NZ TRANSPORT AGENCY
WAKA KOTAHI

Roads of national significance

Ara Tūhono – Pūhoi to Wellsford

FURTHER NORTH

Pūhoi to Warkworth

Air Quality Assessment Report

August 2013

Pūhoi to Warkworth

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Glossary of abbreviations

Abbreviation	Definition
AADT	Average annual daily traffic
AEE	Assessment of Environmental Effects
ARAQT	Auckland Regional Air Quality Targets
ARC	Auckland Regional Council (preceded the Auckland Council)
ARP:ALW	Auckland Regional Plan: Air, Land and Water
CO	Carbon monoxide
DP	Deposited particulate
FIDOL	Frequency, Intensity, Duration, Offensiveness and Location
HCV	Heavy commercial vehicle
HSAPLU	Highly sensitive air pollution land-uses
kph	Kilometres per hour
LCVs	Light commercial vehicles
$M\ m^3$	Million cubic metres
MfE	Ministry for the Environment
MGLCs	Maximum ground level concentrations
NESAQ	National Environmental Standards for Air Quality
NGTR	Northern Gateway Toll Road
NIWA	National Institute of Water and Atmosphere
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
NOR(s)	Notices of Requirement(s)
NZAAQG	New Zealand Ambient Air Quality Guidelines
NZTA	NZ Transport Agency

Abbreviation	Definition
OPW	Outline Plan of Works
PM_{10}	Fine particulate matter less than 10 microns in diameter
$PM_{2.5}$	Fine particulate matter less than 2.5 microns in diameter
RMA	Resource Management Act 1991
RoNS	Roads of National Significance
SH(x)	State Highway (number)
TMS	Traffic Management System
tph	Tonnes per hour
TSP	Total suspended particulate
USEPA	United States Environmental Protection Agency
VEPM	Vehicle Emissions Prediction Model (Version 5.1)
vpd	Vehicles per day
WHO	World Health Organisation

Glossary of defined terms

Term	Definition
Ambient air	The air outside buildings and structures. It does not refer to indoor air, air in the workplace, or to contaminated air as it is discharged from a source.
Atmospheric mixing height	The height to which significant mixing of added pollutants occurs within the atmosphere.
Atmospheric stability	The resistance of the atmosphere to vertical motion. The distribution of temperature vertically in the troposphere influences vertical motion. A large decrease of temperature with height indicates an unstable condition which promotes up and down currents. A small decrease with height indicates a stable condition which inhibits vertical motion. Where the temperature increases with height, through an inversion, the atmosphere is extremely stable.
Auckland Council	The unitary authority that replaced eight councils in the Auckland Region as of 1 November 2010.
Earthworks	The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting or filling operations.
Grade separated interchange	The layout of roads, where one road crosses over/under the other at a different height.
Highly sensitive air pollution land-uses	A location where people or surroundings may be particularly sensitive to the effects of air pollution. These include residential houses, hospitals, schools, early childhood education centres, childcare facilities, rest homes, residential properties, premises used primarily as temporary accommodation (such as hotels, motels, and camping grounds), open space used for recreation, the conservation estate, marae and other similar cultural facilities.
Indicative alignment	A route and proposed designation footprint selected after short-list and long-list development to enable consultation with the community. This development involved specialist work assessing environmental, social and engineering inputs.
MfE Dust Guide	Ministry for the Environment, *Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions,* 2001
MfE Transport Guide	Ministry for the Environment, *Good Practice Guide on Assessing Discharges to Air from Land Transport,* May 2008
Motorway	Motorway means a motorway declared as such by the Governor General in Council under section 138 of the PWA or under section 71 of the Government Roading Powers Act 1989.
NO_X	Oxides of nitrogen – a suite of gaseous contaminants (NO, NO_2 and N_2O) that are emitted from road vehicles and other sources. Some of the compounds can react in the atmosphere and, in the presence of other contaminants, convert to different compounds (for example NO to NO_2).
NZTA 2012 Guide	The NZTA draft *Guide to assessing air quality effects for State highway asset improvement projects V0.6*, September 2012
$PM_{2.5}$	Particulate matter smaller than 2.5 microns in diameter.

Term	Definition
PM_{10}	Fine particulate matter with an equivalent aerodynamic diameter of less than 10 microns. Fine particulates are predominantly sourced from combustion processes. Vehicle emissions are a key source in urban environments.
Portal	The entrance way to a tunnel starting where the road is completely uncovered to where it is completely covered.
Project	Pūhoi to Warkworth section of the Pūhoi to Wellsford Road of National Significance Project
Project area	From the Johnstone's Hill tunnel portals in the south to Kaipara Flats Road in the north.
SATURN Traffic Model	SATURN (Simulation and Assignment of Traffic to Urban Road Networks) is a suite of flexible network analysis programmes developed at the Institute for Transport Studies, University of Leeds in the United Kingdom.
Tier 1 assessment	A risk (NZTA) or preliminary (MfE) assessment is intended to highlight the key issues and help determine the appropriate level of assessment associated with the options under consideration.
Tier 2 assessment	A screening assessment that is intended to provide a conservative estimate of whether air quality guidelines or standard guidelines are likely to be exceeded by the proposal.
Tier 3 assessment	A detailed or full assessment is intended to provide a comprehensive assessment of the likely air quality impacts associated with the project.
Tier 2 Screening Tool	A screening level dispersion modelling tool developed by NZTA for use in medium risk transport assessments to predict concentrations of key indicator air contaminants with distance from a roadway.
Viaduct	A multi-span bridge.

Contents

1. Purpose and scope of this report

This section of the report gives an overview of the purpose and scope of the report and describes the overall approach taken for the air quality assessment of the Pūhoi to Warkworth Project for the operational and construction phases. The scope of this assessment includes:

- The potential effects on air quality from road construction, construction yards, access roads and a rock crushing plant;
- The potential effects on air quality and human health at sensitive receptors of air discharges from vehicles travelling on the road;
- A sensitivity analysis of the potential effects if the alignment was moved within the proposed designation boundary; and
- Recommended mitigation of the air quality effects from construction of the road.

1.1 Introduction

This report forms part of a suite of technical reports prepared for the NZ Transport Agency's (NZTA's) Ara Tūhono Pūhoi to Wellsford Road of National Significance (RoNS) Pūhoi to Warkworth Section (the Project). Its purpose is to inform the Assessment of Environmental Effects (AEE) and to support the resource consent applications and Notices of Requirement for the Project.

The indicative alignment shown on the Project drawings has been developed through a series of multi-disciplinary specialist studies and refinement. A NZTA scheme assessment phase was completed in 2011, and further design changes have been adopted throughout the AEE assessment process for the Project in response to a range of construction and environmental considerations.

It is anticipated that the final alignment will be refined and confirmed at the detailed design stage through conditions and outline plans of works (OPW). For that reason, this assessment has addressed the actual and potential effects arising from the indicative alignment, and covers the proposed designation boundary area.

Except as noted in this report, the recommendations we propose to mitigate adverse effects are likely to be applicable to other similar areas within the proposed designation boundary, subject to confirmation of their suitability at the detailed design stage.

This report provides an assessment of potential air quality effects associated with the construction and operation of the Project. This report has been written by Deborah Ryan, with the invaluable assistance of Chris Bender. The scope of this assessment includes:

- Evaluating the potential effects on air quality arising from road construction, including effects on around 75 residences out to 200m from the construction area, indicative construction yards, access roads and a rock crushing plant;
- Determining the potential effects on air quality and human health at sensitive receptors within 200m of the indicative alignment arising from air discharges from vehicles travelling along the indicative alignment using predicted traffic data for the operational phase;

- Analysis of the construction and operational phases relative to the proposed designation boundary to evaluate the potential effect if the alignment was moved within the proposed designation boundary; and
- Recommended mitigation of the air quality effects from construction of the road.

1.2 Project description

This Project description provides the context for this assessment. Sections 5 and 6 of the Assessment of Environment Effects (Volume 2) further describe the construction and operational aspects of the Project and should be relied upon as a full description of the Project.

The Project realigns the existing SH1 between the Northern Gateway Toll Road (NGTR) at the Johnstone's Hill tunnels and just north of Warkworth. The alignment will bypass Warkworth on the western side and tie into the existing SH1 north of Warkworth. It will be a total of 18.5km in length. The upgrade will be a new four-lane dual carriageway road, designed and constructed to motorway standards and the NZTA RoNS standards.

1.3 Project features

Subject to further refinements at the detailed design stage, key features of the Project are:

- A four-lane dual carriageway (two lanes in each direction with a median and barrier dividing oncoming lanes);
- A connection with the existing NGTR at the Project's southern extent;
- A half diamond interchange providing a northbound off-ramp at Pūhoi Road and a southbound on-ramp from existing SH1 just south of Pūhoi;
- A western bypass of Warkworth;
- A roundabout at the Project's northern extent, just south of Kaipara Flats Road to tie-in to the existing SH1 north of Warkworth and provide connections north to Wellsford and Whangarei;
- Construction of seven large viaducts, five bridges (largely underpasses or overpasses and one flood bridge), and 40 culverts in two drainage catchments: the Pūhoi River catchment and the Mahurangi River catchment;
- A predicted volume of earthworks being approximately 8M m^3 cut and 6.2M m^3 fill within a proposed designation area of approximately 189ha earthworks;

The existing single northbound lane from Waiwera Viaduct and through the tunnel at Johnstone's Hill will be remarked to be two lanes. This design fully realises the design potential of the Johnstone's Hill tunnels.

The current southbound tie-in from the existing SH1 to the Hibiscus Coast Highway will be remarked to provide two way traffic (northbound and southbound), maintaining an alternative route to the NGTR. The existing northbound tie-in will be closed to public traffic as it will no longer be necessary.

1.4 Interchanges and tie-in points

The Project includes one main interchange and two tie-in points to the existing SH1, namely:

- The Pūhoi Interchange;
- Southern tie-in where the alignment will connect with the existing NGTR; and
- Northern tie-in where the alignment will terminate at a roundabout providing a connection with the existing SH1, just south of Kaipara Flats Road north of Warkworth.

1.5 Route description by Sector

For assessment and communication purposes, the Project has been split into six sectors, as shown in Figure 1: Project sectors. Section 5.3 of the AEE describes these sectors.

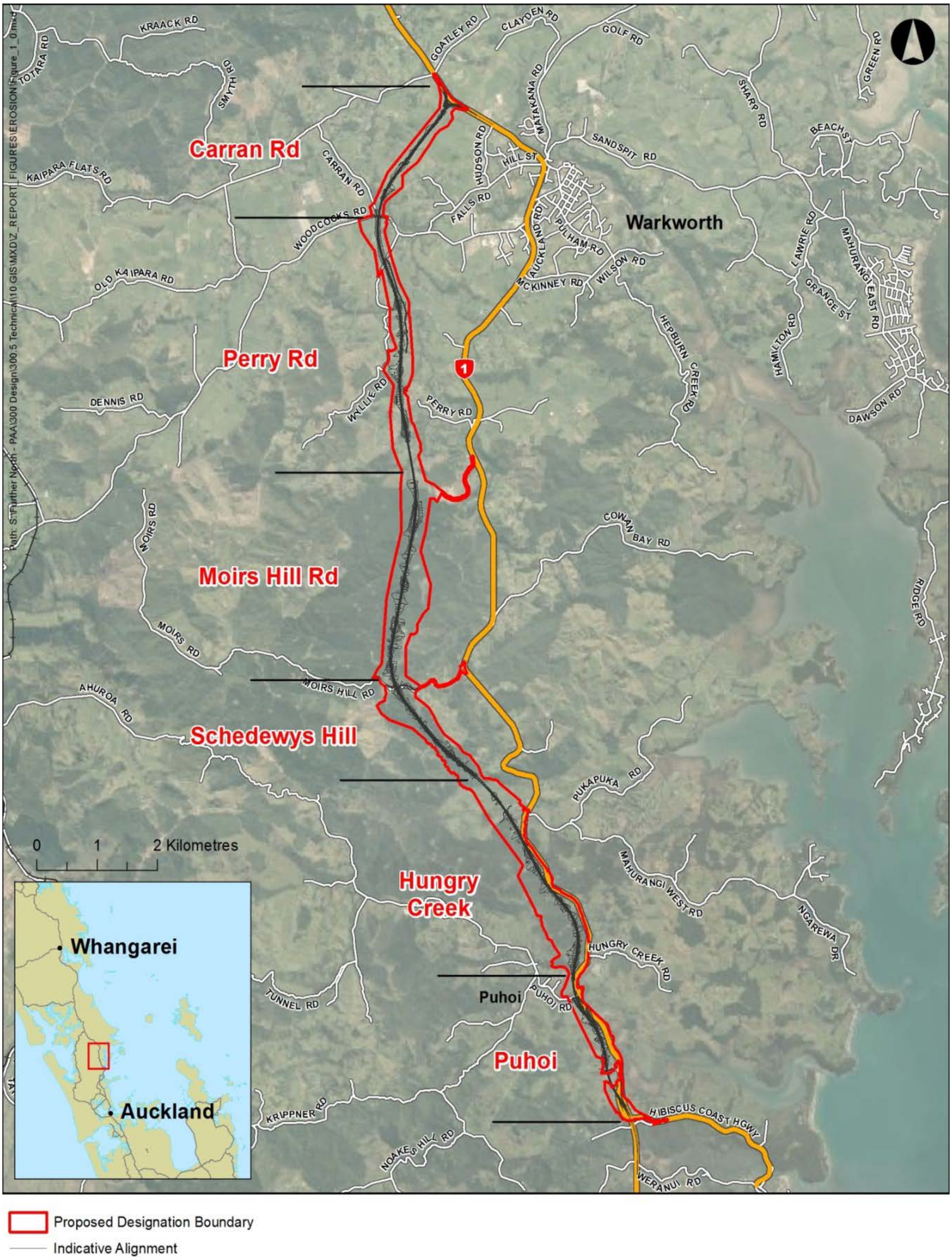

Figure 1: Project sectors

2. Methodology

Our assessment considers both the operational and construction effects of the Project on air quality, but focusses mainly on the construction phase where the potential effects present a higher risk. Our assessment methods are based on national guidance from both the NZTA and the Ministry for the Environment (MfE). For the operational assessment we used the NZTA's Tier 2 Screening Tool, which was specifically developed to predict conservative estimates of the potential effects on air quality for indicator contaminants with distance from the roadway for a given traffic volume and speed.

