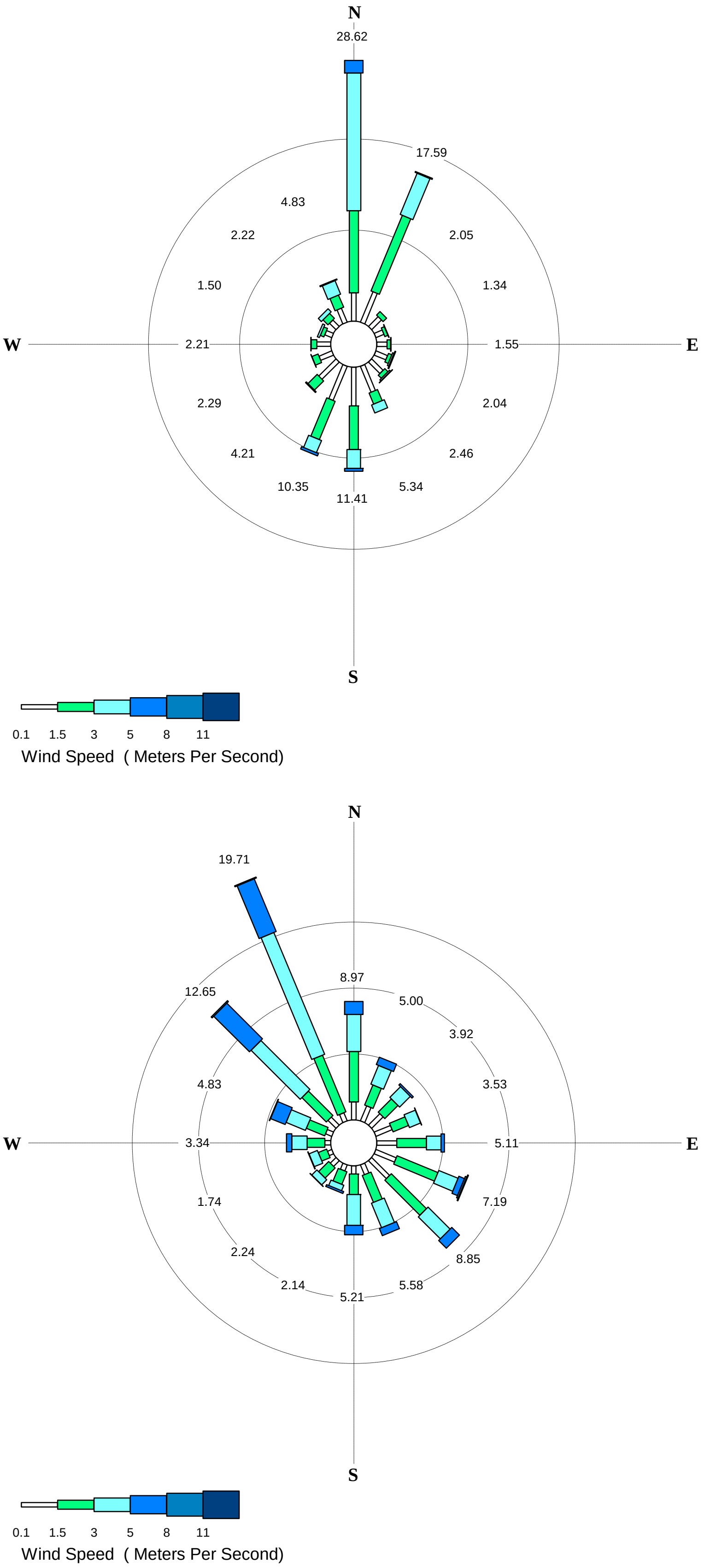


Figure 13.14: Predicted wind speed wind direction frequency distributions for L1 and L2 (top) and L3 (bottom)

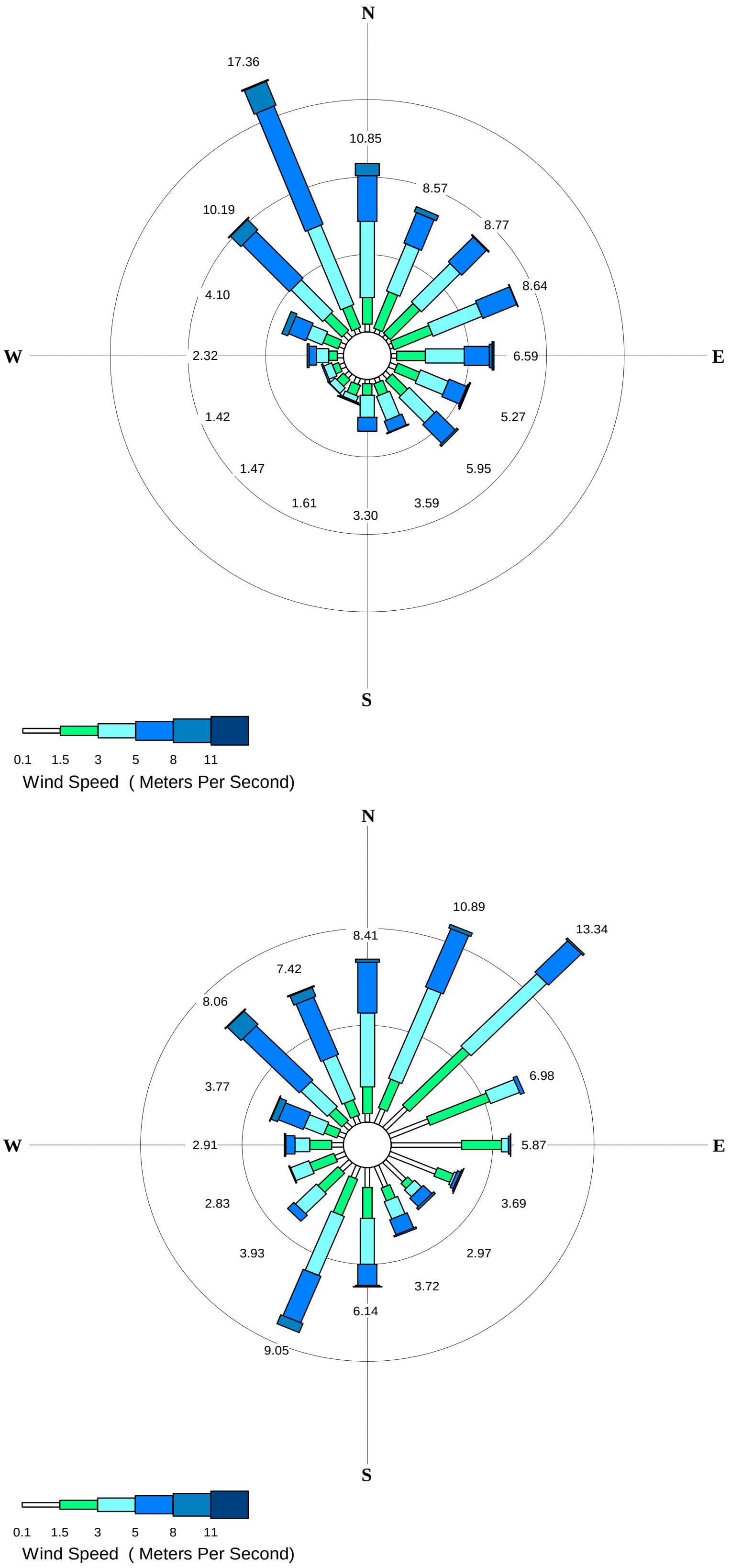


Figure 13.15: Predicted wind speed and wind direction frequency distributions for L4 (top) and L5 (bottom)

8.6 Assessment of Nitrogen Dioxide

NO_2 passive sampling and the continuous monitoring data indicate that current NO_2 concentrations in the Project area are currently unlikely to exceed the AQNES and AAQG air quality criteria level (refer to Section 6.3). However, due to the reactivity of nitrogen oxides once released in the atmosphere, and the absence of any continuous monitoring data in the area, it is difficult to estimate precisely what actual NO_2 concentrations are likely to be in the vicinity of the Main Alignment.

The methodology for estimating NO_2 concentrations is detailed in Appendix 13.F.

8.7 Model uncertainties

Air quality assessments for new projects rely on statistical models to estimate likely impacts of those projects. The use of statistical models, by their very nature, will introduce a degree of uncertainty into the outcomes, in addition to uncertainty in the raw data used as model inputs.

In this assessment, some raw data has been derived from measurements (e.g. ambient air quality and meteorological monitoring and traffic count data), while other data relies on the outputs from other models (eg traffic flows predicted by SATURN, vehicle emission rates from VEPM).

The degree of uncertainty in the modelling reported in this assessment has not been quantified. The only difference in inputs between the ‘do minimum’ and ‘with Project’ scenarios in 2026 and 2031 is the Project itself. Therefore, notwithstanding the uncertainties in the actual results of the dispersion modelling, it is reasonable to base conclusions on a comparison of the relative differences between the predicted results of this modelling, both with and without the project.

9 Assessment of effects of vehicle emissions

9.1 Introduction

This section summarises the predicted CO, PM_{10}, NO_X and benzene concentration associated with emissions from the proposed Project and nearby roads and ramps at nearby sensitive receptors.

9.2 Predicted Nitrogen Oxide concentrations

A summary of the predicted maximum incremental 99.9 percentile 1-hour average NO_X concentrations and maximum cumulative 99.9 percentile 1-hour average NO_2 concentrations for the five detailed dispersion models is presented in Table 13.32. Maximum incremental NO_X concentrations correspond to the maximum contribution of modelled road sources to ambient pollutant levels. The maximum cumulative NO_2 concentrations are the resulting concentration taking into account both from background pollutant levels and the modelled road sources. Potential effects are assessed by comparing the cumulative concentration against the air quality criteria level.

The table shows predicted concentrations for the 2006 base year, 2031 ‘do-minimum’ (DM), and 2031 ‘with project’ (WP) emissions scenarios. Concentrations are shown for the sensitive receptors and the residential properties most affected by emissions from the modelled road sources. The residential addresses where the peak pollutant levels are predicted are also shown in the table. The location of the receptor points with respect to the modelled road sources is shown in Appendix 13.C.

Predicted NO_2 concentrations have been estimated using the methodology presented in Appendix 13.F. The method assumes a background NO_2 concentration of 45µg/m^3 based on pollutant levels recorded in the suburb of Tawa. The background concentration is expected to overestimate pollutant levels in the vicinity of the SH58 interchange (L4) and MacKays Crossing (L5) which are more rural in nature. Predicted cumulative concentrations at these sites are consequently expected to be overestimated.

At each of the receptors lower 99.9 percentile 1-hour average NO_X and NO_2 concentrations are predicted for the 2031 ‘do-minimum’ and ‘with project’ emissions scenarios compared to concentrations predicted for the 2006 base year. Predicted NO_2 concentrations are slightly lower for the 2031 ‘do-minimum’ emissions scenario compared to the ‘with project’ emissions scenario. However, these differences are comparatively small.

For the 2031 ‘with Project’ emission scenario, the maximum 99.9 percentile 1-hour average NO_2 concentration predicted at any sensitive receptor is 57 µg/m^3, or 29% of the 1-hour average NO_2 AQNES of 200 µg/m^3. A comparable maximum 99.9 percentile 1-hour average NO_2 concentration of 56 µg/m^3 is predicted for the 2031 ‘do-minimum’ emission scenario. Cumulative NO_2 concentrations are predicted to be less than 60% of the GWRC ‘maximum desirable level’ of 95 µg/m^3 (refer Table 13.3).

The modelling indicates that existing pollutant levels are not predicted to increase as a consequence of the Project, or exceed air quality criteria. Instrumental and passive monitoring data indicates that current NO_2 levels in the region are generally low and do not exceed air quality criteria limits (refer Section 6.3). The modelling prediction indicates that the Project is unlikely to results in a future exceedance of the AQNES air quality criteria limit.

Table 13.32: Predicted Maximum 1-hour Average Incremental NO_X Concentrations and Cumulative NO_2 Concentrations (µg/m^3)

Receptor	Incremental NO_X concentration			Cumulative NO_2 concentration		
	2006	2031 DM	2031 WP	2006	2031 DM	2031 WP
	Location 1: Kenepuru Drive intersection					
R4 - Kapi Mana School	29	16	18	48	47	47
R5 - Kenepuru Community Health Hospital	27	14	20	48	46	47
Highest Residential	100	42	53	55	49	50
Highest Residential, Receptor ID and Address	MN11: 53 Kenepuru Drive	MN10: 73 Kenepuru Drive	MN11: 53 Kenepuru Drive			
	Location 2: Linden motorway					
R5 - Linden School Sportsground	155	65	75	61	51	53
R6 - Linden School	177	74	84	63	52	53
R13 - Arthur Carman Park	99	46	58	55	50	51
R14 - Tui Park Kindergarten	25	11	14	47	46	46
Highest Residential	238	108	122	69	56	57
Highest Residential, Receptor ID and Address	MN13: 42A Mahoe Street					
	Location 3: Warspite Avenue intersection					
R1 - 6 Kokiri Cres (Natone Park School)	8	4	5	46	45	45
R2 - Maraeroa Marae Health Centre	21	11	12	47	46	46
R3 - Maraeroa Marae	16	8	14	47	46	46
Highest Residential	46	24	31	50	47	48
Highest Residential, Receptor ID and Address	MN5: 263 Warspite Avenue		MN7: 3 Niagara Street			
	Location 4: State Highway 58 Interchange					
Highest Residential	73	27	34	52	48	48
Highest Residential, Receptor ID and Address	R4: 51 Paremata Haywards Rd		R1: 75F Paremata Hayward s Rd			
	Location 5: MacKays Crossing					
Highest Residential	125	75	32	57	52	48
Highest Residential, Receptor ID and Address	R5 and R6: 334, State Highway 1					

A summary of the predicted maximum incremental 24-hour average NO_X concentrations and maximum cumulative 24-hour average NO_2 concentrations are presented in Table 13.33. The tables show predicted concentrations for the 2006 base year, 2031 'do-minimum' (DM), and 2031 'with project' (WP) emissions scenarios. Concentrations are shown for the sensitive receptors and the residential properties most affected by emissions from the modelled road sources. The residential addresses where the peak pollutant levels are predicted are also shown in the table. The location of the receptor points with respect to the modelled road sources is shown in Appendix 13.C.

Predicted NO_2 concentrations have been estimated using the methodology presented in Appendix 13.F. The methodology assumes a background NO_2 concentration of 29 µg/m^3 based on pollutant levels recorded in the suburb of Tawa. The assumed background is therefore expected to overestimate background pollutant levels in the vicinity of the SH58 interchange (L4) and MacKays Crossing (L5).

Maximum incremental 24-hour average NO_X concentrations for the 2031'with project' and 'do minimum' emissions scenarios are all predicted to be lower than 2006 levels. However, predicted differences are comparatively small. Similar maximum cumulative 24-hour average NO_2 concentrations are predicted for three emissions scenarios. For instance, the maximum 24-hour average NO_2 concentrations predicted at any sensitive receptor for the 2006, 2031 DM, and 2031 WP emission scenarios are 37 µg/m^3, 33 µg/m^3, and 33 µg/m^3 respectively.

The maximum predicted cumulative 24-hour NO_2 concentration for the 2031 'with project' emission scenario is approximately 4 µg/m^3 higher than the assumed maximum background level of 29 µg/m^3. The predicted maximum concentration is 33% of the AAQG air quality limit of 100 µg/m^3. The results of the dispersion modelling indicate that 24-hour NO_2 concentrations are unlikely to exceed the AAQG as a consequence of vehicle emissions from the Project.

The results also indicate that air pollutant levels are unlikely to be higher than existing levels near SH1. The instrumental and passive sampling ambient monitoring data near the project and within the Wellington region indicates that current 24-hour average NO_2 are generally low and do not exceed 24-hour AAQG limits (refer Section 6.3). The monitoring data provides further evidence to indicate that ambient pollutant levels are unlikely to exceed the AAQG.

Predicted cumulative 24-hour average NO_2 concentrations are also less than the annual average WHO guideline level of 40 µg/m^3. Since annual average NO_2 concentrations will be significantly lower than maximum 24-hour concentrations the results indicate that NO_2 levels are highly unlikely to exceed the WHO guideline.

At sensitive receptors near MacKays Crossing and the SH58 interchange maximum cumulative 24-hour NO_2 concentrations are predicted to be less 30 µg/m^3. Predicted cumulative concentrations at these locations have assumed urban background levels of NO_2. In actuality background NO_2 concentrations in these rural areas are expected significantly lower than what has been assumed. Maximum 24-hour NO_2 concentrations are expected to be lower than those shown in the table and annual average NO_2 concentrations significantly less than 30 µg/m^3. The results of modelling indicate that at these locations, and at other rural location near the Main Alignment, annual average NO_2 concentrations are expected to be significantly less than MfE Critical Level for ecosystems of 30 µg/m^3.

Table 13.33: Predicted Maximum 24-hour Average Incremental NO_X Concentrations and Cumulative NO_2 Concentrations (µg/m^3)

Receptor	Incremental NO_X concentration			Cumulative NO_2 concentration		
	2006	2031 DM	2031 WP	2006	2031 DM	2031 WP
	L1: Kenepuru Drive intersection					
R4 - Kapi Mana School	8.8	4.6	5.3	29.9	29.5	29.5
R5 - Kenepuru Community Health Hospital	8.6	4.4	6.4	29.9	29.4	29.6
Highest Residential	28.5	14.1	18.0	31.9	30.4	30.8
Highest Residential, Receptor ID and Address	MN5: 4 Bluff Road		R3: 34 Kenepuru Drive			
	L2: Linden motorway					
R5 - Linden School Sportsground	47.2	24.7	26.3	33.7	31.5	31.6
R6 - Linden School	53.0	27.9	29.7	34.3	31.8	32.0
R13 - Arthur Carman Park	35.2	18.0	19.3	32.5	30.8	30.9
R14 - Tui Park Kindergarten	7.3	3.6	4.3	29.7	29.4	29.4
Highest Residential	79.3	40.8	44.2	36.9	33.1	33.4
Highest Residential, Receptor ID and Address	MN13: 42A Mahoe Street					
	L3: Warspite Avenue intersection					
R1 - 6 Kokiri Cres (Natone Park School)	1.1	0.5	0.8	29.1	29.1	29.1
R2 - Maraeroa Marae Health Centre	3.7	1.9	2.3	29.4	29.2	29.2
R3 - Maraeroa Marae	3.7	1.8	3.5	29.4	29.2	29.4
Highest Residential	11.1	5.6	6.9	30.1	29.6	29.7
Highest Residential, Receptor ID and Address	263 Warspite Avenue					
	L4: State Highway 58 interchange					
Highest Residential	16.8	6.0	7.3	30.7	29.6	29.7
Highest Residential, Receptor ID and Address	51 Paremata Haywards Rd		85 Paremata Haywards Rd			
	L5: MacKays Crossing					
Highest Residential	21.1	10.0	4.9	31.1	30.0	29.5
Highest Residential, Receptor ID and Address	R6: 334, State Highway 1					

9.3 Predicted Carbon Monoxide Concentrations

9.3.1 Predicted PM_{10} Concentrations

A summary of the predicted maximum incremental and cumulative 8-hour average CO concentrations (mg/m^3) is presented in Table 13.33. The table shows predicted concentrations for the 2006 base year, 2031 'do-minimum' (DM), and 2031 'with project' (WP) emissions scenarios. Concentrations are shown for the sensitive receptors and the residential properties most affected by emissions from the modelled road sources. The residential addresses where the peak pollutant levels are predicted are also shown in the table. The location of the receptor points with respect to the modelled road sources is shown in Appendix 13.C.

Estimated cumulative concentration presented in the table assumes a background concentration of 3.1 mg/m^3 for the modelled urban areas (L1, L2, and L3) and a concentration of 0.0 mg/m^3 for the rural areas in the vicinity of the SH58 interchange (L4) and MacKays Crossing (L5).

The results show that lower maximum 8-hour average incremental CO concentrations are predicted for the 2031 'do-minimum' (DM), and 2031 'with project' compared to the 2006 base year. However, compared to the AQNES of 10 mg/m^3, predicted contributions from the modelled road sources are comparatively small for all three emissions scenarios. The maximum incremental concentrations predicted at any of the discrete receptors for the 2031 'with project' emissions scenario is 0.09 mg/m^3, or less than 1% of the AQNES, and less than 3% of the expected maximum background concentration of 3.1 mg/m^3. Incremental concentrations predicted for the 2031 'do minimum' emissions scenario are similar to those predicted for the 'with project' emissions scenario.

Predicted incremental concentrations for both 2031 emissions scenarios are over a factor of four lower than those predicted for the base year 2006. The results indicate that emissions from the Project are unlikely to increase existing ambient pollutant levels.

The table shows that predicted cumulative 8-hour average CO levels near areas affected by the Project are all significantly less than the AQNES. The results indicate that vehicle emissions from the modelled roads sources are highly unlikely to result in an exceedance of the AQNES.

Table 13.34: Predicted Maximum Incremental and Cumulative 8-hour Average CO Concentrations (mg/m^3)

Receptor	Incremental CO concentration			Cumulative CO concentration		
	2006	2031 DM	2031 WP	2006	2031 DM	2031 WP
	L1: Kenepuru Drive intersection					
R4 - Kapi Mana School	0.05	0.01	0.01	3.15	3.11	3.11
R5 - Kenepuru Community Health Hospital	0.05	0.01	0.02	3.15	3.11	3.12
Highest Residential	0.2	0.04	0.06	3.28	3.14	3.16
Highest Residential, Receptor Identifier and Address	MN5: 4 Bluff Road		R3: 34 Kenepuru Drive			
	L2: Linden motorway					
R5 - Linden School Sportsground	0.2	0.05	0.06	3.34	3.15	3.16
R6 - Linden School	0.3	0.06	0.06	3.37	3.16	3.16
R13 - Arthur Carman Park	0.2	0.04	0.04	3.27	3.14	3.14
R14 - Tui Park Kindergarten	0.04	0.01	0.01	3.14	3.11	3.11
Highest Residential	0.4	0.08	0.09	3.49	3.18	3.19
Highest Residential, Receptor Identifier and Address	MN13: 42A Mahoe Street					
	L3: Warspite Avenue intersection					
R1 - 6 Kokiri Cres (Natone Park School)	0.01	0.002	0.003	3.11	3.10	3.10
R2 - Maraeroa Marae Health Centre	0.03	0.007	0.008	3.13	3.11	3.11
R3 - Maraeroa Marae	0.02	0.005	0.008	3.12	3.11	3.11
Highest Residential	0.06	0.016	0.018	3.16	3.12	3.12
Highest Residential, Receptor Identifier and Address	MN5: 263 Warspite Avenue					
	L4: State Highway 58 Interchange					
Highest Residential	0.08	0.01	0.02	0.08	0.01	0.02
Highest Residential, Receptor Identifier and Address	R4: 51 Paremata Haywards Rd		R1:75F Paremata Haywards Rd			
	L5: MacKays Crossing					
Highest Residential	0.10	0.02	0.01	0.1	0.02	0.01
Highest Residential, Receptor Identifier and Address	R6: 334 State Highway 1					

A summary of the predicted maximum incremental and cumulative 99.9 percentile 1-hour average CO concentrations (mg/m^3) is presented in Table 13.35. The tables show predicted concentrations for the 2006 base year, 2031 'do-minimum' (DM), and 2031 'with project' (WP) emissions scenarios. Concentrations are shown for the sensitive receptors and the residential properties most affected by emissions from the modelled road sources. The residential addresses where the peak pollutant levels are predicted are also shown in the table. The location of the receptor points with respect to the modelled road sources is shown in Appendix 13.C.

Estimated cumulative concentration presented in the table assumes a background concentration of 3.4 mg/m^3 in the modelled urban areas (L1, L2, and L3) and a concentration of 0.0 mg/m^3 for the rural areas in the vicinity of the SH58 interchange (L4) and MacKays Crossing (L5).

Table 13.33 shows the maximum incremental CO concentrations for the two 2031 emissions scenarios are predicted to be lower than those for the 2006 base year at all discrete receptor points. The results indicate that pollutant levels in areas impacted by the Project are not expected to increase from existing levels.

The maximum incremental 99.9 percentile 1-hour average CO concentration predicted at any of the sensitive receptors for the 2006 emissions scenario is 0.8 mg/m^3, or 2.7% of the AAQG. The maximum incremental concentrations predicted for the 2031 'do minimum', and 2031 'with project' emissions scenarios are less than 0.2 mg/m^3, or 0.6% of the AAQG. Compared to the 1-hour average AAQG level of 30 mg/m^3 the results of the dispersion modelling assessment show that predicted maximum incremental concentrations are low for all three of emission scenarios modelled.

For the 2031 'with project' emission scenario, maximum 99.9 percentile 1-hour average cumulative concentrations are predicted to be less than 3.6 mg/m^3, or 12% of the of AAQG. Contributions from the modelled road sources are predicted to be significantly less than worse case background pollutant levels. The dispersion modelling indicates that CO concentrations at sensitive receptors are unlikely to exceed the 1-hour average AAQG.

