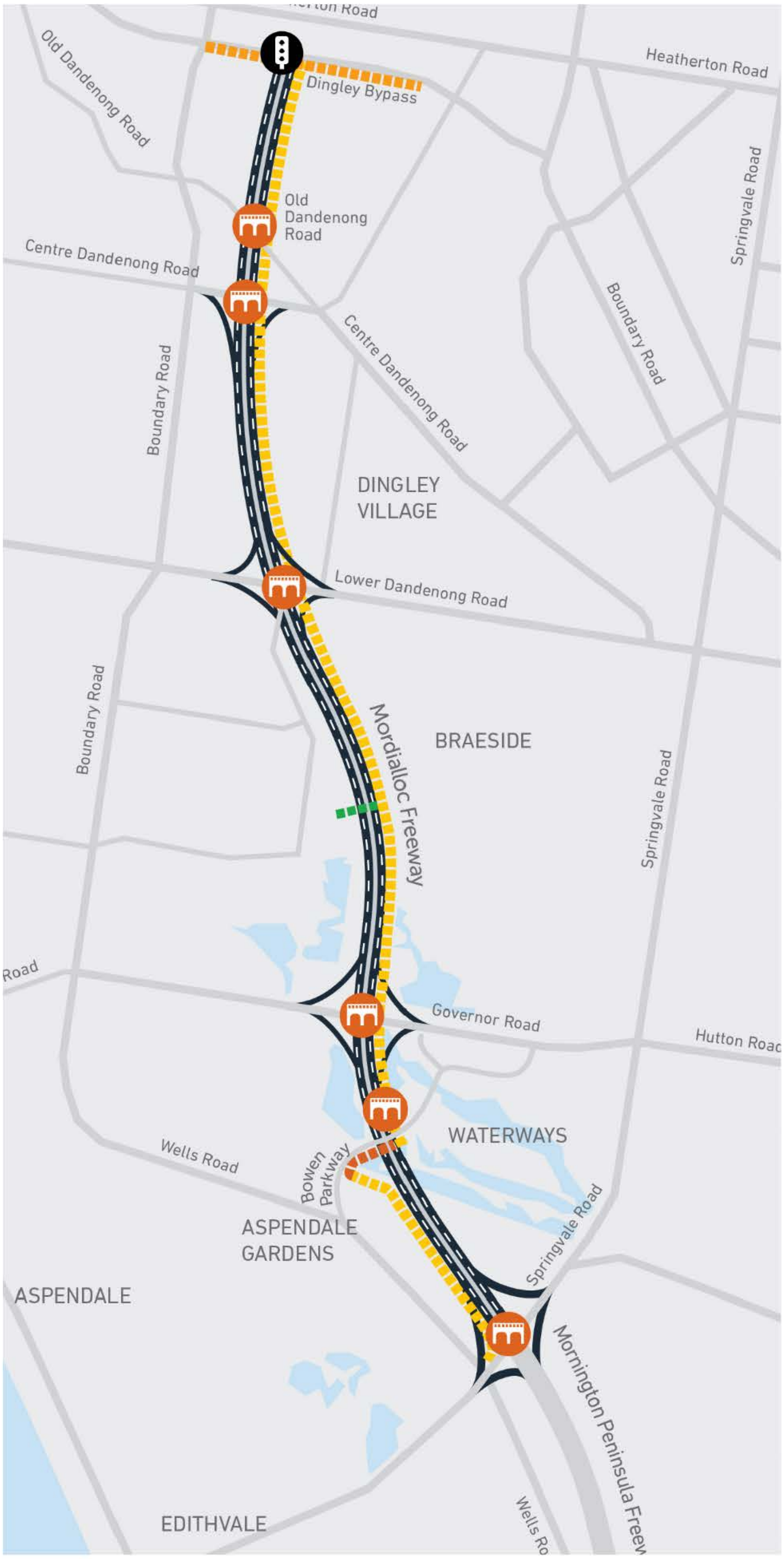


MAJOR ROAD PROJECTS AUTHORITY

24 JULY 2018

MORDIALLOC BYPASS

AIR QUALITY ASSESSMENT

CONSULTING ENVIRONMENTAL ENGINEERS

CEE

Air Quality Assessment for Mordialloc Bypass Project

Table of Contents

Glossary

BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CH4	Methane
Class 1 Indicators	Common environmental indicators in the SEPP(AQM)
CO	Carbon Monoxide
CO2	Carbon Dioxide
DELWP	Department of Environment, Land, Water and Planning
DOEE	Department of Environment and Energy (Commonwealth)
EE Act	Environment Effects Act 1978
EES	Environment Effects Statement
EMP	Environmental Management Plan
EP Act	Environment Protection Act 1970
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPA	Environment Protection Authority
HCV	Heavy Commercial Vehicle
Kg/d	Kilograms per day
km	kilometre
m/s	Metres per second
NEPM	National Environment Protection Measures
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NEPC	National Environment Protection Council
NPI	National Pollutant Inventory
PAH	Polycyclic Aromatic Hydrocarbon
PIARC	World Road Association (PIARC is the name in French)
PM_{10}	Particulate Matter with diameter of less than 10 µm
$PM_{2.5}$	Particulate Matter with diameter of less than 2.5 µm
ppm	parts per million
SEPP(AAQ)	State Environment Protection Policy - Ambient Air Quality
SEPP(AQM)	State Environment Protection Policy - Air Quality Management
TSP	Total Suspended Particulates,
t/yr	Tonnes per year
$\mu g/m^3$	Micrograms per cubic metre
v/v	Volume per volume

Document History

Ver	Status	Originator	Review	Date
00	First draft to WSP	I Wallis	JR (CEE)	7 April 2018
01	Second draft to TRG	I Wallis	JR (CEE)	15 April 2018
02	Draft Report for Freeway	I Wallis	JR (CEE)	31 May 2018
03	Updated Receptors	I Wallis	CEE	16 June 2018
04	Updated for VicRoads comments	I Wallis	JR (CEE)	16 July 2018
05	Updated summary table	I Wallis	JR (CEE)	20 July 2018
06	Draft for TRG	I Wallis	JR (CEE)	24 July 2018

Executive Summary

In September 2017, the Victorian Government announced its intention to build the Mordialloc Bypass Project and the requirement to prepare an Environment Effects Statement (EES) under Section 3 of the *Environment Effects Act 1978*.

The EES has been prepared in accordance with the Victorian Government's *Scoping Requirements for Mordialloc Bypass*, May 2018. Consulting Environmental Engineers was commissioned by WSP to undertake the air quality impact assessment.

The EES objective for the Mordialloc Bypass Project, relevant to air quality is:

- ***Amenity and environmental quality** – to protect the health and wellbeing of residents and local communities, and minimise effects on air quality, noise and the social amenity of the area, having regard to relevant limits, targets or standards.*

Background

The Mordialloc Bypass Project is a proposed new route in Melbourne's south-eastern suburbs, located in an existing road reservation. The 9.7 kilometre (km) new freeway will provide a link between the Mornington Peninsula Freeway at Thames Promenade in Chelsea Heights and the Dingley Bypass in Dingley, creating a continuous freeway from Frankston to Clayton.

The proposed road will have two lanes in each direction with a posted maximum speed of 100 km/hr. The reservation and roadway planning allows for a future upgrade to a six lane freeway in the future.

Potential air quality impacts associated with the project primarily relate to:

- Emissions during construction activities from on-site vehicles and on-site mobile machinery
- Exhaust emissions from vehicles travelling along the new Mordialloc Freeway (the Bypass Project)

This report assesses the impact of these activities on air quality with guidance from relevant legislation.

Regulatory context

The following legislation, policies and guidelines, were referenced during the assessment of air quality impacts of contaminants for the construction and operation of the Mordialloc Bypass Project:

- State Environment Protection Policy (Air Quality Management) December 2001 [SEPP(AQM)]
- State Environment Protection Policy (Ambient Air Quality) [SEPP(AAQ)] as amended in July 2016 to incorporate changes to the Air NEPM particles standards (February 2016)
- Environment Protection Authority (EPA) Guidelines for Major Construction Sites (EPA 1996)
- National Environment Protection (Ambient Air Quality) Measure [Air NEPM] (February 2016)

Risk assessment

An environmental risk assessment (ERA) including an assessment of air quality impacts resulting from the project was undertaken. The ERA assessed all project phases, namely: Initial Phase (the current approvals and concept design stage); Construction Phase; and Operations and Maintenance Phase. The air quality impact assessment and risk assessment processes were integrated throughout the development of the EES. For all risks ranked Medium, High or Extreme in the Initial risk rating, technical specialists were required to identify additional controls which could be implemented to further reduce risk and to determine the residual risk rating. Additional controls specify management measures over and above those considered as Standard Controls to ensure the residual risk is effectively avoided or mitigated to as low as reasonably practicable.

These assessments also underpin the establishment of the Environmental Performance Requirements (EPRs), which set out the desired environmental outcomes for the project.

Existing Conditions

Existing air quality conditions were derived from the measurements at Environment Protection Authority (EPA) monitoring sites in metropolitan Melbourne, with Brighton being the closest EPA monitoring site to the Mordialloc Bypass Project. Comparison of the results from different sites show that air quality contaminants are slightly higher in the Central Business District and eastern Melbourne than in the outer suburbs, but surprisingly similar throughout the urban area.

The carbon monoxide levels in the region, including at Mordialloc, are well within the 8 hour air quality objective of 9 ppm. The nitrogen dioxide levels in the region are within the 1 hour air quality objective of 0.12 ppm. The 24-hour PM_{10} levels meet the air quality objective of 50 µg/m^3 except for one to two days per year when there are major bushfires or dust storms. The 24-hour $PM_{2.5}$ levels meet the air quality objective of 25 µg/m^3 except during the same events, although the margin of safety is less.

Former Enviromix Landfill

A section of the proposed Mordialloc Bypass near Dingley Bypass extends over a disused landfill that is still emitting landfill gases, principally methane and hydrogen sulfide. A design solution is recommended to disperse these gases so they will not accumulate under the roadways, and there will be negligible change in odour levels beyond about 250 m from the landfill.

Air Quality Assessment

The air quality impacts of the Freeway Project that are assessed in detail include:

- Particulate matter emissions from clearing, filling and other construction activities and
- Vehicle emissions during operations.

Air quality impacts during the initial phase of the Project which includes geotechnical investigations, was not considered to be of significance and consequently not addressed in detail in this report.

Modelling of both construction and operation emissions was carried out to predict the potential impacts on the local environment. Air dispersion modelling was conducted using *Ausroads* to predict the dispersal of air emissions during construction and operation of the project.

The dust emissions were calculated from the range of construction equipment required on the site while vehicle emissions were calculated from EPA emission factors and modelled traffic data from WSP, taking account of the proportions of different vehicles, vehicle speed at various hours of the day and the gradient of the roadway. Meteorological data were derived from Bureau of Meteorology measurements at Moorabbin Airport.

The dispersion model predictions were compared with SEPP(AQM) design criteria for both construction and operation phases, as directed by EPA in June 2018.

Construction Impacts

Ground level concentrations of the following contaminants during construction were assessed:

- Total Suspended Particulates (TSP)
- PM_{10}

Construction dust is predicted to be greatest during the stage of forming the roadway and pavement base. The predicted maximum zone of nuisance dust is predicted to extend up to about 100 m from the edge of the construction zone on a few hot days with moderate to strong winds, although less than 60 m for most of the construction period.

The construction period is two years, and dust impacts will generally be localised in extent and temporary in duration. A range of management measures has been recommended to limit the extent of dust and adverse effects on sensitive receptors.

It is concluded that the potential impacts from construction works would be localised, of short duration and intermittent, and would be managed through a Construction Environmental Management Plan (CEMP) that includes dust monitoring adjacent to residential areas during the construction phase.

Operational Impacts

Ground level concentrations of the following contaminants were assessed during operation of the Mordialloc Bypass project:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- PM_{10}
- $PM_{2.5}$

Predicted ground level concentrations are expected to be minor for CO, NO_2, PM_{10} and $PM_{2.5}$. NO_2 is expected to be higher than current air quality concentrations on and adjacent to the roadways. However, all residential and commercial receptors are predicted to be within relevant SEPP design criteria.

Environmental Performance Requirements

EPRs relating to air quality impacts were developed to manage and mitigate risk during construction and operation of the project.

The risk and impact assessments identified that the EPRs will reduce the risks to a range from negligible to low impacts on air quality during construction and operation of the project. It is considered these EPRs are appropriate for managing the likely air quality impacts.

In summary, these include:

- The Contractor must design the Project to ensure air quality impacts during operation are minimised in accordance with relevant Victorian legislation, policies and guidelines.
- The Contractor must prepare and implement a CEMP to minimise air quality impacts during construction in accordance with relevant Victorian legislation, policies and guidelines.

Conclusion

Existing air quality and meteorological conditions were characterised, relevant air quality assessment criteria established and sensitive receptors in the vicinity of the project alignment were identified. The potential impacts on air quality were assessed for both construction and operation with predicted ground level concentrations below relevant criteria.

It is concluded the air quality impacts can be controlled by procedures and methods routinely applied to major road projects and therefore no significant air quality effects.

Environmental Performance Requirements (EPRs) for the management of air quality impacts were developed for construction and operation of the Mordialloc Bypass Project. The mitigation measures and management processes put in place to achieve the EPR's will result in negligible to low impacts on air quality during construction and operation of the project.

It is concluded that the Mordialloc Bypass Project satisfies the EES evaluation objective relating to air quality.

1. Introduction

In light of the potential for significant environmental effects, on 13 September 2017 the Victorian Minister for Planning (the Minister) determined under the Environment Effects Act 1978 (EE Act) that VicRoads (the proponent) is to prepare an environment effects statement (EES) for the Mordialloc Bypass project. The purpose of the EES is to provide a description of the proposed project, assess its potential effects on the environment and assess alternative designs and approaches to avoid and mitigate environmental effects.

The EES will inform and seek feedback from the public and stakeholders, and enable the Minister to issue an assessment of the environmental effects of the project under the EE Act at the conclusion of the process. The Minister's assessment will then inform statutory decision-makers responsible for the project's approvals.

CEE has been commissioned to undertake an air quality impact assessment based on the project design to inform the EES.

1.1 Purpose of this Report

This report assesses the potential air quality impacts associated with constructing and operating the Mordialloc Bypass. It sets out EPRs for the project relating to air quality, and defines actions to eliminate or minimise any potential air quality impacts.

1.2 Study Objectives

The objectives of the air quality assessment were to:

- Characterise existing air quality and meteorological conditions for the Project.
- Establish air quality design criteria relevant to the sensitive receptors in the vicinity of the project.
- Identify air quality risks and assess potential impacts of the construction and operation of the project, and where appropriate, propose measures to avoid, mitigate or manage adverse impacts on the receiving environment.
- Satisfy regulatory requirements, particularly the requirements of the State Environment Protection (Air Quality Management) [SEPP(AQM)].
- Develop ambient air quality performance requirements that specify the limits and processes that must be followed to achieve an acceptable outcome.

1.3 Scoping Requirements

The Scoping Requirements for the Mordialloc Bypass (Scoping Requirements) set out the specific matters to be investigated and documented in the EES for the project. The Minister has issued the Scoping Requirements after considering public comments received on draft Scoping Requirements. Scoping requirements relevant to air quality are set out in Table 1.1.

The relevant draft evaluation objective for air quality is:

*'**Amenity and environmental quality** – To protect the health and wellbeing of residents and local communities, and minimise effects on air quality, noise and the social amenity of the area, having regard to relevant limits, targets or standards.'*

Note that the amenity issues of noise, vibration and greenhouse gas emissions are addressed in other technical reports.

Table 1-1 Air Quality Scoping Requirements

Aspect	Scoping Requirement	See Section
Key Issues	Potential for dust emissions resulting from construction works and activities, including dust from potentially contaminated soil.	8
	Potential for increased vehicle traffic to affect local air quality adversely due to exposure to vehicle emissions.	9
Priorities for characterising existing environment	Identify dwellings and any other potentially sensitive receptors (e.g. community centres, open spaces etc.) that could be affected by the project's potential effects on air quality, especially vulnerable receptors including children and the elderly.	7
	Monitor and characterise background levels of air quality (e.g. dust and greenhouse gas emissions from equipment), noise and vibration in the vicinity of the project, including the established residential areas and other sensitive urban receptors along the road corridor.	6
Design and mitigation measures	Identify potential and proposed design responses and/or other mitigation measures to avoid, reduce and/or manage any significant effects for sensitive receptors during the project construction and operation arising from specified air pollution indicators in the context of applicable policy and standards.	8, 9, 10, 11 and 12
Assessment of likely effects	Predict likely atmospheric concentrations of dust and other relevant air pollution indicators at sensitive receptors along the road corridor, during project construction and operation, using an air quality impact assessment undertaken in accordance with relevant SEPP environmental objectives	8, 9, 10
Approach to manage performance	Measures to manage other potentially significant effects on amenity and environmental quality should be addressed in the EES, including a framework for identifying and responding to emerging issues, as part of the EMF.	11, 12 and 13

As noted above, existing air quality data from EPA monitoring stations has been used to characterise the existing air quality environment and is considered adequate for the purposes of this assessment. No additional monitoring of air quality has been carried out as part of the EES preparation. Air quality monitoring may be prescribed in pre-construction and/or post-construction after assessment of the EES. Monitoring of dust during construction adjacent to sensitive receptors is recommended in this report.

1.4 Air Contaminants

Air contaminants of relevance to construction which have been quantitatively assessed for the Mordialloc Bypass Project are:

- Total Suspended Particulates (TSP)
- Particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}).

These air contaminants are among the main components of emissions from mobile plant machinery and vehicles.

For the operation phase, the following contaminants, emitted from vehicular traffic were quantitatively assessed:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Particulate matter with an aerodynamic diameter less than 10 microns (PM_{10})
- Particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$).

EPA has noted that other contaminants including volatile organic compounds, polycyclic aromatic hydrocarbons (PAHs) compounds and air toxics are emitted by vehicles but, in EPA's experience, it is unlikely that design criteria will be exceeded. Consequently, assessment of these contaminants was not conducted and were not further considered in this report.

2 Project Description

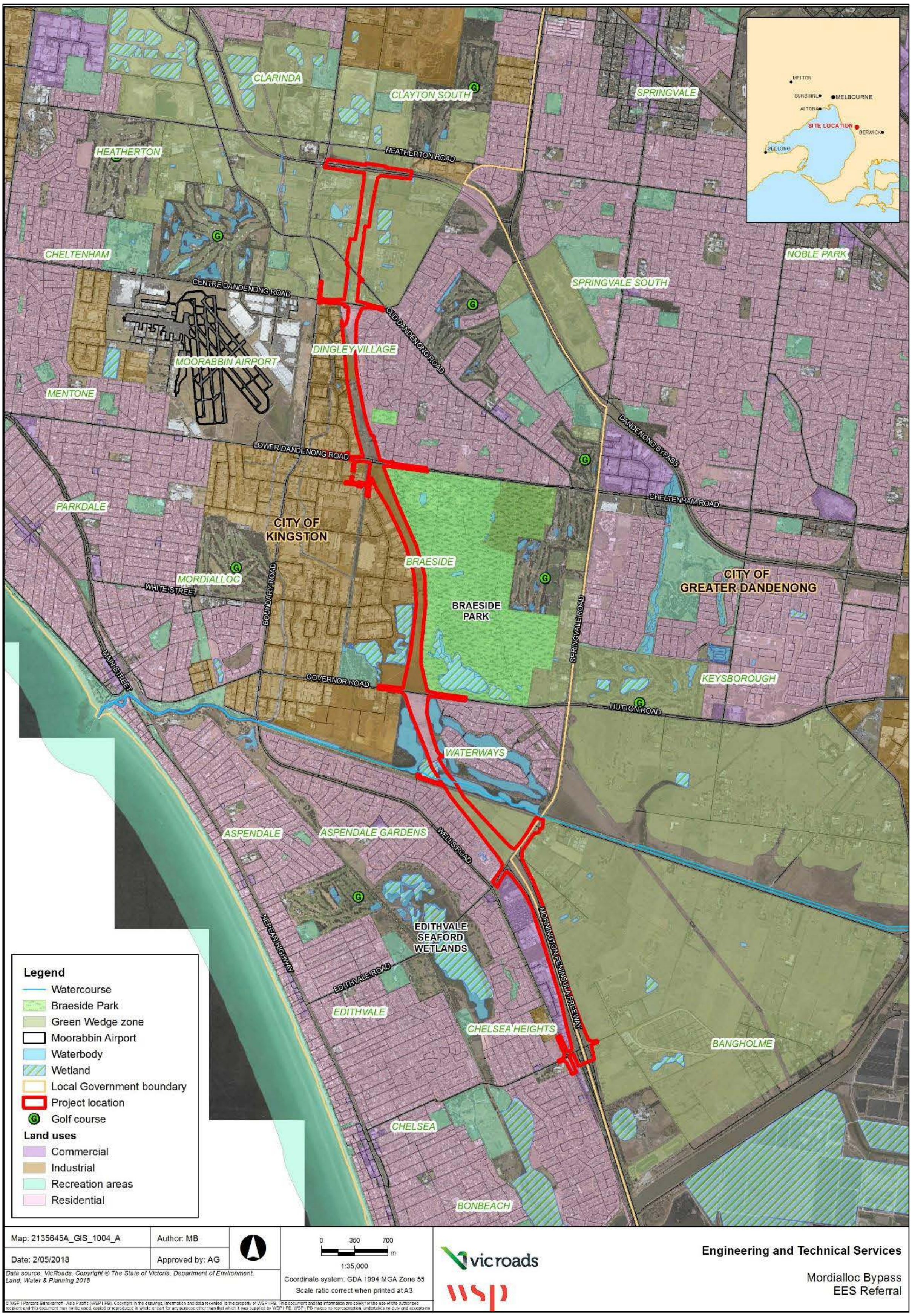
The Mordialloc Bypass Project is a proposed new route in Melbourne's south-eastern suburbs, located in an existing road reservation. The 9.7 kilometre (km) long freeway will provide a link between the Mornington Peninsula Freeway at Thames Promenade in Aspendale and the Dingley Bypass in Dingley, creating a continuous freeway from Frankston to Clayton. Figure 2-1 shows the route of the Mordialloc Freeway Project.

There will be a range of features incorporated in the Mordialloc Bypass Project that will help improve traffic flow and reduce travel times, including new bridges over Springvale Road, Governor Road, Lower Dandenong Road and Centre Dandenong Road. Each of these interchanges will have entry and exit ramps.

Traffic lights will be installed for the intersection between the Freeway and Dingley Bypass, and at the existing interchange at Thames Promenade, where the existing Mornington Peninsula Freeway will be upgraded to provide on/off ramps in both directions. The roadways would be wider at the intersections.

The Bypass will go over Old Dandenong Road, without access to and from the Freeway. Twin bridges approximately 400 m long will be constructed over land at The Waterways and Mordialloc Creek, and adjacent drainage lines, to maintain light on the water surface adjacent to and beneath the bridge structures.

Figure 2-1. Route of Proposed Mordialloc Bypass Project



Works associated with the project include:

- Four-lane freeway with two lanes each side of a divided central median, extending for 9.7 km from Dingley Bypass in the north to Thames Promenade in the south (connecting to the existing Mornington Peninsula Freeway).
- Full grade-separated interchanges at Thames Promenade, Springvale Road, Governor Road, and Lower Dandenong Road.
- Elevated structures over Bowen Parkway, Mordialloc Creek and the adjacent wetlands, with piers at about 25 m spacing;
- Bypass to go over Old Dandenong Road, without access to and from the bypass.
- At-grade signalised intersection at Dingley Freeway.
- Shared cycling and pedestrian paths.

The Bypass reservation and roadway design includes two lanes in each direction with room for a future third lane in the centre median.

The Bypass extends southward from Dingley Freeway to Centre Dandenong Road. The adjacent land use in this section is predominantly commercial/industrial and horticulture with nurseries and vegetable farms. The Bypass crosses over an old landfill a short distance south of Dingley Bypass. Further south, the Freeway rises over Old Dandenong Road (with no traffic connections).

There will be grade-separated interchanges at each of Centre Dandenong Road and Lower Dandenong Road, with a full set of on and off ramps. The adjacent land use west of the Bypass in this section is the Redwood Gardens Industrial Estate, while adjacent land use east of the Freeway is predominantly residential (Dingley Village) with a local park (Chadwick Reserve).

There will be grade-separated interchanges at each of Lower Dandenong Road and Governor Road, with a full set of on and off ramps. The adjacent land use west of the Bypass is largely warehouses and other commercial/light industrial uses, with wetlands over the southern 750 m. East of the Freeway, the adjacent land use is parks and recreation (Braeside Park) with wetlands over the southern 700 m.

There will be grade-separated interchanges at each of Governor Road and Springvale Road, with a full set of on and off ramps. There are wetlands on both sides of the route in this section for 1 km southward from Governor Road to Mordialloc Creek. South of Mordialloc Creek, there is residential use (Aspendale Gardens) and a retirement village to the west of the Freeway and rural open space to the east of the Bypass.

The southern section of the Bypass extends from Springvale Road to Thames Promenade along the centre of the existing Mornington Peninsula Freeway. There will be grade-separated interchanges over Springvale Road and Thames Promenade. The adjacent land use west of the Freeway is the Chelsea Heights shopping centre and a retirement village, noting that these properties have been adjacent to an existing freeway for about twenty years. East of the Bypass, the adjacent land use is a Church, a dog club and rural open space.

There is an existing road reservation along the whole length of the proposed Mordialloc Bypass Project that is generally 110 to 125 m wide and the reservation has a Public Acquisition Overlay. Although there are residences and other sensitive premises adjacent to the road reserve, there is generally a wide buffer between the planned roadways and the receptors. The extent to which these nearby receptors will experience elevated dust levels during construction and an increase in pollutant concentrations discharged by vehicles is assessed in this report.

3 Methodology

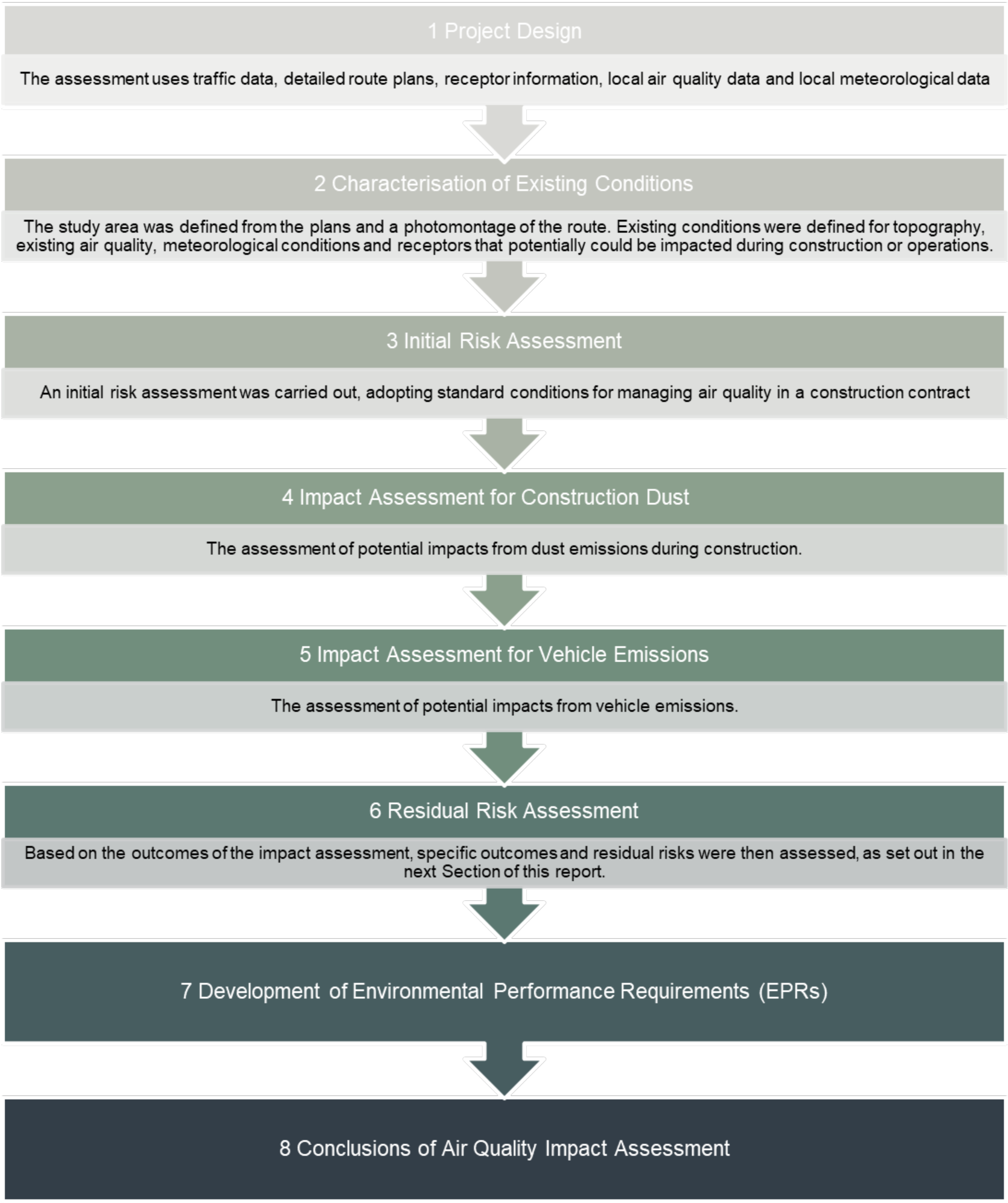
This section describes the methodology used to assess the potential impacts of the Mordialloc Bypass Project during construction and operation. The methodology describes the methods and data used to carry out the impact assessment. It also explains the application of the EES risk assessment method as part of the impact assessment process.

The steps in the impact assessment process are shown in Figure 3-1. The assessment of significant air quality risks is set out in this section and expanded in later sections.

The study area for the air quality impact assessment is the full route of the Mordialloc Bypass Project including all intersections. The topography of the area is flat.

A detailed plan of the route was provided by WSP in June 2018. Traffic data were provided in May 2018, comprising the total daily traffic flow and the morning and afternoon peak traffic flow, in each direction, as well as the proportion of heavy commercial vehicles and the typical speed in the peak and non-peak hours. The traffic data is described in Section 9. Figure 3-1 presents an overview of the air quality impact assessment process.

Figure 3-1 Overview of Air Quality Impact Assessment Process



3.1 Risk Assessment

As outlined in the Ministerial Guidelines for Assessment of Environmental Effects (2006) and the Scoping Requirements for the Project EES (2018), a risk-based approach was adopted for the EES studies to direct a greater level of effort at investigating matters that pose relatively higher risk of adverse environmental effects.

The following definitions were adopted for the assessment:

- *Environmental impact:* is described as any change to the environment as a result of project activities.
- Environmental risk: as defined by the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978 (DSE, 2006),* i.e.: "Environmental risk reflects the potential for negative change, injury or loss with respect to environmental assets".

The purpose of the environmental risk assessment (ERA) is to provide a systematic approach to identifying and assessing the project's environmental risks, including social, health, safety and economic aspects as a result of the project. It articulates the likelihood of an incident with environmental effects occurring and the consequential impact to the environment.

The impact assessment and risk assessment processes were integrated throughout the development of the EES. The environmental risk assessment (ERA) process allowed the project team to identify as many environmental risks as a result of the project as possible and refine and target impact assessments accordingly. The impact assessments ensured the project team has a robust understanding of the nature and significance of impacts and the mitigation measures developed to minimise and control those impacts.

The risk and impact assessment processes were essential components of the project design process and in the formulation of construction and additional mitigation measures to minimise environmental impacts. These assessments also underpin the establishment of the Environmental Performance Requirements (EPRs), which set out the desired environmental outcomes for the project.

The below methodology was developed to assess the potential impacts of the Mordialloc Bypass on air quality and sets out the process, methods and tools used to complete the impact and risk assessments.

Risk Assessment Methodology

The risk assessment is a critical part of the EES process as it guided the level and extent of impact assessment work required and facilitated a consistent approach to risk assessment across the various technical disciplines. The risk assessment process was based on the approach defined in *ISO 31000:2018 Risk Management – Principles and Guidelines*, which describes an environmental risk management process which is iterative and supported by ongoing communication and consultation with project stakeholders. The ERA process incorporated VicRoads key risk management requirements, specifically from the VicRoads Environmental Risk Management Guidelines (2012) and the VicRoads Environmental Sustainability Toolkit (2017).

Scope and Boundaries

The ERA assessed all project phases, namely: Initial Phase (the current approvals and concept design stage); Construction Phase; and Operations and maintenance Phase. The risk process evaluated environmental risks that would result from the development of the project based on the concept designs for the project, the draft construction methodology and the existing conditions of the study area, as well as the draft environmental impact assessment reports which were in development during the ERA.

Risk Identification

To effectively and comprehensively recognise all potential environmental risks that may result from the project, it was necessary to identify impact pathways for all project activities during all its project phases. An impact pathway is the cause and effect pathway or causal relationship that exists between a project activity and an asset, value or use of the environment

Environmental impact pathways were identified under two categories:

- Primary environmental impacts: The impacts to environmental values that are directly attributable to project activities within a cause and effect paradigm. Project activities cause environmental impacts (effects) on environmental values through an environmental impact pathway such as construction activities. The assessment of these impacts and their associated risks assumes that all standard mitigation measures are in place and working as intended.
- Cumulative impacts: The potential cumulative impacts to environmental values that may result from the implementation of the project. This allowed for the identification of:
  - Secondary environmental risks which may result from the implementation of a risk response in mitigating a primary environmental risk;
  - On-site aggregate risks resulting from multiple on-site project activities on an environmental asset (risks were assessed in two ways, as a single project phase and as a whole project risk);
  - Off-site cumulative environmental risks which accounted for potential off-site cumulative impacts of the Mordialloc Bypass project in conjunction with surrounding off-site projects in the local area.

Risk Analysis

With risks identified for each discipline, VicRoads and industry best practice and standard mitigation controls intrinsic to the project were identified, including requirements under relevant sections of the VicRoads Standard Specifications, EPA guidelines and Government environmental management policies.

Cumulative Effects

The ERA process also allowed for the assessment of cumulative effects (CE) associated with the project. CE can result from multiple influences/impacts on an environmental asset and were assessed in two categories.

1. Aggregate: Where there are multiple activities within the project that impact on a single asset. Aggregate risks are included as additional risk pathways in the risk register.
2. External projects: current project risks that could, when compounded with those of surrounding projects, lead to an overall increase in the environmental impact of the project. Each impact pathway is reviewed to determine if a potential cumulative effect exists.

Risk Evaluation

The ERA process developed for the project is based on the risk analysis matrix used on recent and similar VicRoads projects, as presented in Table 3-1. It follows the standard industry semi-quantitative risk analysis methodology that utilises pre-defined consequence and likelihood criteria as the factors to arrive at a risk rating.

Table 3-1 Risk Assessment Matrix

			LIKELIHOOD				
	Risk Categories		Rare	Unlikely	Possible	Likely	Almost Certain
			A	B	C	D	E
CONSEQUENCE	Catastrophic	5	Medium	High	High	Extreme	Extreme
	Major	4	Medium	Medium	High	High	Extreme
	Moderate	3	Low	Medium	Medium	High	High
	Minor	2	Negligible	Low	Low	Medium	Medium
	Insignificant	1	Negligible	Negligible	Negligible	Low	Low

Based on the project objectives and context, a set of project-specific and appropriate likelihood and consequence criteria were developed in consultation with VicRoads, the TRG and technical specialists, see Table 3-2 and 3-3.

Table 3-2 Risk Assessment Likelihood Categories

LIKELIHOOD				
Less than once in 12 months OR 5% chance of recurrence during course of the contract	Once to twice in 12 months OR 10% chance of recurrence during course of the contract	3 to 4 times in 12 months OR 30% chance of recurrence during course of the contract	5 to 6 times in 12 months OR 50% chance of recurrence during course of the contract	More than 6 times in 12 months OR 100% chance of recurrence during course of the contract
The event may occur only in exceptional circumstances	The event could occur but is not expected	The event could occur	The event will probably occur in most circumstances	The event is expected to occur in most circumstances
It has not happened in Victoria but has occurred on other road projects in Australia.	It has not happened in the greater Melbourne region but has occurred on other road projects in Victoria	It has happened in the greater Melbourne region	It has happened on an road project in the region in the last 5 years	It has happened on a road project of similar size and nature in the region within the last 2 years. OR It has happened multiple times on a road project in the region within the last 5 years.
Rare	Unlikely	Possible	Likely	Almost Certain
A	B	C	D	E

Table 3-3 Air Quality - Consequences Descriptors

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
Air quality – construction	No measurable impact on air quality at nearby sensitive receptors.	Measurable impacts on air quality at nearby sensitive receptors below relevant guideline values.	Measurable (localised) impacts on air quality at nearby sensitive receptors above relevant guideline values.	Measurable (widespread) impacts on air quality at nearby sensitive receptors causing short-term exceedances of relevant guideline values.	Measurable (widespread) impacts on air quality at nearby sensitive receptors causing long-term exceedances of relevant guideline values.
Air quality – operation	No measurable impact on air quality (particulate matter and nitrogen dioxide) at nearby sensitive receptors.	Measurable impact on air quality at nearby sensitive receptors not causing exceedance of applicable air quality standards (as stated in SEPP(AQM)).	Measurable (localised) impact on air quality at nearby sensitive receptors causing marginal exceedances of applicable air quality standards (as stated in SEPP(AQM)).	Measurable (widespread) short-term impacts on air quality at nearby sensitive receptors causing exceedances of applicable air quality standards (as stated in SEPP(AQM)).	Measurable (widespread) long-term impacts on air quality at nearby sensitive receptors causing significant exceedances of applicable air quality standards and resulting in adverse impacts on human health.