The outputs of the Transportation and Traffic Assessment were interpolated to obtain average annual daily traffic (AADT) projections for the years relevant to our air quality assessment. The opening and design years considered for our air quality assessment were 2021 and 2031.

We considered highly sensitive air pollution land-uses (HSAPLUs) out to 200m from the alignment and undertook a sensitivity analysis to consider the potential effect of shifting the alignment within the proposed designation boundary.

We also assessed the potential effects of the 'with Project' and 'without Project' scenarios on SH1 and the Project itself on a total mass emission basis. To do this, the Further North transportation and traffic specialists used air emission factors for indicator contaminants from the Vehicle Emissions Prediction Model (VEPM, Version 5.1) and integrated these factors with the SATURN model outputs, to develop estimates of the mass emission of contaminants as a basis for comparing scenarios.

Our assessment of the effects of dust from the construction phase of the Project is qualitative, in accordance with the MfE Dust Guide and the Auckland Regional Plan: Air, Land and Water (ARP:ALW). A qualitative assessment is preferred because predicting a dust emission impact from an earthworks programme using fugitive dust modelling is too uncertain and most often not representative of the true effects, this is due to the assumptions required for unknown parameters.

We assessed air quality construction effects by considering the Project location, the location of the construction areas relative to HSAPLUs along the route, and the nature and extent of the construction activities and construction traffic. HSAPLUs within 200m of the construction area were considered as being potentially affected by construction dust. We undertook a sensitivity analysis to consider the effect of shifting the construction areas within the proposed designation. We then recommended mitigation measures to ensure that potential adverse effects will be avoided, removed, or mitigated.

To assess the operational effects of the Project for this report, we followed the methods set out in the MfE, *Good Practice Guide on Assessing Discharges to Air from Land Transport,* May 2008 (MfE Transport Guide), and the NZTA draft *Guide to assessing air quality effects for State highway asset improvement projects V0.6* (September 2012) (NZTA 2012 Guide). We undertook a Tier 2 screening level quantitative assessment for vehicles operating on the route appropriate to the medium level of risk identified from the Scheme Assessment phase for the Project.

To undertake the assessment of effects from dust during construction, we had regard to the MfE, *Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions,* 2001 (MfE Dust Guide) and relevant provisions in the ARP: ALW. We identified mitigation measures and monitoring via visual observations and complaint response appropriate to ensure that effects from construction dust will be minor or otherwise mitigated as far as practicable.

Our assessment addresses the variables that influence the level of effect on air quality from roads and road construction activities, these being:

- The existing air quality in the Project area;
- The proximity and number of HSAPLUs[1] that could be exposed to air emissions from the operation and construction phases of the Project;
- The total amount of the emissions from the operation of the road determined by the predicted daily traffic flow, speed and percentage of heavy vehicles;
- The scale and extent of the construction works and associated activities; and
- The prevailing meteorology, in particular, wind direction and strength.

2.1 Traffic modelling

The Transportation and Traffic Assessment Report summarises the traffic modelling undertaken for this Project. Traffic modelling used data from the Auckland Regional Transport Model to predict network traffic flows for 2026 for the Project, SH1, and the Project side-roads. The Further North Transportation team interpolated this data to obtain AADT projections for the years relevant to our air quality assessment. The opening and design years considered for our air quality assessment for the operational phase were 2021 and 2031[2]. We used the AADT for the air quality assessment of effects consistent with a Tier 2 screening level approach.

2.2 Operational effects from the indicative alignment

The NZTA 2012 Guide promotes a three-tiered assessment approach to assess air quality effects resulting from the operation of State highway projects[3] as follows:

- Tier 1 – Risk assessment
- Tier 2 – Screening assessment
- Tier 3 – Detailed assessment

The Tier 1 risk assessment dictates the level of detail required in the assessment (i.e. a Tier 2 screening assessment or a Tier 3 detailed assessment) according to the risk. NZTA has developed a document *Checklist and Risk Assessment for Tier 1 Air Quality Social and Environmental Screening (SES)* to assist in carrying out a Tier 1 risk assessment. This checklist considers the existing air quality in the project area, likely exposure to potential discharges from the proposed project, and level of emissions based on predicted AADT. The checklist was completed for the Pūhoi to Wellsford RoNS during the Scheme Assessment phase. The Project was determined to be low risk for existing air quality, medium risk for emissions based on AADT and high risk for exposure to sensitive receptors. The overall risk for the Project was determined to be medium resulting in a Tier 2 assessment approach as in this report.

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[1] Defined as a location where people or surroundings may be particularly sensitive to the effects of air pollution (e.g. residences, hospitals, schools, childcare facilities, retirement homes, etc).

[2] Determined by linearly interpolating between the 2009, 2026 and 2051 modelled traffic volumes. Note that the 2051 modelled traffic volumes are not reported in the Transportation and Traffic Assessment Report.

[3] http://air.nzta.govt.nz/assessment/AQ-Guide.

The NZTA has developed a web-based screening tool to assist with implementing the approaches in the NZTA 2012 Guide. The Tier 2 Screening Tool incorporates the Vehicle Emissions Prediction Model (Version 5.1) (VEPM) and predicts the maximum ground level concentrations (MGLCs) of PM_{10}, $PM_{2.5}$ and nitrogen dioxide (NO_2) at the nearest HSAPLU based on the traffic flow AADT, fleet composition and average speed. If the Screening Tool predicts that the MGLCs exceed the air quality threshold criteria[4] derived by NZTA based on the MfE Transport Guide, then a review is undertaken to determine whether a Tier 3 assessment is needed.

The NZTA Screening Tool has been evaluated against the results from four Tier 3 assessments performed for road developments in New Zealand. The validation study is documented in *NZTA Air Quality Screening Tool User Notes* (2012) and was shown to be generally conservative compared to the full Tier 3 modelling assessment[5].

To assess the operational effects on air quality from the Project, as presented in Section 7 of this report, our approach was to:

- Characterise the environmental setting, in particular identify the HSAPLUs within 200m of the indicative alignment and the proposed designation boundary;
- Review the background air quality for key contaminants from vehicles and assess the likely background for the Project area;
- Review the relevant air quality assessment criteria applicable nationally and regionally to determine the acceptability of air quality effects;
- Use the Tier 2 Screening Tool to predict concentrations of contaminants at the nearest HSAPLUs from the operation of the new road;
- Undertake an analysis using the Tier 2 Screening Tool to consider the potential effects of shifting the indicative alignment within the proposed designation boundary;
- Assess the predicted concentrations of contaminants downwind, including consideration of the likely background air quality, against relevant assessment criteria, in particular, the NZTA – threshold criteria and the Resource Management (National Environmental Standards for Air Quality) Regulations 2004[6] (NESAQ); and
- Review the need for Tier 3 full modelling assessment.

2.3 Road network effects and alternatives

The main network effect for the Project will be to reduce traffic on the existing SH1. The traffic scenarios we considered in this assessment are the 'with Project' and 'without Project' on the existing SH1 and we compared these predictions with the Project. Without the Project, all traffic would continue to travel on SH1, leading to increased congestion along that route, particularly at Warkworth. Consequently, there would be increased emissions and therefore a potential for increased exposure to air contaminants in the township and at HSAPLUs along SH1 over time.

4 Threshold criteria referred to in this report are the "significance criteria" recommended for Tier 2 air quality assessments in both the MfE Transport Guide and the NZTA 2012 Transport Guide. The criteria are intended only as a trigger for assessing the incremental effect of the proposal on air quality and do not determine whether the overall effect on air quality is significant from an RMA perspective.

5 NZTA, *NZTA air quality screening tool user notes*, July 2012.

6 *Resource Management (National Environmental Standards for Air Quality) Regulation 2004*, www.mfe.govt.nz.

The Further North Alliance Transportation and Traffic Team quantified the likely contaminant emissions ‘with Project’ and ‘without Project’ along SH1. The results from those calculations are presented in Section 6.3 of this report and the assessment methodology is detailed in **Appendix A** of this report.

2.4 Construction effects

We assessed construction air quality effects considering the location of the construction areas and associated activities, vehicle movements, indicative construction yards and access roads relative to HSAPLUs for the Project. Those HSAPLUs within 200m of a construction area were considered as being possibly affected by construction activities, particularly dust. We also considered the proposed designation boundary as part of a sensitivity analysis for construction effects. We then recommended mitigation measures to ensure that any identified significant adverse effects will be avoided, remedied or mitigated.

3. Existing environment

The Project area is largely rural in nature with farming and forestry activities predominating. We have assessed the background ambient air quality along the alignment assuming air quality will be better than that measured in the Warkworth and Auckland urban areas i.e. without the peak concentrations observed in urban areas.

The reviewed data indicates background concentrations of air contaminants in the Project area will likely be better than:

Particulate matter smaller than ten microns (PM_{10})	<20 µg/m^3 24 hour average
Particulate matter smaller than 2.5 microns ($PM_{2.5}$)	<10 µg/m^3 24 hour average
Carbon monoxide (CO)	<1 mg/m^3 one hour average
Nitrogen dioxide (NO_2)	<20 µg/m^3 annual average

There is a relatively low density of residential use in the vicinity of the alignment throughout many of the sectors, although there are some dwellings that will be relatively close to construction activities and the alignment once operational.

The Project environment is characterised by:

Hilly terrain requiring a series of cuts and fills for road construction;
All sectors other than Moirs Hill have residences which are within 200m of the proposed designation boundary and therefore considered potentially sensitive to the construction and operational effects of the Projects;
Prevailing winds are from the west to south-west sector, with winds above 5m/s likely around 30% of the time; and strong winds are predominant from that direction; and
Strong winds over 10m/s are likely to be infrequent at around 2% of the time.

3.1 Sensitive land-uses

Other than rural residences, HSAPLUs tend to be located in urban or suburban areas removed from the Project area. The NZTA 2012 Guide defines HSAPLUs as including residential houses, hospitals, early childhood centres and schools. Commercial activities may also be sensitive to the discharge of contaminants to air. In particular, the Genesis Aquaculture fish farm located near the Perry Road Sector of the Project has the potential to be sensitive to the effects from the construction and operation of the road.

Genesis Aquaculture is located within 50m of the Kauri Eco Viaduct, 60m of earthworks, and the closest pond is approximately 15m from the proposed designation boundary. The Freshwater Ecology Assessment Report assesses the potential for the fish farming operation to be affected by air discharges. That report concludes that the fish are not sensitive to suspended solids in the pond that may result from dust deposition during construction. Further, given the low level of predicted impact on ambient air quality relative to ambient air guidelines and standards (and being below threshold criteria), the effects from the road operation will be less than minor. Accordingly, we have not assessed the fish farm as a highly sensitive receptor in this report.

The Terrestrial Ecology Assessment Report raised the potential issue of dust effects, particularly on the native vegetation and some fauna within close proximity to the construction areas. The report considers the effects are generally of a temporary nature and manageable through dust suppression measures to mitigate effects as discussed below.

Table 1 identifies the number of residences within 200m of the proposed designation boundary and the distance of the nearest residence to the indicative alignment for assessing air quality effects of the operational stage of the Project. The table also gives the distance of the nearest residence to the construction areas for assessing the effects of the construction phase of the Project. The information on HSAPLUs was taken from Drawings C-101 to C-117.

The distance of residences to the proposed designation boundary has also been considered for a sensitivity analysis of the operational and construction phases should the indicative alignment be moved in future. In total, there are 76 residences within 200m of the proposed designation boundary, including one yet to be built.

