Air Discharge Assessment of Effects

Prepared for

Tasman Bay Asphalt

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PATTLE DELAMORE PARTNERS LTD
Level 4, 111 Customhouse Quay,
Wellington 6011
PO Box 6136, Wellington 6141, New Zealand

Tel +64 4 **471 4130** Fax +64 4 **471 4131**
Website **http://www.pdp.co.nz**
Auckland Tauranga **Wellington** Christchurch

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Prepared by

SIGNATURE

Chris Bender

Reviewed and Approved by

SIGNATURE

Deborah Ryan

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Executive Summary

Tasman Bay Asphalt is proposing to establish an asphalt manufacturing plant at Bartlett Road, near Richmond in Tasman District. Tasman Bay Asphalt is applying to Tasman District Council for a resource consent for discharges to air that will result from the operation of the plant. The proposed site is in a rural area approximately 3.5 kilometres to the west of the Richmond airshed.

The asphalt plant will typically operate for up to 10 hours per day and produce up to 130 tonnes of asphalt per hour of operation. The discharges to air from the processes at the proposed site are principally particulate matter and products of combustion associated with the manufacture of asphalt.

This report provides an assessment of effects on the environment for the proposed site's discharges to air. The assessment demonstrates that the proposed processes and controls will result in a level of effects on the environment that are less than minor. In particular, air dispersion modelling for the discharges show concentrations downwind of the asphalt plant will be well below guidelines and standards for air quality and will not exceed air quality standards when considering the background.

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1.0 Introduction

Tasman Bay Asphalt is proposing to establish an asphalt plant to be located at 272 Bartlett Road, Richmond.

This report provides a technical report to support an assessment of effects on the environment (AEE) of air discharges from the proposed asphalt plant and associated activities. This report:

- Describes the operation of the asphalt plant;
- Discusses the discharge of contaminants into air from the asphalt plant and their potential effects on the environment; and,
- Assess the potential effects of the asphalt plant referencing the relevant assessment criteria.

2.0 Statutory Requirements

2.1 Tasman Resource Management Plan

The Tasman District Council's (TDC) *Tasman Resource Management Plan* (TRMP) became operative on November 2008. The TRMP addresses the effects of the discharge of contaminants to air in the district. Chapter 36.3 of the TRMP provides rules for managing discharges to air from industrial and agricultural activities in the District.

2.2 National Environmental Standards

In 2004, the New Zealand Government gazetted the Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (NESAQ). The NESAQ are designed to protect public health and the environment. The NESAQ differ from the New Zealand Ambient Air Quality Guidelines (NZAAQGs) in that they set an allowable level of exceedance and cover only one time period for the average concentration that is set for each contaminant. Table 1 presents the NESAQ relevant to Tasman Bay's proposal.

Table 1: NES Air Quality: Ambient Air Quality Standards

Contaminant	Threshold Concentration	Averaging Time	Permissible Exceedances
Carbon monoxide (CO)	10 mg/m^3	8-hour	One in a 12-month period
Nitrogen dioxide (NO_2)	200 µg/m^3	1-hour	9 in a 12-month period
Particulate matter (PM_{10})	50 µg/m^3	24-hour	One in a 12-month period
Sulphur dioxide (SO_2)	350 µg/m^3	1 hour	9 in a 12-month period
	570 µg/m^3	1 hour	None

The Ministry for the Environment (MfE) has consulted on proposed amendments to the NESAQ which would establish ambient air quality standards for $PM_{2.5}$. The proposal is that the $PM_{2.5}$ NES be set at a level 50% of the PM_{10} standards (i.e. 25 µg/m^3 as a 24-hour and 10 µg/m^3 as an annual average). We have therefore included an assessment of the discharges against the potential NESAQ for $PM_{2.5}$[1].

The NESAQ uses the term "airshed", which defines where air quality must be monitored and for polluted airsheds determines the basis for certain decisions on resource consents discharging PM_{10}. MfE has gazetted airsheds for managing air quality, which are generally in populated areas where the NESAQ for PM_{10} is being breached or is likely to be breached.

The NESAQ Regulations have a particular emphasis on managing PM_{10}, with specific requirements for new discharges as follows:

- **Regulation 17(1) -** Applies to an application for resource consent to discharge PM_{10} into a polluted airshed. If the discharge is likely to increase the concentration of PM_{10} by more than 2.5 micrograms per cubic metre in any part of a polluted airshed other than the site on which the consent would be exercised, then the consenting authority must decline the application for resource consent.
- **Regulation 17(2) –** States that Regulation 17(1) does not apply if the proposed consent is for the same activity at the same site (*i.e.* is a renewal of an existing consent), or is a new activity replacing an existing consented activity, and the amount and rate of PM_{10} discharge of the proposed consent is the same as or less than that permitted by the existing consent.

[1] MfE, *Proposed amendments to the National Environmental Standards for Air – Particulate Matter and Mercury Emissions - Summary document,* February 2020.

- **Regulation 17(3) –** States that the consenting authority may allow the consent if the applicant can reduce (offset) the PM_{10} discharged from another source or sources into the polluted airshed by the same or greater amount than the amount likely to be discharged by the proposed consent.

The proposed Tasman Bay asphalt plant is located approximately 3 kilometres to the west of the Richmond airshed. The potential for discharges from the site to contribute to the ambient PM_{10} concentrations in the airshed has been considered in this assessment. Figure 1 shows the proposed site relative to the Richmond airshed.

TDC has undertaken monitoring for PM_{10} at Oxford Street, which is in the Richmond airshed, since 2003. The monitoring has demonstrated that the Richmond airshed is deemed polluted under the NESAQ regulations. Consequently, any new consent for air discharges impacting on the airshed needs to consider Regulation 17 of the NESAQ.

2.3 Ambient Air Guidelines

The Ministry for the Environment published ambient air guideline values for New Zealand in 2002. The primary purpose of the guidelines is to promote sustainable management of the air resource in New Zealand. The guideline values published are the minimum requirements that outdoor air quality should meet to protect human health and the environment. The guidelines provide values for contaminants that are commonly discharged from industrial sources. Table 2 presents the relevant New Zealand Ambient Air Guideline (NZAAQG) values.

Table 2: New Zealand Ambient Air Guidelines (NZAAQG), May 2002

Contaminant	Threshold Concentration	Averaging Time
Carbon monoxide	30 mg/m^3	1-hour
	10 mg/m^3	8-hour
Fine particles (PM_{10})	50 µg/m^3	24-hour
	20 µg/m^3	annual
Nitrogen dioxide	200 µg/m^3	1-hour
	100 µg/m^3	24-hour
Sulphur dioxide	350 µg/m^3	1-hour
	120 µg/m^3	24-hour

Figure 1: Tasman Bay Asphalt Site with Richmond Airshed

3.0 Location and Receiving Environment

3.1 Location and Zoning of Site, and Adjacent Land Use

The proposed Tasman Bay Asphalt site is located at within the Rural 2 zone under the Tasman District Plan. The site is on the eastern bank of the Waimea River and is surrounded by agricultural and viticultural land uses. The nearest residence is approximately 700 metres to the east of the site.

Figure 2 shows the location of the proposed asphalt plant. The site is at 272 Bartlett Road, with legal description Lot 1 DP 368439 RT493293. Access to the site is provided from Bartlett Road.

Figure 2: **Location of Tasman Bay Asphalt Plant**

3.2 Topography and Meteorology

The surrounding topography is generally of low relief. The average altitude of the area is approximately 18 metres above mean sea level. The site is located in the Waimea River Valley with the terrain gradually rising to the east and west of the river, and to the south away from the coast.

The nearest full-time meteorological station is located at Nelson Airport, which is around 9 kilometres to the northeast of the site. A windrose of the 2007-2012 period is provided as Figure 3. The most common wind directions are between the west and southwest. The average wind speed for the period was 3.8 m/s, with calm periods (wind speeds less than 0.5 m/s) for 1 percent of the time.

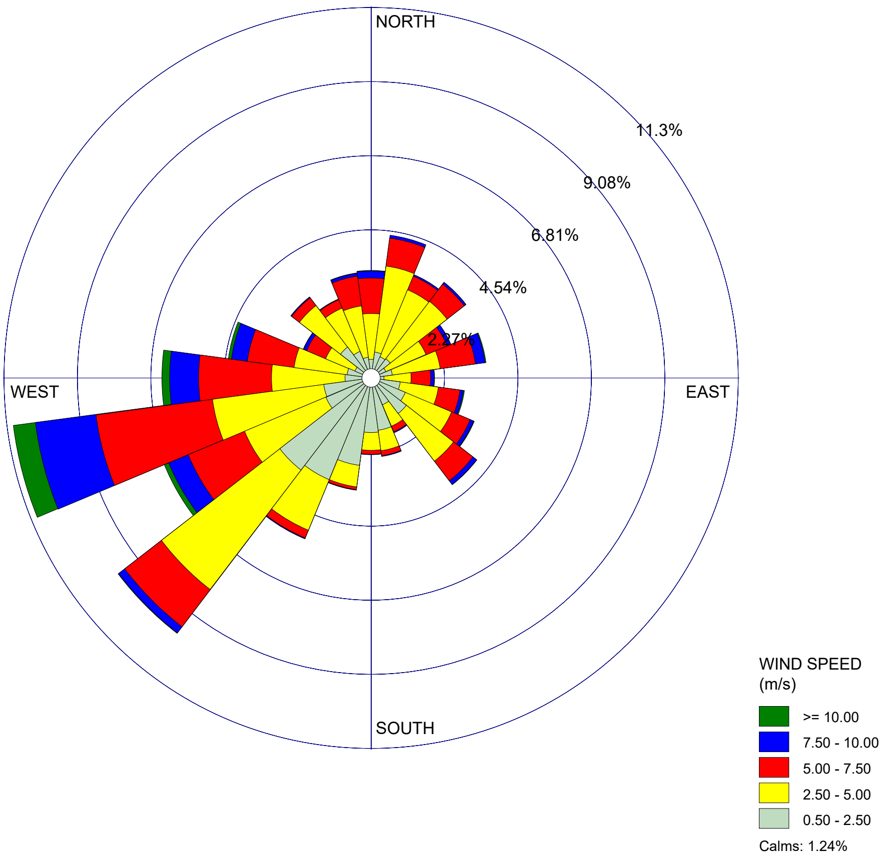

Figure 3: Nelson Airport Windrose, 2007-2012

3.3 Sensitive Receptors

Sensitive receptors are considered for their susceptibility to the effects from discharges to air. Typical sensitive receptors considered include:

