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EDITHVALE AND BONBEACH LEVEL CROSSING REMOVAL PROJECTS

ENVIRONMENT EFFECTS STATEMENT

EES TECHNICAL REPORT I
Air Quality Impact Assessment

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Executive summary

The Victorian Government is removing 50 of Melbourne's most dangerous and congested level crossings. The Edithvale Road, Edithvale and Station Street/Bondi Road, Bonbeach level crossing removal projects were referred to the Minister for Planning who decided an Environment Effects Statement (EES) was required.

This report assesses potential impacts to air quality resulting from construction activity (dust and vehicle emissions), rail operations (combustion emissions from diesel freight trains), and changed traffic movements as a result of removing the level crossings.

Air quality context

An air quality impact assessment has been undertaken for the Edithvale Road, Edithvale (Edithvale) and Station Street/Bondi Road, Bonbeach (Bonbeach) level crossing removal projects.

The Edithvale and Bonbeach level crossing removal projects are located along the Frankston railway line and are within the Port Phillip airshed.

There are approximately 240 train movements per day on the Frankston line, the majority of which are electric and do not result in air emissions. There are up to six diesel freight train movements on weekdays and up to four movements on weekends, and two diesel powered V/Line train (Sprinter) movements on a single weekday (twin cars rotated between Frankston stabling and the Melbourne maintenance yard).

Method

State and Commonwealth legislation prescribe design criteria and intervention levels for particular pollutants to ensure that the beneficial uses of the environment are protected. The beneficial uses to be protected include:

- human health and well-being
- health and well-being of other forms of life including the protection of ecosystems and biodiversity
- visibility
- useful life and the aesthetic appearance of buildings, structures, property and materials
- local amenity and aesthetic enjoyment.

The nearest sensitive receptors to the Edithvale and Bonbeach project areas are residents located along Nepean Highway and Station Street.

This assessment considers the air quality impacts resulting from both the construction and the operation of the projects.

Construction emissions include dust and vehicle combustion. The three major concerns from the construction phase concerning off-site dust impacts are:

- material transfer
- vehicle movement on unconsolidated surfaces
- wind erosion from exposed surfaces and stockpiles.

Construction dust impacts have been addressed qualitatively by identifying the management and mitigation measures capable of controlling impacts to an acceptable level that are consistent with air quality management policy. Reactive management measures and a monitoring program are incorporated into the environmental performance requirements to minimise off-site impacts.

Operational emissions are already present with the existing operation of the rail corridor which are mixed with ambient concentrations of air pollutants from local traffic and regional sources. The rail corridor contributes emissions of diesel engine trains on the Frankston line in the vicinity of the Edithvale and Bonbeach level crossing removal projects. Combustion emissions from freight trains include the key air quality indicators of carbon monoxide, sulphur dioxide, nitrogen dioxide, particulates, benzene and polycyclic aromatic hydrocarbons. The change of rail height (from at-grade to within a rail trench) may alter the dispersion pattern of these pollutants. The change in ground level concentrations at sensitive receptor locations needs to be assessed so that the proposed design does not result in excessive air pollutants that would adversely affect the beneficial uses of the environment. The changed emission profile of diesel train emissions through the projects and changed traffic conditions are assessed as having minimal change on concentration levels. Changes in air quality levels are minimal compared to existing background levels and negligible compared to intervention levels. Traffic emissions are expected to decrease over time due to State environment protection policy (Air Quality Management) incentives.

To estimate the change to ground level concentrations at nearby sensitive receptors, AUSROADS modelling was conducted for the existing at-grade rail infrastructure and the proposed rail trenches at Edithvale and Bonbeach. AUSROADS is a simple line source Gaussian plume dispersion model developed by Environment Protection Authority Victoria (EPA Victoria) and is based on the United States CALINE model developed by the California Department of Transportation. It predicts the transport corridor impact of vehicle emissions (in whatever form – car, truck, bus, train) in relatively uncomplicated terrain by employing a mixing zone concept to characterise contaminant dispersion over a roadway.

Existing conditions

The existing air quality at and around the Edithvale and Bonbeach project areas is typical of the Melbourne metropolitan air environment. The project areas are on the interface between the urbanised metropolitan area and the generally pollutant source-free Port Phillip Bay. Being close to the Bay, the project areas are subject to weather conditions that influence the dispersal of particulates pollutants in the air more readily, resulting in enhanced dispersion conditions. Ambient air quality levels are measured at EPA Victoria Air Quality Monitoring Stations, with the two closest and most indicative at Brighton and Dandenong. The measured ambient air quality indicators at these locations, and therefore by extrapolation at Edithvale and Bonbeach, are considered to be ‘good’.

Impact assessment

A qualitative assessment of construction air emission pathways and impacts has been undertaken. Even though the construction site would be less than five hectares, construction activities would adopt the management and mitigation measures as a major site as per EPA Victoria’s *Environmental Guidelines for Major Construction Sites.*

Construction dust due to civil works has the potential to elevate particulate matter levels in areas local to the EES project area.

Construction impacts related to dust impacts off-site can be controlled by recommendations identified within the *Environmental Guidelines for Major Construction Sites* (EPA Victoria, 1996). This guideline recommends that preventative measures are used in preference to applying dust suppression measures. In addition to these measures, other measures available for the control of dust generation would ensue from a specific Environmental Performance Requirement developed for the project to control construction dust impacts within acceptable policy standards and goals.

The use of an Environmental Management Framework for management strategies that would be documented in the project's Construction Environmental Management Plan would ensure the residual risk is acceptable by considering potential emissions from dust, combustion emissions, odours and air quality implications due to changes in traffic.

For operational impacts, the air modelling predicts that for all modelled pollutants, pollutant concentrations are predicted to be much lower than background concentrations and significantly lower than the air quality criterion at all sensitive receptors to the point of negligibility.

At the nearest sensitive receptor locations along Nepean Highway and Station Street, the differences between the calculated concentrations due to the existing at-grade infrastructure and the level crossing removal is predicted to be minimal. The level crossing removal would result in very similar concentrations of all pollutants at the nearest sensitive receptors compared to the existing infrastructure.

Overall, air quality emissions resulting from the existing at-grade rail infrastructure and the level crossing removal projects are well below design and intervention limits. Therefore, measures to avoid, minimise and manage impacts to air quality are not required.

Environmental Performance Requirements

The following Environmental Performance Requirements are recommended for the Edithvale and Bonbeach level crossing removal projects:

EPR ID	Environmental Performance Requirement	Stage
AQ1	**Air Quality (construction)** Manage construction activities to minimise dust, odour and other emissions in accordance with EPA Publication 480 *Environmental Guidelines for Major Construction Sites.*	Construction
AQ2	**Air Quality management** Control the emission of smoke, dust, fumes and other pollution into the atmosphere during construction and operation in accordance with the State Environment Protection Policy Air Quality Management and State Environment Protection Policy Ambient Air Quality.	Construction
CL2	**Acid Sulfate Soil Management Plan** Prepare and implement an Acid Sulfate Soil Management Plan prior to construction of the project to the satisfaction of the EPA in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999, EPA Publication 655.1 Acid Sulfate Soil and Rock, and relevant EPA regulations, standards and best practice guidance in consultation with the EPA. This plan will include: a) identify locations and extent of potential acid sulfate soils. b) assess potential impact for human health, odour and environment c) identify and implement measures to prevent oxidation of acid sulfate soils wherever possible d) dentify suitable sites for management, reuse or disposal of acid sulfate soils.	Construction

EPR ID	Environmental Performance Requirement	Stage
CL3	**Waste management** Manage wastes during the construction of the projects through development and implementation of a Construction Environmental Management Plan in accordance with the EPA Publication 480 Environmental Guidelines for Major Construction Sites, EPA Publication 347.1 Bunding, Australian Standard AS1940 Storage and Handling of Flammable and Combustible Liquids, and relevant EPA and Victorian WorkCover Authority regulations, standards and best practice guidance that includes: a) application of the waste management hierarchy in assessing waste management options b) contamination and waste management requirements (e.g. use of waste and recycling facilities, maintenance of a clean site policy) c) designated vehicle refuelling area d) chemical management procedures, such as minimising use and storage of chemicals on site, bunded storage facilities to ensure spills, washing residues, slurries or other contaminated water can be contained, and are managed/disposed of appropriately e) location and type of spill kits required f) staff training and competence requirements g) use of well-maintained plant to minimise the potential for spills to occur h) procedures to remove, treat and/or dispose soil that becomes contaminated due to a fuel or chemical spill i) storage of litter in bins from which it cannot escape (temporary fencing may be used as a secondary containment measure for litter).	Construction

Abbreviations

Term	Definition
AAQ	Ambient air quality
AQM	Air quality management
CASS	Coastal Acid Sulfate Soils
CEMP	Construction Environmental Management Plan
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DMU	Diesel multiple units
EPA Victoria	Environment Protection Authority Victoria
IL	Intervention level
JV	AECOM-GHD Joint Venture
LXRA	Level Crossing Removal Authority
m	Metres
m^3	Cubic metres
NEPM	National Environment Protection Measure
NEPM-AAQ	National Environment Protection Measure (Ambient Air Quality)
NO_2	Nitrogen dioxide
NOx	Oxides of nitrogen
NPI	National Pollutant Inventory
PAH	Polycyclic aromatic hydrocarbons
PM	Particulate matter
$PM_{2.5}$	Particulate matter 2.5 micrometres or less in diameter
PM_{10}	Particulate matter 10 micrometres or less in diameter
ppm	Parts per million
SEPP	State Environment Protection Policy
SEPP-AAQ	State environment protection policy (Ambient Air Quality)
SEPP-AQM	State environment protection policy (Air Quality Management)
SO_2	Sulphur dioxide
SOx	Oxides of sulphur
TEOM	Tapered Element Oscillating Microbalance
US	United States
$\mu g/m^3$	Micrograms per cubic metre

Glossary

Term	Definition
At-grade	A transport corridor, especially at an intersection, where the various corridors are at the same level/height
Dn	Down – train travel away from Melbourne/Flinders Street Station
Up	Up – train travel toward Melbourne/Flinders Street Station

1 Introduction

1.1 Purpose

The Victorian Government is removing 50 of Melbourne's most dangerous and congested level crossings, including the level crossings at Edithvale Road, Edithvale (Edithvale) and Station Street/Bondi Road, Bonbeach (Bonbeach).

The level crossing removal projects have three core objectives. To provide:

- improved productivity from more reliable and efficient transport networks
- better connected, liveable and thriving communities
- safer communities.

The Edithvale and Bonbeach level crossing removal projects were referred to the Minister for Planning on 9 March 2017. On 5 April 2017, the Minister issued a decision determining that an Environment Effects Statement (EES) is required for the projects due to the potential for a range of significant environmental effects.

The purpose of this report is to assess and address the air quality impacts resulting from construction (dust and vehicle emissions) and operation (combustion emissions from diesel freight trains) and changed traffic movements as a result of removing the level crossings.

1.2 Why understanding air quality is important

State and Commonwealth legislation prescribe air quality criteria for particular pollutants to ensure that the beneficial uses of the air environment are protected. The beneficial uses to be protected include:

- human health and well-being
- health and well-being of other forms of life including the protection of ecosystems and biodiversity
- visibility
- useful life and the aesthetic appearance of buildings, structures, property and materials
- local amenity and aesthetic enjoyment.

1.3 Project description

1.3.1 Overview

Edithvale

The Level Crossing Removal Authority (LXRA) proposes to remove the level crossing by lowering the Frankston railway line into a trench under Edithvale Road while maintaining Edithvale Road at the current road level. The trench would be located between Lochiel Avenue and Berry Avenue. It would be up to 1,300 metres in length and 14 metres wide at its narrowest point, widening to up to 24 metres (including pile widths) at the new Edithvale station platforms.

The rail track would be approximately eight metres below ground level, and sit above the trench base slab and infrastructure to collect and divert rain water from the trench. The maximum depth of the excavation would be 15 metres. Pile depths would be a maximum of 24 metres at the deepest point of the trench.

Barriers, fencing and screening would be erected along the trench at road level to prevent unauthorised access by vehicles or people. Decking above the rail trench would provide for the new station building, car parking and a new substation required to ensure sufficient power is available for passenger services on the Frankston railway line. New pedestrian bridges would be constructed to retain pedestrian access across the railway line. A new station is to be constructed with lift, ramp and stair access to the below-ground train platforms.

Bonbeach

LXRA proposes to remove the level crossing by lowering the Frankston railway line into a trench under Bondi Road while maintaining Bondi Road at the current road level. The trench would be located between Golden Avenue and The Glade. It would be up to 1,200 metres in length and 14 metres wide at its narrowest point, widening to up to 24 metres (including pile widths) at the new Bonbeach station platforms.

The rail track would be approximately eight metres below ground level, and sit above the trench base slab and infrastructure to collect and divert rain water from the trench. The maximum depth of the excavation would be 15 metres. Pile depths would be a maximum of 24 metres at the deepest point of the trench.

Barriers, fencing and screening would be erected along the trench at road level to prevent access by vehicles or people. Decking above the rail trench would provide for the new station building and car parking. New pedestrian bridges would be constructed to retain pedestrian access across the railway line. A new station building would be constructed with lift, ramp and stair access to the below-ground train platforms.

1.3.2 Construction

The key construction activities for the Edithvale and Bonbeach level crossing removal projects include:

- site establishment including:
  - clearing of vegetation and ground levelling
  - establishment of site fencing, staff facilities and temporary construction areas
- protection and/or relocation of utility services
- excavation for piling, foundations and the rail trench
- on site waste management including removal, management and appropriate disposal of excavated soil, rock, stormwater and groundwater
- transport of spoil, excavated material and groundwater offsite
- demolition of existing stations and removal of existing rail and road infrastructure
- construction of bridge/deck structures to support Edithvale Road and Station Street/Bondi Road where they cross the railway line
- construction of base slab and waterproofing, including stormwater tanks
- construction of new station infrastructure including platforms and buildings
- construction of pedestrian overpasses and decking over the rail trench
- installation and commissioning of new rail infrastructure including ballast, overhead line equipment and rail.

In preparation for the main rail occupation, the existing Edithvale and Bonbeach train stations would be closed approximately four weeks in advance. Both projects would be constructed concurrently under the same rail closure which is anticipated to take six weeks.

During the closure of the rail corridor, construction activities would occur 24 hours per day, seven days per week. Additional periodic road closures and lane closures would be required and access along adjacent streets could be restricted. Additional weekend rail shutdowns would likely be required prior to and after the main rail occupation. Construction is expected to be completed within an 18 month period.

1.3.3 Operations and maintenance

Following the construction of the Edithvale and Bonbeach level crossing removal projects, the key operation and maintenance phase activities would include:

- operation – monitoring, controlling and operation of the asset in accordance with the rail and road network requirements
- maintenance – routine inspection and monitoring of the condition of the asset, planned routine maintenance and refurbishment work, and unplanned intervention and repair of the asset.

Operation and maintenance activities would be consistent with existing practices and subject to the evolving operational demands of the road and rail networks.

1.3.4 Air quality considerations in the design

There are approximately 240 train movements per day on the Frankston line, the majority of which are electric and do not result in air emissions. There are up to six diesel freight train movements on weekdays and up to four movements on weekends, and two diesel powered V/Line trains (Sprinter) movements on a single weekday (empty twin cars rotated between Frankston stabling and the Melbourne maintenance yard during a Thursday evening). The change of rail height (from at-grade to a rail trench) would slightly alter the dispersion pattern of the pollutants. The change in ground level concentrations at sensitive receptor locations needs to be assessed so that the proposed design does not result in excessive air pollutants that would adversely affect the beneficial uses of the environment.

Traffic volumes were surveyed at Edithvale and Bonbeach (refer to EES Technical Report G *Traffic)*, and the results are presented in Table 1. Changes to traffic conditions as a result of the removal of the level crossings are a consideration for air quality due to traffic emissions.

Table 1 Nepean Highway, Station Street and Edithvale Road - vehicle survey volumes

Intersection approach	Total surveyed vehicle volumes 6:00 am to 7:00 pm	Peak vehicle hourly volumes	
Nepean Highway (north)	9,675	1469	5:00 pm to 6:00 pm
Nepean Highway (south)	9,062	1384	7:30 am to 8:30 am
Station Street (north)	5,833	717	4:00 pm to 5:00 pm
Station Street (south)	4,694	667	7:30 am to 8:30 am
Edithvale Road	3,391	356	5:00 pm to 6:00 pm

1.4 Project area

1.4.1 Edithvale

The Edithvale Road, Edithvale level crossing project investigation area (Edithvale project area) extends from Lincoln Parade, Aspendale to Chelsea Road, Chelsea. It includes the rail corridor and all of Station Street and Nepean Highway to the east and west of the rail corridor, and small sections of adjacent road reserves. Refer to Figure 1.

1.4.2 Bonbeach

The Station Street/Bondi Road, Bonbeach level crossing removal project area (Bonbeach project area) extends from Chelsea Road, Chelsea to Patterson River, Bonbeach. It includes the rail corridor and all of Station Street and Nepean Highway located to the east and west of the rail corridor, and small sections of adjacent road reserves. Refer to Figure 2.

1.4.3 Temporary construction laydown areas

Specific construction areas have not been identified at this time. Temporary construction areas would be used for site offices, storing materials, plant and equipment, parking for construction works and construction traffic standby.

Figure 1 Edithvale project area

Figure 2 Bonbeach project area

2 Scoping Requirements

In order to meet statutory requirements, protect environmental values and sustain stakeholder confidence, the EES would include an Environmental Management Framework (EMF). The EMF would provide a transparent framework with clear accountabilities for managing and monitoring environmental effects and hazards associated with the construction and operational phases of the projects.

Section 3.5 of the Scoping Requirements (issued September 2017), states 'Environmental Performance Requirements (EPRs) should be clearly described in the EMF'. The proposed objectives, indicators and monitoring requirements' to be described that are relevant to this study are:

- emissions to air - particularly with respect to managing impacts on amenity both during construction and operation.

3 Legislation, policy and guidelines

Table 2 summarises the relevant primary legislation that applies to the Edithvale and Bonbeach level crossing removal projects as well as the implications, required approvals.