Table 1: Sensitive Receptors near the Project Alignment and construction areas

Sector	Number of residences within 200m of designation boundary	Distance of nearest residence to designation boundary (m)	Distance of nearest residence to current alignment (m)	Distance of nearest residence to earthworks (m)
1 – Pūhoi	24	31	117	50
2 – Hungry Creek	9	50	187	118
3 – Schedewys Hill	8	17	184	142
4 – Moirs Hill Road	0	n/a	n/a	n/a
5 – Perry Road	18	7	140	125
6 – Carran Road	17	31	130	124

Note: The designation boundary for the purposes of this table is that closest to the alignment and excludes access roads not adjacent to the alignment.

We have assumed that all residences within the proposed designation boundary will be empty during the construction phase. These residences have therefore, been excluded as being HSAPLUs for specific consideration in the assessment.

For the operational phase assessment, the nearest residence to the road edge of the indicative alignment is located around 115m from the alignment at 466 SH1, Pūhoi. If the indicative alignment were to shift within the proposed designation boundary then the closest residences are potentially less than 10m from the indicative alignment (numbers 99 and 101 Moirs Hill Road). We also consider the Hungry Creek Arts School to be a HSAPLU, located at 682 SH1 (Drawing C-104). The school is within 100m of the indicative alignment and 90m of the construction area.

Access roads for indicative construction yards are shown in Drawings C-101 to C-117. Table 2 summarises the access roads with residences within 200m of the proposed designation boundary around the access roads.

Table 2: Houses within 200m of the proposed designation boundary at access roads

Yard access road number	Number of residences within 200m of the designation boundary	Distance of nearest residence to access road (m)
1,2 and 3	2 (east of alignment)	80
4	3 (east of alignment)	90
6a and 6b	2 (east of alignment)	120
7 (via Moirs Hill Road)	8 (east of alignment)	17
8 (via Moirs Hill Road)	5 (west of alignment)	120
9 and 10	5	53
11 and 12 (via Wyllie Road)	3 (east of alignment)	120
11 and 12 (Wyllie Road)	1 (east of alignment)	35

Note: The proposed designation boundary, for the purposes of this table, is that closest to the access relevant road.

Overall there are 24 HSAPLUs within 200m of the proposed designation boundary around the access roads, with the nearest being 17m from yard access road 7.

3.2 Topography

The topography in the Project area is predominately hill country, characterised by valleys and irregular ridgelines abutting a heavily indented coast around Mahurangi Harbour, Kawau Bay and Whangaparaoa Bay. Much of the study area has slopes between 20% and 60% and some areas have slopes in excess of 60%. Elevations through the Project area range from near sea level to 360m.

A result of this topography is that the road will run through some cuttings, overpasses and bridges or viaducts that will affect the dispersion of emissions from vehicles operating on the road.

3.3 Meteorology

Wind speed and direction and rainfall are key determinants for the potential for impacts to occur from emissions during road construction and operation. For construction effects, winds above 5m/s will start to give rise to airborne dust from exposed surfaces, particularly after extended periods without rainfall. High wind speeds above 10m/s have the most potential for excessive dust if winds are blowing towards the direction of sensitive receptors.

The conditions most likely to produce the worst case effect in terms of dispersion of contaminants discharged from the road are light winds, particularly under stable atmospheric conditions (categories E and F)[7]. For receptors within close proximity to a ground level line source, like a road, the stability of the atmosphere is almost irrelevant and the rate of dispersion is dominated by the strength of the winds. Light winds will have the effect of limiting dispersion of traffic discharges, resulting in higher concentrations of contaminants near the road. Strong winds result in greater dispersion of traffic emissions and lower concentrations. The nearest full time meteorological station to the Project is located approximately 2km to the east of the Project and 3km south of Warkworth. The data recorded at this meteorological station is indicative of the wind speeds and directions of the general area, although they do not take into account the influences of terrain along the Project route, which may result in variations in wind speed and direction locally.

Figure 2 provides a windrose for the meteorological station for data measured during the period January 2005 to December 2008, which was obtained from the National Climate Database operated by NIWA. Given that the main earthworks season is generally from November to April, Figure 2 also presents a windrose for the earthworks season for comparison with the full year.

On an annual basis, light winds blow relatively frequently from the west and south-west, but there is also a smaller component from the east. Winds below 2m/s in strength occur approximately 4% of the time from the west and 7% of the time from the west-southwest and approximately 1% of the time from the east. Strong winds greater than 5m/s occur approximately 30% of the time, predominantly from a westerly direction but also occur from the east. Very strong winds above 10m/s occur approximately 2% of the time from the west and west-southwest. The comparison of the two windroses indicates that the winds for the main earthworks season are similar to those for the whole year, with strong winds occurring predominantly from a westerly direction. There is no significant difference in the wind speed frequency distribution between the winds observed on an annual basis and those in the main earthworks season of November to April.

[7] Atmospheric stability is frequently characterised by one of six Pasquill Stability Classes, named A, B, C, D, E, and F with class A being the most unstable and class F being the most stable classification. More stable conditions result in less mixing of contaminants, and therefore higher concentrations near the source of emission.

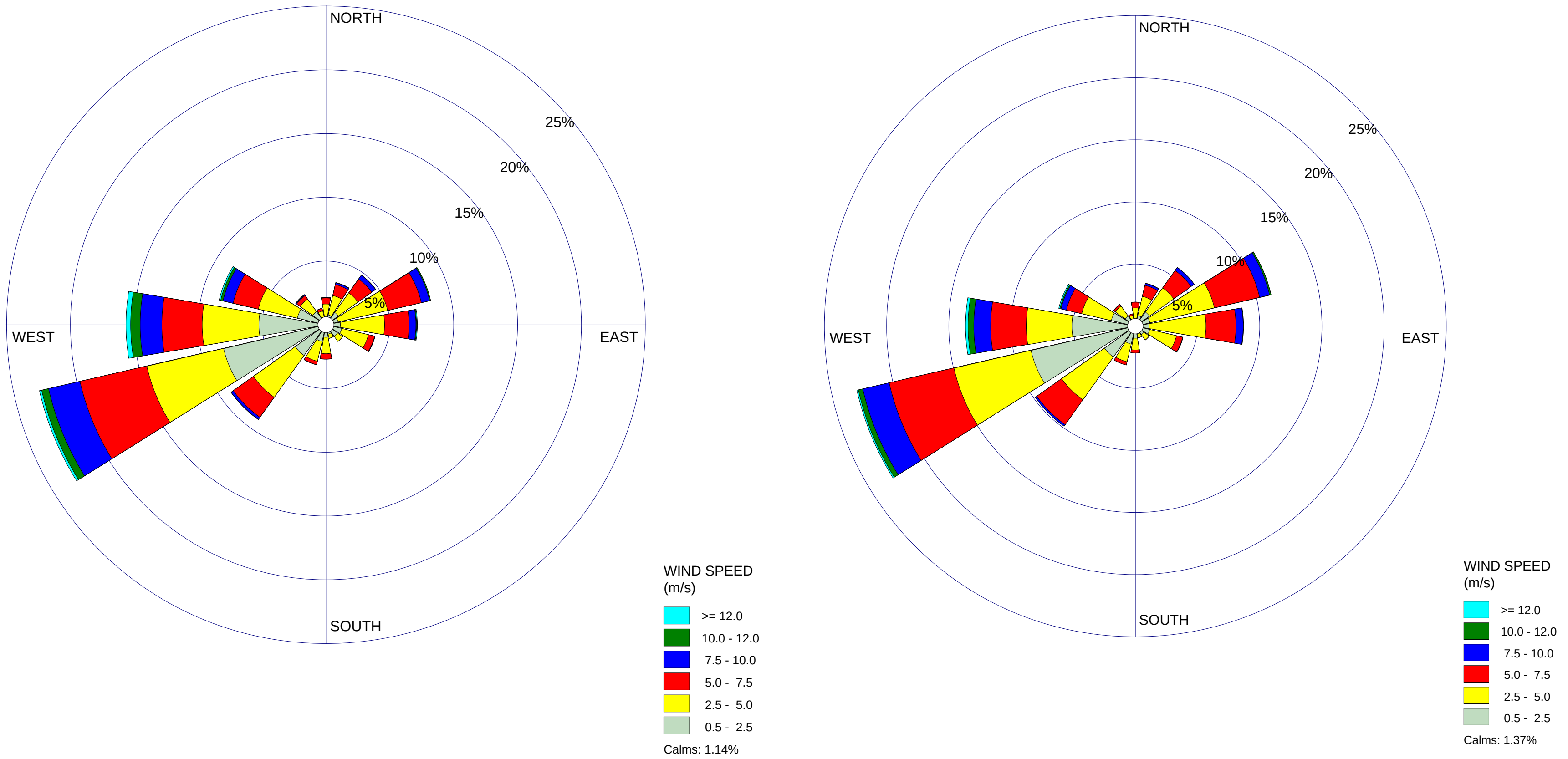

Figure 2: Windrose comparison for annual (left) and November to April (right) winds as measured at Warkworth, 2005-2008

3.4 Existing ambient air quality

Background concentrations of contaminants will vary depending on land-use activities and seasonal variations. The area surrounding the Project is a combination of rural activities (mainly farming) with rural-residential developments. Consequently, background ambient air contaminant concentrations for the Project area will be low, which is typical of rural areas.

Contaminants emitted into air by vehicle traffic and road construction may also be emitted from industrial activities and from domestic activities. The only activity with a current air discharge permit from Auckland Council within a distance of 1km of the Project is Atlas Concrete. Atlas Concrete is located in Warkworth just less than 1km to the east of the indicative alignment. The main contaminant of interest for air quality from Atlas is particulate matter from concrete batching. Cumulative effects from Atlas will be negligible at this distance from the indicative alignment and construction areas.

3.4.1 Auckland Council data

Ambient air monitoring sites operated by local authorities are typically located in urban or residential areas where people may be exposed to air pollution and/or where air quality is likely to be worst. The Auckland Council (formerly Auckland Regional Council (ARC)) measures ambient air quality at a network of monitoring sites in the Auckland Region. Most of the sites are in urban residential areas and are likely to experience higher concentrations of contaminants than what is experienced in the Project area.

The nearest ambient air monitoring site to the Project was a temporary site located in Warkworth from 12/04/07 to 21/11/08. The Warkworth site[8] was located at a busy intersection in the vicinity of Hill Street and Sandspit Road where they intersect with SH1. The monitoring site measured particulate matter smaller than ten microns in diameter (PM_{10}), particulate matter smaller than 2.5 microns in diameter ($PM_{2.5}$), and NO_2.

In the Auckland Region, ambient monitoring data for carbon monoxide (CO) is available from suburban monitoring sites within Auckland City (at Takapuna and Henderson) for the same period as the Warkworth data. Using the Warkworth and Auckland data to represent background concentrations along the Project is conservative given the generally rural nature of the Project area.

Auckland Council has two rural ambient air monitoring stations, one located at Whangaparaoa and the other at Patumahoe. Ambient monitoring data from these rural stations for 2010 indicate that PM_{10} concentrations were generally less than 30μg/m^3 as a 24 hour average, and $PM_{2.5}$ concentrations are less than 11μg/m^3 as a 24 hour average. Typical 24 hour concentrations at the rural sites were 11μg/m^3 for PM_{10} and 4μg/m^3 for $PM_{2.5}$.

Table 3 summarises the available Auckland Council data reviewed for the Project.

Table 3: Auckland Council Ambient Air Quality indicative for the Project area

Location	PM_{10} µg/m³		$PM_{2.5}$ µg/m³		NO_2 µg/m³	CO mg/m³
	Maximum measured 24 hour average	Annual average	Maximum measured 24 hour average	Annual average	Annual average	Maximum measured one hour average
Assessment Criteria (Source)	50 (NESAQ[1])	20 (NZAAQG[2])	25 (ARAQT[3])	-	40 (WHO[4])	30 (NZAAQG[3])
Warkworth (2007/08)	39	17	18	9	19	-
Whangaparaoa (2010)	29	11	11	4	-	-
Patumahoe (2010)	31	11	9	4	-	-
Takapuna (2007/08)	-	-	-	-	24	7.4
Henderson (2007/08)	-	-	-	-	15	4.9

[1] National Environmental Standards for air quality (2004)
[2] New Zealand Ambient Air Quality Guidelines (2002)
[3] Auckland Regional Air Quality Targets, ARP:ALW
[4] World Health Organisation, Air Quality Guidelines (2000)

There were no exceedances of the relevant air quality standards or guidelines, which are set out in Section 4 of this report, at any of the sites considered in the review of Auckland Council data. This lack of exceedances is even though the Warkworth monitoring site was located near a busy intersection on SH1 at Sandspit Road. Concentrations of PM_{10} at Warkworth were less than 33µg/m³ as a 24 hour average 97% of the time; this is compared to the NESAQ of 50µg/m³ as a 24 hour average. Given the low intensity of dwellings and the absence of other sources of PM_{10} in the Project area, background concentrations will be generally lower than measured at Warkworth, and typically less than 20µg/m³ as a 24 hour average as also indicated by the Auckland Council rural monitoring stations discussed above.