Table 13.35: Predicted Maximum Incremental and Cumulative 99.9 Percentile 1-hour Average CO Concentrations (mg/m^3)

Receptor	Incremental CO concentration			Cumulative CO concentration		
	2006	2031 DM	2031 WP	2006	2031 DM	2031 WP
	L1: Kenepuru Drive intersection					
R4 - Kapi Mana School	0.11	0.02	0.03	3.51	3.42	3.43
R5 - Kenepuru Community Health Hospital	0.11	0.02	0.03	3.51	3.42	3.43
Highest Residential	0.39	0.1	0.11	3.79	3.5	3.51
Highest Residential, Receptor Identifier and Address	MN11: 53 Kenepuru Drive					
	L2: Linden motorway					
R5 - Linden School Sportsground	0.53	0.1	0.12	3.93	3.5	3.52
R6 - Linden School	0.60	0.12	0.13	4.00	3.52	3.53
R13 - Arthur Carman Park	0.34	0.07	0.09	3.74	3.47	3.49
R14 - Tui Park Kindergarten	0.08	0.02	0.02	3.48	3.42	3.42
Highest Residential	0.82	0.17	0.18	4.22	3.57	3.58
Highest Residential, Receptor Identifier and Address	42A Mahoe Street					
	L3: Warspite Avenue intersection					
R1 - 6 Kokiri Cres (Natone Park School)	0.03	0.01	0.01	3.43	3.41	3.41
R2 - Maraeroa Marae Health Centre	0.08	0.02	0.02	3.48	3.42	3.42
R3 - Maraeroa Marae	0.06	0.02	0.02	3.46	3.42	3.42
Highest Residential	0.18	0.05	0.05	3.58	3.45	3.45
Highest Residential, Receptor Identifier and Address	263 Warspite Avenue					
	L4: State Highway 58 Interchange					
Highest Residential	0.23	0.04	0.09	0.23	0.04	0.09
Highest Residential, Receptor Identifier and Address	R4: 51 Paremata Haywards Rd		R1: 75F Paremata Haywards Rd			
	L5: MacKays Crossing					
Highest Residential	0.32	0.08	0.05	0.32	0.08	0.05
Highest Residential, Receptor Identifier and Address	R5 and R6: 334, State Highway 1					

9.4 Predicted particulate concentrations

A summary of predicted maximum incremental and cumulative 24-hour average PM_{10} concentrations are presented in Table 13.36. The table shows predicted concentrations for the 2006 base year, 2031 do-minimum (DM), and 2031 with project (WP) emissions scenarios. Concentrations are shown for the sensitive receptors and the residential properties most affected by emissions from the modelled road sources. The residential addresses where the peak pollutant levels are predicted are also shown in the table. The location of the receptor points with respect to the modelled road sources is shown in Appendix 13.C. Cumulative concentrations assume a background concentration of 39 µg/m^3 for the modelled urban areas (L1, L2, and L3) and a concentration of 15 µg/m^3 for the rural areas (L4 and L5). Predicted incremental and cumulative concentration contour plots for each of the modelling domains and emissions scenarios are presented in Appendix 13.G.

Table 13.36 shows that for all of the modelled emission scenarios maximum 24-hour PM_{10} incremental concentrations are predicted to be relatively low compared to the AQNES limit of 50 µg/m^3. Maximum incremental concentrations at sensitive receptors are predicted to be similar but lower for the 2031 'with project' and 'do minimum' emission scenarios compared to the 2006 base year. At the most impacted receptor (the residential property located near the main alignment and SH1 interchange) the maximum 24-hour concentration predicted for the 2006, 2031 'do minimum', and 2031 'with project' emissions scenarios are 5.6 µg/m^3, 3.8 µg/m^3, and 4.1 µg/m^3 respectively. Predicted maximum incremental concentrations for the three emission scenarios are within 2 µg/m^3 of one another. Compared to the AQNES there is no significant difference between the emission scenario predictions. The results indicate that emissions from the proposed Project are not expected to increase existing PM_{10} levels at sensitive receptors located near the Project.

Predicted cumulative 24-hour PM_{10} concentrations are less than the 24-hour average AQNES limit of 50µg/m^3 at all of the discrete receptors, and for all of the three emissions scenarios considered. The maximum cumulative concentration predicted at any of the receptors for the 2031 'with project' emission scenario is 43 µg/m^3, or 86% of the AQNES. Significantly lower cumulative concentrations are predicted in the more rural areas located near the SH58 interchange and MacKays Crossing due to the lower background concentrations. The highest 24-hour PM_{10} concentrations predicted at sensitive receptors in these area is less than 17 µg/m^3, or 34% of the AQNES.

The maximum contribution from the modelled road sources are predicted to be comparatively small compared to background emission sources. The dispersion modelling results indicate that PM_{10} vehicle emissions are unlikely to result in an exceedance of the AQNES.

Table 13.36: Predicted Maximum Incremental and Cumulative 24-hour average PM_{10} Concentrations (µg/m^3)

Receptor	Incremental PM_{10} concentration			Cumulative PM_{10} concentration		
	2006	2031 DM	2031 WP	2006	2031 DM	2031 WP
	L1: Kenepuru Drive intersection					
R4 - Kapi Mana School	0.7	0.4	0.5	39.7	39.4	39.5
R5 - Kenepuru Community Health Hospital	0.7	0.4	0.6	39.7	39.4	39.6
Highest Residential	2.3	1.4	1.8	41.3	40.4	40.8
Highest Residential, Receptor Identifier and Address	MN5: 4 Bluff Road		R3: 34 Kenepuru Drive			
	L2: Linden motorway					
R5 - Linden School Sportsground	3.3	2.3	2.4	42.3	41.3	41.4
R6 - Linden School	3.8	2.6	2.8	42.8	41.6	41.8
R13 - Arthur Carman Park	2.5	1.7	1.8	41.5	40.7	40.8
R14 - Tui Park Kindergarten	0.5	0.3	0.4	39.5	39.3	39.4
Highest Residential	5.6	3.8	4.1	44.6	42.8	43.1
Highest Residential, Receptor Identifier and Address	MN13: 42A Mahoe Street					
	L3: Warspite Avenue intersection					
R1 - 6 Kokiri Cres (Natone Park School)	0.09	0.05	0.07	39.09	39.05	39.07
R2 - Maraeroa Marae Health Centre	0.3	0.2	0.2	39.3	39.2	39.2
R3 - Maraeroa Marae	0.3	0.2	0.3	39.3	39.2	39.3
Highest Residential	1	0.6	0.7	40	39.6	39.7
Highest Residential, Receptor Identifier and Address	MN5: 263 Warspite Avenue					
	L4: State Highway 58 Interchange					
Highest Residential	1.2	0.5	0.7	16.2	15.5	15.7
Highest Residential, Receptor Identifier and Address	R4: 51 Paremata Haywards Rd	R4: 51 Paremata Haywards Rd	R5: 85 Paremata Haywards Rd			
	L5: MacKays Crossing					
Highest Residential	1.7	0.9	0.4	16.7	15.9	15.4
Highest Residential, Receptor Identifier and Address	R6: 334 State Highway 1					

9.4.1 Predicted fine particulate concentrations

A proportion of the PM_{10} emitted from vehicle will be fine particulates with diameters less than 2.5 micrometres ($PM_{2.5}$). Fine particulates have the ability to penetrate deeper into the lungs and therefore have a greater potential to cause respiratory diseases compared to larger particulates. No long term ambient monitoring of $PM_{2.5}$ has been conducted in the Wellington region.

Currently there is no AQNES, AAQG or RAAQG for $PM_{2.5}$. Therefore the potential impact of $PM_{2.5}$ emissions has not been assessed in the report. However, an indication of maximum 24-hour average incremental $PM_{2.5}$ levels has been derived based on predicted PM_{10} concentrations. Emissions of $PM_{2.5}$ from traffic have been estimated as the proportion of particulates emitted from vehicle exhausts. Larger particles are expected to be emitted from tyre and brake wear.

Approximately 55-60% of total particulates emitted from vehicles for the year 2031 are estimated to be emitted from vehicle exhausts. Therefore, at the most affected sensitive receptor the maximum 24-hour average incremental $PM_{2.5}$ concentration for the 2031 'with project' emissions scenario is estimated to be 2.5 µg/m^3. (ie 60% of the predicted maximum PM_{10} concentration of 4.1 µg/m^3).

9.5 Predicted Benzene concentrations

A summary of the predicted maximum incremental and cumulative annual average benzene concentrations for the three emissions scenarios is presented in Table 13.37. The table shows predicted concentrations for the 2006 base year, 2031 do-minimum (DM), and 2031 with project (WP) emissions scenarios. Concentrations are shown for the sensitive receptors and the residential properties most affected by emissions from the modelled road sources. The residential addresses where the peak pollutant levels are predicted are also shown in the table. The location of the receptor points with respect to the modelled road sources is shown in Appendix 13.C. Cumulative concentrations assume a background concentration of 1.0 µg/m^3 for all of the modelling domains. The assumed background concentration is expected to overestimate pollutant levels in the rural areas such as those near MacKays Crossing and the State Highway 58 interchange.

Predicted concentrations for all of the modelled emission scenarios are all significantly less than the annual average AAQG limit of 3.6 µg/m^3 for all of the modelled emissions scenarios. At the most affect receptor predicted annual average incremental concentrations are predicted to be less than 0.3 µg/m^3, or less than 8% of the AAQG. Predicted cumulative concentrations are predicted to be less than 1.3 µg/m^3 or 36% of the AAQG. Predicted concentrations are marginally lower for the 2031 emissions scenarios. The results suggest that cumulative benzene concentrations are unlikely to exceed the AAQG at any of the discrete receptors.

Table 13.37: Predicted Maximum Incremental and Cumulative Annual Average Benzene Concentrations (µg/m^3)

Receptor	Incremental Benzene concentration			Cumulative Benzene concentration		
	2006	2031 DM	2031 WP	2006	2031 DM	2031 WP
	L1: Kenepuru Drive intersection					
R4 - Kapi Mana School	0.02	0.04	0.01	1.02	1.04	1.01
R5 - Kenepuru Community Health Hospital	0.03	0.02	0.02	1.03	1.02	1.02
Highest Residential	0.1	0.3	0.1	1.1	1.3	1.1
Highest Residential, Receptor Identifier and Address	MN11: 53 Kenepuru Drive	R1: 18 Japonica Crescent	MN11: 53 Kenepuru Drive			
	L2: Linden motorway					
R5 - Linden School Sportsground	0.1	0.07	0.07	1.1	1.07	1.07
R6 - Linden School	0.1	0.08	0.08	1.1	1.08	1.08
R13 - Arthur Carman Park	0.08	0.05	0.05	1.08	1.05	1.05
R14 - Tui Park Kindergarten	0.01	0.01	0.01	1.01	1.01	1.01
Highest Residential	0.3	0.2	0.2	1.3	1.2	1.2
Highest Residential, Receptor Identifier and Address	MN13: 42A Mahoe Street					
	L3: Warspite Avenue intersection					
R1 - 6 Kokiri Cres (Natone Park School)	0.004	0.002	0.003	1.004	1.002	1.003
R2 - Maraeroa Marae Health Centre	0.02	0.009	0.01	1.02	1.009	1.01
R3 - Maraeroa Marae	0.02	0.007	0.02	1.02	1.007	1.02
Highest Residential	0.06	0.03	0.03	1.06	1.03	1.03
Highest Residential, Receptor Identifier and Address	MN5: 263 Warspite Avenue					
	L4: State Highway 58 Interchange					
Highest Residential	0.03	0.02	0.02	1.03	1.02	1.02
Highest Residential, Receptor Identifier and Address	R1: 75F Paremata Haywards Rd	R1: 75F Paremata Haywards Rd	R2: No address			
	L5: MacKays Crossing					
Highest Residential	0.09	0.04	0.02	1.09	1.04	1.02
Highest Residential, Receptor Identifier and Address	R6: 334 State Highway 1					

9.6 Summary of dispersion modelling predictions

The results of the dispersion modelling indicate that cumulative PM_{10}, NO_2, CO or benzene concentrations are unlikely to exceed the relevant AQNES and AAQG air quality criteria limits at sensitive receptors and residential properties in the near vicinity of the Project based on the 2031 'with project' emissions scenario. Comparable pollutant levels are predicted at these receptors for the 2031 'do minimum' emissions scenario. The results of the modelling indicate similar pollutant levels are expected to occur at sensitive receptors in 2026 and 2031 whether the Project is developed or not.

Pollutant levels at nearby sensitive receptors for both 2031 emissions scenarios are predicted to be lower than those predicted for the 2006 base year. The results indicate that future pollutant levels are expected to be comparable or lower than existing levels.

9.7 Post construction ambient air monitoring

Post project ambient air pollution monitoring is appropriate in instances where, as a consequence of a proposed project, pollutants levels are predicted to have a significant effect on the surrounding environment, or uncertainty in predicted pollutant levels requires further assurance that actual future air pollutant levels will not have an adverse effect.

This assessment indicates that emissions from the Project are not expected have a significant impact on existing air pollutant levels or the surrounding community. Even if the maximum contribution from the Project sources were twice as high as those predicted, cumulative pollutant levels would still remain within the relevant assessment criteria levels. As such, the results indicate that, even considering uncertainty in predictions, post-project monitoring is not be necessary to provide assurance that emissions from the Project will not result in an exceedance of any of the air quality criteria levels at any sensitive receptors affected by the Project.

The results also indicate that the maximum contribution from the Project related emission sources are expected to be significantly lower that the estimated maximum contribution from background sources and that any exceedance of the criteria levels would most likely only occur if there was a significant increase in urban background pollutant levels. The greatest concern would be associated with any potential increases in background PM_{10} levels in the Linden area. Due to the proximity of the GWRC Tawa ambient air monitoring station to Linden, background levels and trends at the most affected sensitive receptors are expected to be comparable to levels recorded. Due to the proximity of the monitoring site additional background monitoring is believed to be unnecessary.

9.8 Regional effects

The Project is forecast to improve the overall performance of the road network by improving average vehicle speeds, and reducing the variability of traveling times. From an air quality perspective the most important regional effect of the project is associated with the diversion of a significant proportion of the traffic from the existing SH1 to the Transmission Gully Main Alignment. The reduction in forecast traffic volumes on SH1 is expected to reduce congestion improving vehicle flow. Without the Project traffic conditions in the immediate vicinity of SH1 are expected to rapidly deteriorate as roading capacity declines with the projected increases in traffic volumes, including a decrease in the level of service (LOS) at key intersections along the corridor.

Total heavy commercial vehicle movements within the region are also forecast to increase regardless of whether the Project is built or not. Per vehicle kilometre travelled, heavy commercial vehicles are higher emitter of pollutants. The Project is predicted to reduce volume of heavy commercial vehicle traffic using the existing SH1 coastal route as Transmission Gully Main Alignment becomes the preferred freight transportation corridor.

A detailed description of the forecast changes in network's traffic patterns is provided in the "*Transmission Gully - Traffic and Transportation Assessment Report*" (2011).

The Project is expected result improved traffic conditions and reduced traffic along the existing SH1 coastal route, and consequently lower vehicle emissions. Improvement in the LOS at several key local road intersections which link into the existing SH1 are also expected to improve air pollutant levels in adjacent areas.

The existing SH1 corridor runs through a number dense urban settlements located between Linden and Camborne. Expected improvements in air quality are expected to reduce the levels of exposure to the community which live and work in the vicinity of the existing SH1 corridor. The decrease in pollutant levels associated with the decreased traffic volumes has not been directly assessed using dispersion modelling techniques; however, an indication of the effect is provided by the predicted decrease in vehicle emission rates as discussed in Section 7.5.

Higher pollutant concentrations are expected to occur in areas near the Main Alignment. However, unlike the existing SH1, the Main Alignment passes predominantly through rural land where the public are less likely to be exposed. Changes in traffic pattern within the network will result in increases in traffic volumes on roads which connect into to the Main Alignment. In areas where the public could be exposed for extended periods of time, maximum predicted pollutant concentrations are less than air quality criteria limits. Overall the Project is expected to reduce the public's exposure to air contaminants emitted from traffic emissions.

10 Assessment of effects of road construction emissions

10.1 Potential effects of road construction emissions

The principal air quality issue in relation to road construction is the discharge of dust. Although certain activities may cause discharges of odour and construction vehicles will discharge exhaust emissions, these are relatively minor issues by comparison to the potential effects of dust. Therefore, this section of the report focuses largely on the assessment, management, mitigation and monitoring of dust discharges from road construction. Discharges of odour and vehicle related emissions are discussed briefly in Sections 10.6 and 10.7.

Due to the specific issues related to concrete batching and rock crushing, discharges of dust from these activities are discussed in Section 11 of this report.

The following sections provide an assessment of potential environmental effects of air discharges associated with the proposed construction activities.

10.2 Dust generation during construction

The construction of the Project will entail large scale earthworks over a considerable area. The overall Project is expected to take approximately five to seven years to complete, in a number of stages.

Exposed earthworks can be a significant source of dust. Dust can affect human health and plant life along the edge of the earthworks area, can be a nuisance to the surrounding public, and can contribute to sediment loads by depositing in areas (such as streams) without sediment control measures. Sediments deposited on sealed public roads can also result in a dust nuisance. Rainfall, water evaporation, and wind speed, are meteorological conditions having the greatest effect on dust mobilisation.

Dust discharges from earthworks typically fall into the larger particle sizes, generally referred to as “deposited particulates”, although there may also be a significant component in the smaller size ranges. Deposited particulates are particulates having an aerodynamic size range greater than about 20 microns. As a class of material such particulates have minimal physical health impact (particles have only limited penetration into the respiratory tract), but may cause nuisance in sensitive areas due to soiling. Soiling includes excessive dust deposits on houses, cars, and laundry and excessive dust within houses.

Potential sources of dust which are liable to cause nuisance beyond the site boundary during adverse conditions if adequate controls and mitigation measures are not adopted are:

- Dust from roads and access areas generated by trucks and other mobile machinery movements during dry and windy conditions
- Excavation and disturbance of dry material
- Loading and unloading of dusty materials to and from trucks
- Stockpiling of materials including material placement and removal

Dust may be generated from dry undisturbed surfaces at wind speeds over 5-5.5 m/s (approximately 10 knots). Wind can transport dust which has been mobilised from dry surfaces by machinery or vehicle movements or mechanical disturbance. Transportation of dust is dependent on dust particle size and wind speed. Dust generation by truck and machinery movements in dry conditions is a function of vehicle speed, number of wheels and vehicle size. Judder bars or humps to reduce vehicle speeds are not recommended as they can cause spillage of loads and may cause damage to loaded vehicles.

Unpaved roads and depot areas can be very dusty during dry weather. This can be aggravated if surfaces are allowed to get muddy during wet weather which eventually dries out and then becomes ground-up by vehicle movements. It is intended that the total length of bare earth is limited to 3km on each of the fronts and that the road is progressively paved.

Carrying out extensive earthworks during dry conditions exposes large areas to effects of wind while being disturbed by machinery. Excavated areas left exposed during dry windy conditions can be significant dust sources. Stockpiling of excavated material, and in particular dry dusty materials, may also be major dust sources.

Based on the discussion regarding particle size in the MfE Dust GPG (MfE, 2004) and the results of research into dust entrainment, only premises within approximately 100m of significant dust sources have been considered as potentially sensitive receptors for assessing the effects of construction dust. Dust may travel further than 100 m in high wind-speeds (eg over 10 m/s), though the frequency of high winds is likely to be low over the majority of the alignment as it generally avoids ridgelines and elevated, exposed terrain.

The purpose of the controls outlined in the following sections will be to prevent (if possible) or otherwise minimise the effects of dust emissions on those premises.

10.3 Project location specific dust assessments

10.3.1 Introduction

The construction methodology for the Project is described in the AEE. This section provides an overview of the construction methodology and sensitive receptors in each Section of the Project.

Dust generating activities common to all sectors will be open earthworks with frequent vehicle movements and landscaping. In addition, the following activities will be undertaken in specific locations: construction of sediment control ponds, contractor yards, concrete batching, bridge construction and deep excavations.

In general, the same receptors that are sensitive to the effects of vehicle exhaust emissions (residential areas, schools, preschools and healthcare facilities – previously discussed in Section 0) are also likely to be sensitive to the effects of dust emissions from construction works. However, as discussed in Section 10.1, these effects are likely to be even more localised than for vehicle exhaust emissions. Therefore, only sensitive receptors within 100m of surface sections of the proposed construction areas are identified in this section of the report.

The Main Alignment consists of nine sections (refer to Section 5.1 for detailed description of the nine sections), which are addressed below in the following Sections of this report.

10.3.2 Section 1: MacKays Crossing

Dust generating activities

- Earthworks and construction: bridge construction (bridges 1, 2 and 3), road construction and pavements
- Mobile rock crushing may be carried out

Sensitive Receptors: Rural residential properties along SH1.

10.3.3 Section 2: Wainui Saddle

Dust generating activities

- Earthworks and construction: deep excavations, road construction and pavements
- Mobile rock crushing may be carried out

Sensitive receptors: There are no residential properties in this area.

10.3.4 Section 3: Horokiri Stream

Dust generating activities

- Earthworks and construction: excavations, road construction and pavements. Mobile rock crushing may be used
- Vehicle movements: location of minor site office and laydown area (chainage 8500m)

Sensitive receptors: There are no residential properties in this area.

10.3.5 Section 4: Battle Hill and Section 5: Golf Course

Dust generating activities

- Earthworks and construction: excavations, road construction, pavements and bridge construction. Mobile rock crushing may be used
- Vehicle movements: operation of a site office at the Toomey property as a base for road construction. Vehicles accessing the site office via Paekakariki Hill Road

Sensitive Receptors: Only a very small number of rural/residential properties on Paekakariki Hill Road are within 100m of the construction footprint. Users of Battle Hill farm forest park and Pauatahanui Golf course.

10.3.6 Section 6: State Highway 58

Dust generating activities

- Earthworks and construction: excavations, road construction, pavements
- Spoil
- Vehicle movements: location of the main site office, traffic access off SH58
- Concrete batching within main site office compound

Sensitive receptors: Only a very small number of rural/residential properties are within 100m of the construction footprint. Some properties on Bradey Road and SH58, the Pauatahanui Rd substation.

10.3.7 Section 7: James Cook

Dust generating activities

- Earthworks and construction: excavations, road construction, pavements
- Spoil handling and stockpiles: transfer of cut material to areas of alignment requiring fill

Sensitive receptors: Only a very small number of rural/residential properties on Bradey Road are within 100m of the construction footprint. Future residential properties in the Silverwood subdivision will overlook the construction alignment. However, these properties will be more than 100m away and at higher elevation than the alignment and so are therefore unlikely to be significantly affected.

10.3.8 Section 8: Cannons Creek

Dust generating activities

- Earthworks and construction: deep excavations, road construction, bridge construction (Cannons Creek bridge and 3 bridges across Duck Creek tributaries)
- Spoil handling and stockpiles: excavation of cut material with excess material to be transferred to disposal sites nearby

Sensitive receptors: There are no sensitive receptors within 100m of the main alignment**.** However, the Takapu Rd substation, located approximately 150m from the main alignment, could be potentially be affected.

10.3.9 Section 9: Linden

Dust generating activities

- Earthworks and construction: road widening (existing SH1), bridge construction (Collins Ave bridge), construction of a site office at the proposed Kenepuru interchange, creation of access tracks
- Vehicle movements: initial access through Ranui Heights via existing logging tracks and suburban streets
- Spoil handling and stockpiles: excavation of cut material with excess material to be transferred to two possible disposal sites nearby
- Early works harvesting pine forest near proposed Kenepuru interchange

Sensitive receptors: Linden Primary School, residential properties which back onto SH1 (Collins Ave, Rangatira Rd, Matai St, South St, Raroa Tce, Mahoe St, Tremewan St), Ranui Heights residential properties during the construction phase

10.3.10 Waitangirua Link Road

Dust generating activities

- Earthworks and construction: excavations, road construction, pavements.

Sensitive receptors: Maraeroa Marae, North City Apostolic Church, residential properties close to intersection of Warspite and Niagara St, some residential properties on Corinna St.

10.3.11 Whitby Link Road

Dust generating activities

- Earthworks and construction: excavations, road construction, pavements.

Sensitive receptors: existing and future residential properties on James Cook Drive, Semaphore Lane, Navigation Drive.

10.3.12 Summary of Location Specific Dust Assessment

Overall, the most dust sensitive locations have been identified as Linden and the area around James Cook Drive and Warspite Avenue due to construction of the Waitangirua and Whitby link roads. The proposed dust monitoring programme will be designed to monitor the effects in these sensitive locations and ensure that the proposed dust management procedures are effective.

Dust generated from construction activities may also be deposited to waterways near the construction corridor. The location and sensitivity of waterways which may be affected is discussed in the Construction Erosion and Sediment Control Plan (CESP). The increased sedimentation to these waterways associated with dust deposition will be significantly less than the sediment loading associated with related construction earthworks. In addition to standard dust control measures, the management of sedimentation associated with earthworks will also be effective for the control of any construction dust deposited on the waterways.

10.4 Control and management of dust emissions

An array of measures are proposed to control and manage dust from the proposed construction with a focus on control of emissions at source, where practicable, with further management of any residual dust emissions to avoid or mitigate any environmental effects. These measures are outlined in more detail in the Construction Air Quality Management Plan (CAQMP).