- Residential properties;
- Retirement villages;
- Hospitals or medical centres;
- Schools;
- Marae;
- Libraries; and
- Public outdoor locations (e.g. parks, reserves, sports fields, beaches).

The proposed site is surrounded principally by agricultural land uses, with a few residences, which are considered as 'sensitive receptors' for this assessment.

Table 3 presents the selected residential receptors nearest to the proposed site and their locations are shown in Figure 4. These residences represent 'worst-case' sensitive receptor locations for this assessment given that they are the closest receptors to the discharge location.

Table 3: Nearest Sensitive Receptor Locations

ID	Address	Distance from Asphalt Plant	NZTM	
			Easting (m)	Northing (m)
R1	554 Waimea West Rd	1.1 km west	1609074	5423687
R2	29 Challies Way	1.7 km northwest	1608886	5424452
R3	34 Challies Way	1.7 km northwest	1609052	5424617
R4	701 Waimea West Rd	1.8 km northwest	1609470	5425041
R5	150 Bartlett Rd	1.2 km northeast	1610851	5424269
R6	208 Bartlett Rd	0.7 km northeast	1610675	5423803
R7	239 Bartlett Rd	0.7 km east-southeast	1610757	5423083
R8	202 Edens Road	0.6 km southeast	1610403	5422760

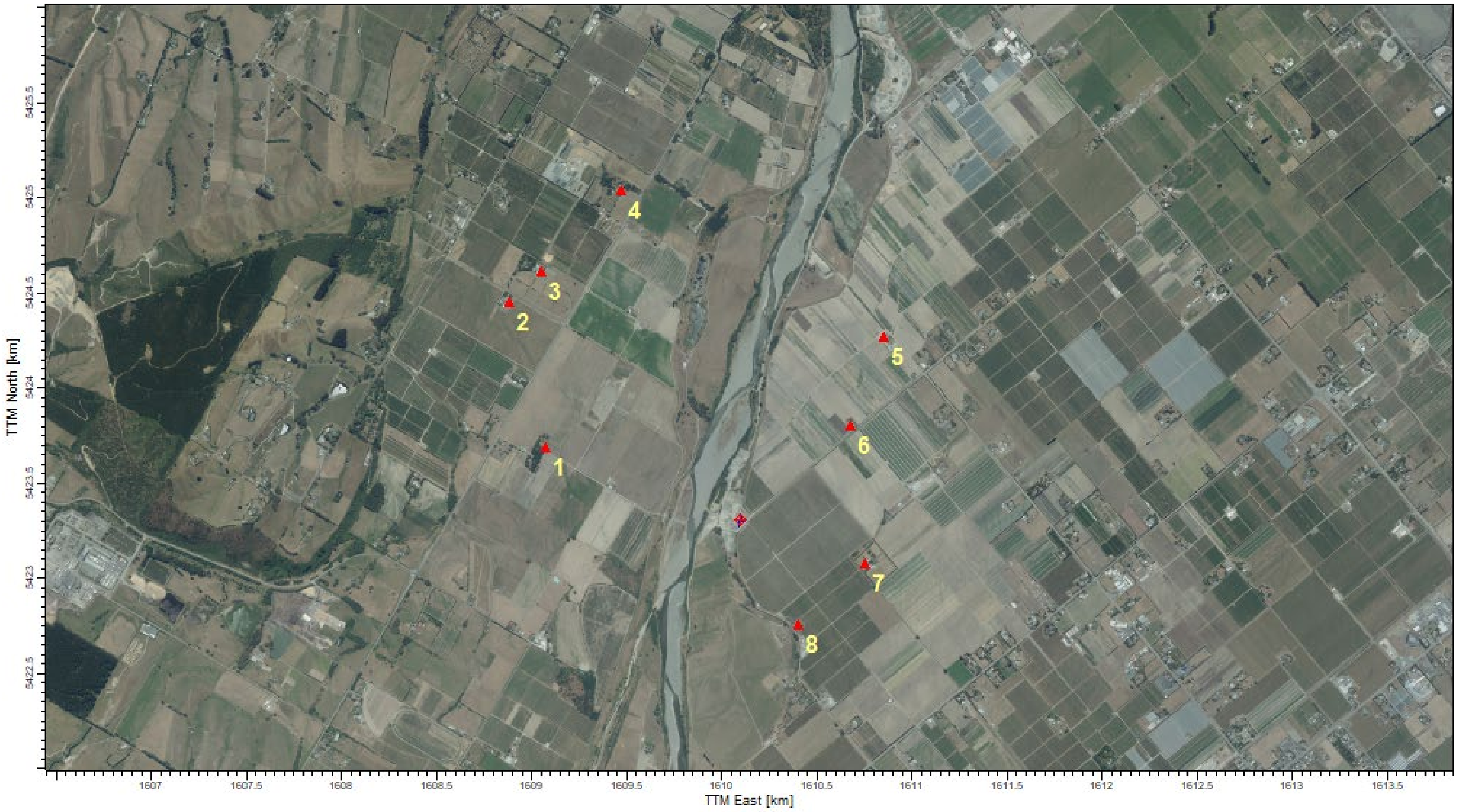

Figure 4: Nearby Sensitive Receptors

3.4 Background Ambient Air Quality

Background concentrations of contaminants will vary depending on local activities and seasonal variations. Activities in the surrounding area are a combination of rural land uses, with a range of sources contributing to contaminants in air.

As mentioned above the Richmond airshed monitoring station is located at 86 Oxford Street, which is approximately 5 kilometres to the east of the site.

Table 4 summarises the highest 24-hour average PM_{10} concentrations and annual average concentrations measured at the monitoring site for the most recent five-year period. Figure 5 graphically represents the 24-hour average PM_{10} concentrations for the 2019 year.

Table 4: Measured PM_{10} Concentrations at Central Richmond Ambient Air Monitoring Station

Year	Number of Exceedances	Measured PM_{10} Concentration (µg/m³)	
		Maximum 24-Hour Average Concentration	Annual Average Concentration
2015	3	60	18
2016	5	66	18
2017	2	52	17
2018	12	76	19
2019	4	58	18

Notes: Data obtained from https://www.lawa.org.nz/explore-data/tasman-region/air-quality/

A GNS report commissioned by TDC[2] (GNS, November 2017), found that the main contribution of particulate matter to the Richmond airshed is from biomass burning, assumed to be primarily from solid fuel fires used for domestic heating. From the available data GNS found that biomass burning was the source of around 49% of PM_{10} measured during June 2013 to October 2016. For $PM_{2.5}$ measured during October 2015 to October 2016 biomass burning was 75% of the measured $PM_{2.5}$.

[2] *Apportionment of $PM_{2.5}$ and PM_{10} sources in the Richmond airshed, Tasman District, GNS, 2017*

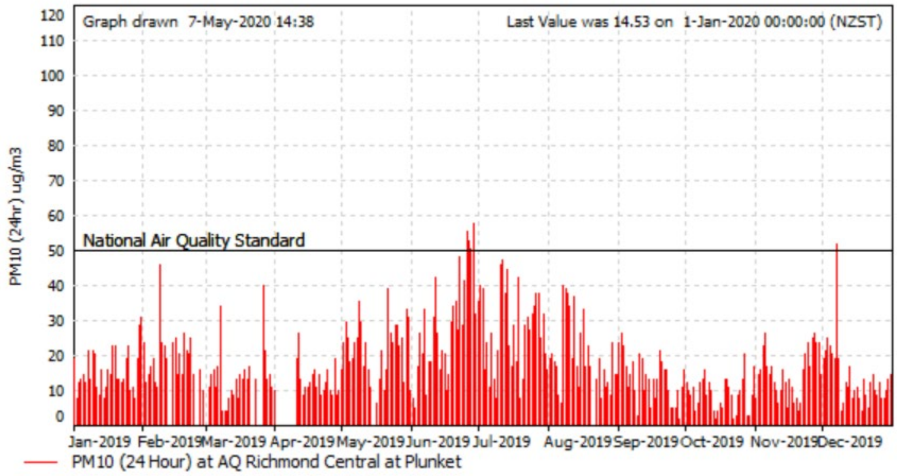

Figure 5: PM_{10} Concentrations as Measured at Richmond Central Monitoring Station in 2019

The concentrations of particulate matter near the proposed asphalt plant site will be lower than what has been measured at the Richmond monitoring site, given the rural nature of the surroundings and the distance to the residential and industrial sources in the Richmond area.