Table 2 Primary legislation and associated information

Legislation/policy	Key policies/strategies	Implications for this project	Approvals required
Commonwealth			
National Environment Protection Council Act 1994	National Environment Protection Measure (Ambient Air Quality)	Standards and goals set to achieve equivalent population exposure that protects the beneficial uses of the air environment.	N/A
State			
Environment Protection Act 1970	State environment protection policy (Ambient Air Quality) (SEPP AAQ) State environment protection policy (Air Quality Management) (SEPP AQM) Protocol for Environmental Management (PEM): Mining and Extractive Industries (EPA Victoria, 2007)	Provides design criteria and intervention levels for the assessment of impacts associated with emissions to air. Sets the Intervention Levels for which monitoring data can be assessed as protecting the beneficial uses of the air environment.	No approval is required, however, compliance with the SEPP (AQM) is required, which is given effect under the *Environment Protection Act 1970*
Environment Protection Act 1970	Environmental Guidelines for Major Construction Sites – Publication 480 (EPA Victoria, 1996).	Guideline recommends a dust prevention strategy be developed at the project planning stage and outlines a range of dust control and suppression measures.	No approval is required, however the Guidelines are given effect under the *Environment Protection Act 1970*
Planning and Environment Act 1987	All Planning Schemes. Clause 13.04-2 provides for air quality, with the objective of assisting the protection and improvement of air quality.	Strategies to assist are: Ensuring that land-use planning and transport infrastructure provision contribute to improved air quality by: Integrating transport and land-use planning to improve transport accessibility and connections Providing infrastructure for public transport, walking and cycling Ensure, wherever possible, that there is suitable separation between land uses that reduce amenity and sensitive land uses. Planning must consider the State environment protection policy - SEPP AQM.	N/A

3.1 Air quality criteria

State and Commonwealth legislation prescribe design criteria and intervention levels for particular pollutants to ensure that the beneficial uses of the environment are protected. The beneficial uses to be protected include:

- human health and well-being
- health and well-being of other forms of life including the protection of ecosystems and biodiversity
- visibility
- useful life and the aesthetic appearance of buildings, structures, property and materials
- local amenity and aesthetic enjoyment.

For the purposes of this assessment, dust emissions from construction would be required to meet the Mining PEM levels as detailed in Table 3 below, while operational emissions from ground level line or area sources (such as the existing at-grade rail lines or rail trench) are assessable against the intervention levels detailed in Schedule B of the SEPP AQM (Table 4 provided below). Construction dust expected from the projects can be considered equivalent to a large area source such as that emitted by a mining or extractive industry. EPA Victoria Publication 1191 Protocol for Environmental Management (PEM) *Mining and Extractive Industries* (EPA Victoria, 2007) uses the argument that the assessment criteria applicable for the mining and extractive industries are developed based on the protection of human health and for particulate matter the indicators reflect the intervention levels in SEPP AQM. Operational emissions are not required to be assessed against Schedule A of SEPP AQM as the project is not a scheduled premises and in the case of particulate matter are not from a point source.

Existing background concentrations of pollutants must be considered where appropriate and adequate data exist. In the case of design criteria or intervention levels with averaging times of 24 hours, daily-varying 24-hour average background concentration data are to be used as specified in SEPP AQM. In instances where the averaging period is one hour or less, a fixed 70^{th} percentile hourly average concentration is to be used (SEPP AQM. Schedule C, Part B, Clause 3 (b)).

Table 3 Mining PEM levels of relevance to construction dust

Pollutant	Class	Reason for classification	Mining PEM level	Averaging period	Background concentration
Particulate matter 10 micrometres or less in diameter (PM_{10})	1	Toxicity	60 µg/m³	24-hour	Daily varying 24-hour average.
Particulate matter 2.5 micrometres or less in diameter ($PM_{2.5}$)	2	Toxicity	36 µg/m³	24-hour	Daily varying 24-hour average.
Deposited dust	Unclassified	Amenity (nuisance)	4 g/m²/ month	Monthly average	No more than 2 g/m²/month above background

Note: Deposited dust is an indicator of the effectiveness of site management practices and the potential for off-site "nuisance". Mining PEM (EPA Victoria , 2007, p.12)

Table 4 SEPP AQM intervention levels of relevance to diesel train emissions

Pollutant	Class	Reason for classification	Intervention level (µg/m^3)	Averaging period	Background concentration
Carbon monoxide (CO)	1	Toxicity	33,210	1-hour	70th percentile
Sulphur dioxide (SO_2)	1	Toxicity	550	1-hour	70th percentile
Nitrogen dioxide (NO_2)	1	Toxicity	263	1-hour	70th percentile
Particulate matter 10 micrometres or less in diameter (PM_{10})	1	Toxicity	60	24-hour	Daily varying 24-hour average.
Particulate matter 2.5 micrometres or less in diameter ($PM_{2.5}$)	2	Toxicity	36	24-hour	Daily varying 24-hour average.
Benzene	3	IARC Group 1 carcinogen	75	1-hour	No hourly data supplied
Polycyclic aromatic hydrocarbons (PAH)	3	IARC Group 2A carcinogen	0.5	1-hour	No hourly data supplied[5]

Note: Class 1 – substances which are widely distributed in the regional air environment, Class 2 – substances that are considered hazardous and may threaten the beneficial uses of the air environment by virtue of its toxicity or odorous properties, Class 3 – substances that are considered extremely hazardous due to their carcinogenic, mutagenic, teratogenic, highly toxic or highly persistent characteristics. Intervention level values for NO_2, CO and SO_2 converted from parts per million (as presented in Schedule B of the SEPP AQM), to micrograms per cubic meter. Conversion made based on standard temperature and pressure: 25 degrees Celsius at 101,325 Pascals. Background concentrations where no hourly data is supplied: the modelled increments and background are both low compared to the assessment criteria and therefore 'not significant' SEPP AQM, Schedule C, Part B, Clause 3 (a).
These will not be critically constraining constituents for the purposes of this assessment. See Table 4 in Section 3.1.

4 Method

This section describes the method that was used to assess the potential impacts of the Edithvale and Bonbeach level crossing removal projects.

A systematic risk based approach was applied to understand the existing environment, potential impacts of the projects and how to avoid, minimise or manage the risk of impact.

The iterative nature of the assessment is illustrated in Figure 3.

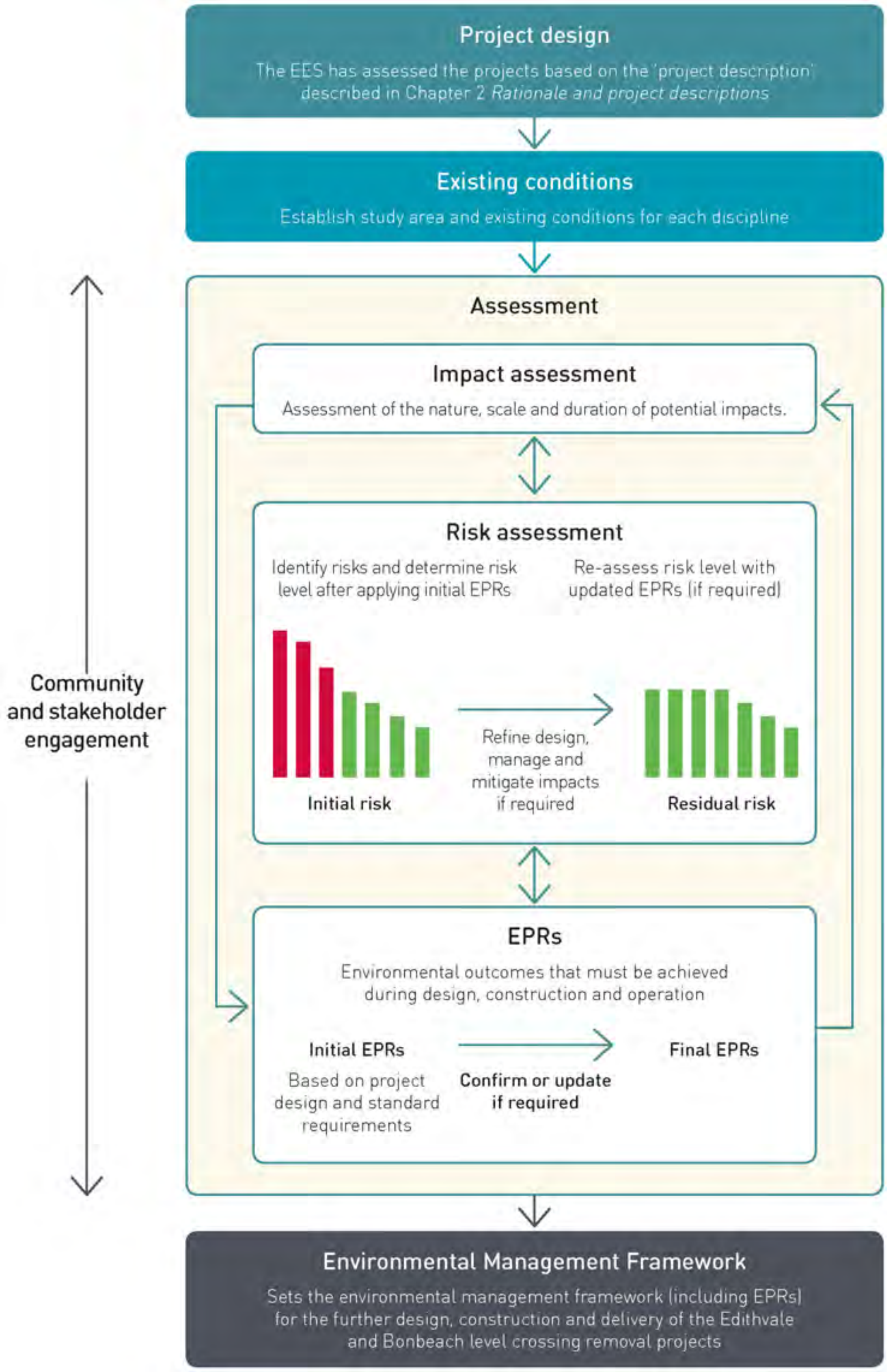

Figure 3 Overview of assessment process

The following sections outline the methodology for the air quality impact assessment.

4.1 Existing conditions assessment

The existing air environment is characterised by the concentrations of substances in the ambient air and the local meteorology. Ambient air quality from the EPA Victoria ambient air quality monitoring network and meteorological data from the Bureau of Meteorology Moorabbin Airport station were reviewed in order to gain an understanding of the existing conditions.

Meteorology conditions as recorded at Moorabbin Airport are considered to be site-representative of bayside conditions on the eastern shore of Port Phillip north of Frankston, while ambient air quality (background) levels at Edithvale and Bonbeach are considered to be no higher than the levels recorded at either Dandenong or Brighton. The project area is on the edge of Greater Melbourne with a large area of relatively low-emission sources to the west (Port Phillip). EPA Victoria and CSIRO produced a report on future air quality in Victoria with a final version published in 2013 (EPA Victoria, 2013). Annual average $PM_{2.5}$ can be considered a tracer for ambient air quality impact across a wide metropolitan area such as Greater Melbourne. Predictions for 2030 in the future air quality report (EPA Victoria, 2013, p.23) are reproduced in Figure 4. The Project area is in a lighter shade of green than both Dandenong and Brighton.

The approaches outlined below for modelling air quality impacts associated with the proposed level crossing removals at Edithvale and Bonbeach were discussed with EPA Victoria in November 2016.

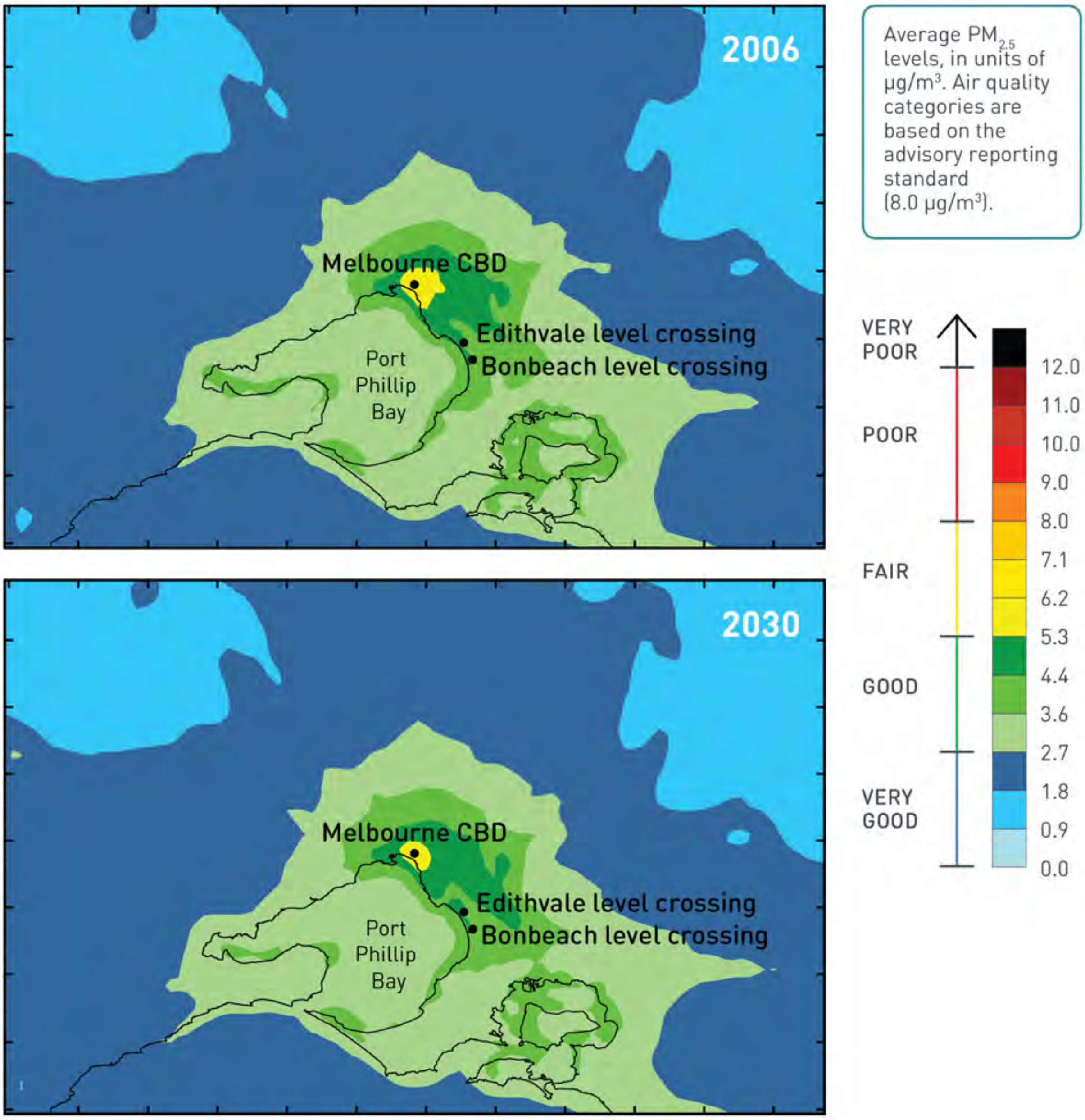

Figure 4 EPA Victoria (2013) predicted 10-year average fine particle ($PM_{2.5}$) levels

4.2 Risk assessment method

A risk-based approach is integral to the EES as required by Section 3 of the Scoping Requirements for the EES.

The risk management approach adopted for the Edithvale and Bonbeach EES is consistent with AS/NZS ISO 31000:2009 Risk Management Process and involves the following steps:

- establishment of the context of the risk assessment – this identifies the boundaries of the projects including the project definition, the duration of construction and operation, the design and environmental controls that would be in place (initial Environmental Performance Requirements (EPRs) – refer to Section 8), and the location of the projects
- risk identification – identification of risk pathways by specialists in each relevant discipline area
- risk analysis – assessment of risk for each risk pathway, whereby risk is a combination of:
  - the likelihood of an event and its associated consequences occurring
  - the magnitude of potential consequences of the event.
- risk evaluation – review key risks posed by the projects to focus effort in terms of impact assessment and mitigation.
- risk treatment – identification of additional management and mitigation where required to reduce risk levels where possible.

An initial risk assessment was undertaken to assess potential risks to the environment arising from the implementation of the projects. Where risks were minor or above, further mitigation was explored. Risks were re-assessed to determine the residual risk based on further mitigation.

A more detailed description of each step in the risk assessment process is provided in EES Attachment II *Environmental Risk Report*.

This technical report describes the risks associated with the projects on air quality.

4.3 Impact assessment methods

4.3.1 Construction

Potential dust and other air emissions, including odour, from construction activities and construction equipment are expected to be able to be successfully managed using standard construction management techniques and EPRs that would form part of the EMF. Hence these impacts have been assessed qualitatively by consideration of industry standard practice inclusive of guidance material from EPA Victoria governing the control measures and monitoring of construction related activity.

4.3.2 Operation

The operation of cars and trucks on the local roads produces air emissions from the combustion of fuel. After the Edithvale and Bonbeach level crossings are removed and the signalised intersections operate independently of train movements, and traffic movements in the local area can be expected to change slightly. The emission rate is a function of vehicle type, speed (in particular acceleration) and distance travelled, and vehicle speed is the only parameter that would vary after the projects. At times when congestion is reduced (such as after the level crossings are removed), vehicular emissions in the vicinity of the level crossings could be expected to reduce slightly as the average vehicle speed increases slightly, resulting in improved air quality (see Appendix C). The quantum of this change would be very low compared to ambient levels and expected lower fleet emissions over time. Air quality as a result of changed traffic conditions would be highly unlikely to breach the levels set by SEPP AAQ so the risk of impact to air quality from car and truck emissions has not been modelled in detail and is considered to be negligible.

The impact assessment considers the air quality impacts resulting from emissions of diesel engine trains on the Frankston line in the vicinity of the Edithvale and Bonbeach level crossing removal projects as there are no emissions from passenger trains. Key combustion emissions from freight trains include carbon monoxide, sulphur dioxide, nitrogen dioxide, particulates, benzene and polycyclic aromatic hydrocarbons.