General measures that may be employed to control dust from construction activities include:

- Maintenance of surface moisture content through watering/wet suppression on dry or dusty exposed areas. Watering of exposed surfaces and materials that may be disturbed is a primary method of control. Given the variable sensitivity of the receiving environment over the length of the alignment (and the low sensitivity and risk of adverse dust effects), wet suppression has been targeted at high and medium sensitivity/risk areas. Temporary stabilisation of unpaved roading surfaces or yard areas could provide an alternative to wet suppression, where necessary.
- Limiting wind speed across exposed surfaces through the use of windbreaks, vegetation, surface stabilisation or existing topographical features and through limits on vehicle speeds
- Limiting disturbance of soil or dusty materials: through minimisation of cut and fill volumes, where practicable, reduction in vehicle movements and use of lighter vehicles
- Limiting the area of soil exposure through staging of works and minimisation of soil exposure in works areas
- Rapid stabilisation of completed earthworks areas and spoil areas (eg through hydro-seeding) and temporary stabilisation of inactive stockpiles

These measures have been developed in accordance (where relevant) with a number of New Zealand and international best practice guidance documents for construction dust control, including:

- MfE Dust GPG (MfE, 2004)
- Greater London Authority/London Councils Best Practice Guidance for the control of dust and emissions from construction and demolition (GLA/LC, 2006)
- The NZ Transport Agency Draft Erosion and Sediment Control Field Guide for Contractors (NZTA, 2010), which contains guidance on dust management

Considering the nature of both the proposed construction activities and the receiving environment, the proposed measures are considered to represent the best practicable option for control and management of dust emissions. A regime of dust monitoring measures is proposed (as detailed in section 0). These monitoring measures provide a mechanism for modifying or refining control measures if required.

With the implementation of the proposed control and management measures, offensive or objectionable dust emissions are not anticipated and any adverse effects of dust emissions from the proposal should be less than minor.

10.5 Dust monitoring

A regime of dust monitoring methods is proposed to identify conditions where dust nuisance or adverse effects may occur and to assess the effectiveness of dust management and control methods employed. The proposed methods, which include both observational (visual inspection) and instrumental methods, are outlined in detail in the CAQMP.

Visual observational monitoring methods include the inspection of operation sites and surrounding areas for evidence of dust discharges; regular inspection of operational areas for dampness and amount of exposed surface area and regular inspection of stockpiles; maintenance and inspection of water spray systems and windbreak fences; and responding to complaints.

The requirement for instrumental monitoring depends on the nature, scale and duration of construction activities, the sensitivity of surrounding areas and the availability of suitable monitoring sites. As the construction will proceed on three separate fronts along the alignment, it is possible that instrumental monitoring may be appropriate at one or more fronts simultaneously.

Continuous monitoring of total suspended particulates (TSP) is recommended in areas within the receiving environment with the highest risk of dust effects occurring (determined on the nature of the construction activities occurring and the sensitivity of the receiving environment). Provision of real-time monitoring data provides information on both ambient dust levels (and the potential for adverse effects) and the adequacy of control measures employed. This in turn provides site managers the ability to rapidly investigate and respond to dust incidents.

10.6 Odour generated during construction

Where construction activities involve disturbance of land contaminated with organic wastes (such as closed landfills or offal pits) discharges of odour may occur. There is a small possibility that excavations along the route may disturb historic landfill or offal pit sites (not previously identified in the contaminated land assessment) which could potentially result in some temporary discharge of odour.

Measures to control and manage odour emissions to avoid nuisance and adverse effects in the event of disturbance of odorous material are outlined in the CAQMP. Those measures include temporary cessation of earthworks activities, temporary covering of the exposed material; use of odour suppressant sprays; and management of any excavations in such a way that odorous material is removed from the site as quickly as possible once exposed. Through the use of these methods, it is considered that any odour emissions can be control and managed such that adverse effects from such discharges are avoided or mitigated.

One aspect of road construction that is likely to cause discharges of odour is the application of bitumen to form the road surface. However, this is a normal activity that is routinely part of road maintenance undertaken across the Wellington region and will be of relatively short duration in any specific location.

10.7 Vehicle exhaust emissions from construction traffic

Emissions from vehicles associated with Project construction have the potential to impact on air quality. Contaminants discharged will include fine particles (PM_{10}), NO_x, CO and organics such as benzene. Most construction vehicles are diesel powered, and are therefore likely to emit larger quantities of PM_{10}, NO_x and organics than the general vehicle fleet (which is mostly petrol driven).

Excessive smoke and odour from diesel-fuelled heavy vehicles, generators and other machinery is primarily caused by poor engine maintenance. Failure to maintain air filters, fuel filters, and fuel injectors to manufacturer's specifications may cause excessive black smoke and objectionable odour.

Excessive smoke from trucks, earth moving machinery and generators, while unlikely, could cause nuisance effects at neighbouring sensitive locations under adverse meteorological conditions if vehicles and machinery are not well maintained. The CAQMP describes measures to be undertaken to control and monitor vehicle emissions, including requirements to maintain vehicles and equipment in accordance with manufacturer specifications and immediately service units discharging excessive exhaust smoke.

Factors considered in the selection of haulage routes for construction traffic include the minimisation of the effects of truck exhaust emissions and noise on surrounding sensitive areas where possible and where use of local roads in necessary, to minimise the length of time required for this purpose.

One of the key issues for the construction of the project is the very large cut and fill volumes of earthworks and balancing the mass haul of material along the route to minimise haul distances, and disposal costs. Construction of the Project will therefore temporarily increase truck numbers in the Project vicinity. However, the selection of haulage routes includes consideration of air quality and other amenity effects (eg noise). In some instances suburban or rural roads are required to be used temporarily for construction traffic. However, this will be replaced by traffic using the Main Alignment as construction is completed. Construction has been programmed on the basis of work being undertaken on three fronts simultaneously. For the work between SH58 and Cannons Creek, Bradey Road will be utilised as a temporary access route. At the northern end, access to the site office on the Toomey property will be via Paekakariki Hill Rd until an access is created from SH58. At the Linden end, initial access will be via suburban streets and logging tracks off Ranui Heights. Once access is created from SH1, this will reduce the traffic travelling through Ranui Heights.

On major roads, such as SH1 at Linden, the expected number of truck movements would result in a minor increase in air quality impacts.

10.8 Contaminated soil

A Stage 1 and 2 land contamination investigation has been conducted for the Project. A report of findings has been prepared, along with a Contaminated Soil Management Plan (CSMP). Across much of the Porirua Gun Club site, recorded lead and polycyclic aromatic hydrocarbons (PAH) levels are above human health risk-based guideline values in the upper 0.3m of soil. It is likely that this upper layer of soil will be removed during the remediation of the site and therefore extra measures should be put in place to minimise dust generation so that contaminated dust does not adversely impact on adjacent properties, particularly nearby residents of the site. Several sites had contaminants present above ecological risk-based guideline values, typically in the upper 0.3m of soil. Similarly if this upper layer of soil is removed at these sites during remediation, dust control measures should take potential contamination into consideration and additional precautions put in place to minimise dust generation. Once the contaminated soil is removed, standard construction dust control measures should be applied.

Areas with contamination present above risk-based guideline values, as well as any potentially contaminated areas identified during construction works, will be managed in accordance with the CSMP.

11 Assessment of effects of concrete batching and rock crushing

11.1 Background to concrete batching and rock crushing activities

The construction of the Project will necessitate the pouring of large quantities of concrete. In order to facilitate the overall management of the project, it is proposed to locate a temporary concrete batching plant in the main contractors yard on SH58, and use a mobile rock crushing plant along some areas of the alignment.

This section of the report specifically considers the potential impacts of discharges of contaminants into air from the proposed concrete batching and rock crushing activities, primarily focussing on methods to avoid and mitigate those potential effects.

The following sections of this report detail:

- The proposed concrete batching and rock crushing activities in general (as neither activity has been specified in detail)
- The nature of the associated emissions and the methods proposed to control and monitor those emissions
- An assessment of the potential environmental effects of those emissions

In parallel with this assessment, recommended control, management and monitoring measures have been detailed in the CAQMP, which forms part of the Construction Environmental Plan (CEMP) for the Project.

11.2 Activity descriptions

11.2.1 Concrete batching

The concrete batching plant will be located in the main contractor’s yard on SH58. The yard will be located in the GWRC Porirua airshed.The site is located immediately to the northwest of the proposed Main Alignment/SH58 interchange. The area which surrounds the plant is predominantly rural in nature. Lanes Flat is located on the western side of the site. The closest house is located approximately 250m to the east of the site’s boundary. Residential urban areas are located to the north-west and west of the site on Joseph Banks Drive, Scoresby Grove, and Young Nick’s Lane. The closest house in these areas is similarly separated from the boundary by approximately 250m. The Pauatahanui substation is located immediately to north-east of the site.

The manufacture of concrete involves mixing, in carefully controlled proportions, Portland cement or a mixture of cement materials in powder form, together with coarse and fine aggregates (gravel, crushed stone and sand), and water. The proportions chosen are determined by the performance or composition necessary to meet the specification or performance requirements of the final product. Small amounts of admixtures may be included to modify the properties of the mix.

Aggregates will be transported to the site via truck and trailer units and unloaded into ground storage bays. Aggregate from ground storage bays will be transferred into a receiving hopper by front end loader, and then into a weigh hopper by belt conveyors and enclosed gravity feed. Aggregate is then transferred from the weigh hopper to the mixing drum by belt conveyor.

Cement will be delivered to site in bulk tankers, and transferred into fully enclosed silo(s) by compressed air feed. Displaced air from each silo is vented to air via a bagfilter unit mounted on top of the silo. Cement is transferred from silo(s) to an enclosed cement weigh hopper and then to the mixing drum by enclosed gravity feed and enclosed screw conveyor. Displaced air from the cement weigh hopper is vented to atmosphere via a bag filter.

Cement, aggregates and water are loaded together into a mixing drum. Once a slurry has been formed to the correct proportions, this will be emptied either into the drum of a truck mixer unit for use anywhere within the project. The intention is to use a mobile (truck-mounted) concrete batching plant for the Project, coupled with portable cement storage silos and ground storage bays.

11.2.2 Rock crushing

Crushing of rocks from the excavations will be required to produce a usable aggregate product

The locations where the mobile rock crusher will be sited have yet to be determined, although crusher sites will most likely be located close to where the rock is extracted in order to reduce truck movements. No rock crushing is proposed in the Linden area which is the area of greatest urban density.

Extracted rock will be transferred from the excavation site to the crusher by truck. Crushed rock will be removed from the crusher by belt conveyor and may be screened into different size grades. These may either be loaded directly into truck and trailer units, or temporarily stockpiled prior to removal from the site.

The crushing capacity of the proposed crushing plant has yet to be determined. In general, the higher the capacity, the less time the crusher will be required to operate each day.

11.3 Discharges into air and emissions controls

11.3.1 Concrete batching

Discharges into air from concrete batching include dust from aggregates and cement powder. Almost all of this material falls into larger particle sizes, generally with an aerodynamic diameter greater than 30-50µm.

Aggregate dust is usually inert, only causing nuisance (amenity) effects. However, cement dust is basically calcium oxide (CaO), which is highly alkaline when dissolved in water and can be corrosive to skin.

The main sources of aggregate dust are the storage and handling of dry, fine aggregates (eg sand). Effective emissions control can be achieved by partial enclosure of load hoppers, conveyors and storage bays (to minimise wind entrainment of dusty materials), and the use of water sprays and regular sweeping of sealed yard areas.

Discharges of cement dust into air can be controlled through enclosed transport, storage and handling. Good practice for cement handling includes venting of air displaced from silos via filter units as required in the CAQMP. The bag filter units to be installed on the cement silos will be designed to current best practice, which is expected to be a reverse-pulse jet type baghouse, or equivalent.

Cement silos will also be fitted with pressure relief valves (to avoid over-pressurisation) and high fill alarms. The seating of pressure relief values and operation of these alarms will be checked regularly (refer CAQMP)

Any spills which do occur will be cleaned up as soon as detected by sweeping or vacuuming.

Bulk cement is to be transported, handled and stored in fully enclosed systems with any displaced air being discharged via bag filter units. All bulk deliveries of cement are to be made during operating hours, so that site staff can oversee the delivery.

Similar controls on fugitive dust will be applied to concrete batching plant as to other operating areas of the contractors' yards, including the use of water on aggregate stockpiles and areas used for vehicle movement (fixed water sprays or water trucks) and windbreak fencing where appropriate.

11.3.2 Rock crushing

The main discharge into air from rock crushing is dust. Most of this material falls into coarse particle sizes, generally with an aerodynamic diameter greater than 30-50 µm. Dust from crushing of greywacke that is prevalent over the Project alignment is usually inert, causing only nuisance (amenity) effects.

Water sprays are to be fitted at the end of the conveyor from the crusher, to minimise discharges of dust at the transfer point. If the crushed rock is then screened into different size fractions, water sprayers will be fitted to the ends of each screen conveyor to control dust produced at the screens. Wet suppression is recognised as an effective means of emission control.

11.4 Proposed monitoring

Proposed monitoring requirements for concrete batching and rock crushing activities are outlined in the CAQMP, in order to assess the effectiveness of emissions control measures and methods for these activities and to monitor any environmental impacts of emissions.

The proposed monitoring measures involve inspections and observations of control measures and alarms, as well as potential dust generating activities, such as conveyance of cement from tankers to silos.

11.5 Assessment of effects

11.5.1 Buffer distance

There is no New Zealand guidance on buffer or separation distances between activities that discharge contaminants into air and potentially sensitive receptors. In lieu of this, reference is often made to guidance published by the Environmental Protection Authorities of Victoria (Vic EPA, 1990) and South Australia (South Aus EPA, 2007).

The South Australia EPA and Vic EPA both recommend a separation distance of 100m for concrete batching plants. The South Australia EPA also recommends a separation distance of 500m for the crushing, grinding or milling of rocks. The Vic EPA does not provide a specific recommendation for the crushing, grinding or milling of rocks but does specify a separation distance for quarrying activities. The Vic EPA recommends a separation distance of 500m for the quarrying of hard rock with blasting, 300m for the quarrying of material other than hard rock with blasting, and 200m for any material without blasting.

In all cases, these separation distances are designed to minimise the likelihood of complaints regarding dust discharges and noise, and assume a standard level of emissions control and site management. Where separation distances are smaller than this, a higher level of emissions control is generally required.

The separation distance between residential activities and the proposed location of the concrete batching plant in the contractor's yard at SH58 will be more than 100m, which complies with South Australian and Vic EPA guidance.

Rock crushing will take place at various places along the alignment, depending on the type of material being excavated. However crushing will generally be restricted to the sections of the Main Alignment which are predominantly rural and well separated from houses. It is therefore expected that the buffer distance of at least 200m can be maintained. The crusher sites will be compliant with the Vic EPA recommendations for quarrying. It is possible that the separation distance may for some sites be smaller than the distance recommended by South Aus EPA (500 metres), however, the high degree of emission controls proposed (wet suppression) coupled with the separation distance and the rural location of the sites should be sufficient to avoid any adverse effects. It should also be noted that the crushing plant will only be located at each site on a temporary basis, whereas buffer distance guidance is designed for permanently located activities, which have a higher potential for chronic health and/or nuisance effects.

11.5.2 Health effects

Both concrete batching and rock crushing have the potential to discharge $PM_{10.}$ PM_{10} particulate has the potential to cause a range of health effects, including increased morbidity and mortality; there are no apparent threshold concentrations for those health effects.

In practice, most of the material used on site has a considerably larger particle size – cement dust typically has an aerodynamic diameter in the range 30µm to 50µm, while sand and aggregates and primary crushed rock are larger still. However, all such materials may include a fraction of PM_{10}.

Due to the difficulty in quantifying releases of PM_{10}, no attempt has been made to assess the potential health effects of PM_{10} discharges from the site. Instead, the focus is on ensuring that the location of the activity provides sufficient separation from houses and sensitive receptors. Furthermore, effective emissions control will be used to prevent adverse health effects.

11.5.3 Amenity effects

Dust particles larger than about 20-30 µm in aerodynamic diameter have the potential to cause localised 'dust nuisance' eg soiling of surfaces.

Both concrete batching and rock crushing have the potential to generate fugitive discharges of dust. However, as for PM_{10}, due to the difficulty in quantifying releases of dust, the focus of this assessment is on the effectiveness of measures to control such releases.

As previously stated, all aggregate will either be stored damp or in enclosed bins and conveyors will be partially enclosed. Vehicle access areas will be either sealed or metalled and water sprayers will be used to minimise dust emissions from vehicle movements.

The separation distance between residential activities and the proposed location of the concrete batching plant in the contractor's yard at SH58 will be more than 100m. This separation distance should be sufficient to avoid effects on amenity values caused by discharges of dust from the plant.

12 Mitigation measures

In accordance with the requirements of the LTMA 2003, NZTS and the objectives of the RLTS which include the objective of "protecting and promoting public health", this section of the report describes how the Project remedies or mitigates potential adverse effects of vehicle emissions on human health. Whilst the assessment has shown there are no locations where people will be exposed to air pollution levels that exceed the national ambient air quality standards, there remains an overall requirement to reduce the effects of vehicle emissions.

Mitigation measures for reducing effects of vehicle emissions are usually centred on either reducing the emissions from the road or reducing the exposure of people close to the road.

In accordance with the NZTA Environmental Plan, the route avoids increasing the exposure of sensitive receivers to poor air quality. As described in Section 7.2, the Project will result in a significant diversion of traffic movements away from the existing SH1 coastal route, where dense urban settlements are located, to the more rural Transmission Gully Main Alignment corridor. The existing coastal route will likely become a local road once the Project is completed and as a result there will be a corresponding reduction in traffic volumes on the existing SH1.

Traffic flow options for mitigation of the effects of vehicle emissions on State Highways also include promoting the most efficient traffic flow. Vehicle emissions are very dependent on the speed and stop-start flow, and can be significantly reduced with improved traffic flow.

The existing SH1 corridor suffers from an inadequate level of capacity provision which results in congested traffic conditions during weekday peaks and holiday weekend periods. Traffic demands are forecast to increase in the future as a consequence of demographic patterns and levels of economic activity which will increase travel delays and travel time variability, even with expected improvements to the rail network. The Project is predicted to improve traffic flows on the existing SH1 corridor, and improve the operational performance at a number of key intersections.

The Project is also predicted to result in the removal of a large number of heavy commercial vehicles from the existing SH1 coastal route to the new Transmission Gully Main Alignment.

The relocation of a significant proportion of general traffic and heavy commercial vehicles from the coastal route, together with the resulting reduction in congestion on the coastal route will result in a reduced in exposure to vehicle emissions for the people living, working and spending time at the coastal communities.

The Project will result in significant redistribution of traffic flows in the Project area. Some roads are expected experience higher traffic volumes as a consequence. However, average daily traffic volumes on suburban roads which link into the Waitangirua and Whitby link roads are not expected to increase significantly and any increases are expected to be easily absorbed by the road network existing capacity (SKM, 2011). Therefore, the Project is not expected to have a significant effect on ambient air pollutant levels near these suburban roads.

New intersections and interchanges will also be built to connect local roads to the Main Alignment and associated link roads. Typically higher emission levels occur at intersections as a consequence of vehicle queuing and start-stop traffic conditions. The preferred designs for these intersections have been chosen to maintain a high level of operational performance and comparatively low vehicle queuing times (SKM, 2011). The high levels of performance predicted for the new intersections assists in minimising vehicle emission rates and therefore the potential exposures of the community.

The exception is the Warspite Avenue/Waitangirua Link Road intersection. At this intersection a traffic signal control design is currently the preferred option, although improved traffic performance is predicted for a roundabout intersection design. In this instance the choice of the preferred option has been based on pedestrian and cyclist safety concerns. As a consequence the intersection is expected to be operating near capacity during peak morning and afternoon periods (SKM, 2011). Although higher vehicle emission rates are expected for the signalled control option compared to the roundabout design, the contribution from local road sources to ambient pollutant levels near the intersections are still predicted to be low compared to air quality criteria levels and assumed worst case background levels.

Overall the Project is predicted to improve the total traffic performance within the network. The Project will also reduce public exposure to air pollutants emitted from vehicles.

The measures proposed to control emissions to air from construction activities (including concrete batching and crushing) and avoid and mitigate any associated effects on air quality are discussed in Sections 0 and 11.3 and outlined in greater detail in the CAQMP.

13 Summary and conclusions

13.1 Overview

This report has assessed the effects on air quality of the proposed Project. Dispersion modelling has been used as the primary tool to quantitatively assess pollutant concentrations in the study area.

The GWRC has classified eight airsheds in the Wellington region where the PM_{10} standard is regularly breached, or are considered to have potential to breach the AQNES. Parts of the Project and wider regional impacts of the Project will affect the Porirua airshed, which is one of these gazetted airsheds. This assessment has considered the impacts on the Porirua airshed as a result of the Project.

This report has assessed the effects of the Project on all members of the community; particularly those considered to represent the most vulnerable (eg school children and the elderly or infirm).

13.2 Assessment process

Five different scenarios were considered in this assessment, representing:

- The current situation (2006 Base Year);
- The projected year of opening (2026 Do Minimum and With Project); and
- Five years after opening (2031 Do Minimum and With Project).

Emission rates for the various pollutants were estimated from the results of the traffic modelling, using the Vehicle Emissions Prediction Model. Atmospheric dispersion modelling was undertaken for vehicle related emissions from surface roads in all five scenarios for both With Project scenarios. The results of this modelling have been added to estimated background concentrations and then compared to relevant air quality standards and guidelines.

Air quality impacts from construction activities, including the operation of concrete batching and rock crushing have been assessed and the proposed mitigation measures and monitoring are described in the Construction Air Quality Management Plan (CAQMP).

13.3 Discussion

People living, working or spending time (eg at school or in reserves) close to SH1 and many existing busy arterial routes through the project area are predicted to have a reduced exposure to vehicle related contaminants as a result of the Project, than would occur without the Project.

Some locations around the Kenepuru interchange and SH1 at Linden are predicted to slightly increase the exposure to vehicle related contaminants for people living, working or spending time in the Project area above the ‘do minimum’ scenario (ie without the Project). However, exposure levels are predicted to comply with the AQNES which are designed to protect the health of the most vulnerable individuals in the community.

In terms of regional air quality, the Project is expected to have a beneficial effect on Wellington’s regional air quality, due to reductions in traffic flow and heavy vehicles on the SH1 coastal route brought about by traffic transferring to the Main Alignment.

The construction programme for the Project requires that concrete batching and rock crushing plant be located along the Main Alignment at various times. Through the use of appropriate emissions control and good on-site management, adverse effects that may otherwise be caused by discharges of dust from concrete batching or rock crushing will be adequately avoided or mitigated.

13.4 Conclusions

The key conclusions of this report can be summarised as follows:

- Pollutant concentrations in the study area in future years (2026+) arising from motor vehicles would be expected to be similar or better than existing (2006) concentrations. This is the case for both ‘with project’ and ‘do minimum’ scenarios (ie without the Project).
- The most significant increases in PM_{10} concentrations as a result of the Project occur around Linden and the Kenepuru interchange. This is because this area is the most densely populated in the Project area, and experiences the most significant increase in traffic due to vehicles accessing the Main Alignment at the southern end.
- The ‘with project’ and ‘do minimum’ scenarios are predicted to be very similar. That is, regional air quality with the Project may be expected to be similar to air quality without the Project.
- The Project is not predicted to impact the GWRC’s ability to issue future resource consents within the Porirua airshed, as the regional effects of the Project on the airshed are minor.
- The route for the Project was selected based on a prioritisation of a route option for a new State highway that avoids increasing the exposure of sensitive receivers to poor air quality. The relocation of a significant proportion of traffic from the coastal route to the Project will result in significantly reduced exposure to vehicle emissions for the people in coastal communities between MacKays and Linden.
- It is concluded from the report that there would be no adverse air quality impacts as a result of the Project.

14 References

Abbot, J. 2005. *Primary nitrogen dioxide emissions from road traffic: analysis of monitoring data*. Report to Department for the Environment, Food and Rural Affairs; Scottish Executive; Welsh Assembly Government; Department of the Environment for Northern Ireland.

Aurecon, 2011. *Contaminated Soil Management Plan: Transmission Gully.*

Cowherd, C Jr and Grelinger, MA, *Characterization of Enhanced Dust Deposition on Vegetation Groundcover Bordering Emission Sources*; Prepared by Midwest Research Institute for U.S. Army Construction Engineering Research Laboratory, June 2003.

Cowherd, C Jr, Grelinger, MA and Gebhart, DL. De*velopment of an Emission Reduction Term for Near Source Depletion*. 15th International Emission Inventory Conference "Reinventing Inventories - New Ideas in New Orleans. US Environmental Protection Agency, May 2006.

Etymezian, V, Ahonen, S, Nikolic, D, Gillies, J Kuhns, H, Gillette, D and Veranth, J. *Deposition and Removal of Fugitive Dust in the Arid Southwestern United States: Measurements and Model Results.* Journal of Air & Waste Management Association 54:1099-1111, 2004.

Greater London Authority/London Councils. 2006. *The control of dust and emissions from construction and demolition -Best Practice Guidance*.

Minoura H., Ito A., 2009. NO_2 *Behaviour analysis in a roadside atmosphere for the validation of the RSAQSM*. The seventh International Conference on Urban Climate, 29 June - 3 July, Yokohama, Japan.