Background monitoring data for carbon monoxide, oxides of nitrogen, and other contaminants of potential interest were not found to be available for the locality.

The MfE's *Good Practice Guide for Assessing Discharges to Air from Industry* (MfE, 2016) (Good Practice Guide) provides guidance on using default values for background air quality where there is no monitoring data. The Good Practice Guide recommends using default background air quality values provided by Waka Kotahi, New Zealand Transport Agency (NZTA). The default values are intended to provide a conservative estimate of likely background concentrations.

Table 5 shows the default values for PM_{10} and NO_2 provided by NZTA relevant to the Tasman Bay Asphalt site. We have used the default values for assessing the likely background air quality and potential for cumulative impacts in the surrounding rural area. We consider this is appropriate for PM_{10} in preference to using monitoring data for the Richmond airshed because air quality in the immediate environs will be better than measured within the airshed.

Background values for carbon monoxide and SO_2 concentrations have been adopted from the Good Practice Guide default values recommended for a rural residential area.

To estimate the $PM_{2.5}$ background concentrations, it has been assumed that the $PM_{2.5}$ to PM_{10} ratio is 50%, which is consistent with assumptions generally applied for rural areas[3].

Table 5: Assumed Background Contaminant Concentrations

Contaminant	Averaging Period	Assumed Background Value	Source
PM_{10}	24-hour average	24.7 µg/m^3	NZTA[1]
	Annual average	18 µg/m^3	Richmond Monitoring Site
$PM_{2.5}$	24-hour average	12.4 µg/m^3	NZTA[1,2]
	Annual average	9 µg/m^3	Richmond Monitoring Site[2]
NO_2	1-hour average	65 µg/m^3	NZTA[1]
	24-hour average	43 µg/m^3	NZTA[1]
	Annual average	16 µg/m^3	NZTA[1]
CO	1-hour average	5 mg/m^3	MfE
	8-hour average	2 mg/m^3	MfE
SO_2	1-hour average	20 µg/m^3	MfE
	24-hour average	8 µg/m^3	MfE

Notes:

1. *https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/planning-and-assessment/background-air-quality/*
2. *Background $PM_{2.5}$ concentrations assumed to be 50% of background PM_{10}.*

4.0 Description and Operation of Plant & Associated Processes

4.1 Drum Mix Plant

The proposed asphalt plant is a Marini Carbon T-Box 130 drum mix plant. Drum mix asphalt plants have historically been the most common type of asphalt plant

[3] NIWA, *$PM_{2.5}$ in New Zealand Modelling the current (2018) levels of fine particulate air pollution*, December 2019.

in New Zealand. Drum mix plants operate on a continuous basis with the drum used to both dry and heat aggregate and to mix liquid bitumen with hot aggregate to produce hot mix asphalt. A photograph of the Marini T-box 130 plant is shown as Figure 6 and Figure 7 is a diagram of a typical parallel-flow drum mix plant.

Figure 6: Marini T-Box Asphalt Plant

The plant will have a maximum production capacity of 130 tonne product per hour. The particulate emission control system is by bag filtration and hot mix asphalt storage is in elevated bins. The plant will consist of the following sections:

- Aggregate storage facilities;
- Four aggregate cold feed bins and associated conveyor to the dryer drum;
- Recycled Asphalt Product (RAP) feed unit;

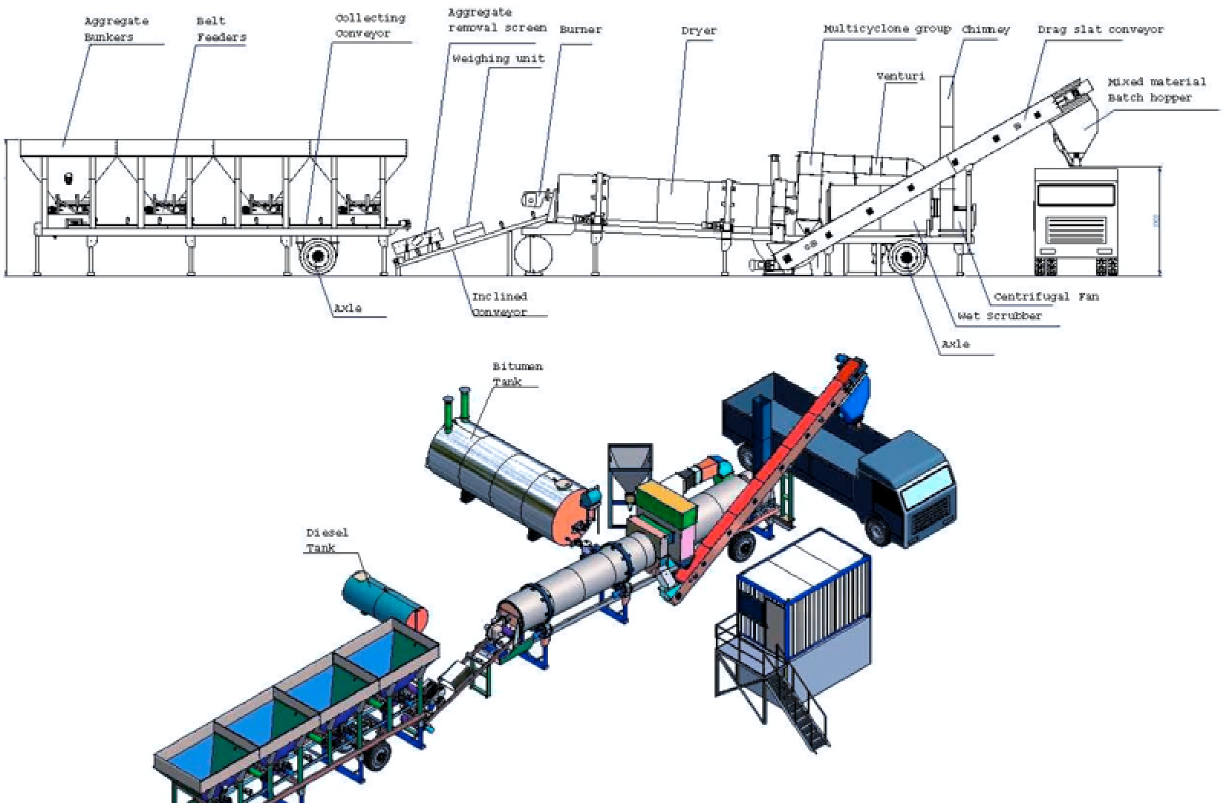

Figure 7: Diagram of Parallel Drum Mix Asphalt Plant

- Asphalt storage silo, electrically heated, fitted with atmospheric breathers for pressure equalisation;
- Double-skinned diesel oil fuel storage tank;
- Drum mix asphalt plant (consisting of the rotary drying drum; fuel burner and integral combustion air fan; bitumen drum injection system; and an expansion box);
- A bag filtration system with a 7.8 m high discharge stack (effective stack height of 7.3 m due to local ground elevations);
- Hot mix storage bins supplied from an enclosed slat conveyor from the mixer; and,
- A control room.

A burner for a 130 tonne/hour parallel flow plant at maximum rate of heat release has a required thermal capacity of about 13 MW gross. This rate of heat release is calculated from a fuel consumption rate of about 6 litres of diesel oil per tonne of product. At the maximum asphalt production rate of 130 tonne per hour, about 780 litres (650 kg) of diesel oil will be burnt per hour.

4.2 Raw Materials

4.2.1 Aggregates

Aggregate raw materials for asphalt manufacture are gravel chip, sand and crusher dust (collectively called aggregates). Aggregates are obtained from greywacke, the rock almost exclusively used in most areas of New Zealand for asphalt and for most road and general construction purposes.

The only mineral of potential concern in greywacke is crystalline silica (e.g. quartz) which is present in variable concentrations depending on the aggregate source. If quartz is in a respirable form and breathed in high concentration for sufficient time it may cause the occupational illness silicosis. It is highly unlikely that the emission of respirable quartz dust from any part of the process (even during upset conditions) will be of sufficiently high concentration and duration to have any occupational or (especially) public health significance.

Provided that it is well washed, storage of coarse aggregate has low dust potential even when the aggregate is dry and during strong winds. Crusher dust, which has a high fines content (and to a lesser degree sand), is generally received damp and kept damp while in storage to prevent dust generation while unloading, and during storage and transfer from the storage bin to the cold feed bins.

Aggregate storage will be semi-enclosed, and crusher dust and sand will be covered as necessary during warm weather to minimise drying out without having to apply excessive water. Aggregate received by truck at the site will be damp to minimise dust generation during tipping and subsequent transfer operations.

4.2.2 Bitumen

Bitumen is a solid to semi-solid residue resulting from the distillation of heavy crude oils. Bitumen consists of a complex mixture of high boiling point paraffinic, aromatic hydrocarbons, and heterocyclic compounds containing sulphur, nitrogen and oxygen. Bitumen is stored hot (135°C to 165°C) using electric heating via thermal oil heat exchangers to keep contents sufficiently fluid to pump to the hot mix drum and inject into the aggregate mix. Bitumen tank temperature is controlled by thermostat set in fail-safe mode. The storage tanks are fitted with a short breather vent to permit pressure equalisation.