CO concentrations measured at Henderson and Takapuna nearly all fall below 3 mg/m³ as a 1-hour average (i.e. less than 10% of the New Zealand Ambient Air Quality Guidelines[9] (NZAAQG)). We expect that CO measured at Takapuna and Henderson would over-represent the likely CO levels throughout the generally rural environs of the Project.

[9] MfE, *Ambient Air Quality Guidelines*, May 2002.

NO_2 concentrations at Warkworth were below 20μg/m^3 as an annual average (i.e. one-third of the NESAQ).

3.4.2 NZTA Data

(i) NO_2

The NZTA has a national network of NO_2 passive monitors to provide annual average NO_2 measurements. Table 4 presents the annual average NO_2 measured in the towns of Wellsford and Warkworth.

Table 4: Passive sampling results for annual average NO_2 (NZTA, 2007 – 2009)[10]

Site reference	Area	Annual average NO_2 μg/m^3		
		2007	2008	2009
AUC002	Wellsford	11	14	12
AUC003	Warkworth	16	18	20

The passive sampling results indicate that air quality in Wellsford is better than at Warkworth, which is likely due to the higher traffic volumes and greater congestion experienced in Warkworth.[11] Annual average concentrations of NO_2 along the indicative alignment would be expected to be better than those measured in both Warkworth and Wellsford, and based on the monitoring data review, we consider they would be below 20μg/m^3 as an annual average. The NZAAQG for annual average NO_2 is 30μg/m^3, which is set for ecosystem protection. The World Health Organisation (WHO) has also published an annual average criterion for NO_2 of 40μg/m^3, which is generally used in New Zealand for assessing human health effects for longer term exposure to NO_2.

NZTA has also undertaken passive NO_2 sampling over a three month period in conjunction with the operation of the Johnstone's Hill tunnels, which directly links to the Project. Table 5 summarises the Johnstone's Hill data at the southern end of the northbound tunnel. The AADT for the Johnstone's Hill tunnels during monitoring was 14,000vpd and the proportion of heavy commercial vehicles (HCVs) was 9.5%[12].

[10] Data supplied from Watercare Laboratory Services.

[11] The 2008 AADT in Wellsford, south of Centennial Park Road is 9,500vpd compared with the AADT in Warkworth, south of Hill Street is 20,500vpd as per the AADT book from the Traffic Management System (TMS) database.

[12] NZTA, Johnstone's Hill tunnel air quality monitoring March to July 2010, Summary Reports.

Table 5: Monthly passive sampling results and seasonally adjusted annual averages* for NO_2 at Northbound Johnstone's Hill tunnel[13]

Site reference	Distance from southern side of tunnel portal	3-month average NO_2 µg/m^3	Seasonally adjusted annual average NO_2 µg/m^3
AUC153	200m	11	8
AUC154	150m	11	9
AUC155	100m	12	9
AUC156	50m	19	14

* Calculated using NIWA monthly adjustment factors to estimate annual mean concentrations of NO_2 from less than a year of monthly passive monitoring data[14].

The Johnstone's Hill monitoring was undertaken upwind and downwind of the northbound tunnel, which is longitudinally ventilated in accordance with the direction of the northbound traffic. The NGTR experiences very similar traffic volumes to those expected for the Project. Therefore, the data upwind of the tunnel is representative of the likely levels for the Project once the road is operational, but with somewhat increased levels due to projected increased traffic overtime.

The data from the NGTR adjacent to the southern end of the tunnel indicates an annual average ambient air concentration of less than 9µg/m^3, even with the operation of the road. This assessment excludes data from monitoring site location AUC156 because it is likely to be impacted by emissions from the tunnel portal under northerly wind conditions.

(ii) PM_{10}

The NZTA commissioned a report recommending default values for background air quality, based on data collected at ambient air monitoring sites throughout New Zealand (Emission Impossible, 2013).[15] For 24 hour average concentrations of particulate matter, the recommended background level is based on the second highest 24 hour average over one year's monitoring data, which correlates approximately to the 99th percentile.

The background values of PM_{10} for Warkworth recommended by Emission Impossible are 38µg/m^3 as a 24 hour average and 16µg/m^3 as an annual average. We have used the more typical or average values as being indicative of background for the Project area rather than the second highest value from the Warkworth data to reflect the rural nature of the environment, although even if the maximum values recommended by Emission Impossible were used, it does not alter the conclusions for this assessment.

[13] Watercare Laboratory Services, NZ Transport Agency Johnstone's Hill Tunnels.

[14] Emission Impossible, *Background Air Quality for NZ Transport Agency State Highway Assessments,* April 2013.

4. Assessment framework

This section of the report presents the air quality assessment criteria we used to evaluate the effects of the Project on air quality.

For operational effects, we considered assessment criteria from a range of sources, including both ambient air quality standards and guidelines set nationally for managing air quality for human health and environmental protection; and criteria taken from NZTA guidance to evaluate the level of risk from the predicted increment in contaminant levels for land transport projects.

The criteria we have used to evaluate operational phase effects relevant to a Tier 2 screening level assessment are:

- NO_2 guideline of 40µg/m^3 annual average (WHO), significance criteria 2µg/m^3 annual average
- PM_{10} standard of 50µg/m^3 24 hour average (NESAQ), significance criteria 2.5µg/m^3 24 hour average
- $PM_{2.5}$ guideline of 25µg/m^3 24 hour average (ARAQT), significance criteria 1.25µg/m^3 24 hour average

For construction effects relating to dust, the criterion for assessment is of the form "no objectionable or offensive effects from dust deposition." The assessment criterion is necessarily subjective, but are in line with the MfE Dust Guide and relevant provisions of the ARP:ALW.

4.1 Introduction

The legal and planning framework for the air quality assessment is outlined in the AEE, including the Resource Management Act 1991 (RMA), the Land Transport Management Act 2003, and the ARP:ALW. This section of our report outlines the statutory and non-statutory criteria specific to the assessment of effects of discharges to air, i.e. covers air quality standards, guidelines and other criteria used to assess the Project's effects on air quality.

4.2 National Environmental Standards for air quality

The NESAQ are designed to protect public health and the environment by setting concentration limits of contaminants in air for specified averaging periods and regulating or prohibiting certain activities. Other than the ambient air quality standards themselves, there are no provisions of the NESAQ relevant to emissions from the transport sector. The Foreword to the MfE Transport Guide (2008) states that "territorial authorities and/or requiring authorities must now consider the national environmental standards for air quality when granting new designations and land-use consents".[16] Table 6 presents the ambient air standards in the NESAQ relevant to the Project.

[16] MfE Transport Guide, page iii.

Table 6: New Zealand national environmental standards for ambient air quality[3]

Contaminant	Standard	Averaging time	Permissible excess
Particulate matter (PM_{10})	50µg/m^3	24 hour	One in a 12-month period
Carbon monoxide (CO)	10mg/m^3	8 hour	One in a 12-month period
Nitrogen dioxide (NO_2)	200µg/m^3	1 hour	Nine in a 12-month period

The Project corridor does not pass through airsheds designated under the NESAQ within the Auckland Region. In particular, the Project area is outside the Warkworth airshed. In any case, as shown by the data presented in Section 3, the Warkworth airshed and by implication the project area complies with the relevant ambient air quality standards under the NESAQ.

4.3 Ambient Air Guidelines

The NZAAQG were published in 2002. The primary purpose of the guidelines is "to promote sustainable management of the air resource in New Zealand".[17] We have used the published Guideline values as the minimum requirements that outdoor air quality should meet in order to protect human health and the environment. The Guidelines include values for contaminants that are commonly discharged from vehicle traffic. Table 7 presents the Guideline values relevant to the Project.

Table 7: New Zealand ambient air quality guideline values

Contaminant	Guideline value	Averaging time
Particulate matter (PM_{10})	50µg/m^3	24 hour
	20µg/m^3	Annual
Carbon monoxide (CO)	30mg/m^3	1 hour
	10mg/m^3	8 hour
Nitrogen dioxide (NO_2)	200µg/m^3	1 hour
	100µg/m^3	24 hour
	30µg/m^3	Annual (ecosystems)

[17] Page 1

The WHO criteria for NO_2 is 40µg/m^3 as an annual average. This criteria is generally used in New Zealand for assessing human health effects for longer term exposures in the absence of an equivalent New Zealand guideline or standard.

4.4 Auckland Regional Plan

4.4.1 Air quality targets

Part 2 of the ARP:ALW (Operative in Part October 2012) addresses the air environment. The ARP:ALW provides Auckland Regional Air Quality Targets (ARAQTs), which cover ambient pollutants or averaging periods not included in the NESAQ. In particular, the targets provide a 24 hour average criteria for $PM_{2.5}$ and an annual average criteria for PM_{10}. The ARAQTs aim to:[18]

- Maintain air quality in areas where it is already good; and
- Enhance air quality in areas where it is degraded or unacceptable.

Table 8 sets out the ARAQTs relevant to the Project.

Table 8: Auckland regional air quality targets

Contaminant	Target (µg/m^3)	Averaging time
Particulate matter ($PM_{2.5}$)	25µg/m^3	24 hour
Particulate matter (PM_{10})	20µg/m^3	Annual
Carbon monoxide (CO)	30mg/m^3	1 hour
Nitrogen dioxide (NO_2)	100µg/m^3	24 hour

4.4.2 Dust provisions

The ARP:ALW provides policies and rules regarding dust effects, which are set out below:

Policy 4.4.5 specifies criteria for assessing dust:

> *"The discharge of contaminants into air shall be considered inappropriate where:*
>
> *(a) It causes, or is likely to cause, noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash, beyond the boundary of the premises on which the discharge is occurring."*

Policy 4.4.5 seeks to permit most activities on the proviso that they meet the conditions of Rule 4.5.1, which is outlined below.

Policy 4.4.6 addresses how to assess objectionable or offensive adverse effects from dust:

[18] ARP:ALW, Page 79.

"In assessing noxious, dangerous, offensive or objectionable adverse effects from odour, dust, particulate, smoke or ash and visible discharges, consideration will be given to the Frequency, Intensity, Duration, Offensiveness and Location (FIDOL) of the discharge.

Explanation: FIDOL factors will be considered in combination, as no single FIDOL factor determines how noxious, dangerous, offensive or objectionable odour or dust is. 'Location' includes the receiving environment – part of this assessment includes the relevant provisions of the underlying District Plan zones. For example a low frequency, high intensity odour or dust event may be objectionable, as may be a high frequency, low intensity odour or dust event. If the odour or dust is assessed as being offensive or objectionable, the discharger may be asked to take whatever action is necessary to avoid, remedy or mitigate the effects of the discharge and/or provide further information. Where circumstances warrant, enforcement action may be taken in the form of an abatement notice, infringement notice, enforcement order."

Rule 4.5.1 is a General Permitted Activity which states:

"Unless provided for otherwise in this plan, activities that discharge contaminants into air are Permitted Activities, subject to the following conditions:

(a) That beyond the boundary of the premises where the activity is being undertaken there shall be no noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash.

(b) That there shall be no noxious, dangerous, offensive or objectionable visible emissions; and

(c) That beyond the boundary of the premises where the activity is being undertaken there shall be no discharge into air of hazardous air pollutants that does, or is likely to, cause adverse effects on human health, ecosystems or property;"

The explanation to Rule 4.5.1 goes on to define noxious, dangerous, offensive and objectionable effects and how these are assessed.

Rule 4.5.48 is a permitted activity for dust from unsealed public roads which states:

"The discharge of contaminants, namely dust, into air from unsealed public roads is a Permitted Activity, subject to conditions (a) and (c) of Rule 4.5.1.

Explanation: To minimise the discharge of dust into air associated with motor vehicle movements on unsealed public roads, standard dust suppression measures such as the application of water and appropriate grading should be used by the relevant road controlling authority."

Rule 4.5.49 is a permitted activity for earthworks and construction associated with road works:

"The discharge of contaminants into air from earthworks or from the construction, maintenance or repair of roads (road works) is a Permitted Activity, subject to conditions (a) to (c) of Rule 4.5.1."

Rule 4.5.50 is a permitted activity for temporary crushing less than 60 tonnes per hour (tph):

"The discharge of contaminants into air from the temporary crushing of concrete, masonry products, minerals, ores and/or aggregates with a mobile crusher at a rate not exceeding a total on-site capacity of 60tph is a Permitted Activity subject to the following conditions:

(a) Conditions (a) to (c) of Rule 4.5.1; and

(b) The crusher plant shall be fitted with an effective watering system so that dust emissions are minimised; and

(c) Temporary crushing plants located on development sites shall only crush material originating from and to be utilised at the development site.