Kar K., Baral B., Elder S., 2008. *Development of a Vehicle Emissions Prediction Model*. Energy and Fuels Research Unit, University of Auckland.

Laxen D., Marner B., 2003. *Analysis of the Relationship Between 1-hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites*. Report prepared for DEFRA and the Devolved Administrations.

Longley I., Olivares G., Khan B., Zawar-Reza P., 2008. *The determinant of levels of secondary particulate pollutant and nitrogen dioxide in urban New Zealand – Part 1*. Report prepared for FRST, NIWA Client Report AKL2008-053.

Metcalfe J., 2009. *Instructions for using the vehicle emissions prediction model (VEPM) Version 3.0*. Report prepared for the Auckland Regional Council by Emission Impossible Ltd.

Ministry for the Environment. 2000. *Effects of Air Contaminants on Ecosystems and Recommended Critical Levels and Critical Loads.*. Ministry for the Environment, Wellington.

Ministry for the Environment. 2001. *Good practice guide for assessing and managing the environmental effects of dust emissions.* ISBN 0-478-24038-4. Ministry for the Environment, Wellington.

Ministry for the Environment. 2004. *Good Practice Guide for Atmospheric Dispersion Modelling*. ISBN 0-478-18941-9. Ministry for the Environment, Wellington.

Ministry for the Environment. 2005. *Updated Users Guide to Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 (Including Amendments 2005*).

Ministry for the Environment. 2008. *Good Practice Guide for Assessing Discharges to Air from Land Transport*. ISBN 0-978-0-0478-30237-0. Ministry for the Environment, Wellington.

NZ Transport Agency, 2009. *New Zealand motor vehicle registration statistics*. http://www.nzta.govt.nz. NZ Transport Agency, Wellington.

NZ Transport Agency, 2010. *Standard for Producing Air Quality Assessments for State Highway Projects* (Draft), July 2010NZ Transport Agency, Wellington.

NZ Transport Agency, 2010. *Draft Erosion and Sediment Control Field Guide for Contractors*. NZ Transport Agency, Wellington.

SKM, 2011. *Transmission Gully - Traffic & Transportation Assessment Report.*

South Australia Environmental Protection Authority, *2007.Guidelines for Separation Distances.* South Australia Environmental Protection Authority

Victoria Environmental Protection Authority, 1990. *Recommended buffer distances for industrial residual air emissions*. Environmental Protection Authority

15 Glossary

Abbreviation	Definition	
AADT	Annual Average Daily Total	-
AAQG	Ambient Air Quality Guidelines	Guidelines published by the Ministry for the Environment
AQNES	Air Quality National Environmental Standards	New Zealand National Environmental Standards
ARTEMIS	Assessment and Reliability of Transport Emission Models and Inventory Systems	Used to integrate road gradient into the emission rates calculations.
Atmospheric stability	A measure of the atmosphere's tendency to encourage or deter vertical motion.	Determined by changes in air temperature and humidity with height.
AUSROADS	Atmospheric dispersion model	Roadway dispersion model developed by the Victoria EPA
Background pollutant levels	Refers to existing pollutant levels without the contribution from the Project.	
CSIRO	Commonwealth Scientific and Industrial Research Organisation	-
CAQMP	Construction Air Quality Management Plan	
CO	Carbon monoxide	-
GIS	Geographical Information System	-
GPG	Good Practice Guide	Assessment guidelines published by the Ministry for the Environment
GWRC	Greater Wellington Regional Council	-
HCV	Heavy Commercial Vehicle	-
LCV	Light Commercial Vehicle	-
Line Source	Used to represent vehicle emissions from road source in the dispersion model	-
Link	Representative of road section in the traffic model	Each link is defined by a starting and ending node points
MfE	Ministry for the Environment	-
mg/m^3	concentration in milligrams per cubic metre	One milligram is one thousandth of a gram
$\mu g/m^3$	concentration in micrograms per cubic metre	One microgram is one millionth of a gram
Neutral atmosphere	When the vertical movement of air is neither assisted nor inhibited by the thermal structure of the atmosphere.	Typical of overcast conditions and/or high wind speeds. May occur during the day or night
NO_X	Nitrogen oxides ($NO + NO_2$)	-
NO	Nitric oxide	-

Abbreviation	Definition	
NO_2	Nitrogen dioxide	-
Node	A geographic points in the traffic model used to define used to define the end points of links	-
PM_{10}	Airborne particulate matter with a diameter less than 10 micrometres	-
$PM_{2.5}$	Airborne particulate matter with a diameter less than 2.5 micrometres	-
RAAQG	Regional Ambient Air Quality Guidelines	-
RMA	Resource Management Act 1991	-
SATURN	Traffic prediction model	-
SKM	Sinclair Knight Merz	Engineering Consultancy
Stable atmosphere	When the air has little or no tendency to rise and so there is very little vertical movement. A lifted parcel of air will be cooler than its surroundings and so will tend to sink back to its original height	Typical of cool cloudless winter nights with low wind speeds when surface inversions may form
TAPM	The Air Pollution Model	Advanced meteorological and air dispersion model developed by CSIRO
TSP	Total Suspended Particulate	
USEPA	United States Environmental Protection Agency	-
Unstable atmosphere	When the air is able to rise easily. A lifted parcel of air will be warmer than its surroundings and will keep rising with increasing speed	Typical of hot cloudless summer days when there is a high level of convective heating
VEPM	Vehicle Emission Prediction Model	Vehicle fleet profile prediction and emission rate evaluation
WHO	World Health Organisation	-

Appendix 13.A

Regional Air Quality Trends 2005-2009

Appendix 13.A: Regional Air Quality Trends 2005-2009

Figure 13.A1: GWRC Monitoring Stations – Highest 24- Hour Average PM_{10} Concentrations 2005-2009

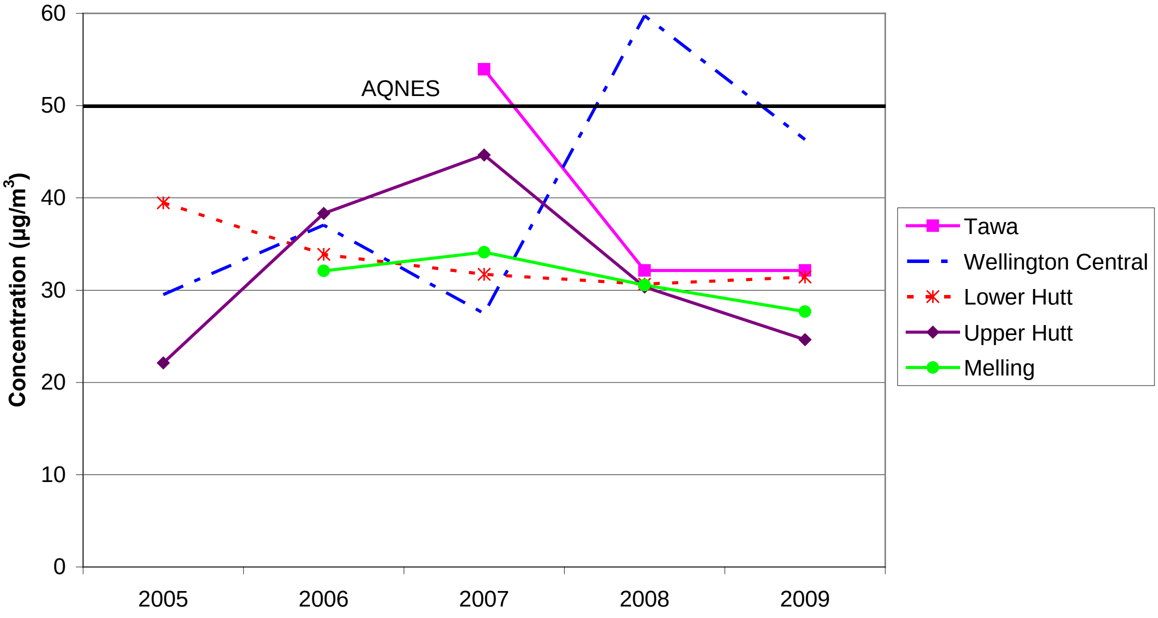


Figure 13.A2: GWRC Monitoring Stations – 2nd Highest 24- Hour Average PM_{10} Concentrations 2005-2009

Figure 13.A3: GWRC Monitoring Stations – Annual Average PM_{10} Concentrations 2005-2009

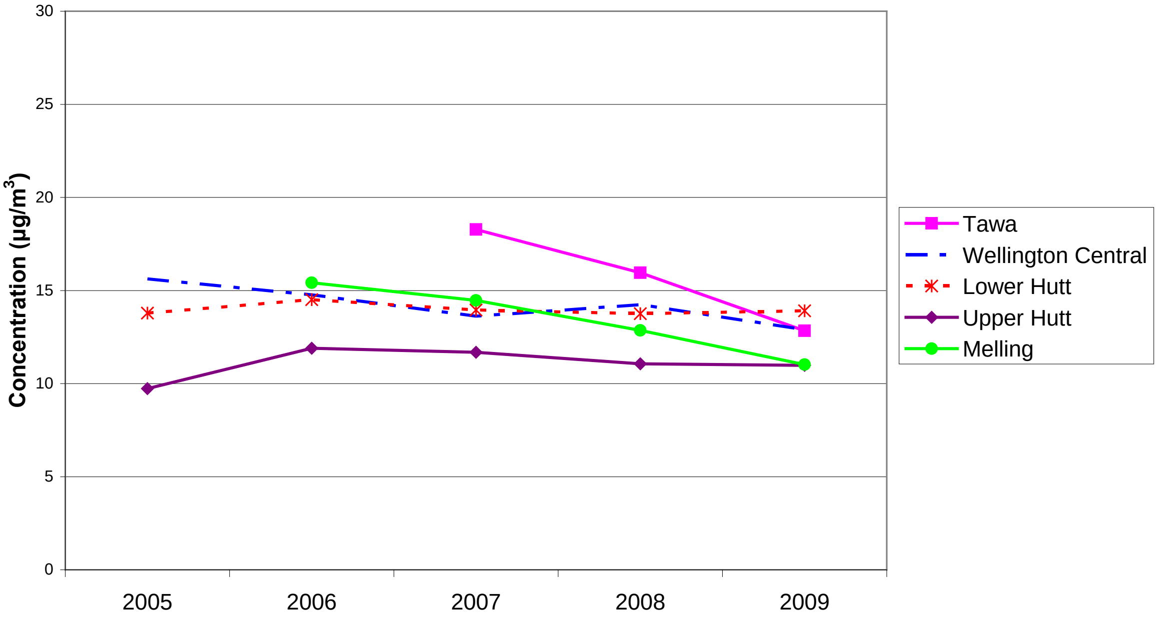


Figure 13.A4: GWRC Monitoring Stations – Highest 8- Hour Average CO Concentrations 2005-2009

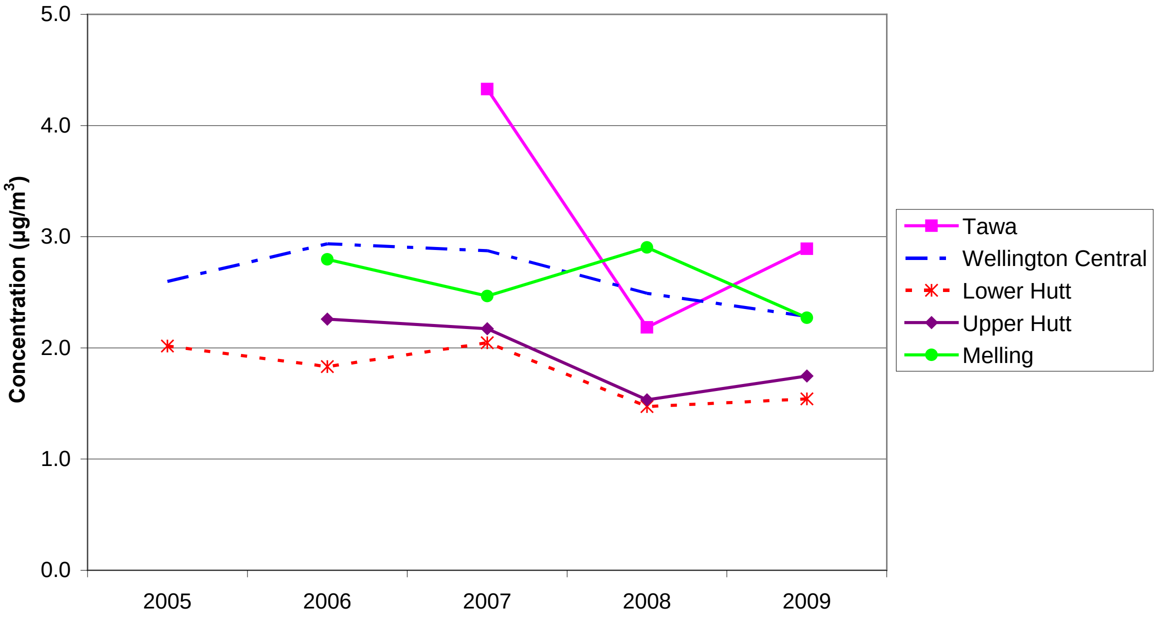


Figure 13.A5: GWRC Monitoring Stations 99.9th Percentile 1-hour Average NO_2 Concentrations, 2005-2009

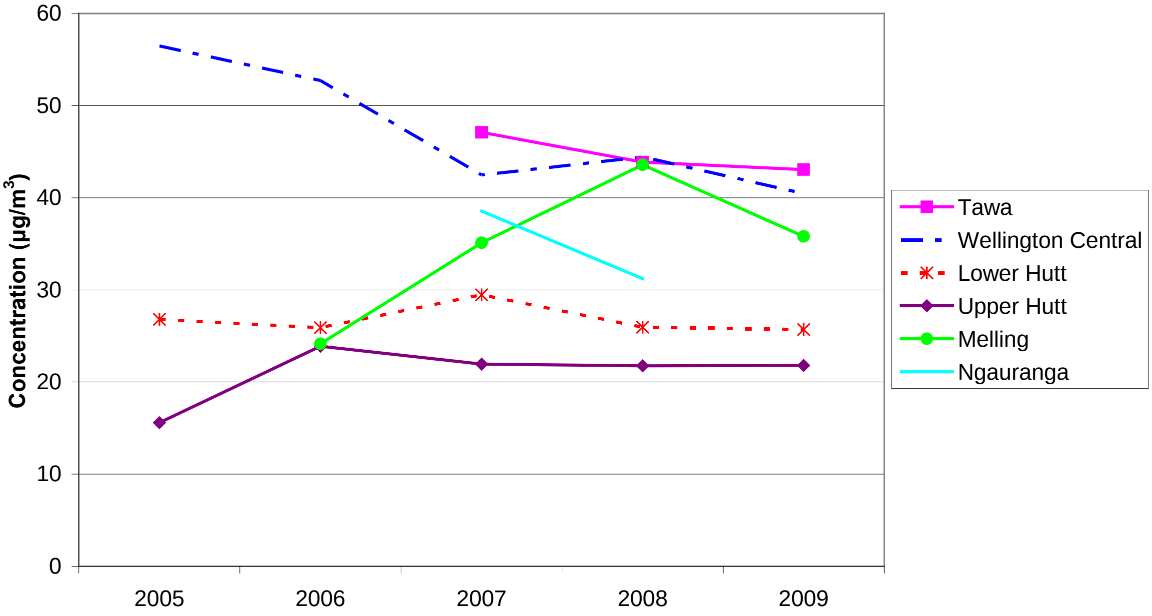


Figure 13.A5: GWRC Monitoring Stations Highest 24-hour Average NO_2 Concentrations, 2005-2009

Appendix 13.B

Predicted Regional Traffic Volumes

Appendix 13.B: Predicted Regional Traffic Volumes

Three categories of traffic volume are presented on the maps below:

- Green links: between 7000-15000 vehicles per day;
- Blue links: between 15000-30000 vehicles per day; and
- Red links: over 30000 vehicles per day.

(Note, these traffic volumes represent flow in EACH direction)

These maps are intended to illustrate the main impacts of the redistribution of traffic across the Wellington region as a result of the Project.

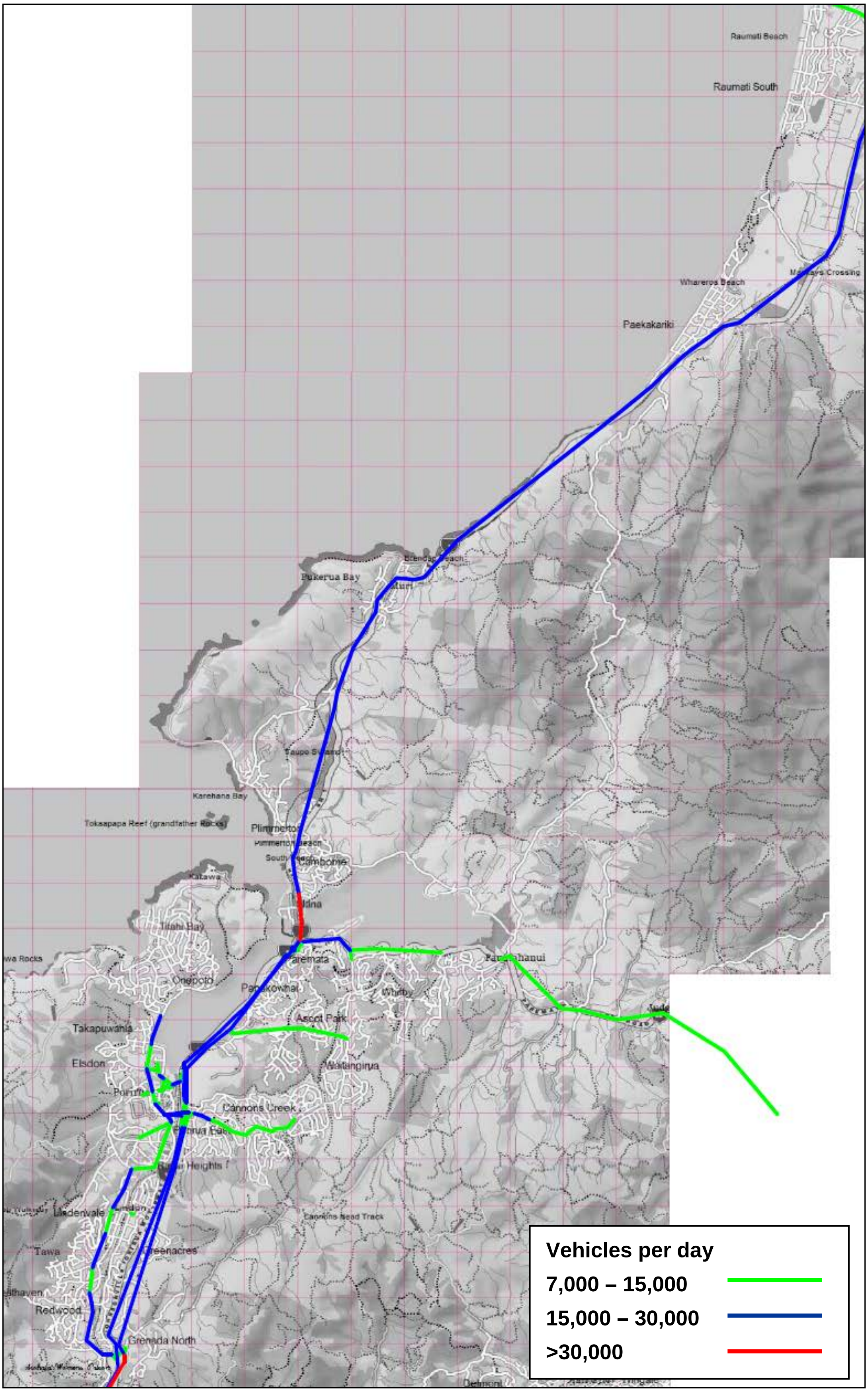


Figure 13.B1: Predicted Regional Traffic Volumes in 2006

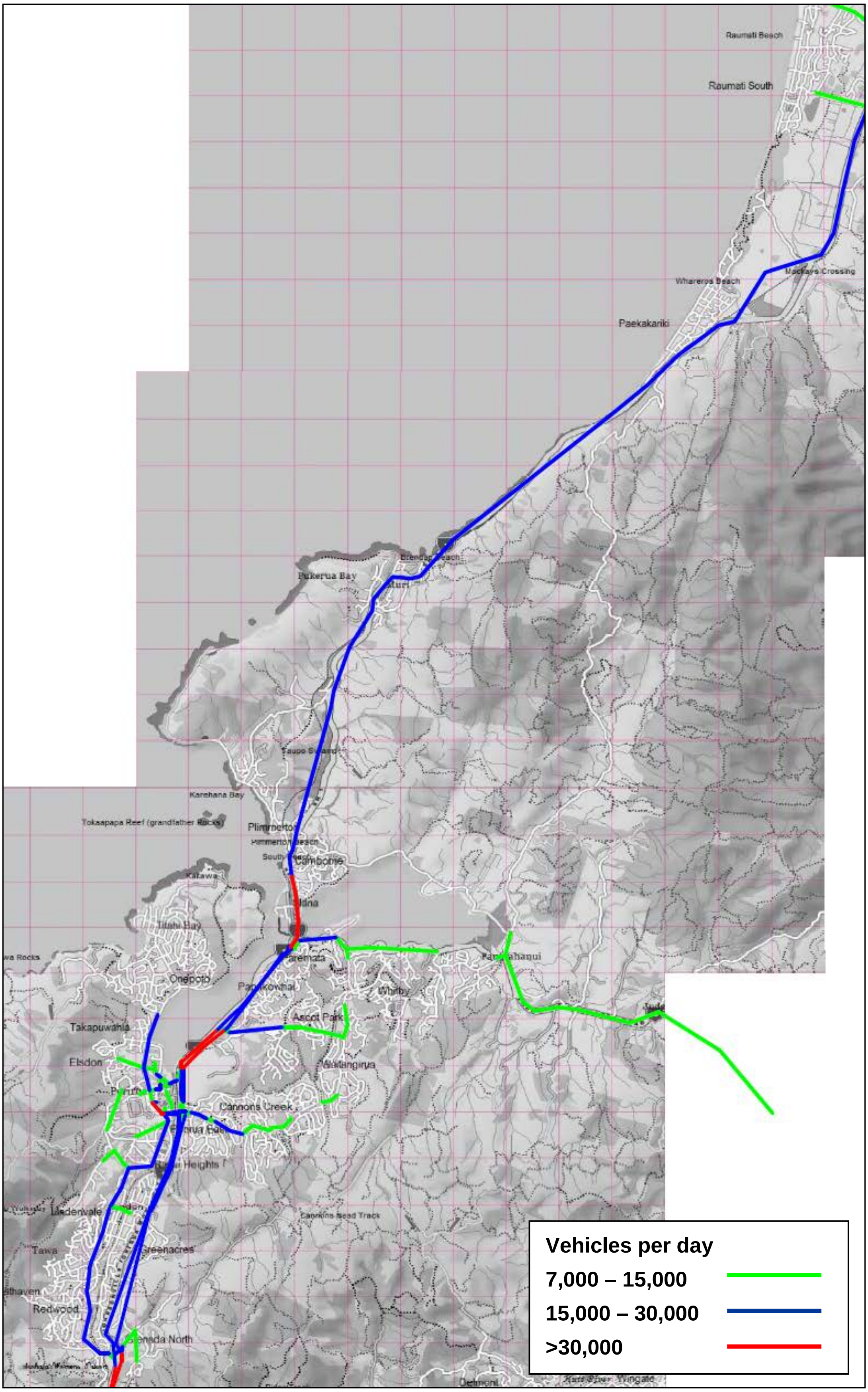


Figure 13.B2: Predicted Regional Traffic Volumes in 2031 Do Minimum

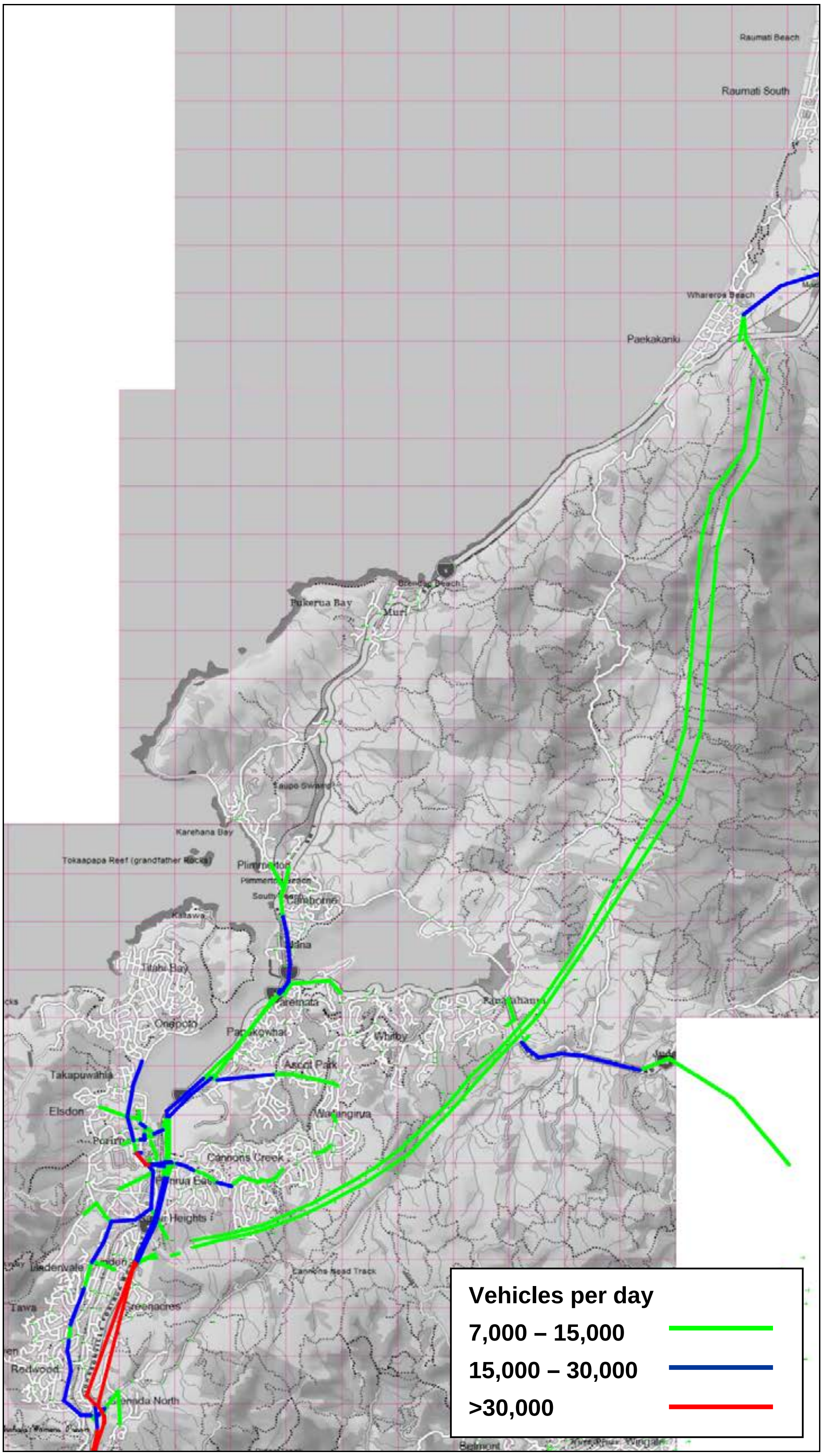


Figure 13.B3: Predicted Regional Traffic Volumes in 2031 with Project

Appendix 13.C

Discrete Receptors Location

Appendix 13.C: Discrete Receptors Location

The location of the discrete receptor points defined for the dispersion modelling domains L1, L2, L3, L4 and L5 are shown below.