For all risks ranked Medium, High or Extreme in the Initial Risk rating, technical specialists were required to identify additional controls which could be implemented to further reduce risk and to determine the residual risk rating. Additional controls specify management measures over and above those considered as Standard Controls to ensure the residual risk is effectively avoided or mitigated to as low as reasonably practicable.

Where risks could not be eliminated or sufficiently reduced (e.g. by engineering controls or re-design), these will typically be addressed by specific conditions in a site Environmental Management Plan (EMP), or be the subject of a separate management plan, including adaptive management plans based on ongoing studies or monitoring.

Environmental Performance Requirements

Following the evaluation of risk and through consultation with VicRoads, EPR's were developed to define relevant, achievable and measurable environmental outcomes for the project. The mitigation measures identified during the risk assessment process were used to inform the EPRs and also specify the means by which the EPRs are to be satisfied. The EPRs for air quality are outlined in Table 13-1.

3.2 Methodology for Air Quality Assessment

The sequence of tasks in the air quality assessment is set out in Figure 3-1. Existing air quality conditions in the project area are generally good, with background air quality meeting the objectives for carbon monoxide and nitrogen dioxide all the time. The objectives for PM_{10} and $PM_{2.5}$ are met almost all the year, except for one or two days when there are major bushfires or dust storms.

Local meteorology (wind speed, wind direction and temperature) was defined using monitoring data collected at Moorabbin airport - the nearest monitoring Bureau of Meteorology (BoM) station to the project - for 2013 to 2017. The meteorological data are described in Section 5.

The EPA monitors some (but not all) air quality parameters at Brighton and these data were used to characterise background air quality in the study area. Additional data monitoring were obtained from other EPA stations in Melbourne when Brighton data were not available. Existing air quality conditions are described in Section 5.

Impacts from Dust during Construction

The detailed impact assessment for construction dust is presented in Section 8. The basis of the assessment is the volumes of material to be moved during construction from excavation and formation of the base for the roadways and embankments at grade-separated interchanges. Dust emissions generated by construction equipment are modelled using the *Ausroads* dispersion model and concentrations at various distances each side of the route are developed for the peak day.

The assessment of potential impacts from dust emissions during construction involved the following steps:

- Establish the volume of excavation and fill for each route (from data supplied by WSP);
- Establish the construction period (2 years);
- Estimate the type, number and characteristics of construction equipment (the type and number of construction equipment is based on observations of the actual construction equipment used to construct the Western Highway, which is a recent road construction project of similar scale);

- Estimate the dust emissions by equipment using published information (see references in Section 8);
- Model the transport and dispersion of dust as total dust and as PM_{10} using the *Ausroads* model;
- Plot the PM_{10} and dust (as TSP) concentrations during construction activities;
- Compare the predicted levels to SEPP design criteria and assess impacts.

It is acknowledged that at the EES preparation stage, the Contractor, construction program and type and numbers of construction equipment are not known and the details will not be available for some time. For that reason, for many road projects the prediction of dust (as total suspended particles and PM_{10}) is not made, with the emphasis being given to management measures to control dust during construction.

However, for the Mordialloc Bypass Project, there are many residential and commercial receptors adjacent to the proposed construction route and thus a 'best estimate' was made of the frequencies of elevated dust levels at these receptors to provide a quantitative basis for defining the level of risk and to establish the appropriate EPR to manage dust during construction.

The full methodology for the construction dust assessment is provided in Section 8.

Impacts from Vehicle Emissions during Operations

The detailed impact assessment for vehicle emissions is presented in Section 9. The basis of the assessment is the volume of traffic using each section of the route, including on and off ramps, and emission rates per vehicle. Factors taken into account in calculating the emissions from the vehicle fleet are the number of vehicles per day and in peak hours, proportion of various types of vehicles, gradient of the road and the vehicle speed each hour.

Vehicle emissions were modelled using the *Ausroads* dispersion model and concentrations at various distances each side of the route are developed for the 99.9 percentile hour as required in the SEPP(AQM).

The assessment of potential impacts from vehicle emissions involved the following steps:

- Establish the number of vehicles per day and in the peak hour each day (based on traffic data supplied by WSP);
- Establish the type of vehicles (fleet composition based on Australian Bureau of Statistics (ABS) data);
- Estimate the vehicle emissions using EPA projections for carbon monoxide (CO), nitrogen dioxide (NO_2), PM_{10} and $PM_{2.5}$;
- Adjust the emission rates for the effects of vehicle speed and road gradient;
- Model the transport and dispersion of these contaminants at the 99.9 percentile frequency (i.e., on the highest 8 hours in a year);
- Plot the distribution of concentration on a cross-section of the road, up to 200 m east and west of the roadway;
- Compare the predicted levels to the EPA design criteria and assess the zone of potential impact.

The *Ausroads* dispersion model as issued by the VIC EPA was used in predicting the distribution of dust and vehicle emissions near roads. *Ausroads* requires a range of inputs including:

- Modelling domain and road geometry;
- Topographical data;
- Meteorological data;
- Source emission characteristics.

The modelling domain matched the route plans provided by WSP. The area is flat, and there was no need to include topography in the model, other than the different levels of overpasses and ramps.

Meteorological data was obtained from Moorabbin Airport, which is close to the route of the Project. Hourly meteorological data for 2013-2017 was obtained and is discussed in Section 5.

Source emission rates for dust during construction are described in Section 8 and for vehicle emissions in Section 9.

Other Air Quality Impacts

Other possible impact pathways for air quality considered but screened out in the preliminary risk assessment due to the site location, scale and type of project, were:

- Contamination by dust of roof rainwater catchments;
- Effect of dust on crops or native vegetation;
- Effect of dust on sensitive avifauna.

Air quality risks associated with landfill gas emissions from the disused Enviromix landfill are addressed Section 10, whilst further details on the landfill site and design implications can be found in the Contaminated Land Impact Assessment report.

There are no major sources of industrial discharges of contaminants close to the study route that would cause a significant increment in background air quality. The Moorabbin Airport is source of plane emissions but is 1 km from the Project route and the airport occupies a large site, so the concentration of emissions is no different from a series of urban roads over the same area.

4. Legislative Requirements for Air Quality

A detailed review of the legislation and policy environment was undertaken as part of establishing the context for the impact assessments, and to identify the legislative requirements, standards, limits and processes the project must meet. This Section presents the legislative context for the Mordialloc Bypass Project and the criteria for assessing construction and operational air quality impacts.

4.1 Construction

There are no current Australian, Victorian or local government legislation or policies that govern air quality during construction of the Project. However, the following guidelines apply to its construction:

- EPA Environmental Guidelines for Major Construction Sites (EPA 1996)
- VicRoads Contract Construction for major road projects (VicRoads, 2012).

4.2 Operation

The Victorian legislation and government policies relevant to the air quality assessment are listed in Table 4-1.

Table 4-1. Relevant Victorian Air Quality Legislation and Policies

Legislation/Policy	Description
Transport Integration Act 2010	Part 2, Division 2, Section 10 of the Act outlines the transport objectives relating to environmental sustainability. These are: '*The transport system should actively contribute to environmental sustainability by:* • *Protecting, conserving and improving the natural environment;* • *Avoiding, minimising and offsetting harm to the local and global environment, including transport-related emissions and contaminants and the loss of biodiversity;* • *Promoting forms of transport and the use of forms of energy and transport technologies which have the least impact on the natural environment;* • *Improving the environmental performance of all forms of transport and the forms of energy used in transport*'.
Environment Protection Act 1970	Air quality in Victoria is managed by the *Environment Protection Act 1970* (EP Act); and the relevant State environment protection policies created under Section 16 of the Act. The two policies for air quality are: • State Environment Protection Policy (Air Quality Management) 2001 – SEPP (AQM); and • State Environment Protection Policy (Ambient Air Quality) 1999 – SEPP (AAQ).

The *State Environment Protection Policy for Air Quality Management (SEPP (AQM))* requires road projects to be assessed under Part D of Schedule C, which involves modelling emissions to air from proposed major new roads. The models require, as inputs, the emission rates for various contaminants, wind and other meteorological data and background (ambient) concentrations of contaminants.

The EPA has specified that the 1 hour design criteria for CO, NO_2, PM_{10} and $PM_{2.5}$ are to be used in the assessing of air quality impact for operation of the Mordialloc Bypass Project. Design criteria for those contaminants to be assessed are listed in Table 4-2.

Table 4-2 Design Criteria for Air Contaminants

Contaminant	Design criteria	Averaging Period
CO	29,000 µg/m^3	1-hour
NO_2	190 µg/m^3	1-hour
PM_{10}	80 µg/m^3	1-hour
$PM_{2.5}$	50 µg/m^3	1-hour

With respect to air emissions, SEPP(AQM) Clause 19 states that a generator of new emissions '*must apply best practice to the management of those emissions*'. Best practice is defined in SEPP(AQM) as *'the best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity'.*

The *State Environment Protection Policy (Ambient Air Quality)* lists environmental quality objectives for CO, NO_2, photochemical oxidants (as ozone), sulphur dioxide (SO_2), lead and particles (as PM_{10} and $PM_{2.5}$), together with an additional objective for visibility reducing particles. The SEPP(AAQ) objectives apply to air quality within a region or sub-region considered to be representative of exposure of the general population in Victoria.

The SEPP(AAQ) includes objectives for 24 hour average and annual PM_{10} concentrations of 50 µg/m^3 and 20 µg/m^3 respectively, and 24 hour average and an annual $PM_{2.5}$ objective of 25 µg/m^3 (24-hour average) and 8 µg/m^3 (one year average). These objectives are listed in Table 4-3.

Table 4-3 SEPP(AAQ) Objectives for Air Contaminants

Contaminant	Objective	Averaging Period	Conversion to µg/m^3
CO	9 ppm	8-hours	10,400 µg/m^3
NO_2	0.12 ppm	1-hour	228 µg/m^3
	0.03 ppm	1-year	57 µg/m^3
PM_{10}	50 µg/m^3	24-hours	50 µg/m^3
	20 µg/m^3	1-year	20 µg/m^3
$PM_{2.5}$	25 µg/m^3	24-hours	25 µg/m^3
	8 µg/m^3	1-year	8 µg/m^3

The SEPP(AAQ) predicts a reduction on $PM_{2.5}$ in 2025 to future annual $PM_{2.5}$ objectives of 20 µg/m^3 (24-hour average) and 7 µg/m^3 (one year average). The expected improvement in background air quality would result from improved vehicle emission control technologies.

Table 4-4 SEPP(AAQ) Future Objectives for $PM_{2.5}$

Contaminant	Objective	Averaging Period
$PM_{2.5}$	20 µg/m^3	24-hours
	7 µg/m^3	1-year

The SEPP design criteria apply at the property boundary of residential buildings (including aged care and retirement villages), although not necessarily in car parks that are generally only occupied for a few minutes. They apply in commercial and industrial areas that are used by the general public, but not in industrial buildings where OHS standards apply. The SEPP design criteria apply to all the property of schools, kindergartens, hospitals and parks with recreational access.

4.3 Dust Requirements

SEPP(AQM) has a design criterion for TSP of 330 µg/m^3 as a 3-minute average. This translates to a 1-hour average limit of 180 µg/m^3 (from application of the one-fifth power law). An hour is a more appropriate time averaging period for activities at a construction site.

For dust-fall, accepted limits are (EPA, 2012):
- 4 g/m^2/month total, averaged over 30 days and
- 2 g/m^2/month increase over elevated background, averaged over 30 days.

Dust-fall limits apply and should be monitored during the construction period to avoid adverse amenity effects from excessive dust.

4.4 National Environment Protection Measures (NEPM)

The National Environment Protection Council (NEPC) was established under the National Environment Protection Council Act 1994 to:
- Develop National Environment Protection Measures (NEPMs)
- Assess and report on the implementation and effectiveness of the NEPMs in each State and Territory.

NEPMs relevant to air quality are the:
- National Environment Protection (Ambient Air Quality) Measure (Air NEPM) (February 2016)
- National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) (December 2004).

The NEPM policies relevant to the air quality are listed in Table 4-5.

Table 4-5. Relevant National Air Quality Policies

Legislation/Policy	Description
National Environmental Protection Air Quality Measure **AQ NEPM**	AQ (NEPM) defines the national standards for air contaminants in Australia. These establish protection levels for exposure to air contaminants. The key air contaminants relevant to a road project are: • Carbon monoxide; • Nitrogen dioxide; and • Particulate matter (PM_{10} and $PM_{2.5}$).
National Environment Protection (Air Toxics) Measure **Air Toxics NEPM**	The Air Toxics NEPM establishes '*monitoring investigation levels*' for air toxics including: • Benzene; • Toluene; • Formaldehyde • Xylenes; and • Benzo(a)pyrene as indicator for Polycyclic Aromatic Hydrocarbons (PAH)

Plots of 24-hour and annual average concentrations of parameters, the averaging times listed in the NEPM, are presented in Appendix A. The EPA advised that air toxic concentrations are unlikely to be an issue in the Project and that they need not be modelled in the assessment of operational impacts.

4.5 Assessment Criteria

In summary, the assessment criteria are as listed in Table 4-6.

Table 4-6. Summary of 1-Hour Assessment Criteria

Parameter	Concentration	
	ppm	µg/m^3
Carbon monoxide	9	29,000
Nitrogen Dioxide	0.1	190
PM_{10}	-	80
$PM_{2.5}$	-	50
TSP	-	180

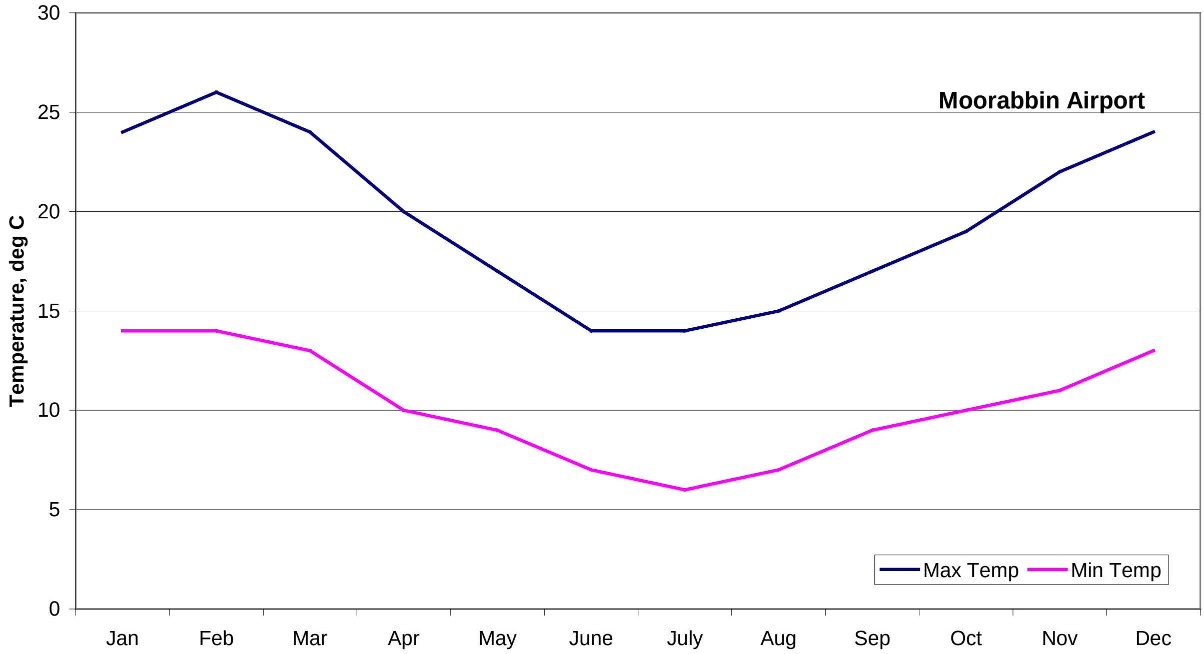
5. Existing Climate and Meteorology

The prevailing climate and meteorology influences the generation and the dispersion of dust and vehicle emissions. Ambient air quality provides the background levels used in the modelling assessment of potential impacts (for construction and operation).

5.1 Air Temperature

The study area has a temperate climate with a warm summer and cool winter. Rainfall occurs sporadically throughout the year. Figure 5-1 shows the monthly temperature range recorded at Moorabbin Airport for 1971 to 2017. Air temperature is generally below 20ºC for the months of April to October but above 20ºC for the remainder of the year.

Figure 5-1. Monthly Temperature Range Recorded at Moorabbin Airport



5.2 Rainfall

Figure 5-2 shows the variation in monthly rainfall recorded at Moorabbin Airport for 1971 to 2017. The average annual rainfall is 714 mm/yr, and this is reasonably evenly distributed over the year, apart from a dry summer.

Figure 5-2. Monthly Rainfall Recorded at Moorabbin Airport

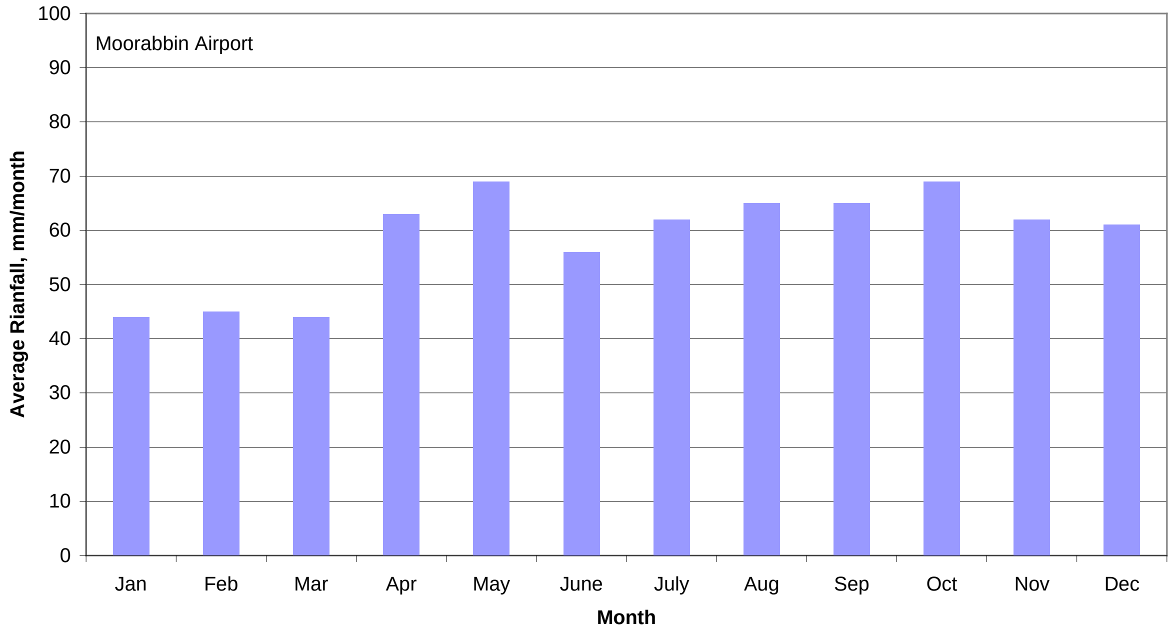
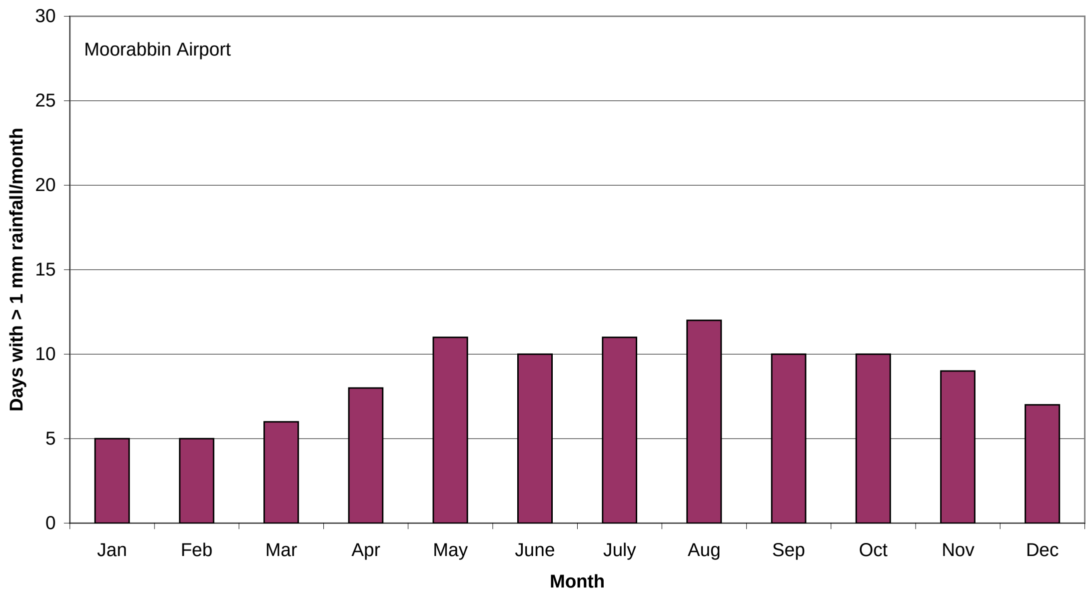


Figure 5-3 shows the number of days each month (on average) at Moorabbin Airport with more than 1 mm of rain. Generally, there are 5 to 10 days of rain each month Over the year, there are 145 days with > 1 mm rain, and these are strongly skewed towards winter.

Figure 5-3. Days with Rainfall Recorded at Moorabbin Airport



There is a large variability in the pattern of annual rainfall and the total rainfall from year to year. For example, in 2015, the annual rainfall at Moorabbin was 505 mm/yr. In the following year (2016), the annual rainfall was a much higher 712 mm/yr.

This variability makes it impossible to predict the rainfall in the future construction period, so that dust management and erosion control plans must reflect conditions that occur in the period of construction.

5.3 Winds

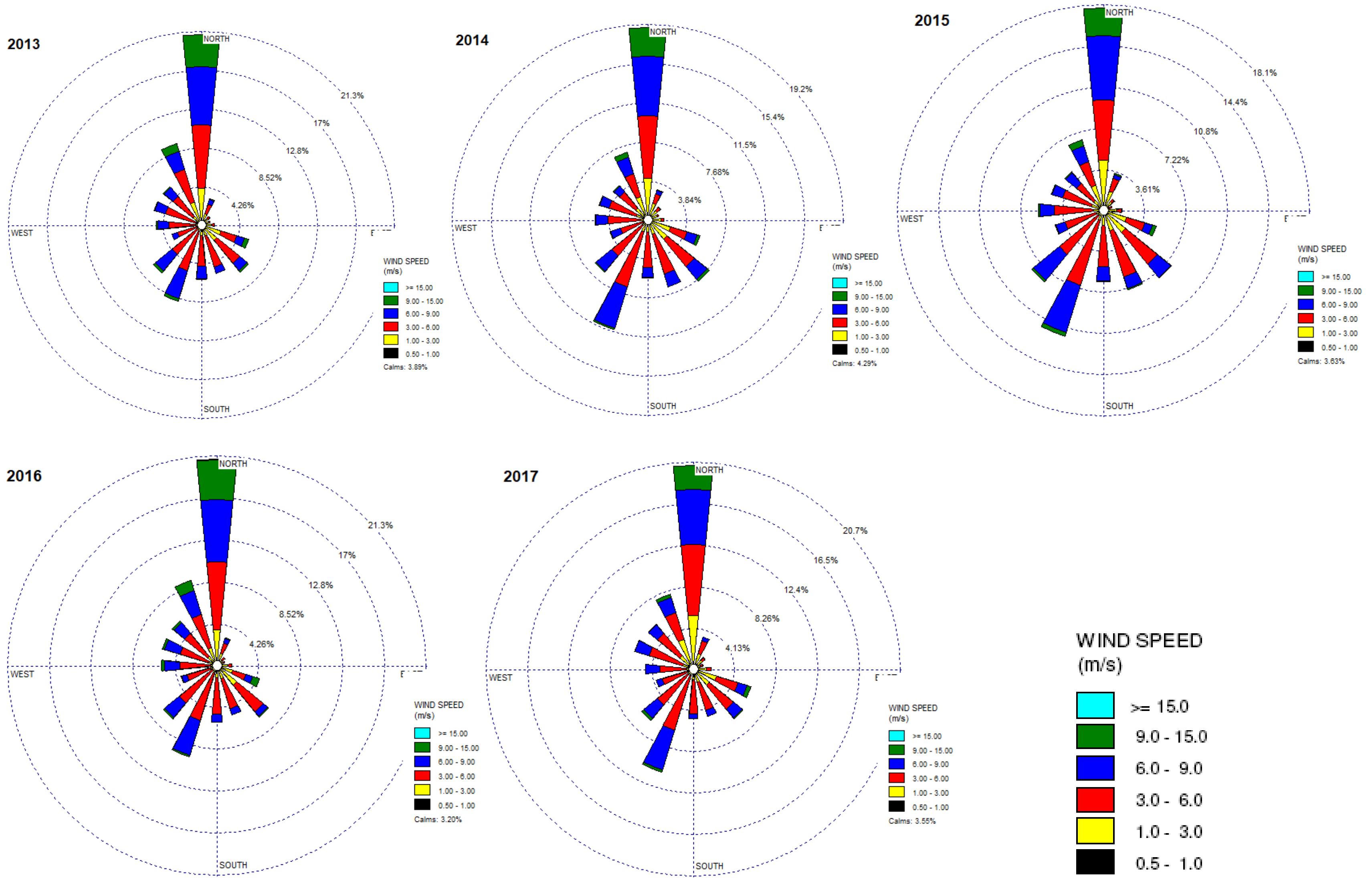
Table 5-1 compares the 10, 50 and 90 percentile wind speeds for the five years of data from Moorabbin airport, and shows good similarity in wind speed distribution from year to year.

Table 5-1. Distribution of Wind Speeds in Annual Wind Files

Source of Wind Data	Wind speed percentile, in m/s		
	10 %	50 %	90 %
Moorabbin Airport BoM 2013	1.5	4.4	8.2
Moorabbin Airport BoM 2014	1.4	4.2	7.9
Mordialloc Airport BoM 2015	1.3	4.2	8.2
Mordialloc Airport BoM 2016	1.4	4.2	8.5
Moorabbin Airport BoM 2017	1.5	4.2	7.7

Figure 5-4 presents the annual wind rose for each year. It can be seen that the distribution of wind directions is the same from year to year.

Figure 5-4. Wind Roses for Annual Wind Files



The black and yellow segments near the centre of the wind roses represent the low speed winds (less than 3 m/s). The width of the bars represents the strength of the winds in each sector, with wider bars representing stronger winds. The length of the bars represents the proportion of winds in each sector, with longer bars indicating more winds from the sector.

A high proportion of winds from the north is evident for all years (reflecting the measured pattern at Moorabbin Airport), but otherwise the dominant wind directions are from the west, south-west and south.

A feature of the wind rose at Moorabbin Airport, and this is common to wind roses for sites throughout the south-eastern suburbs, is that there is a small proportion of winds from the north-east and east. Thus, sites to the west of the Bypass (such as in Aspendale Gardens) may experience dust less often during construction than sites to the east of the Bypass, simply because of the different frequencies of winds from the east compared to winds from the west.

The median wind speed in the study area averages 4.2 m/s, which reflects the largely flat open terrain in the area with no hills or other major obstacles to the path of the winds. Because of the consistent winds, there will be generally good dispersion of contaminants released by vehicles.

6. Background Air Quality

Background air quality was derived from the records of monitoring stations maintained by the EPA. The air quality parameters assessed in this study are CO, NO_2, PM_{10} and $PM_{2.5}$.

6.1 Carbon Monoxide

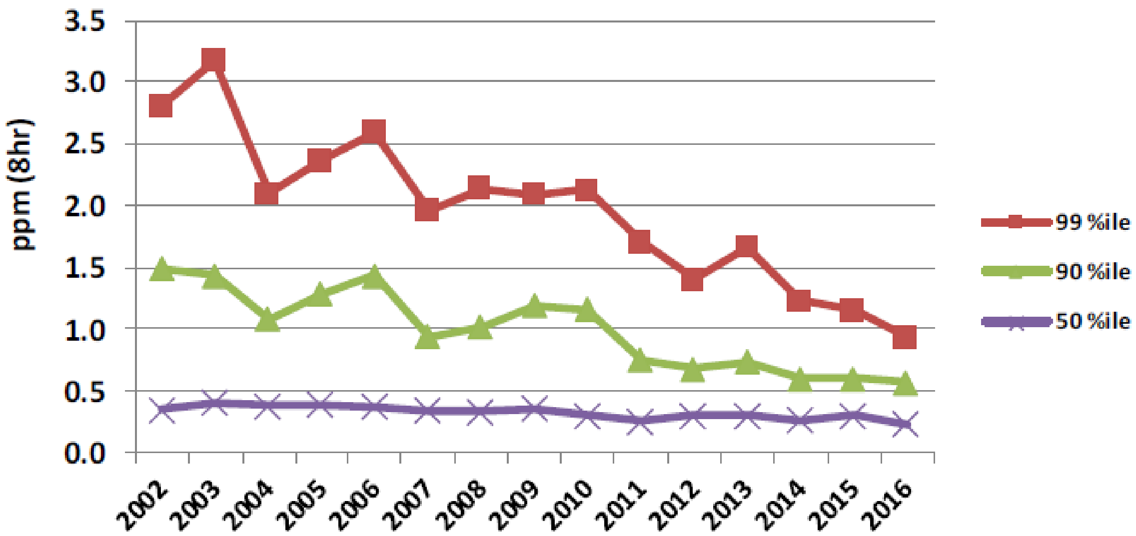
CO is monitored at Alphington, Richmond and the Central Business District (CBD). Alphington is the closest EPA monitoring station for CO to the Mordialloc Bypass Project. Table 6-1 lists the historical record for CO at Alphington for the years 2012 to 2016. Based on this data, the 8-hour background concentration (70 percentile level as specified by the EPA) is considered to be 0.5 ppm. The equivalent 1-hour background CO level is 0.75 ppm.

The air quality objective is 9 ppm over an 8-hour averaging period. Figure 6-1 shows carbon monoxide concentrations in Melbourne are decreasing with time due to the requirement to have catalytic converters on vehicle exhausts and are well within the air quality objective.

Table 6-1 Percentiles of 8-hour Carbon Monoxide at Alphington

Year	Percentiles of CO (ppm)			
	99 %	90 %	70 %	50 %
2012	1.3	0.9	0.5	0.2
2013	1.9	1.1	0.7	0.4
2014	1.2	0.8	0.6	0.4
2015	1.3	0.8	0.5	0.4
2016	1.2	0.8	0.5	0.3

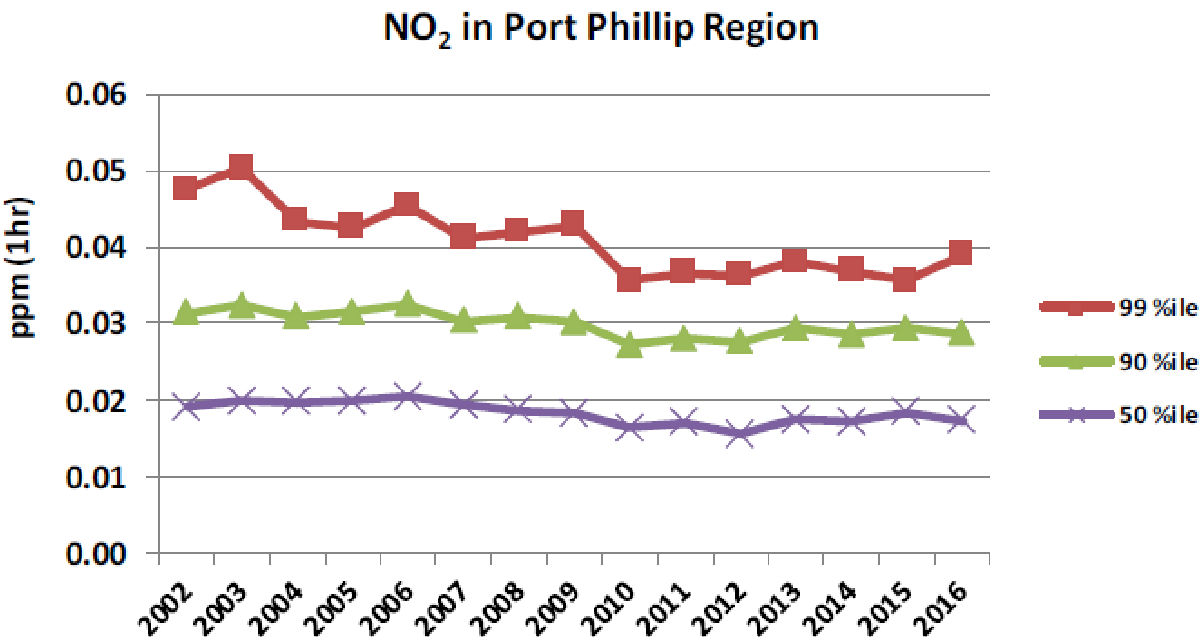
Figure 6-1 Trends in 8-hour Carbon Monoxide Concentrations at Port Phillip



6.2 Nitrogen Dioxide

Figure 6-2 shows nitrogen dioxide concentrations have decreased in Melbourne with time from 2002 to 2016 but are now stable from year to year. The air quality objective is 0.12 ppm over a 1-hour averaging period (equivalent to 230 µg/m³).

Figure 6-2 Trends in 1-hour NO_2 at Port Phillip Region



Nitrogen dioxide (NO_2) was monitored at Brighton until 2014 and continues to be monitored at several other sites in Melbourne. Brighton is the station that best represents NO_2 levels at Mordialloc. Table 6-2 lists the historical record for NO_2 at Brighton. NO_2 concentrations have been stable since 2009, and the background concentration (70 percentile level as specified by the EPA) is considered to be 0.025 ppm based on the most recent records at Brighton (equivalent to 48 µg/m³).

Table 6-2 Percentiles of 1-hour Nitrogen Dioxide at Brighton

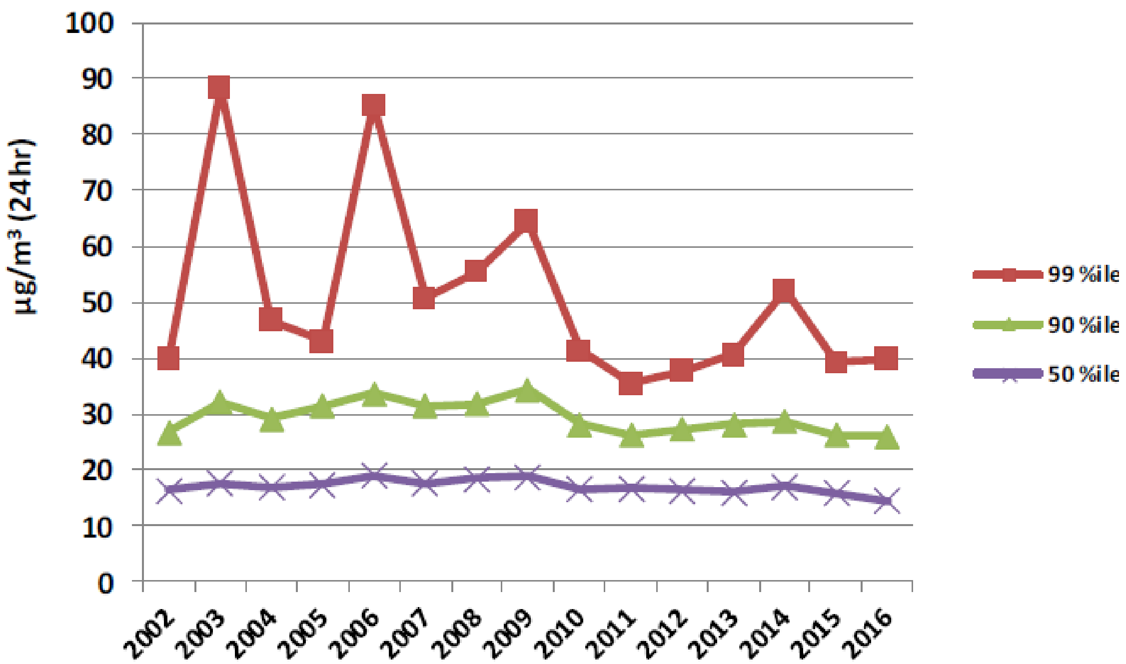
Year	Percentiles of NO_2 (ppm)			
	99%	90 %	70 %	50 %
2010	0.036	0.029	0.024	0.018
2011	0.035	0.030	0.025	0.018
2012	0.035	0.029	0.024	0.017
2013	0.038	0.031	0.025	0.019
2014	0.038	0.031	0.025	0.019

Current nitrogen dioxide concentrations are well within the 1-hour air quality objective of 0.12 ppm.

6.3 PM_{10}

As shown in Figure 6-3, PM_{10} concentrations have decreased in the Port Phillip region with time but are now stable from year to year. The air quality objective for PM_{10} is 50 µg/m^3 over a 24-hour averaging period. The objective for PM_{10} is met almost all the year, except for one or two days when there are major bushfires or dust storms.