Explanation: To minimise the discharge of dust into air from dust generating activities, including earthworks or road works, in Rules 4.5.44 – 4.5.48, 4.5.49, 4.5.50 and 4.5.51 adequate dust suppression measures should be in place such as the following:

- *A Dust Management Plan detailing methods for minimising and monitoring dust emissions;*
- *Retain shelter belts;*
- *Erect temporary windbreaks;*
- *Keep piles, including stockpiles, adequately watered, covered or protected, to prevent windblown dust;*
- *Enclose any conveying equipment or have adequate dust minimisation;*
- *Cease dust generating operations, e.g. vehicle movements, in windy or dry conditions;*
- *Water exposed surfaces, including by water carts or sprinkler systems, in windy or dry conditions; and*
- *Undertake early revegetation/surfacing of exposed soils."*

A resource consent for discharges to air for a rock crusher is being sought for the Project because the proposed capacity for rock crushing will exceed the permitted activity threshold of less than 60tph. The potential effects of rock crushing are addressed in Section 7 of this report.

4.5 Threshold criteria

The NZTA 2012 Guide recommends the use of threshold criteria for PM_{10}, $PM_{2.5}$ and NO_2, which are used for Tier 2 screening level assessments to inform whether a Tier 3 (more detailed) assessment should be undertaken. The threshold criteria for undertaking a Tier 3 assessment is based on 5% of the: 24 hour average PM_{10} NESAQ; $PM_{2.5}$ NZAAQG and the WHO annual average NO_2 guideline. Using 5% of the air quality guideline for the threshold criteria is consistent with the approach in the MfE Transport Guide. If these criteria are predicted to be exceeded at the nearest receptor to the road then the NZTA Guide recommends a review to determine if a Tier 3 assessment should be undertaken.

A breach of the threshold criteria does not directly signify a certain level of effect. The criteria are simply risk assessment tools to assist in identifying higher risk sites that may require additional assessment.

Table 9 summarises the criteria that relate to the incremental effect on ambient air quality. We have used these criteria to assess the predictions from the Tier 2 Screening Tool in Section 6 of this report.

Table 9: NZTA threshold criteria for Tier 2 assessment

Contaminant	**Standard/Guideline ($\mu g/m^3$)**	**Averaging time**	Criteria
NO_2	40	Annual	$2\mu g/m^3$
PM_{10}	50	24 hour	$2.5\mu g/m^3$
$PM_{2.5}$	25	24 hour	$1.25\mu g/m^3$

4.6 Dust guidance

The construction of the Project will have different air quality effects from the road when it is operational. Dust is the primary contaminant of concern from the road construction phase. Depending on the method of measurement, dust can be classified as deposited particulate (DP) or total suspended particulate (TSP). The MfE has recommended trigger levels for assessing the potential effects of dust in the MfE Dust Guide. Table 10 provides the recommended trigger levels for dust above which remedial action or additional mitigation may be required.

Table 10: MfE recommended trigger levels for dust

Dust type	**Location type**	**Trigger level**
Deposited particulate (DP)	All areas	4 g/m^2/30 days (above background concentration)
Total suspended particulate (TSP)	Sensitive area	$80\mu g/m^3$ (24 hour average)
	Moderate sensitivity	$100\mu g/m^3$ (24 hour average)
	Insensitive area	$120\mu g/m^3$ (24 hour average)

Our assessment of effects of construction dust for this Project focuses on dust nuisance effects. These are effects on amenity values, such as soiling of clean surfaces and visual impacts. The MfE Dust Guide identifies that nuisance effects can be subjective and are difficult to measure in any quantitative way. The MfE Dust Guide states that dust nuisance effects have been linked to community perception, which is affected by background dust levels and the comparative rate of change. The MfE Dust Guide thereby recommends dust nuisance be dealt with using management programmes tailored to the local conditions and local community concerns. We recommend construction air quality management measures be developed through a management plan to manage, mitigate and / or avoid air quality effects of construction.

We note that dust effects on fauna and flora are considered in the Terrestrial Ecology Report, and having read that report, it is apparent that some species and/or locations may be particularly sensitive to dust (see Section 7.4 below). Mitigation measures for construction dust are considered in Section 8.2 of this report.

The NZTA 2012 Guide recommends that, for low risk projects, generic dust management requirements be applied based on the MfE Dust Guide and that for high risk projects conditions should be structured around a management plan. The level of risk from dust effects associated with the project relates to the number of HSAPLUs within 200m of the project as follows:

- Less than 10 – low risk;
- 10 to 50 – medium risk; and
- Greater than 50 – high risk.

There are in excess of 50 HSAPLUs so the Project is classified as high risk for construction air quality impacts. We note, however, that the HSAPLUs are spread throughout the entire length of the Project and we therefore consider much of the Project length to be low risk.

4.7 Criteria applied to the assessment

Our assessment in Section 6 of this report provides a Tier 2 screening level assessment for the operational phase of the Project. The criteria set out in Table 9 above were applied to the Tier 2 assessment to identify the need for a more detailed Tier 3 assessment. Because a more detailed Tier 3 assessment was not needed, we made an overall assessment of the effect on air quality with reference to the relevant standards and guidelines in Table 6 and Table 7. Other contaminants, in particular CO, and other averaging periods were not specifically assessed due to the low risk to air quality associated with the operation of the Project.

For construction effects we undertook a qualitative assessment of the potential adverse effects of the Project from dust by considering the FIDOL factors as per the ARP:ALW. The construction effects assessment is addressed in Section 7 of this report.

5. Traffic data and emission estimation

The traffic data that we used for our air quality assessment of the operational effects of vehicles travelling on the alignment was:

- A projected AADT for 2031 of 21,500 south of the Pūhoi ramps and 15,140 north of the Pūhoi ramps;
- A projected percentage of heavy commercial vehicles (HCVs) of 13% of the vehicle fleet; and
- A speed limit for the Project alignment of 100kph assessed as an hourly average speed of 80kph to account for periods of heavy traffic and heavy vehicle speed limits.

5.1 Factors affecting vehicle emissions

The emissions to air from the operation of roadways are dependent on the number of vehicles travelling, the characteristics of the vehicle fleet, driving patterns, and the characteristics of the road, particularly average speed, gradient and the presence of intersections.

Air emissions from vehicles arise from:

- the by-products of fuel combustion (emitted via the exhaust system);
- the evaporation of fuel itself; and
- particulate matter from brakes and tyre wear and re-suspension from the road surface.

Principal factors affecting emissions from vehicles are:

- Vehicle type (light or heavy);
- Fuel type and composition of the fuel used by a vehicle (diesel or petrol);
- Type and condition of a vehicle's emission control equipment; and
- Age, state and maintenance of the vehicle.

Congestion is a significant factor influencing vehicle emissions, with emissions typically a factor of five to ten times higher in congested traffic when compared to a free flowing highway without interruptions. Average trip length also influences emission rates, as emissions are greatest when the vehicles are started up (cold start emissions), and decrease after the engine warms.

5.2 Forecast traffic parameters

Table 11 sets out the forecast AADT for the opening and design years for the Project and for SH1 "with Project' and 'without Project'.

Table 11: Forecast AADT 2021 and 2031.

Description	AADT (2021)	AADT (2031)
Project south of Pūhoi access ramps	16,800	21,500
Project north of Pūhoi access ramps	11,530	15,140
SH1 north of Pūhoi (with Project)	12,700	15,800
SH1 north of Pūhoi (without Project)	22,100	26,600
SH1 south of Hill Street, Warkworth (with Project)	16,900	18,500
SH1 south of Hill Street, Warkworth (without Project)	22,400	22,300

For our assessment using the Tier 2 Screening Tool we used an HCV% of 13% representative of the projection for the Project. Fleet data used in the network effects analysis, in Section 6.3 of this report, was consistent with the above 13% value for the Project with 0% HCVs on SH1 and 7% on SH1 without the Project.

5.3 Vehicle emission rates

For the Project, the predominant operation mode will be free flow travel, generally involving warm running at constant speeds of 80kph or more along most of the road. The posted speed limit for the new motorway will be 100kph. For the Tier 2 Screening Tool a speed of 80kph was used to account for periods of slower traffic due to congestion. This approach is generally more conservative for the particulate matter assessment because these emissions increase with decreasing average speed.

The Tier 2 Screening Tool incorporates emission rates for PM_{10} and $PM_{2.5}$ based on VEPM Version 5.1 and include particulate matter from combustion and tyre and break wear. The equations in the Screening Tool for NO_2 are based on empirical data for Auckland from work undertaken by NIWA[19]. When using VEPM, particulate matter emission factors are predicted to decrease with time due to the introduction of national controls and changes in vehicle technology, but NO_2 emission factors are not projected to change with time.

The methodology used to develop the emission estimates used for the comparative assessment of SH1 and the Project are presented in Appendix A.

[19] The NZTA air quality screening tool user guide Version 0.1, October 2012.

6. Assessment of operational air quality effects

For this Project, the Tier 2 Screening Tool predicted that the NZTA criteria for air contaminant levels would be marginally exceeded for NO_2 at one residence.

The Tier 2 Screening Tool model predictions for the majority of the alignment, other than at one residence and the Hungry Creek Arts School, were less than half the NZTA criteria for contaminant levels. Considering the predicted concentrations from the Tier 2 assessment with the background air quality, we have assessed the operational effects of the road as less than minor. Accordingly, as per the MfE and the NZTA transport assessment guides, we did not undertake a Tier 3 level assessment for the Project.

There is a benefit to air quality from the operation of the Project because total emissions in the vicinity of the existing SH1 will be reduced. This reduction will result in an overall reduction in the exposure of the population to increases in contaminant levels because the existing SH1 route is more populated, particularly through Warkworth.

6.1 Potential effects of road operation

The MfE Transport Guide identifies the indicator contaminants for transport effects and the pollutants of most concern are CO, PM_{10} and oxides of nitrogen (NO_X). The MfE Transport Guide states that if the assessment of these indicator contaminants is within relevant assessment criteria, then there is reasonable confidence that levels of other traffic related pollutants will also be acceptable.

The NZTA Guide (2012) and the Tier 2 Screening Tool also include criteria for assessing $PM_{2.5}$, but exclude CO. CO has been consistently shown to comply with the NZAAQGs except in the vicinity of roadways with high AADT and significant congestion, such as Khyber Pass[20]. The Project is not expected to have high AADT or significant congestion. The potential environmental effects of each of the Tier 2 screening contaminants are discussed below.

6.1.1 Oxides of nitrogen

NO_X are principally formed by the oxidation of nitrogen contained in air at high combustion temperatures. Vehicle traffic is a major source of anthropogenic NO_X emissions. Most NO_X is emitted as nitric oxide (NO), approximately 95% at the point of discharge. NO is generally considered not harmful to human health. The remaining 5% of NO_X is nitrogen dioxide (NO_2), which is reported to have an effect on human respiratory function. NO will convert to NO_2 as it is transported downwind depending on the presence of atmospheric oxidants, primarily ozone, which will increase the rate of conversion of NO to NO_2.

NO_2 causes inflammation of the airways, particularly in young children, asthmatics and those with respiratory disease. It can cause both short-term and long-term effects[21]. While there is some uncertainty over the thresholds at which these human health effects can occur, we consider the guidelines set out in Section 5 to be conservative.

[20] MfE, *Air Quality (Four Pollutants) Environmental Report Card*, May 2010.

[21] USEPA, *Integrated Science Assessment for Oxides of Nitrogen*, July 2008.

6.1.2 Particulate matter

Particulate matter is composed of a mixture of various sizes of solid and liquid particles suspended in air and may have an adverse effect on health and amenity. Large particulate matter (eg dust) generally causes loss of amenity or nuisance caused by soiling of surfaces due to deposition. Particulate matter less than 10 microns (PM_{10}) poses adverse health effects as it can enter the human respiratory tract.

The health effects of fine particulate (PM_{10}) have been well studied in New Zealand and overseas. The principal motivation for this work in New Zealand has been the relatively high levels measured in areas like Christchurch as a result of solid fuel combustion.

PM_{10} is inhalable, penetrating into and depositing in the respiratory tract, and if in high concentration for sufficient time will increase lung irritation and decrease lung function. Epidemiological studies have shown increased levels of PM_{10} are associated with an increase in a range of health effects including respiratory disease, cardiopulmonary disease and the exacerbation of asthma[22].

Increases in PM_{10} have also been associated with increases in daily mortality rates. Most of these effects are associated with short-term exposure. The evidence of long-term health effects associated with fine particulate is not clear. Biological accumulation is not a concern unless the particulate contains significant concentrations of contaminants like heavy metals.

$PM_{2.5}$ is assumed to have the same effects as PM_{10}, but because the particles can be inhaled more deeply into the lungs, the effects are likely to be greater. It has been shown that most of the particulate matter in vehicle exhaust is less than one micron in diameter and is therefore in the $PM_{2.5}$ range. The percentage of $PM_{2.5}$ as a proportion of particulate matter from vehicle tyre and brake wear is, however, highly variable, and is dependent on vehicle type.

Abrasion plays a part in three distinct sources of non-tailpipe discharges from vehicles (tyre wear, brake wear and re-suspension of material from roads). Abrasion processes produce particulate matter across a wide range of particles size, with approximately 40% of tyre wear being greater than PM_{10}. Brake wear is predominantly (>90%) PM_{10}.[23]

6.2 Operational effects for indicative alignment

6.2.1 Nearest residence to the indicative alignment

We used the Tier 2 NZTA Screening Tool to assess the effects of the Project on the nearest residential receptor, which is at 466 SH1, Pūhoi, 117m from the indicative alignment and 25m from the existing SH1. We evaluated the Project for the years 2021 and 2031. Because the residence at 466 SH1 is located on SH1 and is also close to the Pūhoi southbound ramp, we included the cumulative effects of these roads and the ramps with the indicative alignment, and compared this to the 'without project' (SH1 only) scenario. Figure 3 shows the location of the residence relative to the roads assessed.