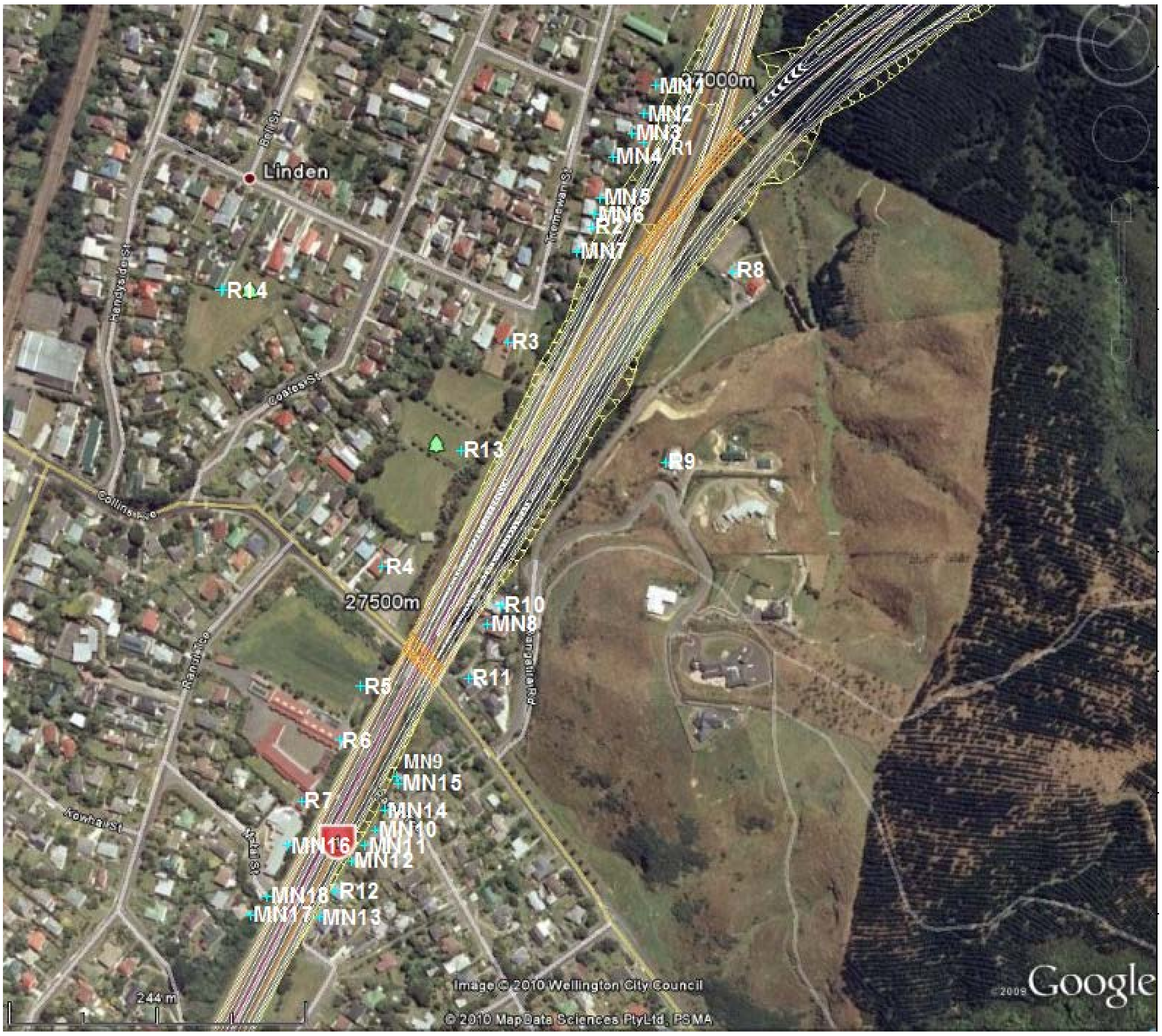
Location of Discrete Modelling Receptors

L1 - Kenepuru Interchange and Link Road

Note: Image sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

Location of Discrete Modelling Receptors

L2 - Linden



Note: Image sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

Location of Discrete Modelling Receptors

L3 - Warspite Interchange

Note: Image sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

Location of Discrete Modelling Receptors

L4 – State Highway 58

Note: Image sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

Location of Discrete Modelling Receptors
L5 - MacKays Crossing

Note: Image sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

Appendix 13.D

Vehicle Emissions Discussion

Appendix 13.D: Vehicle Emissions Discussion

The volume and relative concentrations of vehicle emissions depend on a variety of factors as described below.

Vehicle age

The New Zealand vehicle fleet is old in comparison with other countries where car ownership is high. Figure D1 summarises the total distance travelled in each year for vehicles of different ages. This shows that the vast majority of mileage is driven by cars manufactured between 1990 and 1999. The average age of New Zealand cars is 12.6 years, with the current majority having been used overseas prior to importation to New Zealand (MoT, 2010). The average fleet age of trucks is 14.3 years, whereas the average for buses is marginally older at 15.5 years. Older vehicle tend to have higher emission levels for both CO and NO_x as the vehicle deteriorates with age.

In 2003 the ARC carried out remote sensing of emissions from over 40000 vehicles in the Auckland region (ARC, 2003).This report identified “gross emitters” in the fleet, which are older or poorly tuned vehicles. This study showed that “gross emitters” (defined as the most polluting 10% of vehicles) were responsible for approximately half the total emissions of PM_{10}.

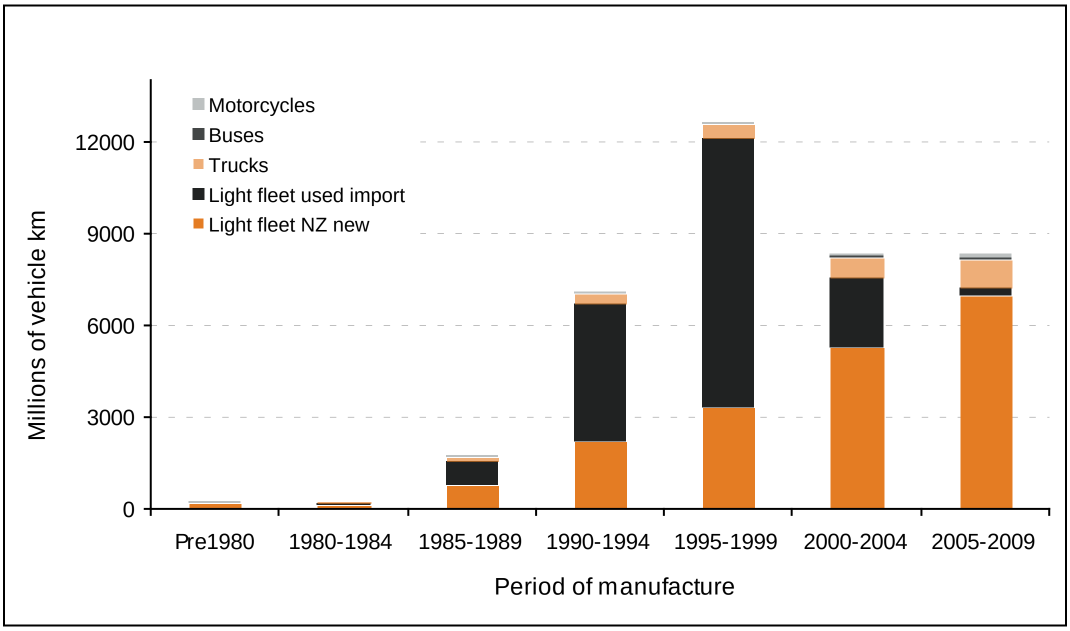


Figure 13.D1: New Zealand Vehicle Fleet Travel by Year of Manufacture (MoT, 2010)

Catalytic converters

Emissions of CO, VOC and NO_x from a catalytic converter equipped petrol vehicle are approximately ten times lower than an equivalent non catalyst equipped vehicle. Catalytic converters do not reduce the level of PM_{10} discharged from vehicles.

The Land Transport Rule: Vehicle Exhaust Emissions 2007 Vehicle Exhaust emissions rule was introduced in NZ in 2008 and updated the minimum standards for new and used vehicles imported into New Zealand. More than 95% of vehicles imported to New Zealand are from Japan. Under this Rule, all used vehicles are now tested before entering New Zealand to ensure their emissions control equipment is working. It is also illegal to modify vehicle emissions control equipment including catalytic converters.

Due to the high average fleet age, the New Zealand fleet has a higher proportion of vehicles operating without catalytic converters compared to Australia and Europe. About one quarter of the New Zealand fleet have catalytic converters, although this situation is expected to improve as the New Zealand fleet is almost entirely composed of vehicles manufactured overseas to international standards. The majority of newer cars (eg petrol vehicles manufactured since 2000) are assumed to have catalytic converters installed.

Vehicle speed

Maintaining a steady flow of traffic will produce fewer pollutants than the stop start traffic often experienced at peak times. In general:

- Reducing traffic speed reduces emissions of CO and PM_{10}
- NOx emissions increase slightly with as speed increases

Fuel

The bulk of the NZ car fleet is fuelled by petrol; however the number of diesel cars and commercial vehicles is forecast to continue to increase. The removal of lead from petrol in 1996 and the lowering of sulphur in diesel from 2002 have resulted in a significant improvement in the emission of these contaminants.

Diesel vehicles produce emissions with different concentrations of pollutants than those produced by petrol vehicles. Particulate emissions are significantly higher for diesel vehicles and can impact on visibility in the tunnels, human health and the wider environment.

Proportion of Heavy Vehicles

The proportion of heavy vehicles (usually diesel fuelled) that use a road has a significant effect on the road’s overall emission rate, due to their relatively higher emissions of particulate matter per kilometre travelled compared to light vehicles. For example, in terms of relative emissions, a large (eg 16-32 tonne) diesel heavy vehicle emits around fifty times more particulate matter than a petrol passenger car.

Trip Length and Cold Starts

Vehicle exhaust emissions tend to be highest when the engine is cold (‘cold start’); once the engine has warmed up, exhaust emissions decrease substantially. This is especially true of vehicles fitted with catalytic converters – these tend to be ineffective until they have reached operating temperature. Therefore, average emissions will decrease as the individual trip length increases. For this assessment, an average trip length of 25 km was assumed for all of the modelled links. Average trip lengths predicted by the SATURN-TG traffic model (2026 WP) are greater than 25 km for the Main Alignment and the major arterial road which link to the motorway. Although predicted average trip lengths vary from 21 – 24 km for James Cook Drive, the overall assumption of 25km is still considered valid for the purposes of this assessment.

Appendix 13.E

NO_2 Passive Sampler Locations

Appendix 13.E: NO_2 Passive Sampler Locations

The location of passive samplers is shown in Figure E1, Figure E2, Figure E3.

Figure 13.E1: TG Passive NO_2 sampler monitoring site locations

TUMONZ, The Ultimate Map of New Zealand (Software)

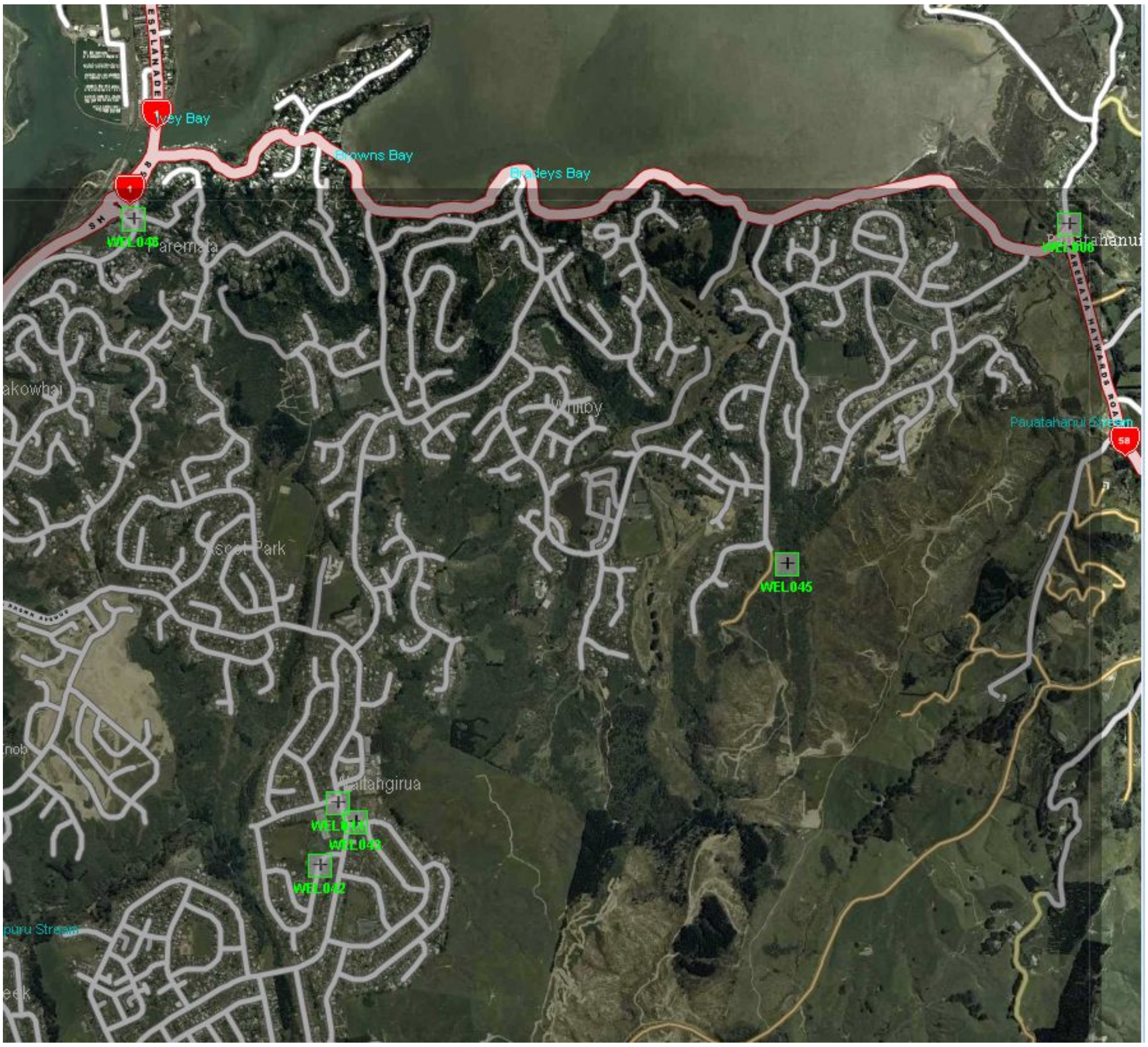


Figure 13.E2: TG Passive NO_2 sampler monitoring site locations

TUMONZ, The Ultimate Map of New Zealand (Software)

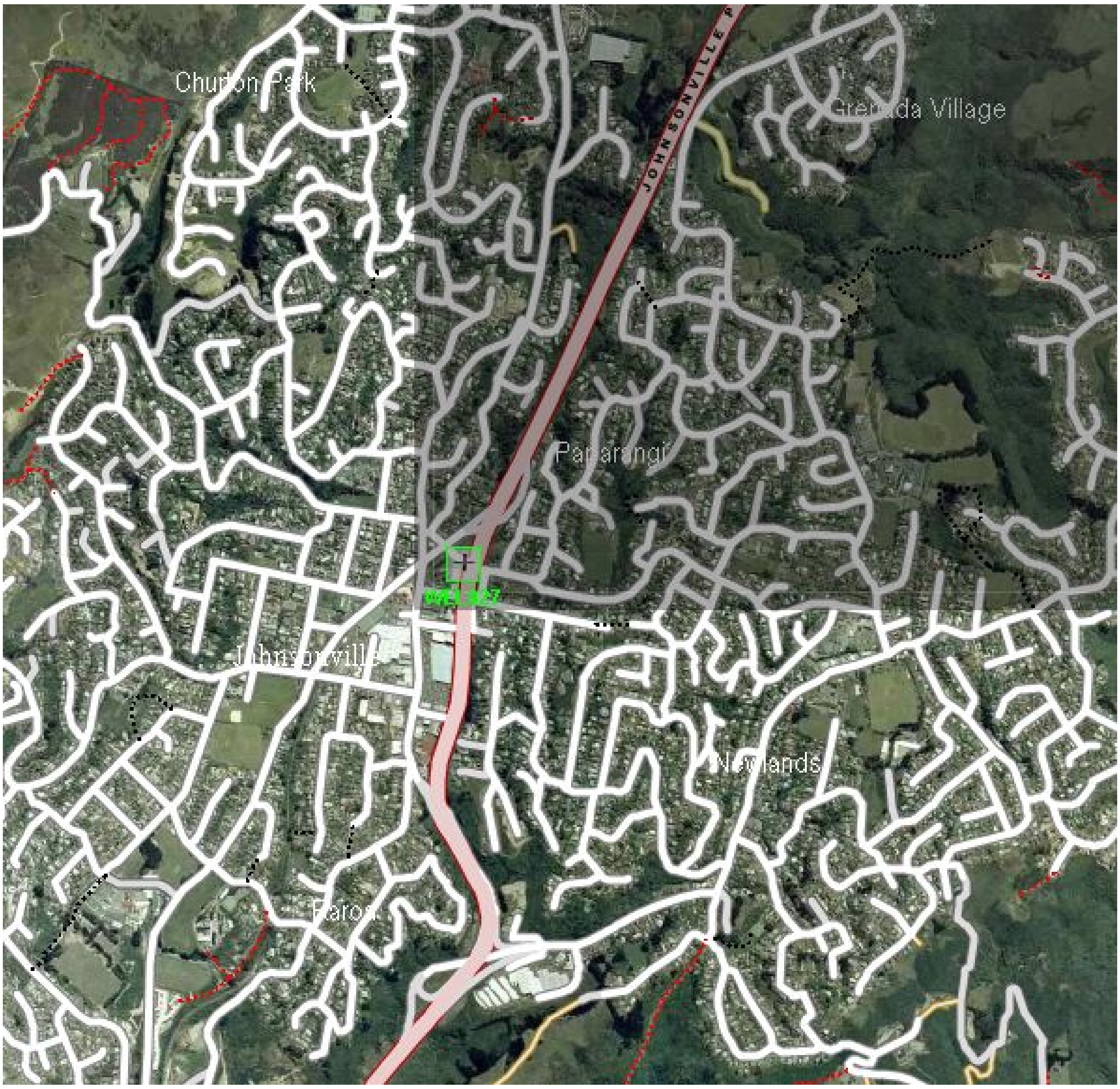


Figure 13.E3: TG Passive NO_2 sampler monitoring site locations

TUMONZ, The Ultimate Map of New Zealand (Software)

Appendix 13.F

Assessment of Nitrogen Dioxide

Appendix 13.F: Assessment of Nitrogen Dioxide

Nitrogen oxides (NO_x) are emitted mainly in the form of nitric oxide (NO) but, once released into the atmosphere, variable proportions are oxidised to the more harmful nitrogen dioxide (NO_2), predominantly by ozone (O_3). Typically only about 10% or less of the total nitrogen oxides released from a combustion source are in the form of NO_2. Air quality standards and guidelines are defined only for NO_2. Therefore, when assessing the potential impact of NO_x emissions from the Project it is important to consider the chemical processes that occur in the atmosphere.

The most important short-term transformation is the reaction of NO in the emission plume with ambient ozone to form NO_2:

$$NO + O_3 \longrightarrow NO_2 + O_2$$

Since the reaction is a 1-to-1 molecular transformation, the maximum possible concentration of NO_2 that can occur in the emission plume is directly related to the maximum ambient concentration of ozone. During the daytime, the main competing reaction in the short term is the photo-dissociation of NO_2 to form NO, which can decrease the concentrations of NO_2 to some degree.

$$3NO_2 + hv \longrightarrow 3NO + O_3$$

Near an emission source, the formation of NO_2 is in general limited by the availability of NO in the emission plume to react with ambient ozone (reactant limited), or alternatively the availability of ambient ozone to react with NO (oxidant limited). At the highest recorded background ozone concentrations of 37 ppb (Gomez, 1996), up to 37 ppb of nitrogen dioxide (equivalent to 72 µg/m^3) could be formed in the emission plume by the oxidation of NO, if sufficient NO is present, in addition to the NO_2 in the plume originally released in the emissions. Therefore, there is effectively a limit to the maximum concentration of NO_2 that could actually occur near an emission source.

Elevated levels of ozone can, on occasion, occur from photochemical smog formation processes. These episodes require significant emissions of both NO_x and reactive organic compounds, usually from large city areas, under conditions where the dispersion of the polluted air mass is limited for periods of several hours combined with warm air temperatures and sunlight. However, Wellington is well ventilated so it is unlikely these events would to occur in the region.

Figure F1 and Figure F2 show the relationship of 1-hour average NO_2 and NO_x concentration recorded at the GWRC monitoring sites of Tawa (2007-2009) and Ngaurunga Gorge (2006-2007). Tawa is a residential monitoring site located 550 m west of SH1 where it is joined by the proposed Main Alignment. Ngauranga Gorge was a roadside ambient monitoring site located on the western side of SH1 between 2006 -2007. Pollutant levels recorded at the site are indicative of concentrations near a main road within the region.

The limiting effect of ambient ozone on NO_2 concentrations is clearly evident in both figures when NO_x concentrations exceed approximately 80-100 µg/m^3. For NO_x concentrations above 100 µg/m^3, NO_2 concentrations are shown to increase only gradually. This increase in NO_2 with NO_x concentrations above 80 µg/m^3 is primarily associated with NO_2 directly emitted from vehicle tail pipes; the slope of this increase correlates to the percentage of NO_x emitted as NO_2.

The figures show that 1-hour average NO_2 concentrations rarely exceed 50 even though 1-hour average NO_X concentrations on occasion do exceed 600 µg/m^3.