4.2.3 Release Agent

Truck and trailer trays will be swabbed with a proprietary release agent solution to prevent asphalt sticking to the tray. This is normal practice in the industry.

4.2.4 Fuel Storage

Diesel fuel will be standard automotive fuel grade, which currently has a maximum sulphur content of 0.001% by weight. Diesel fuel storage tanks are double skinned and equipped with internal monitoring to ensure leaks do not occur. Facilities are also designed to ensure that if spills occur, they will be contained to prevent land and water contamination.

4.3 Operation of the Plant

Drum mix plants operate on a continuous basis with the drum used to both dry and heat aggregate and to mix hot aggregate with bitumen. Aggregate is conveyed into the drum at the burner end and then travels down the slightly inclined rotating drum (which is fitted with flights) where products of combustion from the burner and excess air dries and heats the aggregate.

The lifting motion of the flights achieves good contact between aggregate and drying gases. Hot liquid bitumen is injected into the drum about halfway down and the mixing action of the rotating drum ensures a good and even coating of bitumen on aggregate particles. A steam barrier generated by the drying aggregate, and burner design, prevents the burner flame impinging on the bitumen. Hot mix temperature ranges from about 135 to 170°C depending on the blend (about 150°C for the standard blends) and contains about 3-5% moisture. Hot asphalt discharges at the burner end about ¾ of the way along the drum onto a conveyor for transfer to thermally insulated hot storage bins and then load-out.

Combustion gases, dust, bitumen volatile matter and combustion products are drawn by an induced draught fan through the baghouse filters before gases are discharged into air through the stack. Bag filtration will remove most of the particulate matter before discharge to air and will be designed to achieve emission concentrations of less than 20 mg/Nm^3 on a dry gas basis. Most of the particulate discharged from the bag filter is expected to be PM_{10}. USEPA emission factors for asphalt plants estimate that 70% of PM_{10} will be $PM_{2.5}$[4].

Operating hours are typically expected to be between 6:30 AM and 4:00 PM during the summer, and 7:30 AM to 3:00 PM in the winter. Provision for operating at night-time is, however, needed to provide asphalt for road works that require night-time construction. The Applicant is, therefore seeking consent to operate up to a maximum of 10 hours within a 24-hour period to allow for limited night-time operations.

5.0 Properties of Contaminants Discharged into Air

5.1 Contaminants Discharged to Air from Asphalt Manufacture

The properties of contaminants discharged into air are discussed below.

5.1.1 Carbon Monoxide

Carbon monoxide (CO) is colourless and odourless but has high mammalian toxicity in relatively high concentrations. It is slowly oxidised in the atmosphere to carbon dioxide. Its most significant environmental effect, in 'high' concentrations, is human health effects.

5.1.2 Oxides of Nitrogen (NO_X)

Nitric oxide (NO), which is relatively non-toxic, odourless and colourless, is the primary compound produced during combustion (around 95% of the NO_X emitted is NO). Some of the NO in the discharge will oxidise to NO_2 as the plume drifts down wind, with the rate of conversion being dependent on the presence of oxidising capacity of the receiving atmosphere.

NO_2 is an acidic gas with a characteristic odour. It is substantially more toxic and more reactive than NO and is of more concern as an air contaminant if concentrations are excessive. In sufficient concentration, NO_2 irritates the eyes and the respiratory tract and damages vegetation.

Other sources of NO_X in the area will include motor vehicles, and other commercial and industrial fuel burning equipment.

5.1.3 Particulate Matter

Deposited particulate is particulate matter having significant settling velocity in still air, and generally has a particle diameter greater than 10 - 20 microns. The primary impact of deposited particulate is nuisance (mainly soiling).

Dust particles less than about 10 to 20 microns in size are termed 'suspended particulate' as their settling velocities are low and they disperse similar to a gas.

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[4] USEPA, *AP-42, Chapter 11.1, Hot Mix Asphalt Plants*, April 2004.

Fine particulate matter (PM_{10}), in sufficient concentration, can cause respiratory distress, soiling of surfaces and will accelerate corrosion of surfaces by retaining moisture and acidic materials.

Health surveys have shown a correlation between the concentration of fine particulate in the atmosphere and increased frequency of respiratory and cardiovascular illness, and increased mortality, especially in those who are suffering from significant illness. These studies have also shown a correlation with increased prevalence of asthma symptoms. To date, the increase in adverse health effects with increasing concentration of fine particulate in the air has not been related to particle composition but only to particle size, concentration, and exposure time. Particles having a diameter of 10 microns or less (PM_{10}), being respirable, are of principal concern. Particles with a diameter of less than 2.5 microns ($PM_{2.5}$) are similarly respirable and able to go deeper into the lungs with the potential for adverse health effects.

Other sources of suspended particulate matter in the area of the site will include dust from vehicle movements on roads, PM_{10} from motor vehicles; areas of exposed soils during dry weather conditions; and agricultural production activities.

5.1.4 Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless and pungent gas which, in sufficient concentration, irritates the eyes and respiratory tract, may damage vegetation, and promotes corrosion of some materials. Low concentrations of sulphur trioxide are also generated by oxidation of SO_2. The discharge of sulphur oxides from burning automotive diesel oil is very low, and the environmental effects from emitted SO_2 will be negligible.

Other sources of sulphur oxides in the area will be diesel-fuelled vehicles and machinery.

5.1.5 Volatile Organic Compounds (VOCs)

Combustion of diesel oil and hot bitumen emit unburnt hydrocarbons and products of incomplete combustion, or Volatile Organic Compounds (VOCs). Some VOCs are odorous and, if of excessive concentration, can cause nuisance to neighbours. Such discharges are minimised by maintaining burners, and by ensuring that drum mix plants are set-up and operated to minimise over-heating of bitumen. The main effect of emitted VOCs is odour.

5.2 Discharges from Other Activities

Table 6 describes other activities that result in discharges to air associated with the proposed asphalt plant operations.

Table 6: Other Air Discharge Activities

Process Resulting in Discharge	Nature of Discharge and Degree of Effects
Stored fine aggregate (dust)	Low if protected and kept damp
Transfer aggregate to cold bins (dust)	Low if sand/crusher dust damp
Cold bins and conveyor (dust)	Low if aggregate damp
Bitumen storage (volatile compounds/odour)	Low – slight odour
Product conveyor/hot bin (odour)	Limited bitumen odour
Product-bin to truck (odour/smoke)	Moderate in immediate vicinity

5.2.1 Despatch of Product from the Premises

Despatch of asphalt product from the premises will be in covered trucks and trailers. Odour from product will be minimal. No other emissions to air are expected.

5.3 Nature and Composition of Discharges to Air – Normal Operation

Table 7 presents the plant stack discharges relating to normal operations at maximum operating capacity for the asphalt plant.

Table 7: Parameters for Tasman Bay Asphalt Plant

Parameter	Values
Heat release	Up to 13 MW gross
Fuel consumption rate[2]	6 litres diesel per tonne of asphalt (up to 780 litres per hour)
Volumetric Flow	48,000 Am^3/hr (31,000 Nm^3/hr)
Efflux Temperature	150 °C
Efflux velocity	20 m/s
Carbon monoxide	0.65 g/s
Oxides of nitrogen (as NO_2)	1.37 g/s
SO_2	0.35 mg/s[3]
PM_{10}	0.17 g/s
$PM_{2.5}$	0.12 g/s

Notes:

1. *Based on USEPA Emission factors, AP-42, January 1995a. Compilation of Air Pollutant Emission Factors Volume 1: Stationary Point and Area Sources, Fifth Edition, AP-42 Section 11.1, Hot-Mix Asphalt Plants.* Assuming maximum production rate of 130 tonnes per hour.
2. *Based on manufacturer guaranteed emission rate of particulate matter of 20 mg/Nm³.*
3. *Assumption of 10 ppm Sulphur in diesel fuel and 780 L/hour fuel usage rate.*

5.4 Nature and Composition of Discharges to Air – Abnormal Operation

Abnormal discharges into air can occur under the circumstances described in this section.

If the drum burner when fired on diesel fuel is poorly maintained or adjusted, the emission of black smoke may occur from the stack. Providing the burner is appropriately maintained and adjusted then the likelihood of significant smoke emissions is low.

Faulty adjustment of the burner, and/or failure of the induced draught fan to sufficiently extract products of combustion and drying from the drum may generate positive pressure in the drum with fugitive discharges to atmosphere ('puffing'). Proper burner adjustment and induced draught fan regulation to maintain slight negative pressure in the drum prevents this problem.

The plant will have controls to notify the plant operators of potential faults. The controls include alarm functions for all important parameters including bitumen tank temperature, burner parameters, drying drum temperature, fan parameters, fabric filter temperature and pressure, and fuel consumption.

Nuisance dust effects may arise from poor control of transport and storage of aggregate; failing to keep working areas clean; failing to keep truck and machinery speeds low to minimise dust emissions during dry (and especially windy) weather, and/or failing to keep such surfaces damp. Proper management and maintenance of plant and facilities reduces the frequency of such events and reduces their impact to a minimum if they do occur. Dust management and mitigation measures will be included in the Environmental Management Plan for the sites.