Operational impacts are estimated from the number, type and time of transit of diesel locomotives using the Metro Trains Melbourne network and timetable, and assumes that the current diesel train fleet uses all available timetable slots.

AUSROADS modelling was conducted for the existing at-grade rail infrastructure and the proposed rail trenches at Edithvale and Bonbeach. AUSROADS is a simple line source Gaussian plume dispersion model developed by EPA Victoria and is based on the United States CALINE model developed by the California Department of Transportation. It predicts the transport corridor impact of vehicle emissions (in whatever form – car, truck, bus, train) in relatively uncomplicated terrain by employing a mixing zone concept to characterise contaminant dispersion over a roadway or transport corridor. This model was selected as it was developed by EPA Victoria for the purposes of air quality assessment for transport infrastructure.

For Edithvale, AUSROADS modelling was conducted for the existing infrastructure as well as the proposed trench to understand the potential air quality effects of the projects. In the model, a 'link type' of 'depressed' trench was used to model the rail trench.

The existing scenario model comprised a single straight-line separate link to account for the rail alignment of both Up and Down tracks not being a straight line. At Edithvale, the total length of both the up and down 'links' was 1300 metres from about Lochiel Avenue in the north to near Berry Avenue in the south. At Bonbeach, the total length of the joined 'links' was 1,430(1,200) metres from about Golden Avenue in the north to near The Glade in the south. The average length of the links was 205 metres ranging from 66 metres to 390 metres. In both instances, the model has assumed a slightly longer trench to provide a conservative assessment in relation to the description provided in EES Chapter 2 *Rationale and descriptions*.

At Edithvale, the rail trench model consisted of 19 'depressed'/trench links (over the same 1,300 metres chainage as the existing scenario model). The average length of the links was therefore 70 metres. A total of 490 metres was at a depth of at least six metres with the deepest section of eight metres under the Edithvale Road deck at the southern end of the station. This is also conservatively consistent with the description provided in EES Chapter 2 *Rationale and project descriptions*.

At Bonbeach, the at-grade model comprised seven separate links to account for the rail alignment of both Up and Down tracks not being a straight line. The total length of the joined 'Links' was 1,430 metres from about Glenola Road in the north to near Mernda Avenue in the south. The average length of the links was 205 metres ranging from 66 metres to 390 metres. The model has assumed a slightly longer trench to provide a conservative assessment.

The model consisted of 19 'depressed'/trench links (over a similar 1,411 metres chainage as the at-grade model) based on the design described in EES Chapter 2 *Rationale and project descriptions*. The average length of the links was 75 metres ranging from 40 to 230 metres. A total of 480 metres was at a depth of at least six metres with the deepest section of eight metres under the Bondi Road 'deck' at the southern end of the new station.

4.4 Environmental Performance Requirements

The environmental outcomes that must be achieved during design, construction and operation of the projects are referred to throughout the EES as Environmental Performance Requirements (EPRs). EPRs must be achieved regardless of the construction methodology or design solutions adopted. Measures identified in this EES to avoid or minimise environmental impacts have formed part of the recommended EPRs for the projects.

The development of a final set of EPRs for the project has been iterative.

4.4.1 Initial EPRs

Environmental performance requirements were identified to inform the assessment of initial risk ratings (where appropriate). These initial EPRs were based on compliance with legislation and standard requirements that are typically incorporated into the delivery of construction contracts for rail projects.

4.4.2 Confirm or update EPRs

The risk assessment either confirmed that these EPRs were adequate or identified the need for further refinement.

EPRs were updated or new EPRs were developed for any initial risk that could not be appropriately managed by standard requirements. The risk and impact assessment processes confirmed the effectiveness of new or updated EPRs to determine the residual risk rating.

4.4.3 Final EPRs

The EPRs recommended for the projects are outlined in Section 8 of this report and are included in the EES Environmental Management Framework.

The EPRs are applicable to the final design, construction approach and operation and provide certainty regarding the environmental performance of the projects.

4.5 Linkage to other technical reports

This report relies on, or informs the following technical assessments:

- EES Technical Report C *Acid Sulfate Soils and Contamination*
- EES Technical Report G *Traffic.*

5 Existing conditions

5.1 Ambient air quality

Air quality at and around the project area is typical of the Melbourne metropolitan air environment, albeit that the Frankston line is on the interface of an urbanised metropolitan area and the generally pollutant source-free Port Phillip Bay. The proximity of the site to the Bass Strait coast and Port Phillip Bay provides meteorological influences which enhance dispersion conditions when compared to locations further inland or more surrounded by urbanised sources.

The nearest and most relevant EPA Victoria air quality monitoring stations are located at Dandenong and Brighton. These are the most appropriate for the project as they are located to provide data on community exposure to air pollution for the south-eastern suburbs of Greater Melbourne. The annual monitoring data report (EPA Victoria, 2015) states that:

- the national environment protection objectives for ambient air quality were met for carbon monoxide, nitrogen dioxide and sulphur dioxide
- the four-hour standard for ozone was exceeded for a single event at Dandenong (but not Brighton)
- annual particulate matter 10 micrometres or less in diameter (PM_{10}) at Dandenong and Brighton was 18.6 microgram per cubic metre (µg/m^3) and 16.0 µg/m^3, respectively (against a standard of 50 µg/m^3)
- annual visibility[1] at Dandenong and Brighton was 0.51 (against a standard of 2.35) and was equal to the eastern suburbs regional average.

Occasional dust storms and bushfires influence local and regional air quality, potentially resulting in sporadic exceedances of ambient air quality standards. However, the National Environment Protection (Ambient Air Quality) Measure (NEPM AAQ) does not include these ‘natural’ events when assessing achievement (goals) of the (particulate matter) standards. While NEPM AAQ is the national policy, SEPP AQM is the Victorian legislation used for this assessment (as levels are based on NEPM AAQ).

Background data from the calendar year 2014 was adopted for this assessment as it is the latest full year of statistics reported by EPA Victoria (2015). Sufficient data was available to meet NEPM requirements and the data is considered to be representative of local background air quality conditions. During the 2014 year, PM_{10} data was recorded using a Tapered Element Oscillating Microbalance (TEOM) instrument, whereas $PM_{2.5}$ data was recorded using both TEOM and partisol samplers. In the case of $PM_{2.5}$ (but not PM_{10}), the EPA Victoria indicated that the partisol sampler provides superior accuracy and that data from that instrument should be used in preference to the TEOM data. Partisol sampling was undertaken once every three days. Table 5 provides the adopted background air quality levels with values from the nearest available data source. It is standard practice to use a location that is representative of the project locations. In this case, by default, the nearest available is also the most representative.

It should be noted that data from near the Westgate Freeway and inner Melbourne are almost certainly higher than the air quality conditions along the Frankston corridor for the reasons outlined above.

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[1] Visibility is measured as an inverse distance related to an extinction coefficient. The atmospheric extinction coefficient (β_{ext} - as used by EPA Victoria) is a measure of the attenuation of light in the atmosphere by gases and particles. Its physical measurement, in units of inverse distance (for example, per kilometre), is generally regarded as the sum of the absorption and the scattering coefficients of gases and particles in the atmosphere.

Table 5 Background air quality analysis

Pollutant	Short-term ($\mu g/m^3$)	Daily average ($\mu g/m^3$)	Comment	Representative (upper bound) EPA Victoria monitoring location
CO	250	N/A	8-hour data published by EPA Victoria, so used a known 70th percentile from western suburbs	Footscray
SO_2	8 $\mu g/m^3$	N/A	75th percentile published by EPA Victoria	Alphington
NO_2	48 $\mu g/m^3$	N/A	75th percentile published by EPA Victoria	Brighton
PM_{10}	N/A	23.0	75th percentile published by EPA Victoria	Dandenong
$PM_{2.5}$	N/A	8.7	75th percentile published by EPA Victoria	Alphington
Benzene	7 $\mu g/m^3$ max 24-hr	N/A	Limited air toxic monitoring available across the network	West Gate Freeway (Brooklyn 2004)
PAH	0.55 ng/m^3 max 24-hr	N/A	Limited air toxic monitoring available across the network	Yarraville, Francis Street, May 2012-May 2013

Note: Daily averages only applicable to PM_{10} and $PM_{2.5}$ for which intervention levels are for 24-hour averages. $PM_{2.5}$ is based on 116 days of data (daily averages for Partisol $PM_{2.5}$ from Alphington recorded every three days). Benzene values from EPA, Air Monitoring Alongside the West Gate Freeway in Brooklyn – March to November 2004, Publication No. 974.PAH values from EPA, Francis Street Monitoring Programme – Final Report, Publication No. 1546.1.

5.2 Sensitive receptors

For the purposes of the air quality assessment, sensitive receptor locations are described in Schedule C, Part B, 5(c) of SEPP(AQM) to include 'hospitals, schools or residences'.

EPA Victoria 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 particular 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'.

Potential sensitive receptors in proximity to the Edithvale and Bonbeach project areas include residential premises and parks/open space. This is typical of outer and middle metropolitan areas in Melbourne. The parallel road corridors of Nepean Highway and Station Street separate sensitive receptors from the rail corridor. Residential housing dominates the eastern (inland) side of Station Street. The western (coastal) side of the project areas (on Nepean Highway) are generally residential areas with a small commercial strip opposite the stations at Edithvale and Bonbeach. These commercial properties are still considered sensitive receptor locations despite not being directly identified in EPA Victoria Publication 1518 to assess potential upset conditions that may occur at the commercial strips at Edithvale and Bonbeach. These sites are routinely exposed to emissions as people may be present (during the working hours or in carparks) when a diesel trains go past.

The nearest sensitive receptors to the project area are residents located along Nepean Highway and Station Street.

5.3 Meteorology

The prevailing site meteorology can be defined by a full data set of Moorabbin Airport meteorological data (these include cloud cover observations for determination of stability used for dispersion modelling). Manual three-hourly cloud observations at Moorabbin Airport have been superseded by automated cloud observations using a ceilometer. Automatic weather station data from the Bureau of Meteorology (Site ID: 086077) were obtained inclusive of temperature, wind speed and direction and cloud cover. The annual period of August 2009 to July 2010 was selected as this was after the installation of the ceilometer in 2004. This 12-month period had average rainfall within 10 percent of the annual median and avoids the very wet period of the 2010-2012 La Nina event. The cloud cover data was used to derive hourly atmospheric stability according to the Turner Workbook Method as defined by the United States Environmental Protection Agency (US EPA). Atmospheric mixing heights were calculated conservatively as just the mechanical mixing height using the algorithms from the New South Wales Approved Methods (EPA NSW, 2017).

The wind rose in Figure 5 shows proportions of wind strengths (colour scale) from various directions (16-point compass) – the direction indicated showing that winds blow from that direction. The prevailing wind direction is north, with the strongest winds also from this direction (cyan colour), and the lightest wind speed ranging below four metres per second are possible from most directions with the exception of north-east through to east.

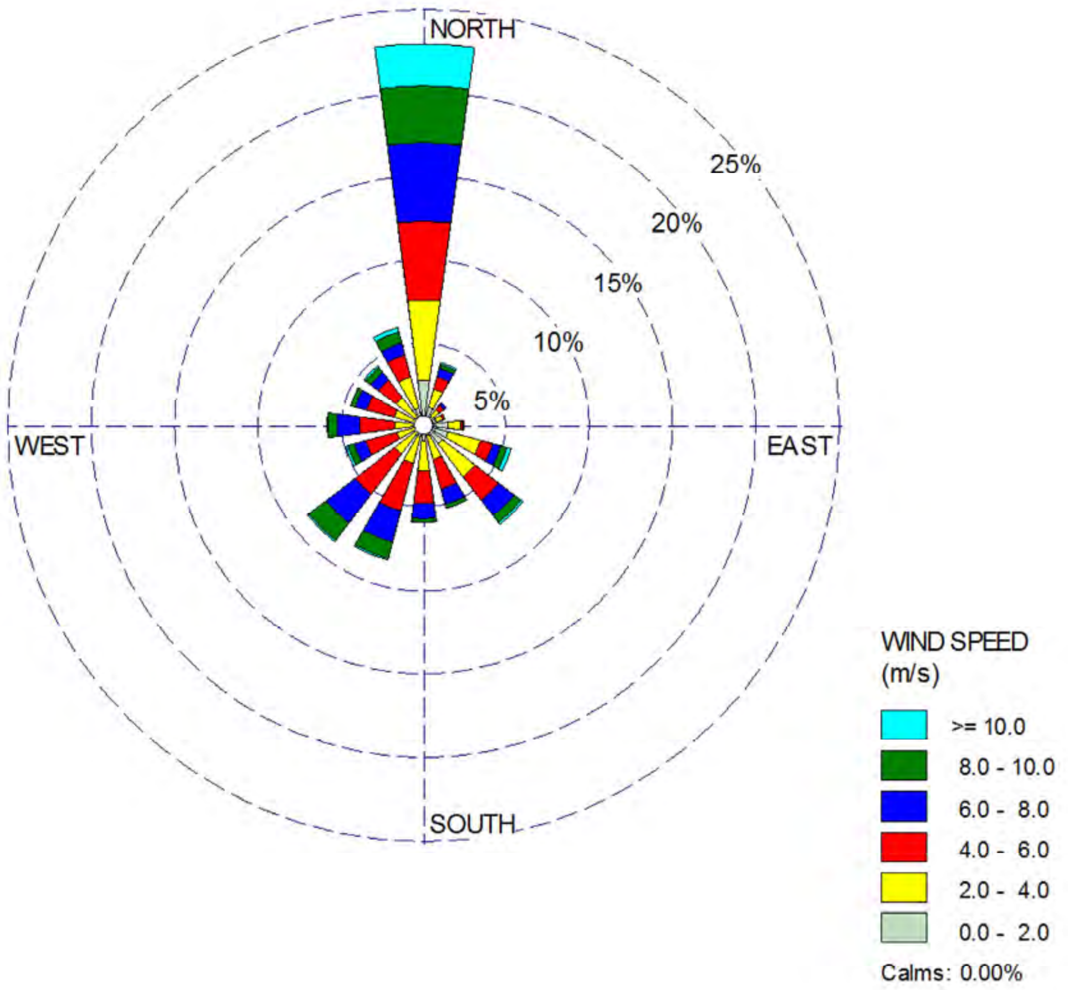

Figure 5 Annual wind rose for bayside suburbs – Moorabbin to Frankston

5.4 Scheduled train movements

Worst-case scenario train movements through the two stations were based on six diesel freight train movements for weekdays and four movements on weekends, and two diesel powered V/Line Sprinter train movements on a weekday (twin cars rotated from Frankston to the Melbourne maintenance yard). The V/Line Sprinter train between Frankston and Stony Point is a two-car train operating six days per week. For maintenance purposes, the Metro Trains Melbourne timetable allows for a Thursday-only Up and Down transit timeslots for Frankston to Southern Cross (via Caulfield and Flinders Street) for the Sprinter cars. It is assumed that both Sprinter railcars are active.

5.5 Edithvale existing conditions

At Mentone station (the closest station to Edithvale with a timetabled transit) approximate non-suburban train transit times can be derived for Edithvale from the Metro C2025/15 Circular on third-party timetabled movements. While all of these movements may not be used on any particular day, they are assumed to occur as shown below to illustrate a worst-case scenario.

Table 6 Estimated Edithvale station timetable transit of diesel (freight) train[2] – time and direction

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12:30 am Dn	12:50 am Dn	12:50 am Dn	12:50 am Dn	12:50 am Dn	12:50 am Dn	12:40 am Dn
5:10 am Up	5:10 am Up	5:10 am Up	5:10 am Up	5:10 am Up	5:25 am Up	7:20 am Up
12:20 pm Dn	12:20 pm Dn	12:20 pm Dn	12:20 pm Dn	12:20 pm Dn	1:10 pm Dn	12:55 pm Dn
2:20 pm Dn	2:20 pm Dn	2:20 pm Dn	2:20 pm Dn	2:20 pm Dn	-	-
5:20 pm Up	5:20 pm Up	5:20 pm Up	5:20 pm Up	5:20 pm Up	6:45 pm Up	6:45 pm Up
7:50 pm Up	7:50 pm Up	7:50 pm Up	7:50 pm Up	7:50 pm Up	-	-

The freight diesel locomotive was assumed to be either an XR or BL class locomotive with a rated power output of 2460 kilowatts (3300 horse power). The V/Line Sprinter railcar, see Figure 6, uses two Deutz turbocharged V8:BFL513C engines with a power output of 470 kilowatts per car at 2300 revolutions per minute. At cruising speed (not accelerating or idling/braking), the power rating was pro-rated to 900 revolutions per minute – the steel trains at 942 kilowatts and the Sprinter cars at 180 kilowatts.

The swap over of the Sprinter two-car train is scheduled to occur on a Thursday evening as indicated by Table 7. It is assumed that a single driver leaves Frankston at 2037 hours and arrives at Southern Cross at 2102 hours. A new two-car train is then returned to Frankston, by leaving Southern Cross or Flinders Street Station at 9:38 pm and arriving at the Frankston yard at 10:18 pm. The 30 to 40 minute transit time suggests an average speed not less than 60 kilometres per hour (48.9 kilometres from Flinders Street to Frankston).

The AUSROADS line source model (used in this assessment for the dispersion modelling) can differentiate Monday to Friday, Saturday and Sunday. For the purposes of this assessment, it has been conservatively assumed that the Sprinters run every weeknight.

Table 7 Estimated Edithvale station timetable transit of Sprinter (empty – no passengers) train

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
-	-	-	8:39 pm Up	-	-	-
-	-	-	10:01 pm Dn	-	-	-

[2] Notes: Commodity; Steel. Operator; PNI - Pacific National Intermodal (steel trains). Mentone station is the closest station to Edithvale with a timetabled transit – timing adjusted where needed for the model hour.