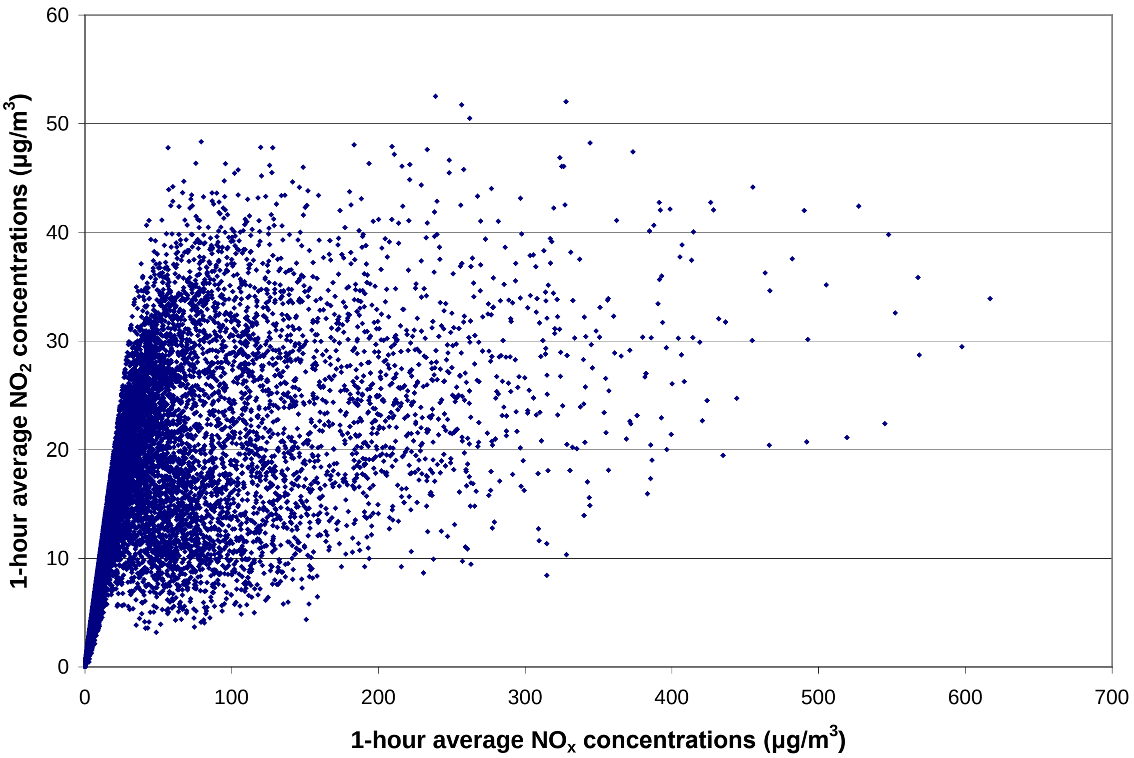


Figure 13.F1: Relationship between 1-hour average NO_2 and NO_x concentrations recorded at the Tawa monitoring station in 2007-2009 (monitoring data courtesy of the GWRC)

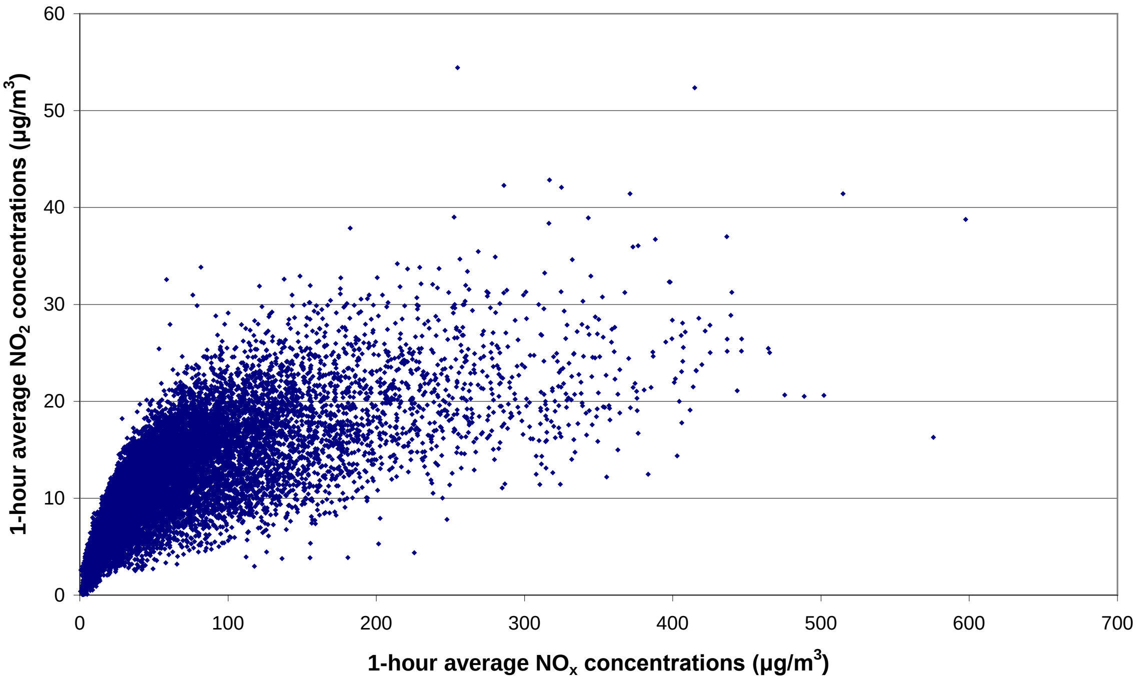


Figure 13.F2: Relationship between 1-hour average NO_2 and NO_x concentrations recorded at the Ngauranga Gorge monitoring station in 2007-2009 (monitoring data courtesy of the GWRC)

Minoura and Ito (2009) estimated 7.3% of NO_x vehicle emissions were emitted as NO_2, based on studies of Japanese roads. A UK study of ambient air quality estimated the percentage as varying between 8-14% (Abbot, 2005). From the average NO_2 to NO_x slope observed in Figure 3.1 when NO_x concentrations exceed 100 µg/m^3, the percentage of NO_2 emitted as NO_X can be estimated to be less than 5%, which is lower but comparable to these reported emission ratios. The lower ratio may be due to the older vehicle fleet and lower proportion of diesel vehicles in New Zealand fleet compared to Japan and UK.

In the analysis, cumulative NO_2 levels have been estimated by assuming a worse case background NO_2 concentrations equal to the 99.9 percentile 1-hour average NO_2 recorded at the Tawa monitoring site of 45 µg/m^3 occurs during the same hour as the maximum ground level concentrations associated with the modelled road source also occurs. During these periods the formation of NO_2 is expected to be ozone limited, as shown in Figure F1 and Figure F2 by the flattening of the NO_2-NO_x curve. During these conditions additional NO_2 is expected to be associated with NO_2 emitted at the point of discharge. Therefore, the contribution from the modelled road sources to ambient pollutant levels has been calculated by multiplying the predicted incremental 99.9 percentile 1-hour average NO_X concentration by the percentage of NO_x assumed to be emitted as NO_2. In this instance it has been assumed that 10% of NO_X is emitted as NO_2. The Wellington monitoring data indicates that this is a conservative assumption. The expression used to calculate cumulative 99.9 percentile 1-hour average NO_2 concentrations is shown below:

$$[NO_2]_{\text{cumulative 99.9\%ile 1-hour average}} = 0.10 * [NO_X]_{\text{predicted 99.9\%ile 1-hour average}} + 45$$

A similar method has been used to estimate maximum 24-hour average NO_2 concentrations. However, NO_x and ambient ozone concentrations can vary significantly throughout any 24-hour period. Therefore during any 24-hour period, the formation of NO_2 may be both NO limited and ozone limited. Figure F3 and Figure F4 shows the relationship between recorded 24-hour average NO_2 and NO_x concentrations at the GWRC Tawa (2007-2009) and Ngauranga (2006-2007) monitoring sites.

The figures show comparatively linear relationships between 24-hour average NO_2 and NO_X concentrations when 24-hour NO_X concentrations are higher than 50µg/m^3. At these concentrations, 24-hour average NO_2 concentrations increase only slowly with respect to increases in 24-hour average NO_X concentrations. Simple regression models fitted to the GWRC Tawa, Central Wellington, Ngauranga Gorge, Melling monitoring data indicates that increases in 24-hour average NO_2 concentrations are approximately equal to 4 – 10% of the increase in the 24-hour NO_X concentrations at NO_X concentrations above 50 µg/m^3. The results suggest that at these concentrations, increases are predominantly associated with increases in NO_2 tail pipe emission rates.

Therefore, in the analysis, cumulative NO_2 levels have been estimated by assuming a worst case background NO_2 concentrations equal to the average of the maximum 24-hour average NO_2 concentration recorded at the Tawa monitoring site between 2007 – 2009 of 29 µg/m^3. The contribution from the modelled motorway sources to ambient pollutant levels has been calculated by multiplying the predicted maximum incremental 24-hour average NO_X concentration by 10%. Based on the monitoring data this is expected to be conservative. The expression used to calculate cumulative 24-hour average NO_2 concentrations is shown below:

$$[NO_2]_{\text{cumulative 24-hour average}} = 0.10 * [NO_X]_{\text{predicted 24-hour average}} + 29$$

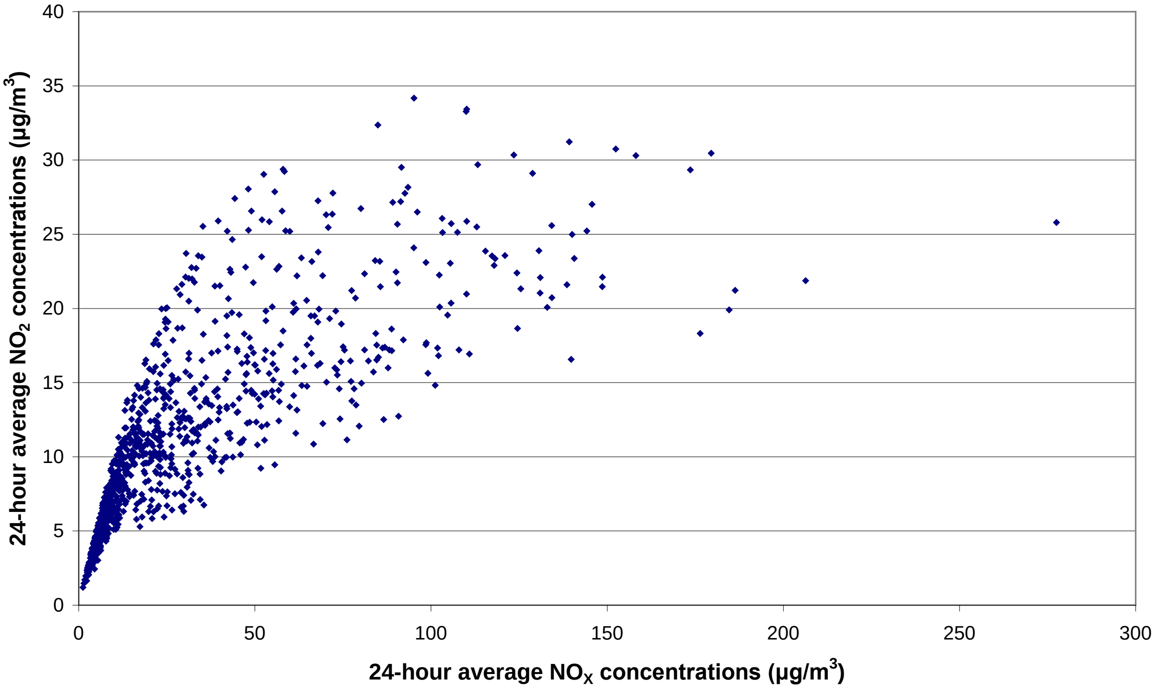


Figure 13.F3: Relationship between 24-hour average NO_2 and NO_x concentrations recorded at the Tawa monitoring station in 2007-2009 (monitoring data courtesy of the GWRC)

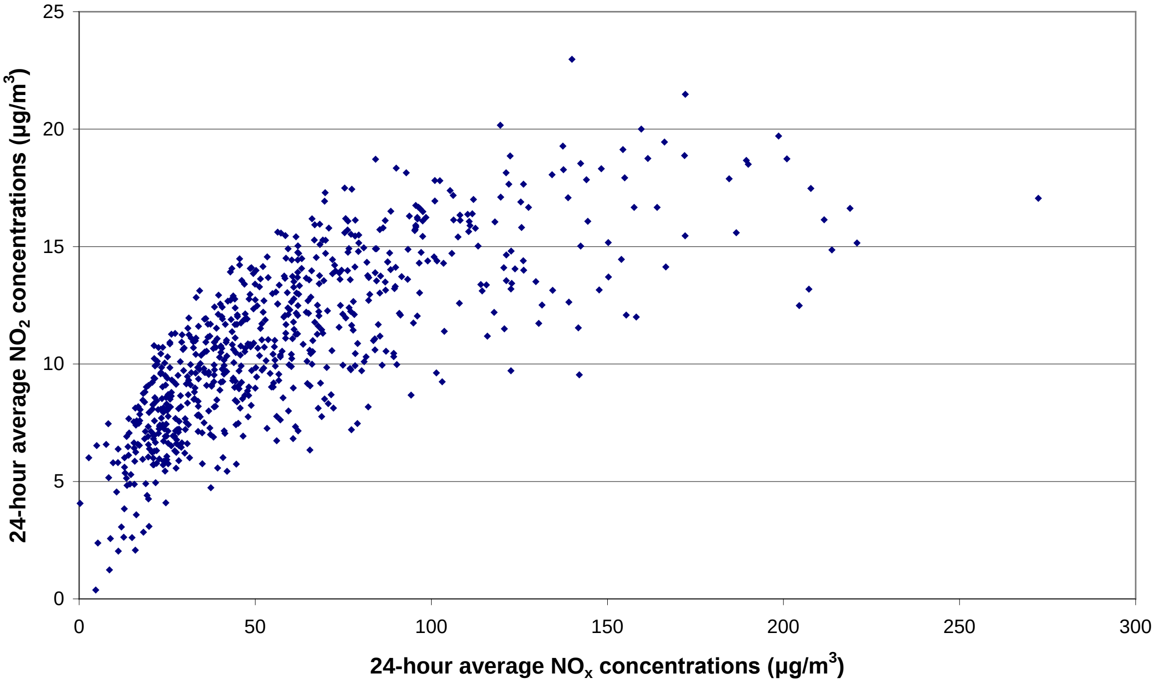
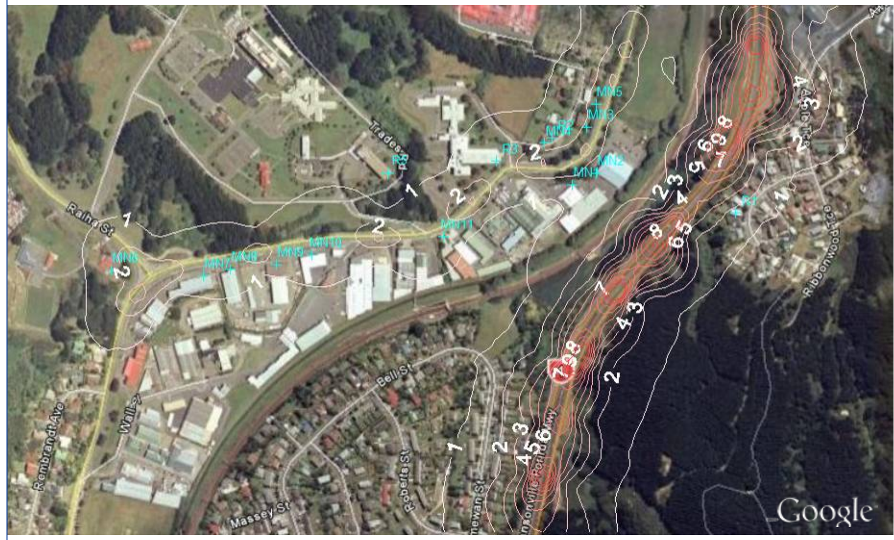
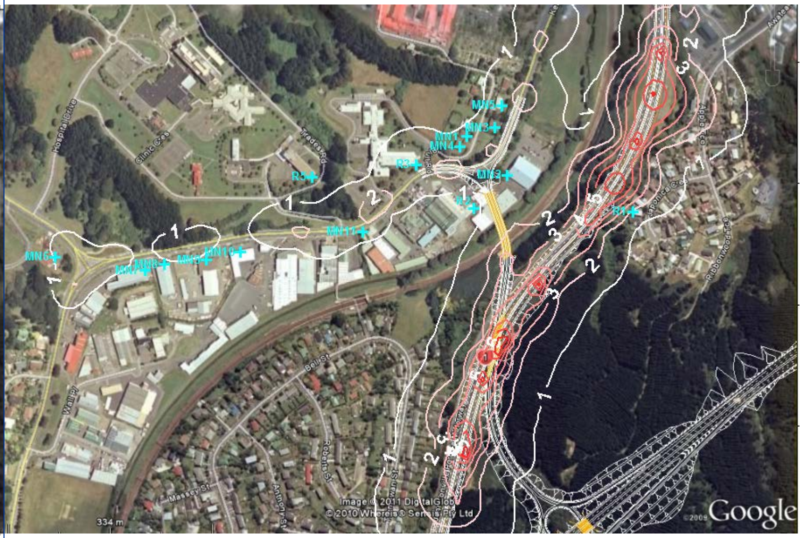
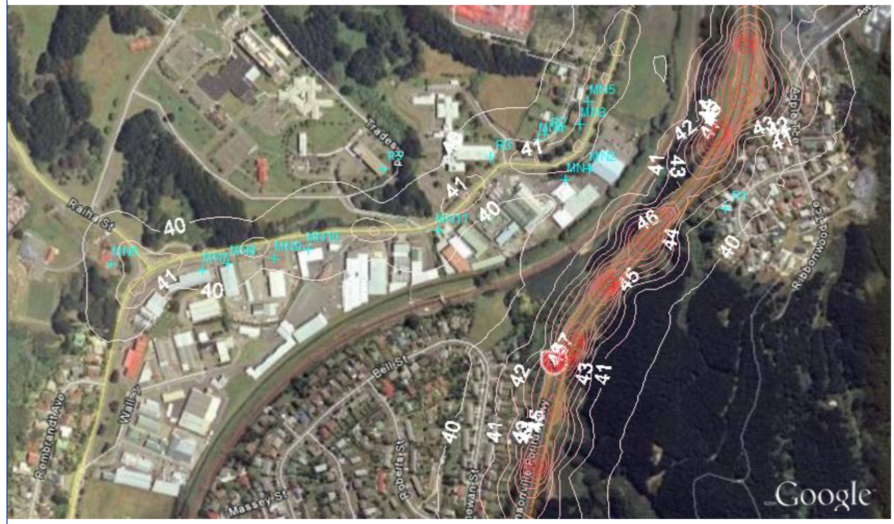
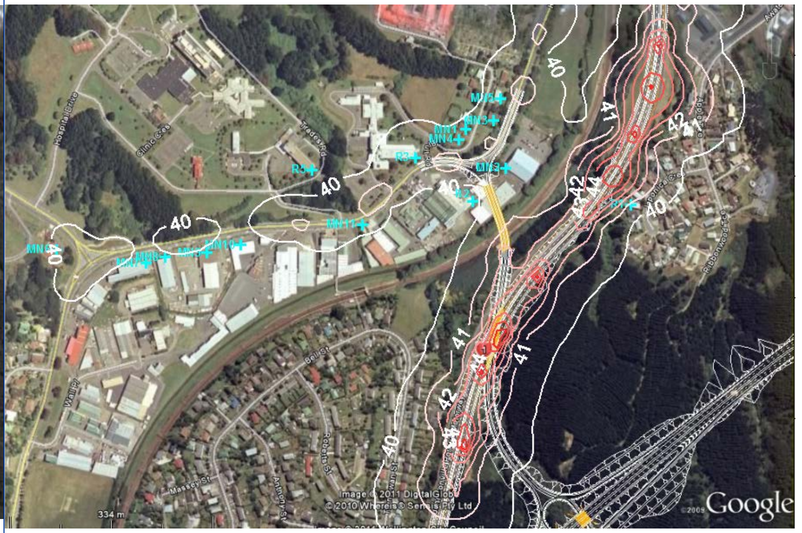


Figure 13.F4: Relationship between 24-hour average NO_2 and NO_x concentrations recorded at the Ngauranga Gorge monitoring station in 2006-2007 (monitoring data courtesy of the GWRC)

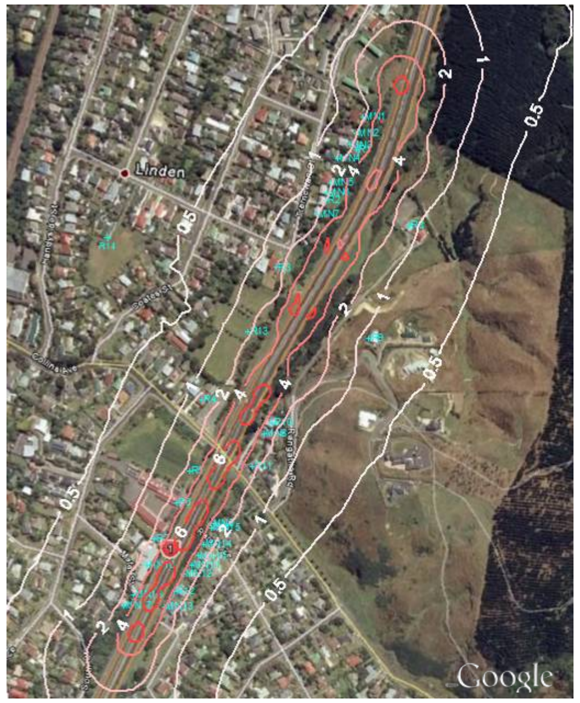
Appendix 13.G

Ground Level Concentrations Contour Maps

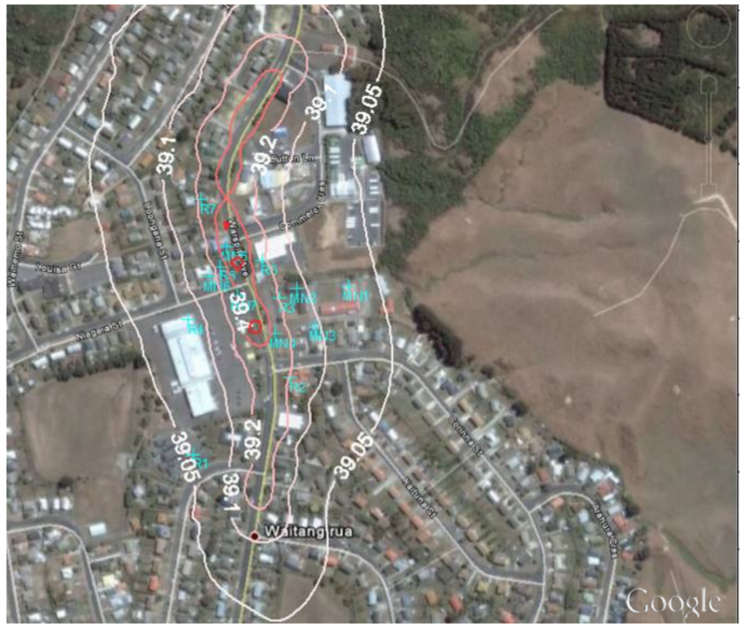
Appendix 13.G: Ground Level Concentrations Contour Maps

L1-Kenepuru Interchange	**2006**	**2031 Do Minimum**	**2031 With Project**
PM10, 24h Average, **Incremental** Ground Level Concentration			
PM10, 24h Average, **Cumulative** Ground Level Concentration (Assumed Background Concentration: 39µg/m3)			

Note: All Images sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

L2 - Linden	2006	2031 Do Minimum	2031 With Project
PM10, 24h Average, **Incremental** Ground Level Concentration			
PM10, 24h Average, **Cumulative** Ground Level Concentration (Assumed Background Concentration: 39µg/m3)			