5.5 Process Monitoring

Operation of the asphalt plant will be automatically controlled by a computerised control system. Automatic controls measure the input of aggregates and controls the addition of bitumen and the mix temperature. The control system will be programmed by the operator to the desired blend and production rate and the system automatically provides consistent aggregate and bitumen feed. Key parameters for control include:

- Aggregate and bitumen feed rates;
- Hot mix production as total tonnes; and,
- Hot mix temperature.

Important parameters will also be manually logged. Product quality is the definitive test of proper process operation (product will be monitored by a registered technician).

Discharges of contaminants to air are generally not monitored directly on a continuous basis, but they are visually assessed and minimised as documented in the Site Environmental Management Plan.

6.0 Assessment of Effects of Discharges on the Environment

6.1 Introduction

Under normal operation, discharges from the hot mix plant will consist of:

- A noticeable white steam plume, which dissipates as the steam evaporates;
- Products of combustion, including carbon dioxide, CO, oxides of nitrogen and SO_2;
- Particulate matter (as PM_{10} and $PM_{2.5}$);
- Limited dust from process fugitive emissions, truck and machinery movements during dry weather, and from receipt and handling of aggregate; and
- Minimal dust from storage of aggregates.

6.2 Atmospheric Dispersion Modelling of Chimney Discharge

6.2.1 Introduction

Computer dispersion modelling is an internationally accepted method for predicting concentrations of contaminants in air downwind of a source for use in assessing the effects of discharges on the environment. Particular dispersion models may be approved by regulatory agencies for specific applications. Dispersion models account for factors including the emission rate of the contaminant(s), the height of the discharge, building downwash effects, local topography, and meteorology. The main meteorological aspects considered in modelling are wind speed and direction, ambient temperature, atmospheric mixing height and atmospheric stability.

The accuracy of model predictions depends on:

- The quality of the input data and assumptions;
- The inherent limitations in the model for predicting plume rise at any point downwind;
- The ability to predict plume dispersion coefficients (plume spread);
- The assumption that meteorological conditions remain constant between the source and receptor; and,
- That varying terrain can be accounted for.

6.2.2 Modelling Approach

The dispersion of contaminants from the proposed asphalt plant stack have been estimated using the CALPUFF dispersion model. The CALPUFF model, through the CALMET meteorological processor, simulates complex meteorological patterns that exist in a particular location. The effects of local topography and changes in land surface characteristics are accounted for by this model. CALPUFF has been adopted by the US Environmental Protection Agency (US EPA) in its Guideline on Air Quality Models as the preferred model for assessing long range transport (>50km downwind), and shorter downwind distances for applications involving complex wind regimes. Due to its treatment of complex terrain and meteorology CALPUFF is one of the more widely used dispersion models in New Zealand.

The CALPUFF Modelling System consists of three main components CALMET, CALPUFF and CALPOST. CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modelling domain. Two-dimensional fields such as mixing heights, surface characteristics, and dispersion properties are included in the file developed by CALMET. CALPUFF is a dispersion model that transports puffs of material from modelled sources, simulating dispersion and transformation processes along the way, using the meteorological fields generated by CALMET. The output file from CALPUFF contains hourly concentrations at selected receptor locations. CALPOST is then used to process this file, producing tabulations that summarise the results of the simulation and gridded results used to produce isopleth lines of equal concentrations for the modelling averaging times.

6.1.1. CALMET Meteorological Data

TDC provided the CALMET datasets for the years 2008 and 2009. The datasets were developed by Golder Associates (Golder). No CALMET input files or detailed input data (surface data, upper data etc.) were supplied with the files. The CALMET settings were obtained with an attached short document and other files provided with the datasets. CALMET version 6.326 was used to produce the data sets.

The following are the CALMET settings as provided by Golder:

- Grid Domain - 26 km x 26 km with grid spacing of 0.25 km, with 10 vertical levels;
- Number of Grid Cells (West to East, South to North) – 104, 104;
- Projection [PMAP] – TTM;
- Latitude [RLATO] – 41.298S;
- Longitude [RLONO] – 173.237E;
- False Easting [FEAST] – 1619.842 (NZTM km);
- False Northing [FNORTH] – 5428.134 (NZTM km);
- South west corner X- coordinate [XORIGKM] – 1606.00 (NZTM km); and
- South west corner Y- coordinate [YORIGKM] – 5415.00 (NZTM km).

A set of wind vector data for 2009 were extracted from a pseudo station from the CALMET dataset located near the proposed Tasman Bay Asphalt site. Figure 8 presents the wind-rose showing the wind pattern at this location. The wind-rose shows prevailing winds are from south-west and south-southwest, and winds from north and north-northeast sectors are also common. This compares favourably to the wind-rose of measured winds at the Nelson Airport meteorological station shown in Figure 3.

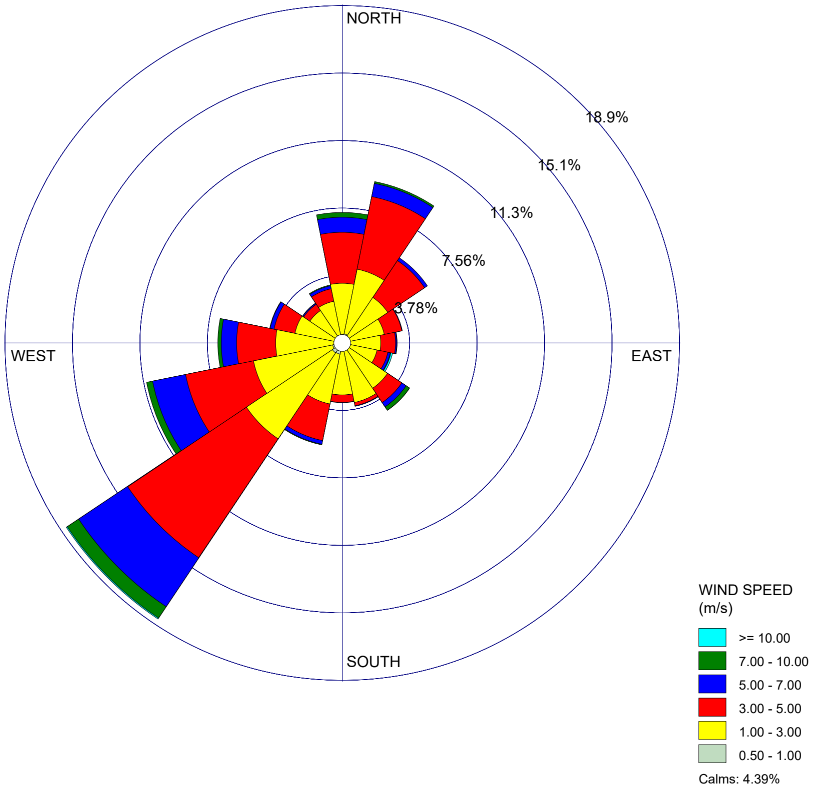

Figure 8: CALMET Windrose Extracted at Tasman Bay Asphalt Site, 2008-2009

6.2.3 CALPUFF Model Settings

The CALPUFF dispersion model (Version 7.2.1) was used for this assessment for the 2008-2009 modelling period. The model was set up as follows:

- A 5 km x 5 km domain with receptors placed at intervals of 50 metres;
- Dispersion rates were calculated using turbulence computed from micrometeorology and the Probability Density Function algorithm;
- No chemical transformation or deposition were included.

The default model settings for CALPUFF were used except as otherwise specified.

Emission parameters including contaminant emission rates as provided in Table 7 and Table 8 were input into the model. The post-processing model CALPOST Version 7.1.0 was run to predict different time averages (1-hour, 8-hour, 24-hour, and annual averages) for comparison with the relevant guidelines or standards.

Building dimensions in the vicinity of the emission source were incorporated for determining the effects of building downwash.

Table 8: Dispersion Modelling Parameters

Parameter	Values for Dispersion Modelling
Chimney height (above grade)	7.8 m for an effective height of 7.3 m
Chimney exit diameter	0.59 m x 0.90 m
Chimney efflux temperature	150°C
Chimney efflux velocity	20 m/s
Hours of Operation	6 am – 4 pm
Modelling domain size	4 x 4 km (64 km^2)
Receptor locations	Nested Grid: • 50 m × 50 m out to 5 km Sensitive receptors at selected residences
Averaging times	1 hour, 8 hour, 24 hour, and annual

As noted earlier the operating hours may vary, but the maximum operation will be limited to 10 hours in a 24-hour period. For the purposes of the dispersion modelling undertaken, we expect that provided the maximum hours do not exceed 10 hours, then there will be very little impact on the overall modelling results and no impact on the conclusions reached in the assessment based on the modelling.

6.3 Dispersion Modelling Results

Table 9 presents the highest predicted maximum ground level concentrations (MGLCs) of the modelled contaminants not including background values. The maximum prediction at or beyond the site boundary, and the highest value at any sensitive receptor are reported.

The highest predicted concentrations of all contaminants are substantially below the assessment criteria for all averaging periods. The predicted MGLCs at the surrounding sensitive receptors will be well below the highest predictions, and the effects of the discharges will be at a level that is less than minor.