Figure 6-3 Trends in 24-hour PM_{10} in Port Philip Region



PM_{10} was monitored at Brighton until 2008 and continues to be monitored at several other sites in Melbourne. Brighton is considered to be the station that best represents PM_{10} levels at the Mordialloc Bypass Project. Table 6-3 lists the historical record for PM_{10} at Brighton (for the data available until 2008). Based on these data, the 24-hour concentration (70 percentile level as specified by the EPA) at Mordialloc is considered to be 20 µg/m^3.

Table 6-3 Percentiles of 24-hour PM_{10} at Brighton

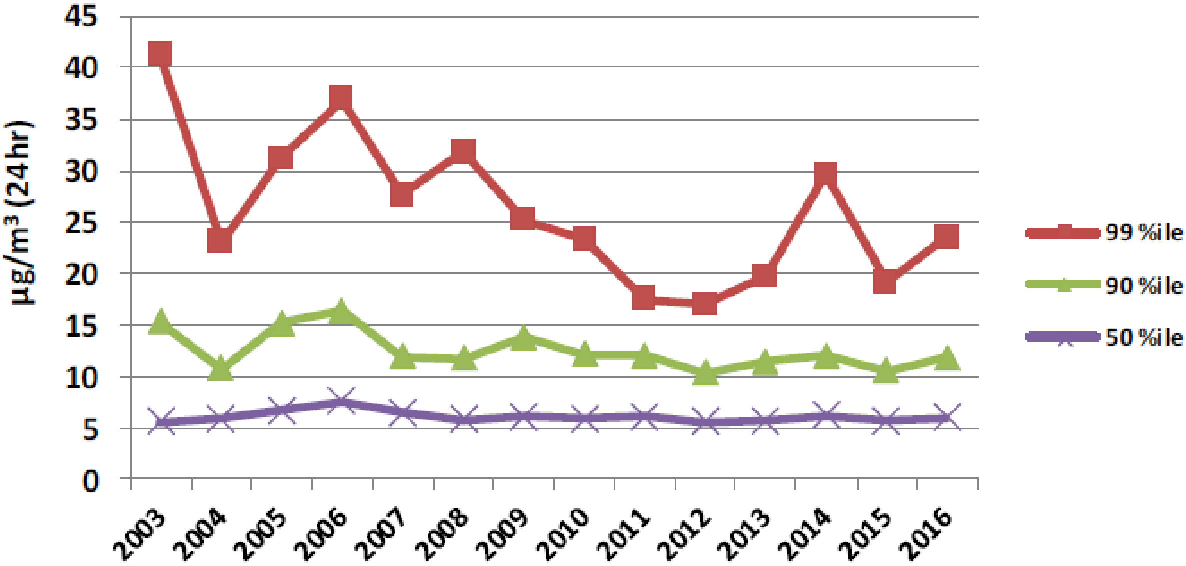
Year	Percentiles of PM_{10} (µg/m^3)			
	99 %	90 %	70 %	50 %
2004	40.5	26.4	20.9	15.9
2005	33.8	25.8	19.7	14.4
2006	78	25.9	19.8	13.8
2007	35.9	24.1	18.1	13.7
2008	52.5	26.7	21.8	16.1

PM_{10} concentrations do not vary much from hour-to-hour over a day. Examination of hourly PM_{10} data for Alphington and Footscray for 2015-2017 showed the 70 percentile hourly concentration was 18 µg/m^3 with little variation from hour to hour.

6.4 $PM_{2.5}$

As shown in Figure 6-4, $PM_{2.5}$ concentrations have decreased in the Port Phillip region with time but are now stable from year to year. The air quality objective for $PM_{2.5}$ is 25 µg/m3 over a 24-hour averaging period. The objective for $PM_{2.5}$ is met almost all the year, except for one or two days when there are major bushfires or dust storms.

Figure 6-4 Trends in 24-hour $PM_{2.5}$ in Port Philip Region



$PM_{2.5}$ is monitored at Alphington and Footscray, but not at Brighton. Table 6-4 lists the 2016 data (the most recent available from the EPA) for these two sites, which have much the same percentile concentrations. The $PM_{2.5}$ levels at Brighton would be expected to be slightly lower than at these inner city sites.

Based on the available monitoring data, the 24-hour background concentration of $PM_{2.5}$ (70 percentile level as specified by the EPA) for Mordialloc is considered to be 8.5 µg/m³.

Table 6-4 Percentiles of 24-hour $PM_{2.5}$ in 2016 in Melbourne

Site in 2016	Percentiles of $PM_{2.5}$ (µg/m³)			
	99 %	90 %	70 %	50 %
Alphington	23.0	11.9	8.6	6.3
Footscray	19.6	11.1	8.4	6.2

$PM_{2.5}$ concentrations do not vary much from hour-to-hour over a day. Examination of hourly $PM_{2.5}$ data for Alphington and Footscray for 2015-2017 showed the 70 percentile hourly concentration was 9 µg/m³ with little variation from hour to hour.

6.5 Summary of Background Concentrations

For carbon monoxide, it is necessary to convert the 8-hour background concentration of 0.5 ppm to a 1-hour background concentration to match the 1-hour averaging period of the SEPP(AQM) design criteria. The conversion factor is 1.5 (based on the one-fifth power law) and thus the 1-hour background concentration of carbon monoxide = 0.75 ppm (which is equivalent to 870 µg/m^3).

For both PM_{10} and $PM_{2.5}$ it is necessary to use a 1-hour background concentration (to match the 1-hour design criteria). For PM_{10} it was established that the 24-hour background was 20 µg/m^3 while the 1-hour background level varied from 15 to 21 µg/m^3 (depending on the hour of the day) with an overall average of 18 µg/m^3. As the background level in peak hours averaged 20 µg/m^3 this concentration was adopted as the background level for both 1-hour and 24-hour PM_{10} predictions.

For $PM_{2.5}$ it was established that the 24-hour background was 8.5 µg/m^3 while the 1-hour background level varied from 8 to 11 µg/m^3 (depending on the hour of the day) with an overall average of 9 µg/m^3. As the background level in peak hours averaged 9 µg/m^3 this concentration was adopted as the background level for both 1-hour and 24-hour $PM_{2.5}$ predictions.

In summary, the 70 percentile background levels for the Mordialloc Bypass Project are as shown in Table 6-5.

Table 6-5 Assumed Background Concentrations of Air Quality Parameters

Parameter	1-hour Background Concentration
Carbon monoxide	870 ug/m^3
Nitrogen dioxide	48 µg/m^3
PM_{10}	20 µg/m^3
$PM_{2.5}$	9 µg/m^3

7. Sensitive Receptors

Schedule C, Part B, 5(c) of SEPP(AQM) describes sensitive locations as "*hospitals, schools or residences*".

EPA Publication No. 1518, *'Recommended Separation Distances for Industrial Residual Air Emissions'* (March 2013) defines a sensitive land use as '*any land uses which require a focus on protecting the beneficial uses of the air environment relating to human health and wellbeing, local amenity and aesthetic enjoyment, for example residential premises, childcare centres, pre-schools, primary schools, education centres or informal outdoor recreation sites*'.

There are no schools near the route of the Mordialloc Bypass. Kingswood Primary School in Dingley Village is 500 m away to the east, St Marks Primary School is 700 m east and Dingley Primary School is 1,300 m east. Parkdale Secondary College is 1,300 m west and Aspendale Gardens Primary School is 860 m west.

Table 7.1 lists selected sensitive receptor locations, as defined above. The locations are illustrated in Figure 7-1.

Table 7.1 Selected Discrete Sensitive Receptor Locations

No	Description	Suburb	East	North	Boundary Distance (m)
1	Hawthorn Football Club	Heatherton	334,800	5,797,186	80
2	Rural Residential	Dingley	334,110	5,796,891	450
3	Commercial	Dingley	334,572	5,795,602	25
4	Residential	Dingley	334,553	5,795,349	36
5	Residential	Dingley	334,550	5,794,840	36
6	Commercial	Dingley	334,671	5,793,856	33
7	Reserve	Braeside	335,216	5,793,061	45
8	Parks Victoria Office	Braeside	335,250	5,792,478	22
9	Reserve	Braeside	335,150	5,792,423	40
10	Reserve	Braeside	334,950	5,792,054	39
11	Residential	Waterways	335,388	5,791,404	30
12	Residential	Aspendale Gardens	335,456	5,790,460	73
13	Residential	Aspendale Gardens	335,737	5,790,092	42
14	Richfield Retirement	Aspendale Gardens	336,059	5,789,708	32
15	Retirement Village	Chelsea Heights	336,400	5,789,209	30
16	Commercial	Chelsea Heights	336,557	5,788,679	47

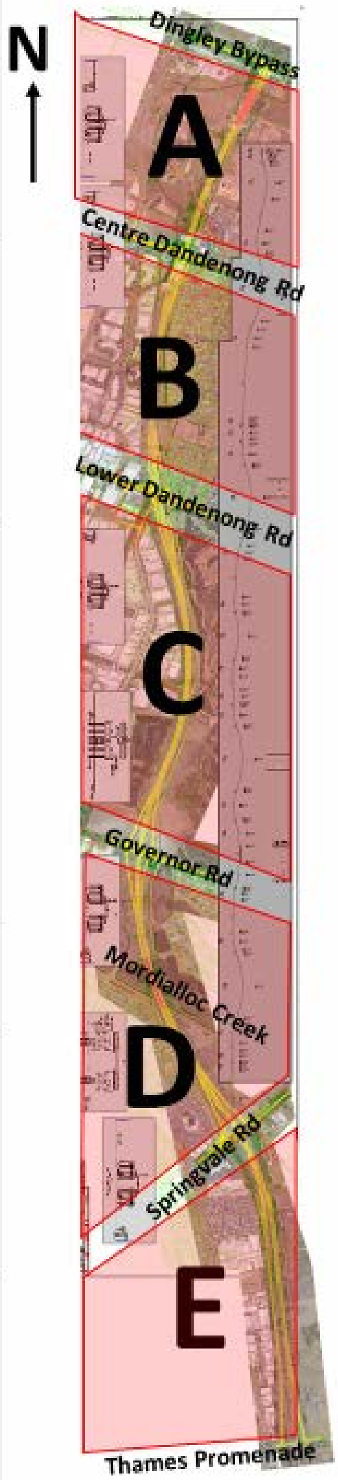
In addition to the sensitive discrete receptors listed above, an assessment was made of the location of strips of sensitive receptors (for example residential and commercial areas) near the road corridor. As discussed in Section 2, the study area was divided into five areas listed as A to E from north to south. Figure 7-2 shows the classification of sub-areas and the adjacent land use in broad terms.

Figure 7-1. Location of Specific Sensitive Receptors

Figure 7-2 shows the division of the route of the Mordialloc Bypass into sub-areas described as Sections A to E, from north to south. The general land use in each section west and east of the route is also shown in the figure.

Figure 7-2. Classification of Sub-areas for Sensitive Receptors

Adjacent Land Use - West	*Adjacent Land Use - East*
Horticulture	Horticulture
Industrial/ Commercial	Dingley Village Residential
Light Industrial Warehouses	Braeside Park
Wetlands	Wetlands
Aspendale Gardens Residential	Rural open space Distant residences
Shopping Retirement Village Industrial	Church Rural open space



Section A extends for 1.4 km from Dingley Freeway to Centre Dandenong Road. Figure 7-3 shows the route and adjacent land uses and receptors in Section A. The adjacent land use is predominantly commercial (truck park, composting, training facility) and horticulture with nurseries and vegetable farms. The Freeway crosses over an old landfill a short distance south of Dingley Bypass. The Hawthorn Football Club has purchased a large block south of the landfill for use as a training facility.

Further south, the Mordialloc Bypass rises over Old Dandenong Road (with no traffic connections). There are a few rural residential houses in the horticulture region, with the closest one being about 80 m west of the edge of the proposed roadway.

There is a wide buffer zone between the edge of the Project roadways and the boundary of the road reserve, with a 48 m buffer each side near Dingley Bypass and 50 m either side near Old Dandenong Road.

Section B extends for 1.6 km from Centre Dandenong Road to Lower Dandenong Road. Figure 7-4 shows the route and adjacent land uses and receptors in Section B. The adjacent land use is the Redwood Gardens Industrial Estate west of the Bypass, while adjacent land use is predominantly residential east of the Freeway (Dingley Village) with a local park (Chadwick Reserve).

Near Centre Dandenong Road, the reserve boundary is generally about 40 m east of the edge of the road, and 35 m at the closest point. The on-ramp from Centre Dandenong Road is typically 16 m from the residential property boundary, and 8 m at the closest point.

The industrial land west of the Mordialloc Bypass is typically 45 to 60 m from the roadway, and 40 m to Redwood Gardens Industrial Estate at the closest point. Chadwick Reserve is more than 80 m from the roadway.

The buffer distances increase near Lower Dandenong Road with the residential properties being 50 to 80 m from the road and the industries typically 45 m or more from the road. The industrial areas facing the route are mostly car parks, storage areas or blank side walls of large factories and warehouses.

Section C extends for 2.4 km from Lower Dandenong Road to Governor Road. The adjacent land uses west of the Mordialloc Bypass is largely warehouses and other commercial/light industrial uses, with wetlands over the southern 750 m. The industrial land is typically 40 to 70 m from the roadway, but with a dead-end road reaching to 25 m at Ch. 27,400 m.

East of the Bypass, the adjacent land use is entirely parks and recreation (Braeside Park) with wetlands over the southern 700 m. The edge of the road reserve along the park is typically 42 to 50 m from the nearest roadway, except for the Parks buildings. These buildings are in the road reserve, as shown in Figure 7-5, with the main building being from 31 m (back corner) to 46 m (front corner) away from the road. The small demountable lunchroom is 22 m from the nearest road (see figure).

Figure 7-3 Sensitive Receptors in Section A

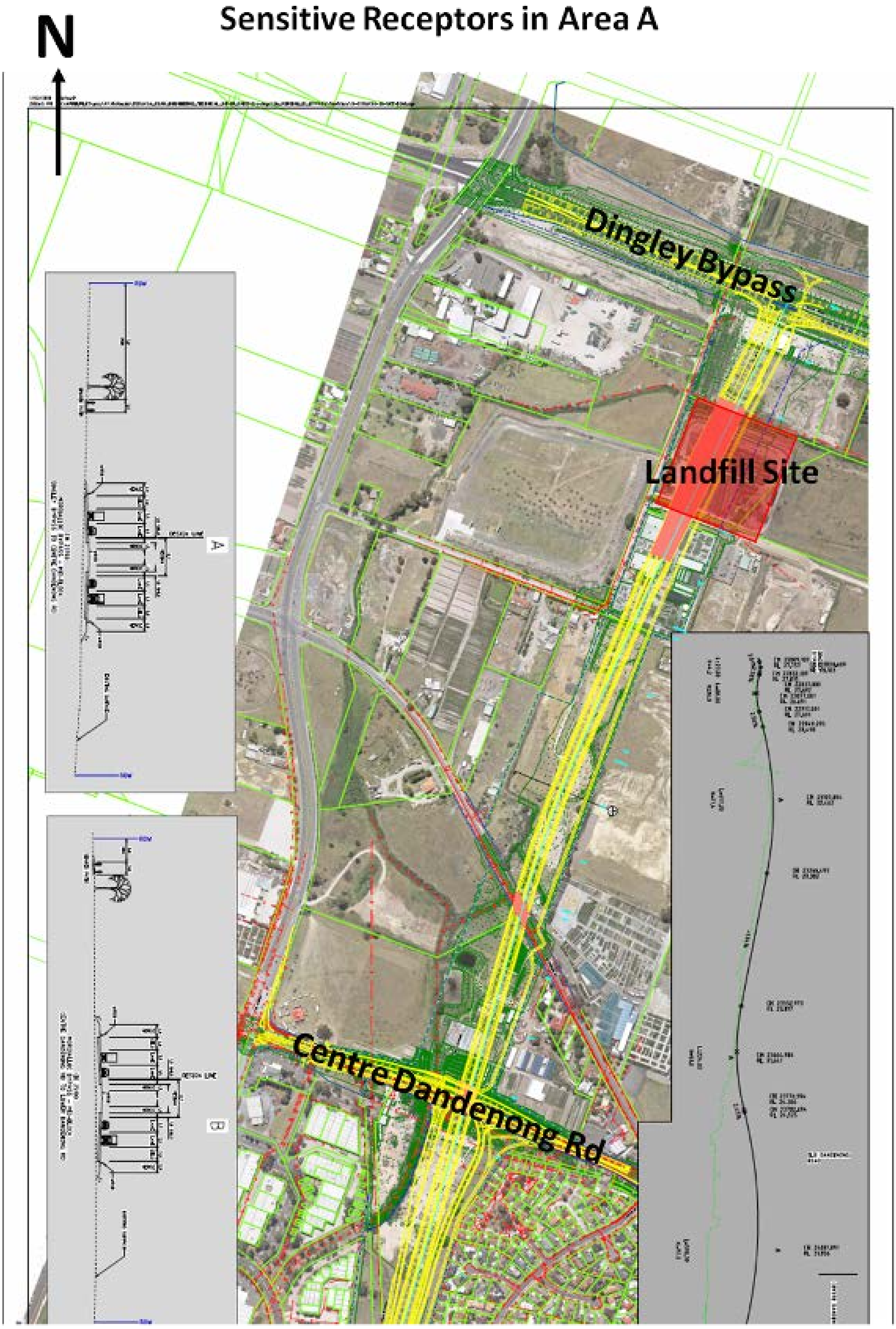


Figure 7-4 Sensitive Receptors in Section B

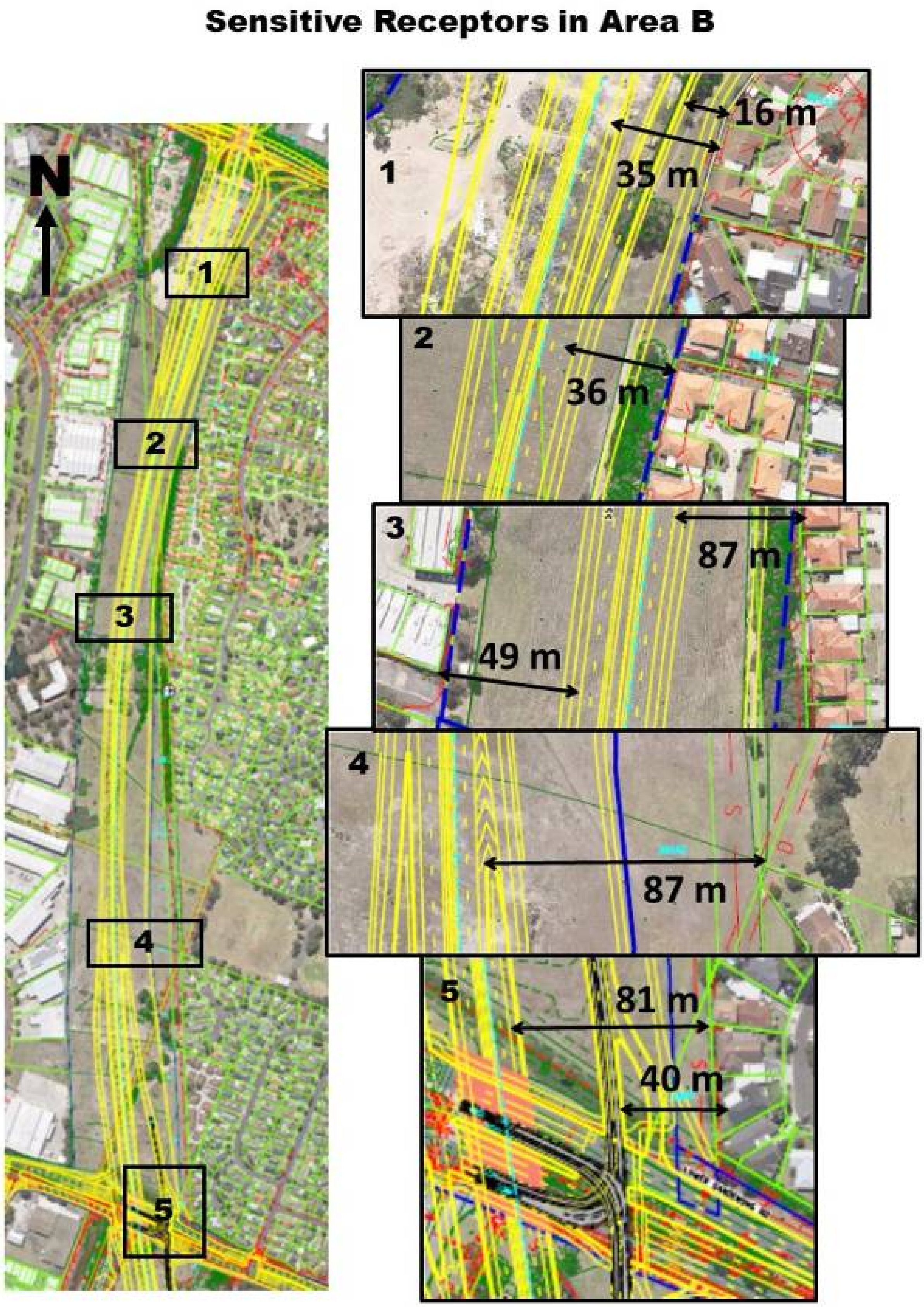
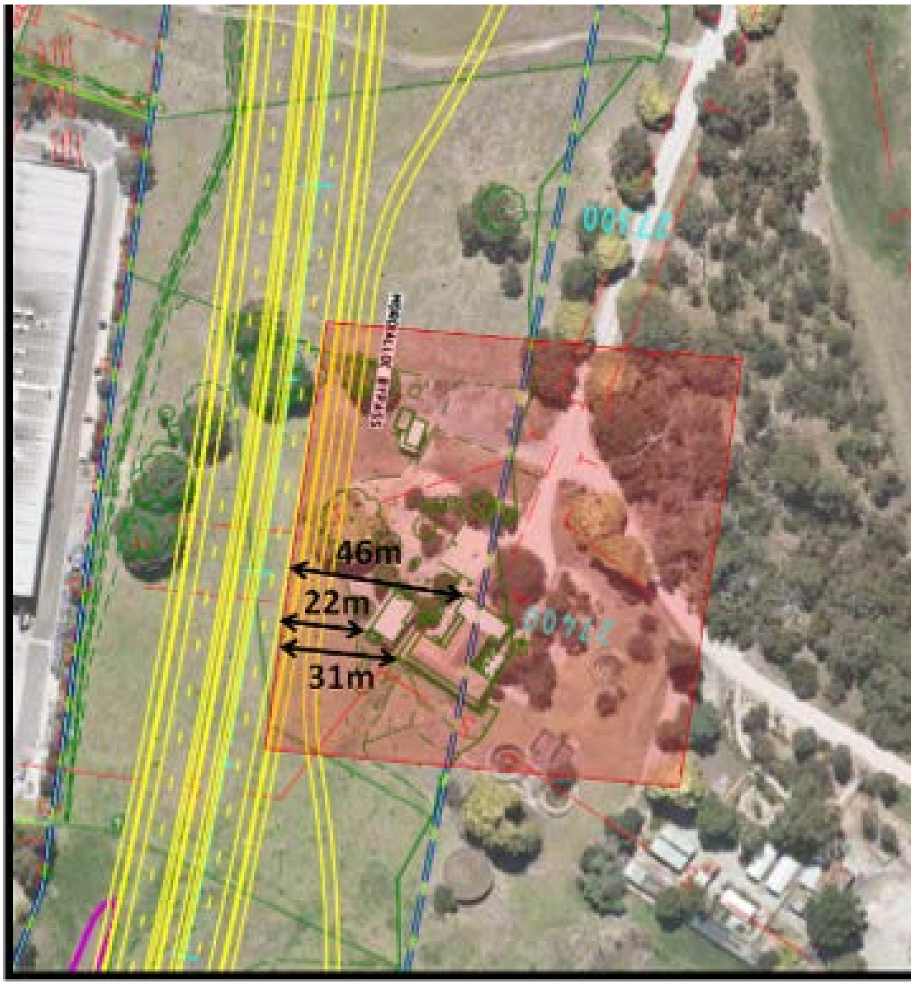


Figure 7-5 Sensitive Receptors in Section C – Braeside Park



Section D extends for 2.0 km from Governor Road to Springvale Road. Figures 7-6 and 7-7 show the route and adjacent land uses and receptors in Section D. The adjacent land use is wetlands on both sides of the route for the 1.0 km distance from Governor Road to Mordialloc Creek. South of Mordialloc Creek, there is residential use (Aspendale Gardens) and a retirement village to the west of the Bypass and rural open space to the east of the Bypass.

The residences between the wetlands and Mordialloc Creek are 140 m or more east of the roadway. There is open rural land east of the route between Mordialloc Creek and Springvale Road and the edge of the road reservation is typically 40 m to 50 m east of the road.

The residences west of the road are mostly 73 m to 85 m west of the road, but there are five residential properties with lot boundaries that extend to the road reservation and thus are only 43 m from the road.

The retirement village near Springvale Road is set back from the roadway, with a distance of 70 m from the road to the storage yard next to the road reserve and 83 m to the nearest boundary of the units. The distance is smaller for the on-ramp from Springvale Road, with a distance of 35 m from the ramp to the storage yard and 46 m to the nearest boundary of the units. The units are 70 m from Springvale Road, and well protected by a commercial area.

Section E extends for 2.2 km south from Springvale Road to Thames Promenade along the centre of the existing Mornington Peninsula Freeway. There will be grade-separated interchanges over Springvale Road, and the new Bypass extends for about 500 m south of Springvale Road, where it merges into the existing Mornington Freeway. Figure 7-8 shows the route, adjacent land uses and receptors in the northern part of Section E.

The adjacent land uses west of the Freeway is the Chelsea Heights shopping centre and a retirement village, noting that these properties have been adjacent to an existing freeway for about twenty years. The shopping centre car park is 96 m to 100 m from the road, although only 50 m from the existing Mornington Peninsula Freeway.

Buffer distances for the Chelsea Heights retirement village are shown in Figure 7-8. The boundary of the village is 35 m to 50 m from the Mordialloc Bypass and 17 m to 22 m from the Mornington Freeway. The combined effect of the two Freeways on air quality is assessed.

East of the Bypass, the adjacent land use is a Church, dog club and rural open space. The road reserve is typically 35 m to 60 m from the nearest road, and currently there are no sensitive receptors within 60 m of the Mordialloc Bypass.

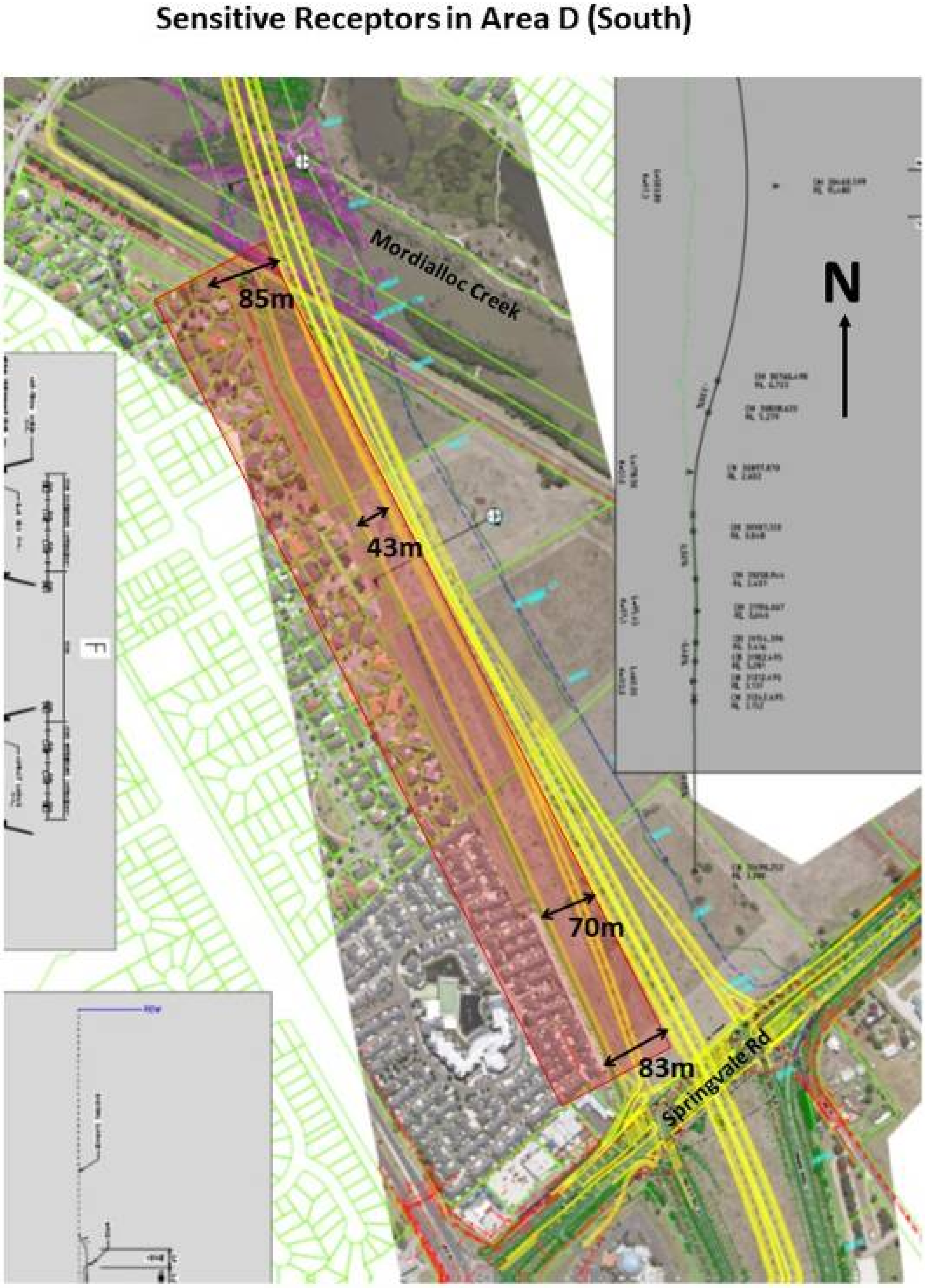
There are also sensitive receptors close to some intersections, although as the Freeway roadways will be elevated 7 m above the existing cross-roads, the contribution of contaminants in operation will be small in relation to those from the existing arterial roads.

Figure 7-6 Sensitive Receptors in Section D - North

Sensitive Receptors in Area D (North)

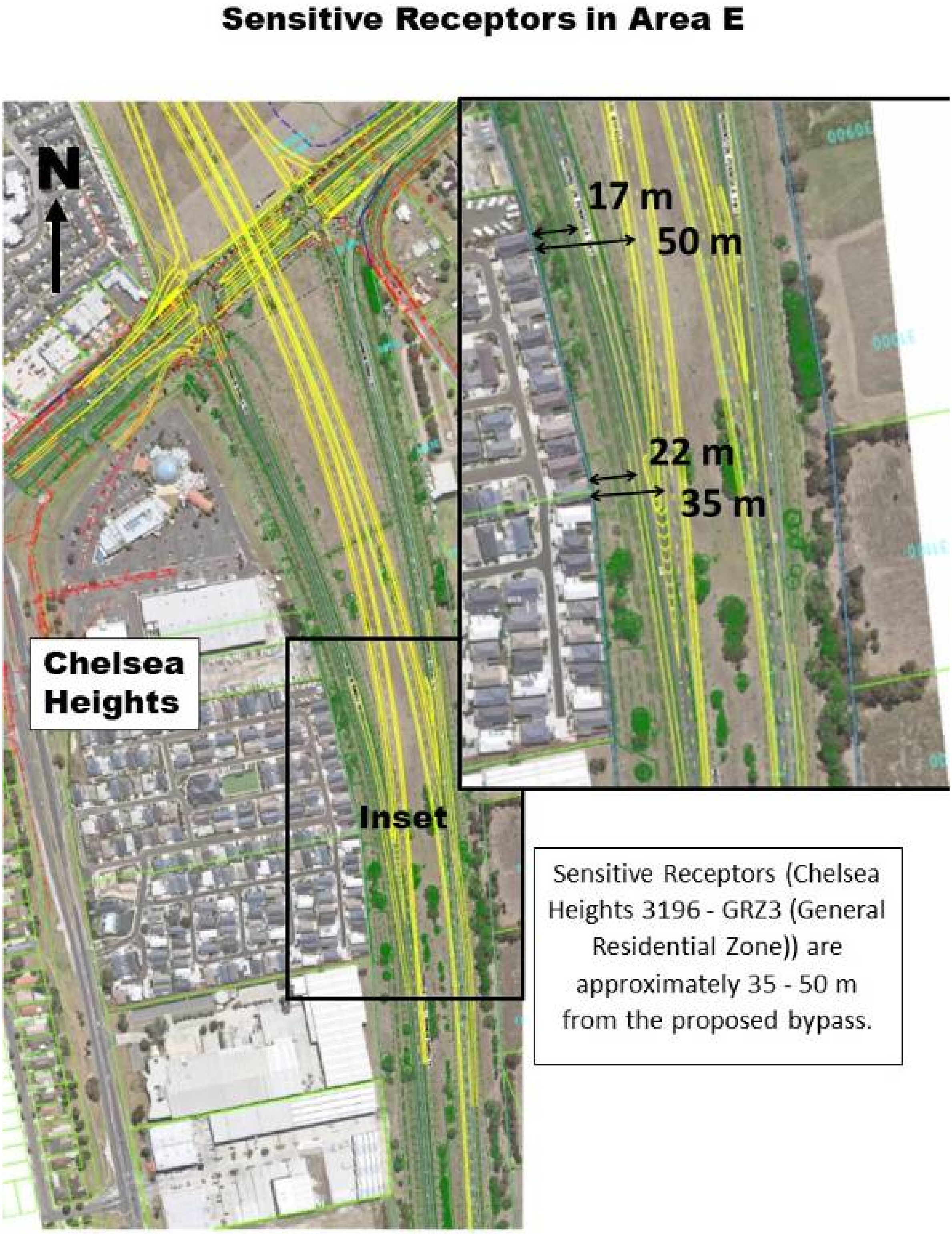
Sensitive Receptors (Waterways 3195 - GRZ3 (General Residential Zone)) are at least 143m from the proposed bypass.

Figure 7-7 Sensitive Receptors in Section D - South



Sensitive Receptors (Aspendale Gardens 3195 - GRZ3 (General Residential Zone)) are approximately 43 – 85 m from the proposed bypass.

Figure 7-8 Sensitive Receptors in Section E



The varying gradient of the Bypass is illustrated in Figures 7-3 and 7-7. The Bypass roadways rise to pass over cross-roads at each major intersections. This creates a gently undulating route for a driver using the Bypass in the future.

Intersection of Freeway and Centre Dandenong Road

The intersections were examined to see if there were sensitive receptors that could experience contributions from the Mordialloc Bypass and the cross-road. In general, there is a wide buffer between the planned Bypass and the cross-roads, although mostly a small buffer between the cross-roads and nearby properties. Some turning lanes are close to properties but these have a small volume of traffic.

Figure 7-9 Sensitive Receptors near Centre Dandenong Road

Summary of Buffer Distances

Table 7-2 summarises the buffer distances from the roadway to strips of sensitive receptors in Sections A to E. The Braeside Parks office (see Section C) is the closest sensitive receptor to the Mordialloc Bypass.

Table 7-2. Summary of Minimum and Typical Buffer Distances

Buffer Distances to West	Section	Buffer Distances to East
Mostly commercial/rural uses Nearest rural house at 80 m	A	Mostly commercial/rural uses Proposed football club at 80 m
Industrial zone Typical buffer 49 m to 60 m	B	Generally residential use Typical buffer of 40 m Minimum buffer of 35 m Chadwick Reserve buffer of 65 m
Generally industrial/commercial uses Typical buffer 40 m to 70 m Minimum buffer of 25 m	C	Braeside Park and wetlands Typical buffer 45 m to 50 m Minimum buffer of 22 m - Parks
Wetlands / residential / open space Typical buffer 40 m to 70 m Minimum buffer of 25 m Retirement village buffer of 83 m	D	Wetlands / residential / open Residential buffer 143 m Mostly open space
Commercial / retirement village Retirement village buffer of 35 m from Mordialloc Freeway 22 m from Mornington Pen.	E	Mostly open space Minimum buffer of 60 m

Industrial Areas

Proposed Hawthorn Football Club Development in Section A

In Section A, just to the south of the Dingley Freeway, the route passes over a former landfill (red shaded area in Figure 7-10) and close to the future development area for the Hawthorn Football Club (blue shaded area).

The Bypass will require piles across the landfill site with the potential to release odour during the construction period. See Section 10 for the assessment of odour from the former landfill, now used as a compost facility.

Figure 7-10 Landfill Site and Hawthorn Football Club Site

The Hawthorn Football Club is likely to have a car park and storage adjacent to the Bypass route and a buffer distance of at least 80 m.

8. Construction Dust Assessment

This section describes the impact assessment for potential dust impacts during construction. The basis of the assessment is the volumes of material to be moved in construction as a result of excavation and formation of the base for the roadways and embankments at grade-separated interchanges. Dust emissions generated by construction equipment are modelled using the *Ausroads* dispersion model and concentrations at various distances each side of the route are developed for the peak day. Other sources of dust emissions could include geotechnical surveys with ground drilling however due to the scale of these works and limited duration they were not modelled.

As discussed in Section 3, it is acknowledged that at the EES preparation stage prediction of dust levels are often not made due to the lack of available information on construction details such as duration and equipment. However, for the Mordialloc Bypass Project, there are many residential and commercial receptors adjacent to the proposed construction route and thus a ‘best estimate’ was made of the frequencies of elevated dust levels at these receptors to provide a quantitative basis for defining the level of risk.