Figure 6 Sprinter locomotive at platform 3 Southern Cross[3]

The National Pollutant Inventory (NPI, 2008) provides the Emission Estimation Technique Manual for Combustion Engines V3.0. The emission factors (kilogram per kilowatt hour) for diesel engines with a capacity greater than 450 kilowatts were adopted (Table 42, NPI, 2008). Table 8 below summarises the predicted emission rates for the two types of (non-suburban electric) diesel trains on the Frankston line.

Ten percent of nitrogen oxide emissions by mass are assumed to be nitrogen dioxide. SEPP-AQM provides intervention levels (see section 3.1) in parts per million but these have been converted to µg/m^3 based on normal temperature and pressure conditions (temperature at 25 degrees Celsius).

Table 8 Freight and Sprinter train emission factors[4]

Pollutant	Train type	Cruise emission rate (kg/hr)	Intervention level (µg/m^3)	Averaging period	Comparison metric
CO	Freight	3.11	33210	1-hour	0.24
	Sprinter	1.19			0.09
SO_2	Freight	0.0046	550	1-hour	0.02
	Sprinter	0.0018			0.008
NO_2	Freight	0.74	263	1-hour	**7.39**
	Sprinter	0.28			**2.82**

[3] https://en.wikipedia.org/wiki/V/Line_Sprinter

[4] See Section 3 for Intervention Levels.

Pollutant	Train type	Cruise emission rate (kg/hr)	Intervention level (µg/m^3)	Averaging period	Comparison metric
PM_{10}	Freight Sprinter	0.405 0.015	60	24-hour	N/A
$PM_{2.5}$	Freight Sprinter	0.396 0.15	36	24-hour	N/A
Benzene	Freight Sprinter	0.0118 0.0045	75	1-hour	0.41 0.16
PAH	Freight Sprinter	5.65E-08 2.16E-08	0.5	1-hour	0.0003 0.0001

Note: all freight trains are XR/BL-class diesel locomotive hauled. Figures in bold indicate highest indicator for air quality.

For the one hour criteria in Table 4, a comparison metric was calculated. This is 1,000 times the peak emission rate (full-load acceleration) divided by the SEPP AQM intervention level. Since the nitrogen dioxide metric is much higher by orders of magnitude in most cases (as indicated in Table 8 by bold type), it is this pollutant indicator that is the critical parameter for any one-hour assessment of train emissions along the linear corridor. Therefore, carbon monoxide, sulphur dioxide, benzene and PAH can be safely assumed to be compliant if the nitrogen dioxide level is modelled to be within the SEPP AQM intervention level.

When the above emission factors, in kilogram per hour, are used with an assumed speed of 60 kilometres per hour, the emission rate converts to a value of kilograms per vehicle kilometres travelled. The emissions factors of Table 8 and the daily train movements of Table 6 and Table 7 are used to determine daily emission profiles as provided in **Error! Reference source not found.**.

The modelling uses these emission patterns with the concurrent meteorology throughout an entire annual cycle so as to predict pollutant concentrations on a surrounding grid of receptors for each hour of the year. A worst case scenario is then identified as the highest predicted concentration at each grid or transect point.

5.6 Bonbeach existing conditions

At Carrum station (the closest station to Bonbeach with a timetabled transit) approximate non-suburban train transit times on track three can be derived for Bonbeach from:

- the Metro C2025/15 Circular on third-party timetabled movements
- the Caulfield-Frankston-Dandenong metro timetable (September 2016).

All of these movements may not be used on any particular day but have been assumed to occur as shown in Table 9 below.

Table 9 Estimated Carrum station timetable transit of diesel (freight) train[5] – time and direction

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1:10 am Dn	1:10 am Dn	1:10 am Dn	1:10 am Dn	1:10 am Dn	1:00 am Dn	12:50 am Dn
4:56 am Up	4:56 am Up	4:56 am Up	4:56 am Up	4:56 am Up	5:09 am Up	7:03 am Up
12:39 pm Dn	12:39 pm Dn	12:39 am Dn	12:39 am Dn	12:39 am Dn	1:26 pm Dn	1:16 pm Dn
2:39 pm Dn	2:39 pm Dn	2:39 am Dn	2:39 am Dn	2:39 am Dn	-	-
5:07 pm Up	5:07 pm Up	5:07 pm Up	5:07 pm Up	5:07 pm Up	6:29 pm Up	6:29 pm Up
7:35 pm Up	7:35 pm Up	7:35 pm Up	7:35 pm Up	7:35 pm Up	-	-

The freight diesel locomotive was assumed to be either an XR or BL class locomotive with a rated power output of 2,460 kilowatts (3,300 horsepower). The Sprinter railcar, see Figure 6, uses two Deutz turbocharged V8:BFL513C engines with a power output of 470 kilowatts per car at 2,300 revolutions per minute. At cruising speed (not accelerating or idling/braking), the power rating was pro-rated to 900 revolutions per minute – the steel trains at 942 kilowatts and the Sprinter cars at 180 kilowatts.

The swap over of the Sprinter two-car train is scheduled to occur on a Thursday evening as indicated by Table 10. It is assumed that a single driver leaves Frankston platform 3 at 8:37 pm and arrives at Southern Cross platform 4 at 9:02 pm. A new two-car train is then returned to Frankston, by leaving Southern Cross or Flinders Street Station platform 4 at 9:38 pm and arriving at the Frankston yard at 10:18 pm. The 30 to 40-minute transit time suggests an average speed not less than 60 kilometres per hour (48.9 kilometres from Flinders Street to Frankston).

The AUSROADS line source model (used in this assessment for the dispersion modelling) can differentiate Monday to Friday, Saturday and Sunday. For the purposes of this assessment, it has been conservatively assumed that the Sprinters run every weeknight.

Table 10 Estimated Bonbeach station timetable transit of empty Sprinter (no passengers) train

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
-	-	-	8:30 pm Up	-	-	-
-	-	-	10:10 pm Dn	-	-	-

The emission rates for the two types of (non-suburban electric) diesel trains on the Frankston line is described in Section 5.5 above.

[5] Notes: Commodity; Steel. Operator; PNI - Pacific National Intermodal (steel trains). Carrum station is the closest station to Bonbeach with a timetabled transit – timing adjusted where needed for the model hour (11 minutes Mordialloc-Carrum for steel trains; 6 minutes for Empty Sprinter).

The emissions factors of Table 8 and the diurnal train movements of Table 9 and Table 10 are used to determine diurnal (daily) emission profiles as provided in Appendix B.

The modelling uses these emission patterns with the concurrent meteorology throughout an entire annual cycle so as to predict pollutant concentrations on a surrounding grid of receptors for each hour of the year. A worst case scenario is then identified as the highest predicted concentration at each grid, transect or discrete point.

6 Risk assessment

A risk assessment of project activities was performed in accordance with the methodology described in Section 0. Risks were assessed for the construction and design/operation phases (where relevant).

The residual air quality risks associated with the projects are listed in Table 11. The likelihood and consequence ratings applied during the risk assessment process are provided in Appendix D. There was no change in the initial risk and final risk levels for air quality.

Table 11 Air quality risks

Risk ID	Risk name	Risk pathway	Final EPR	Residual risk
Construction risks				
AQ 9	Air quality-dust (amenity)	Off-site dust levels results in perceived loss of amenity	EPR AQ1 Air quality (construction) EPR AQ2 Air quality management	Negligible
AQ 10	Air quality-dust (health)	Off-site dust levels above limits causes health impacts	EPR AQ1 Air quality (construction) EPR AQ2 Air quality management	Negligible
AQ 11	Air quality-plant combustion	Off-site NOX, SOX, CO, benzene, polycyclic aromatic hydrocarbons assessed as above SEPP (Air Quality Management) levels resulting in health impacts to sensitive receptors	EPR AQ1 Air quality (construction) EPR AQ2 Air quality management	Negligible
AQ 12	Air quality-odour	Odour from contaminated soils (including acid sulfate soils) resulting in amenity impacts	EPR CL2 Acid Sulfate Soils management sub-plan EPR CL3 Waste management	Negligible
Operational risks				
AQ 13	Air quality (diesel train emissions)	Diesel train emissions (such as particulates, nitrogen dioxide, sulphur dioxide, carbon monoxide benzene, polyaromatic hydrocarbons) above SEPP Air Quality Management levels resulting in health impacts to sensitive receptors.	No EPR required	Negligible

For further details refer to the EES Attachment II *Environmental Risk Report* which includes the full risk register, with initial EPRs and the final EPRs assigned to each risk.

7 Impact assessment

7.1 Edithvale

The Edithvale project area (see Figure 1) includes the transport corridors of the railway and the Nepean Highway and Station Street road reserves. Operationally, emissions would be limited to the narrow rail corridor (Up and Down lines) while the construction area of civil works and surface transport would have a wider footprint. One lane of Station Street and one lane of Nepean Highway would be potentially utilised at times during construction.

7.1.1 Construction impacts

Civil works have the potential to generate dust, odour and gaseous emissions that can be blown off-site to cause environmental nuisance. All emissions can be managed so as to minimise off-site impacts in alignment with Section 3.5 of the Scoping Requirements (released September 2017).

An assessment of the risks of off-site dust impact shows that management and mitigation measures are capable maintaining risk ratings to low or negligible levels. Reactive management measures and a monitoring program can be incorporated into the environmental performance requirements to minimise off-site impacts.

Dust emissions during construction work

The generation of dust during construction works could have the following impacts:

- off-site dust levels resulting in perceived loss of amenity **(risk AQ9)**
- off-site dust levels above regulatory limits causing health impacts **(risk AQ10)**

Construction dust can be caused by civil works such as earthworks, site clearance and establishment, and vehicle movements. A list of potential dust-generating activities is provided below.

Civil works during the construction phase with potential to generate dust would involve:

- stripping and clearing within the project area and temporary construction areas
- excavation for piling, foundations and the rail trench
- transport of spoil and excavated material offsite
- removal of existing level crossing infrastructure
- construction of :
  - lowered rail infrastructure
  - new stations including concourse, buildings, platforms and vertical access infrastructure
  - pedestrian overpasses and decking over the rail trench
  - railways including excavation and installation of ballast, overhead line equipment and rail

The three major concerns from the construction phase concerning the generation of off-site dust impact are:

- material transfer
- vehicle movement on unconsolidated surfaces
- wind erosion from exposed surfaces and stockpiles.

All of the above activities have potential to create construction dust that can move off-site. The physical movement of material, or as generated by vehicles moving over non-sealed surfaces, can raise dust.

Particulate matter impacts depend on the quantity and drift potential of the particles in the atmosphere. Larger dust particles settle close to their source due to their larger mass, while smaller particles can be dispersed at greater distances due to their greater drift potential. The handling and transfer of spoil and other building materials can also cause dust impacts. Particulate matter depositing on surfaces can cause an amenity impact as it can soil surfaces such as clothing on a washing line or by being deposited on window sills. The fine material has the potential to penetrate into the lungs and potentially aggravate existing respiratory diseases (such as asthma and bronchitis) or increase the risk of respiratory problems affecting human health. Both of these pathways have potential consequences for the beneficial uses of the air environment, protecting which is the key policy concern of the SEPP AQM.

The larger particulate matter can create amenity issues as dust fallout anywhere beyond the site boundary (residential, commercial of biodiversity sites such as waterways) while the finer material would affect health if the off-site movement involves humans at sensitive receptor locations.

7.1.1.1 Management and mitigation

The projects would be required to prepare and implement dust management measures **(EPR_AQ1)** to minimise and monitor the impact of construction dust including:

- dust suppression (where appropriate)
- crushed rock on access and egress points
- a dust management and monitoring system.

As the trench at Edithvale and Bonbeach would be lower than ground level it would provide a reduction to the wind speed at the soil surface, thereby reducing dust impacts during construction.

The Environmental Guidelines for Major Construction Sites (EPA Victoria, 1996) recommends that preventative measures are used in preference to applying dust suppression measures. Material transfer cannot be avoided and the usual suppression method of applying water is limited as it is often desirable to not make the material too wet. However, the shallow water table and the ability to apply some water sprays (where needed) would lower the potential of dust generation from these site activities. Management measures available for control of dust generation due to vehicle movement on unconsolidated surfaces mostly relate to lowering of the silt content and raising moisture content. Crushed rock can be applied at some haul route locations as a means to reduce silt content. The size and nature of surface vehicle movements for this project are unlikely to require the use of dust suppressant additives to any water applied. While dust suppressant additives are recommended in the Environmental Guidelines for Major Construction Sites (EPA Victoria, 1996), these are not recommended for these projects as stockpile sizes and durations would be managed in order to control dust emissions (**EPR_AQ3**). It is recommended in the first instance that excavated materials would be taken offsite to an appropriate disposal facility. Any material requiring stockpiling would only be stored on site for a short duration and covered in order to avoid the material drying out, decreasing the potential for dust emissions due to wind erosion. Water can be used for the control of fugitive dust emissions due to wind erosion.

In the event of asbestos being detected on site or disturbed during the construction works, in addition to the dust management measures implemented (**EPR_AQ1** and **EPR_AQ2**), the management of asbestos would be outlined in the Construction Environmental Management

Plan (CEMP) in accordance with WorkSafe Guidelines and EPA Victoria disposal guidance. An investigation would be undertaken by suitably qualified specialists prior to the commencement of works to characterise the soil material and understand mitigation measures for the excavation, transportation and disposal of the asbestos impacted material. This investigation would comply with EPA Victoria publication, Australian Standards and best practice assessment guidelines for characterisation of contaminated soils (**EPR_CL2**). For further detail, refer to Technical Report C *Acid Sulfate Soils and Contamination*.

Implementing dust management measures and adopting appropriate mitigation controls **(EPR_AQ1)**, such as dust suppression, would maintain air quality to a standard which does not impact the health and amenity of nearby residents, open spaces and community facilities in accordance with EPA Victoria Publication 480 *Environmental Guidelines for Major Construction Sites.* Therefore, it is unlikely that there would be an impact to amenity or human health during construction due to off-site dust. Adopting these controls would maintain the risk at a negligible rating.

7.1.1.2 Combustion emissions from construction plant and vehicles

Construction plant and vehicles have the potential for gaseous air pollutant generation due to engine exhaust emissions (**risk AQ11**). Gaseous products of combustion from construction plant, and also from burning of waste, and the finer particulate matter in the $PM_{2.5}$ range, all have potential human health implications if the off-site impact reaches sensitive receptor locations. Human health and wellbeing may be affected when pollutant concentrations reach the levels specified in SEPP AQM. The quantum of emissions from construction plant and vehicles utilised on-site during the construction phase would be much lower than the emissions already provided by vehicle movement on the Nepean Highway and Station Street.

Management and mitigation

The SEPP AQM stipulates recommended air quality management levels within the policy in order to minimise the risk to human health by limiting the concentration of products of combustion within the air environment of Victoria. A recommended measure to manage these levels is for construction plant and vehicles are to be maintained to manufacturer specifications. This measure is suggested in the Environmental Guidelines for Major Construction Sites (EPA Victoria, 1996) (refer to **EPR_AQ1**). Plant maintained in an efficient manner lowers emissions, including 'black smoke', as well as saving fuel.

Implementing these EPRs would maintain a level of impact consistent with EPA Victoria policy and regulations and maintain the risk level at negligible.

7.1.1.3 Odour from acid sulphate soils and organic materials

The 'sand belt' suburbs of Melbourne are well known to require consideration of acid sulfate soils whenever construction activity or excavation is involved. Acid sulfate soils occur naturally and contain iron sulphides, most commonly as pyrite. When these soils are exposed to oxygen through disturbance, they produce sulphuric acid, often releasing odour and also other metals like aluminium and iron. The EES Technical Report C *Acid Sulfate Soils and Contamination* has identified the presence of acid sulphate soils in the project site. It has also identified a risk of organic material such as hydrocarbon contamination of soils. Disturbed soils containing hydrocarbons would produce an odour which may cross the site boundary with sufficient strength to be noticeable (**risk AQ12**). At the expected concentrations (refer to EES Technical Report C *Acid Sulfate Soils and Contamination*), this would be an amenity issue before it becomes a health and wellbeing issue.

Management and mitigation

Requirements for odour to be controlled so that construction air quality impacts associated with odour are managed are recommended (**EPR_AQ3**). Standard management and mitigation measures to minimise odour emissions are to cover stockpiles and haul vehicles (with minimum transit time to an off-site disposal facility), minimise stockpile durations and the use of odour-neutralising agents (see EES Technical Report C *Acid Sulfate Soils and Contamination*). Waste materials encountered during construction or spills could also generate localised odours. Waste management, staff training and spill response would be managed during the construction of the projects through an enviornmental management plan (**EPR_CL3**).

7.1.2 Operational impacts

An assessment of operational impacts regarding air quality is limited to the exhaust emissions from diesel trains using the Metro network with just occasional train movements throughout the day and week. When placed in the context of a wider transport corridor including a major arterial road (Nepean Highway) and a local road (Station Street), the diesel train emissions are less significant. Air quality impacts from the operational phase are therefore assessed to be well within acceptable limits.

7.1.2.1 Diesel engine exhaust emissions

The movements of occasional diesel multiple units (DMU's) along the rail corridor currently produces diesel engine exhaust emissions (**risk AQ13**). These same emissions would occur after the removal of the level crossing but with an altered dispersion pattern due to the source of the emissions (i.e. the DMU's) being lowered into a trench. A conservatively high 'notch setting' was used that assumed a steady, constant power setting so that the driver could adjust speed to allow for down and up slopes of the trench. A notch setting equivalent to an engine rating of 940 kilowatts of power (peak engine rating of 2460 kilowatts) maintains a cruising speed close to 60 kilometres per hour. The train driver is able to manage a slightly higher speed on the downslope into the level crossing with a corresponding decrease in speed coming out of the level crossing trench – the train returning to cruising speed on flat sections of track.

7.1.2.2 Hourly average nitrogen dioxide

At-grade (existing infrastructure)

The one-hour assessment criteria for nitrogen dioxide is 263 microgram per cubic metre. Predicted worst-case scenario one-hour nitrogen dioxide values have been calculated by AUSROADS along an approximate one kilometre stretch of rail corridor centred on the Edithvale Station. This modelling scenario identifies the maximum difference between existing compared to the proposed conditions.