Table 9: Highest Predicted MGLCs for Asphalt Plant Without Background

Contaminant	Averaging Period	Peak Modelled MGLC (µg/m³) (excluding background)	Modelled MGLC (µg/m³) at Nearest Sensitive Receptor (excluding background)	Evaluation Criteria (µg/m³)
PM_{10}	24-hour	14.5	0.8	50 (NES)
	Annual	1.5	0.09	20 (NZAAQG)
$PM_{2.5}$	24-hour	10.2	0.6	50 (NES)
	Annual	1.0	0.06	20 (NZAAQG)
NO_2[1]	1-hour (99.9th percentile)	60	7.8	200 (NZAAQG)
	24-hour	23	1.3	100 (NZAAQG)
	Annual	2.8	0.2	30 (NZAAQG)
CO	1-hour (99.9th percentile)	142	18.5	30,000 (NZAAQG)
	8-hour	117	6.4	10,000 (NZAAQG)
SO_2	1-hour (99.9th percentile)	<1	<1	350 (NZAAQG)
	24-hour	<1	<1	120 (NZAAQG)

Notes:
1. *Assume 20% of NO_X is NO_2.*

6.4 Cumulative Effects

Table 10 provides the cumulative results of the highest predicted concentrations with the assumed background concentrations for comparison against the relevant assessment criteria. The cumulative effects of the discharges with the existing background contaminant concentrations are shown to be within the relevant assessment criteria for all contaminants and averaging periods.

6.5 Contour Plots

The modelling results for PM_{10} are further supported by contour plots to provide information of the locations and distribution of the maximum predicted 24-hour average and annual average concentrations. Other contaminants will follow the same contour profiles for the same averaging periods.

Figure 9 shows the predicted MGLCs of 24-hour average PM_{10} for the proposed plant, with the highest concentrations occurring immediately to the east of the asphalt plant stack. Concentrations are predicted to be significantly lower at further distances and are predicted to be below 0.8 $\mu g/m^3$ at the nearest sensitive receptors. Concentrations of PM_{10} within the Richmond airshed are predicted to be less than 0.1 $\mu g/m^3$ as a 24-hour average.

Figure 10 shows the predicted MGLCs of PM_{10} as annual averages and indicates the highest predicted concentrations immediately to the east of the site boundary, with concentrations rapidly decreasing at further distances. Concentrations at the nearest residences are predicted to be less than 0.05 $\mu g/m^3$ as an annual average.

The discharges to air were assumed to be continuous over a 10-hour day (6 am to 4 pm) and 7 days per week. It is unlikely that the plant would operate at maximum rates of production for 10 hours continuously over an entire year, and so the modelling is a conservative assessment for 24-hour and annual predictions.

Table 10: Highest Predicted MGLCs for the Proposed Asphalt Plant (including background)

Contaminant	Averaging Period	Peak Offsite Modelled MGLC (µg/m^3) (including background)	Peak Modelled MGLC at Nearest Residence (µg/m^3) (including background)	Evaluation Criteria (µg/m^3)
PM_{10}	24-hour	39.2	25.5	50 (NES)
	Annual	19.5	18.1	20 (NZAAQG)
$PM_{2.5}$	24-hour	22.6	13.0	25 (proposed amendment to NES)
	Annual	10	9.06	10 (WHO)
NO_2[1]	1-hour (99.9th percentile)	125	72.8	200 (NES)
	24-hour	66	44.3	100 (NZAAQG)
	Annual	18.8	16.2	30 (NZAAQG)
CO	1-hour (99.9th percentile)	5,142	5,019	30,000 (NZAAQG)
	8-hour	2,117	2,006	10,000 (NES)

Notes:

1. *Assume 20% of NO_X is NO_2.*

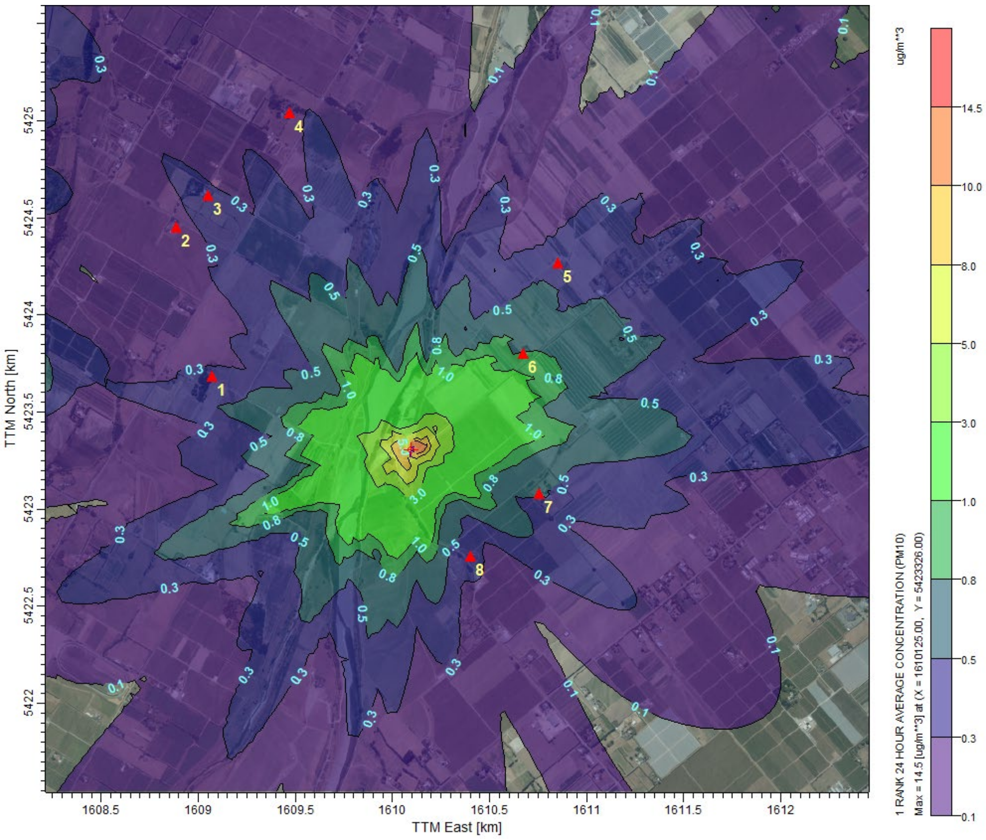

Figure 9: Predicted MGLCs PM_{10} (24-Hour Averages)

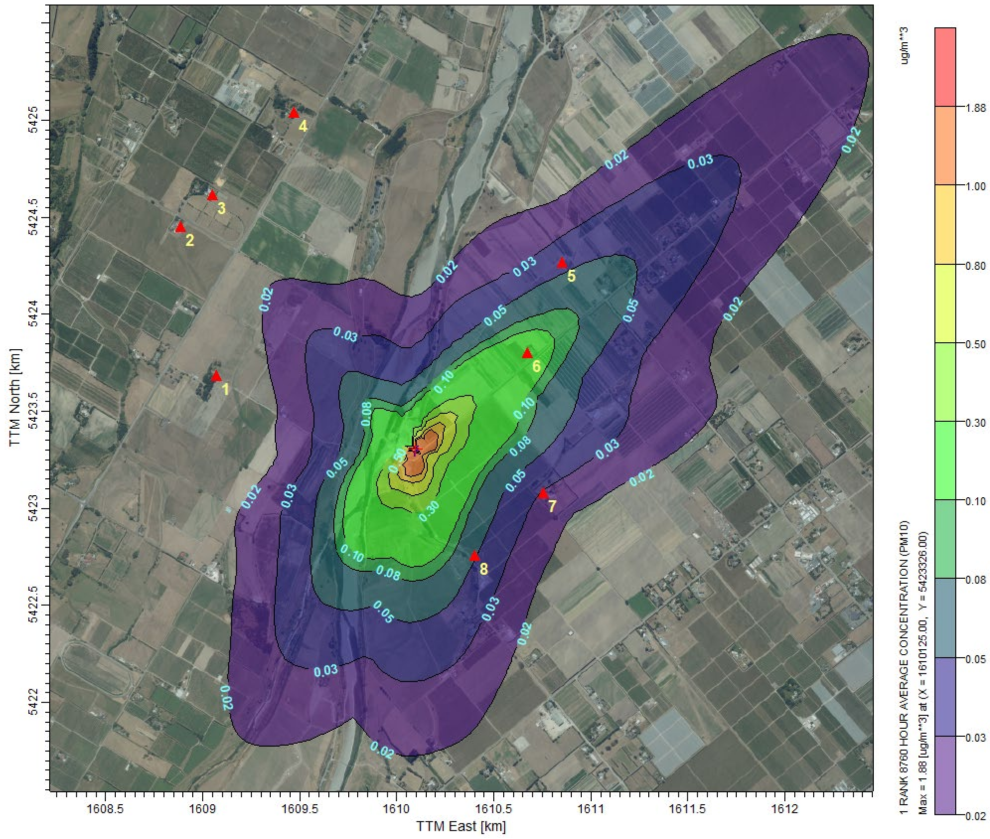

Figure 10: Predicted MGLCs PM_{10} (Annual Averages)

Appendix A: CALPUFF Summary

CALPUFF Parameters

Asphalt and Construction Ltd - asphalt stack
Year 2008-2009 CALMET.
5 x 5 km2 Modelling Domain. Nesting Factor 5 (50 m).