8.1 Assessment Methodology

The assessment of potential impacts from dust emissions during construction involved the following steps:

- Establish the volume of excavation and fill for each route (see next Section);
- Establish the construction period (2 years);
- Estimate the type, number and characteristics of construction equipment;
- Estimate the dust emissions by equipment using published information;
- Model the transport and dispersion of dust as total suspended particulates (TSP) and as PM_{10};
- Plot the PM_{10} and dust (as TSP) concentrations during the construction period;
- Compare the predicted levels to design criteria and assess impacts.

The *Ausroads* dispersion model was used to predict the distribution of dust (as TSP and PM_{10}) near the construction zone. *Ausroads* is a multiple line source model developed by EPA Victoria based on the equivalent US EPA Model Caline 4 developed by the California Department of Transportation. The functionality of the Caline near-road model has been retained in *Ausroads*. However, *Ausroads* allows for road sectors and receptors to be modelled simultaneously. A full year of local meteorological information, at hourly time-steps is read into the program from an external file (EPA, 2002). Road geometry, equipment density, dust emission factors and receptor location information are entered in setting up each model run.

Ausroads is most suitable for use in areas with reasonably flat terrain and where calm wind conditions occur for only a small percentage of the time. The highest air contaminant levels occur within a few metres of the roadside. *Ausroads* uses a ‘mixing zone’, in which contaminants are rapidly mixed in a zone of turbulent air extending 3m either side of the line of road traffic. This zone is generated by the movement of vehicles, and is additional to atmospheric turbulence.

Road Geometry and Topography

The construction area was represented as two sections of roadways, each with two lanes, over a construction zone that is 900 m long and 10 m wide. The topography of the area was assumed to be flat.

Model Scenarios

For TSP and PM_{10}, three model scenarios were conducted to reflect construction stages. These include:

- **Scenario 1** – clearing, removal and stockpiling of topsoil (referred to as 'clearing' from herein);
- **Scenario 2** – filling and compaction to form the base of the roadway (referred to as 'filling' from herein); and
- **Scenario 3** – preparation for pavement and landscaping alongside the route, including construction of cycleways (referred to as 'pavement' from herein).

Source Emission Characteristics

The roadways were modelled as two separate line sources. The emission rates for TSP and PM_{10} during construction were derived from the estimates of excavation and fill in the various sections of the route, the construction equipment involved in the work, and the dust generation per hour for each item of equipment, as described below.

Table 8-1 shows the schedule of quantities for removal of topsoil, excavation and filling for the various sections of the Freeway. Over the project, a total of 69,000 m^3 of topsoil is estimated to be removed, stockpiled and reused on the route, or in other adjacent sites. There will only be a small amount of excavation (16,000 m^3) as the route is flat. Over the project lifetime, a total of 1,230,000 m^3 of fill is estimated to be brought to the site, deposited and spread in layers, watered and compacted.

Table 8-1. Estimated Cut and Fill for Route Options

Earthworks	***Area - >***	***Northern Section***	***Centre Dand. Rd***	***Lower Dand. Rd***	***Governor Rd***	***Southern Section***
	Chainage - >23,500	***Ch.22800 - 23500***	***Ch. 23500 - 25100***	***Ch 25100 - 27200***	***Ch 27200 - 29150***	***Ch. 29540 - 31280***
	Unit	Qty	Qty	Qty	Qty	Qty
Remove soil	m^3	4,117	12,641	17,222	19,687	15,006
Excavation	m^3	0	12,641	0	0	3,154
Total Fill	m^3	19,936	253,308	317,003	381,459	257,716

Equipment Used in Construction

The equipment used during the construction stage comprises excavators, large cartage trucks and trailers, rollers, water trucks, and smaller delivery trucks and vans, as listed in Table 8-2 for the three model scenarios assessed. The table also lists the vehicles used to bring supplies and personnel to the site (cars, utes and vans).

Table 8-2. Equipment Used in Clearing, Filling and Pavement Construction

Construction	**Scenario 1 Clearing**	**Scenario 2 Filling**	**Scenario 3 Pavement**
Graders	0	2	0
Excavators	2	2	2
Truck/trailer	3	9	2
Rollers	0	2	1
Water trucks	1	2	1
Light Trucks	2	4	6
Utes/vans	20	20	20
Cars	20	20	30

Assumptions

The following assumptions have been made to estimate dust emissions:

- Construction proceeds in zones that are approximately 900 m long;
- Construction dust emissions are calculated for the stages of clearing, filling and pavement preparation, each of which has a different fleet of construction equipment and vehicles;
- Equipment used in construction estimated from volume of fill and from observations of a recent road construction project on the Western Highway;
- Bridge construction involves a smaller dust source than the other operations, and thus is not modelled;
- Dust emission rates from published sources are adopted (see following section);
- Equipment operates from 7 am to 6 pm, with large trucks ceasing at 4 pm each day; and
- Equipment operates most of the time throughout the working hours (this is a conservative assumption as observation of most road construction sites shows that there are periods with idle equipment).

It is considered that a smaller construction fleet will be involved in clearing and excavation (Scenario 1), as soil and vegetation will need to be separated, and some topsoil will be stockpiled on the site for use later in the project. The largest construction fleet will be involved in filling (Scenario 2), when the road base (typically around 1.5 m deep) is prepared. As noted above, a substantial quantity of fill will be transported to the site. Preparation of the pavement and related activities (Scenario 3) involves a larger workforce and more small equipment (cranes and small excavators), but they are not large generators of dust.

Construction Emission Rates

The dust emission rate for each stage of construction was developed from estimates of the dust generation by major items of equipment and wind erosion of dust from exposed soil surfaces and stockpiles of soil. The derived emission rates are characterised using the emissions factors for graders, trucks and light vehicles published in the *National Pollutant Inventory Emission Factor Estimation Techniques Manual for Mining (EETM)* (Commonwealth of Australia, 2012).

It is assumed that work on the Mordialloc Bypass Project would be carried out during the recommended hours for construction work set out in the VicRoads DC1 contract specification (VicRoads, April 2012). Thus, heavy construction equipment would generally operate from 7 am to 6 pm. The site wind erosion occurs during all hours. The dispersion modelling reflects these emission periods each day.

The default emission factors listed by NPI assume dry conditions. However, the dust control methods and emission reduction techniques listed above were taken into account and appropriate reductions in emission rates adopted.

In modelling the construction dust emissions, the source release geometry was taken to be two separate line sources along the centreline of the north and south roadways, over a length of 900 m. This is a conservative 'worst-case' basis for assessment. The Mordialloc wind files for 2013 to 2017 were used for the dust dispersion modelling. Initial modelling was carried out for a single year (2016) and later repeated for the full five years of modelling as required by the EPA.

Dust levels have been predicted for both PM_{10} (fine dust particles) and TSP (fine and coarse dust particles). The total emission rate was proportioned over the assumed length of construction and concentrations calculated at discrete receptors set at 10, 20, 30, 40, 50, 60, 80, 100, 150, 200 and 300 m intervals either side of the route.

Meteorological Data

For the calculation of dust and vehicle emission concentrations, hourly values of wind speed and wind direction over five recent years are required. For this Project, 10-minute meteorological data was obtained from the Bureau of Meteorology (BoM) for Moorabbin Airport for the years 2013 – 2017. This data was processed to create wind files with hourly values of wind speed, wind direction, ambient temperature, mixing height and atmospheric stability. Two years of meteorological data generated using the MM5 computer model were purchased from Lakes Environment in the USA, and checked against the measurements at Moorabbin Airport.

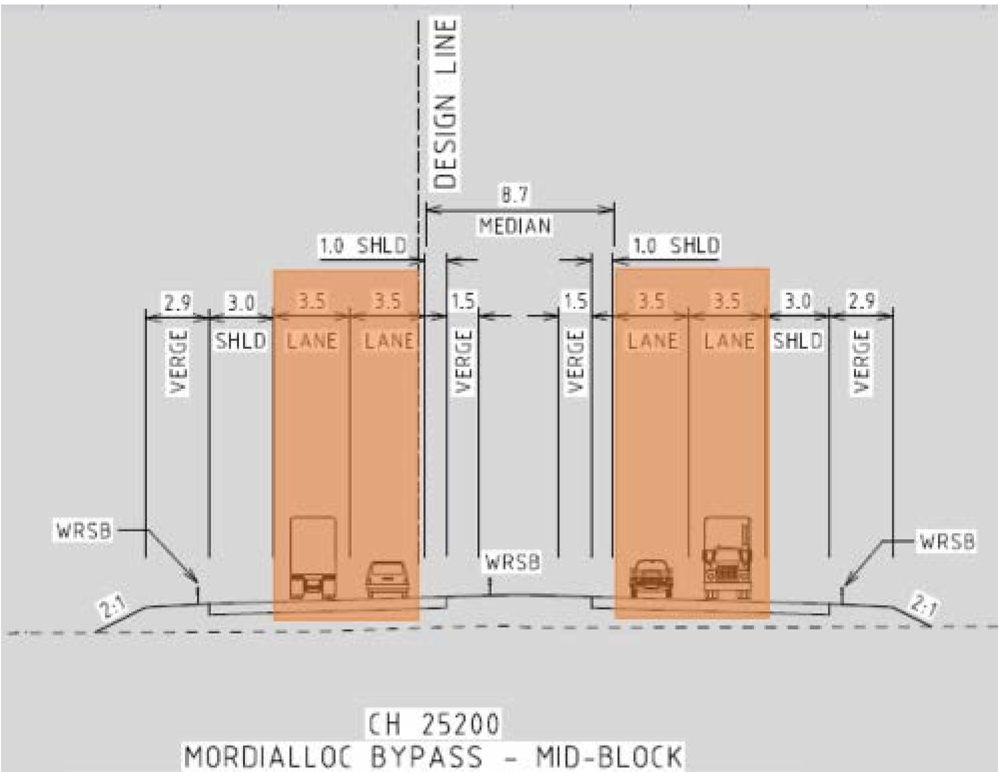
The MM5 model is a three-dimensional hydrodynamic model of the lower atmosphere created by (and regularly updated by) Pennsylvania State University and the US National Centre for Atmospheric Research (US EPA, 2010). The MM5 model is a non-hydrostatic, terrain-following system that solves the full set of physical and thermodynamic equations that govern atmospheric motions. Meteorological model input fields for *Ausroads* were prepared for the years 2015 and 2016 using the MM5 model predictions, and the equivalent files were prepared from BoM Moorabbin Airport data for the years 2013, 2014 and 2017.

Table 5-1 compares the 10, 50 and 90 percentile wind speeds for the five years, and shows good similarity from year to year. Figure 5-4 presents the annual wind rose for each year. The year 2016, which is typical of the five year period, was used to calculate the transport and dispersion of dust.

Road Cross-Section

The cross-section of the road used in modelling was a typical section in cut as shown in Figure 8-1. Modelling for each scenario was conducted on a typical cross section extending north to south across the roadway.

Figure 8-1. Typical Freeway Cross-Section



TSP and PM$_{10}$ Dust Generation Emission Rates

Table 8-3 presents the dust emission rates for the peak hour for each stage of construction i.e. for the three model scenarios. As the emission rates were assumed to be the same from 7 am to 4 pm each day, the peak dust rate represents the conditions over nine hours rather than a single hour.

Table 8-3. Peak Hour Dust Generation Emission Rates

Sources of Dust	TSP Dust Emission (kg/hr)			PM_{10} Dust Emission (kg/hr)		
	Clearing	**Filling**	**Pavement**	**Clearing**	**Filling**	**Pavement**
Graders	0	1.8	0	0	0.6	0
Excavators	6	6	6	2.8	2.8	2.8
Truck/trailer	4.5	15	3	2.1	7	1.4
Rollers	0	1	0.5	0	0.6	0.3
Water trucks	0.5	1	0.5	0.3	0.6	0.3
Light Trucks	1	2	3	0.6	1.2	1.8
Utes/vans	8	8	8	4	4	4
Cars	6	6	6	3	3	3
Stockpiles	4	2	1	2	1	1
Total / hour	**30**	**42.8**	**28**	**14.8**	**20.8**	**14.6**

Summary of Model Assumptions

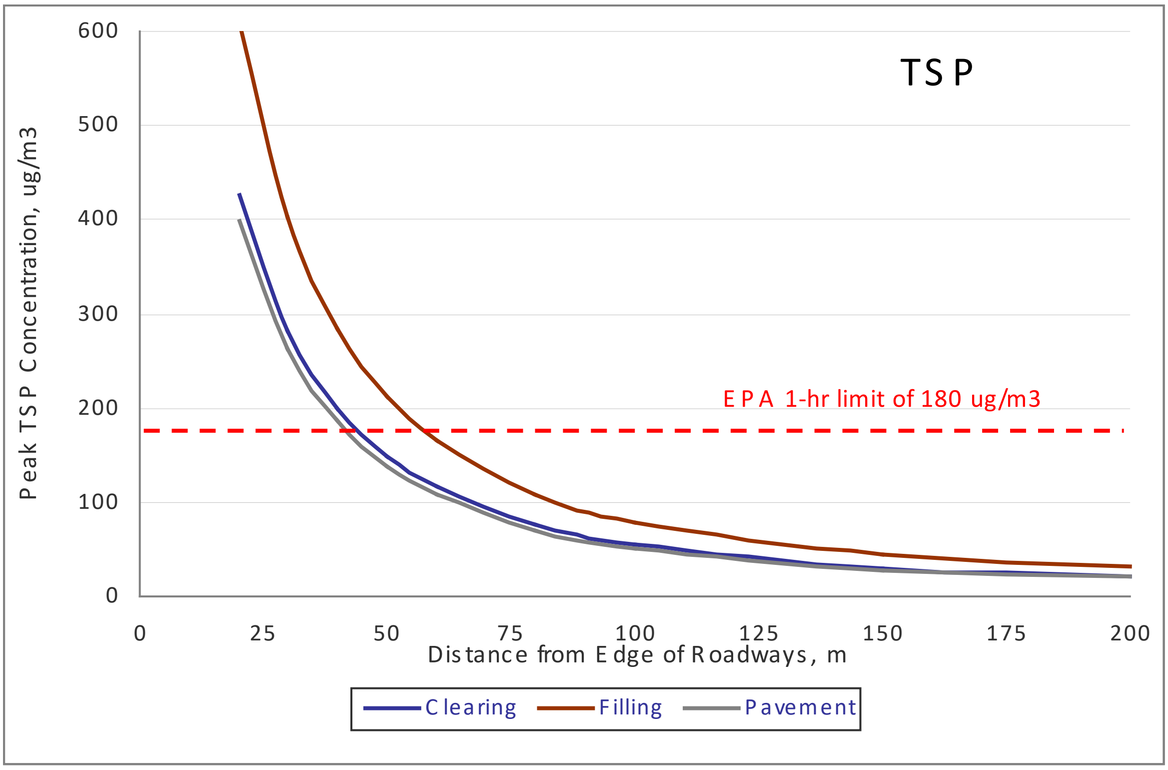
The dust modelling involved a series of conservative assumptions including:
- A typical fleet of construction equipment (with a capacity calculated to handle the specified volume of excavation and fill);
- Construction operations proceed on every working day (although this is unlikely to occur in wet weather);
- Excavation and filling occur over 900 m lengths for the route;
- TSP modelling included the generation and transport of fine and coarse dust particles, and an allowance for the settling of larger dust particles with distance from the work area.
- Background TSP is assumed to be negligible in comparison to the dust generated in construction and has not been included in the assessment.

It is acknowledged that dust dispersion modelling involves a large number of estimates about construction practices by a Contractor who is yet to be appointed and on soils and fill materials for which there is limited knowledge at this stage. Thus, the results must be interpreted as indicative, perhaps with a likely variation of + 20 percent to - 30 percent about the predicted values.

8.3 TSP results

Figure 8-2 shows the predicted peak TSP concentration with distance from the road for the estimated two highest concentration days each year for the three construction scenarios. To allow a larger scale in the plot, the TSP concentration has been shown for one side of the roadway, but the same distribution applies each side of the road – it will depend on the wind direction as to which side of the road is impacted.

Figure 8-2. Predicted Peak TSP Concentration Distribution from the Edge of Roadway through the 3 Stages – Utilising 2016 Meteorological Data



The derived design criterion for TSP corresponds to 180 μg/m^3 over a 1-hour averaging period. Figure 8-2 shows that the predicted peak TSP concentration could exceed the design criterion for a distance of 40 to 65 m from the edge of roadway construction. The greatest distance for which exceedances are predicted to occur is during the months that the fill is being installed.

The predicted peak TSP concentrations shown in Figure 8-2 are based on an "average" year of meteorological data. For the purposes of this assessment, the "average" year is 2016. In practice, any given year may be hotter than average, with more events of high dust emissions, or wetter and cooler than average, with few or even no events of high dust emission events.

The planning and practices of the Contractor will contribute to determine the outcome in terms of dust impacts. For example, if the Contractor maintains a high level of control over dust emissions, and plans filling activities close to houses in the winter to spring seasons, the local impact of dust would be significantly less than shown in Figure 8-2. This issue is explored further in a later section when EPRs for construction are developed.

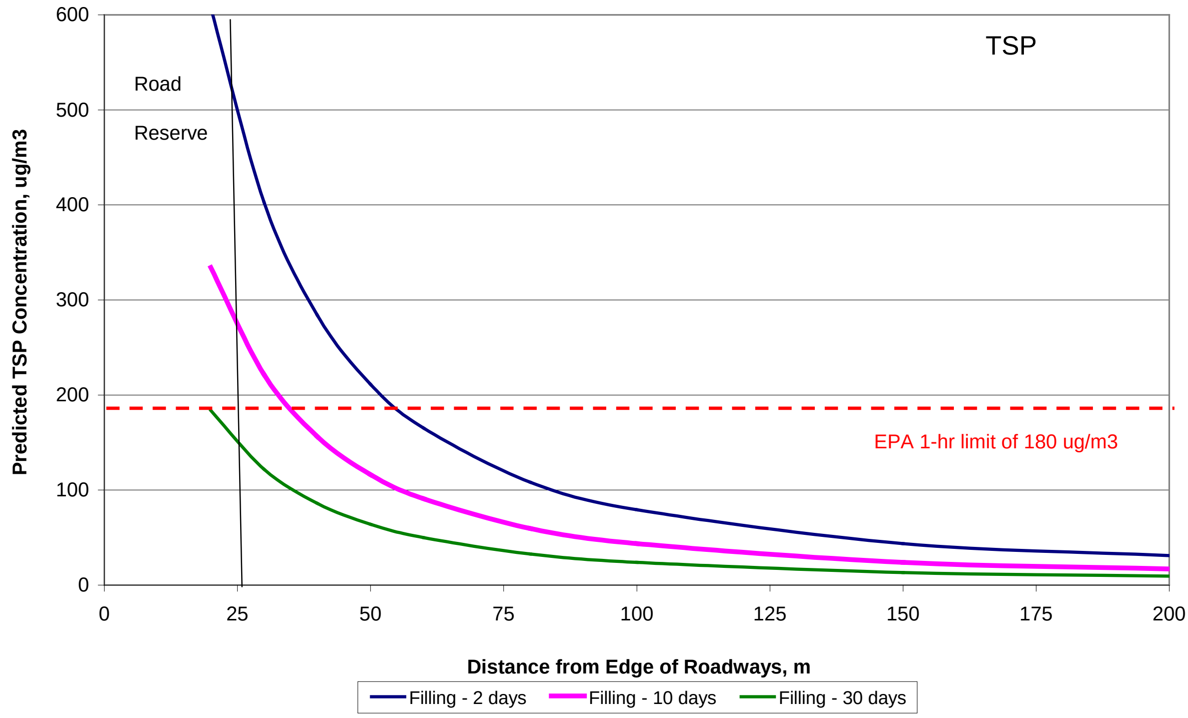
More detailed analysis of predicted TSP and PM_{10} ground level concentrations through the construction period focuses on the period of filling activities, as this is the critical period with respect to dust emissions. Filling activities are expected to take a period of approximately 12 months on the whole project and so they may continue for several months in any 900 m long section.

Figure 8-3 shows the predicted peak TSP concentration with distance from the road for three periods, for the average year (2016) during filling activities for:

- the worst two days,
- the worst 10 days and
- the worst 30 days.

This figure illustrates that an extended distance of nuisance dust will occur on only a few occasions during construction. For the majority of the construction period, dust will not extend at nuisance levels beyond the road reservation.

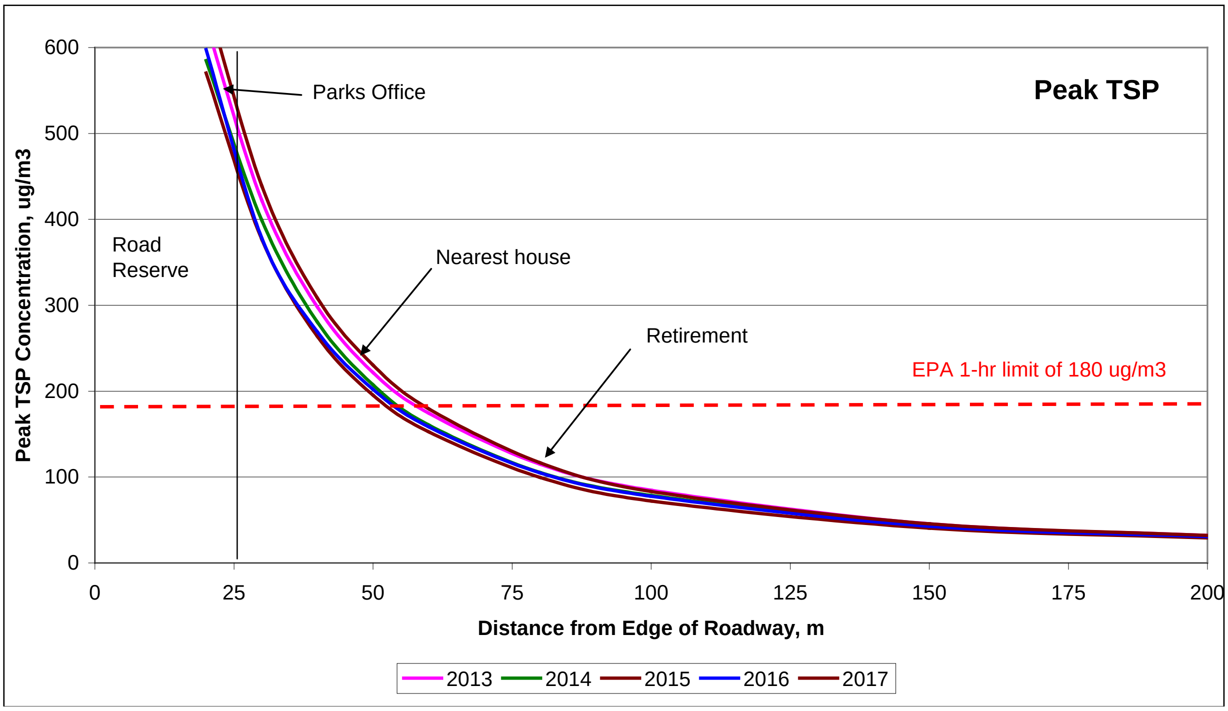
Figure 8-3. Predicted TSP Concentration Distribution in 'Filling' Events – Utilising 2016 Meteorological Data



The predicted peak TSP concentrations shown in Figures 8-2 and 8-3 are based on an "average" year of wind conditions, assumed to be 2016. Figure 8-4 shows the TSP distribution for each of the five years for 2013-2017. It can be seen that, based just on wind speed and dispersion conditions, there is little difference in TSP predictions from year to year.

The peak 2-day concentrations shown in Figure 8-4 represent the worst days in the year (depending on the temperature and wind patterns). Hot dry conditions, generally with moderate northerly winds are worst for erosion and transport of dust and lead to higher dust levels. On the other hand, in cool conditions with some recent rain, and dust erosion and transport well-controlled, there will be less-elevated dust conditions (as depicted by the 30-day line in Figure 8-3).

Figure 8-4. Predicted Peak TSP Concentration Distribution for 'Filling' activities – Utilising 2013-2017 Meteorological Data



The predicted 1-hour TSP levels shown in Figure 8-3 and 8-4 are interpreted as follows:

- Impacts in the two retirement villages will be low as the predicted TSP levels there are within the EPA derived design criterion;
- Impacts at residences beyond 60 m distance from the roadway, which generally corresponds to about 35 m from the edge of the road reserve will also be acceptable, although residents up to a distance of about 200 m from the route will have to tolerate extra dust for a few days during construction;
- Impacts at the residences between 50 m and 60 m distance from the roadway, which includes a long strip of houses in Dingley Village between the centre of Dandenong Road and Lower Dandenong Road, five houses in Aspendale Gardens, and a strip of houses in Chelsea Heights near Springvale Road will experience elevated TSP levels on up to 10 days during construction unless additional dust control measures are taken;
- The Parks office at Braeside Park are predicted to experience high TSP levels for short periods during construction;
- Otherwise, a short period of elevated TSP will not have a significant impact on rural land, parks, open space and most commercial properties.

In summary, on days with high dust generation and transport, the model predicts that elevated TSP levels (over 180 µg/m^3) will extend to approximately 65 m east or west of the construction area (the direction depending of course on the direction of the wind), unless extra measures are taken to control dust.
The planning and practices of the Contractor will determine the outcome in terms of dust impacts. For example, if the Contractor maintains a high level of control over dust emissions, or plans filling activities close to houses in the winter-spring seasons, the

local impact of dust would be significantly less than shown in Figure 8-2. This issue is explored further in Section 13 when EPRs for construction are developed.

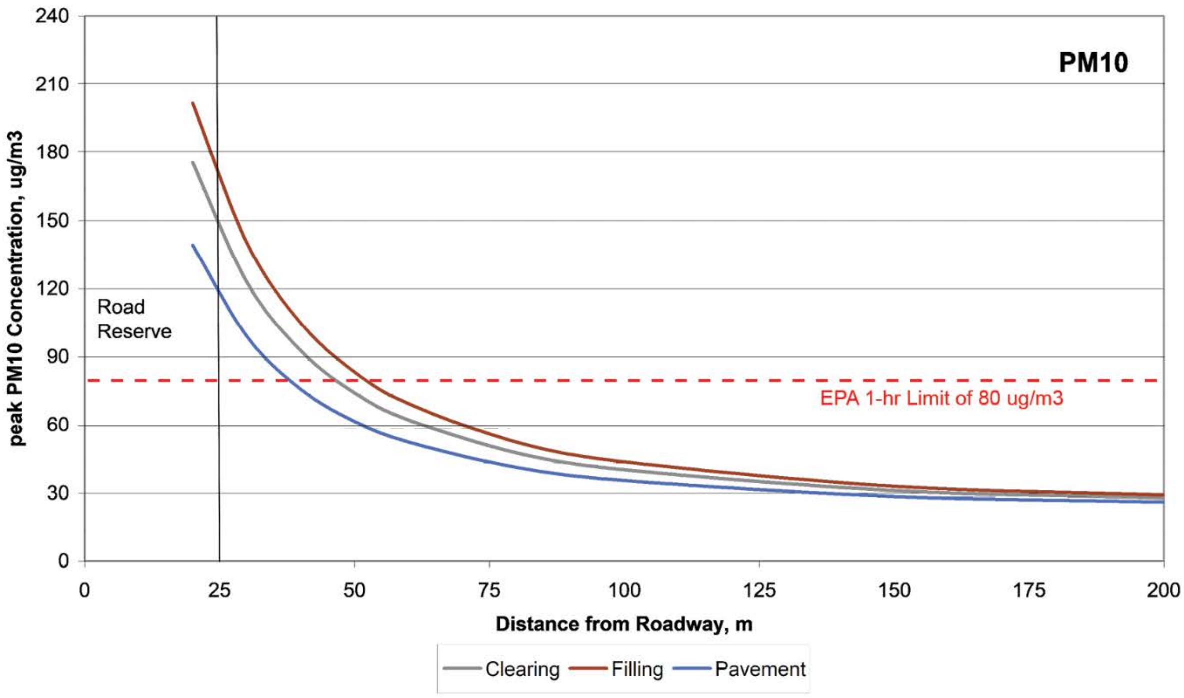
8.4 PM_{10} Results

Figure 8-5 shows the predicted increase in PM_{10} concentration with distance from the road for the estimated two highest concentration days each year for the three construction scenarios as follows:

- Scenario 1 – clearing, removal and stockpiling of topsoil;
- Scenario 2 – filling and compaction to form the base of the roadway and
- Scenario 3 preparation for pavement and landscaping alongside the route, including construction of cycleways.

To allow a larger scale in the contour plot, the PM_{10} concentration has been shown for one side of the roadway only. The same distribution applies to each side of the road - the impacted side of the road will depend on the wind direction.

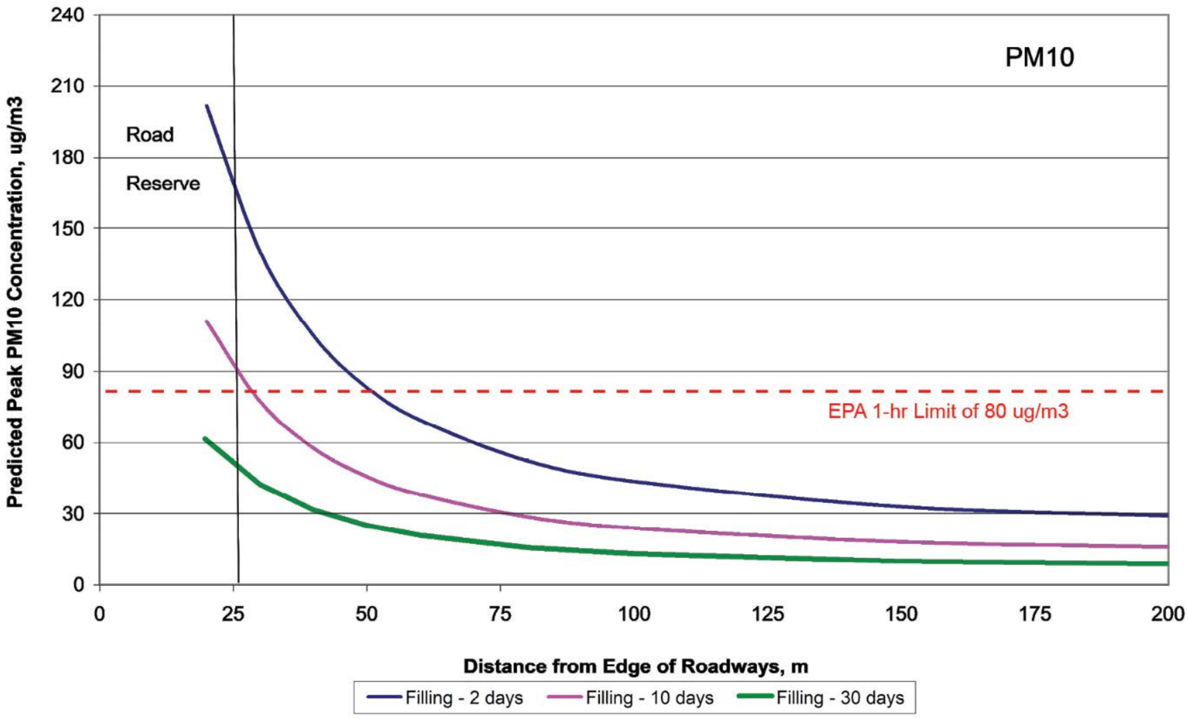
Figure 8-5. Predicted Peak PM_{10} Concentration Distribution



The concentrations shown in Figure 8-5 represent the increase in PM_{10} levels during the worst periods in a year (depending on the temperature and wind patterns). Hot dry conditions, generally with moderate northerly winds, are worst for erosion and transport of dust and lead to higher dust levels. On the other hand, for some days, there will be cool conditions or some recent rain, and dust erosion and transport will be well-controlled. On those days there will not be the peak dust conditions. Predicted peak PM_{10} levels over longer periods are depicted in Figure 8-6.

Higher PM_{10} concentrations are predicted to occur during the filling stage of construction, because in that period, there will be more gravel and other materials being transported and compacted on the site, and a larger fleet of earthmoving and compaction equipment will be in operation. The subsequent more detailed analysis of PM_{10} levels through the construction period focuses on the period of filling activities, as this will be the critical period with respect to dust emissions.

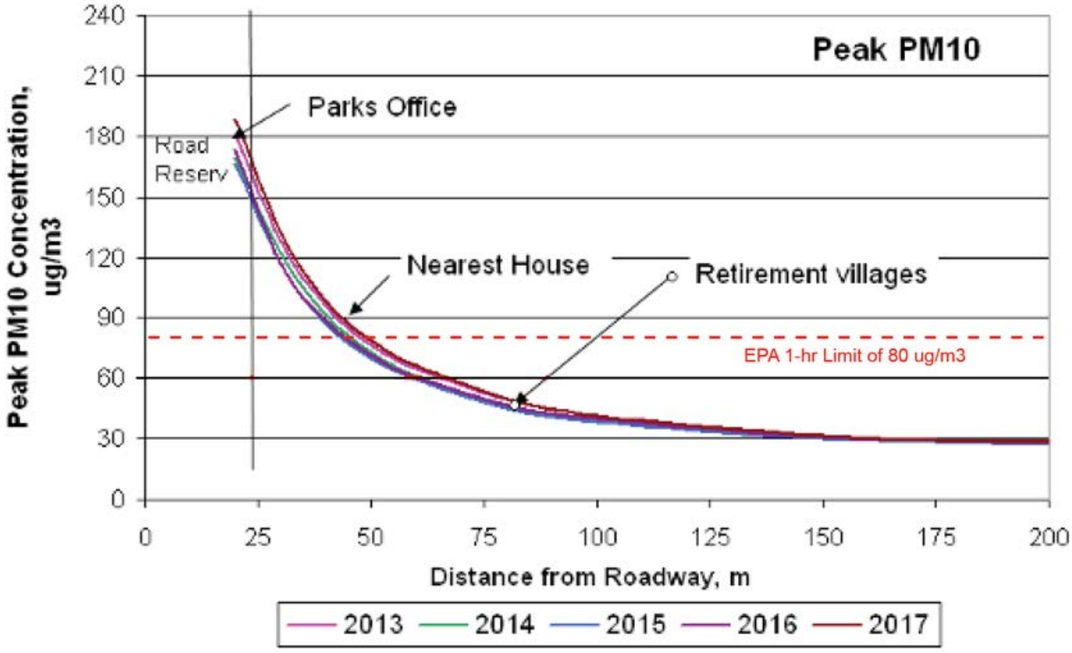
Figure 8-6. Predicted PM_{10} Concentration Distribution in 'Filling' Events



The predicted peak PM_{10} concentrations shown in Figures 8-5 and 8-6 are based on an "average" year of wind conditions. This average year is assumed to be 2016 for the purposes of this assessment. Figure 8-7 shows the PM_{10} distribution for each of the five years for 2013-2017. It can be seen that, based just on wind speed and dispersion conditions, there is little difference in PM_{10} predictions from year to year.

In practice, the year may be hotter than average, with more events of high dust emissions, or wet and cool, with few or even no events of high dust emissions. In addition, background dust conditions change substantially between wet years and hot, dry years. Thus the model predictions are for "average" conditions.

Figure 8-7. Predicted Peak PM_{10} Concentration Distribution – Utilising 2013-2017 Meteorological Data



On days with high dust generation and transport, the model predicts that elevated PM_{10} levels (up to 60 µg/m^3) will extend to approximately 60 m east or west of the excavation area (the direction depending of course on the direction of the wind).

The predicted PM_{10} levels shown in Figures 8-6 and 8-7 are interpreted as follows:

- Impacts in the two retirement villages will be low as the predicted PM_{10} levels there are within the EPA design criterion;
- Impacts at residences beyond 60 m distance from the roadway, which generally corresponds to about 35 m from the edge of the road reserve will also be acceptable;
- Impacts at the residences between 40 m and 60 m distance from the roadway, which includes houses in Dingley Village, Aspendale Gardens and Chelsea Heights Road will suffer elevated PM_{10} levels on up to 10 days unless additional control measures are taken;
- The Parks office in Braeside Park will experience high PM_{10} levels for short periods during construction; but
- Otherwise a short period of elevated PM_{10} will not have a significant impact on rural land, parks, open space and most commercial properties.

8.5 Conclusion on Dust

The actual extent of dust depends on several factors including weather conditions, construction procedures and sequence, and the extent to which the dust mitigation measures outlined earlier are implemented. The predictions in this Section assume a high level of dust control is implemented. Even so, additional dust control measures are likely to be required to minimise impacts on residents living adjacent to the road.

It is apparent that on the worst day, nuisance dust could extend for up to 200 m from the construction area. This will be appropriately managed as per construction best practice and in accordance with the Construction Environment Management Plan (CEMP) as discussed in the EPR section (13) of this report, however nuisance dust will not be considered a significant issue where there is rural land use, open space or warehouses adjacent to the route.

Where there are residential uses adjacent to the route, the Contractor should monitor dust levels at the downwind edge of the construction zone using dust sensing monitors and compare these against trigger limits as set out in Section 12 of this report. In the event of a high reading (above the triggers listed in Section 12), action should be taken quickly to reduce activity, and increase watering and other dust mitigation measures. As a result, there would be minimal dust impact in residential areas. Elsewhere, nuisance dust could extend for about 100 m from the construction area.

9. Vehicle Emissions Assessment

This section describes the assessment of vehicle emissions during operations.