Figure 7 provides a transect of nitrogen dioxide impact either side of the rail corridor. The rail corridor is indicated by vertical gold coloured lines. The rail corridor has the Nepean Highway to the west and Station Street to the east. This provides a separation to sensitive receptor locations of at least 23 metres – indicated by orange coloured vertical lines in Figure 7.

The Edithvale Uniting Church is located to the east of the rail corridor along Edithvale Road. There is a bus stop outside the church, approximately 120 metres from the rail corridor – Figure 8 shows that the worst-case scenario maximum one-hour nitrogen dioxide concentration predicted here is less than one microgram per cubic metre.

Figure 8 also provides a plan view of the nitrogen dioxide worst-case scenario one-hour impact with the highest concentrations occurring along the centre of the rail corridor. Concentrations decrease with increasing distance away from the source – consistent with Figure 7. All predicted values are significantly under the one-hour assessment criteria for nitrogen dioxide (263 micrograms per cubic metre) – the maximum predicted concentration was 10.3 micrograms per cubic metre at the very edge of the rail corridor.

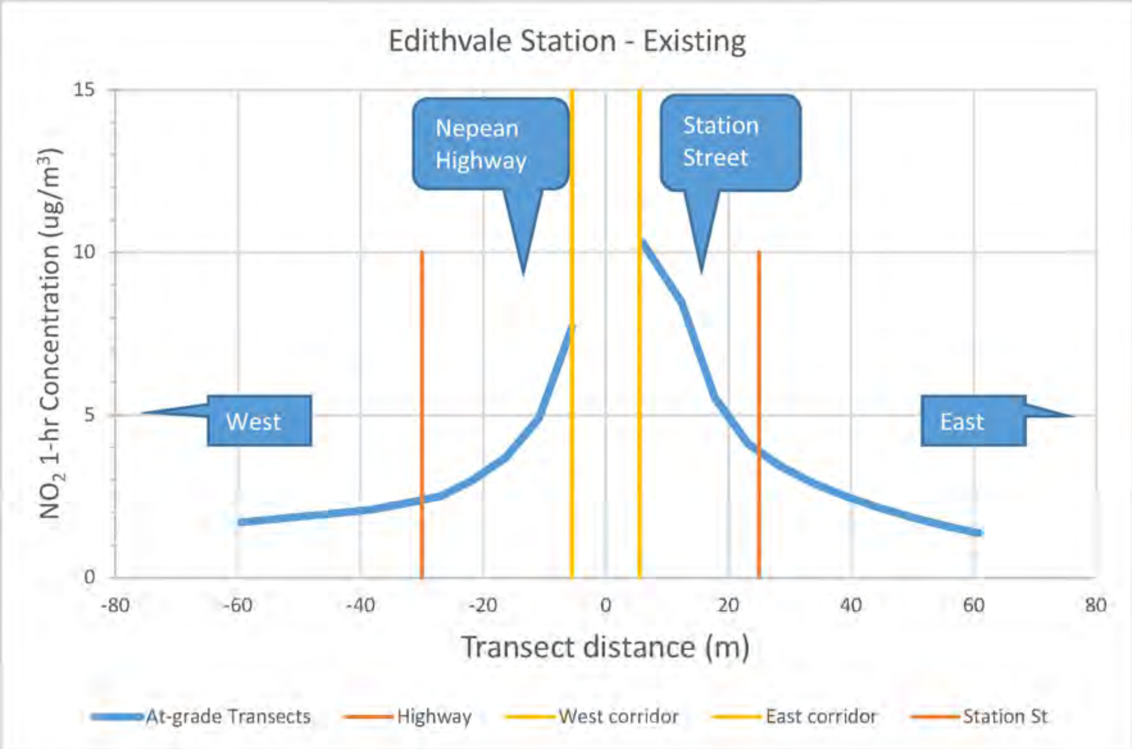

Figure 7 Edithvale transects of one hour maximum nitrogen dioxide - at-grade (criterion = 263 µg/m³)

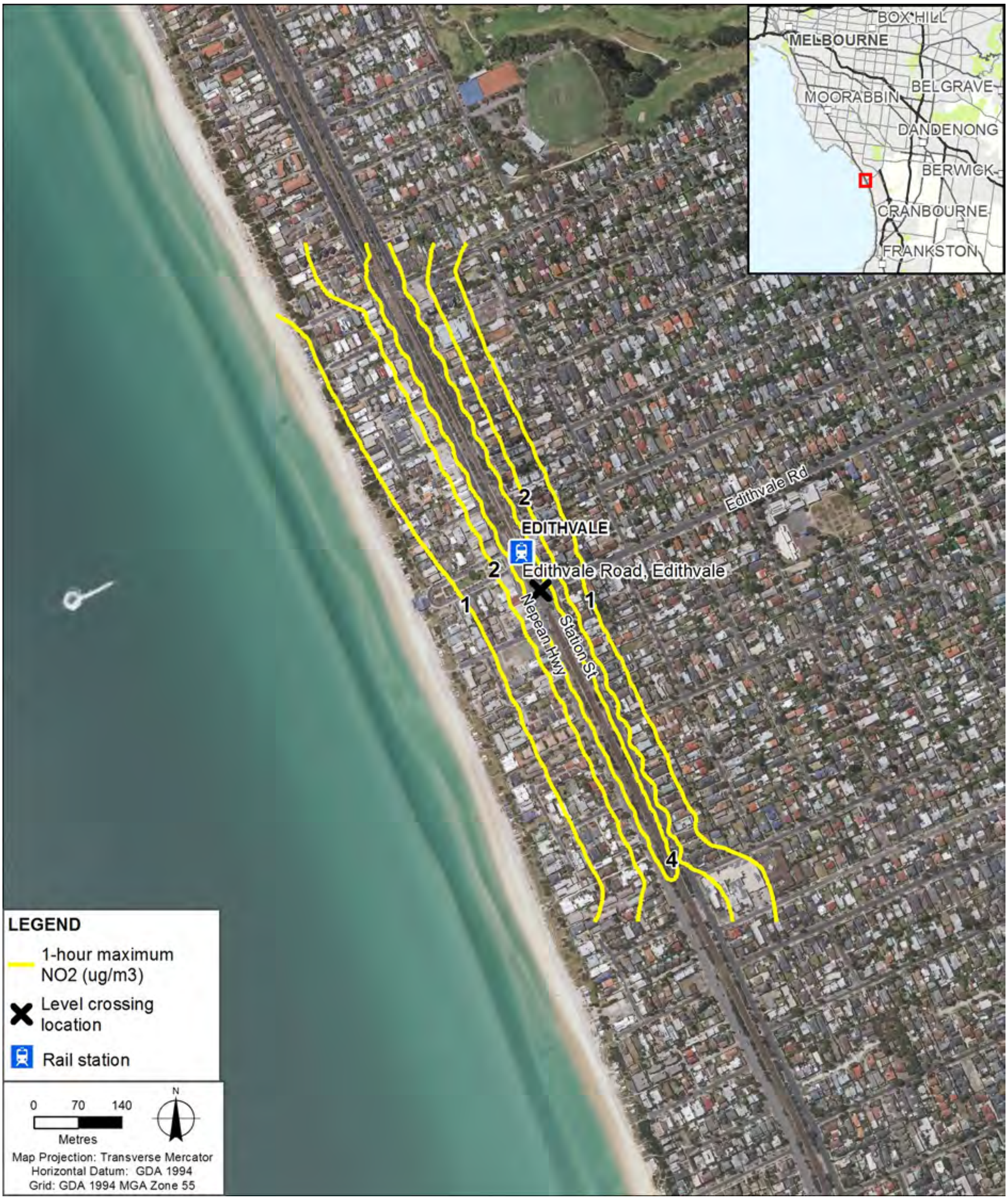

Figure 8 Contour plot of one hour maximum nitrogen dioxide along a one kilometre stretch of rail corridor at Edithvale Station - At-grade (existing)

Rail trench

Predicted worst-case one-hour nitrogen dioxide values were calculated using the AUSROADS model for an approximate one kilometre stretch of rail corridor with a depressed 'trench'. Line segments as 'links' in the model, representing joined transport corridor 'links', of approximately 70 metre lengths were used so that the average depth (rail trench) of the emission source reflected changes in elevation relative to the at-grade (existing infrastructure) modelling. Height changes of eight metres below ground level were used at the mid-point (the approximate location of the Edithvale station) of the one-kilometre-long line source. Whenever an emitting train was under a covering deck (either the station precinct or the carpark) the emission from that link was set to zero with an equivalent emission moved to the next 'open' link. The station precinct decking is 80 metre long with the carpark decking 130 metre long. There is an 80 metre void between the two deck coverings.

Figure 9 shows the predicted concentrations with transects levels for the rail trench and the at-grade predictions. Between the rail corridor and the road reserve, the rail trench produces localised higher concentrations. This is related to emissions initially being 'trapped' within the trench. However, at the distance of sensitive receptor locations beyond the road reserves, the worst-case hourly concentration is predicted to be very similar to that due to the existing at-grade rail infrastructure.

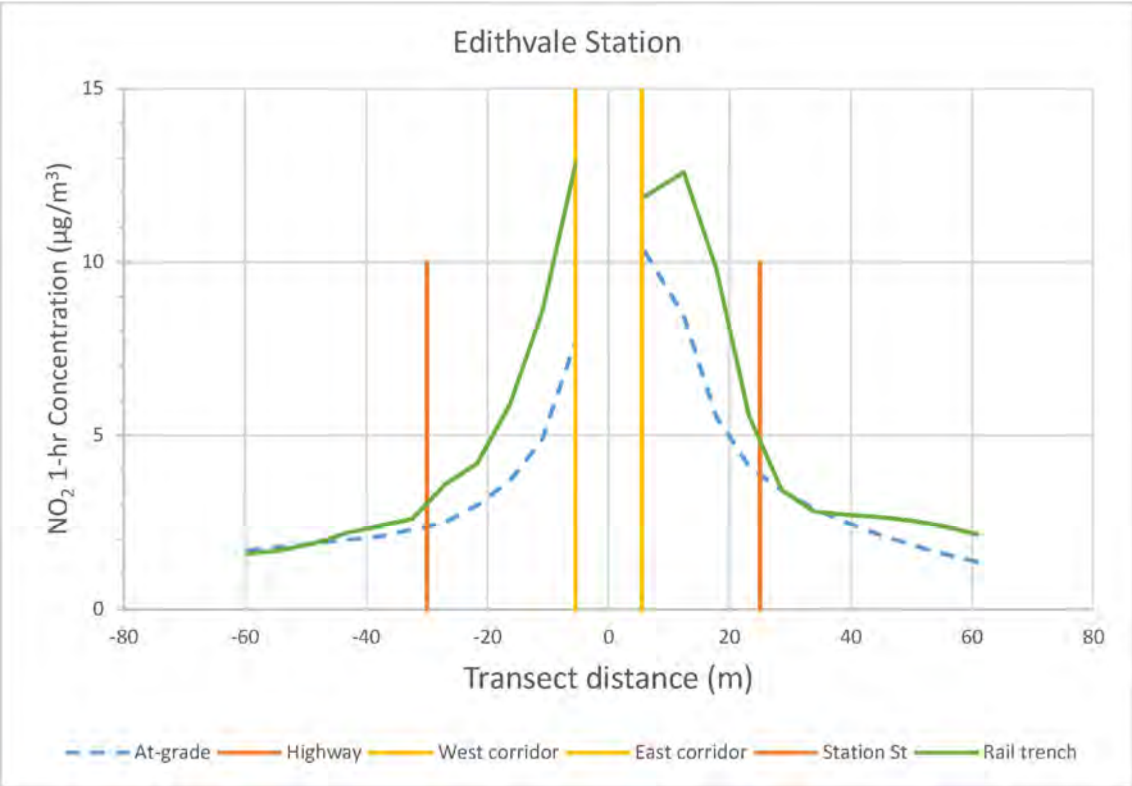

Figure 9 Edithvale predicted transects of one-hour maximum nitrogen dioxide concentrations (criterion = 263 µg/m³)

Daily average PM_{10}

Figure 10 shows the predicted 24-hour PM_{10} concentrations with transect levels for the rail trench and the existing at-grade predictions (dashed blue line). At the distances beyond the edge of the sensitive receptor locations (west of Nepean Highway and east of Station Street) the predicted concentrations for the rail trench are very similar to the existing at-grade (ground level) railway infrastructure. It is only between the rail corridor and the outer edge of the transport corridor that the concentrations vary to the existing at-grade infrastructure. These differences are very low compared to the assessment criterion of 60 µg/m³ and as they are road corridors, no sensitive receptor locations are involved.

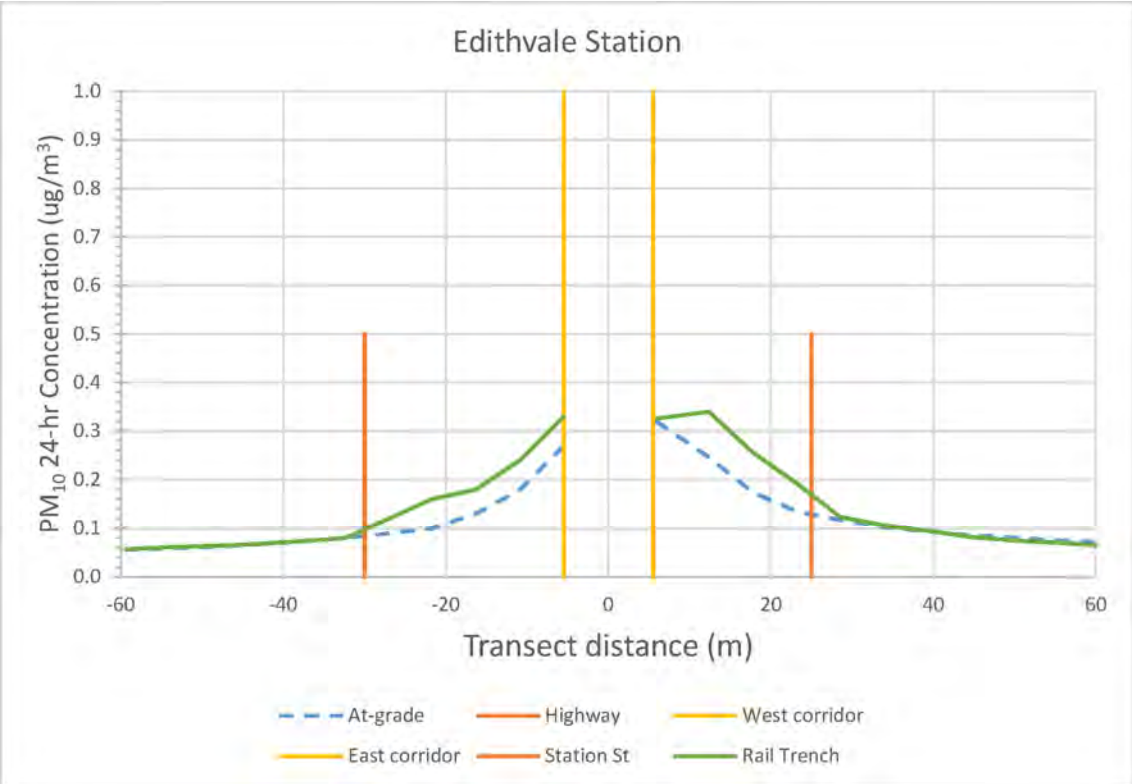

Figure 10 Edithvale predicted transects of 24-hour maximum PM_{10} concentrations with transect levels (criterion = 60 µg/m³)

Impact results for all modelled pollutants

All one hour assessed pollutants (nitrogen dioxide, carbon monoxide, sulphur dioxide, benzene and polycyclic aromatic hydrocarbons) and 24-hour assessed pollutants (PM_{10} and $PM_{2.5}$) have been modelled by AUSROADS. Table 12 provides the predicted concentrations, and an indication of the percentage of the intervention levels of Table 4, at transect location adjacent to the corridor (no sensitive receptors involved) and the sensitive receptor distances of the downwind side of the road corridors (Nepean Highway and Station Street).

As predicted by the metric in Table 12, the one hour nitrogen dioxide worst-case scenario concentrations register the highest impacts as a percentage of the assessment criterion. Concentrations are three to five percent of the assessment criterion adjacent to the rail corridor and one percent of the assessment criterion at the nearest sensitive receptors either side of the transport corridors. All other pollutants, including the 24-hour assessed PM_{10} and $PM_{2.5}$, are less than one percent of the respective assessment criterion.

For all pollutants, worst-case predicted concentrations are orders of magnitude lower than the conservatively estimated worst-case background concentrations.

At the nearest sensitive receptor locations along Nepean Highway and Station Street, the differences between the existing at-grade infrastructure and the level crossing removal are predicted to be minimal. The level crossing removal would result in very similar concentrations of all pollutants at the nearest sensitive receptors compared to the existing infrastructure.