[22] USEPA, *Integrated Science Assessment for Particulate Matter*, July 2009.

[23] EMEP/EEA *Air pollution emission inventory guidebook, 1.A.3.b.vi Road vehicle tyre and brake wear*, 2009.

Figure 3: Aerial image of residence at 466 SH1 showing SH1 and indicative alignment

Table 12 summarises the inputs we used with the Screening Tool. Table 13 presents the Screening Tool results for the predicted maximum ground level concentrations (MGLCs). An example of a Tier 2 Screening Tool output report is provided in **Appendix B**.

Table 12: Tier 2 Screening Tool inputs – 466 SH1 residence

Assessment Scenario	Link	AADT	% HCV	Speed (km / hr)	Distance to residence
Without project 2021	SH1	22,120	7	80	25
With project 2021	SH1	10,170	0[1]	80	25
	Project alignment	11,530	13	80	115
	Project on-ramp alignment	2,900	13	80	65
	Project off-ramp alignment	2,840	13	80	155
Without project 2031	SH1	26,600	7	80	25
With project 2031	SH1	15,840	0[1]	80	25
	Project alignment	15,140	13	80	115
	Project on-ramp alignment	3,100	13	80	65
	Project off-ramp alignment	3,580	13	80	155

[1] VEMP does not accept a zero value, so a value of 1% HCVs was used

Table 13: Tier 2 Screening Tool results[24] – 466 SH1 residence

Link Name and Assessment Year	Link	24 hour average PM_{10} concentration (µg/m³)	Exceeds PM_{10} criteria?	24 hour average $PM_{2.5}$ concentration (µg/m³)	Exceeds $PM_{2.5}$ criteria?	Annual average NO_2 concentration (µg/m³)	Exceeds NO_2 criteria?
Without project 2021	SH1	0.8	No	0.8	No	2.1	Yes
With project 2021	SH1	0.4		0.4		1.0	
	Project alignment	0.1		0.1		0.4	
	Southbound project on-ramp alignment	0.1		0.1		0.1	
	Northbound project off-ramp alignment	<0.1		<0.1		0.1	
	Total	0.6	No	0.6	No	1.8	No
Without project 2031	SH1	<0.1	No	0.0	No	2.5	Yes
With project 2031	SH1	<0.1		<0.1		1.5	
	Project alignment	<0.1		<0.1		0.5	
	Southbound project on-ramp alignment	<0.1		<0.1		0.2	
	Northbound project off-ramp alignment	<0.1		<0.1		0.1	
	Total	-	No	-	No	2.3	Yes

[24] The Screening Tool has a minimum output value of 0.1 µg/m³, anything lower is reported by the Tool as 0.0 µg/m³, although in reality some contaminant will be present. The Tool and dispersion modelling in general is not accurate enough to report to more decimal places. For this report we have reported the 0.0 µg/m³ predictions as <0.1 µg/m³.

The Tier 2 NZTA Screening Tool indicates that the NZTA criteria for NO_2 of 2µg/m^3 as an annual average (ie 5% of the WHO air quality guideline value) is exceeded at the 466 SH1 residence for both the 'with Project' and 'without Project' scenarios for 2031. Due to the close proximity of the residence to the existing SH1, this road has a relatively greater impact on the receptor. The increase in traffic on the Project is largely offset by the decreased emissions from the existing SH1 in the 'with Project' scenario.

For NO_2 the current indicative alignment on its own, including the ramps, does not exceed the criteria at 0.8µg/m^3 as an annual average for 2031. The 'with Project' total combined, MGLC is slightly less than what would occur without the Project for both 2021 and 2031.

For PM_{10} and $PM_{2.5}$, the predicted MGLCs are below or well below the NZTA criteria of 2.5 µg/m^3 and 1.25 µg/m^3 respectively (ie 5% of the NESAQ and NZAAQG values). Accordingly the effects at 466 SH1, which are representative of the worst case for the Project, are less than minor.

6.2.2 Hungry Creek Arts School

The Tier 2 NZTA Screening Tool was used to assess the effects of the Project on the Hungry Creek Arts School, some 90m from the indicative alignment and 45m from SH1. As above, we evaluated the Project for the years 2021 and 2031 and included the cumulative effects of the existing SH1 with the indicative alignment, and compared this to the 'without project' (SH1 only) scenario.

Table 14 summarises the inputs we used with the Screening Tool. Table **15** presents the Screening Tool results for the predicted MGLCs.

Table 14: Tier 2 Screening Tool inputs – Hungry Creek Arts School

Scenario	Link	AADT	% HV	Speed	Distance to road (m)
With project 2021	SH1	10170	0	80	45
	Project	11530	13	80	90
Without project 2021	SH1	22120	7	80	45
With project 2031	SH1	15840	0	80	45
	Project	15140	13	80	90
Without project 2031	SH1	26600	7	80	45

Table 15: Tier 2 Screening Tool results – Hungry Creek Arts School

Link Name and Assessment Year	Link	24 hour average PM_{10} concentration ($\mu g/m^3$)	Exceeds PM_{10} criteria?	24 hour average $PM_{2.5}$ concentration ($\mu g/m^3$)	Exceeds $PM_{2.5}$ criteria?	Annual average NO_2 concentration ($\mu g/m^3$)	Exceeds NO_2 criteria?
Without Project 2021	SH1	0.5	No	0.5	No	1.4	No
With Project 2021	SH1	0.2		0.2		0.7	
	Project Alignment	0.1		0.1		0.5	
	Total	0.3	No	0.3	No	1.2	No
Without Project 2031	SH1	<0.1	No	<0.1	No	1.7	No
With Project 2031	SH1	<0.1		<0.1		1.0	
	Project Alignment	<0.1		<0.1		0.6	
	Total	-	No	-	No	1.6	No

All the results for the Hungry Creek Arts School are below the NZTA criteria for Tier 2 assessments and there is a marginal improvement for the 'with Project' scenario compared to without the project.

6.2.3 Operational effects sensitivity analysis

We understand that the indicative alignment may be moved within the proposed designation boundary. Such a movement has the potential to result in HSAPLUs being closer to the new motorway than assessed above. We have run the Tier 2 NZTA Screening Tool to consider residences at varying distances from 5m to 50m of the indicative alignment to determine at what distance the threshold criteria could be exceeded.

Table **16** presents the Screening Tool results with varying distances using AADT for the indicative alignment north of Pūhoi for 2021 and 2031. The results indicate that the criteria for NO_2 are exceeded at distances less than 20m from the indicative alignment. There are some residences within 20m of the proposed designation boundary, with the nearest residence being within 10m of the boundary. While we understand it is unlikely that the road will actually be moved to the edge of the proposed designation, we have considered air quality effects for those residences that are within 20m of the proposed designation boundary.

Table 16: NZTA Tier 2 Screening Tool results with varying distance (north of Pūhoi ramps)

Link Name and Assessment Year	Distance from Road (m)	24 hour average PM_{10} concentration (µg/m³)	Exceeds PM_{10} criteria?	24 hour average $PM_{2.5}$ concentration (µg/m³)	Exceeds $PM_{2.5}$ criteria?	Annual average NO_2 concentration (µg/m³)	Exceeds NO_2 criteria?
Project north of Pūhoi 2021	5	1.2	No	1.2	No	3.1	Yes
	10	0.9	No	0.9	No	2.0	Yes
	20	0.6	No	0.6	No	1.3	No
	30	0.4	No	0.4	No	1.0	No
	40	0.3	No	0.3	No	0.8	No
	50	0.3	No	0.3	No	0.7	No
Project north of Pūhoi 2031	5	<0.1	No	<0.1	No	4.1	Yes
	10	<0.1	No	<0.1	No	2.6	Yes
	20	<0.1	No	<0.1	No	1.7	No
	30	<0.1	No	<0.1	No	1.3	No
	40	<0.1	No	<0.1	No	1.1	No
	50	0	No	0	No	0.9	No

Based on the above NZTA Screening Tool results, even for a dwelling located 5m from the road edge, air quality guidelines and standards would still be met when considered cumulatively with the background air quality described in Section 3 of this Report.

For the area south of the Pūhoi ramps, where there is a higher AADT, there are only two residences that could be affected by an alignment change within the proposed designation. These residences are located at 24 and 26 Billing Road, 45m and 115m to the west of the proposed designation boundary. Table **17** presents the Tier 2 NZTA Screening Tool results for these residences and shows that the NZTA criteria would not be exceeded if the alignment was moved within the designation boundary south of the Pūhoi ramps.

Table 17: NZTA Tier 2 Screening Tool results for selected residences south of Pūhoi ramps

Link Name and Assessment Year	Distance from proposed designation (m)	24 hour average PM_{10} concentration (μg/m^3)	Exceeds PM_{10} criteria?	24 hour average $PM_{2.5}$ concentration (μg/m^3)	Exceeds $PM_{2.5}$ criteria?	Annual average NO_2 concentration (μg/m^3)	Exceeds NO_2 criteria?
24 Billing Road (2021)	45	0.4	No	0.4	No	1.1	No
26 Billing Road (2021)	115	0.1	No	0.1	No	0.6	No
24 Billing Road (2031)	45	<0.1	No	<0.1	No	1.4	No
26 Billing Road (2031)	115	<0.1	No	<0.1	No	0.8	No

6.2.4 Summary of operational effects

Operation of the Project will result in a small decrease in effects on air quality compared to if the Project did not proceed at the two HSAPLU closet to the Project (ie 466 SH1 and the Hungry Creek Arts School).

From the data in Table 16 above, given the separation distance to HSAPLUs for the remainder of the indicative alignment, the predicted MGLCs for the operation of the Project will be less than half the NZTA threshold criteria for considering a Tier 3 assessment.

Table 18 presents the results of the Tier 2 screening assessment with the assessed maximum background values compared with the relevant standards and guidelines for ambient air quality for 2031.

Table 18: Tier 2 Screening Tool results with assessed background at highest impact locations (2031)

	PM_{10} 24 hour average (μg/m^3)			
Receptor	**MGLC**	**Background**	**Combined (road + background)**	**Standard or guideline**
466 SH1	<0.4	20	<20.4	50 (NESAQ)
Hungry Creek Arts School	<0.2	20	<20.2	

	$PM_{2.5}$ 24 hour average (µg/m³)			
466 SH1	<0.4	10	<20.4	25 (ARAQT)
Hungry Creek Arts School	<0.2	10	<20.2	
	NO_2 annual average (µg/m³)			
466 SH1	2.3	20	22.3	40 (WHO) 30 (NZAAQG)
Hungry Creek Arts School	1.6	20	21.6	

In summary, we consider the effects of the operational phase of the Project to be less than minor, particularly when considered with the background air quality, and we have not undertaken a Tier 3 level assessment. Even if the alignment were moved with the proposed designation, such that separation distances between the motorway and the nearest HSAPLUs were reduced to 5m, the relevant air quality standards and guidelines would not be exceeded.

6.3 Network effects of the Project

The main operational effect of the Project on the transportation network will be reduced traffic on the existing SH1, which will be a benefit to the existing, higher density of HSAPLUs along this route.

We considered the 'with Project' and 'without Project' scenarios to quantify the benefit to air quality on SH1. Without the Project all traffic would continue to travel on SH1, leading to increased traffic and congestion along that route. Increased traffic and congestion would result in increased emissions and therefore exposure to air contaminants particularly at Warkworth.

To quantify the benefit, we calculated the relative differences in the mass emissions from motor vehicle contaminants travelling on the existing network for the 'with' and 'without Project' scenarios. The method is high level in that it does not account for exposure to actual concentrations of contaminants in air at particular locations.

Differences in the mass discharges between scenarios are primarily due to the predicted decrease in traffic volumes on SH1 and auxiliary roads due to the Project, as well as improved traffic flow resulting in higher average vehicle speeds. As expected, the mass of contaminant emissions discharged in Warkworth and on SH1 between Pūhoi and Warkworth is predicted to decrease with the Project. In Pūhoi, traffic volumes generally stay around the same value but are small in comparison to emissions in Warkworth and on the existing SH1.

Table 19 shows the predicted mass emissions of contaminants from the Project, SH1 and auxiliary roads in Pūhoi and Warkworth for the 'with' and 'without the Project' scenarios. The percentage change between the emissions predicted with the Project and those predicted without the Project are also provided, and show that the predicted discharges over the assessed routes decrease with the Project in most cases. Emissions increase slightly around Pūhoi in 2021 due to the increased traffic predicted to pass through the area to access the indicative alignment in 2021, but the traffic volumes are relatively small and the effect of any increase will be less than minor.