INPUT GROUP: 0 -- Input and Output File Names

Parameter	Description	Value
PUFLST	CALPUFF output list file (CALPUFF.LST)	CALPUFF.LST
CONDAT	CALPUFF output concentration file (CONC.DAT)	CONC.DAT
DFDAT	CALPUFF output dry deposition flux file (DFLX.DAT)	DFLX.DAT
WFDAT	CALPUFF output wet deposition flux file (WFLX.DAT)	WFLX.DAT
DEBUG	Puff-tracking output data file (DEBUG.DAT)	DEBUG.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NMETDOM	Number of CALMET.DAT domains	1
NMETDAT	Number of CALMET.DAT input files	24
NPTDAT	Number of PTEMARB.DAT input files	0
NARDAT	Number of BAEMARB.DAT input files	0
NVOLDAT	Number of VOLEMARB.DAT input files	0
NFLDAT	Number of FLEMARB.DAT input files	0
NRDDAT	Number of RDEMARB.DAT input files	0
NLNDAT	Number of LNEMARB.DAT input files	0
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_01.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_02.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_03.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_04.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_05.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_06.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_07.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_08.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_09.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_10.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_11.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2008_12.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_01.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_02.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_03.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_04.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_05.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_06.MET

INPUT GROUP: 0 -- Input and Output File Names		
Parameter	**Description**	**Value**
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_07.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_08.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_09.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_10.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_11.MET
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	2009_12.MET

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
METRUN	Run all periods in met data file? (0 = no, 1 = yes)	0
IBYR	Starting year	2008
IBMO	Starting month	1
IBDY	Starting day	1
IBHR	Starting hour	0
IBMIN	Starting minute	0
IBSEC	Starting second	0
IEYR	Ending year	2009
IEMO	Ending month	12
IEDY	Ending day	31
IEHR	Ending hour	23
IEMIN	Ending minute	0
IESEC	Ending second	0
ABTZ	Base time zone	UTC+1200
NSECDT	Length of modeling time-step (seconds)	3600
NSPEC	Number of chemical species modeled	5
NSE	Number of chemical species to be emitted	5
ITEST	Stop run after SETUP phase (1 = stop, 2 = run)	2
MRESTART	Control option to read and/or write model restart data	0
NRESPD	Number of periods in restart output cycle	0
METFM	Meteorological data format (1 = CALMET, 2 = ISC, 3 = AUSPLUME, 4 = CTDM, 5 = AERMET)	1
MPRFFM	Meteorological profile data format (1 = CTDM, 2 = AERMET)	1
AVET	Averaging time (minutes)	60
PGTIME	PG Averaging time (minutes)	60
IOUTU	Output units for binary output files (1 = mass, 2 = odour, 3 = radiation)	1

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**
MGAUSS	Near field vertical distribution (0 = uniform, 1 = Gaussian)	1

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**
MCTADJ	Terrain adjustment method (0 = none, 1 = ISC-type, 2 = CALPUFF-type, 3 = partial plume path)	3
MCTSG	Model subgrid-scale complex terrain? (0 = no, 1 = yes)	0
MSLUG	Near-field puffs modeled as elongated slugs? (0 = no, 1 = yes)	0
MTRANS	Model transitional plume rise? (0 = no, 1 = yes)	1
MTIP	Apply stack tip downwash to point sources? (0 = no, 1 = yes)	1
MRISE	Plume rise module for point sources (1 = Briggs, 2 = numerical)	1
MTIP_FL	Apply stack tip downwash to flare sources? (0 = no, 1 = yes)	0
MRISE_FL	Plume rise module for flare sources (1 = Briggs, 2 = numerical)	2
MBDW	Building downwash method (1 = ISC, 2 = PRIME)	2
MSHEAR	Treat vertical wind shear? (0 = no, 1 = yes)	0
MSPLIT	Puff splitting allowed? (0 = no, 1 = yes)	0
MCHEM	Chemical transformation method (0 = not modeled, 1 = MESOPUFF II, 2 = User-specified, 3 = RIVAD/ARM3, 4 = MESOPUFF II for OH, 5 = half-life, 6 = RIVAD w/ISORROPIA, 7 = RIVAD w/ISORROPIA CalTech SOA)	0
MAQCHEM	Model aqueous phase transformation? (0 = no, 1 = yes)	0
MLWC	Liquid water content flag	1
MWET	Model wet removal? (0 = no, 1 = yes)	0
MDRY	Model dry deposition? (0 = no, 1 = yes)	0
MTILT	Model gravitational settling (plume tilt)? (0 = no, 1 = yes)	0
MDISP	Dispersion coefficient calculation method (1= PROFILE.DAT, 2 = Internally, 3 = PG/MP, 4 = MESOPUFF II, 5 = CTDM)	2
MTURBVW	Turbulence characterization method (only if MDISP = 1 or 5)	3
MDISP2	Missing dispersion coefficients method (only if MDISP = 1 or 5)	3
MTAULY	Sigma-y Lagrangian timescale method	0
MTAUADV	Advective-decay timescale for turbulence (seconds)	0
MCTURB	Turbulence method (1 = CALPUFF, 2 = AERMOD)	1
MROUGH	PG sigma-y and sigma-z surface roughness adjustment? (0 = no, 1 = yes)	0
MPARTL	Model partial plume penetration for point sources? (0 = no, 1 = yes)	1
MPARTLBA	Model partial plume penetration for buoyant area sources? (0 = no, 1 = yes)	1
MTINV	Strength of temperature inversion provided in PROFILE.DAT? (0 = no - compute from default gradients, 1 = yes)	0
MPDF	PDF used for dispersion under convective conditions? (0 = no, 1 = yes)	1
MSGTIBL	Sub-grid TIBL module for shoreline? (0 = no, 1 = yes)	0
MBCON	Boundary conditions modeled? (0 = no, 1 = use BCON.DAT, 2 = use CONC.DAT)	0
MSOURCE	Save individual source contributions? (0 = no, 1 = yes)	0
MFOG	Enable FOG model output? (0 = no, 1 = yes - PLUME mode, 2 = yes - RECEPTOR mode)	0
MREG	Regulatory checks (0 = no checks, 1 = USE PA LRT checks)	0

INPUT GROUP: 3 -- Species List		
Parameter	**Description**	**Value**
CSPEC	Species included in model run	PM10
CSPEC	Species included in model run	NOX
CSPEC	Species included in model run	SO2
CSPEC	Species included in model run	CO
CSPEC	Species included in model run	PM2.5

INPUT GROUP: 4 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
PMAP	Map projection system	TTM
FEAST	False easting at projection origin (km)	1619.842
FNORTH	False northing at projection origin (km)	5428.134
UTMHEM	Hemisphere (N = northern, S = southern)	N
RLAT0	Latitude of projection origin (decimal degrees)	41.298S
RLON0	Longitude of projection origin (decimal degrees)	173.237E
XLAT1	1st standard parallel latitude (decimal degrees)	30S
XLAT2	2nd standard parallel latitude (decimal degrees)	60S
DATUM	Datum-region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	104
NY	Meteorological grid - number of Y grid cells	104
NZ	Meteorological grid - number of vertical layers	10
DGRIDKM	Meteorological grid spacing (km)	0.25
ZFACE	Meteorological grid - vertical cell face heights (m)	0.0, 20.0, 40.0, 80.0, 120.0, 200.0, 400.0, 800.0, 1200.0, 2000.0, 3000.0
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	1606
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	5415
IBCOMP	Computational grid - X index of lower left corner	1
JBCOMP	Computational grid - Y index of lower left corner	1
IECOMP	Computational grid - X index of upper right corner	104
JECOMP	Computational grid - Y index of upper right corner	104
LSAMP	Use sampling grid (gridded receptors) (T = true, F = false)	T
IBSAMP	Sampling grid - X index of lower left corner	9
JBSAMP	Sampling grid - Y index of lower left corner	26
IESAMP	Sampling grid - X index of upper right corner	27
JESAMP	Sampling grid - Y index of upper right corner	44
MESHDN	Sampling grid - nesting factor	5

INPUT GROUP: 5 -- Output Options		
Parameter	**Description**	**Value**

INPUT GROUP: 5 -- Output Options		
Parameter	**Description**	**Value**
ICON	Output concentrations to CONC.DAT? (0 = no, 1 = yes)	1
IDRY	Output dry deposition fluxes to DFLX.DAT? (0 = no, 1 = yes)	0
IWET	Output wet deposition fluxes to WFLX.DAT? (0 = no, 1 = yes)	0
IT2D	Output 2D temperature data? (0 = no, 1 = yes)	0
IRHO	Output 2D density data? (0 = no, 1 = yes)	0
IVIS	Output relative humidity data? (0 = no, 1 = yes)	0
LCOMPRS	Use data compression in output file (T = true, F = false)	T
IQAPLOT	Create QA output files suitable for plotting? (0 = no, 1 = yes)	1
IPFTRAK	Output puff tracking data? (0 = no, 1 = yes use timestep, 2 = yes use sampling step)	0
IMFLX	Output mass flux across specific boundaries? (0 = no, 1 = yes)	0
IMBAL	Output mass balance for each species? (0 = no, 1 = yes)	0
INRISE	Output plume rise data? (0 = no, 1 = yes)	0
ICPRT	Print concentrations? (0 = no, 1 = yes)	0
IDPRT	Print dry deposition fluxes? (0 = no, 1 = yes)	0
IWPRT	Print wet deposition fluxes? (0 = no, 1 = yes)	0
ICFRQ	Concentration print interval (timesteps)	1
IDFRQ	Dry deposition flux print interval (timesteps)	1
IWFRQ	Wet deposition flux print interval (timesteps)	1
IPRTU	Units for line printer output (e.g., 3 = ug/m**3 - ug/m**2/s, 5 = odor units)	3
IMESG	Message tracking run progress on screen (0 = no, 1 and 2 = yes)	2
LDEBUG	Enable debug output? (0 = no, 1 = yes)	T
IPFDEB	First puff to track in debug output	1
NPFDEB	Number of puffs to track in debug output	1
NN1	Starting meteorological period in debug output	1
NN2	Ending meteorological period in debug output	10