Table 12 Predicted impact results as percentage of Intervention Level (IL) assessment criterion

Pollutant	At-grade (existing rail infrastructure)		Rail trench (proposed project)	
	µg/m³	% of IL	µg/m³	% of IL
NO_2	1-hr criterion = 263 µg/m³		Background = 48 µg/m³ (18 %)	
West corridor	7.7	2.9 %	12.8	4.9 %
East corridor	10.3	3.9 %	11.9	4.5 %
West sensitive receptors	2.3	0.9 %	2.6	1.0 %
East sensitive receptors	3.4	1.3 %	3.4	1.3 %
PM_{10}	24-hr criterion = 60 µg/m³		Background = 23 µg/m³ (38 %)	
West corridor	0.27	0.45 %	0.33	0.55 %
East corridor	0.32	0.53 %	0.33	0.54 %
West sensitive receptors	0.08	0.13 %	0.08	0.13 %
East sensitive receptors	0.12	0.20 %	0.12	0.21 %
$PM_{2.5}$	24-hr criterion = 36 µg/m³		Background = 8.7 µg/m³ (24 %)	
West corridor	0.26	0.72 %	0.32	0.89 %
East corridor	0.31	0.87 %	0.32	0.88 %
West sensitive receptors	0.08	0.22 %	0.08	0.23 %
East sensitive receptors	0.11	0.32 %	0.12	0.33 %
CO	1-hr criterion = 33210 µg/m³		Background = 250 µg/m³ (0.8 %)	
West corridor	32	0.10 %	54	0.16 %
East corridor	43	0.13 %	50	0.15 %
West sensitive receptors	9.6	0.029 %	11.0	0.033 %
East sensitive receptors	14.3	0.043 %	14.4	0.043 %
SO_2	1-hr criterion = 550 µg/m³		Background = 8 µg/m³ (1.5 %)	
West corridor	0.048	0.009 %	0.079	0.014 %
East corridor	0.064	0.012 %	0.074	0.013 %
West sensitive receptors	0.014	0.0025 %	0.016	0.0029 %

Pollutant	At-grade (existing rail infrastructure)		Rail trench (proposed project)	
	µg/m^3	% of IL	µg/m^3	% of IL
East sensitive receptors	0.021	0.0039 %	0.021	0.0039 %
Benzene	1-hr criterion = 75 µg/m^3		Background = 7 µg/m^3 (9.3 %)	
West corridor	0.12	0.16 %	0.21	0.27 %
East corridor	0.17	0.22 %	0.19	0.26 %
West sensitive receptors	0.037	0.049 %	0.042	0.056 %
East sensitive receptors	0.055	0.074 %	0.056	0.074 %
PAH	1-hr criterion = 0.5 µg/m^3		Background = 0.00055 µg/m^3 (0.1 %)	
West corridor	5.82E-07	0.00012 %	9.68E-07	0.00019 %
East corridor	7.80E-07	0.00016 %	9.02E-07	0.00018 %
West sensitive receptors	1.74E-07	0.000035 %	1.99E-07	0.000040 %
East sensitive receptors	2.59E-07	0.000052 %	2.61E-07	0.000052 %

Management and mitigation

Overall, air quality emissions resulting from the existing at-grade rail infrastructure and the level crossing removal are well below design and intervention limits. Therefore, no measures to avoid, minimise or manage air quality impacts are required.

7.1.2.3 Air quality impacts due to changes in traffic conditions

After the removal of the level crossings, the phasing of the traffic signals would be designed to optimise traffic flows, balancing the demands of Nepean Highway, Station Street, Edithvale Road and Bondi Road. Changed traffic conditions from the level crossing removals would result in very minor changes to air quality emissions (**risk T31**). Over time, traffic volumes are expected to increase (as the result of population and economic activity increasing) but per unit and vehicle fleet emissions would decrease due to policy initiatives from the SEPP AQM. As any road traffic congestion decreases and average speeds increase slightly, the emission factors for vehicle emissions decrease (see Appendix C). The resultant decrease in traffic emissions within the project area due to nationwide controls on exhaust emissions would greatly outweigh any increases in vehicle usage and any changes to traffic patterns due to congestion changes on the surrounding road network (as a result of this project). As the existing air quality at these locations is well below EPA Victoria intervention levels, the changed traffic conditions at the two level crossings is not further considered.

Management and mitigation

Should any increase in vehicle emissions occur as a result of changed traffic conditions, air quality would be highly unlikely to breach the levels set by SEPP AAQ. Overall, the impacts to the air environment due to changes in traffic conditions are well below any requirements for management, hence no measures to avoid, minimise or manage air quality impacts are required.

7.2 Bonbeach

The Bonbeach project area (see Figure 2) includes the transport corridors of the railway and the Nepean Highway and Station Street road reserves. Operationally, the emissions would be limited to the narrow rail corridor (up and down lines) while the construction area of civil works and surface transport would have a wider footprint. One lane of Station Street and one lane of Nepean Highway would be utilised at times during construction.

7.2.1 Construction impacts

The construction impacts for Bonbeach are the same as for Edithvale and are discussed in 7.1.1 above.

7.2.2 Operational impacts

AUSROADS modelling was conducted for at-grade (existing infrastructure) and rail trench. A 'link type' of 'depressed' was used for the rail trench model in the AUSROADS software.

7.2.2.1 Diesel engine exhaust emissions

The movements of occasional, ad-hoc diesel multiple units (DMU's) along the rail corridor currently produces diesel engine exhaust emissions (**risk AQ13**). These same emissions would occur after the removal of the level crossing but with an altered dispersion pattern due to the source being lowered into a trench environment.

7.2.2.2 Hourly average nitrogen dioxide

At-grade (existing infrastructure)

Predicted worst-case scenario one-hour nitrogen dioxide values have been calculated by AUSROADS along a 1.4 kilometre stretch of rail corridor centred on the Bonbeach Station and the Bondi Road level crossing. This modelling scenario would identify the maximum difference between existing compared to the proposed conditions.

Figure 11 provides a transect of nitrogen dioxide impact either side of the rail corridor at the Bondi Road level crossing. The rail corridor is indicated by vertical gold coloured lines. The rail corridor has the Nepean Highway to the west and Station Street to the east. This provides a separation from the outer edge of the rail corridor to sensitive receptor locations of about 19 metres – indicated by orange coloured vertical lines in Figure 11.

The second level housing above a commercial property immediately to the west of the Bondi Road level crossing (corner of Harding Road and Nepean Highway) is a potential elevated sensitive receptor relative to the rail corridor and surrounding properties. The worst-case maximum one-hour nitrogen dioxide concentration predicted at a four metre high 'flagpole receptor' at this location is less than one percent of the assessment criterion for all scenarios (2.3 micrograms per cubic metre for existing conditions and 1.57 micrograms per cubic metre).

Figure 12 provides a plan view of the nitrogen dioxide worst-case scenario one-hour impact with the highest concentrations occurring along the centre of the rail corridor. Concentrations decrease with increasing distance away from the source – consistent with Figure 11. All predicted values are significantly under the one-hour assessment criteria for NO_2 (263 micrograms per cubic metre) – maximum predicted concentration was 5.6 micrograms per cubic metre at the very edge of the rail corridor.

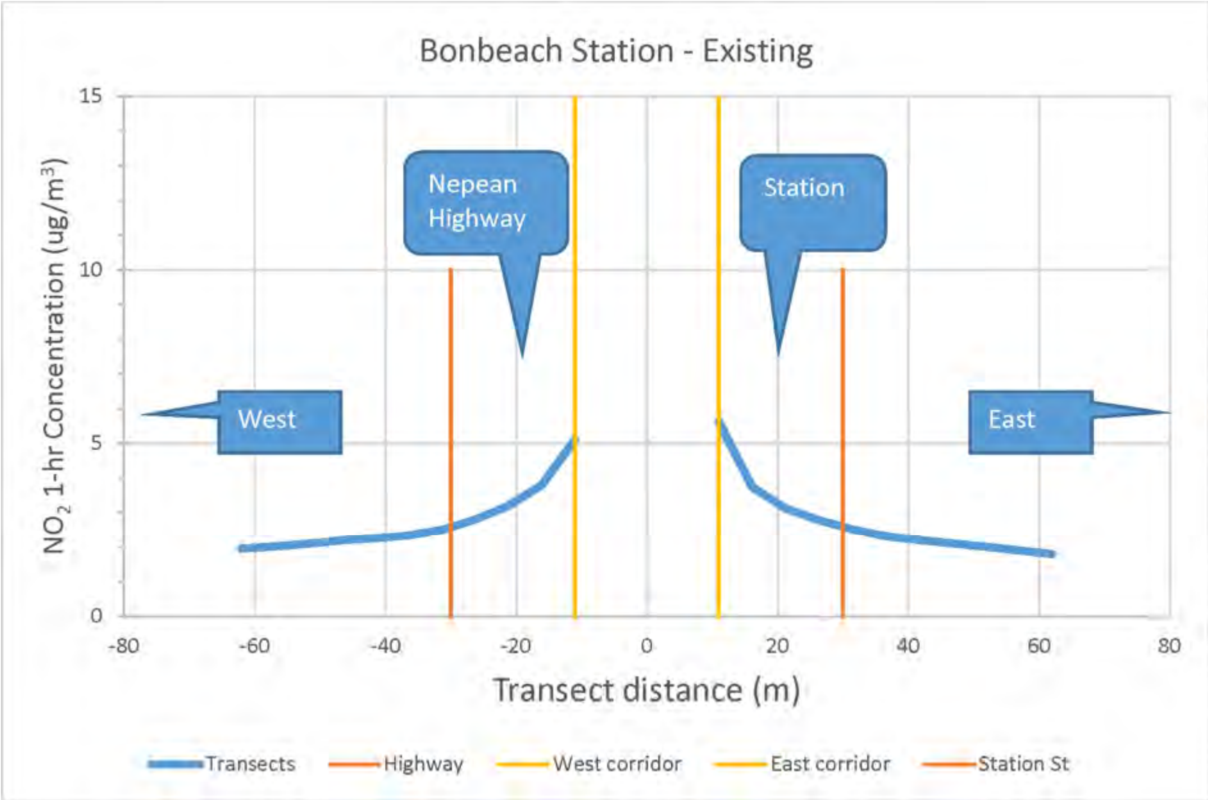

Figure 11 Bonbeach transects of one-hour maximum nitrogen dioxide - at-grade (existing) (criterion = 263 µg/m³)

Figure 12 Contour plot of one hour maximum nitrogen dioxide along a 1.4 kilometre stretch of rail corridor at Bonbeach Station - at-grade (existing)

Rail trench

Predicted worst-case one-hour nitrogen dioxide values have been calculated by AUSROADS along a 1.4 kilometre stretch of rail corridor with a depressed 'trench' for the project. Line segments, representing joined transport corridor 'links', of varying lengths were used so that the average depth (rail trench) of the emission source reflected changes in elevation relative to the at-grade (existing infrastructure) modelling. Height changes of eight metres below the at-grade (existing) along the 1.4 kilometre, line source were used at the approximate location of the Bondi Road level crossing just to the south of Bonbeach station. Whenever an emitting train was under a covering deck (either the station precinct or the carpark) the emission from that link was set to zero with an equivalent emission moved to the next 'open' link. The station precinct decking is 80 metre long with the carpark decking also 80 metre long. There is a 50 metre void between the two deck coverings.

Figure 13 shows the predicted concentrations with transect levels for the rail trench and the at-grade predictions. Between the rail corridor and across the road reserve, the rail trench mostly produces localised higher concentrations. This is related to emissions initially being 'trapped' within the trench[6]. However, at the distance of sensitive receptor locations beyond the road reserves, the worst-case hourly concentration is predicted to be similar or less than the concentrations due to emission sources of existing at-grade rail infrastructure.

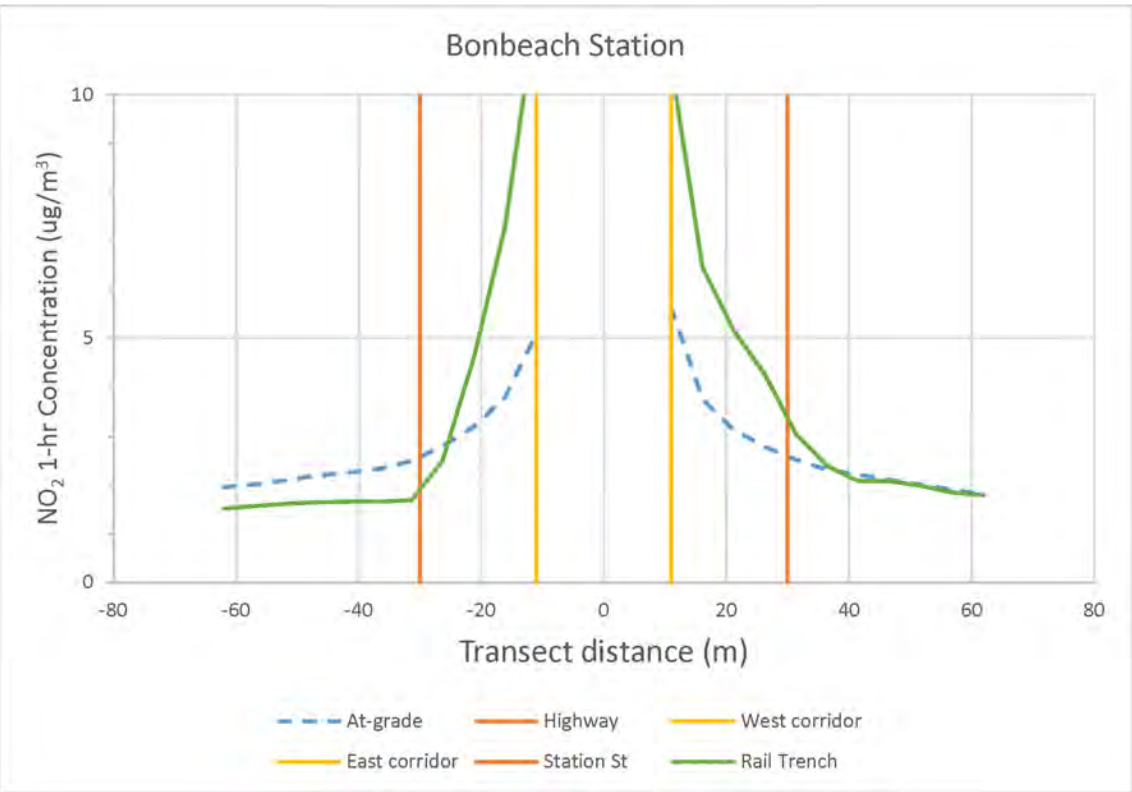

Figure 13 Bondi Road transects - one hour maximum nitrogen dioxide concentrations (criterion = 263 µg/m^3)

[6] The AUSROADS on-line help describes this as: "In a depressed section the air remains longer in the mixing zone (mixing zone = total width of traffic lanes + 3 meters on each side). The residence time increases with increasing depth of the depressed section. Concentrations adjacent to a depressed section are higher than an equivalent At-grade section. However, concentrations further downwind are lower due to the increased vertical mixing."

Alternate transects

Alternate transects are included in order to account for the curve in the railway line to the north and south of the level crossing (refer to Figure 2). Alternate transects were not required for Edithvale as the project area does not curve (refer to Figure 1).The transects presented in Figure 14 and Figure 15 are for the areas to the north and south of the Bonbeach level crossing (at Bondi Road). It is at this location where the trench would be deepest, and it would be expected to have the greatest differences in air quality. This location is south of the mid-point of the project area. Figure 12, demonstrates some asymmetry at the northern end where the rail corridor curves.

Modelling of the two scenarios has been performed for transects near to Broadway Street (north of Bondi Road) and Brixton Street (south of Bondi Road). The depths are not as extreme as at the Bondi Road transect and there are also subtle differences in Up and Down track orientations. At Broadway Street, the trench is approximately two metres deep. At Brixton Street, the trench is approximately 6.5 metres deep. They were modelled to conservatively demonstrate the asymmetrical nature of the trench at its deepest point where it is expected to have the greatest difference in air quality.

The Broadway Street transects (Figure 14) show less differences between the at-grade and the rail trench compared to the Bondi Road scenario. The trench at the Brixton Street transect (Figure 15) shows a greater impact compared to existing at-grade concentrations across the entire road corridor (between the rail corridor and the sensitive receptors). However, at and beyond the distance of the sensitive receptors on both Nepean Highway and Station Street the difference between the trench and at-grade predicted concentrations is very small but always lower.

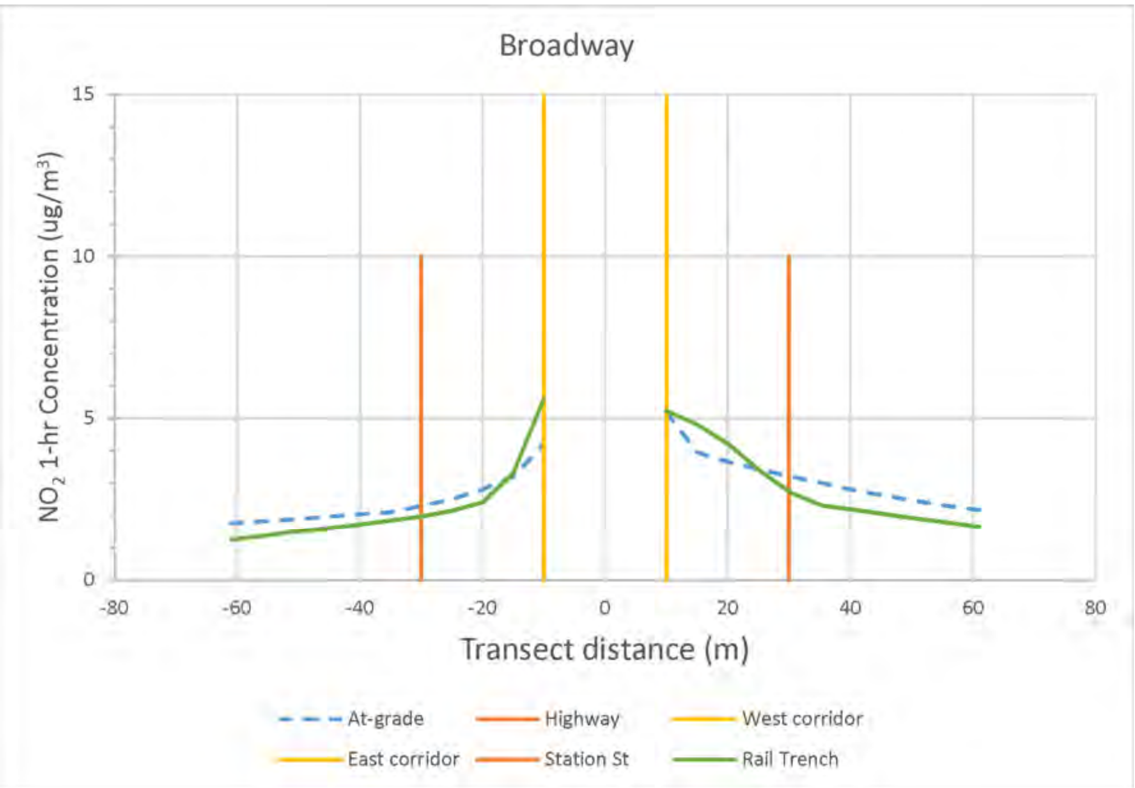

Figure 14 Broadway Street transects - one hour maximum nitrogen dioxide concentrations (criterion = 263 µg/m³)