9.1 Assessment Methodology

The assessment of potential impacts from vehicle emissions involved the following steps:

- Establish the number of vehicles per day and in the peak hour each day;
- Establish the type of vehicles (fleet composition);
- Estimate the vehicle emissions using EPA data for CO, NO_2, PM_{10} and $PM_{2.5}$;
- Model the dispersion of these contaminants at the 99.9 percentile frequency (i.e. on the highest 8 hours in a year);
- Plot the distribution of contaminant concentrations on a cross-section of the road, up to 200 m east and west of the Mordialloc Bypass;
- Compare the predicted levels to the EPA design criteria and assess the zone of potential impact.

The contaminants for which concentration predictions were made are:

- CO;
- NO_2;
- PM_{10}; and
- $PM_{2.5}$.

9.2 Traffic Projections

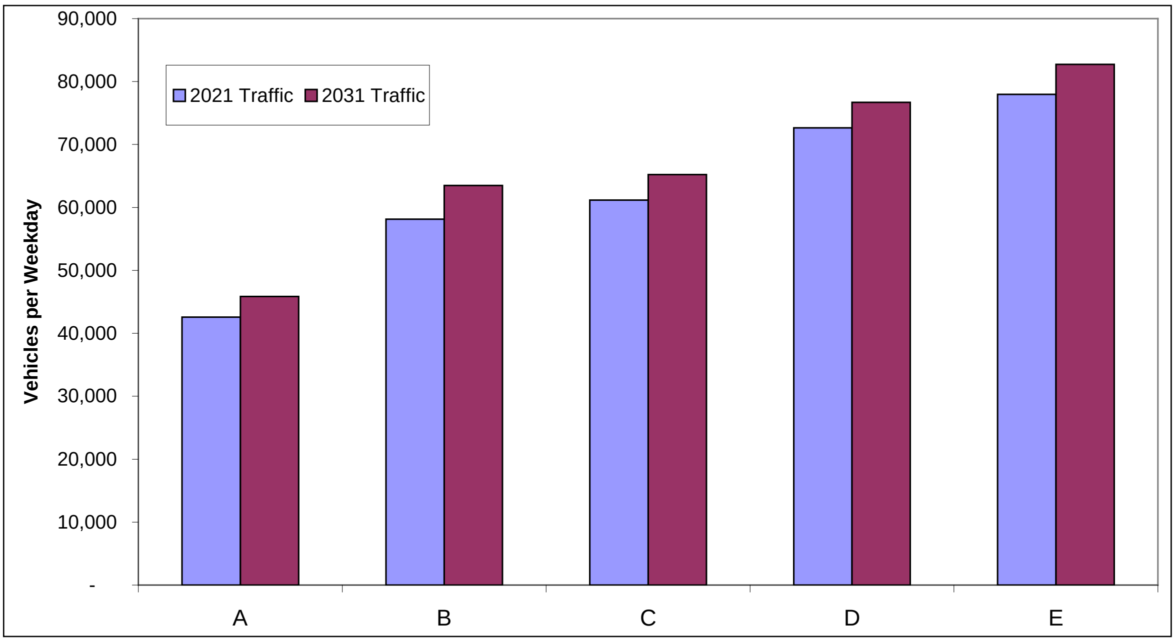
WSP provided traffic predictions for the years 2021 (opening year) and 2031 (10 years post-opening) for each of the five road sections A to E. Figure 9-1 shows the total traffic volume in each section for years 2021 and 2031.

There is a 12 percent growth in traffic between 2021 and 2031, and the traffic conditions in 2031 were considered in modelling the effect of vehicle emissions on sensitive receptors.

Traffic volume scenarios were developed from preliminary forecast data that was simulated using the Victorian Integrated Transport Model (VITM). These projections are for traffic volumes in 2021 and 2031. The simulations provide daily average traffic volume as well as peak hourly AM and PM traffic volumes in each Section. As noted earlier, for this assessment, the Mordialloc Bypass was divided into sections between major cross streets labelled A to E (from north to south). The sections are shown and described in Section 7 (see Figure 7-1).

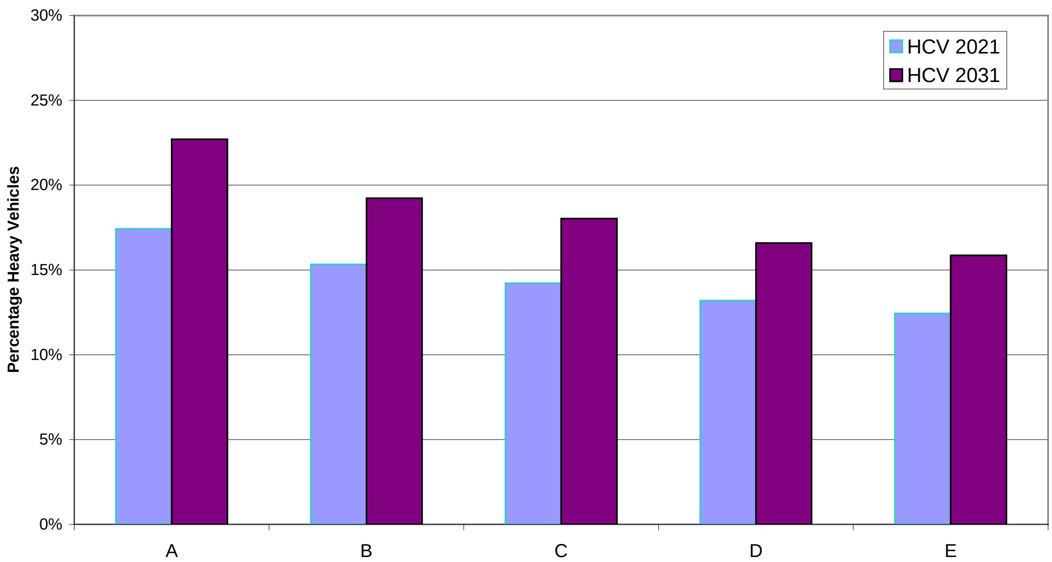
Figure 9-1 shows the projected traffic volume in 2021 (blue column) and 2031 (red column) for each of the five sections. Figure 9-1 shows are that there is a significant difference between traffic volume in the various sections (A to E), with a higher traffic volume in the south (78,000 vehicles/day (veh/d) in 2021) than in the north (43,000 veh/d in 2031).

Figure 9-1. Projected Traffic Volumes in each Road Section for 2021 and 2031



There is a relatively small 7 percent increase in traffic volume between 2021 and 2031 for all sections. This means that total vehicle emissions in 2021 will be greater than in 2031, as the reduction in fleet vehicle emissions of about 10 to 12 percent (excluding the take-up of electric vehicles) is greater than the growth in traffic volume. The increase in the proportion of commercial vehicles i.e. heavy vehicles (see Figure 9-2) shows a trend somewhat in the other direction.

Table 9-2. Projected Commercial Vehicle Volumes in 2021 and 2031



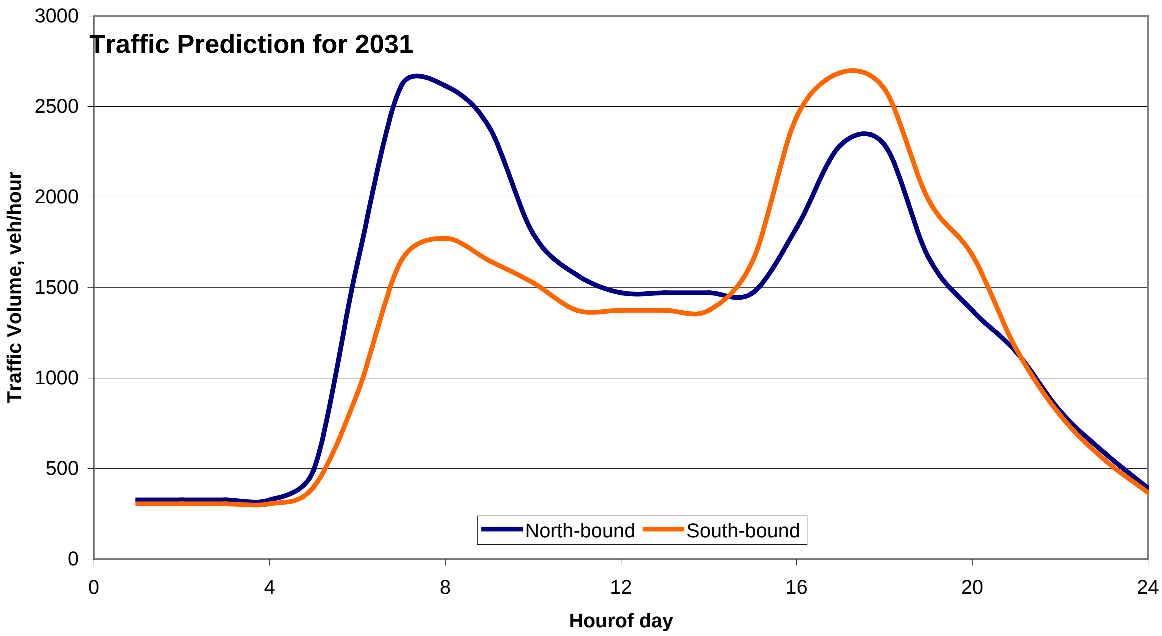
The proportion of commercial vehicles (HCVs) is highest in the north at 23 percent of the total vehicle fleet (in 2031) and decreases with distance to the south, with the lowest proportion of HCV being 16 percent of the fleet in Section E (entering the Mornington Peninsula Freeway). More detailed information and data on the traffic projections is given in other sections of the EES.

The 2031 traffic flows are about 7 percent higher than those in 2021, with a smaller proportion of HCV in the fleet. As discussed previously, vehicle emissions in 2031 are projected to be about 10 percent lower than in 2021. The traffic flow is projected to go up by about 10 percent, and emissions per vehicle are projected to go down by about 10 percent over that decade (from 2021 to 2031). Consequently, total emissions from vehicles on the Mordialloc Freeway in 2031 will be approximately the same as in 2021.

Figure 9-3 shows the 2031 traffic flows in each lane for the Bypass option. There is a marked morning and evening peak in traffic flow, with different peaks in the north-bound and south-bound traffic lanes.

The traffic volume on Lower Dandenong Road is about 60 percent of the projected Bypass traffic. Other cross-streets (including Springvale Road) have smaller traffic volumes than the Mordialloc Freeway.

Figure 9-3 Diurnal Distribution in Year 2031 Traffic



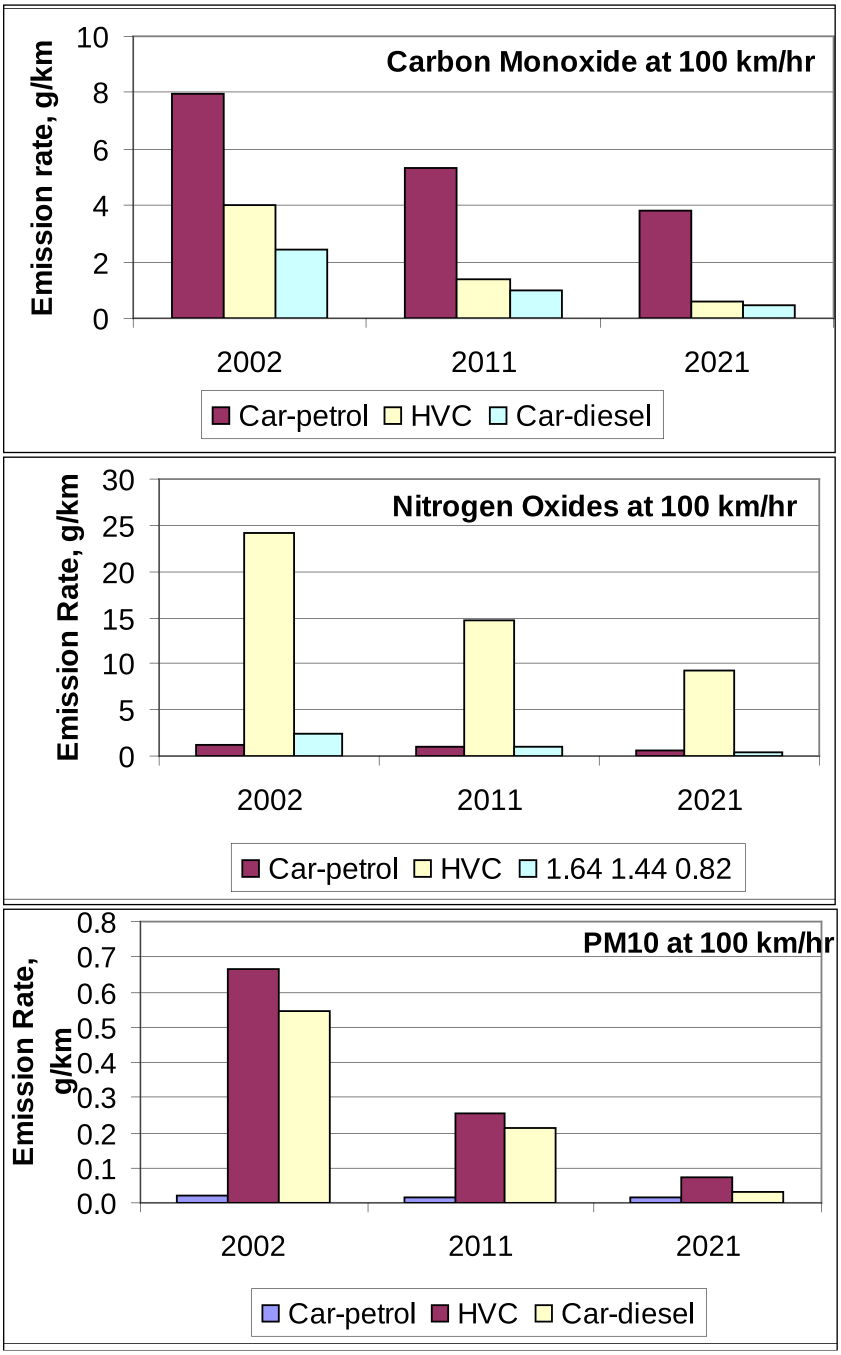
Model Scenario

Given the relatively small increase in traffic volume in 2031, it was decided to base projections of the impacts of vehicle emissions for the Mordialloc Bypass Project on the year 2021. As discussed in Section 5, air quality in Melbourne is either improving or remaining stable (depending on the contaminant) so there should not be a marked difference between background conditions in 2021 and 2031.

9.3 Vehicle Emission Rates

The 2021 fleet emission rates were derived from data provided by EPA Victoria, adjusted for the grades along the Mordialloc Bypass, and variations in speed in the morning and afternoon peak hours. The rates were cross-checked against predicted PIARC emission factors (World Road Congress, 2012) and the actual emission rates from the East Link and City Link tunnel exhausts. A discussion of the variation in vehicle emissions with respect to several influencing factors is discussed below.

Figure 9-4 Reduction in Vehicle Emissions over Time



Emission controls for vehicles are becoming more stringent over time and thus vehicle emissions are decreasing with time, which results in the decline in emission factors over time.

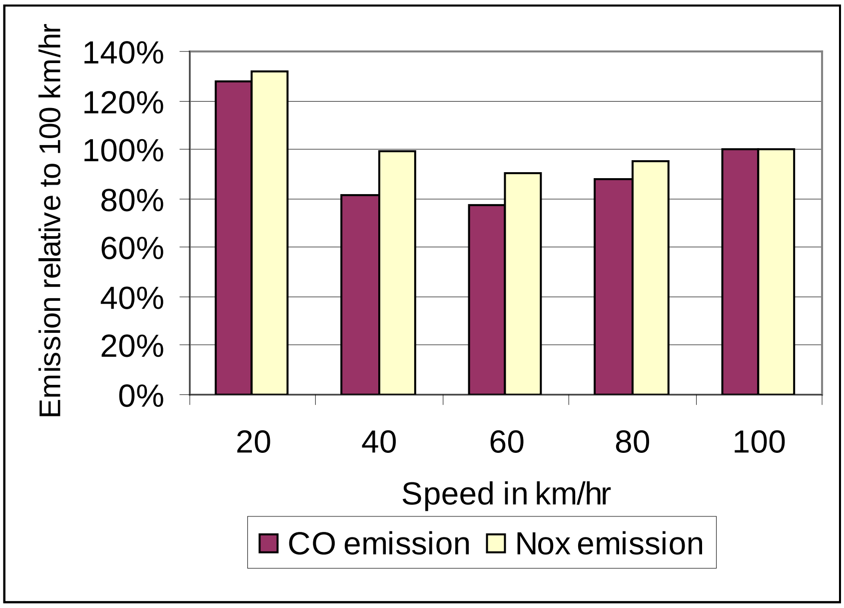
Change in Emissions over Time

As shown in Figure 9-4, there has been a substantial reduction in vehicle emission rates for CO, oxides of nitrogen (NO_x) and PM_{10} over the last decade and a further substantial reduction is projected until the year 2021. On this basis, and noting the scheduled increase in emission controls, it is reasonable to expect a further substantial reduction by the year 2031.

Change in Emissions with Speed

Vehicle emissions are influenced by the speed of the vehicles, as shown in Figure 9-5 for a fleet containing 17 percent HCVs/trucks (typical of the Mordialloc Bypass). Generally, vehicle emissions at 60 km/hr are about 10 percent lower (for nitrogen oxides) to 20 percent lower (for carbon monoxide) than at 60 km/hr. Emissions are also substantially higher from vehicles in congested traffic with speeds of 20 km/hr or less.

Figure 9-5 Change in Vehicle Emissions of NO_x with Fleet Speed

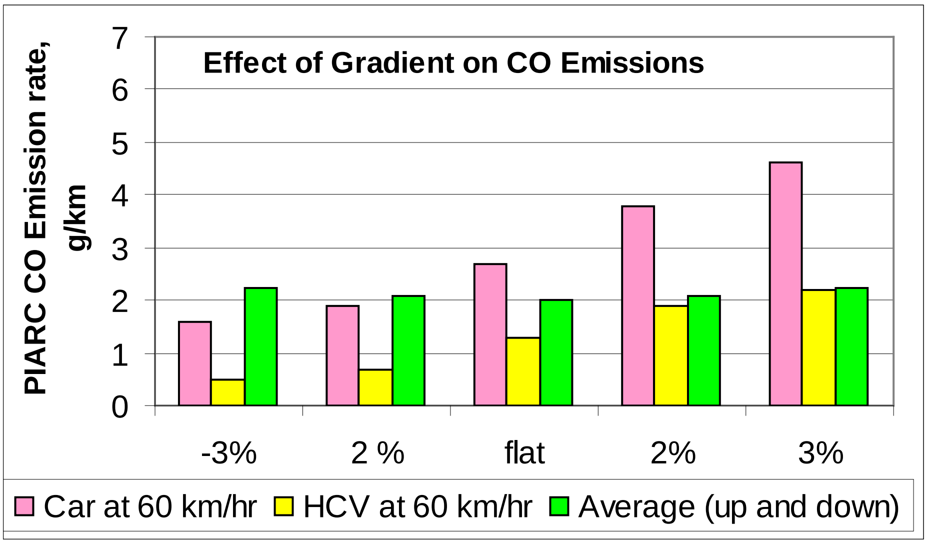


Road Gradient

A further consideration is the effect of the gradient of the road. Figure 9-6 shows the effect of long, sustained gradients on vehicle emissions of CO (as an example). There is a significant increase in fuel use and vehicle emissions on uphill slopes compared to downhill slopes. The Mordialloc Bypass has an undulating profile with gradients of up to 3 percent as the roadway rises to the overpass at each major intersection.
The effect of gradient variations on the Mordialloc Bypass will be less than long hills because the length of the road sectors with gradients are relatively short.

The green columns in Figure 9-6 show the net effect of gradient assuming there is an equal number of vehicles on the uphill slope as on the downhill slope, in which case the effects of an undulating gradient are small but significant – about a 5 to 10 percent increase in emissions overall.

Figure 9-6 Effect of Road Gradient on Vehicle Emissions



Vehicle Speed Projections for Mordialloc Bypass

A further factor considered was the speed in each road Section for the peak hour, in each direction of travel. Table 9-1 summarises the projected speeds in the peak hours, as forecast by WSP. It can be seen that Sections D and E are very congested with low traffic speeds.

Table 9-1 Forecast Year 2021 Traffic Speed

Traffic Speed (km/hr)			2021, km/hr		
No	Road Name	Section	Dirn	AM	PM
A	Mordialloc Bypass	Dingley Bypass - Centre Dandenong Road	NB	92	93
A	Mordialloc Bypass	Dingley Bypass - Centre Dandenong Road	SB	94	92
B	Mordialloc Bypass	Centre Dandenong Road - Lower Dand Rd	NB	87	92
B	Mordialloc Bypass	Centre Dandenong Road - Lower Dand Rd	SB	93	87
C	Mordialloc Bypass	Lower Dandenong Rd - Governor Rd	NB	85	92
C	Mordialloc Bypass	Lower Dandenong Rd - Governor Rd	SB	93	85
D	Mordialloc Bypass	Governor Rd - Springvale Rd	NB	68	91
D	Mordialloc Bypass	Governor Rd - Springvale Rd	SB	92	67
E	Mornington Peninsula	Springvale Rd - Thames Promenade	NB	45	90
E	Mornington Peninsula	Springvale Rd - Thames Promenade	SB	91	43

As a result of all these considerations, the fleet emission rate is different for each hour, in each direction, for each section of the Mordialloc Bypass.

For comparison purposes, the calculated average fleet emission factor for 2021 and 2031 is presented as shown by the central row in Table 9-2. It is likely, though not certain, that the emission rates in the year 2031 and beyond will be considerably lower than shown in Table 9-2 as hybrid and electric vehicles will become a significant part of the vehicle fleet mix.

Table 9-2 Average Vehicle Fleet Emission Rates for Various Contaminants

Year	**Fleet Emission Rate, g/km**			
	Carbon monoxide	**Nitrogen Dioxide**	**PM_{10}**	**$PM_{2.5}$**
2017	4.4	0.50	0.069	0.050
2021	4.0	0.46	0.064	0.045
2031	3.6	0.42	0.060	0.042

9.4 Dispersion Model

Modelling of vehicle emissions during operation of the Mordialloc Bypass was carried out for the year 2031 using the *Ausroads* dispersion model to predict ground level concentrations of CO, NO_2, PM_{10} and $PM_{2.5}$ - the four Class 1 contaminants. The Mordialloc wind files for the years 2013 to 2017, as discussed in Section 5, were used in the modelling. The cross-section of the road used in modelling was the typical section shown in Figure 8-1 shows the typical cross-section of the road used in the modelling assessment.

The Mordialloc Bypass was modelled in *Ausroads* as two rows of line sources (one row for the north-bound lanes and the second set for the south-bound lanes). Extra lines of sources were added at intersections to reflect the contribution from on and off ramps.

For the calculation of near-road concentrations from vehicle emissions, hourly values of wind speed and wind direction for the years 2013-2017 from the Bureau of Meteorology (BoM) measurements at Moorabbin Airport were used. The BoM data was processed to create wind files with hourly values of wind speed, wind direction, ambient temperature, mixing height and atmospheric stability. As a check, two years of meteorological data generated using the MM5 computer model were purchased from Lakes Environmental, and checked against the measurements at Moorabbin Airport. The MM5 data showed similar distributions of wind speed and direction.

9.5 Results and Findings

Given the large number of computer model runs conducted for this assessment, the results have been analysed and the figures represent the most relevant results which include a summary for all road sections and meteorological data years, plus an inclusion of the ‘average’ road section for all four contaminants.

Road Section C is used in the presentation figures as it has the “average” traffic volume and proportion of trucks on the Bypass (see Figures 9-1 and 9-2).

The following figures present the results:

- Figure 9-7 shows the distribution of 1-hour CO concentration in 2016 in Section C, which has a traffic volume in the middle of the range over the five Sections;
- Figure 9-8 shows the distribution of 1-hour CO concentration in Section C for each of the five years of meteorological data;
- Figure 9-9 shows the distribution of 1-hour CO concentration in each Section for the average of the five years of meteorological data;

and

- Figure 9-10 shows the distribution of 1-hour NO_2 concentration in Section C for each of the five years of meteorological data;
- Figure 9-11 shows the distribution of 1-hour NO_2 concentration in each Section for the average of the five years of meteorological data;
- Figure 9-12 shows the distribution of 1-hour PM_{10} concentration in Section C for each of the five years of meteorological data;

- Figure 9-13 shows the distribution of 1-hour PM_{10} concentration in each Section for the average of the five years of meteorological data;

and

- Figure 9-14 shows the distribution of 1-hour $PM_{2.5}$ concentration in Section C for each of the five years of meteorological data;
- Figure 9-15 shows the distribution of 1-hour $PM_{2.5}$ concentration in each Section for the average of the five years of meteorological data.

Note that in each of the figures, the concentration profile extends east-west across the route to illustrate the decrease in concentration with distance from the roadway in each direction, and to show the predicted concentration of the various parameters at any receptor.

As well as the concentration profiles, each figure also shows the background concentration (blue line across the lower part of the figures) and the design criteria (red line across the upper part of each figure). Concentration distributions represent the 99.9 percentile concentration at the 1-hour averaging period for each contaminant, including the background concentration.

CO

Figure 9-7 shows the predicted peak CO concentration distribution (99.9 percentile) including the background level in Section C. The peak CO concentration is well below the design criterion of 29,000 µg/m^3.

Figure 9-7 Predicted Distribution of Peak CO – Section C – Year 2016

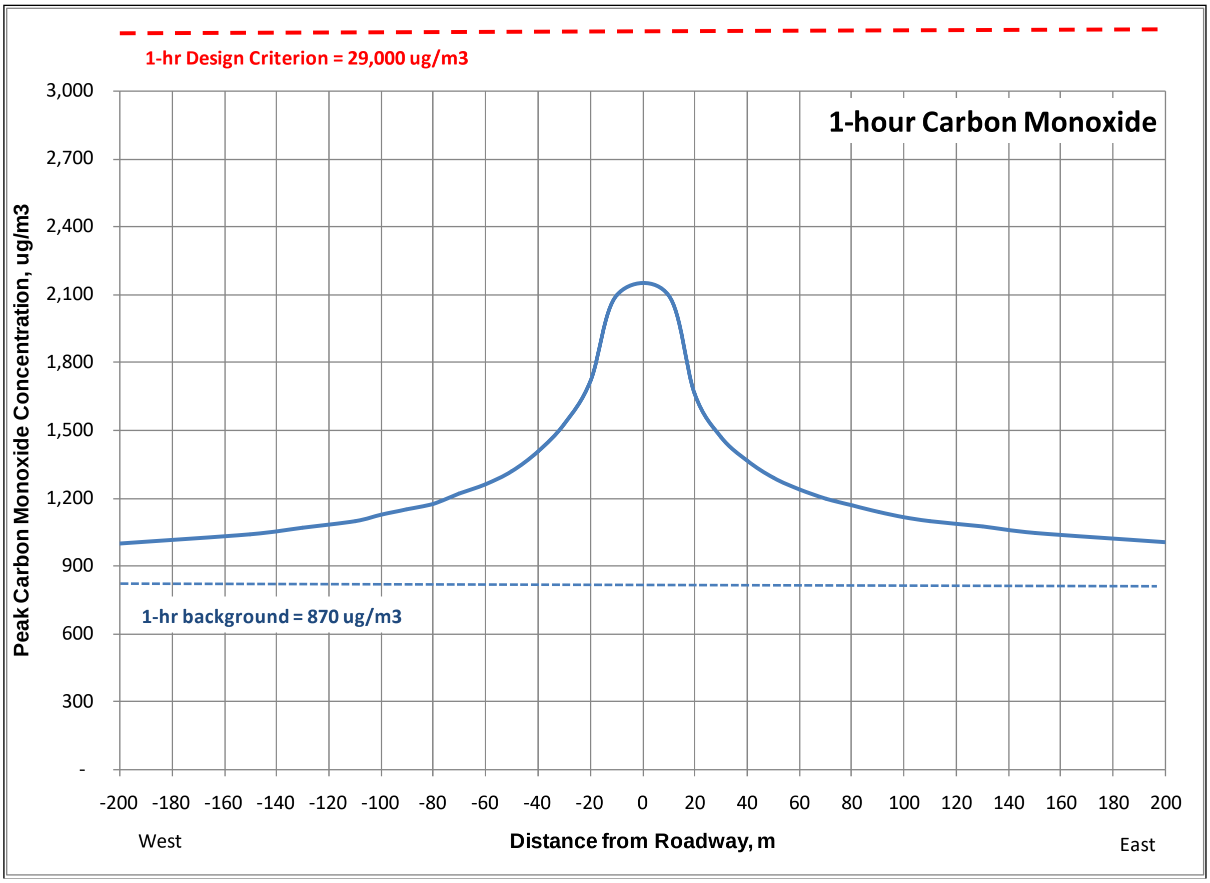


Figure 9-8 shows the predicted peak CO concentration in Section C for each of the five years of meteorological data. There is little difference between the predictions for different years and all meet the SEPP(AQM) design criterion.

Figure 9-8 Predicted Distribution of Peak CO Concentration for 2013-2017 Meteorological Data – Section C

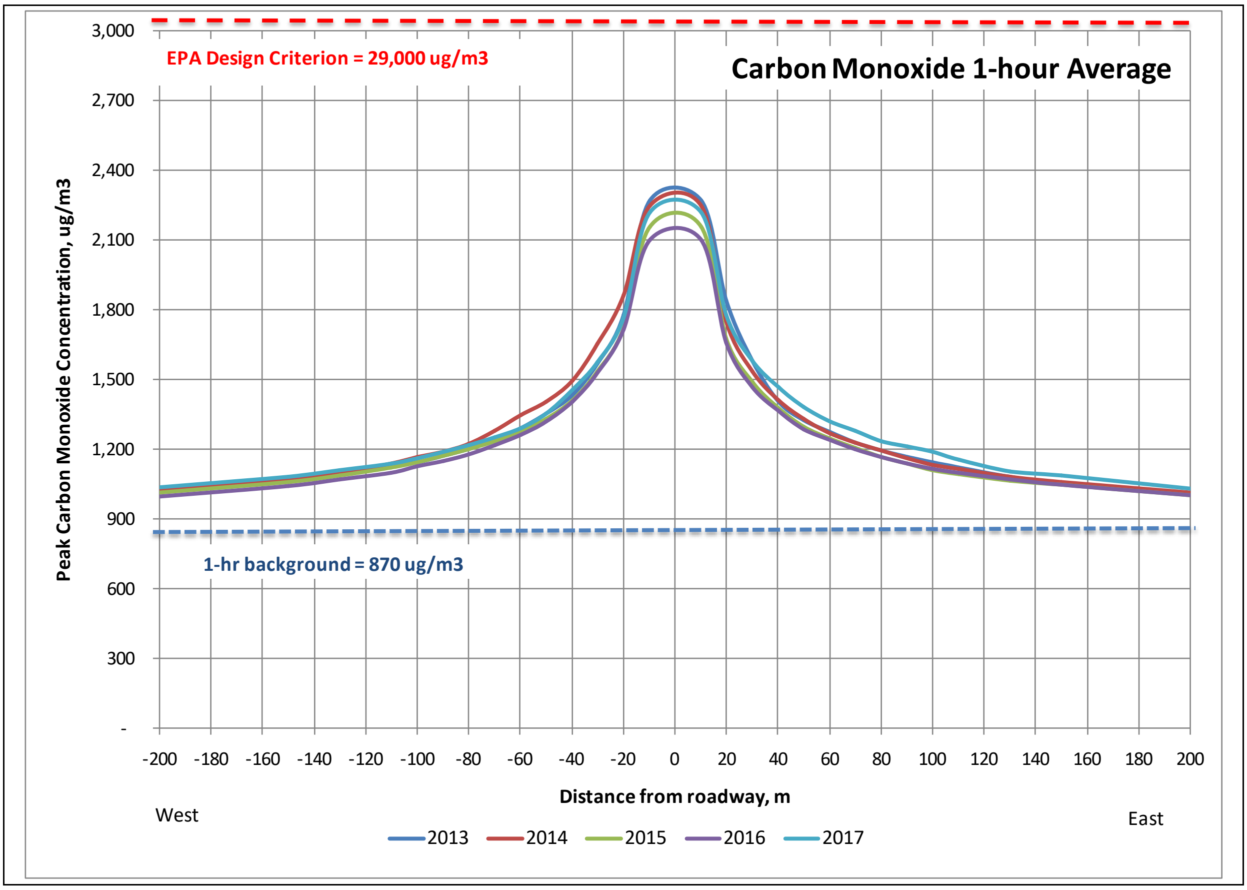
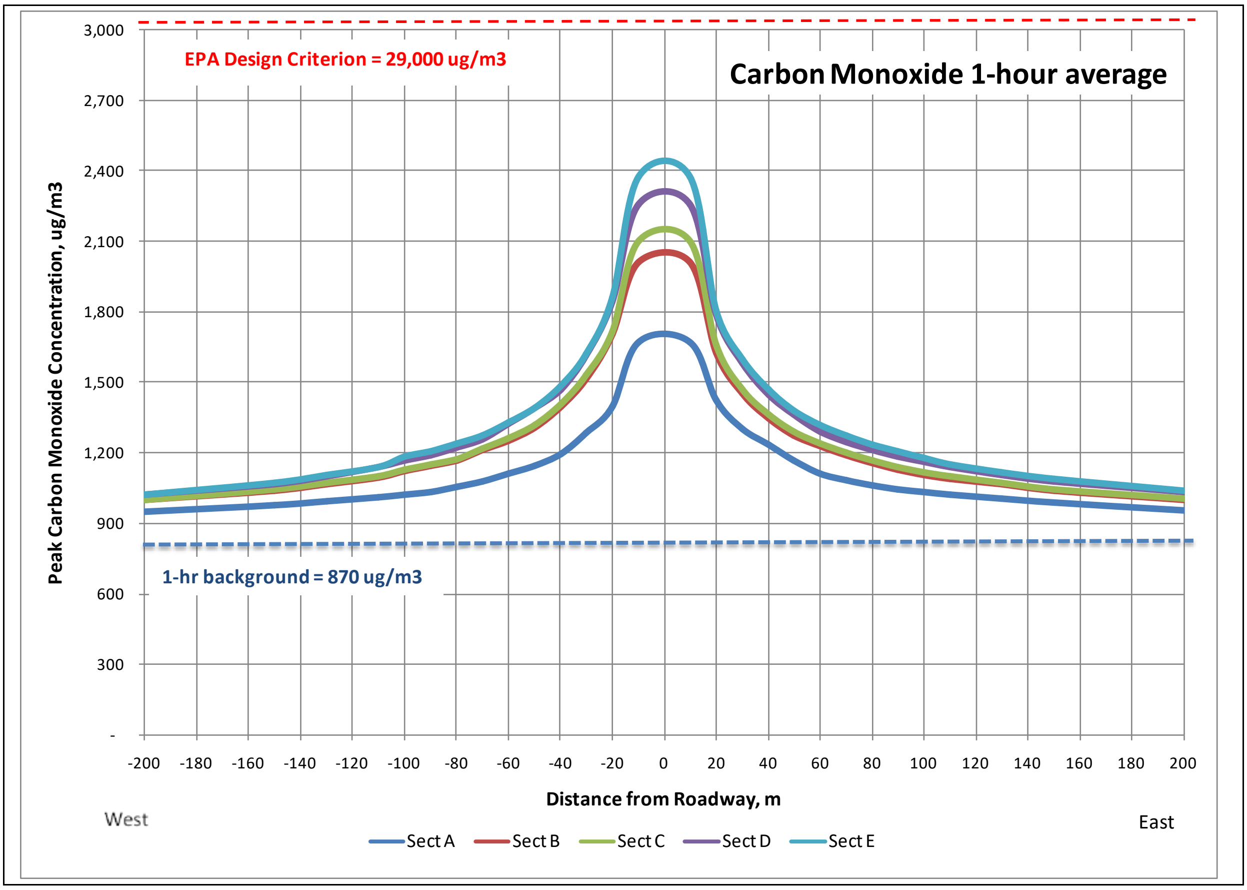


Figure 9-9 shows the distribution of the ground-level CO concentration in each Section - for the average of the five years of meteorological data. There are higher CO levels in Section E than in Section A because of the higher traffic volume.

Figure 9-9 Predicted Distribution of 1-hour CO Concentration for all Sections



It is apparent from Figures 9-7 to 9-9 that the predicted 1-hour carbon monoxide levels are well within the SEPP(AQM) design criterion. There are no issues with carbon monoxide at any receptor in any Section (A to E) modelled.

NO_2

Figure 9-10 shows the predicted peak NO_2 concentration in Section C for each of the five years of meteorological data. There is little difference between the predictions for different years and all meet the design criterion. Figure 9-10 shows that the 1 hour design criterion is exceeded in 2014, up to 20 m from the roadway, and all sensitive receptors are located beyond this distance.