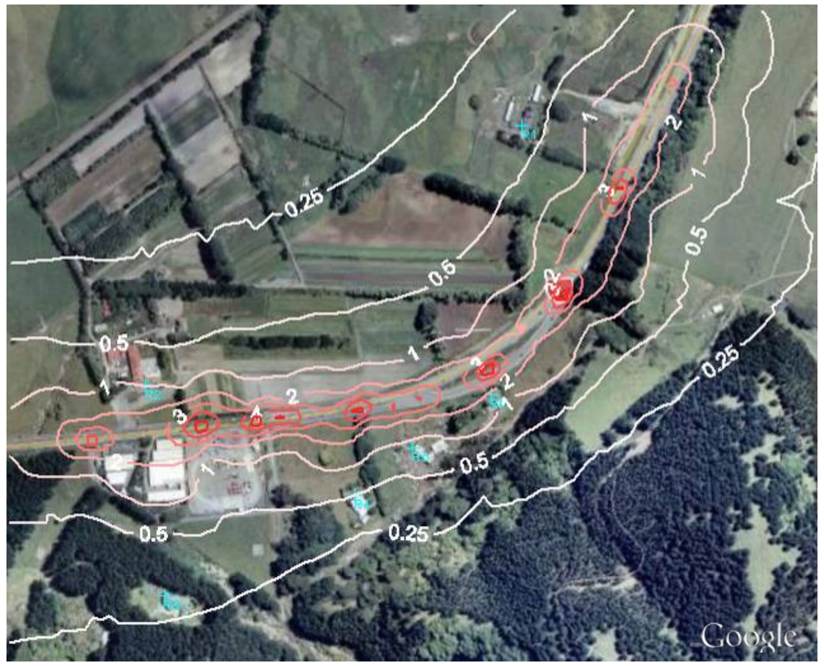
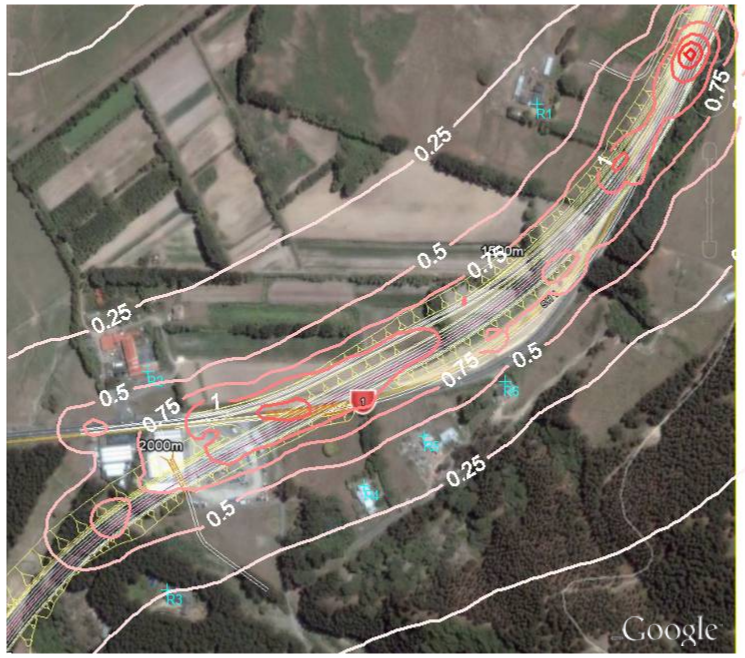
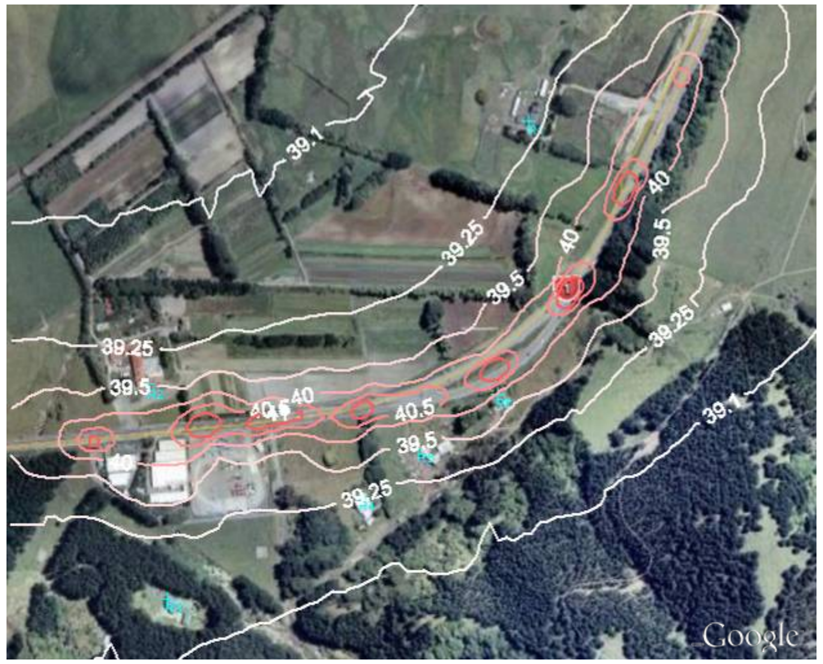
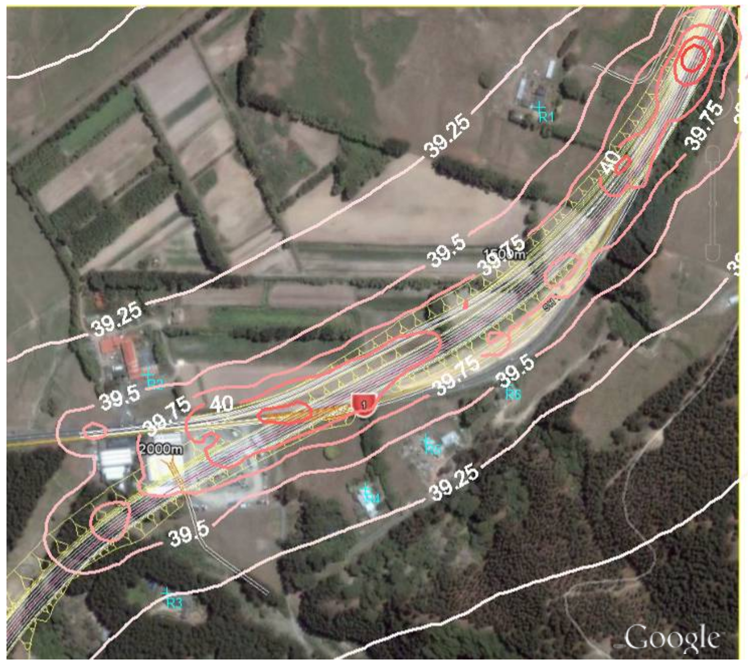
Note: All Images sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

L3 – Warspite Interchange	**2006**	**2031 Do Minimum**	**2031 With Project**
PM10, 24h Average, **Incremental** Ground Level Concentration			
PM10, 24h Average, **Cumulative** Ground Level Concentration			

Note: All Images sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

L4 –SH58	2006	2031 Do Minimum	2031 With Project
PM10, 24h Average, **Incremental** Ground Level Concentration			
PM10, 24h Average, **Cumulative** Ground Level Concentration			

Note: All Images sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

L5 - MacKays Crossing	2006	2031 Do Minimum	2031 With Project
PM10, 24h Average, **Incremental** Ground Level Concentration			
PM10, 24h Average, **Cumulative** Ground Level Concentration			

Note: All Images sourced from Google Earth Pro – Images from SIO, NOAA, U.S. Navy, NGA, GEBCO, Image © 2010 DigitalGlobe.

Appendix 13.H

Screening Model Results

Appendix 13.H: Screening Model Results

The MfE GPG Land Transport defines a screening model as *a "model run that aims to calculate the highest concentration that might occur, but gives no information on the frequency or location of the event"*. They recommend undertaking one "*to determine whether a proposal is likely to result in exceedances of ambient air quality criteria"*.

A screening dispersion modelling assessment was used to assess maximum air pollutant levels that could potentially occur near major arterial roads within the Project area. By definition, screening models are intentionally conservative and are intended to provide an indication of worst case pollutant levels rather than the probability of whether they will occur. For this assessment, pollutant concentrations have been predicted based on worst case dispersion conditions (ie wind speed, wind direction, and atmospheric stability). For road sources, these conditions are associated with low wind speeds (0.5m/s) and stable night time and neutral daytime atmospheric conditions (Pasquill Gifford Stability Classes F and D).

Worst case ground level pollutant concentrations were predicted for four arterial roads within the Project area. The roads modelled were:

- Whitford Brown Avenue (SH1-6)
- Grays Rd (SH1-9)
- Parameta Rd (SH58-East) (SH1-12)
- Paremata Heywood road SH58 east of the Main Alignment (TG-7)

The location of each of the modelled roads and their predicted average daily traffic volumes for the traffic scenarios is shown in Figure H1.

Predicted maximum incremental 1-hour average NO_X, 8-hour average CO, and 24-hour PM_{10} concentrations with increasing distance from the road kerbside for each of the road sources are presented in Table H1, Table H2, Table H3 and Table H4. The tables also show the estimated cumulative 1-hour average NO_2 concentration calculated using the methodology discussed in Appendix G assuming a background NO_2 concentration of 45 $\mu g/m^3$. Predicted concentrations are shown for the 2006 base year, 2031 'Do Minimum' and 2031 'With Project' emission scenarios.

Pollutant levels predicted 5m from the kerbside are intended to be representative of concentrations at the fence line of residential properties located adjacent to the modelled roads. It is highly unlikely that the public would be present at these locations for any extended period of time (ie for periods of 8-hours or 24-hours). The predicted maximum incremental 8-hour average CO and 24-hour average PM_{10} concentrations at 5m from the road sources are included in the tables only for completeness. It is highly unlikely that individuals would be this close to the modelled roads for any extended period.

The results show a rapid decrease in pollutant levels with increasing distance from the roads. Comparable pollutant concentrations are predicted for the 2031 'With Project' and 'Do Minimum' emission scenarios. Although slightly lower concentrations are predicted in areas surrounding Grays Rd for the 'With Project' emission scenario compared to the 'Do Minimum' emission scenarios (refer Table H2), pollutant concentrations for both of the 2031 emission scenarios are lower than those predicted for the 2006 base year. The model predictions indicate that the contribution from the road sources to ambient pollutant levels are expected to decrease with time.

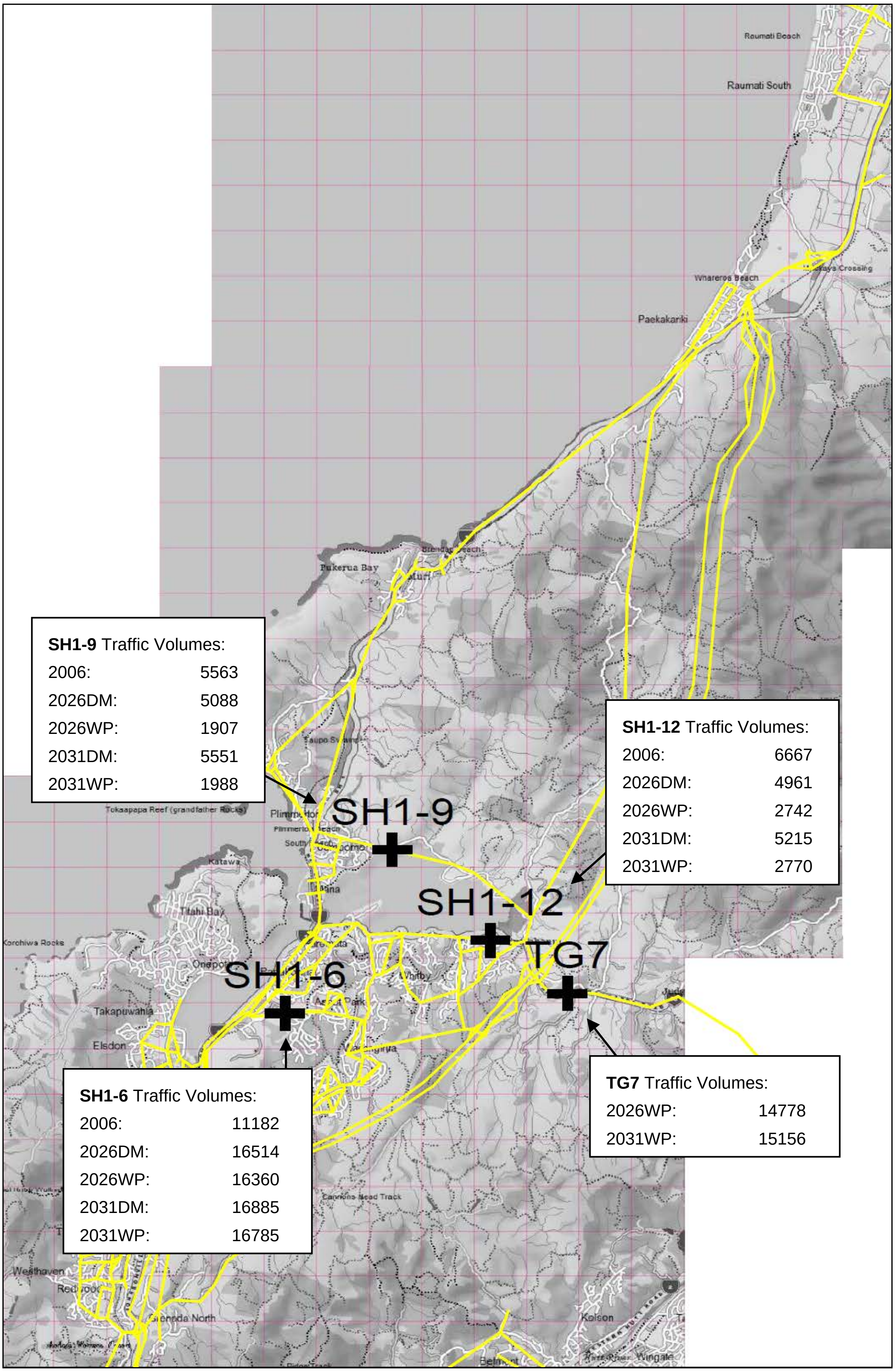
Predicted 8-hour average incremental CO concentration for all of the modelled emission scenarios are low compared to the AQNES of 10 mg/m^3. The highest incremental concentration predicted for the 2031 'With Project' emission scenario 10m from the kerbside is 0.10 mg/m^3 or 1% of the AQNES. The modelling results indicate that even should worse case dispersion conditions occur for the 8-hour averaging period, pollutant levels are not expected exceed the AQNES as a consequence of emissions from the modelled road sources.

Predicted maximum cumulative 1-hour average NO_2 are also low compared to the AQNES criteria limit of 200 µg/m^3. The maximum predicted concentration for the 2031 'With Project' emission scenario is 62 µg/m^3, or 31% of the AQNES. The predicted maximum occurs 5m from the kerb side of SH58 (TG 7) (refer Table H4). At this location background pollutant levels are expected to significantly lower than those assumed.

Maximum incremental 24-hour average PM_{10} concentrations at distances of 10m from the modelled road sources for the 2031 'With Project' emission scenario are predicted to be less than 3.6 µg/m^3, or 7.2% of the 24-hour average AQNES of 50 µg/m^3. At distances 20m from the road sources a maximum 24-hour concentration of 2.2 µg/m^3, or 4.4% of the AQNES, is predicted.

For an assumed maximum background PM_{10} concentration of 39 µg/m^3 (refer Section 6) a maximum cumulative concentration of 42.6 µg/m^3 (85% of the AQNES) has been estimated at locations 10m from the roads. The results indicate that vehicle emissions from the road are unlikely to result in an exceedance of the AQNES and the maximum contribution from the roads to ambient pollutant levels are expected to be relatively low compared to maximum background levels. It should be noted that the predicted concentrations assume that worse case dispersion conditions occur throughout the 24-hour averaging period. Slight increases in wind speed and variations wind direction will significantly reduce pollutant levels. Predicted 24-hour average PM_{10} concentrations using the screening meteorological data are therefore highly conservative.

The results of the screening modelling indicate that even if worse case meteorological conditions were to occur throughout an extended period of time, the contribution from roads to ambient pollutant levels are unlikely to result in an exceedance of air quality criteria limits.



SH1-9 Traffic Volumes:

2006:	5563
2026DM:	5088
2026WP:	1907
2031DM:	5551
2031WP:	1988

SH1-12 Traffic Volumes:

2006:	6667
2026DM:	4961
2026WP:	2742
2031DM:	5215
2031WP:	2770

SH1-6 Traffic Volumes:

2006:	11182
2026DM:	16514
2026WP:	16360
2031DM:	16885
2031WP:	16785

TG7 Traffic Volumes:

2026WP:	14778
2031WP:	15156

Figure 13.H1: Screening Model Locations

Table 13.H1: Whitford Browne Ave (SH1-6) Screening Model Predictions

Pollutant	Averaging Time	AQNES	Scenario	Distance from the kerb [m]				
				5	10	20	50	100
PM_{10} Incremental Ground Level Concentration [µg/m^3]	24 hour	50 µg/m^3	2006	*8.3*	5.2	3.3	1.7	1.0
			2031 Do Minimum	*5.7*	3.6	2.2	1.1	0.6
			2031 With Project	*5.7*	3.6	2.2	1.1	0.6
NOx Incremental Ground Level Concentration [µg/m^3]	1 hour	-	2006	228	138	84	41	23
			2031 Do Minimum	116	69	43	22	12
			2031 With Project	141	84	50	24	13
NO_2 Cumulative Ground Level Concentration [µg/m^3]	1 hour	200 µg/m^3	2006	68	59	53	49	47
			2031 Do Minimum	57	52	49	47	46
			2031 With Project	59	53	50	47	46
CO Incremental Ground Level Concentration [mg/m^3]	8 hour	10 mg/m^3	2006	*0.49*	0.31	0.19	0.10	0.06
			2031 Do Minimum	*0.16*	0.10	0.06	0.03	0.02
			2031 With Project	*0.16*	0.10	0.06	0.03	0.02

Table 13.H2: Grays Rd (SH1-9) Screening Model Predictions

Pollutant	Averaging Time	AQNES	Scenario	Distance from the kerb [m]				
				5	10	20	50	100
PM_{10} Incremental Ground Level Concentration [µg/m^3]	24 hour	50 µg/m^3	2006	*4.2*	2.7	1.7	0.9	0.5
			2031 Do Minimum	*2.1*	1.3	0.8	0.4	0.3
			2031 With Project	*0.8*	0.5	0.4	0.2	0.1
NOx Incremental Ground Level Concentration [µg/m^3]	1 hour	-	2006	146	89	55	27	16
			2031 Do Minimum	81	50	31	15	9
			2031 With Project	24	15	9	5	3
NO_2 Cumulative Ground Level Concentration [µg/m^3]	1 hour	200 µg/m^3	2006	60	54	51	48	47
			2031 Do Minimum	53	50	48	47	46
			2031 With Project	47	46	46	45	45
CO Incremental Ground Level Concentration [mg/m^3]	8 hour	10 mg/m^3	2006	*0.24*	0.16	0.10	0.05	0.03
			2031 Do Minimum	*0.05*	0.03	0.02	0.01	0.01
			2031 With Project	*0.02*	0.01	0.01	0.00	0.00

Table 13.H3: SH58 – Paremata Rd East (SH1-12) Screening Model Predictions

Pollutant	Averaging Time [h]	AQNES	Scenario	Distance from the kerb [m]				
				5	10	20	50	100
PM_{10} Incremental Ground Level Concentration [µg/m^3]	24 hour	50 µg/m^3	2006	*6.1*	3.9	2.4	1.3	0.7
			2031 Do Minimum	*2.1*	1.3	0.8	0.4	0.3
			2031 With Project	*1.1*	0.7	0.5	0.2	0.1
NOx Incremental Ground Level Concentration [µg/m^3]	1 hour	-	2006	179	109	67	33	19
			2031 Do Minimum	60	37	23	11	6
			2031 With Project	30	19	12	6	4
NO_2 Cumulative Ground Level Concentration [µg/m^3]	1 hour	200 µg/m^3	2006	63	56	52	48	47
			2031 Do Minimum	51	49	47	46	46
			2031 With Project	48	47	46	46	45
CO Incremental Ground Level Concentration [mg/m^3]	8 hour	10 mg/m^3	2006	*0.27*	0.17	0.11	0.06	0.03
			2031 Do Minimum	*0.05*	0.03	0.02	0.01	0.01
			2031 With Project	*0.03*	0.02	0.01	0.01	0.003

Table 13.H4: Paremata Heywood road SH58 east of the Main Alignment (TG 7) Screening Model Predictions

Pollutant	Averaging Time	AQNES	Scenario	Distance from the kerb [m]				
				5	10	20	50	100
PM_{10} Incremental Ground Level Concentration [µg/m^3]	24 hour	50 µg/m^3	2006	*11.1*	7.0	4.3	2.2	1.2
			2031 Do Minimum	*4.9*	3.1	1.9	1.0	0.6
			2031 With Project	*5.6*	3.5	2.1	1.1	0.6
NOx Incremental Ground Level Concentration [µg/m^3]	1 hour	-	2006	421	251	151	73	40
			2031 Do Minimum	168	100	60	29	16
			2031 With Project	179	106	64	30	17
NO_2 Cumulative Ground Level Concentration [µg/m^3]	1 hour	200 µg/m^3	2006	87	70	60	52	49
			2031 Do Minimum	62	55	51	48	47
			2031 With Project	63	56	51	48	47
CO Incremental Ground Level Concentration [mg/m^3]	8 hour	10 mg/m^3	2006	*0.68*	0.43	0.26	0.13	0.08
			2031 Do Minimum	*0.13*	0.08	0.05	0.02	0.01
			2031 With Project	*0.14*	0.09	0.06	0.03	0.02

Appendix 13.I

AUSROADS Input Files

Appendix 13.I: AUSROADS Input Files

L1 AUSROADS Input File - PM10 24hr 2031WP

```
  _______________________________________________________________________
    L1 PM10 24hr 2030OPT Modelling RevB_2 - Kenepuru Link Re alignement
  _______________________________________________________________________


              VARIABLES AND OPTIONS SELECTED FOR THIS RUN
              -----------------------------------------------

Emission rate units:                                  g/v-km
Concentration units:                                  micrograms/m3
Aerodynamic roughness:                                0.40 (M)
Aerodynamic roughness at wind vane site:              0.30 (M)
Anemometer height:                                    10.0 (M)
Read sigma theta values from the met file?            No
Use Pasquill Gifford for horizontal dispersion?       Yes
Sigma theta averaging periods:                          60 (min.)
Wind profile exponents set to:                        Irwin Urban
Use hourly varying background concentrations?         No
Use constant background concentrations?               Yes
Constant background concentrations set to:              0.00E+00 micrograms/m3
External file for emission rates and traffic volumes? Yes
----------------------------------------------------------------------

                            LINK GEOMETRY
                           ---------------

LINK               LINK COORDINATES (M)             HEIGHT MIXING ZONE
NAME  TYPE    X1       Y1        X2        Y2         (M)   WIDTH (M)
______________________________________________________________________
LNK1   FL     101.0     402.6     142.4     456.8     0.0      14.0
LNK2   FL      77.8     530.8     142.4     456.8     0.0      14.0
LNK3   FL     142.4     456.8     192.3     475.4     0.0      14.0
LNK4   FL     192.3     475.4     402.9     515.3     0.0      14.0
LNK5   FL     402.9     515.3     557.3     523.0     0.0      14.0
LNK6   FL     437.3     574.5     557.3     523.0     0.0      14.0
LNK7   FL     557.3     523.0     684.2     614.0     0.0      14.0
LNK8   FL     684.2     614.0     781.0     626.0     0.0      14.0
LNK9   FL     781.0     626.0     823.6     672.8     0.0      14.0
LNK10  FL     823.6     672.8     926.1     959.6     0.0      14.0
LNK11  AG     781.0     626.0     795.7     583.4     8.0      14.0
LNK12  BG     795.7     583.4     825.5     486.6    10.0      14.0
LNK13  FL     817.0     390.3     801.9     306.3     0.0      14.0
LNK14  AG     801.9     306.3     795.7     242.0     5.0      14.0
LNK15  AG     795.7     242.0     815.1     163.5     6.0      14.0
LNK16  AG     815.1     163.5     856.5     104.6     6.0      14.0
LNK17  AG     715.6      46.2     770.9     268.7     8.0      14.0
LNK18  DP     825.5     486.6     817.0     390.3    -8.0      14.0
LNK19  AG     770.9     268.7     832.1     392.2     8.0      14.0
LNK20  AG     832.1     392.2     907.6     489.0     6.0      14.0
LNK21  AG     907.6     489.0    1000.0     605.4     4.0      14.0
LNK22  DP    1000.0     605.4    1057.7     739.7    -2.0      14.0
LNK23  FL    1057.7     739.7    1075.1     890.3     0.0      14.0
LNK24  FL    1087.1     886.4    1067.8     732.8     0.0      14.0
LNK25  FL    1067.8     732.8    1003.5     588.4     0.0      14.0
LNK26  FL    1003.5     588.4     917.6     485.1     0.0      14.0
LNK27  FL     917.6     485.1     842.1     389.9     0.0      14.0
LNK28  FL     842.1     389.9     779.1     263.3     0.0      14.0
LNK29  FL     779.1     263.3     727.6      41.9     0.0      14.0
______________________________________________________________________
                            RECEPTOR LOCATIONS
                           --------------------
```

```
                   COORDINATES (M)                        COORDINATES (M)
NAME   No.     X          Y          Z | NAME   No.     X          Y          Z
___________________________________________________________________________
R1       1   1032.2      553.2    0.0 | R2       2    772.1      557.8    0.0
R3       3    676.9      630.6    0.0 | R4       4    911.4     1129.9    0.0
R5       5    506.6      610.5    0.0 | MN1      6    760.5      677.0    0.0
MN2      7    826.3      613.6    0.0 | MN3      8    806.1      691.8    0.0
MN4      9    748.9      660.8    0.0 | MN5     10    817.0      728.1    0.0
MN6     11     84.7      478.9    0.0 | MN7     12    231.8      456.4    0.0
MN8     13    263.5      466.5    0.0 | MN9     14    333.2      473.5    0.0
MN10    15    388.9      486.6    0.0 | MN11    16    588.8      519.9    0.0
MN12    17    806.0      689.9    0.0 | MN13    18    819.7      720.1    0.0
AUT1    19    130.0      424.0    0.0 | AUT2    20    116.0      436.0    0.0
AUT3    21    134.0      422.0    0.0 | AUT4    22    112.0      438.0    0.0
AUT5    23    146.0      412.0    0.0 | AUT6    24    100.0      448.0    0.0
AUT7    25    166.0      398.0    0.0 | AUT8    26     80.0      464.0    0.0
AUT9    27    204.0      368.0    0.0 | AUT10   28     40.0      494.0    0.0
AUT11   29    284.0      306.0    0.0 | AUT12   30    -40.0      554.0    0.0
AUT13   31    104.0      488.0    0.0 | AUT14   32    118.0      500.0    0.0
AUT15   33    100.0      486.0    0.0 | AUT16   34    122.0      504.0    0.0
AUT17   35     88.0      476.0    0.0 | AUT18   36    132.0      514.0    0.0
AUT19   37     70.0      458.0    0.0 | AUT20   38    152.0      530.0    0.0
AUT21   39     32.0      426.0    0.0 | AUT22   40    188.0      562.0    0.0
AUT23   41    -44.0      360.0    0.0 | AUT24   42    264.0      628.0    0.0
AUT25   43    170.0      458.0    0.0 | AUT26   44    164.0      476.0    0.0
AUT27   45    172.0      454.0    0.0 | AUT28   46    162.0      480.0    0.0
AUT29   47    178.0      440.0    0.0 | AUT30   48    158.0      494.0    0.0
AUT31   49    186.0      416.0    0.0 | AUT32   50    148.0      518.0    0.0
AUT33   51    204.0      370.0    0.0 | AUT34   52    132.0      564.0    0.0
AUT35   53    240.0      276.0    0.0 | AUT36   54     96.0      658.0    0.0
AUT37   55    734.0      612.0    0.0 | AUT38   56    732.0      630.0    0.0
AUT39   57    734.0      606.0    0.0 | AUT40   58    732.0      634.0    0.0
AUT41   59    736.0      592.0    0.0 | AUT42   60    730.0      650.0    0.0
AUT43   61    740.0      566.0    0.0 | AUT44   62    726.0      674.0    0.0
AUT45   63    746.0      518.0    0.0 | AUT46   64    720.0      724.0    0.0
AUT47   65    758.0      418.0    0.0 | AUT48   66    708.0      822.0    0.0
AUT49   67    810.0      644.0    0.0 | AUT50   68    796.0      656.0    0.0
              .
              .
              .
              .

AUT358 375    750.4      886.0    0.0 | AUT359 376   1015.2      886.0    0.0
AUT360 377   1280.0      886.0    0.0 | AUT362 378    -44.0      191.6    0.0
AUT363 379    -44.0      365.2    0.0 | AUT364 380    -44.0      538.8    0.0
AUT365 381    -44.0      712.4    0.0 | AUT368 382   1280.0      191.6    0.0
AUT369 383   1280.0      365.2    0.0 | AUT370 384   1280.0      538.8    0.0
AUT371 385   1280.0      712.4    0.0 |
___________________________________________________________________________


                         METEOROLOGICAL DATA
                        --------------------

Meteorolofical data entered via the input file:
P:\329\3291987\AQ Model\TAPM met set\Tawa.met

Title of the meteorological data file is:
 AUSPLUME METFILE Tawa monitoring site TAPM output 01301301
----------------------------------------------------------------------
----------------------------------------------------------------------

             HOURLY VARIABLE EMISSION FACTOR INFORMATION
             -------------------------------------------

Hourly varying traffic volumes and emission factors
entered via the input file:
D:\Data\Projets\Transmission Gully\Inputs\L1_2030OPT_PM10_activity file.act

Title of input hourly emission factor file is:
L1 Activity file_2030OPT_PM10
```