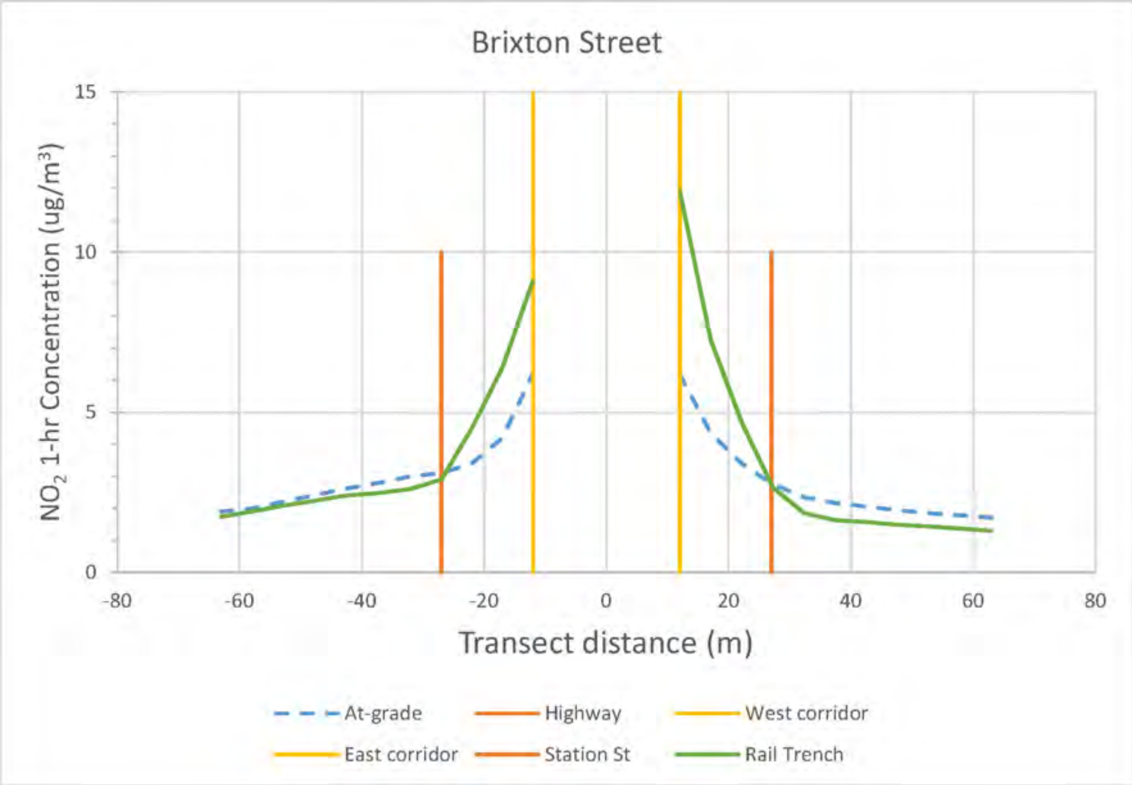

Figure 15 Brixton Street transects - one hour maximum nitrogen dioxide concentrations (criterion = 263 µg/m³)

Daily average PM_{10}

Figure 16 shows the predicted 24-hour PM_{10} concentrations with transect levels for the rail trench and the at-grade predictions (dashed blue line). At the distances beyond the edge of the sensitive receptor locations (west of Nepean Highway and east of Station Street) the predicted concentrations for the trench are very similar or slightly lower than the concentrations produced by emissions sources associated with the existing at-grade railway infrastructure. It is only between the rail corridor and the outer edge of the transport corridor that the built scenario varies to the existing at-grade infrastructure. This difference is very low compared to the assessment criterion of 60 µg/m³ and as they are road corridors, no sensitive receptor locations are present.

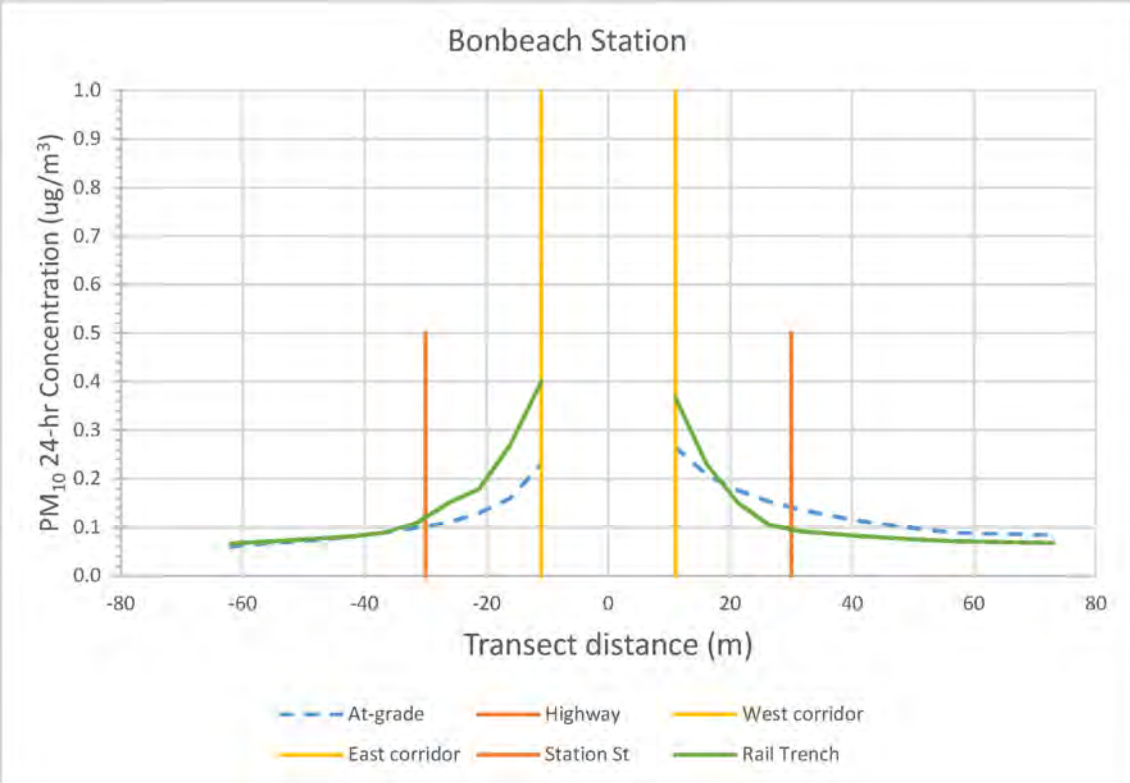

Figure 16 Bondi Road transects - 24-hour maximum PM_{10} concentrations (criterion = 60 µg/m^3)

Impact results for all modelled pollutants

All one hour assessed pollutants (nitrogen dioxide, carbon monoxide, sulphur dioxide, benzene and polycyclic aromatic hydrocarbons) and 24-hour assessed pollutants (PM_{10} and $PM_{2.5}$) have been modelled by AUSROADS. Table 13 provides the predicted concentrations, and an indication of the percentage of the intervention level of Table 4 at transect locations adjacent to the corridor (no sensitive receptors involved) and the sensitive receptor distances of the downwind side of the road corridors (Nepean Highway and Station Street).

As predicted by the metric in Table 4, the one-hour nitrogen dioxide worst-case scenario concentrations register the highest impacts as a percentage of the assessment criterion. Concentrations are two percent of the assessment criterion adjacent to the rail corridor and one to one-half percent of the criterion at the nearest sensitive receptors either side of the transport corridors. All other pollutants, including the 24-hour assessed PM_{10} and $PM_{2.5}$, are well less than one percent of the respective assessment criterion.

For all pollutants, worst-case predicted concentrations are orders of magnitude lower than the conservatively estimated worst-case background concentrations.

At the nearest sensitive receptors, the differences between existing at-grade infrastructure and level crossing removal are predicted to be minimal. However, the level crossing removal would result in very similar concentrations of all pollutants at the nearest sensitive receptors compared to the existing infrastructure.

Table 13 Predicted impact results as percentage of intervention level (IL) assessment criterion

Pollutant	At-grade (existing conditions)		Rail trench	
	µg/m³	% of IL	µg/m³	% of IL
NO_2	1-hr criterion = 263 µg/m³		Background = 48 µg/m³ (18 %)	
West corridor	5.1	1.9 %	11.8	4.5 %
East corridor	5.6	2.1 %	10.6	4.0 %
West sensitive receptors	2.5	1.0 %	1.7	0.6 %
East sensitive receptors	2.5	1.0 %	3.0	1.2 %
PM_{10}	24-hr criterion = 60 µg/m³		Background = 23 µg/m³ (38 %)	
West corridor	0.23	0.38 %	0.40	0.67 %
East corridor	0.27	0.44 %	0.37	0.61 %
West sensitive receptors	0.10	0.17 %	0.11	0.18 %
East sensitive receptors	0.14	0.23 %	0.09	0.15 %
$PM_{2.5}$	24-hr criterion = 36 µg/m³		Background = 8.7 µg/m³ (24 %)	
West corridor	0.22	0.61 %	0.39	1.09 %
East corridor	0.26	0.72 %	0.36	1.01 %
West sensitive receptors	0.10	0.28 %	0.11	0.29 %
East sensitive receptors	0.13	0.37 %	0.09	0.25 %
CO	1-hr criterion = 33210 µg/m³		Background = 250 µg/m³ (0.8 %)	
West corridor	22	0.07 %	45	0.14 %
East corridor	24	0.07 %	49	0.15 %
West sensitive receptors	11	0.033 %	13	0.039 %
East sensitive receptors	11	0.032 %	7.1	0.021 %
SO_2	1-hr criterion = 550 µg/m³		Background = 8 µg/m³ (1.5 %)	
West corridor	0.032	0.006 %	0.066	0.012 %
East corridor	0.035	0.006 %	0.073	0.013 %
West sensitive receptors	0.016	0.0029 %	0.019	0.0035 %
East sensitive receptors	0.016	0.0029 %	0.011	0.0019 %
Benzene	1-hr criterion = 75 µg/m³		Background = 7 µg/m³ (9.3 %)	
West corridor	0.08	0.11 %	0.17	0.23 %

Pollutant	At-grade (existing conditions)		Rail trench	
	µg/m³	% of IL	µg/m³	% of IL
East corridor	0.09	0.12 %	0.19	0.25 %
West sensitive receptors	0.041	0.055 %	0.049	0.065 %
East sensitive receptors	0.041	0.054 %	0.027	0.036 %
PAH	1-hr criterion = 0.5 µg/m³		Background = 0.00055 µg/m³ (0.1 %)	
West corridor	3.88E-07	0.00008 %	8.07-07	0.00016 %
East corridor	4.27E-07	0.00009 %	8.91E-07	0.00018 %
West sensitive receptors	1.91E-07	0.000038 %	2.30E-07	0.000046 %
East sensitive receptors	1.91E-07	0.000038 %	1.28E-07	0.000026 %

Management and mitigation

Overall, air quality emissions resulting from the existing at-grade rail infrastructure and the level crossing removal at Bonbeach are well below design and intervention limits. Therefore, no measures to avoid, minimise or manage air quality impacts are required.

7.2.2.3 Air quality impacts due to changes in traffic conditions

Changes in air quality due to changed traffic conditions for Bonbeach are the same as for Edithvale and are discussed in 7.1.2.3 above.

8 Environmental Performance Requirements

The EPRs required for the projects are summarised in the table below. The EPRs are applicable to the final design and construction approach and provide certainty regarding the environmental performance of the projects.

Table 14 Edithvale and Bonbeach Environmental Performance Requirements

EPR ID	Environmental Performance Requirement	Stage
AQ1	**Air Quality (construction)** Manage construction activities to minimise dust, odour and other emissions in accordance with EPA Publication 480 *Environmental Guidelines for Major Construction Sites.*	Construction
AQ2	**Air Quality management** Control the emission of smoke, dust, fumes and other pollution into the atmosphere during construction and operation in accordance with the State Environment Protection Policy Air Quality Management and State Environment Protection Policy Ambient Air Quality.	Construction
CL2	**Acid Sulfate Soil Management Plan** Prepare and implement an Acid Sulfate Soil Management Plan prior to construction of the project to the satisfaction of the EPA in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999, EPA Publication 655.1 Acid Sulfate Soil and Rock, and relevant EPA regulations, standards and best practice guidance in consultation with the EPA. This plan will include: a) identify locations and extent of potential acid sulfate soils. b) assess potential impact for human health, odour and environment c) identify and implement measures to prevent oxidation of acid sulfate soils wherever possible d) identify suitable sites for management, reuse or disposal of acid sulfate soils.	Construction

EPR ID	Environmental Performance Requirement	Stage
CL3	**Waste management** Manage wastes during the construction of the projects through development and implementation of a Construction Environmental Management Plan in accordance with the EPA Publication 480 Environmental Guidelines for Major Construction Sites, EPA Publication 347.1 Bunding, Australian Standard AS1940 Storage and Handling of Flammable and Combustible Liquids, and relevant EPA and Victorian WorkCover Authority regulations, standards and best practice guidance that includes: a) application of the waste management hierarchy in assessing waste management options b) contamination and waste management requirements (e.g. use of waste and recycling facilities, maintenance of a clean site policy) c) designated vehicle refuelling area d) chemical management procedures, such as minimising use and storage of chemicals on site, bunded storage facilities to ensure spills, washing residues, slurries or other contaminated water can be contained, and are managed/disposed of appropriately e) location and type of spill kits required f) staff training and competence requirements g) use of well-maintained plant to minimise the potential for spills to occur h) procedures to remove, treat and/or dispose soil that becomes contaminated due to a fuel or chemical spill i) storage of litter in bins from which it cannot escape (temporary fencing may be used as a secondary containment measure for litter).	Construction

9 Conclusion

An air quality impact assessment has been undertaken for the Edithvale and Bonbeach level crossing removal projects to determine the impacts of air quality as a result of the projects and to identify management and mitigation options in order to reduce potential risks of the projects.

Existing conditions

Existing ambient air quality can be considered as 'good' as it is rare for the National Environment Measure (Ambient Air Quality) standards to be exceeded at the population exposure monitoring sites of Dandenong and Brighton. These sites are considered to be conservatively site-representative of the projects. The south-eastern suburbs of Greater Melbourne experience meteorological influences to enhance dispersion conditions relative to locations further inland or more surrounded by urbanised sources.

There would be localised increases in air pollutant levels associated with the transport corridors of Nepean Highway and Station Street. A local source of elevated air pollutants is also the transit of diesel multiple units along the rail corridor currently. However, these have been demonstrated to be very low compared to background concentrations due to further afield sources and significantly lower than the relevant air quality criteria.

Impact assessment

The assessment of environmental impact relating to air quality identified impacts relating to:

- dust emissions during construction
- combustion emissions during construction
- odour from the disturbance of acid sulfate soils and organic materials during construction
- diesel engine exhaust emissions from diesel trains during operation
- air quality impacts due to changes in traffic conditions during operation.

During the construction phase, dust, combustion and odour could potentially impact amenity and human health. Implementing dust, combustion and odour management measures (**EPR_AQ1, EPR_AQ2 and EPR_AQ3**) would maintain a risk rating of negligible. These include dust monitoring and management measures, no burning of waste on site and management of odour from acid sulfate soils, all in accordance with Best Practice Environmental Guidelines *Environmental Guidelines for Major Construction Sites* (EPA Victoria Publication 480) and *Victorian Best Practice Guidelines for Assessing and Managing coastal Acid Sulfate Soils* (State of Victoria, 2010).

During the operation phase, air dispersion modelling predicts that for all modelled pollutants, pollutant concentrations are found to be much lower than background concentrations and significantly lower than the air quality criterion at all sensitive receptors to the point of negligibility.

At the nearest sensitive receptor locations along Nepean Highway and Station Street, the differences between the existing at-grade infrastructure and the level crossing removals would be minimal. However, the level crossing removals would result in very similar concentrations of all pollutants at the nearest sensitive receptors compared to impacts from the existing infrastructure.

Additionally, air quality due to changes in traffic conditions are likely to be minimal as current air quality emissions due to traffic are already very low. Implementation of SEPP AQM initiatives demonstrate that per unit and vehicle fleet emissions would decrease (refer to Appendix C).

Operational risks associated with diesel engine exhaust emissions and air quality impacts due to changes in new traffic conditions are well below intervention levels recommended in SEPP AQM, no management and mitigation is recommended for operational phases of the projects.