Table 19: Total emissions existing SH1 with and without the Project (per 24 hour period)

Area Name and Assessment Year	Year	Model	24 hour total PM_{10} Emission (kg/24 hr)	24 hour total $PM_{2.5}$ Emission (kg/24 hr)	24 hour total NO_x Emission (kg/24/hr)
Warkworth	2021	Without Project	7.3	6.4	110
		With Project	5.0	4.3	68
		% Change	-32%	-33%	-38%
Pūhoi	2021	Without Project	0.19	0.15	3.1
		With Project	0.21	0.17	3.3
		% Change	11%	13%	6%
SH1 (Tunnels to Kaipara Flats Road)	2021	Without Project	12.0	10.0	200
		With Project	6.1	4.9	87
		% Change	-49%	-51%	-57%
The Project (Tunnels to Kaipara Flats Road)	2021	With Project	8.1	7.0	150
Warkworth	2031	Without Project	7.6	7.0	110
		With Project	5.0	4.6	68
		% Change	-34%	-34%	-38%
Pūhoi	2031	Without Project	0.22	0.19	3.7
		With Project	0.19	0.15	2.8
		% Change	-14%	-21%	-24%
SH1 (Tunnels to Kaipara Flats Road)	2031	Without Project	11.0	9.1	190
		With Project	5.4	4.4	72
		% Change	-51%	-52%	-62%
The Project (Tunnelsto Kaipara Flats Road)	2031	With Project	7.9	7.1	160

Total mass emissions predicted to be discharged over a 24 hour period from the Project are comparable to those predicted along SH1 in the 'with Project' scenarios, and indicate that the overall traffic discharges will increase in the region, but will be divided more or less equally between the existing SH1 and the Project, and will therefore generally result in reductions in contaminant concentrations at HSAPLUs near the existing roads. Predicted discharges for the Project are similar for both 2021 and 2031, likely due to the increased AADT on the indicative alignment being offset by predicted reductions in emissions over time.

7. Assessment of effects of road construction emissions

The potential effects on air quality from construction are dependent on multiple variables including: the wind direction and strength; the distance from the earthworks activity to potentially affected properties; the size and scale of the earthworks and other construction activities; the number of vehicle movements; and the nature of the surface material (moisture content and particle size distribution).

The preferred approach for effects assessment from large scale fugitive dust sources is to rely on experience with similar projects and apply proven management techniques that are designed to avoid significant adverse effects from objectionable or offensive dust deposition.

Provided the proposed mitigation is implemented, effects from dust deposition are likely to be minor for the majority of the Project.

7.1 Potential sources of construction emissions

The construction phase of the Project has the potential to generate dust particularly from earthworks, topsoil removal and spreading, cut and fill operations, and other activities involved in road construction such as access roads for construction yards and mobile rock crushing and blasting.

Dust will be generated both as a result of vehicle movements and the action of wind (particularly where greater than 5m/s) on exposed/unsealed surfaces. The MfE Dust Guide indicates that limiting vehicle speed has a linear effect on dust emission and recommends a 10-15kph speed limit to minimise dust from vehicle movements on unsealed areas. The MfE Dust Guide also indicates that wind speeds of greater than 5m/s can be used as a trigger for increasing the level of dust control and above 10m/s may be a signal for work to cease.

Other discharges to air from construction include emissions from vehicle and equipment exhausts. These additional discharges have not been specifically assessed in this report as the effects will be less than those assessed for vehicle travel from the operational phase of the Project and will be less than minor.

7.2 Construction methodology

Section 6 of the AEE details 11 construction zones and the extent of the earthworks and other activities in each zone. The total earthworks have been estimated at 8M m^3 cut and 6.2M m^3 fill within an earthworks area of approximately 189ha. All material cut during construction is to remain within the construction area, i.e. no material will need to be disposed of offsite, which will minimise the vehicle movements on access roads.

For Project areas where bridges or viaducts are anticipated, the potential for dust is minor because there is minimal disturbance of land. Although, traffic movements on unsealed surfaces (access roads and staging areas) in these areas will still require mitigation measures to be applied.

The Construction Traffic Assessment Report provides the projected traffic movements of both heavy and light vehicles accessing the various staging areas and the indicative construction yards. Traffic construction periods extend up to 4.5 years in duration, and earthworks would be principally undertaken from November to April.

We reviewed the information provided on the location and scale of construction earthworks, staging areas, blasting and crushing activities and related this to the information on HSAPLUs as presented in Table 1 of this report.

Site access, construction and staging areas and plant and equipment are set out in Section 6 of the AEE. Indicative blasting areas are shown in Drawings C-101 to C-117. A mobile crushing plant will likely be operated within the larger blasting areas identified.

The mobile crushing plant will have a capacity of up to 300tph and accordingly requires a resource consent for discharges to air. Dust is potentially generated from the size reduction operation and the conveying of crushed materials. The potential for dust emissions will largely depend on the moisture content of the materials and the amount of fines present.

7.3 Potential effects of construction dust

The primary air quality effects resulting from construction will be those of dust nuisance and include excessive dust deposits on houses, cars and laundry. Excessive dust may also deposit within houses such as on furniture and curtaining. Excessive dust deposition can cause stress related conditions for some residents. Dust can have effects on visibility, although this is typically near the source and does not pose a wider effect. While the visibility of dust is more of an aesthetic concern, much of the public perception of air quality directly relates to visibility. Given the rural nature of the Project area, dwellings will tend to rely on roof water collection for their water supply. Roof water collection systems may be affected by excessive dust causing increased suspended solids in the water supply. Increased suspended solids (turbidity[25]) are more of an aesthetic than a health concern. As outlined in Section 5, the assessment criteria for dust from the MfE Dust Guide and ARP:ALW relate to "no objectionable or offensive effects from dust beyond the boundary". The means of determining whether dust is offensive or objectionable to the extent that there is an adverse effect relates to the FIDOL factors, which are usually assessed by a council regulatory officer in the event of complaints.

Vegetation in the near vicinity of a dust source can also be affected from dust deposition including reduced photosynthetic potential (reduced growth and crop yield), reduced effectiveness of pesticides and increased potential for diseases and pests. As the effects of dust are generally related to deposited dust, the effects are generally restricted close to the dust source.

Susceptibility to effects of dust from road construction will decrease with distance from the earthworks and associated construction activities. Properties with a separation distance of more than 200m will likely experience less than minor impacts, even without mitigation measures for dust management.

[25] Ministry for the Environment, *Guide to the Ministry of Health Drinking-water Standards for New Zealand,* 2008.

7.4 Dust assessment

7.4.1 Terrestrial Ecology

The Terrestrial Ecology Assessment Report raises the potential issue of dust effects on native flora and fauna within close proximity to the Project construction areas. The report considers the effects on vegetation are generally of a temporary nature but there are some particularly sensitive species and/or locations near construction activities identified. The general dust mitigation measures we recommend will contribute to minimising the Project's potential effects on flora and fauna, however, specific mitigation such as wind protection fencing may be appropriate for earthworks activities very near sensitive locations and could be applied adaptively through a management plan.

7.4.2 Genesis Aquaculture

Project construction has the potential to impact on the Genesis Aquaculture facility through dust deposition into fish ponds some 60m down the prevailing wind direction from the construction area. The Kauri Eco-Viaduct proposed for the Perry Road Sector, significantly reduces the extent of earthworks in the vicinity of the fishponds, but there remains some reasonably significant earthworks upwind of the ponds.

The Freshwater Ecology Assessment Report assesses the potential effects on the fish in the aquaculture ponds and concludes that these fish are not sensitive to dust deposition resulting in increased suspended solids in the ponds. Due to the proximity of the fish ponds to the construction area, however, dust nuisance may still be a concern for the fish farm operation. Mitigation such as wind protection fencing may be appropriate for earthworks activities upwind of the ponds and could be applied adaptively through a management plan.

7.4.3 HSAPLUs

The effects of dust from Project construction at HSAPLUs will be greatest immediately downwind under strong winds and dry conditions. The meteorology of the Project area, as discussed in Section 3.3, indicates that strong winds are predominantly from the west, which would cause increased risk of dust deposition to residences to the east of the corridor.

Wind data measured at Warkworth indicates that winds above 5m/s occur relatively often, approximately 30% of the time. Winds stronger than 10m/s occur relatively infrequently at 2% of the time. There is no significant difference in the wind speed distribution between that observed on an annual basis and for the main construction season.

Table 1, in Section 3 of this report, indicates that the nearest HSAPLU to the proposed earthworks is 50m distant and located at 466 SH1 (Drawing C-102), the same nearest receptor as for operational effects. Activities close to this HSAPLU include:

- Earthworks associated with the construction of the southbound and northbound Pūhoi ramps, and the alignment itself;
- An area of possible blasting to the south;

- Construction traffic on access roads for construction yards 1, 2 and 3 (around 540 two-way vehicle movements per day at peak); and
- The operation of construction yard 2 and bridge staging area 3.

The dwelling is to the east of the indicative alignment and is therefore, subject to potentially significant adverse effects of dust from the prevailing winds and the strongest winds, those greater than 10m/s. The next closest HSAPLUs are more than 100m distant from construction areas and are less likely to be significantly affected by dust deposition, particularly given the application of good industry practice management discussed in Section 8 of this report.

Table 2, Section 3, identifies residences close to access roads for the indicative construction yards. There are five residences located along Moirs Hill Road, which is used for access into indicative construction yards 7 and 8 (Drawing C-107). The Moirs Hill Section will, however, be sealed. Sealing will effectively mitigate the potential for dust deposition effects along this section of the Project. There are two houses (numbers 99 and 101 Moirs Hill Road) located less than 20m to the access road for indicative construction yard 7 (off Moirs Hill Road), that will have up to 160 two-way vehicle movements per day for an estimated construction period of 4.5 years. One other HSAPLU located at 12 Wyllie Road (Drawing C-115), which provides access to potential construction yards 11 and 12, is located about 35m from the roadway. Peak construction traffic is around 400 two-way vehicle movements per day for a construction period of 4.5 years. We consider the potential for dust effects from construction traffic for these three properties as potentially significant, and consider mitigation by way of sealing sections of the road would be appropriate.

For the dwellings in particularly close proximity to the construction activities, the recommended mitigation measures for dust will minimise the potential effects on roof water supplies. If drinking water supplies are, however, affected by dust provision of drinking water (or other mitigation) for residences would need to be considered via a management plan.

7.4.4 Mobile Rock Crusher

The nearest residence to the edge of any blasting areas and potentially rock crushing activities, as per Drawings C-101 to C-117, is number 20 Pūhoi Close, which is about 150m away (Drawing C-103).

We recommend industry standard dust control measures for the rock crusher to avoid excessive dust discharges. Dust control systems may include watering systems for dust suppression and/or enclosure and extraction to specific air pollution control systems for particulate matter removal, such as to a water scrubber or bag house filtration system.

7.4.5 Summary

Much of the indicative alignment is relatively remote, but there are a few HSAPLUs that are nearby and potentially affected by dust from construction activities and traffic on access roads for construction yards.

Those locations we have identified as being particularly susceptible to effects of dust from construction are:

- 466 SH1, Pūhoi (Drawing C-102) – earthworks, ramp construction, road construction and construction traffic on access roads for indicative construction yards;
- 20 Pūhoi Close (Drawing C-103), proximity to blasting and rock crushing areas;
- 99 and 101 Moirs Hill Road (Drawing C-107) - construction traffic on the access road for indicative construction yard 7;
- Genesis Aquaculture fish ponds (Drawing C-113) – proximity to earthworks; and
- 12 Wyllie Road (Drawing C-115) - construction traffic on access roads for indicative construction yards 11 and 12.

Good practice measures for dust control via a management plan will be sufficient to avoid significant adverse effects for the majority of the time and the majority of the route. There are, however, many variables, in particular, wind direction and strength, sunshine or rainfall, and the management methods that may be applied. It is therefore, difficult to be certain that significant adverse effects will be able to be avoided under all circumstances. Accordingly we consider the earthworks consent conditions need to require that a dust complaint system is put in place so that action can be taken to avoid, remedy or mitigate dust incidents and adapt the dust management systems if adverse effects do occur.

8. Mitigation measures

The operation of the Project on the current alignment will have less than minor impacts on air quality. We consider that no further mitigation measures are needed for the Project operation because the potential effects have been appropriately mitigated through the Project design.), the separation distance to HSAPLUs could be significantly less than for the current alignment as assessed. Our assessment of HSAPLUS potentially affected by a shift of the indicative alignment indicates that even if the separation distance to the new road was reduced to 5m, air quality guidelines and standards would still be achieved for the Project.

Project construction activities have the potential to give rise to dust emissions that could have moderate to significant adverse environmental effects. The residence at 466 SH1 is particularly close to sources of dust including from construction traffic on access roads, the indicative construction yards and road construction activities.