INPUT GROUP: 6 -- Subgrid Scale Complex Terrain Inputs		
Parameter	**Description**	**Value**
NHILL	Number of terrain features	0
NCTREC	Number of special complex terrain receptors	0
MHILL	Terrain and CTSG receptor data format (1= CTDM, 2 = OPTHILL)	2
XHILL2M	Horizontal dimension conversion factor to meters	1.0
ZHILL2M	Vertical dimension conversion factor to meters	1.0
XCTDMKM	X origin of CTDM system relative to CALPUFF system (km)	0.0
YCTDMKM	Y origin of CTDM system relative to CALPUFF system (km)	0.0

INPUT GROUP: 9 -- Miscellaneous Dry Deposition Parameters		
Parameter	**Description**	**Value**

INPUT GROUP: 9 -- Miscellaneous Dry Deposition Parameters		
Parameter	**Description**	**Value**
RCUTR	Reference cuticle resistance (s/cm)	30
RGR	Reference ground resistance (s/cm)	10
REACTR	Reference pollutant reactivity	8
NINT	Number of particle size intervals for effective particle deposition velocity	9
IVEG	Vegetation state in unirrigated areas (1 = active and unstressed, 2 = active and stressed, 3 = inactive)	1

INPUT GROUP: 11 -- Chemistry Parameters		
Parameter	**Description**	**Value**
MOZ	Ozone background input option (0 = monthly, 1 = hourly from OZONE.DAT)	1
BCKO3	Monthly ozone concentrations (ppb)	80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00
MNH3	Ammonia background input option (0 = monthly, 1 = from NH3Z.DAT)	0
MAVGNH3	Ammonia vertical averaging option (0 = no average, 1 = average over vertical extent of puff)	1
BCKNH3	Monthly ammonia concentrations (ppb)	10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2
MH2O2	H2O2 background input option (0 = monthly, 1 = hourly from H2O2.DAT)	1
BCKH2O2	Monthly H2O2 concentrations (ppb)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
RH_ISRP	Minimum relative humidity for ISORROPIA	50.0
SO4_ISRP	Minimum SO4 for ISORROPIA	0.4
BCKPMF	SOA background fine particulate (ug/m**3)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
OFRAC	SOA organic fine particulate fraction	0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15
VCNX	SOA VOC/NOX ratio	50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00
NDECAY	Half-life decay blocks	0

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
SYTDEP	Horizontal puff size for time-dependent sigma equations (m)	550

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
MHFTSZ	Use Heffter equation for sigma-z? (0 = no, 1 = yes)	0
JSUP	PG stability class above mixed layer	5
CONK1	Vertical dispersion constant - stable conditions	0.01
CONK2	Vertical dispersion constant - neutral/unstable conditions	0.1
TBD	Downwash scheme transition point option (<0 = Huber-Snyder, 1.5 = Schulman-Scire, 0.5 = ISC)	0.5
IURB1	Beginning land use category for which urban dispersion is assumed	10
IURB2	Ending land use category for which urban dispersion is assumed	19
ILANDUIN	Land use category for modeling domain	20
Z0IN	Roughness length for modeling domain (m)	.25
XLAIIN	Leaf area index for modeling domain	3.0
ELEVIN	Elevation above sea level (m)	.0
XLATIN	Meteorological station latitude (deg)	-999.0
XLONIN	Meteorological station longitude (deg)	-999.0
ANEMHT	Anemometer height (m)	10.0
ISIGMAV	Lateral turbulence format (0 = read sigma-theta, 1 = read sigma-v)	1
IMIXCTDM	Mixing heights read option (0 = predicted, 1 = observed)	0
XMXLEN	Slug length (met grid units)	1
XSAMLEN	Maximum travel distance of a puff/slug (met grid units)	1
MXNEW	Maximum number of slugs/puffs release from one source during one time step	99
MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99
NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2
SYMIN	Minimum sigma-y for a new puff/slug (m)	1
SZMIN	Minimum sigma-z for a new puff/slug (m)	1
SZCAP_M	Maximum sigma-z allowed to avoid numerical problem in calculating virtual time or distance (m)	5000000
SVMIN	Minimum turbulence velocities sigma-v (m/s)	0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37, 0.37
SWMIN	Minimum turbulence velocities sigma-w (m/s)	0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06, 0.03, 0.016
CDIV	Divergence criterion for dw/dz across puff (1/s)	0, 0
NLUTIBL	TIBL module search radius (met grid cells)	4
WSCALM	Minimum wind speed allowed for non-calm conditions (m/s)	0.5
XMAXZI	Maximum mixing height (m)	3000
XMINZI	Minimum mixing height (m)	50
TKCAT	Emissions scale-factors temperature categories (K)	265., 270., 275., 280., 285., 290., 295., 300., 305., 310., 315.

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
PLX0	Wind speed profile exponent for stability classes 1 to 6	0.07, 0.07, 0.1, 0.15, 0.35, 0.55
PTG0	Potential temperature gradient for stable classes E and F (deg K/m)	0.02, 0.035
PPC	Plume path coefficient for stability classes 1 to 6	0.5, 0.5, 0.5, 0.5, 0.35, 0.35
SL2PF	Slug-to-puff transition criterion factor (sigma-y/slug length)	10
FCLIP	Hard-clipping factor for slugs (0.0 = no extrapolation)	0
NSPLIT	Number of puffs created from vertical splitting	3
IRESPLIT	Hour for puff re-split	0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0
ZISPLIT	Minimum mixing height for splitting (m)	100
ROLDMAX	Mixing height ratio for splitting	0.25
NSPLITH	Number of puffs created from horizontal splitting	5
SYSPLITH	Minimum sigma-y (met grid cells)	1
SHSPLITH	Minimum puff elongation rate (SYSPLITH/hr)	2
CNSPLITH	Minimum concentration (g/m**3)	1E-007
EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	0.0001
EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-006
DSRISE	Trajectory step-length for numerical rise integration (m)	1.0
HTMINBC	Minimum boundary condition puff height (m)	500
RSAMPBC	Receptor search radius for boundary condition puffs (km)	10
MDEPBC	Near-surface depletion adjustment to concentration (0 = no, 1 = yes)	1

INPUT GROUP: 13 -- Point Source Parameters		
Parameter	**Description**	**Value**
NPT1	Number of point sources	1
IPTU	Units used for point source emissions (e.g., 1 = g/s)	1
NSPT1	Number of source-species combinations with variable emission scaling factors	5
NPT2	Number of point sources in PTEMARB.DAT file(s)	0

INPUT GROUP: 14 -- Area Source Parameters		
Parameter	**Description**	**Value**
NAR1	Number of polygon area sources	0
IARU	Units used for area source emissions (e.g., 1 = g/m**2/s)	1
NSAR1	Number of source-species combinations with variable emission scaling factors	0
NAR2	Number of buoyant polygon area sources in BAEMARB.DAT file(s)	0

INPUT GROUP: 15 -- Line Source Parameters		
Parameter	**Description**	**Value**
NLN2	Number of buoyant line sources in LNEMARB.DAT file	0
NLINES	Number of buoyant line sources	0
ILNU	Units used for line source emissions (e.g., 1 = g/s)	1
NSLN1	Number of source-species combinations with variable emission scaling factors	0
NLRISE	Number of distances at which transitional rise is computed	6
XL	Average building length (m)	0.0
HBL	Average building height (m)	0.0
WBL	Average building width (m)	0.0
WML	Average line source width (m)	0.0
DXL	Average separation between buildings (m)	0.0
FPRIMEL	Average buoyancy parameter (m**4/s**3)	0

INPUT GROUP: 16 -- Volume Source Parameters		
Parameter	**Description**	**Value**
NVL1	Number of volume sources	0
IVLU	Units used for volume source emissions (e.g., 1 = g/s)	1
NSVL1	Number of source-species combinations with variable emission scaling factors	0
NVL2	Number of volume sources in VOLEMARB.DAT file(s)	0

INPUT GROUP: 17 -- FLARE Source Control Parameters (variable emissions file)		
Parameter	**Description**	**Value**
NFL2	Number of flare sources defined in FLEMARB.DAT file(s)	0

INPUT GROUP: 18 -- Road Emissions Parameters		
Parameter	**Description**	**Value**
NRD1	Number of road-links sources	0
NRD2	Number of road-links in RDEMARB.DAT file	0
NSFRDS	Number of road-links and species combinations with variable emission-rate scale-factors	0

INPUT GROUP: 19 -- Emission Rate Scale-Factor Tables		
Parameter	**Description**	**Value**
NSFTAB	Number of emission scale-factor tables	1

INPUT GROUP: 20 -- Non-gridded (Discrete) Receptor Information		
Parameter	**Description**	**Value**
NREC	Number of discrete receptors (non-gridded receptors)	8
NRGRP	Number of receptor group names	0