10 References

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Appendix A – Diurnal emission profiles for Edithvale

Table A1 Train emission factors (g/km) for nitrogen dioxide (Edithvale)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	12.4	0	12.4	0	12.4	0
1:00 am – 2:00 am	0	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	12.4	0	12.4	0	0
6:00 am – 7:00 am	0	0	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	12.4
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	12.4	0	0	0	12.4	0
1:00 pm – 2:00 pm	0	0	12.4	0	0	0
2:00 pm – 3:00 pm	12.4	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	12.4	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	12.4	0	12.4
7:00 pm – 8:00 pm	0	12.4	0	0	0	0
8:00 pm – 9:00 pm	0	4.7	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	4.7	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table A2 Train emission factors (g/km) for carbon monoxide (Edithvale)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	52	0	52	0	52	0
1:00 am – 2:00 am	0	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	52	0	52	0	0
6:00 am – 7:00 am	0	0	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	52
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	52	0	0	0	52	0
1:00 pm – 2:00 pm	0	0	52	0	0	0
2:00 pm – 3:00 pm	52	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	52	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	52	0	52
7:00 pm – 8:00 pm	0	52	0	0	0	0
8:00 pm – 9:00 pm	0	20	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	20	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table A3 Train emission factors (g/km) for sulphur dioxide (Edithvale)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	0.077	0	0.077	0	0.077	0
1:00 am – 2:00 am	0	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	52	0	0.077	0	0
6:00 am – 7:00 am	0	0	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	0.077
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	0.077	0	0	0	0.077	0
1:00 pm – 2:00 pm	0	0	0.077	0	0	0
2:00 pm – 3:00 pm	0.077	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	0.077	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	0.077	0	0.077
7:00 pm – 8:00 pm	0	0.077	0	0	0	0
8:00 pm – 9:00 pm	0	0.030	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	0.030	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table A4 Train emission factors (g/km) for PM10 (Edithvale)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	6.7	0	6.7	0	6.7	0
1:00 am – 2:00 am	0	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	6.7	0	6.7	0	0
6:00 am – 7:00 am	0	0	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	6.7
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	6.7	0	0	0	6.7	0
1:00 pm – 2:00 pm	0	0	6.7	0	0	0
2:00 pm – 3:00 pm	6.7	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	6.7	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	6.7	0	6.7
7:00 pm – 8:00 pm	0	6.7	0	0	0	0
8:00 pm – 9:00 pm	0	2.6	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	2.6	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table A5 Train emission factors (g/km) for PM2.5 (Edithvale)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	6.6	0	6.6	0	6.6	0
1:00 am – 2:00 am	0	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	6.6	0	6.6	0	0
6:00 am – 7:00 am	0	0	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	6.6
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	6.6	0	0	0	6.6	0
1:00 pm – 2:00 pm	0	0	6.6	0	0	0
2:00 pm – 3:00 pm	6.6	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	6.6	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	6.6	0	6.6
7:00 pm – 8:00 pm	0	6.6	0	0	0	0
8:00 pm – 9:00 pm	0	2.5	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	2.5	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table A6 Train emission factors (g/km) for benzene (Edithvale)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	0.20	0	0.20	0	0.20	0
1:00 am – 2:00 am	0	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	52	0	0.20	0	0
6:00 am – 7:00 am	0	0	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	0.20
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	0.20	0	0	0	0.20	0
1:00 pm – 2:00 pm	0	0	0.20	0	0	0
2:00 pm – 3:00 pm	0.20	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	0.20	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	0.20	0	0.20
7:00 pm – 8:00 pm	0	0.20	0	0	0	0
8:00 pm – 9:00 pm	0	0.07	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	0.07	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table A7 Train emission factors (g/km) for polycyclic aromatic hydrocarbons (Edithvale)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	9.4E-7	0	9.4E-7	0	9.4E-7	0
1:00 am – 2:00 am	0	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	9.4E-7	0	9.4E-7	0	0
6:00 am – 7:00 am	0	0	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	9.4E-7
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	9.4E-7	0	0	0	9.4E-7	0
1:00 pm – 2:00 pm	0	0	9.4E-7	0	0	0
2:00 pm – 3:00 pm	9.4E-7	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	9.4E-7	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	9.4E-7	0	9.4E-7
7:00 pm – 8:00 pm	0	9.4E-7	0	0	0	0
8:00 pm – 9:00 pm	0	3.6E-7	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	3.6E-7	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Appendix B – Diurnal emission profiles for Bonbeach

Table B1 Train emission factors (g/km) for nitrogen dioxide (Bonbeach)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	0	0	12.4	0	12.4	0
1:00 am – 2:00 am	12.4	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	0	0	12.4	0	0
6:00 am – 7:00 am	0	12.4	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	12.4
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	12.4	0	0	0	0	0
1:00 pm – 2:00 pm	0	0	12.4	0	12.4	0
2:00 pm – 3:00 pm	12.4	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	12.4	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	12.4	0	12.4
7:00 pm – 8:00 pm	0	12.4	0	0	0	0
8:00 pm – 9:00 pm	0	4.7	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	4.7	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table B2 Train emission factors (g/km) for carbon monoxide (Bonbeach)

Hour	Monday-Friday		Saturday		Sunday	
	Down	Up	Down	Up	Down	Up
12:00 am – 1:00 am	0	0	52	0	52	0
1:00 am – 2:00 am	52	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	0	0	52	0	0
6:00 am – 7:00 am	0	52	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	52
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	52	0	0	0	0	0
1:00 pm – 2:00 pm	0	0	52	0	52	0
2:00 pm – 3:00 pm	52	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	52	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	52	0	52
7:00 pm – 8:00 pm	0	52	0	0	0	0
8:00 pm – 9:00 pm	0	20	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	20	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table B3 Train emission factors (g/km) for sulphur dioxide (Bonbeach)

Hour	Monday-Friday		Saturday		Sunday	
	Down	Up	Down	Up	Down	Up
12:00 am – 1:00 am	0	0	0.077	0	0.077	0
1:00 am – 2:00 am	0.077	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	0	0	0.077	0	0
6:00 am – 7:00 am	0	0.077	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	0.077
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	0.077	0	0	0	0	0
1:00 pm – 2:00 pm	0	0	0.077	0	0.077	0
2:00 pm – 3:00 pm	0.077	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	0.077	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	0.077	0	0.077
7:00 pm – 8:00 pm	0	0.077	0	0	0	0
8:00 pm – 9:00 pm	0	0.030	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	0.030	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table B4 Train emission factors (g/km) for PM10 (Bonbeach)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	0	0	6.7	0	6.7	0
1:00 am – 2:00 am	6.7	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	0	0	6.7	0	0
6:00 am – 7:00 am	0	6.7	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	6.7
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	6.7	0	0	0	0	0
1:00 pm – 2:00 pm	0	0	6.7	0	6.7	0
2:00 pm – 3:00 pm	6.7	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	6.7	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	6.7	0	6.7
7:00 pm – 8:00 pm	0	6.7	0	0	0	0
8:00 pm – 9:00 pm	0	2.6	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	2.6	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table B5 Train emission factors (g/km) for PM2.5 (Bonbeach)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	0	0	6.6	0	6.6	0
1:00 am – 2:00 am	6.6	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	0	0	6.6	0	0
6:00 am – 7:00 am	0	6.6	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	6.6
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	6.6	0	0	0	0	0
1:00 pm – 2:00 pm	0	0	6.6	0	6.6	0
2:00 pm – 3:00 pm	6.6	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	6.6	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	6.6	0	6.6
7:00 pm – 8:00 pm	0	6.6	0	0	0	0
8:00 pm – 9:00 pm	0	2.5	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	2.5	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table B6 Train emission factors (g/km) for benzene (Bonbeach)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	0	0	0.20	0	0.20	0
1:00 am – 2:00 am	0.20	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	0	0	0.20	0	0
6:00 am – 7:00 am	0	0.20	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	0.20
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	0.20	0	0	0	0	0
1:00 pm – 2:00 pm	0	0	0.20	0	0.20	0
2:00 pm – 3:00 pm	0.20	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	0.20	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	0.20	0	0.20
7:00 pm – 8:00 pm	0	0.20	0	0	0	0
8:00 pm – 9:00 pm	0	0.07	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	0.07	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Table B7 Train emission factors (g/km) for polycyclic aromatic hydrocarbons (Bonbeach)

Hour	Monday-Friday		Saturday		Sunday	
	Down	**Up**	**Down**	**Up**	**Down**	**Up**
12:00 am – 1:00 am	0	0	9.4E-7	0	9.4E-7	0
1:00 am – 2:00 am	9.4E-7	0	0	0	0	0
2:00 am – 3:00 am	0	0	0	0	0	0
3:00 am – 4:00 am	0	0	0	0	0	0
4:00 am – 5:00 am	0	0	0	0	0	0
5:00 am – 6:00 am	0	0	0	9.4E-7	0	0
6:00 am – 7:00 am	0	9.4E-7	0	0	0	0
7:00 am – 8:00 am	0	0	0	0	0	9.4E-7
8:00 am – 9:00 am	0	0	0	0	0	0
9:00 am – 10:00 am	0	0	0	0	0	0
10:00 am – 11:00 am	0	0	0	0	0	0
11:00 am – 12:00 pm	0	0	0	0	0	0
12:00 pm – 1:00 pm	9.4E-7	0	0	0	0	0
1:00 pm – 2:00 pm	0	0	9.4E-7	0	9.4E-7	0
2:00 pm – 3:00 pm	9.4E-7	0	0	0	0	0
3:00 pm – 4:00 pm	0	0	0	0	0	0
4:00 pm – 5:00 pm	0	0	0	0	0	0
5:00 pm – 6:00 pm	0	9.4E-7	0	0	0	0
6:00 pm – 7:00 pm	0	0	0	9.4E-7	0	9.4E-7
7:00 pm – 8:00 pm	0	9.4E-7	0	0	0	0
8:00 pm – 9:00 pm	0	3.6E-7	0	0	0	0
9:00 pm – 10:00 pm	0	0	0	0	0	0
10:00 pm – 11:00 pm	3.6E-7	0	0	0	0	0
11:00 pm – 12:00 am	0	0	0	0	0	0

Appendix C – Traffic emissions as a function of average speed

Traffic emissions

For an example of how road transport emissions improve as congestion decreases and average speeds increase slightly, the emission factors for oxides of nitrogen are shown in Figure C1. The curves display the difference in emissions due to:

- speed (x-axis)
- vehicle category (heavy and light vehicles shown as solid and dashed lines, respectively)
- time horizon (years 2011 and 2021 shown as blue and red lines, respectively).

It is noted that (for most, but not all, constituent types):

- emissions decrease from 2011 to 2021 due to the vehicle fleet being progressively replaced by vehicles with tighter regulation and control (Australian Design Rules, which reflect European standards) over tail-pipe emissions of the newest vehicles. Euro-2 and Euro-3 introduced for Australian vehicles during 2002 to 2006 (ADR79/01 & ADR80/01) with Euro-4 for heavy-duty vehicles after 2006 and light-duty vehicles after 2008, and Euro-5 for heavy-duty vehicles beyond 2009.
- the lowest emissions occur in the mid-range of speeds with the highest increase seen at heavily congested traffic speeds and, to a lesser degree, at higher freeway speeds
- light/car emissions differ from heavy/truck emissions due mainly to the dominance of fuel type (petrol for cars and diesel for trucks).

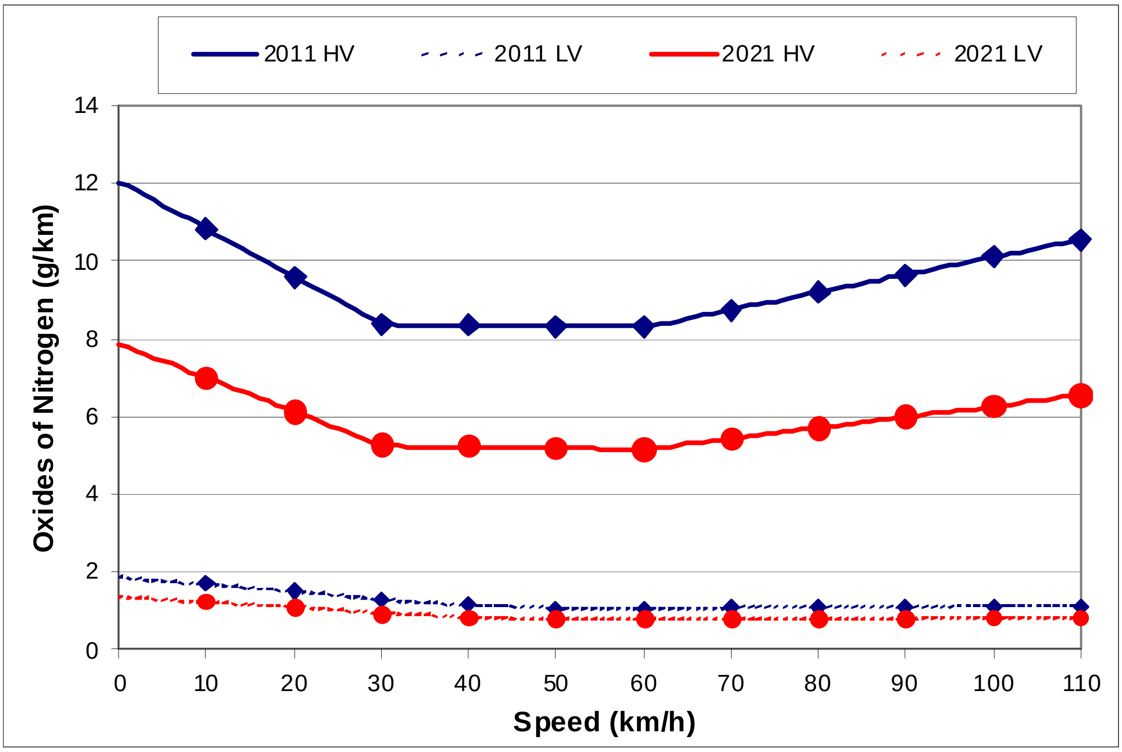

Figure C1 Emissions of Oxides of Nitrogen (NOx) due to speed, vehicle type and year

Appendix D – Risk assessment

Table D1 Guide to quantification of likelihood

Qualitative descriptions	Probability over a given time period	Basis
A. Certain	1 (or 0.999, 99.9 %)	Certain, or as near to as makes no difference
B. Almost certain	0.2 – 0.9	One or more incidents of a similar nature has occurred here
C. Highly probable	0.1	A previous incident of a similar nature has occurred here
D. Possible	0.01	Could have occurred already without intervention
E. Unlikely	0.001	Recorded recently elsewhere
F. Very unlikely	1×10^{-4}	It has happened elsewhere
G. Highly improbable	1×10^{-5}	Published information exists, but in a slightly different context
H. Almost impossible	$1 X 10^{-6}$	No published information on a similar case

Source: Bowden, A.R., Lane, M.R. and Martin, J.H., 2001, Triple Bottom Line Risk Management – Enhancing Profit, Environmental Performance and Community Benefit, Wiley and Sons, New York, 314 pp.

Table D2 Consequence table used for air quality risk assessment

<table>
<tr><th>Qualitative descriptor</th><th colspan="2">Negligible</th><th colspan="2">Minor</th><th colspan="2">Moderate</th><th colspan="2">Major</th><th>Extreme</th></tr>
<tr><td>Consequence description</td><td colspan="2">Minimal, if any impact for some communities. Potentially some impact for a small number (<10) of individuals</td><td colspan="2">Low level impact for some communities, or high impact for a small number (<10) of individuals</td><td colspan="2">High level of impact for some communities, or moderate impact for communities area-wide</td><td colspan="2">High level of impact for communities area-wide</td><td>High level of impact State-wide</td></tr>
<tr><td></td><td>0.1</td><td>0.3</td><td>1</td><td>3</td><td>10</td><td>30</td><td>100</td><td>300</td><td>1000</td></tr>
<tr><td>ENVIRONMENT
Air quality</td><td colspan="2">Applicable air quality standards SEPP (AQM) met across the region.</td><td colspan="2">Isolated, short-term exceedance of SEPP (AQM).</td><td colspan="2">Minor local exceedance of SEPP (AQM).</td><td colspan="2">Minor, short-term exceedance of SEPP (AQM) over a widespread area.</td><td>Major, widespread, long-term exceedance of SEPP (AQM).</td></tr>
<tr><td rowspan="2">SOCIAL
Amenity
(Traffic/ air/noise/odour/visual impacts)</td><td colspan="2">Short term impacts that alter perception of area as a high amenity place to live / visit.</td><td colspan="2">Short term (months) localised impacts that alter perception of area as a high amenity place to live / visit.</td><td colspan="2">Medium term (1-2 years) regional impacts that alter perception of area as a high amenity place to live / visit.</td><td colspan="2">Community perception that the area is significantly damaged.</td><td>Community perception that the area has experienced major damage.</td></tr>
<tr><td colspan="2">Region still seen as attractive place to live.</td><td colspan="2">Region not locally seen as attractive place to live.</td><td colspan="2">Region not widely seen as attractive place to live.</td><td colspan="2">Area loses appeal as residential area.
Recovery > 2 yrs.</td><td>Area is a place to be avoided.
Recovery, if at all, >10 yrs.</td></tr>
<tr><td>PUBLIC HEALTH AND SAFETY
Illness/Injury/Fatality</td><td colspan="2">Potentially some impact to less than 10 individuals.</td><td colspan="2">Minor injury or illness to less than 10 individuals.</td><td colspan="2">Minor injury or illness to between 10 and 100 individuals.
Major injury or illness to 1 individual.</td><td colspan="2">Minor injury or illness to between 100 and 1000 individuals.
Major injury or illness to between 1 and 10 individuals.
1 fatality or serious injury.</td><td>Major injury or illness to between 10 and 100 individuals.
Between 1 and 10 fatalities or serious injuries.</td></tr>
</table>

Table D3 Air Quality risks

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Construction risks										
AQ 9	Air quality-dust (amenity)	Off-site dust levels results in perceived loss of amenity	EPR AQ1 Air quality (construction) EPR AQ2 Air quality management	Unlikely	Minor	Negligible	As initial EPR	Unlikely	Minor	Negligible
AQ 10	Air quality-dust (health)	Off-site dust levels above limits causes health impacts	EPR AQ1 Air quality (construction) EPR AQ2 Air quality management	Highly improbable	Minor	Negligible	As initial EPR	Highly improbable	Minor	Negligible
AQ 11	Air quality-plant combustion	Off-site NOX, SOX, CO, benzene, polycyclic aromatic hydrocarbons assessed as above SEPP (Air Quality Management) levels resulting in health impacts to sensitive receptors	EPR AQ1 Air quality (construction) EPR AQ2 Air quality management	Almost impossible	Minor	Negligible	As initial EPR	Almost impossible	Minor	Negligible
AQ 12	Air quality-odour	Odour from contaminated soils (including acid sulfate soils) resulting in amenity impacts	EPR CL2 Acid Sulfate Soils management sub-plan EPR CL3 Waste management	Possible	Minor	Negligible	As initial EPR	Possible	Minor	Negligible

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Operation risks										
AQ 13	Air quality (diesel train emissions)	Diesel train emissions (such as particulates, nitrogen dioxide, sulphur dioxide, carbon monoxide benzene, polyaromatic hydrocarbons) above SEPP Air Quality Management levels resulting in health impacts to sensitive receptors.	No EPR required	Highly improbable	Negligible	Negligible	No EPR required	Highly improbable	Negligible	Negligible