Figure 9-10 Predicted Distribution of Peak 1 hour NO_2 Concentration for 2013 – 2017 Meteorological Data

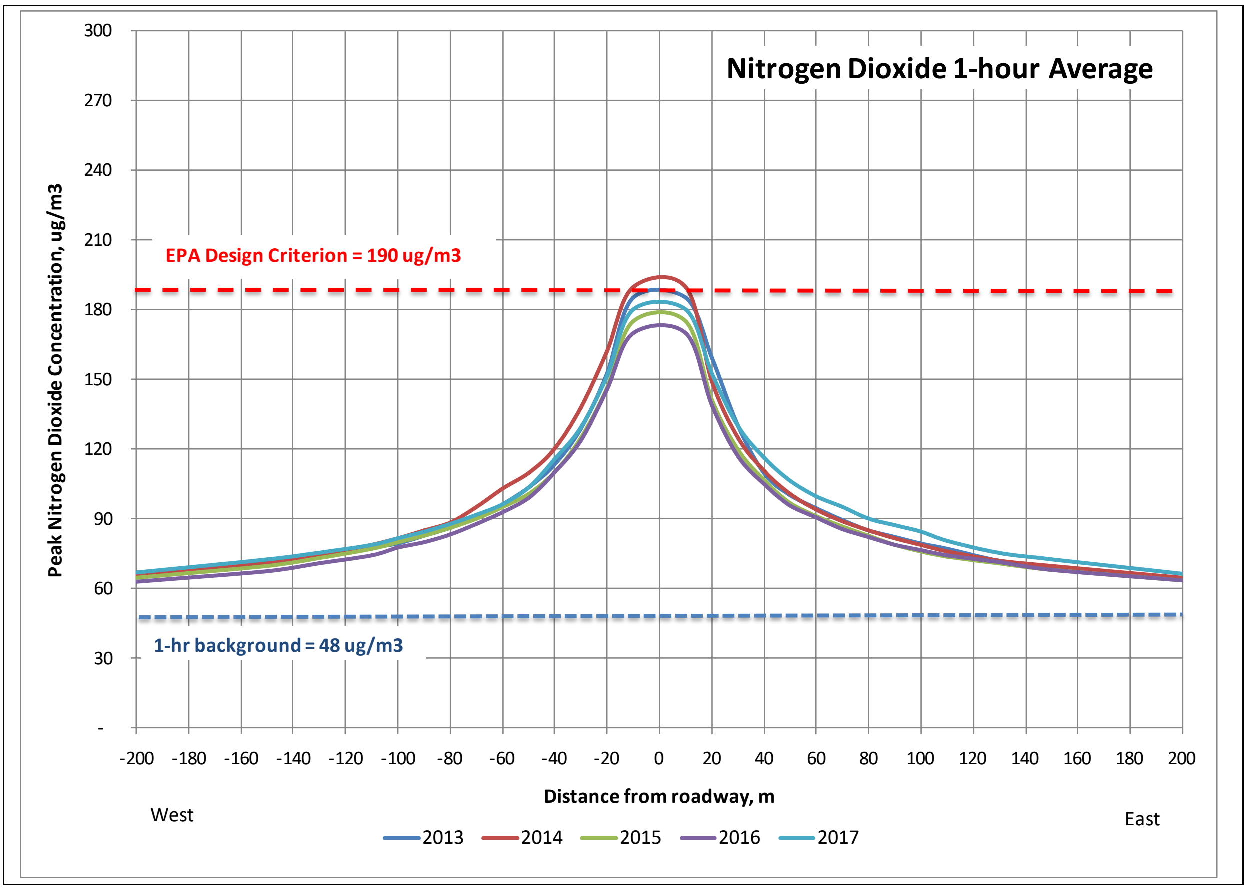
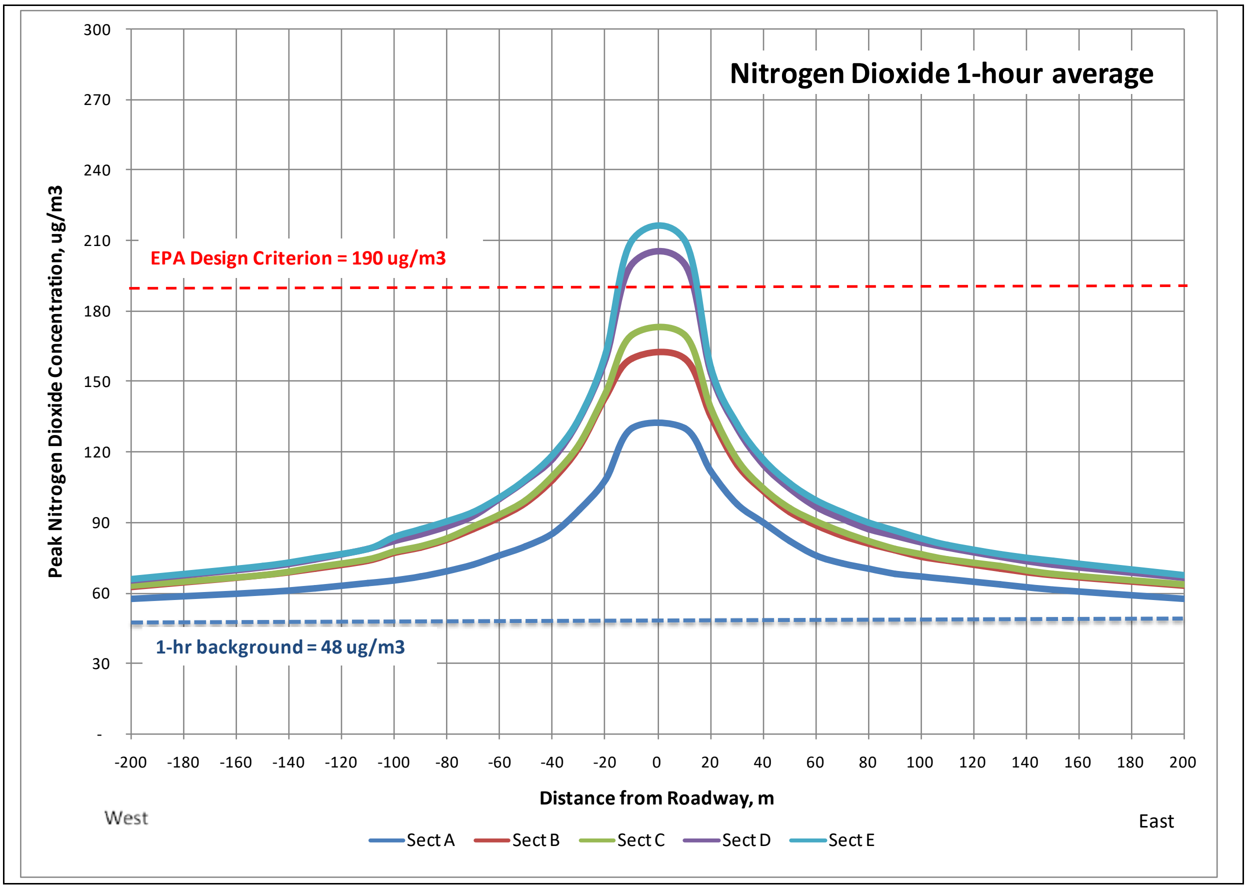


Figure 9-11 shows the distribution of 1-hour NO_2 concentration in each Section for the average of the five years of meteorological data. There are higher NO_2 levels in Section E than in Section A, because of the higher traffic volume. Figure 9-11 shows that for Sections D and E, the 1 hour design criterion of 190 µg/m^3 is exceeded up to approximately 20 m from the roadway and all sensitive receptors are located beyond this distance.

Figure 9-11 Predicted Distribution of 1-hour NO_2 Concentration for all Sections



PM_{10}

Figure 9-12 shows the predicted peak PM_{10} concentration in Section C for each of the five years of meteorological data. There is little difference between the predictions for different years and all meet the design criterion.

Figure 9-12 Predicted Distribution of Peak 1 hour PM_{10} concentration at Section C for 2013 - 2017 Meteorological Data

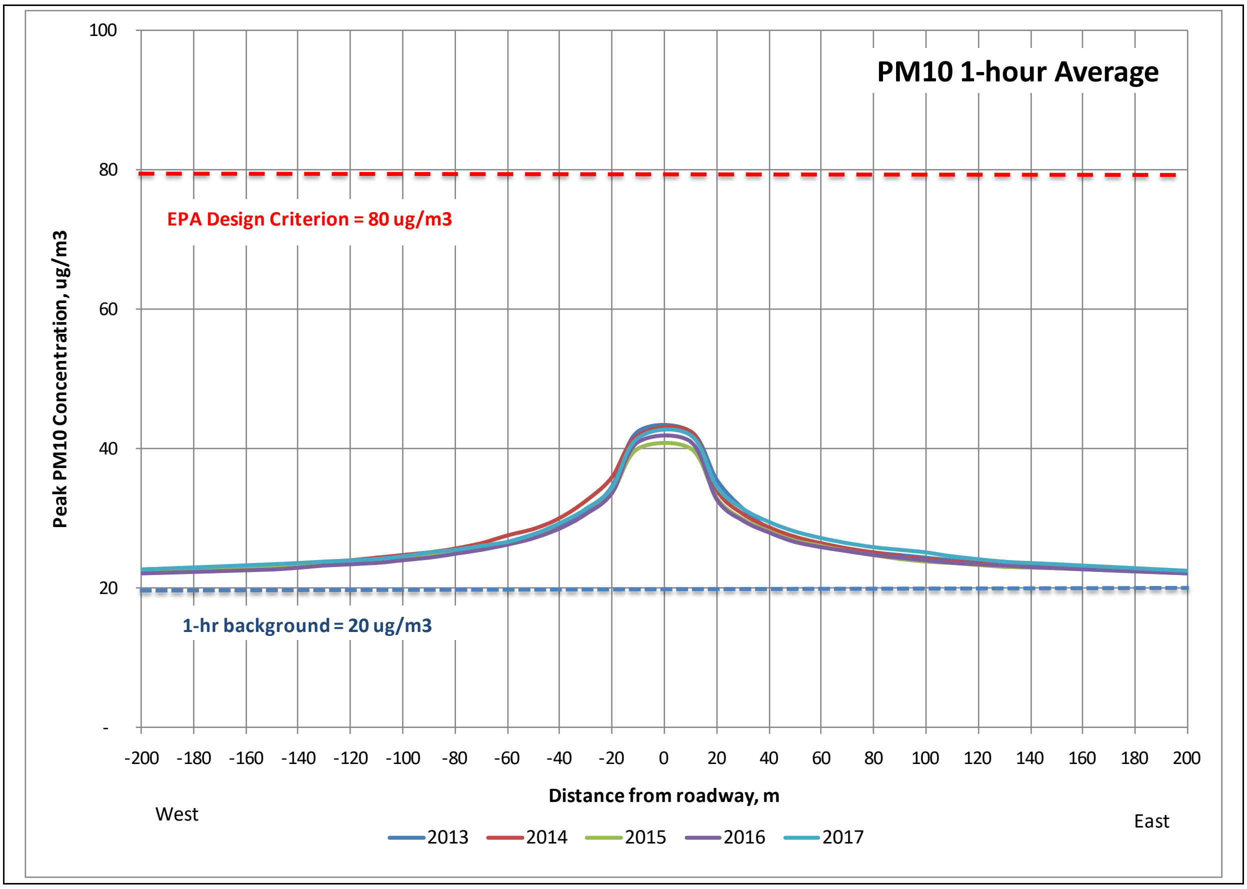
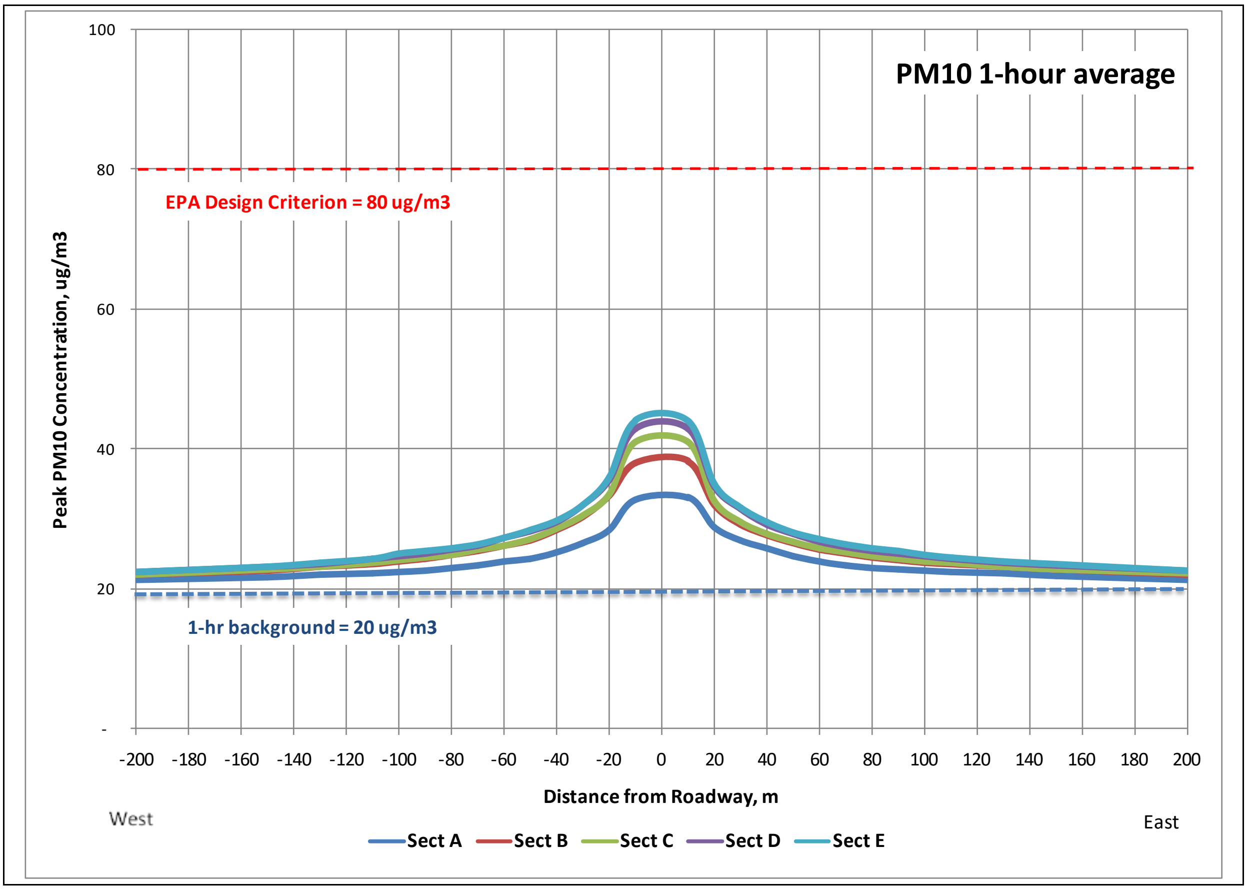


Figure 9-13 shows the distribution of 1-hour PM_{10} concentration in each Section for the average of the five years of meteorological data. The design criterion will be met at all receptors in each Section.

Figure 9-13 Predicted Distribution of 1-hour PM_{10} concentration for all Sections



$PM_{2.5}$

Figure 9-14 shows the predicted peak $PM_{2.5}$ concentration in Section C for each of the five years of meteorological data. There is little difference between the predictions for different years and all meet the design criterion.

Figure 9-14 Predicted Distribution of Peak 1 hour $PM_{2.5}$ Concentration at Section C for all Meteorological Data

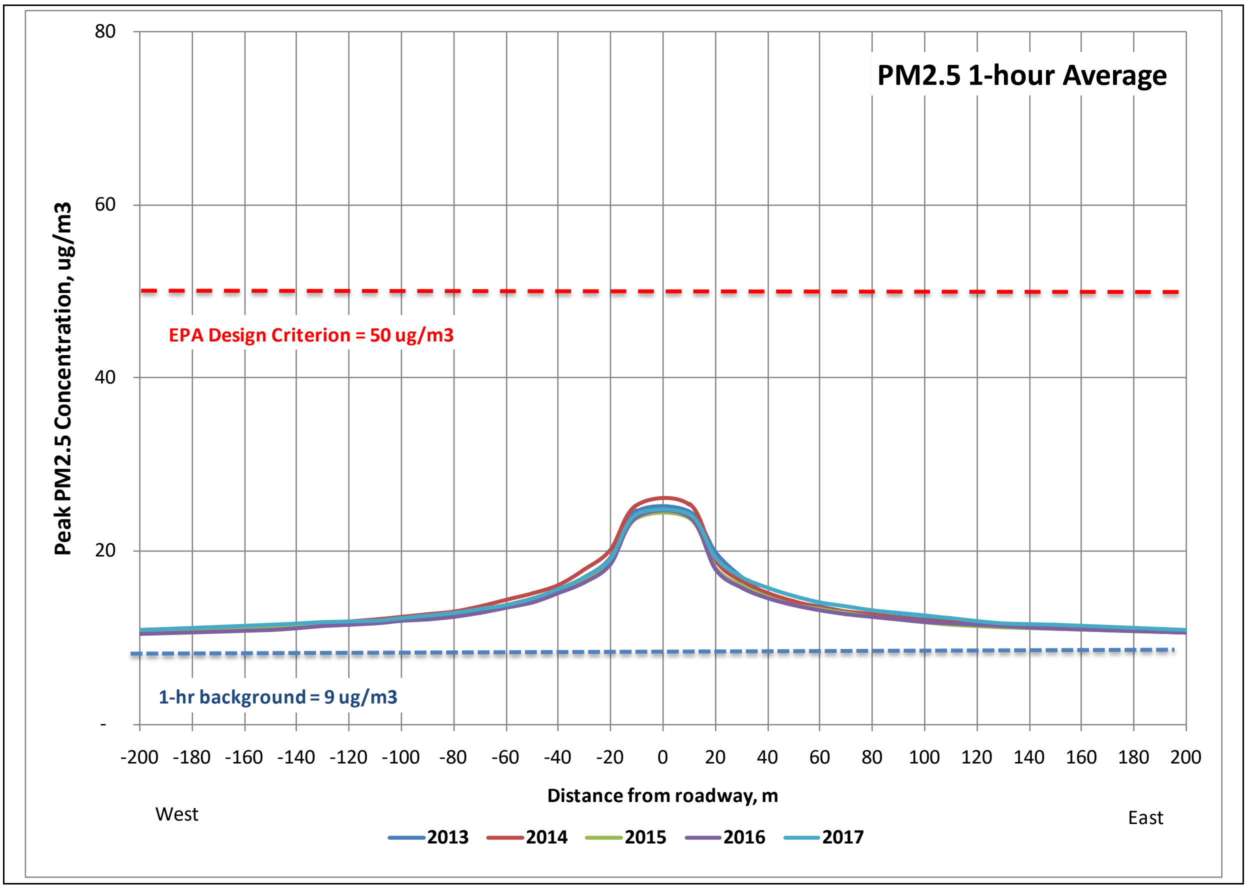
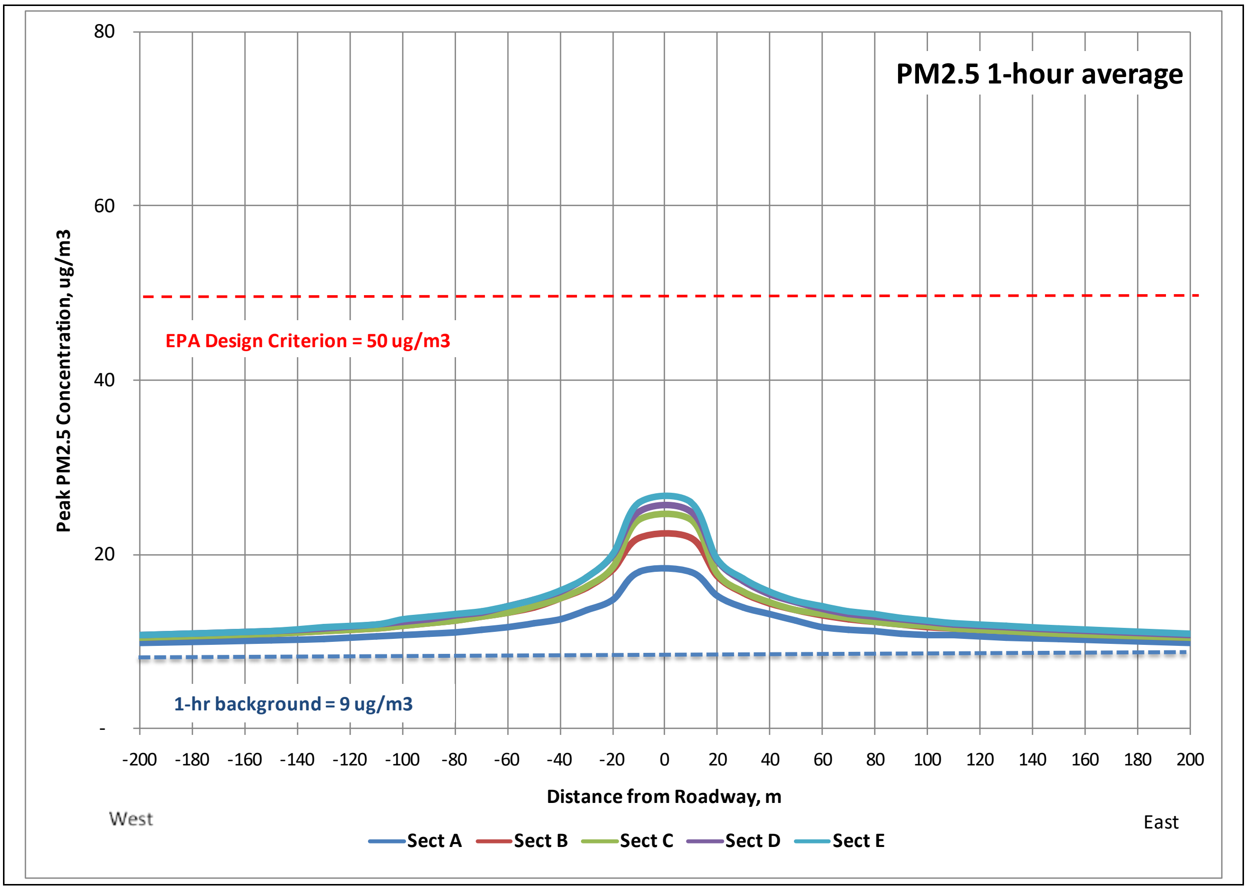


Figure 9-15 shows the distribution of 1-hour $PM_{2.5}$ concentration in each Section for the average of the five years of meteorological data. Figure 9-15 shows that the design criterion will be met at all receptors in all Sections.

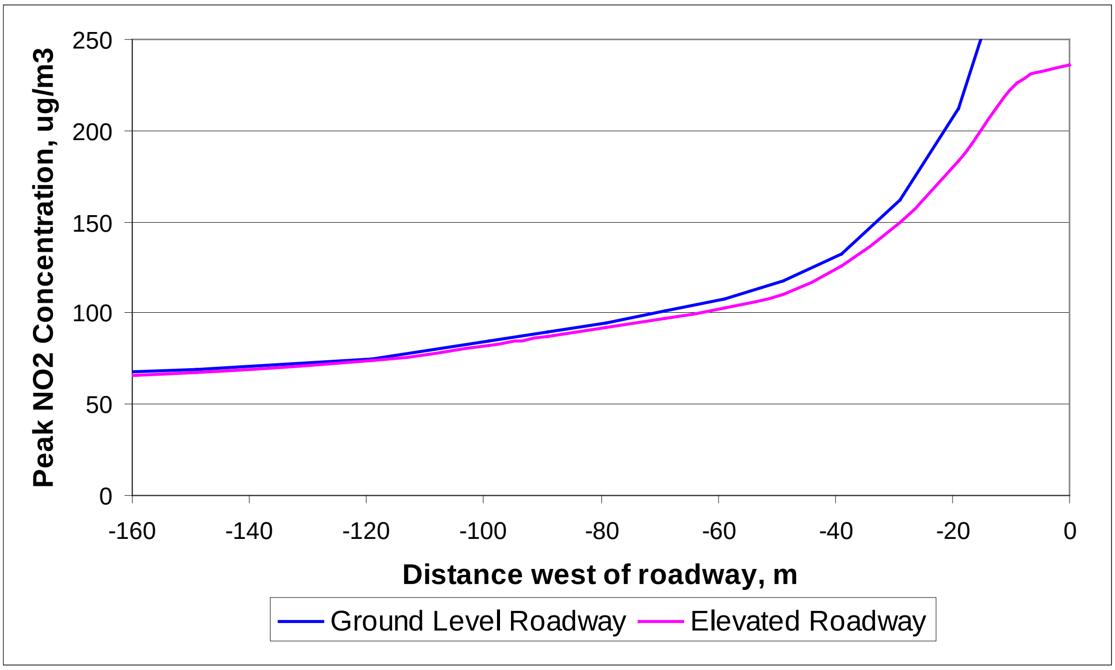
Figure 9-15 Predicted Distribution of 1-hour $PM_{2.5}$ Concentration for all Sections



Intersections

For the purposes of modelling the emissions from intersections, it is considered that the surface of Project roadways are elevated at 6 m above the surface of the cross roads with a 1 m high solid barrier on each side of the overpass bridge. Consequently, the contribution of emissions from the Mordialloc Bypass is considerably reduced when compared to a ground level roadway, as illustrated in Figure 9-16. It can be seen that the peak NO_2 concentrations from the overpass are lower than for a ground level source (due to the extra mixing depth).

Figure 9-16 Predicted Peak NO_2 Concentrations for Elevated Roadway



Predicted Concentrations at Sensitive Receptors

A list of specific sensitive receptors are presented in Table 7-1 and illustrated in Figure 7-1. The predicted 99.9 percentile concentrations (including the background concentration) at each of these receptors for CO, NO_2, PM_{10} and $PM_{2.5}$ the four key air quality pollutants, are listed in Table 9-3. The peak concentrations are also expressed in terms of the percentage of the relevant design criterion in the far right columns of the table.

Summary of Findings on Vehicle Emissions

In summary, the operational impacts on air quality are expected to be very low for CO and low for PM_{10} and $PM_{2.5}$. The highest ground level concentrations of these air contaminants from vehicles are predicted to be well within the SEPP (AQM) relevant 1-hour design criteria. For NO_2, the predicted concentrations at all receptors are also predicted to be within the design criterion.

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Table 9-3 Predicted 99.9 % Concentrations at Discrete Sensitive Receptors

			Results in µg/m^3				Results as percentage of design criteria			
No	**Description**	**Suburb**	**CO**	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**NO_2**	**PM_{10}**	**$PM_{2.5}$**
EPA 1-hour Design Criteria, µg/m^3			***29,000***	***190***	***80***	***50***				
Background concentrations, µg/m^3			***870***	***48***	***20***	***9***				
1	Hawthorn Football Club	Heatherton	1,050	71	25	12	4%	37%	31%	24%
2	Rural Residential	Dingley	910	55	20	10	3%	29%	25%	20%
3	Commercial	Dingley	1,605	139	33	16	6%	73%	41%	32%
4	Residential	Dingley	1,410	120	30	14	5%	63%	38%	28%
5	Residential	Dingley	1,410	120	30	14	5%	63%	38%	28%
6	Commercial	Moorabbin	1,750	145	32	18	6%	76%	40%	36%
7	Reserve	Braeside	1,530	128	31	17	5%	67%	39%	34%
8	Parks Victoria Office	Braeside	1,405	114	29	17	5%	60%	36%	34%
9	Reserve	Braeside	1,370	109	29	16	5%	57%	36%	32%
10	Reserve	Braeside	1,250	107	27	15	4%	56%	34%	30%
11	Residential	Waterways	1,580	128	32	18	5%	67%	40%	36%
12	Residential	Aspendale Gardens	1,520	125	31	17	5%	66%	39%	34%
13	Residential	Aspendale Gardens	1,460	116	28	16	5%	61%	35%	32%
14	Richfield Retirement	Aspendale Gardens	1,200	93	25	11	4%	49%	31%	22%
15	Chelsea Heights	Chelsea Heights	1,640	153	35	18	6%	81%	44%	36%
16	Commercial	Chelsea Heights	1,320	125	20	16	5%	66%	25%	32%

10 Assessment of Odour from the Enviromix Landfill

The route of the Mordialloc Bypass Project will cross a former Enviromix landfill just to the south of Dingley Bypass. The proposed route across the landfill is shown in Figure 10-1. The roadways will cover an area of about 0.94 ha with an estimated old waste thickness of about 5 m.

Figure 10-1 Freeway Route over Landfill Site

The proposed construction method is to cover the landfill surface on the route with a 600 mm thick layer of coarse gravel and drive a series of piles through the landfill into the underlying soil. Gases may be released when the piles are being driven and subsequently the gas will continue to seep out of the surface into the gravel layer.

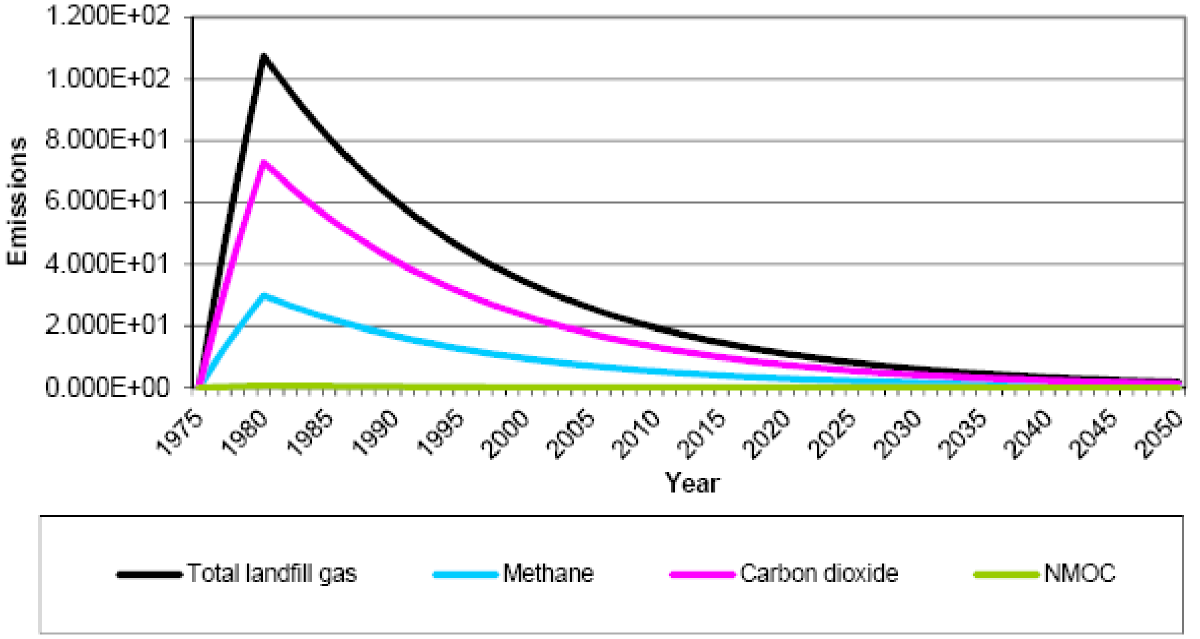
From an air quality perspective, the main issue is the potential odour impact from hydrogen sulphide or other odorous gases released from the landfill during construction and operation of the Mordialloc Bypass. There are no sensitive receptors within 300 m of the site and it is considered that piling during the day is unlikely to cause odour impacts at distant receptors.

WSP summarised survey data on the site as follows. Methane was detected in elevated concentrations in monitoring wells installed directly above or immediately adjacent to the waste mass (at between 53 percent volume per volume (v/v) and 67 percent v/v. However, surface methane monitoring across the site found only background concentrations except for a concentration of 35 parts per million (ppm) recorded in a manhole to the west of the former Enviromix Landfill.

Low concentrations of carbon monoxide and hydrogen sulphide were recorded in several monitoring wells across the site. A large concentration of carbon monoxide was identified to the west of the former Din San Landfill, which is located to the southeast of the Enviromix Landfill (inferred to have migrated from the nearby Din San landfill site and not from the Enviromix Landfill). Hydrogen cyanide (HCN) and ammonia were not detected in any gas monitoring bores during the monitoring.

The methane generating capacity of the landfill was modelled by WSP using LandGEM and the model predicted that the peak landfill gas generation was in 1980 and has reduced significantly since then. The current total emissions are about 10 t/yr, of which hydrogen sulphide could be 0.25 kg/d. If spread over the whole landfill, this emission would only be noticeable in prolonged calm conditions.

Figure 10-2. Predicted Landfill Gas Generation in Tonnes per Year
(Source, WSP, 2018)



Based on the limited available data, odour is not anticipated to be a concern, because of the low emission rate of hydrogen sulphide and the large buffer to sensitive receptors. The roadway will need to be designed without concave lower surface (to avoid gas collection) and a fresh air layer between the road and the gravel layer to permit gases to escape and disperse.

Currently, there are composting operations at the Enviromix landfill as illustrated in Figure 10-1 which will be relocated before commencing construction.

11. Risk Findings

Impacts to air quality can be summarised into seven categories: AQR1 to AQR7.Note AQR refers to Air Quality Risk.

AQR1 - Geotechnical exploration that causes dust was assessed as a negligible risk because the exploratory drilling will occur in very limited areas, with limited dust generation and generally well away from sensitive receptors.

AQR2 - Excavation and filling activities during construction that causes dust was assessed as a low risk given the standard and additional controls proposed that ensure off-site impacts are minimised.

AQR3 - Construction that releases contaminated dust was assessed as a low risk because the information available to date indicates that there is a negligible amount of contaminated soil to be removed from anywhere near sensitive receptors.

AQR4 - Construction that releases air emissions was assessed as a low risk given the number of plant machinery and trucks operational in any given period.

AQR5 - Vehicles using the Freeway and release contaminants was assessed as a low risk because there is a wide buffer between the roadway and receptors, and calculations, described in a later section of this report, show that the SEPP requirements will be met with a margin of safety.

AQR6 – Maintenance that releases dust was assessed as a low risk because maintenance vehicles are few, operate only occasionally and dust emissions from regular maintenance activities are expected to be very small.

AQR7 – Aggregate Cumulative Effects was assessed as a low risk given there are no significant air emissions sources local to the Project area.

The primary environmental risks, additional controls and residual risks identified for air quality are provided in Table 11-1. The initial risk ratings presented below for both project and cumulative impacts consider standard inherent controls as listed in the Environmental Risk Assessment Report. The additional controls are those recommended to further mitigate and minimise the primary environmental risks which were risk rated as medium or above. Primary environmental risks which were scored as low did not require additional controls to be applied.

Table 11-1 Air Quality Environmental Risk Assessment Register

Risk ID	Impact Pathway	Primary Environmental Risk Description	Secondary Env. Risk	Initial risk			Additional Mitigation / Controls	EPR	Residual risk		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
AQR1	Dust impacts on nearby sensitive receptors during Initial project phase (preconstruction activities)	Geotechnical investigations to potentially increase air emissions (including dust).	-	Insignificant	Unlikely	Negligible	Not required	AQ2	Insignificant	Unlikely	Negligible
AQR2	Dust impacts on nearby sensitive receptors during the construction phase	Potential for nuisance and respirable dust to nearby residents during site clearing, topsoil stripping and overburden earthworks, filling and excavation.	External sourcing of water	Minor	Possible	Low	Not required	AQ2	Minor	Possible	Low

AQR3	Impacts from air emissions on nearby sensitive receptors during the construction phase	Increasing gaseous emissions from earthmoving machinery impact on air quality.	-	Insignificant	Almost Certain	Low	Not required	AQ2	Insignificant	Almost certain	Low
AQR4	Impacts from air emissions on nearby sensitive receptors during construction phase	Increasing gaseous emissions from construction machinery impact on air quality.	-	Insignificant	Almost Certain	Low	Not required	AQ2	Insignificant	Almost certain	Low
AQR5	Contaminants impact on nearby sensitive receptors during operation	Increased air emissions (particulates, including dust and gaseous products) from the increased vehicle numbers based on wider road section (greater capacity) impact on air quality	-	Minor	Unlikely	Low	Not required	AQ1	Minor	Unlikely	Low

AQR6	Dust impacts on nearby sensitive receptors during operation	Localised air emissions associated with occasional maintenance activities impact on air quality	-	Minor	Unlikely	Low	Not required	AQ1	Minor	Unlikely	Low
Cumulative Impacts - On-Site Aggregate											
AQR7	Aggregate Cumulative: Dust and air quality impacts on nearby sensitive receptors.	Clearing, earthworks and construction generated dust lead to an increase impact on air quality	-	Minor	Possible	Low		AQ2	Minor	Possible	Low

The assessment of cumulative impacts was competed in two stages, namely the assessment of aggregate project impacts and the assessment of the cumulative impact of multiple off-site projects in addition to the Mordialloc Bypass project for air quality. The cumulative environmental risks identified for air quality is provided in Table 11-2.

Large construction projects within 1 km of the project alignment have the potential to impact on local air quality. LXRA Edithvale and Bonbeach projects are greater than 1 kilometre from Thames Promenade, at the southern end of the Project and are not considered to have a cumulative impact.