L2 AUSROADS Input File - PM10 24hr 2031WP

```
                     __________________________________
                       L2 Modelling 2030OPT PM10 24hr
                     __________________________________


               VARIABLES AND OPTIONS SELECTED FOR THIS RUN
               ----------------------------------------------

Emission rate units:                                   g/v-km
Concentration units:                                   micrograms/m3
Aerodynamic roughness:                                 0.40 (M)
Aerodynamic roughness at wind vane site:               0.30 (M)
Anemometer height:                                     10.0 (M)
Read sigma theta values from the met file?             No
Use Pasquill Gifford for horizontal dispersion?        Yes
Sigma theta averaging periods:                           60 (min.)
Wind profile exponents set to:                         Irwin Urban
Use hourly varying background concentrations?          No
Use constant background concentrations?                Yes
Constant background concentrations set to:               0.00E+00 micrograms/m3
External file for emission rates and traffic volumes? Yes
----------------------------------------------------------------------

                            LINK GEOMETRY
                           ---------------

LINK              LINK COORDINATES (M)             HEIGHT MIXING ZONE
NAME  TYPE    X1        Y1        X2        Y2        (M)   WIDTH (M)
______________________________________________________________________

LNK1   AG     203.3      16.8     429.9     443.2     0.0      14.0
LNK2   DP     429.9     443.2     623.8     717.6    -2.0      14.0
LNK3   DP     623.8     717.6     773.3     854.3    -3.0      14.0
LNK4   AG     429.9     443.2     567.8     682.6     0.0      14.0
LNK5   AG     567.8     682.6     620.3     848.5     0.0      14.0
LNK6   AG     187.0       9.8     417.1     456.0     0.0      14.0
LNK7   DP     417.1     456.0     605.1     849.6    -3.0      14.0
LNK8   AG     417.1     456.0     531.6     645.2     0.0      14.0
LNK9   BG     531.6     645.2     613.3     748.0   -10.0      14.0
LNK10  AG     613.3     748.0     744.1     853.1     0.0      14.0
______________________________________________________________________
                            RECEPTOR LOCATIONS
                           --------------------

                  COORDINATES (M)                       COORDINATES (M)
NAME   No.     X         Y          Z | NAME   No.     X         Y          Z
___________________________________________________________________________

RCP1     1    530.6     737.6     0.0 | RCP2     2    487.8     667.7     0.0
RCP3     3    419.0     572.8     0.0 | RCP4     4    314.7     387.1     0.0
RCP5     5    296.9     288.0     0.0 | RCP6     6    279.2     243.2     0.0
RCP7     7    247.9     193.1     0.0 | RCP8     8    604.6     631.2     0.0
RCP9     9    548.3     473.7     0.0 | RCP10   10    412.7     354.8     0.0
RCP11   11    385.6     294.3     0.0 | RCP12   12    276.1     119.1     0.0
RCP13   13    379.3     483.1     0.0 | RCP14   14    540.2     784.2     0.0
RCP15   15    530.5     761.3     0.0 | RCP16   16    520.8     744.6     0.0
RCP17   17    504.8     725.9     0.0 | RCP18   18    494.4     691.8     0.0
RCP19   19    489.5     677.9     0.0 | RCP20   20    475.6     647.4     0.0
RCP21   21    402.0     339.7     0.0 | RCP22   22    327.0     213.9     0.0
RCP23   23    308.9     168.8     0.0 | RCP24   24    299.9     156.3     0.0
RCP25   25    288.8     143.8     0.0 | RCP26   26    262.4      97.2     0.0
RCP27   27    316.6     185.4     0.0 | RCP28   28    328.4     207.7     0.0
RCP29   29    236.7     156.3     0.0 | RCP30   30    205.4      99.3     0.0
RCP31   31    219.3     114.6     0.0 | AUT333  32    258.0      98.0     0.0
AUT334  33    242.0     106.0     0.0 | AUT335  34    262.0      96.0     0.0
AUT336  35    236.0     110.0     0.0 | AUT337  36    274.0      88.0     0.0
AUT338  37    224.0     116.0     0.0 | AUT339  38    296.0      78.0     0.0
              .
              .
              .
              .
AUT644 343    872.0     970.0     0.0 | AUT646 344     32.0     168.4     0.0
AUT647 345     32.0     368.8     0.0 | AUT648 346     32.0     569.2     0.0
AUT649 347     32.0     769.6     0.0 | AUT652 348    872.0     168.4     0.0
```

```
AUT653 349    872.0     368.8    0.0 | AUT654 350    872.0     569.2    0.0
AUT655 351    872.0     769.6    0.0 |
__________________________________________________________________________


                         METEOROLOGICAL DATA
                        ---------------------

Meteorological data entered via the input file:
C:\TG\Modelling\AUSROADS\Met files\Tawa.met

Title of the meteorological data file is:
 AUSPLUME METFILE Tawa monitoring site TAPM output 01301301
----------------------------------------------------------------------
----------------------------------------------------------------------

             HOURLY VARIABLE EMISSION FACTOR INFORMATION
             -------------------------------------------

Hourly varying traffic volumes and emission factors
entered via the input file:
C:\TG\Modelling\AUSROADS\Detailed Modelling\L2\L2_2030OPT_PM10_activity file.a

Title of input hourly emission factor file is:
L2 Activity file_2030OPT_PM10
```

L3 AUSROADS Input File - PM10 24hr 2031WP

```
                    __________________________________
                      L3 Modelling 2030OPT PM10 24hr
                    __________________________________


              VARIABLES AND OPTIONS SELECTED FOR THIS RUN
              -----------------------------------------------

Emission rate units:                                  g/v-km
Concentration units:                                  micrograms/m3
Aerodynamic roughness:                                0.40 (M)
Aerodynamic roughness at wind vane site:              0.30 (M)
Anemometer height:                                    10.0 (M)
Read sigma theta values from the met file?            No
Use Pasquill Gifford for horizontal dispersion?       Yes
Sigma theta averaging periods:                          60 (min.)
Wind profile exponents set to:                        Irwin Urban
Use hourly varying background concentrations?         No
Use constant background concentrations?               Yes
Constant background concentrations set to:              0.00E+00 micrograms/m3
External file for emission rates and traffic volumes? Yes
----------------------------------------------------------------------

                            LINK GEOMETRY
                           ---------------

LINK               LINK COORDINATES (M)             HEIGHT MIXING ZONE
NAME  TYPE    X1       Y1        X2        Y2         (M)   WIDTH (M)
______________________________________________________________________
LNK1   AG     846.2     603.3     787.5     509.2     0.0      14.0
LNK2   AG     787.5     509.2     766.3     477.7     1.0      14.0
LNK3   DP     766.3     477.7     730.1     441.1    -3.0      14.0
LNK4   DP     730.1     441.1     658.1     414.3    -3.0      14.0
LNK5   AG     658.1     414.3     457.8     387.0     3.0      14.0
LNK6   FL     457.8     387.0     488.9     284.9     0.0      14.0
LNK7   FL     488.9     284.9     616.3     299.5     0.0      14.0
LNK8   FL     488.9     284.9     488.4     228.5     0.0      14.0
LNK9   FL     488.4     228.5     476.2     148.1     0.0      14.0
LNK10  FL     476.2     148.1     428.2     154.7     0.0      14.0
LNK11  FL     428.2     154.7     392.5     138.2     0.0      14.0
LNK12  FL     476.2     148.1     470.1     103.0     0.0      14.0
LNK13  FL     452.3     399.2     191.0     316.2     0.0      14.0
LNK14  FL     457.8     387.0     427.8     499.5     0.0      14.0
LNK15  FL     427.8     499.5     440.6     573.1     0.0      14.0
LNK16  FL     440.6     573.1     505.3     686.7     0.0      14.0
______________________________________________________________________
                            RECEPTOR LOCATIONS
                           --------------------

                   COORDINATES (M)                        COORDINATES (M)
NAME   No.     X         Y         Z | NAME   No.     X         Y         Z
__________________________________________________________________________
RCP1     1     389.4     170.7     0.0 | RCP2     2    515.5     270.4     0.0
RCP3     3     501.4     373.9     0.0 | RCP4     4    382.7     345.7     0.0
RCP5     5     478.2     422.2     0.0 | RCP6     6    424.3     414.9     0.0
RCP7     7     399.2     501.8     0.0 | RCP8     8    590.7     389.1     0.0
RCP9     9     522.8     386.1     0.0 | RCP10   10    546.9     336.7     0.0
RCP11   11     495.3     328.1     0.0 | RCP12   12    432.9     440.7     0.0
RCP13   13     410.2     401.6     0.0 | RCP14   14    445.8     376.7     0.0
AUT1    15     784.0     488.0     0.0 | AUT2    16    770.0     498.0     0.0
AUT3    17     790.0     486.0     0.0 | AUT4    18    766.0     502.0     0.0
AUT5    19     802.0     478.0     0.0 | AUT6    20    754.0     510.0     0.0
AUT7    21     822.0     464.0     0.0 | AUT8    22    732.0     524.0     0.0
AUT9    23     864.0     436.0     0.0 | AUT10   24    692.0     552.0     0.0
AUT11   25     946.0     380.0     0.0 | AUT12   26    608.0     608.0     0.0
AUT13   27     756.0     454.0     0.0 | AUT14   28    742.0     466.0     0.0
AUT15   29     758.0     450.0     0.0 | AUT16   30    738.0     470.0     0.0
AUT17   31     770.0     440.0     0.0 | AUT18   32    728.0     480.0     0.0
              .
              .
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              .
AUT321 335    496.4     754.0    0.0 | AUT322 336    665.6     754.0    0.0
AUT323 337    834.8     754.0    0.0 | AUT324 338   1004.0     754.0    0.0
AUT326 339    158.0     110.8    0.0 | AUT327 340    158.0     271.6    0.0
AUT328 341    158.0     432.4    0.0 | AUT329 342    158.0     593.2    0.0
AUT332 343   1004.0     110.8    0.0 | AUT333 344   1004.0     271.6    0.0
AUT334 345   1004.0     432.4    0.0 | AUT335 346   1004.0     593.2    0.0
__________________________________________________________________________


                         METEOROLOGICAL DATA
                        ---------------------

Meteorological data entered via the input file:
C:\TG\Modelling\AUSROADS\Met files\Warspite.met

Title of the meteorological data file is:
 AUSPLUME METFILE Warspite TAPM output 01701601
----------------------------------------------------------------------
----------------------------------------------------------------------

             HOURLY VARIABLE EMISSION FACTOR INFORMATION
             -------------------------------------------

Hourly varying traffic volumes and emission factors
entered via the input file:
C:\TG\Modelling\AUSROADS\Detailed Modelling\L3\L3_2030OPT_PM10 activity file.a

Title of input hourly emission factor file is:
L3_2030DM_PM10
```

L4 AUSROADS Input File - PM10 24hr 2031WP

```
                 __________________________________
                      L4 2030OPT PM10 24hr Modelling
                    __________________________________


              VARIABLES AND OPTIONS SELECTED FOR THIS RUN
              -----------------------------------------------

Emission rate units:                                  g/v-km
Concentration units:                                  micrograms/m3
Aerodynamic roughness:                                0.40 (M)
Aerodynamic roughness at wind vane site:              0.30 (M)
Anemometer height:                                    10.0 (M)
Read sigma theta values from the met file?            No
Use Pasquill Gifford for horizontal dispersion?       Yes
Sigma theta averaging periods:                          60 (min.)
Wind profile exponents set to:                        Irwin Urban
Use hourly varying background concentrations?         No
Use constant background concentrations?               Yes
Constant background concentrations set to:              0.00E+00 micrograms/m3
External file for emission rates and traffic volumes? Yes
----------------------------------------------------------------------

                            LINK GEOMETRY
                           ---------------

LINK               LINK COORDINATES (M)              HEIGHT MIXING ZONE
NAME  TYPE    X1       Y1        X2        Y2         (M)   WIDTH (M)
______________________________________________________________________
LNK1   AG     438.0     154.4     563.4     366.0     2.0      14.0
LNK2   AG     563.4     366.0     730.6     598.5    10.0      14.0
LNK3   FL     730.6     598.5     692.1     610.9     0.0      14.0
LNK4   FL     692.1     610.9     673.8     658.6     0.0      14.0
LNK5   AG     673.8     658.6     694.0     695.2     3.0      14.0
LNK6   AG     694.0     695.2     650.9     765.7     3.0      14.0
LNK7   AG     650.9     765.7     615.0     873.5     3.0      14.0
LNK8   AG     694.0     695.2     739.1     708.9     3.0      14.0
LNK9   FL     739.1     708.9     774.4     688.0     0.0      14.0
LNK10  FL     774.4     688.0     781.6     652.7     0.0      14.0
LNK11  FL     781.6     652.7     763.9     608.9     0.0      14.0
LNK12  FL     763.9     608.9     859.3     430.6     0.0      14.0
LNK13  FL     763.9     608.9     730.6     598.5     0.0      14.0
LNK14  FL     428.9     157.0     502.7     369.2     5.0      14.0
LNK15  AG     502.7     369.2     673.8     658.6     5.0      14.0
LNK16  AG     739.1     708.9     875.0     791.8     3.0      14.0
LNK17  DP     875.0     791.8    1163.6     930.3    -5.0      14.0
LNK18  DP    1237.4     967.5     891.9     750.0    -5.0      14.0
LNK19  DP     891.9     750.0     781.6     652.7    -5.0      14.0
LNK20  FL     428.9     157.0     564.7     439.8     0.0      14.0
LNK21  AG     564.7     439.8     678.4     599.8     8.0      14.0
LNK22  AG     678.4     599.8     837.1     746.1    10.0      14.0
LNK23  AG     837.1     746.1    1163.6     930.3     3.0      14.0
LNK24  FL     438.0     154.4     570.6     436.5     0.0      14.0
LNK25  AG     570.6     436.5     688.2     593.3     8.0      14.0
LNK26  AG     688.2     593.3     847.5     741.5    10.0      14.0
LNK27  AG     847.5     741.5    1237.4     967.5     3.0      14.0
LNK28  FL     861.9     428.0     816.2     502.5     0.0      14.0
LNK29  FL     816.2     502.5     789.4     680.8     0.0      14.0
LNK30  FL     789.4     680.8     667.9    1057.6     0.0      14.0
______________________________________________________________________
                            RECEPTOR LOCATIONS
                           --------------------

                   COORDINATES (M)                      COORDINATES (M)
NAME   No.      X          Y         Z | NAME   No.      X          Y         Z
___________________________________________________________________________
RCP1     1     827.9     624.6    0.0 | RCP2     2    704.5     535.8    0.0
RCP3     3     853.4     521.4    0.0 | RCP4     4    756.7     870.8    0.0
RCP5     5    1006.2     953.1    0.0 | RCP6     6   1146.7    1030.9    0.0
RCP7     7     426.9     664.5    0.0 | AUT1     8    710.0     596.0    0.0
AUT2     9     714.0     614.0    0.0 | AUT3    10    708.0     592.0    0.0
AUT4    11     716.0     618.0    0.0 | AUT5    12    702.0     578.0    0.0
```

```
AUT6    13    720.0     632.0    0.0 | AUT7    14    696.0     554.0    0.0
AUT8    15    728.0     656.0    0.0 | AUT9    16    680.0     506.0    0.0
AUT10   17    744.0     704.0    0.0 | AUT11   18    650.0     412.0    0.0
AUT12   19    774.0     800.0    0.0 | AUT13   20    676.0     632.0    0.0
AUT14   21    692.0     638.0    0.0 | AUT15   22    670.0     630.0    0.0
AUT16   23    696.0     640.0    0.0 | AUT17   24    656.0     624.0    0.0
              .
              .
              .
              .
AUT372 379   1174.0    1046.0    0.0 | AUT374 380    274.0     334.0    0.0
AUT375 381    274.0     512.0    0.0 | AUT376 382    274.0     690.0    0.0
AUT377 383    274.0     868.0    0.0 | AUT380 384   1174.0     334.0    0.0
AUT381 385   1174.0     512.0    0.0 | AUT382 386   1174.0     690.0    0.0
AUT383 387   1174.0     868.0    0.0 |
__________________________________________________________________________


                         METEOROLOGICAL DATA
                        ---------------------

Meteorolofical data entered via the input file:
C:\TG\Modelling\AUSROADS\Met files\SH58interc.met

Title of the meteorological data file is:
 AUSPLUME METFILE  SH58 interchange TAPM output 02001801
----------------------------------------------------------------------
----------------------------------------------------------------------

             HOURLY VARIABLE EMISSION FACTOR INFORMATION
             -------------------------------------------

Hourly varying traffic volumes and emission factors
entered via the input file:
C:\TG\Modelling\AUSROADS\Detailed Modelling\L4\L4_2030OPT_PM10_activity file.a

Title of input hourly emission factor file is:
L4_2030OPT_PM10_Activity file
```

L5 AUSROADS Input File – PM10 24hr 2031WP

```
                     __________________________________
                        L5 Modelling 2031OPT PM10 24hr
                      __________________________________


              VARIABLES AND OPTIONS SELECTED FOR THIS RUN
              -----------------------------------------------

Emission rate units:                                   g/v-km
Concentration units:                                   micrograms/m3
Aerodynamic roughness:                                 0.40 (M)
Aerodynamic roughness at wind vane site:               0.30 (M)
Anemometer height:                                     10.0 (M)
Read sigma theta values from the met file?             No
Use Pasquill Gifford for horizontal dispersion?        Yes
Sigma theta averaging periods:                           60 (min.)
Wind profile exponents set to:                         Irwin Urban
Use hourly varying background concentrations?          No
Use constant background concentrations?                Yes
Constant background concentrations set to:               0.00E+00 micrograms/m3
External file for emission rates and traffic volumes? Yes
----------------------------------------------------------------------

                            LINK GEOMETRY
                           ---------------

LINK                   LINK COORDINATES (M)                HEIGHT MIXING ZONE
NAME  TYPE     X1       Y1        X2        Y2          (M)   WIDTH (M)
______________________________________________________________________

LNK1   AG      54.4     360.2     355.4     388.5      0.0      14.0
LNK2   AG     355.4     388.5     469.6     425.9      0.0      14.0
LNK3   AG     469.6     425.9     705.0     551.1      4.0      14.0
LNK4   AG     705.0     551.1     808.7     639.1      8.0      14.0
LNK5   AG     808.7     639.1     918.7     777.5      4.0      14.0
LNK6   AG     918.7     777.5     976.7     902.6      3.0      14.0
LNK7   AG     918.7     777.5     823.0     638.1      6.0      14.0
LNK8   AG     823.0     638.1     737.5     557.7      8.0      14.0
LNK9   AG     737.5     557.7     623.5     479.3      8.0      14.0
LNK10  AG     623.5     479.3     280.6     297.2      6.0      14.0
LNK11  AG     280.6     297.2     173.8     213.7      8.0      14.0
LNK12  AG     355.4     388.5     542.3     402.6      0.0      14.0
LNK13  AG     542.3     402.6     645.4     439.0      0.0      14.0
LNK14  AG     645.4     439.0     760.5     513.7      0.0      14.0
LNK15  AG     760.5     513.7     844.4     607.7      0.0      14.0
LNK16  AG     844.4     607.7     926.8     773.4      0.0      14.0
LNK17  AG     355.3     389.9     580.2     415.6      0.0      14.0
LNK18  AG     580.2     415.6     683.8     440.5      0.0      14.0
LNK19  AG     683.8     440.5     767.1     495.5      0.0      14.0
LNK20  AG     767.1     495.5     844.4     607.7      0.0      14.0
LNK21  AG     844.4     607.7     914.1     760.2      0.0      14.0
LNK22  AG     988.9     902.6     926.8     773.4      3.0      14.0
LNK23  AG     926.8     773.4     831.1     634.0      6.0      14.0
LNK24  AG     831.1     634.0     745.7     551.6      8.0      14.0
LNK25  AG     745.7     551.6     629.6     473.2      8.0      14.0
LNK26  AG     629.6     473.2     287.7     293.1      6.0      14.0
LNK27  AG     287.7     293.1     182.9     208.6      8.0      14.0
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                            RECEPTOR LOCATIONS
                           --------------------

                   COORDINATES (M)                       COORDINATES (M)
NAME   No.      X         Y         Z | NAME   No.      X         Y         Z
__________________________________________________________________________

RCP1     1    760.5     779.3     0.0 | RCP2     2    275.4     446.2     0.0
RCP3     3    298.9     174.6     0.0 | RCP4     4    544.8     304.3     0.0
RCP5     5    619.6     364.6     0.0 | RCP6     6    720.2     433.9     0.0
AUT1     7    416.0     400.0     0.0 | AUT2     8    410.0     416.0     0.0
AUT3     9    418.0     394.0     0.0 | AUT4    10    408.0     422.0     0.0
AUT5    11    422.0     380.0     0.0 | AUT6    12    404.0     436.0     0.0
AUT7    13    430.0     356.0     0.0 | AUT8    14    396.0     460.0     0.0
AUT9    15    446.0     308.0     0.0 | AUT10   16    380.0     506.0     0.0
AUT11   17    476.0     214.0     0.0 | AUT12   18    350.0     602.0     0.0
```

```
AUT13   19    764.0      588.0    0.0 | AUT14   20    752.0      602.0    0.0
AUT15   21    766.0      584.0    0.0 | AUT16   22    748.0      606.0    0.0
AUT17   23    776.0      574.0    0.0 | AUT18   24    738.0      618.0    0.0
AUT19   25    792.0      554.0    0.0 | AUT20   26    722.0      636.0    0.0
AUT21   27    824.0      516.0    0.0 | AUT22   28    690.0      674.0    0.0
              .
              .
              .
              .
AUT357 363    518.0      926.0    0.0 | AUT358 364    726.0      926.0    0.0
AUT359 365    934.0      926.0    0.0 | AUT360 366   1142.0      926.0    0.0
AUT362 367    102.0      258.8    0.0 | AUT363 368    102.0      425.6    0.0
AUT364 369    102.0      592.4    0.0 | AUT365 370    102.0      759.2    0.0
AUT368 371   1142.0      258.8    0.0 | AUT369 372   1142.0      425.6    0.0
AUT370 373   1142.0      592.4    0.0 | AUT371 374   1142.0      759.2    0.0
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                         METEOROLOGICAL DATA
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Meteorolofical data entered via the input file:
C:\TG\Modelling\AUSROADS\Met files\Paraumu.met

Title of the meteorological data file is:
 AUSPLUME METFILE TAPM derived at paraunum with real data input
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             HOURLY VARIABLE EMISSION FACTOR INFORMATION
             -------------------------------------------

Hourly varying traffic volumes and emission factors
entered via the input file:
C:\TG\Modelling\AUSROADS\Detailed Modelling\L5\L5_2030OPT_PM10_activity file.a

Title of input hourly emission factor file is:
L5_2030OPT_PM10_activity file
```