For the construction phase, a comprehensive construction air quality plan should be developed prior to construction activities commencing. The plan should incorporate procedures for daily visual monitoring and recording of activities, and for responding to dust complaints in order to ensure that the appropriate mix of controls are put in place and adapted as necessary to suit the conditions. If an exceptional event should occur such that controls fail or are inadequately applied, cleaning services to mitigate adverse effects from dust deposition onto neighbouring properties should be provided. In such circumstances, dust monitoring may be needed to be added to the plan to provide information to better apply dust controls to avoid future incidents.

We specifically, recommend sealing access roads adjacent to properties with residences closer than 50m, as occurs on sections of the access road to indicative construction yard 7 via Moirs Hill Road and a section of Wyllie Road for access to indicative construction yards 9 and 10.

8.1 Operational effects

Specific mitigation measures for the operational effects of the Project are not needed because the potential effects assessed for the indicative alignment are less than minor. In the event that the indicative alignment is shifted within the proposed designation boundaries reducing the separation distance of the road to any HSAPLU, relevant air quality guidelines and standards would still be achieved for the Project.

8.2 Construction dust

8.2.1 Management Plan

The construction phase of the Project has the potential to create adverse dust effects offsite. Based on experience with dust management and the MfE Dust Guide, we recommend that a management plan be developed for the Project including a range of measures, such as:

- Construct semi-permanent working areas, construction site access and haul roads with an appropriate base, keep metalled, and damp using watering trucks or fixed sprinkler systems during dry weather;
- Pave access roads where there are residential dwellings closer than 50m separation;
- For paved access roads, maintain using sweepers or vacuum trucks to limit dust build-up;

- Metal or re-vegetate and cordon cleared areas not required for construction access or for parking;
- Water as necessary, or preferably metal excavated areas exposed during dry windy conditions;
- Limit vehicle speeds to less than 15kph on unpaved areas close to sensitive areas;
- Train construction staff to make them aware of the sensitivity of the receiving environment and the need to take appropriate precautions;
- Use vehicle wheel wash facilities and/or any material tracked out from the site onto public roads, to be removed by scraping and/or washing if creating a dust issue;
- Load and unload trucks in a manner which minimises the discharge of dust;
- During dry windy conditions, loads may need to be wetted prior to loading or unloading to minimise dust generation;
- For locations close to HSAPLUs, limit earthworks as far as practical when there are high winds in conjunction with dry conditions;
- Stage the earthworks as far as practicable to limit the exposed surface area at any one time;
- Install wind fencing of suitable length and height, particularly adjacent to sensitive areas. Note the effectiveness of wind fencing is greatest when perpendicular to the prevailing wind conditions and of a porosity of 50%; and
- Manage exposed areas including stockpiles of topsoil, sand, and other potentially dusty materials by keeping surfaces damp, allowing to crust over, protect by wind barriers, or cover as appropriate. Define stockpile margins to minimise spread onto access areas and limit stockpile heights if uncovered or unprotected. Vegetate semi-permanent stockpiles;
- Consider the need for cleaning services for residences nearest the construction corridor in the event that dust discharges cannot be adequately controlled;
- Re-vegetate exposed surfaces whenever practicable;
- Provide water sprays to dampen down haul roads and stockpiles in dry conditions;
- Provide dust suppression and/or enclosure to control dust from the mobile rock crushing plant;
- Cover or dampen loads of potentially dusty material whenever practicable, and limit load sizes to avoid spillage;
- Consider the need for the provision of drinking water for residences where drinking water supply is affected; and
- Provide for the specific dust control measures recorded in the Terrestrial Ecology Assessment report.

We also recommend that a management plan identify procedures for implementing site dust controls, including identifying responsibilities, including for the monitoring recommended in Section 8.2.3, as follows:

- What has to be done and why;
- Who has to do it and/or see that it is done;
- How it will be done;
- The desired outcomes; and
- How these outcomes will be monitored and procedures for acting on any issues identified.

8.2.2 Mobile crushing plant

The mobile crushing plant will likely have a capacity of up to 300tph and will be operated at a minimum distance of 150m from any dwelling. Systems for dust suppression will need to be incorporated into the design and management of the crushing plant. These systems could include enclosure of dust sources and extraction to control equipment or water suppression.

8.2.3 Construction phase air quality monitoring

Monitoring is recommended to manage the dust risk. Three methods of monitoring are recommended:

- Visual inspection and record keeping on a daily basis;
- Weather observations; and
- Dust complaint investigation and reporting.

Monitoring of wind speed, wind direction, air temperature and rainfall is recommended to assist with decision making for applying the appropriate level of controls and to assist with complaint investigation.

Complaint investigation and reporting would test the effectiveness of the dust mitigation measures applied through a management plan, and provide an indicator as to whether improvements are required to a management plan and/or the mix of measures being applied under particular circumstances. For example, additional watering or wind fencing may be necessary for some locations if other measures are insufficient.

We recommend that a specific dust complaint response procedure be developed as part of a management plan and that this be communicated to potentially affected parties prior to commencement of construction activities in a particular zone, including contact numbers for site staff.

If any complainants remain unsatisfied with actions taken or complaints are otherwise difficult to resolve, dust measurement can be carried out for deposited dust or for TSPs. While measurement of deposited dust is generally simple and inexpensive the sampling period is generally too long (minimum 15 days) to allow for quick response to dust emission problems. The measurement of TSPs is preferred because it can give real time results and can be used for immediate response to dust issues. The dust trigger levels presented in Table 10, Section 4.6 of this report can be applied to monitoring data to indicate whether remedial action or additional mitigation should be applied.

No specific monitoring of the rock crusher discharges is recommended other than visual assessment.

9. Conclusions

Our assessment shows that maximum predicted concentrations of contaminants using the NZTA Tier 2 Screening Tool are generally well below the NZTA threshold criteria for Tier 2 assessments. The operation of the Project will result in increased concentrations of contaminants in ambient air along the new road, but this level of increase will have less than minor effects on human health and the environment due to:

- the low predicted concentrations of contaminants from traffic as compared to the relevant air quality guidelines and standards;
- the low background concentrations of contaminants in the area; and
- the generally rural nature of the surrounding environment with good separation distances to HSAPLUs.

We therefore conclude that the effect on air quality from the road operation will be less than minor.

The benefits of the Project in reducing mass emissions of contaminants in the vicinity of SH1 were quantified by comparing the 'with-Project' and 'without Project' scenarios. Without the Project, emissions to air from operating the existing SH1 will increase, due to increased AADT along SH1 and increased congestion resulting in higher emissions per vehicle due to lower average speeds and stationary traffic. Overall, there is a moderate benefit from the Project of reducing mass emissions on SH1 and relocating a portion of these emissions to a less populated area.

Construction activities will generate dust that may impact areas in close proximity to the construction areas and access roads. Industry good practice mitigation and controls for dust will be adequate to avoid significant adverse effects for the majority of the Project. Additional measures in particularly sensitive locations may include wind fencing and sealing of unsealed access roads.

10. References

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Appendix A. SH1 network assessment

A.1 Introduction

We investigated the network effects of the “without Project” scenario using a tool developed to directly calculate the mass emissions of air contaminant discharges from the alternative traffic scenarios. To do this the Further North Traffic Assessment Team developed a spread sheet to interface with the SATURN traffic model to automate the calculation of emissions directly from the outputs of SATURN.

In order to calculate emissions over a particular road length and reduce the steps in the emissions calculation process, the generic emission factor outputs from the VEPM model were integrated with the SATURN traffic model outputs. The process calculates emission factors of air contaminants for every link. The results spread sheet can then be used for extracting whole model outputs for an entire road and for looking at individual road links.

A.2 Methodology

To estimate the mass of contaminant discharges to air in a single step, using the SATURN model for all calculations, the following steps were undertaken:

1) All links in the SATURN model for which emissions were to be calculated were defined in consultation with the Air Quality Assessment Team.
2) The contaminants selected for the assessment were the key indicator contaminants consistent with the NZTA Tier 2 Screening Tool: particulate matter (as PM10 and PM2.5) and NOX.
3) VEPM was run with a range of vehicle speeds, road gradients, vehicle fleet compositions and years to produce vehicle emission factors for contaminants of interest for each combination of variables.
4) To allow SATURN to access the appropriate emission factors an equation was fitted to each emission factor curve.
5) An input data file that included the gradient and HCV percentage for each of the links was developed to interface with the SATURN process.
6) The emission factor trend line functions were incorporated into a SATDB batch file process (ie the process from the SATURN modelling programme that was used to calculate the results), The SATDB batch file uses the gradient and HCV percentage data file, vehicle speeds, link distance and traffic volumes to calculate the contaminant mass emissions as outputs for each of the peak hours which are covered in the transport models.
7) Peak hour outputs were then combined in a spread sheet process and factored up to daily levels, equivalent to the AADT.

Appendix B. Tier 2 screening model outputs

NZ TRANSPORT AGENCY
WAKA KOTAHI

Transport and Air Quality

Puhoi to Warkworth RoNS - 21 May 2013

Updated: Tuesday, May 21, 2013 - 10:28

Assessment year:
2021
Results:
Scenario Puhoi to Warkworth RoNS - 21 May 2013 Output Table

		Contribution of each link to air quality at the nearest highly sensitive air pollution land use					
Link Number	**Link Name**	**24hr average PM_{10} concentration ($\mu g/m^3$)**	**Exceeds PM_{10} significance criteria?**	**24hr average $PM_{2.5}$ concentration ($\mu g/m^3$)**	**Exceeds $PM_{2.5}$ significance criteria?**	**Annual average NO_2 concentration ($\mu g/m^3$)**	**Exceeds NO_2 significance criteria?**
1	South of Puhoi (2021)	0.4	No	0.4	No	1.0	No
2	North of Puhoi (2021)	0.3	No	0.3	No	0.7	No

Contribution to air quality:
Number of links that exceed PM_{10}, $PM_{2.5}$ or NO_2 significance criteria: No links
Are there any highly sensitive receptors within 200m of the road edge? Yes

Tier 2 report:
This screening assessment tool should be used in accordance with the guidance provided in the Guide to assessing air quality effects for state highway asset improvement projects.

The following data has been used for each link.

Link	Link Name	AADT (vpd)	%HV	Speed (km/h)	Nearest HSAPLU Receptor (m)
1	South of Puhoi (2021)	16,800	13	80	50
2	North of Puhoi (2021)	11,530	13	80	50

As sensitive receptors are within 200 metres, construction dust needs to be considered. Refer to the assessment guide for detail.

This option does not exceed ambient air quality significance criteria. No significant adverse effects on ambient air quality are expected.
For projects with a high air quality risk (based on the results of the Tier 1 risk assessment for the project) a qualitative assessment of construction dust and odour effects in accordance with MfE Good Practice Guide [1] and a draft CAQMP should be prepared using the NZTA template [2].

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Source URL: http://air.nzta.govt.nz/scenario/puhoi-to-warkworth-rons-21-may-2013
Links:
[1] http://www.mfe.govt.nz/publications/air/good-practice-guide-air-quality-2009/index.html
[2] http://air.nzta.govt.nz/AQ/tools/templates

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Transport and Air Quality

Puhoi to Warkworth RoNS - 21 May 2013b

Updated: Tuesday, May 21, 2013 - 10:34

Assessment year:
2031
Results:
Scenario Puhoi to Warkworth RoNS - 21 May 2013b Output Table

		Contribution of each link to air quality at the nearest highly sensitive air pollution land use					
Link Number	Link Name	24hr average PM_{10} concentration ($\mu g/m^3$)	Exceeds PM_{10} significance criteria?	24hr average $PM_{2.5}$ concentration ($\mu g/m^3$)	Exceeds $PM_{2.5}$ significance criteria?	Annual average NO_2 concentration ($\mu g/m^3$)	Exceeds NO_2 significance criteria?
1	South of Puhoi (2031)	0.0	No	0.0	No	1.3	No
2	North of Puhoi (2031)	0.0	No	0.0	No	0.9	No

Contribution to air quality:
Number of links that exceed PM_{10}, $PM_{2.5}$ or NO_2 significance criteria: No links
Are there any highly sensitive receptors within 200m of the road edge? Yes

Tier 2 report:
This screening assessment tool should be used in accordance with the guidance provided in the Guide to assessing air quality effects for state highway asset improvement projects.

The following data has been used for each link.

Link	Link Name	AADT (vpd)	%HV	Speed (km/h)	Nearest HSAPLU Receptor (m)
1	South of Puhoi (2031)	21,500	13	80	50
2	North of Puhoi (2031)	15,140	13	80	50

As sensitive receptors are within 200 metres, construction dust needs to be considered. Refer to the assessment guide for detail.

This option does not exceed ambient air quality significance criteria. No significant adverse effects on ambient air quality are expected.
For projects with a high air quality risk (based on the results of the Tier 1 risk assessment for the project) a qualitative assessment of construction dust and odour effects in accordance with MfE Good Practice Guide [1] and a draft CAQMP should be prepared using the NZTA template [2].

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Source URL: http://air.nzta.govt.nz/scenario/puhoi-to-warkworth-rons-21-may-2013b
Links:
[1] http://www.mfe.govt.nz/publications/air/good-practice-guide-air-quality-2009/index.html
[2] http://air.nzta.govt.nz/AQ/tools/templates

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