Table 11-2 Air Quality Cumulative Effects Environmental Risk Assessment Register

Risk ID	Impact Pathway	Projects Considered	Cumulative Risk Description	Additional Mitigation / Controls	EPR	Cumulative Risk Rating		
						Consequence	Likelihood	Rating
AQR2	Dust impacts on nearby sensitive receptors from construction activities.	Hawthorn Football Club Development LXRA Edithvale and Bonbeach projects	Potential for nuisance and respirable dust to nearby residents during site clearing, topsoil stripping and overburden earthworks, filling and excavation. Potential for higher impact of dust levels at sensitive receptors if construction of both the Hawthorn Football Club Development, projects and the Mordialloc Bypass Project occur simultaneously.	Not required	AQ2 As part of the Construction Environment Management Plan (CEMP), measures to minimise dust, odour and other air emissions must be implemented in accordance with relevant legislation, policies and guidelines including, but not limited to: • EPA Victoria Publication 480: *Environmental Guidelines for Major Construction Sites* *VicRoads Contract Specification Section 177*.	Minor	Possible	Low

12. Management Measures

12.1 Construction

VicRoads Standard Conditions for Dust Control

The standard measures for dust management detailed in the VicRoads Contract are set out below.
"(a) General

All work under the Contract shall comply with the following requirements:

- *Emissions of odorous substances or particulates shall not create or be likely to create objectionable conditions for the public;*
- *Materials of any type shall not be disposed of through burning;*
- *Material that may create a hazard or nuisance dust shall be covered during transport;*
- *Dust generated from road construction activities shall not create a hazard or nuisance to the public, shall not disperse from the site or across roadways, nor interfere with crops, stock or any other dust-sensitive receptors.*

(b) Plant and Equipment

All work under the Contract shall comply with the following requirements:

- *Emissions of visible smoke to the atmosphere from construction plant and equipment shall not be for periods greater than 10 consecutive seconds;*
- *Where practicable all heavy duty diesel engines must be fitted with Selective Catalytic Reduction (SCR) and diesel particulate filters.*

(c) Monitoring

Monitoring shall comply with the following requirements:

- *Insoluble solids from any air quality monitoring station, as measured by a dust deposit gauge in accordance with the requirements of AS 3580.10.1, shall not exceed 4 g/m²/month or 2 g/m²/month above the background measurement, whichever is the lesser;*
- *Directional dust gauges that comply with the equipment requirements of AS 2724.5 shall be installed alongside each air quality monitoring station. Directional dust gauges shall be orientated such that one of the collecting cylinders is directed towards the construction activities;*
- *Directional dust shall be measured as insoluble solids in accordance with AS 3580.10.1 for each of the four collecting cylinders. Directional dust gravimetric results shall be expressed as the percentage of the total directional dust gauge catch for each cylinder;*
- *Dust deposition and directional dust monitoring shall be supplemented with continuous monitoring using a portable laser light scattering instrument, or equivalent, to allow changes to dust control measures if the PM_{10} 1 hour average concentration exceeds 120 µg/m³ and with a visible a visible and logged alarm and SMS notification if the 1-hour average criterion of 120 µg/m³ is exceeded";*
- *Portable laser light scattering instruments shall be operational daily while undertaking construction activities. The instruments shall be calibrated and maintained in accordance with manufacturer's instructions with calibration and maintenance records.*

The Project construction phase will be required to comply with these requirements.

Additional Dust Mitigation Measures

As construction dust is the air quality issue that poses the highest potential risk to the receiving environment, additional dust mitigation measures are recommended to limit, as far as practicable, prolonged adverse impacts on sensitive receptors during the construction period, acknowledging that some local increase in dust is inevitable. These additional dust mitigation measures will be incorporated into the Construction Environment Management Plan (CEMP) and the EPR (AQ2) for the project. These include:

- Reduce activities with high dust generating potential (including heavy excavations and drilling) during periods when strong winds are blowing towards sensitive regions.
- Install portable PM_{10} monitoring monitors between the work site and residential receptors as per the VicRoads specification. Take action promptly in response to high readings of dust (as set out below) on portable monitoring equipment (e.g. reducing operations, moving operations or increasing watering).
- Best practice would involve stringent response trigger response levels to elevated dust levels adjacent to residences (measured as PM_{10}) during the construction period. These trigger response levels will be developed and agreed with relevant stakeholders prior to commencement of construction works.
- Undertake regular watering of exposed surfaces, including exposed stockpiles, and unsealed roadways, to suppress dust generation, with extra watering on days with hot northerly winds.
- Locate haulage routes for rock and soil away from sensitive receivers as much as practicable, and restrict speeds of construction vehicles (e.g. to 20 to 40 km/hr, depending on surface travelled) to minimise wheel-generated dust on unsealed routes.
- Cover truck loads where there is potential for dust emissions during transport. Install appropriate emission control mechanisms (e.g. fabric filter on crushers, concrete batchers) to minimise air emissions.
- Install truck tyre cleaning stations at site boundaries for earth moving vehicles to minimise off-site transport of material, which could cause dust emissions.
- Develop a construction traffic management plan and advise all truck drivers, contractors and vehicular machinery operators of designated vehicle access routes and protocols.
- Locate stockpiles away from sensitive receivers, as far as practicable.
- On stockpiles of topsoil, use mulch or surfactants (e.g. polymer based crusting agents) to agglomerate soil particles and increase the threshold erosion velocity.
- On other stockpiles or temporary soil surfaces lasting more than three weeks, use surfactants (e.g. polymer based crusting agents if there is low traffic flow or vegetable oil-based agents if there is heavy traffic flow) to reduce dust emissions.

12.2 Operational

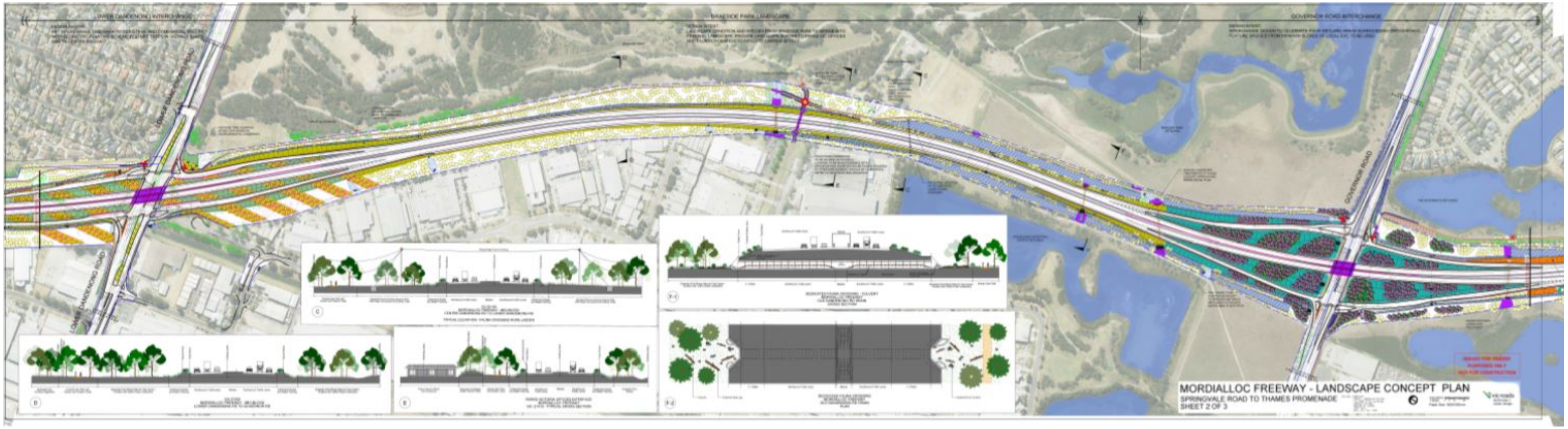
The predicted ground level concentrations of all contaminants assessed are within the relevant design criteria.

The levels of nitrogen dioxide are elevated at sites close to the Mordialloc Bypass and the design criterion for $PM_{2.5}$ may decrease at some time after 2025. Thus it is appropriate to consider design options that could be used to reduce the level of these parameters.

VicRoads are proposing to install multi-purpose barriers along sections of the Project which may help in reducing pollutant concentrations at the nearest receptor locations, emitted from vehicle exhausts.

Figure 12-1 presents a schematic of the multi-purpose barrier proposed at Braeside Park.

Figure 12-1 Landscape Concept Plan Example



13. Environmental Performance Requirements

Table 13.1 presents the EPRs relating to air quality, for the Mordialloc Bypass Project air quality assessment report addressing the potential impacts during the construction and operation phases.

Table 13-1 EPRs for Air Quality Assessment

Number	EPR	Project Phase
AQ1	The project must be designed to minimise air quality impacts during operation and to ensure the requirements of relevant legislation, policies and guidelines are met, including but not limited to: • *State Environment Protection Policy (Air Quality Management)* • *State Environment Protection Policy (Ambient Air Quality).*	Design
AQ2	As part of the Construction Environment Management Plan (CEMP), measures to minimise dust, odour and other air emissions must be implemented in accordance with relevant legislation, policies and guidelines including, but not limited to: • EPA Victoria Publication 480: *Environmental Guidelines for Major Construction Sites* • *VicRoads Contract Specification Section 177*.	Construction

14. Conclusions

The air quality impacts of the Mordialloc Bypass Project that were quantitatively assessed are:

1. Dust emissions from clearing, filling and other construction activities and
2. Vehicle emissions during operations.

Modelling of both construction dust and operation vehicle emissions was carried out to predict the potential impacts on the local environment.

Construction Impacts and Management Measures

Construction impacts to air quality are expected to extend a short distance beyond the construction corridor on dry days with moderate to strong winds. Construction dust is predicted to be greatest during the stage of forming the roadway and pavement base.

The predicted maximum zone of nuisance dust is predicted to extend up to about 100 m from the edge of the construction zone on a few days a year, although less than 60 m for most of the construction period of two years.

A range of management measures are recommended to limit the extent of dust and adverse effects on sensitive receptors. A Construction Environmental Management Plan (CEMP) will be prepared for the Project that includes dust monitoring (with prescribed trigger limits) adjacent to residential areas during the construction phase.

It is concluded that the potential impacts from construction works would be localised, of short duration and intermittent.

Operations Impacts and Management Measures

Operational impacts to air quality are expected to be minor for all parameters modelled - carbon monoxide, nitrogen dioxide, PM_{10} and $PM_{2.5}$. No residential or commercial receptors will be adversely affected. The concentration of air contaminants outside the road reserve from vehicles is predicted to be well within the SEPP design criteria.

Installation of multi-purpose barriers along the proposed roadway is proposed to help reduce the effects of vehicle emissions on nearby receptors.

Disused Enviromix Landfill

A section of the Bypass near Dingley Bypass extends over the disused Enviromix landfill that is still emitting landfill gases, principally methane and hydrogen sulphide. A design solution is recommended to disperse these gases to prevent accumulation under the roadways, and ensure there will be negligible change in odour levels beyond about 250 m from the landfill.

Environmental Performance Requirements

EPRs relating to air quality impacts were developed to manage and mitigate risk during construction and operation of the project.

The risk and impact assessments identified that the EPRs will reduce the risks to a range from negligible to low impacts on air quality during construction and operation of the project. It is considered these EPRs are appropriate for managing the likely air quality impacts.

In summary, these include:

- The Contractor must design the Project to ensure air quality impacts during operation are minimised in accordance with relevant Victorian legislation, policies and guidelines.
- The Contractor must prepare and implement a CEMP to minimise air quality impacts during construction in accordance with relevant Victorian legislation, policies and guidelines.

Conclusion

The potential impacts on air quality were assessed for both construction and operation with predicted ground level concentrations below relevant criteria.

The mitigation measures and management processes put in place to achieve the EPR’s will result in negligible to low impacts on air quality during construction and operation of the Project.

It is concluded that the Mordialloc Freeway Project satisfies the EES evaluation objective relating to air quality.

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Appendix A. Concentration Profiles for Longer Time Averaging

This appendix presents concentration plots of vehicle emissions for longer time scales.

Design Criteria – 1-hour Averaging

The EPA has specified that the 1 hour design criteria for CO, NO_2, PM_{10} and $PM_{2.5}$ are to be used in the assessing of air quality impact for operation of the Mordialloc Bypass Project. Design criteria for those contaminants to be assessed are listed in Table A-1.

Table A-1 Design Criteria for Air Contaminants

Contaminant	Design criteria	Averaging Period
CO	29,000 µg/m^3	1-hour
NO_2	190 µg/m^3	1-hour
PM_{10}	80 µg/m^3	1-hour
$PM_{2.5}$	50 µg/m^3	1-hour

Air Quality Objectives – SEPP(AAQ)

The SEPP(AAQ) includes objectives for longer time periods including 8-hours for CO, 24-hours for PM_{10} and $PM_{2.5}$, and 1-year for NO_2, PM_{10} and $PM_{2.5}$, as listed in Table A-2.

Table A-2 SEPP(AAQ) Objectives for Air Contaminants

Contaminant	Objective	Averaging Period	Conversion to µg/m^3
CO	9 ppm	8-hours	10,400 µg/m^3
NO_2	0.12 ppm	1-hour	228 µg/m^3
	0.03 ppm	1-year	57 µg/m^3
PM_{10}	50 µg/m^3	24-hours	50 µg/m^3
	20 µg/m^3	1-year	20 µg/m^3
$PM_{2.5}$	25 µg/m^3	24-hours	25 µg/m^3
	8 µg/m^3	1-year	8 µg/m^3

The main report (see Figures 9-7 to 9-9) shows CO concentrations are low compared to the 1-hour CO design criterion. The 8-hour CO levels meet the SEPP(AAQ) objectives by a large margin and are not examined further in this appendix.

The 1-hour NO_2 design criterion of 190 µg/m^3 is less than the SEPP(AAQ) 1-hour NO_2 objective of 228 µg/m^3. Thus the 1-hour NO_2 objective is not examined further in this appendix.

In this appendix, attention is given to the 24-hour and annual levels of contaminants. The next step is to establish the background concentrations of contaminants for the 24-hour and annual averaging periods. These values were developed from EPA monitoring data using the same procedure as for the 1-hour levels, and are summarised in Table A-3.

Table A-3 Assumed Background Concentrations of Air Quality Parameters

Parameter	1-hour Background Concentration	24-hour Background Concentration	Annual Background Concentration
Nitrogen dioxide	48 µg/m^3	20 µg/m^3	16 µg/m^3
PM_{10}	20 µg/m^3	19 µg/m^3	16 µg/m^3
$PM_{2.5}$	9 µg/m^3	8.5 µg/m^3	6.5 µg/m^3

The fleet emission factors for various contaminants are listed in Table A-4.

Table A-4 Average Vehicle Fleet Emission Rates for Various Contaminants

Year	Fleet Emission Rate, g/km			
	Carbon monoxide	Nitrogen Dioxide	PM_{10}	$PM_{2.5}$
2017	4.4	0.50	0.069	0.050
2021	4.0	0.46	0.064	0.045
2031	3.6	0.42	0.060	0.042

Using this information, the Ausroads model and the year 2016 meteorological file, the 99.9 percentile 24-hour concentrations were calculated for Section C for PM_{10} and $PM_{2.5}$, and 1-year averages for NO_2, PM_{10} and $PM_{2.5}$.

Figures A-1 and A-2 show the 24-hour average and annual average PM_{10} concentration profiles for Section C. Very similar profiles would apply for all the other sections. It can be seen that the predicted PM_{10} levels comply with the SEPP(AAQ) objectives.

Figures A-3 and A-4 show the 24-hour average and annual average $PM_{2.5}$ concentration profiles for Section C. Very similar profiles would apply for all the other sections. It can be seen that the predicted $PM_{2.5}$ levels comply with the SEPP(AAQ) objectives. although the margin is small for the annual average, owing to the elevated background concentration.

Figure A-5 shows the annual average NO_2 concentration profile for Section C. Very similar profiles would apply for all the other sections. It can be seen that the predicted NO_2 levels comply with the SEPP(AAQ) annual objective.

Figure A-1 Predicted 24-hour PM_{10} Concentration

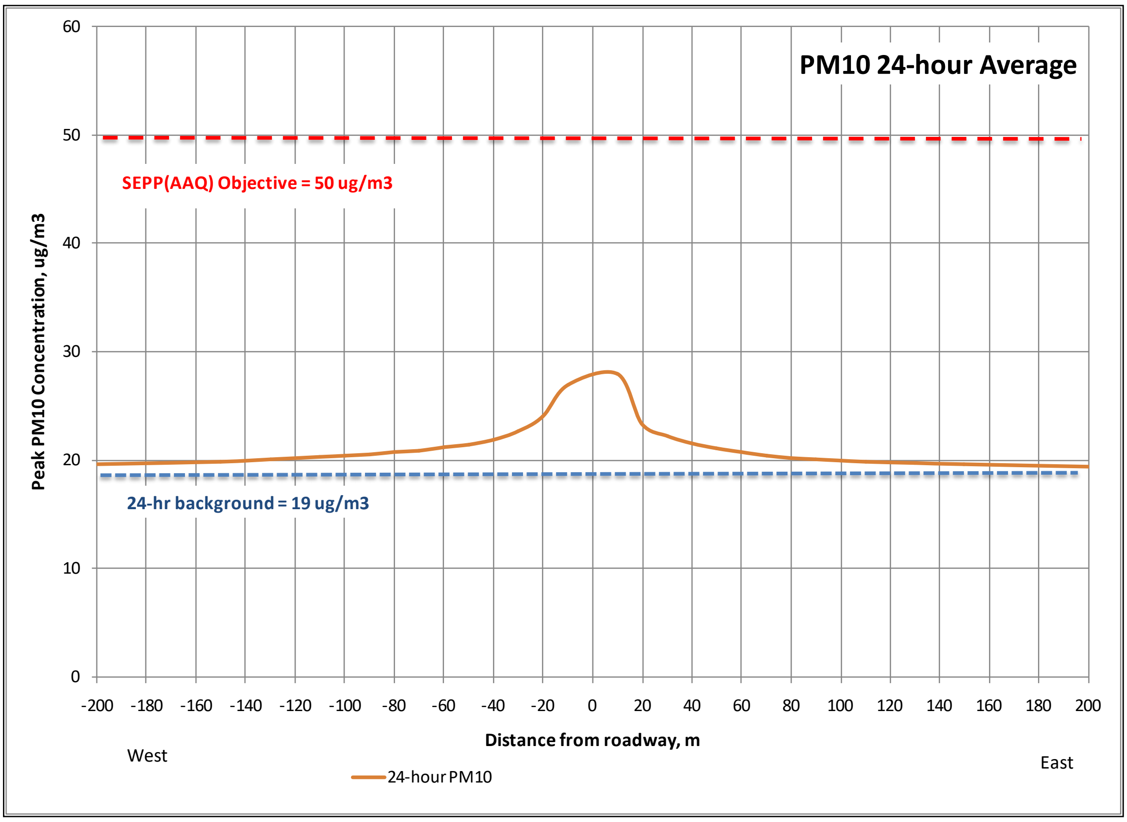


Figure A-2 Predicted Annual PM_{10} Concentration

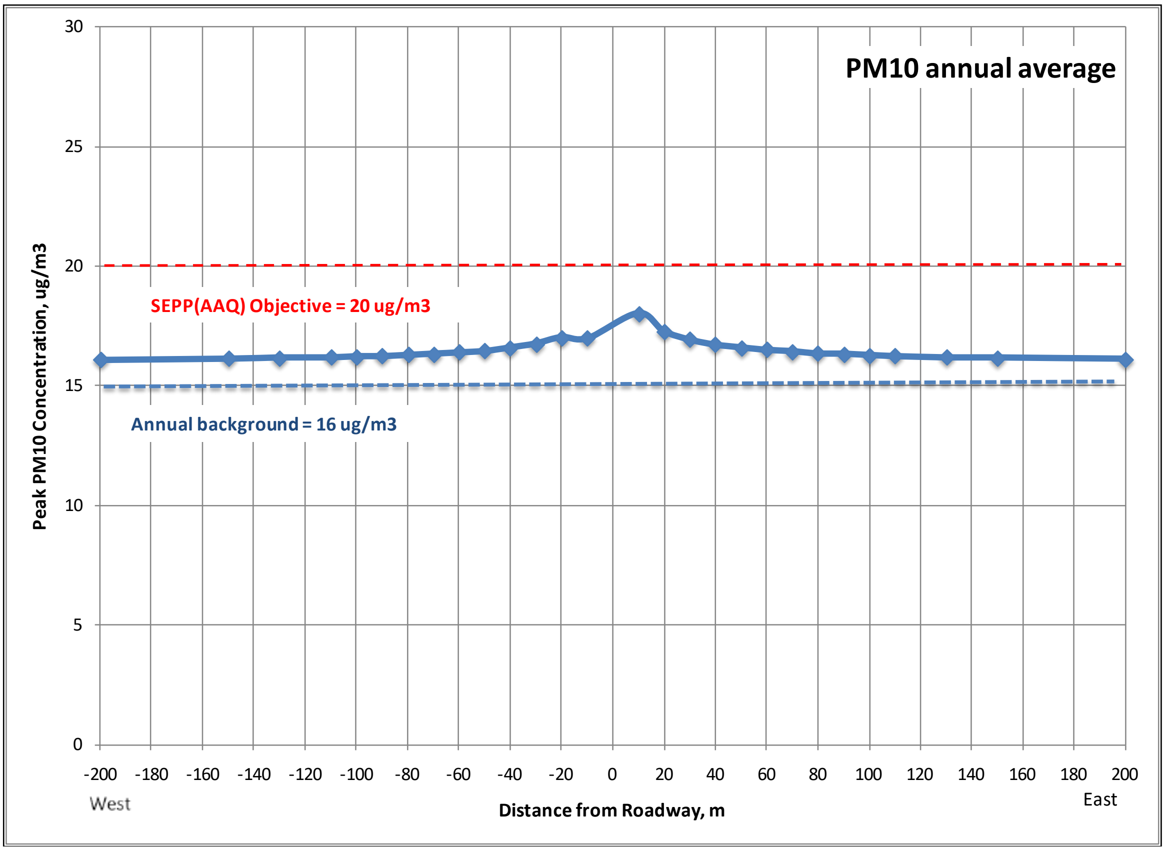


Figure A-3 Predicted 24-hour $PM_{2.5}$ Concentration

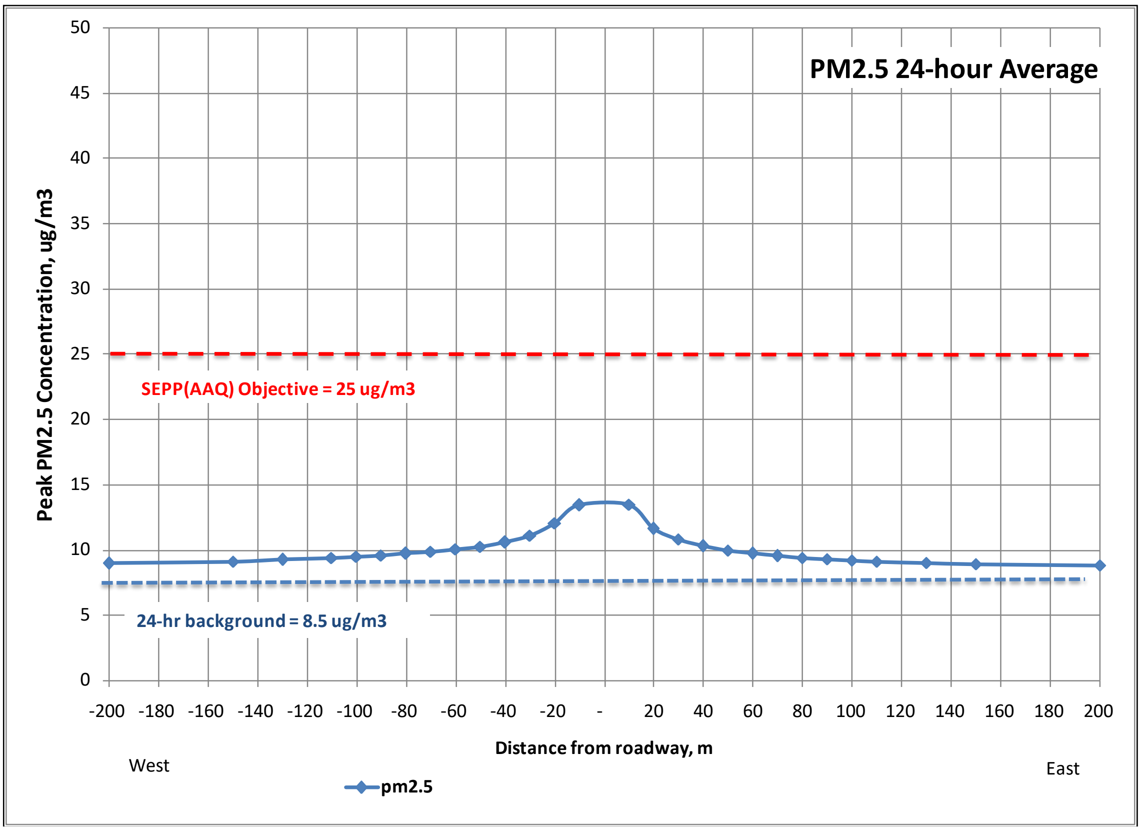


Figure A-4 Predicted Annual $PM_{2.5}$ Concentration

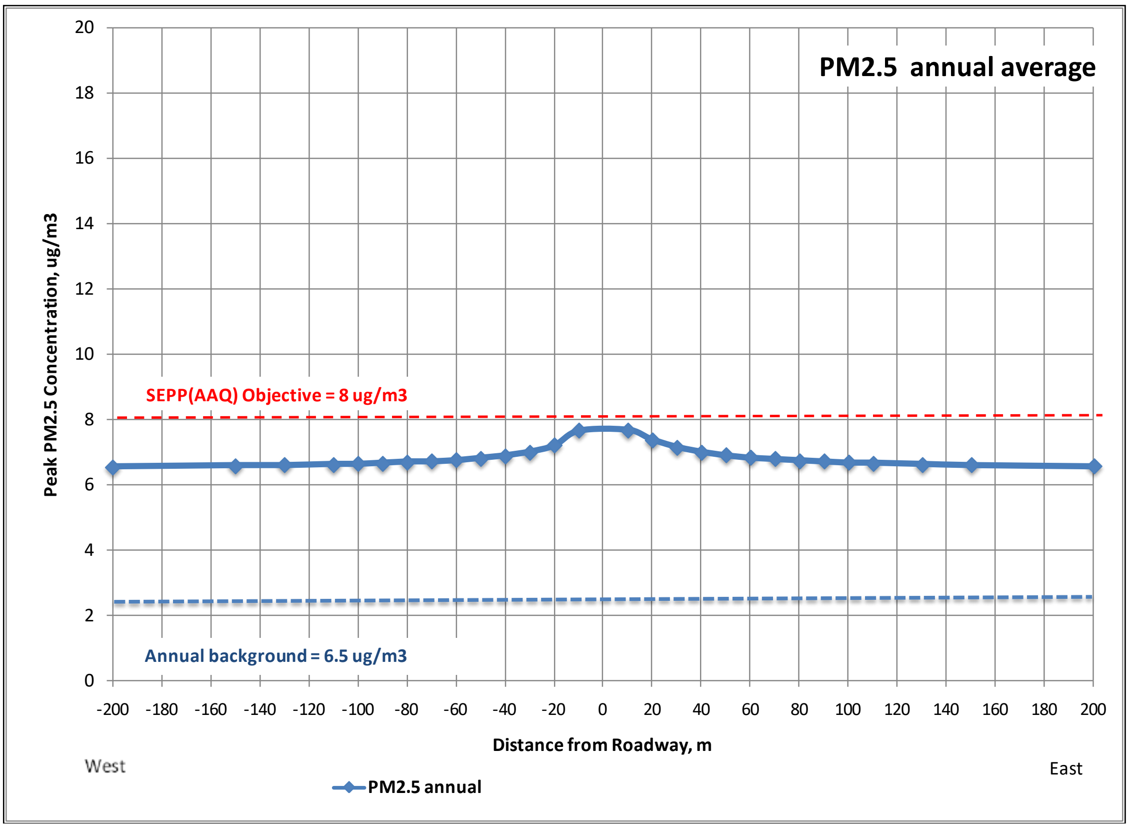
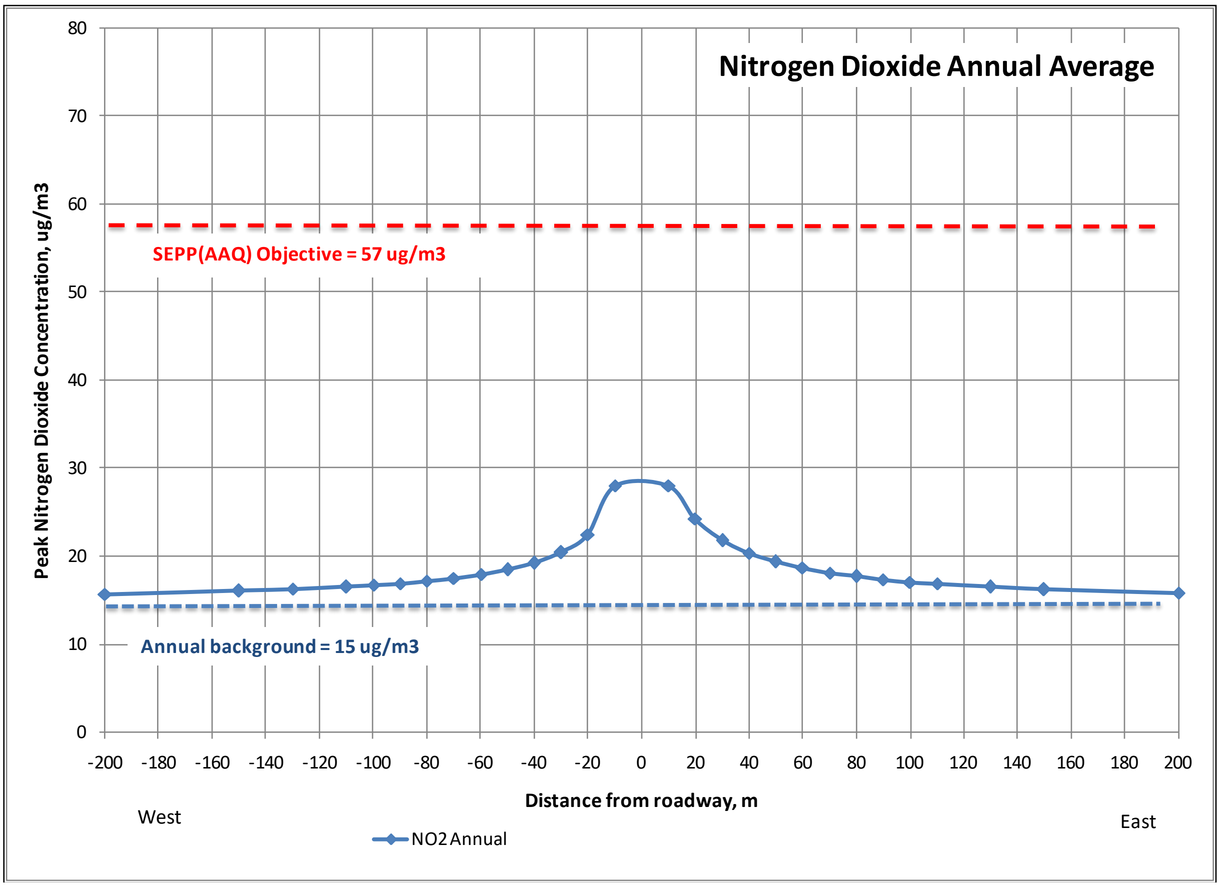


Figure A-5 Predicted Annual NO_2 Concentration



Appendix B. Example of Dispersion Modelling Output

This appendix contains the printout from the Ausroads Model for simulation of Carbon Monoxide in Section C of the Mordialloc Bypass Project.

Mordialloc Freeway - Option C - 2016 Met

VARIABLES AND OPTIONS SELECTED FOR THIS RUN

```
Emission rate units:                                   g/v-km
Concentration units:                                   micrograms/m3
Aerodynamic roughness:                                 0.40 (M)
Aerodynamic roughness at wind vane site:               0.30 (M)
Anemometer height:                                     10.0 (M)
Read sigma theta values from the met file?             No
Use Pasquill Gifford for horizontal dispersion?        Yes
Sigma theta averaging periods:                         60 (min.)
Wind profile exponents set to:                         Irwin Urban
Use hourly varying background concentrations?          No
Use constant background concentrations?                Yes
Constant background concentrations set to:             0.0 micrograms/m3
External file for emission rates and traffic volumes? No
```

LINK GEOMETRY

LINK NAME	TYPE	LINK COORDINATES (M) X1	Y1	X2	Y2	HEIGHT (M)	MIXING ZONE WIDTH (M)
LNK1	AG	-8.0	-300.0	-8.0	300.0	1.0	13.0
LNK2	AG	8.0	-300.0	8.0	300.0	1.0	13.0

LINK ACTIVITY

NOTE: TF = TRAFFIC VOLUMES; EF = EMISSION FACTORS

LNK1 HOUR	TF WEEK DAY	EM WEEK DAY	TF SATURDAY	EM SATURDAY	TF SUNDAY	EM SUNDAY
1	3.27E+02	1.61E+00	3.27E+02	1.61E+00	3.27E+02	1.61E+00
2	3.27E+02	1.61E+00	3.27E+02	1.61E+00	3.27E+02	1.61E+00
3	3.27E+02	1.61E+00	3.27E+02	1.61E+00	3.27E+02	1.61E+00
4	3.27E+02	1.61E+00	3.27E+02	1.61E+00	3.27E+02	1.61E+00
5	4.90E+02	1.61E+00	4.90E+02	1.61E+00	4.90E+02	1.61E+00
6	1.63E+03	1.61E+00	1.63E+03	1.61E+00	1.63E+03	1.61E+00
7	2.62E+03	1.61E+00	2.62E+03	1.61E+00	2.62E+03	1.61E+00
8	2.62E+03	1.61E+00	2.62E+03	1.61E+00	2.62E+03	1.61E+00
9	2.39E+03	1.61E+00	2.39E+03	1.61E+00	2.39E+03	1.61E+00
10	1.80E+03	1.61E+00	1.80E+03	1.61E+00	1.80E+03	1.61E+00
11	1.57E+03	1.61E+00	1.57E+03	1.61E+00	1.57E+03	1.61E+00
12	1.47E+03	1.61E+00	1.47E+03	1.61E+00	1.47E+03	1.61E+00
13	1.47E+03	1.61E+00	1.47E+03	1.61E+00	1.47E+03	1.61E+00
14	1.47E+03	1.61E+00	1.47E+03	1.61E+00	1.47E+03	1.61E+00

15	1.47E+03	1.61E+00	1.47E+03	1.61E+00	1.47E+03	1.61E+00
16	1.83E+03	1.61E+00	1.83E+03	1.61E+00	1.83E+03	1.61E+00
17	2.29E+03	1.61E+00	2.29E+03	1.61E+00	2.29E+03	1.61E+00
18	2.29E+03	1.61E+00	2.29E+03	1.61E+00	2.29E+03	1.61E+00
19	1.67E+03	1.61E+00	1.67E+03	1.61E+00	1.67E+03	1.61E+00
20	1.37E+03	1.61E+00	1.37E+03	1.61E+00	1.37E+03	1.61E+00
21	1.14E+03	1.61E+00	1.14E+03	1.61E+00	1.14E+03	1.61E+00
22	8.17E+02	1.61E+00	8.17E+02	1.61E+00	8.17E+02	1.61E+00
23	5.88E+02	1.61E+00	5.88E+02	1.61E+00	5.88E+02	1.61E+00
24	3.92E+02	1.61E+00	3.92E+02	1.61E+00	3.92E+02	1.61E+00

LNK2 HOUR	TF WEEK DAY	EM WEEK DAY	TF SATURDAY	EM SATURDAY	TF SUNDAY	EM SUNDAY
1	3.05E+02	1.61E+00	3.05E+02	1.61E+00	3.05E+02	1.61E+00
2	3.05E+02	1.61E+00	3.05E+02	1.61E+00	3.05E+02	1.61E+00
3	3.05E+02	1.61E+00	3.05E+02	1.61E+00	3.05E+02	1.61E+00
4	3.05E+02	1.61E+00	3.05E+02	1.61E+00	3.05E+02	1.61E+00
5	3.97E+02	1.61E+00	3.97E+02	1.61E+00	3.97E+02	1.61E+00
6	9.16E+02	1.61E+00	9.16E+02	1.61E+00	9.16E+02	1.61E+00
7	1.65E+03	1.61E+00	1.65E+03	1.61E+00	1.65E+03	1.61E+00
8	1.77E+03	1.61E+00	1.77E+03	1.61E+00	1.77E+03	1.61E+00
9	1.65E+03	1.61E+00	1.65E+03	1.61E+00	1.65E+03	1.61E+00
10	1.53E+03	1.61E+00	1.53E+03	1.61E+00	1.53E+03	1.61E+00
11	1.37E+03	1.61E+00	1.37E+03	1.61E+00	1.37E+03	1.61E+00
12	1.37E+03	1.61E+00	1.37E+03	1.61E+00	1.37E+03	1.61E+00
13	1.37E+03	1.61E+00	1.37E+03	1.61E+00	1.37E+03	1.61E+00
14	1.37E+03	1.61E+00	1.37E+03	1.61E+00	1.37E+03	1.61E+00
15	1.65E+03	1.61E+00	1.65E+03	1.61E+00	1.65E+03	1.61E+00
16	2.44E+03	1.61E+00	2.44E+03	1.61E+00	2.44E+03	1.61E+00
17	2.87E+03	1.61E+00	2.87E+03	1.61E+00	2.87E+03	1.61E+00
18	2.60E+03	1.61E+00	2.60E+03	1.61E+00	2.60E+03	1.61E+00
19	1.99E+03	1.61E+00	1.99E+03	1.61E+00	1.99E+03	1.61E+00
20	1.68E+03	1.61E+00	1.68E+03	1.61E+00	1.68E+03	1.61E+00
21	1.16E+03	1.61E+00	1.16E+03	1.61E+00	1.16E+03	1.61E+00
22	7.94E+02	1.61E+00	7.94E+02	1.61E+00	7.94E+02	1.61E+00
23	5.50E+02	1.61E+00	5.50E+02	1.61E+00	5.50E+02	1.61E+00
24	3.66E+02	1.61E+00	3.66E+02	1.61E+00	3.66E+02	1.61E+00

RECEPTOR LOCATIONS

RCP1	1	-211.0	0.0	0.0	RCP2	2	-161.0	0.0	0.0
RCP3	3	-131.0	0.0	0.0	RCP4	4	-111.0	0.0	0.0
RCP5	5	-101.0	0.0	0.0	RCP6	6	-91.0	0.0	0.0
RCP7	7	-81.0	0.0	0.0	RCP8	8	-71.0	0.0	0.0
RCP9	9	-61.0	0.0	0.0	RCP10	10	-51.0	0.0	0.0
RCP11	11	-41.0	0.0	0.0	RCP12	12	-31.0	0.0	0.0
RCP13	13	-21.0	0.0	0.0	RCP14	14	-11.0	0.0	0.0
RCP15	15	0.0	0.0	0.0	RCP16	16	11.0	0.0	0.0
RCP17	17	21.0	0.0	0.0	RCP18	18	31.0	0.0	0.0
RCP19	19	41.0	0.0	0.0	RCP20	20	51.0	0.0	0.0
RCP21	21	61.0	0.0	0.0	RCP22	22	71.0	0.0	0.0
RCP23	23	81.0	0.0	0.0	RCP24	24	91.0	0.0	0.0
RCP25	25	101.0	0.0	0.0	RCP26	26	111.0	0.0	0.0
RCP27	27	131.0	0.0	0.0	RCP28	28	161.0	0.0	0.0
RCP29	29	211.0	0.0	0.0					

```
                          METEOROLOGICAL DATA
                         ---------------------

 Meteorological data entered via the input file:
 C:\TEMP\Mord\Mordialloc 2016.met

 Title of the meteorological data file is:
 ** Mordialloc 2016 Met data -
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```

```
                    AVERAGE OVER ALL HOURS AND FOR ALL SOURCES
                                in micrograms/m3

 Concentrations at the discrete receptors (No. : Value):

1:9.16E-01   2:1.39E+00   3:1.88E+00   4:2.37E+00   5:2.69E+00   6:3.09E+00
7:3.60E+00    8:4.25E+00
9:5.12E+00      10:6.34E+00     11:8.18E+00     12:1.13E+01     13:1.81E+01
14:4.50E+01   15:5.16E+01   16:5.68E+01
17:3.12E+01     18:2.06E+01     19:1.55E+01     20:1.24E+01     21:1.03E+01
22:8.80E+00   23:7.64E+00   24:6.71E+00
25:5.95E+00   26:5.33E+00   27:4.38E+00   28:3.38E+00   29:2.36E+00
```

```
       HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
       AVERAGING TIME =  1 HOUR

 At the discrete receptors:
   1: 4.30E+01 @Hr18,19/07/16
   2: 5.46E+01 @Hr18,19/07/16
   3: 6.97E+01 @Hr18,27/05/16
   4: 9.59E+01 @Hr18,27/05/16
   5: 1.08E+02 @Hr18,27/05/16
   6: 1.20E+02 @Hr18,27/05/16
   7: 1.34E+02 @Hr18,27/05/16
   8: 1.50E+02 @Hr18,27/05/16
   9: 1.69E+02 @Hr18,27/05/16
  10: 1.96E+02 @Hr18,27/05/16
  11: 2.36E+02 @Hr18,27/05/16
  12: 3.00E+02 @Hr18,27/05/16
  13: 4.47E+02 @Hr18,27/05/16
  14: 9.58E+02 @Hr18,06/05/16
  15: 7.15E+02 @Hr18,06/05/16
  16: 1.05E+03 @Hr18,06/05/16
  17: 4.26E+02 @Hr19,19/09/16
  18: 2.73E+02 @Hr19,19/09/16
  19: 1.94E+02 @Hr19,19/09/16
  20: 1.62E+02 @Hr17,31/07/16
  21: 1.40E+02 @Hr17,31/07/16
  22: 1.22E+02 @Hr17,31/07/16
  23: 1.08E+02 @Hr17,31/07/16
  24: 9.76E+01 @Hr17,31/07/16
  25: 8.96E+01 @Hr17,31/07/16
  26: 8.29E+01 @Hr17,31/07/16
  27: 7.29E+01 @Hr17,31/07/16
  28: 6.16E+01 @Hr17,31/07/16
  29: 4.82E+01 @Hr17,31/07/16
```

```
      HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
      AVERAGING TIME =  8 HOURS

 At the discrete receptors:
   1: 1.18E+01 @Hr08,10/11/16
   2: 1.50E+01 @Hr08,10/11/16
   3: 1.85E+01 @Hr16,02/06/16
   4: 2.33E+01 @Hr08,09/01/16
   5: 2.65E+01 @Hr08,09/01/16
   6: 3.00E+01 @Hr08,09/01/16
   7: 3.41E+01 @Hr08,09/01/16
   8: 3.93E+01 @Hr08,09/01/16
   9: 4.58E+01 @Hr08,09/01/16
  10: 5.45E+01 @Hr08,09/01/16
  11: 6.74E+01 @Hr08,09/01/16
  12: 8.94E+01 @Hr08,09/01/16
  13: 1.34E+02 @Hr08,09/01/16
  14: 2.32E+02 @Hr24,08/04/16
  15: 2.19E+02 @Hr24,08/04/16
  16: 2.36E+02 @Hr24,24/08/16
  17: 1.37E+02 @Hr16,07/08/16
  18: 8.69E+01 @Hr24,30/05/16
  19: 6.51E+01 @Hr24,30/05/16
  20: 5.22E+01 @Hr16,06/08/16
  21: 4.41E+01 @Hr16,06/08/16
  22: 3.80E+01 @Hr16,06/08/16
  23: 3.32E+01 @Hr16,06/08/16
  24: 2.96E+01 @Hr16,06/08/16
  25: 2.67E+01 @Hr16,06/08/16
  26: 2.43E+01 @Hr16,06/08/16
  27: 2.03E+01 @Hr16,04/04/16
  28: 1.66E+01 @Hr16,04/04/16
  29: 1.24E+01 @Hr16,04/04/16
```

```
      HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
      AVERAGING TIME = 24 HOURS

 At the discrete receptors:
   1: 6.67E+00 @Hr24,19/06/16
   2: 9.40E+00 @Hr24,19/06/16
   3: 1.19E+01 @Hr24,19/06/16
   4: 1.42E+01 @Hr24,19/06/16
   5: 1.55E+01 @Hr24,19/06/16
   6: 1.71E+01 @Hr24,19/06/16
   7: 1.90E+01 @Hr24,19/06/16
   8: 2.14E+01 @Hr24,19/06/16
   9: 2.46E+01 @Hr24,19/06/16
  10: 2.89E+01 @Hr24,19/06/16
  11: 3.53E+01 @Hr24,19/06/16
  12: 4.56E+01 @Hr24,19/06/16
  13: 6.72E+01 @Hr24,19/06/16
  14: 1.23E+02 @Hr24,07/08/16
  15: 1.25E+02 @Hr24,24/08/16
  16: 1.39E+02 @Hr24,30/05/16
  17: 8.10E+01 @Hr24,30/05/16
  18: 5.21E+01 @Hr24,30/05/16
  19: 3.97E+01 @Hr24,20/07/16
  20: 3.26E+01 @Hr24,20/07/16
  21: 2.77E+01 @Hr24,20/07/16
```

```
22: 2.41E+01 @Hr24,20/07/16
23: 2.14E+01 @Hr24,20/07/16
24: 1.92E+01 @Hr24,20/07/16
25: 1.74E+01 @Hr24,20/07/16
26: 1.60E+01 @Hr24,20/07/16
27: 1.37E+01 @Hr24,20/07/16
28: 1.14E+01 @Hr24,20/07/16
29: 8.63E+00 @Hr24,20/07/16
```

```
SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR - in micrograms/m3
AVERAGING TIME =  1 HOUR
```

```
Peak values for the  100 worst cases - in micrograms/m3
AVERAGING TIME =  1 HOUR
```

Rank	Value	Time Recorded hour,date	Coordinates		
1	1.05E+03	@Hr18,06/05/16	(11.0,	0.0,	0.0)
2	7.69E+02	@Hr19,19/09/16	(11.0,	0.0,	0.0)
3	6.35E+02	@Hr18,27/05/16	(-11.0,	0.0,	0.0)
4	6.28E+02	@Hr17,08/03/16	(11.0,	0.0,	0.0)
5	5.89E+02	@Hr19,19/04/16	(-11.0,	0.0,	0.0)
6	5.69E+02	@Hr18,31/07/16	(11.0,	0.0,	0.0)
7	5.62E+02	@Hr06,03/08/16	(-11.0,	0.0,	0.0)
8	5.60E+02	@Hr18,31/03/16	(-11.0,	0.0,	0.0)
9	5.53E+02	@Hr07,09/01/16	(-11.0,	0.0,	0.0)
10	5.40E+02	@Hr08,09/01/16	(-11.0,	0.0,	0.0)
11	5.37E+02	@Hr21,24/08/16	(-11.0,	0.0,	0.0)
12	5.36E+02	@Hr19,08/04/16	(-11.0,	0.0,	0.0)
13	5.24E+02	@Hr17,31/07/16	(11.0,	0.0,	0.0)
14	5.11E+02	@Hr07,27/11/16	(-11.0,	0.0,	0.0)
15	5.10E+02	@Hr17,27/05/16	(11.0,	0.0,	0.0)
16	5.10E+02	@Hr08,20/07/16	(-11.0,	0.0,	0.0)
17	4.93E+02	@Hr18,16/07/16	(-11.0,	0.0,	0.0)
18	4.78E+02	@Hr17,09/07/16	(-11.0,	0.0,	0.0)
19	4.76E+02	@Hr07,09/11/16	(-11.0,	0.0,	0.0)
20	4.64E+02	@Hr17,19/07/16	(11.0,	0.0,	0.0)
21	4.60E+02	@Hr16,07/05/16	(11.0,	0.0,	0.0)
22	4.58E+02	@Hr17,31/03/16	(11.0,	0.0,	0.0)
23	4.57E+02	@Hr06,11/01/16	(-11.0,	0.0,	0.0)
24	4.53E+02	@Hr17,30/05/16	(11.0,	0.0,	0.0)
25	4.51E+02	@Hr18,18/04/16	(11.0,	0.0,	0.0)
26	4.49E+02	@Hr07,03/08/16	(-11.0,	0.0,	0.0)
27	4.48E+02	@Hr17,16/07/16	(11.0,	0.0,	0.0)
28	4.47E+02	@Hr08,25/02/16	(-11.0,	0.0,	0.0)
29	4.47E+02	@Hr07,01/12/16	(-11.0,	0.0,	0.0)
30	4.45E+02	@Hr07,11/01/16	(-11.0,	0.0,	0.0)
31	4.45E+02	@Hr09,14/03/16	(-11.0,	0.0,	0.0)
32	4.44E+02	@Hr09,28/03/16	(-11.0,	0.0,	0.0)
33	4.42E+02	@Hr18,30/05/16	(11.0,	0.0,	0.0)
34	4.42E+02	@Hr18,08/04/16	(11.0,	0.0,	0.0)
35	4.34E+02	@Hr20,08/04/16	(-11.0,	0.0,	0.0)
36	4.28E+02	@Hr19,27/09/16	(-11.0,	0.0,	0.0)
37	4.26E+02	@Hr07,24/01/16	(-11.0,	0.0,	0.0)
38	4.21E+02	@Hr18,24/08/16	(11.0,	0.0,	0.0)
39	4.19E+02	@Hr08,24/02/16	(-11.0,	0.0,	0.0)
40	4.19E+02	@Hr07,20/07/16	(11.0,	0.0,	0.0)
41	4.12E+02	@Hr09,20/07/16	(-11.0,	0.0,	0.0)

42	4.07E+02	@Hr16,31/01/16	(11.0,	0.0,	0.0)
43	4.05E+02	@Hr08,20/03/16	(-11.0,	0.0,	0.0)
44	4.01E+02	@Hr18,19/07/16	(-11.0,	0.0,	0.0)
45	4.01E+02	@Hr08,09/11/16	(0.0,	0.0,	0.0)
46	3.98E+02	@Hr19,24/08/16	(-11.0,	0.0,	0.0)
47	3.98E+02	@Hr07,14/04/16	(-11.0,	0.0,	0.0)
48	3.94E+02	@Hr08,24/01/16	(11.0,	0.0,	0.0)
49	3.93E+02	@Hr19,19/07/16	(-11.0,	0.0,	0.0)
50	3.91E+02	@Hr08,10/11/16	(-11.0,	0.0,	0.0)
51	3.91E+02	@Hr08,04/03/16	(-11.0,	0.0,	0.0)
52	3.90E+02	@Hr06,24/03/16	(11.0,	0.0,	0.0)
53	3.88E+02	@Hr21,08/04/16	(-11.0,	0.0,	0.0)
54	3.87E+02	@Hr09,11/01/16	(11.0,	0.0,	0.0)
55	3.86E+02	@Hr22,24/08/16	(11.0,	0.0,	0.0)
56	3.84E+02	@Hr16,31/07/16	(11.0,	0.0,	0.0)
57	3.84E+02	@Hr08,11/01/16	(11.0,	0.0,	0.0)
58	3.83E+02	@Hr16,16/07/16	(11.0,	0.0,	0.0)
59	3.75E+02	@Hr07,24/03/16	(11.0,	0.0,	0.0)
60	3.74E+02	@Hr09,11/11/16	(-11.0,	0.0,	0.0)
61	3.71E+02	@Hr18,26/08/16	(11.0,	0.0,	0.0)
62	3.71E+02	@Hr17,28/08/16	(11.0,	0.0,	0.0)
63	3.67E+02	@Hr08,27/11/16	(11.0,	0.0,	0.0)
64	3.66E+02	@Hr07,30/03/16	(11.0,	0.0,	0.0)
65	3.66E+02	@Hr17,24/04/16	(11.0,	0.0,	0.0)
66	3.65E+02	@Hr09,29/11/16	(0.0,	0.0,	0.0)
67	3.65E+02	@Hr19,18/04/16	(11.0,	0.0,	0.0)
68	3.63E+02	@Hr06,09/01/16	(-11.0,	0.0,	0.0)
69	3.63E+02	@Hr09,27/02/16	(0.0,	0.0,	0.0)
70	3.63E+02	@Hr16,09/07/16	(11.0,	0.0,	0.0)
71	3.58E+02	@Hr17,17/01/16	(11.0,	0.0,	0.0)
72	3.56E+02	@Hr09,04/03/16	(11.0,	0.0,	0.0)
73	3.52E+02	@Hr09,24/02/16	(11.0,	0.0,	0.0)
74	3.52E+02	@Hr07,24/02/16	(-11.0,	0.0,	0.0)
75	3.51E+02	@Hr20,24/08/16	(-11.0,	0.0,	0.0)
76	3.50E+02	@Hr08,13/10/16	(-11.0,	0.0,	0.0)
77	3.48E+02	@Hr09,10/11/16	(-11.0,	0.0,	0.0)
78	3.48E+02	@Hr09,24/10/16	(0.0,	0.0,	0.0)
79	3.47E+02	@Hr17,05/08/16	(11.0,	0.0,	0.0)
80	3.44E+02	@Hr21,30/03/16	(-11.0,	0.0,	0.0)
81	3.39E+02	@Hr15,30/05/16	(11.0,	0.0,	0.0)
82	3.38E+02	@Hr19,31/03/16	(-11.0,	0.0,	0.0)
83	3.30E+02	@Hr09,04/04/16	(-11.0,	0.0,	0.0)
84	3.29E+02	@Hr18,17/08/16	(11.0,	0.0,	0.0)
85	3.27E+02	@Hr18,29/10/16	(11.0,	0.0,	0.0)
86	3.23E+02	@Hr07,19/11/16	(-11.0,	0.0,	0.0)
87	3.23E+02	@Hr10,11/01/16	(11.0,	0.0,	0.0)
88	3.23E+02	@Hr10,20/07/16	(-11.0,	0.0,	0.0)
89	3.20E+02	@Hr09,13/02/16	(11.0,	0.0,	0.0)
90	3.20E+02	@Hr09,20/11/16	(11.0,	0.0,	0.0)
91	3.20E+02	@Hr20,16/09/16	(11.0,	0.0,	0.0)
92	3.19E+02	@Hr20,01/03/16	(-11.0,	0.0,	0.0)
93	3.18E+02	@Hr16,31/05/16	(11.0,	0.0,	0.0)
94	3.16E+02	@Hr10,06/03/16	(11.0,	0.0,	0.0)
95	3.14E+02	@Hr16,07/08/16	(11.0,	0.0,	0.0)
96	3.13E+02	@Hr08,07/08/16	(-11.0,	0.0,	0.0)
97	3.12E+02	@Hr07,06/08/16	(-11.0,	0.0,	0.0)
98	3.12E+02	@Hr10,22/03/16	(-11.0,	0.0,	0.0)
99	3.10E+02	@Hr16,30/05/16	(11.0,	0.0,	0.0)
100	3.09E+02	@Hr22,08/04/16	(-11.0,	0.0,	0.0)

Peak values for the 100 worst cases - in micrograms/m3
AVERAGING TIME = 8 HOURS

Rank	Value	Time Recorded hour,date	Coordinates		
1	2.36E+02	@Hr24,24/08/16	(11.0,	0.0,	0.0)
2	2.32E+02	@Hr24,08/04/16	(-11.0,	0.0,	0.0)
3	2.27E+02	@Hr08,09/01/16	(-11.0,	0.0,	0.0)
4	2.26E+02	@Hr16,07/08/16	(11.0,	0.0,	0.0)
5	2.21E+02	@Hr16,02/06/16	(-11.0,	0.0,	0.0)
6	2.16E+02	@Hr24,30/05/16	(11.0,	0.0,	0.0)
7	2.04E+02	@Hr24,06/05/16	(11.0,	0.0,	0.0)
8	1.97E+02	@Hr16,06/08/16	(11.0,	0.0,	0.0)
9	1.96E+02	@Hr24,19/09/16	(11.0,	0.0,	0.0)
10	1.91E+02	@Hr24,31/07/16	(11.0,	0.0,	0.0)
11	1.86E+02	@Hr16,09/07/16	(11.0,	0.0,	0.0)
12	1.83E+02	@Hr16,04/04/16	(11.0,	0.0,	0.0)
13	1.79E+02	@Hr08,11/01/16	(-11.0,	0.0,	0.0)
14	1.76E+02	@Hr08,24/03/16	(11.0,	0.0,	0.0)
15	1.75E+02	@Hr16,29/10/16	(11.0,	0.0,	0.0)
16	1.75E+02	@Hr24,31/03/16	(-11.0,	0.0,	0.0)
17	1.75E+02	@Hr24,18/04/16	(11.0,	0.0,	0.0)
18	1.73E+02	@Hr08,03/08/16	(-11.0,	0.0,	0.0)
19	1.72E+02	@Hr24,31/05/16	(-11.0,	0.0,	0.0)
20	1.70E+02	@Hr16,31/01/16	(11.0,	0.0,	0.0)
21	1.67E+02	@Hr16,20/11/16	(11.0,	0.0,	0.0)
22	1.66E+02	@Hr24,12/04/16	(11.0,	0.0,	0.0)
23	1.65E+02	@Hr16,02/02/16	(11.0,	0.0,	0.0)
24	1.64E+02	@Hr16,16/07/16	(11.0,	0.0,	0.0)
25	1.64E+02	@Hr16,20/07/16	(11.0,	0.0,	0.0)
26	1.63E+02	@Hr16,30/05/16	(11.0,	0.0,	0.0)
27	1.58E+02	@Hr08,09/11/16	(-11.0,	0.0,	0.0)
28	1.57E+02	@Hr24,27/05/16	(-11.0,	0.0,	0.0)
29	1.56E+02	@Hr24,19/07/16	(11.0,	0.0,	0.0)
30	1.55E+02	@Hr16,31/05/16	(11.0,	0.0,	0.0)
31	1.55E+02	@Hr08,24/02/16	(-11.0,	0.0,	0.0)
32	1.53E+02	@Hr16,24/10/16	(11.0,	0.0,	0.0)
33	1.53E+02	@Hr16,23/09/16	(11.0,	0.0,	0.0)
34	1.53E+02	@Hr16,19/06/16	(-11.0,	0.0,	0.0)
35	1.51E+02	@Hr16,07/05/16	(11.0,	0.0,	0.0)
36	1.50E+02	@Hr24,16/07/16	(-11.0,	0.0,	0.0)
37	1.46E+02	@Hr16,11/01/16	(11.0,	0.0,	0.0)
38	1.45E+02	@Hr24,30/03/16	(11.0,	0.0,	0.0)
39	1.44E+02	@Hr24,09/07/16	(-11.0,	0.0,	0.0)
40	1.43E+02	@Hr16,17/01/16	(11.0,	0.0,	0.0)
41	1.42E+02	@Hr08,14/04/16	(-11.0,	0.0,	0.0)
42	1.42E+02	@Hr24,26/08/16	(11.0,	0.0,	0.0)
43	1.41E+02	@Hr24,15/04/16	(11.0,	0.0,	0.0)
44	1.41E+02	@Hr16,01/06/16	(0.0,	0.0,	0.0)
45	1.39E+02	@Hr16,31/07/16	(11.0,	0.0,	0.0)
46	1.38E+02	@Hr08,24/01/16	(-11.0,	0.0,	0.0)
47	1.37E+02	@Hr24,07/04/16	(11.0,	0.0,	0.0)
48	1.37E+02	@Hr16,04/08/16	(-11.0,	0.0,	0.0)
49	1.36E+02	@Hr16,20/03/16	(0.0,	0.0,	0.0)
50	1.36E+02	@Hr08,01/12/16	(-11.0,	0.0,	0.0)
51	1.36E+02	@Hr16,24/08/16	(11.0,	0.0,	0.0)
52	1.34E+02	@Hr24,19/04/16	(-11.0,	0.0,	0.0)
53	1.33E+02	@Hr16,19/07/16	(11.0,	0.0,	0.0)
54	1.32E+02	@Hr16,27/02/16	(11.0,	0.0,	0.0)
55	1.30E+02	@Hr24,25/08/16	(11.0,	0.0,	0.0)
56	1.29E+02	@Hr24,25/03/16	(11.0,	0.0,	0.0)
57	1.29E+02	@Hr16,21/02/16	(11.0,	0.0,	0.0)

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 58    1.28E+02  @Hr08,07/08/16  (   -11.0,      0.0,     0.0)
 59    1.28E+02  @Hr16,18/04/16  (    11.0,      0.0,     0.0)
 60    1.26E+02  @Hr08,06/08/16  (   -11.0,      0.0,     0.0)
 61    1.25E+02  @Hr16,14/03/16  (   -11.0,      0.0,     0.0)
 62    1.25E+02  @Hr16,31/03/16  (    11.0,      0.0,     0.0)
 63    1.23E+02  @Hr16,06/03/16  (    11.0,      0.0,     0.0)
 64    1.23E+02  @Hr08,07/12/16  (   -11.0,      0.0,     0.0)
 65    1.22E+02  @Hr08,20/07/16  (     0.0,      0.0,     0.0)
 66    1.21E+02  @Hr16,08/07/16  (    11.0,      0.0,     0.0)
 67    1.21E+02  @Hr08,10/11/16  (   -11.0,      0.0,     0.0)
 68    1.21E+02  @Hr16,29/11/16  (    11.0,      0.0,     0.0)
 69    1.20E+02  @Hr16,04/03/16  (    11.0,      0.0,     0.0)
 70    1.20E+02  @Hr16,24/02/16  (    11.0,      0.0,     0.0)
 71    1.20E+02  @Hr16,28/03/16  (    11.0,      0.0,     0.0)
 72    1.18E+02  @Hr24,18/06/16  (   -11.0,      0.0,     0.0)
 73    1.17E+02  @Hr24,14/04/16  (   -11.0,      0.0,     0.0)
 74    1.16E+02  @Hr08,04/03/16  (   -11.0,      0.0,     0.0)
 75    1.16E+02  @Hr16,14/04/16  (    11.0,      0.0,     0.0)
 76    1.16E+02  @Hr16,22/01/16  (   -11.0,      0.0,     0.0)
 77    1.16E+02  @Hr24,20/09/16  (   -11.0,      0.0,     0.0)
 78    1.16E+02  @Hr08,13/10/16  (   -11.0,      0.0,     0.0)
 79    1.16E+02  @Hr24,27/09/16  (    11.0,      0.0,     0.0)
 80    1.15E+02  @Hr16,16/03/16  (    11.0,      0.0,     0.0)
 81    1.15E+02  @Hr16,11/11/16  (     0.0,      0.0,     0.0)
 82    1.15E+02  @Hr16,10/11/16  (    11.0,      0.0,     0.0)
 83    1.15E+02  @Hr24,24/04/16  (   -11.0,      0.0,     0.0)
 84    1.15E+02  @Hr08,27/11/16  (     0.0,      0.0,     0.0)
 85    1.15E+02  @Hr24,22/04/16  (    11.0,      0.0,     0.0)
 86    1.14E+02  @Hr24,01/03/16  (    11.0,      0.0,     0.0)
 87    1.14E+02  @Hr16,06/02/16  (    11.0,      0.0,     0.0)
 88    1.13E+02  @Hr16,24/04/16  (    11.0,      0.0,     0.0)
 89    1.13E+02  @Hr16,09/02/16  (    11.0,      0.0,     0.0)
 90    1.13E+02  @Hr16,10/01/16  (    11.0,      0.0,     0.0)
 91    1.13E+02  @Hr24,14/10/16  (    11.0,      0.0,     0.0)
 92    1.12E+02  @Hr16,14/10/16  (    11.0,      0.0,     0.0)
 93    1.12E+02  @Hr16,13/04/16  (    11.0,      0.0,     0.0)
 94    1.12E+02  @Hr24,16/09/16  (    11.0,      0.0,     0.0)
 95    1.11E+02  @Hr24,22/01/16  (    11.0,      0.0,     0.0)
 96    1.11E+02  @Hr24,23/03/16  (    11.0,      0.0,     0.0)
 97    1.11E+02  @Hr08,20/03/16  (   -11.0,      0.0,     0.0)
 98    1.11E+02  @Hr24,17/01/16  (     0.0,      0.0,     0.0)
 99    1.09E+02  @Hr16,16/11/16  (    11.0,      0.0,     0.0)
100    1.09E+02  @Hr16,23/08/16  (    11.0,      0.0,     0.0)
```

Peak values for the 100 worst cases - in micrograms/m3
AVERAGING TIME = 24 HOURS

Rank	Value	Time Recorded hour,date	Coordinates		
1	1.39E+02	@Hr24,30/05/16	(11.0,	0.0,	0.0)
2	1.35E+02	@Hr24,24/08/16	(11.0,	0.0,	0.0)
3	1.24E+02	@Hr24,20/07/16	(11.0,	0.0,	0.0)
4	1.23E+02	@Hr24,07/08/16	(-11.0,	0.0,	0.0)
5	1.23E+02	@Hr24,02/06/16	(-11.0,	0.0,	0.0)
6	1.21E+02	@Hr24,31/07/16	(11.0,	0.0,	0.0)
7	1.19E+02	@Hr24,31/05/16	(-11.0,	0.0,	0.0)
8	1.16E+02	@Hr24,09/01/16	(-11.0,	0.0,	0.0)
9	1.14E+02	@Hr24,11/01/16	(11.0,	0.0,	0.0)
10	1.13E+02	@Hr24,19/07/16	(11.0,	0.0,	0.0)
11	1.11E+02	@Hr24,31/03/16	(11.0,	0.0,	0.0)
12	1.10E+02	@Hr24,24/02/16	(-11.0,	0.0,	0.0)
13	1.09E+02	@Hr24,09/07/16	(0.0,	0.0,	0.0)
14	1.08E+02	@Hr24,08/04/16	(11.0,	0.0,	0.0)
15	1.08E+02	@Hr24,14/04/16	(-11.0,	0.0,	0.0)
16	1.07E+02	@Hr24,16/07/16	(11.0,	0.0,	0.0)
17	1.05E+02	@Hr24,06/05/16	(11.0,	0.0,	0.0)
18	1.04E+02	@Hr24,24/03/16	(11.0,	0.0,	0.0)
19	1.04E+02	@Hr24,18/04/16	(11.0,	0.0,	0.0)
20	1.04E+02	@Hr24,06/08/16	(-11.0,	0.0,	0.0)
21	1.02E+02	@Hr24,29/10/16	(11.0,	0.0,	0.0)
22	1.01E+02	@Hr24,20/03/16	(-11.0,	0.0,	0.0)
23	1.01E+02	@Hr24,15/04/16	(11.0,	0.0,	0.0)
24	9.69E+01	@Hr24,30/03/16	(11.0,	0.0,	0.0)
25	9.68E+01	@Hr24,18/06/16	(-11.0,	0.0,	0.0)
26	9.52E+01	@Hr24,14/03/16	(-11.0,	0.0,	0.0)
27	9.50E+01	@Hr24,28/03/16	(-11.0,	0.0,	0.0)
28	9.48E+01	@Hr24,02/02/16	(-11.0,	0.0,	0.0)
29	9.44E+01	@Hr24,19/09/16	(11.0,	0.0,	0.0)
30	9.38E+01	@Hr24,26/08/16	(11.0,	0.0,	0.0)
31	9.28E+01	@Hr24,19/06/16	(-11.0,	0.0,	0.0)
32	9.26E+01	@Hr24,12/04/16	(11.0,	0.0,	0.0)
33	9.25E+01	@Hr24,01/06/16	(-11.0,	0.0,	0.0)
34	9.20E+01	@Hr24,17/01/16	(11.0,	0.0,	0.0)
35	9.11E+01	@Hr24,10/11/16	(-11.0,	0.0,	0.0)
36	9.06E+01	@Hr24,24/10/16	(11.0,	0.0,	0.0)
37	9.05E+01	@Hr24,24/04/16	(11.0,	0.0,	0.0)
38	9.01E+01	@Hr24,03/08/16	(11.0,	0.0,	0.0)
39	8.83E+01	@Hr24,07/05/16	(-11.0,	0.0,	0.0)
40	8.80E+01	@Hr24,04/04/16	(11.0,	0.0,	0.0)
41	8.76E+01	@Hr24,23/09/16	(11.0,	0.0,	0.0)
42	8.74E+01	@Hr24,01/03/16	(11.0,	0.0,	0.0)
43	8.71E+01	@Hr24,08/03/16	(0.0,	0.0,	0.0)
44	8.70E+01	@Hr24,23/03/16	(11.0,	0.0,	0.0)
45	8.68E+01	@Hr24,13/10/16	(-11.0,	0.0,	0.0)
46	8.61E+01	@Hr24,09/11/16	(-11.0,	0.0,	0.0)
47	8.55E+01	@Hr24,28/05/16	(11.0,	0.0,	0.0)
48	8.52E+01	@Hr24,27/02/16	(-11.0,	0.0,	0.0)
49	8.51E+01	@Hr24,19/04/16	(11.0,	0.0,	0.0)
50	8.50E+01	@Hr24,22/01/16	(-11.0,	0.0,	0.0)
51	8.49E+01	@Hr24,04/08/16	(-11.0,	0.0,	0.0)
52	8.48E+01	@Hr24,14/10/16	(11.0,	0.0,	0.0)
53	8.45E+01	@Hr24,27/11/16	(11.0,	0.0,	0.0)

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 54    8.36E+01  @Hr24,08/05/16  (   -11.0,       0.0,     0.0)
 55    8.28E+01  @Hr24,01/09/16  (    11.0,       0.0,     0.0)
 56    8.25E+01  @Hr24,25/03/16  (    11.0,       0.0,     0.0)
 57    8.20E+01  @Hr24,22/04/16  (    11.0,       0.0,     0.0)
 58    8.17E+01  @Hr24,11/11/16  (   -11.0,       0.0,     0.0)
 59    8.12E+01  @Hr24,07/12/16  (    11.0,       0.0,     0.0)
 60    8.11E+01  @Hr24,21/05/16  (   -11.0,       0.0,     0.0)
 61    8.07E+01  @Hr24,11/03/16  (    11.0,       0.0,     0.0)
 62    8.04E+01  @Hr24,24/01/16  (    11.0,       0.0,     0.0)
 63    8.03E+01  @Hr24,10/12/16  (    11.0,       0.0,     0.0)
 64    8.00E+01  @Hr24,07/09/16  (   -11.0,       0.0,     0.0)
 65    8.00E+01  @Hr24,31/01/16  (    11.0,       0.0,     0.0)
 66    7.94E+01  @Hr24,13/02/16  (    11.0,       0.0,     0.0)
 67    7.93E+01  @Hr24,01/12/16  (    11.0,       0.0,     0.0)
 68    7.93E+01  @Hr24,04/03/16  (   -11.0,       0.0,     0.0)
 69    7.92E+01  @Hr24,18/11/16  (    11.0,       0.0,     0.0)
 70    7.91E+01  @Hr24,27/05/16  (    11.0,       0.0,     0.0)
 71    7.82E+01  @Hr24,15/06/16  (    11.0,       0.0,     0.0)
 72    7.79E+01  @Hr24,07/07/16  (   -11.0,       0.0,     0.0)
 73    7.76E+01  @Hr24,12/01/16  (   -11.0,       0.0,     0.0)
 74    7.73E+01  @Hr24,07/04/16  (    11.0,       0.0,     0.0)
 75    7.71E+01  @Hr24,25/12/16  (    11.0,       0.0,     0.0)
 76    7.66E+01  @Hr24,17/06/16  (    11.0,       0.0,     0.0)
 77    7.66E+01  @Hr24,30/08/16  (   -11.0,       0.0,     0.0)
 78    7.64E+01  @Hr24,20/04/16  (   -11.0,       0.0,     0.0)
 79    7.62E+01  @Hr24,08/10/16  (   -11.0,       0.0,     0.0)
 80    7.61E+01  @Hr24,20/11/16  (   -11.0,       0.0,     0.0)
 81    7.59E+01  @Hr24,19/01/16  (    11.0,       0.0,     0.0)
 82    7.58E+01  @Hr24,10/03/16  (   -11.0,       0.0,     0.0)
 83    7.56E+01  @Hr24,22/02/16  (     0.0,       0.0,     0.0)
 84    7.54E+01  @Hr24,29/12/16  (    11.0,       0.0,     0.0)
 85    7.53E+01  @Hr24,06/07/16  (    11.0,       0.0,     0.0)
 86    7.53E+01  @Hr24,27/03/16  (   -11.0,       0.0,     0.0)
 87    7.52E+01  @Hr24,19/11/16  (     0.0,       0.0,     0.0)
 88    7.50E+01  @Hr24,07/02/16  (    11.0,       0.0,     0.0)
 89    7.49E+01  @Hr24,28/04/16  (    11.0,       0.0,     0.0)
 90    7.48E+01  @Hr24,16/11/16  (    11.0,       0.0,     0.0)
 91    7.46E+01  @Hr24,22/12/16  (   -11.0,       0.0,     0.0)
 92    7.45E+01  @Hr24,05/03/16  (   -11.0,       0.0,     0.0)
 93    7.45E+01  @Hr24,02/03/16  (    11.0,       0.0,     0.0)
 94    7.44E+01  @Hr24,10/02/16  (   -11.0,       0.0,     0.0)
 95    7.39E+01  @Hr24,16/04/16  (    11.0,       0.0,     0.0)
 96    7.37E+01  @Hr24,02/09/16  (   -11.0,       0.0,     0.0)
 97    7.35E+01  @Hr24,22/08/16  (    11.0,       0.0,     0.0)
 98    7.33E+01  @Hr24,23/10/16  (   -11.0,       0.0,     0.0)
 99    7.31E+01  @Hr24,03/03/16  (   -11.0,       0.0,     0.0)
100    7.29E+01  @Hr24,29/08/16  (   -11.0,       0.0,     0.0)
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Sorted 1-Hour CO Data for Various Percentiles

Mordialloc Bypass
Section C

Dist	Max	2nd	99.9%	99.8%	99.5%	99.0%	98.0%	95.0%	90.0%
200	41	41	34	27	21	15	11	8.20	6.63
150	53	52	44	37	29	21	15	11.02	8.93
130	59	58	51	44	32	25	17	12.68	10.29
110	67	65	57	51	37	29	21	14.91	11.95
100	72	70	62	56	41	32	23	16.27	12.96
90	77	76	68	61	44	35	25	17.84	14.23
80	84	83	74	68	48	39	28	19.87	15.80
70	93	92	82	75	55	44	31	22.16	17.84
60	104	104	93	84	64	50	36	25.22	20.36
50	121	118	105	97	73	57	42	29.17	23.78
40	150	140	123	115	86	68	49	34.80	28.17
30	213	168	150	141	106	85	61	43.15	34.64
20	304	215	198	181	140	111	82	57.55	45.59
10	488	324	302	270	215	175	128	88.93	69.91
-10	424	360	327	287	211	163	112	76.97	58.58
-20	284	244	212	192	137	101	71	49.94	37.43
-30	223	193	165	144	103	75	52	37.52	27.89
-40	185	163	135	117	81	60	42	30.05	22.04
-50	159	140	112	95	67	50	35	25.24	18.13
-60	141	124	98	84	56	43	29	21.57	15.33
-70	126	109	87	73	49	38	26	18.75	13.04
-80	113	96	77	64	45	33	23	16.57	11.17
-90	101	82	70	57	41	30	21	14.77	9.75
-100	89	73	64	53	37	27	19	13.22	8.63
-110	77	68	57	49	35	24	17	12.09	7.66
-130	60	58	50	42	30	20	14	10.14	6.21
-150	54	51	43	35	25	17	12	8.53	4.95
-200	43	40	33	26	18	12	9	5.88	3.13