VicRoads

Western Highway Project – Section 3: Ararat to Stawell

Air Quality Impact Assessment Report

November 2012

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Executive Summary

VicRoads is progressively upgrading the Western Highway as a four-lane divided highway between Ballarat and Stawell (Western Highway Project). The Western Highway Project consists of three sections, to be constructed in stages. Section 3 (Ararat to Stawell) of the Western Highway Project (the Project) is the subject of this report.

On 27 October 2010, the Victorian Minister for Planning advised that an Environment Effects Statement (EES) would be required to identify the anticipated environmental effects of the Project. GHD has been commissioned by VicRoads to undertake an air quality impact assessment for Section 3 of the Project as part of the EES.

Following a multi-criteria assessment of numerous potential alignment options, VicRoads selected an alignment for the Project (the Alignment or Alignment Option) which was subject to the risk and impact assessment presented in this report. The Alignment Option is outlined in section 6.1 of this report.

The EES scoping requirements for the air quality impact assessment of the Project are detailed in section 2 of this report. In summary, they require a characterisation of ambient air quality and identification of sensitive receptors, and an identification and assessment of the potential effects of road construction and operation activities on sensitive receptors, and an identification of any measures to avoid, mitigate and manage any potential adverse effects.

The air impact assessment undertaken by GHD involved a review of available information to assess the existing air quality and prevailing conditions within the Project Area (outlined in section 5). This was followed by an assessment of the Proposed Alignment against the existing conditions to determine the potential positive and negative impacts of the Project both during construction and operation.

Assessment of existing meteorology indicates that the entire Study Area from Ararat to Stawell can be classified as having a ‘temperate’ climate with ‘no dry season (warm summer)’. Extreme values in temperature occur, with hot days more frequent at the north-western (Stawell) end and frosty mornings occurring more often at the south-eastern (Ararat) end. A meteorological data file for the Project was constructed based on the BoM Automatic Weather Station at Stawell (Project site representative). Annual average winds are predominantly from the south, with a seasonal switch to come from the south during the warmer months and then to the north with a north-west sector tendency during winter. The atmospheric stability class for the Project (represented by Stawell) is predominantly ‘neutral’ for about one half of all hours but ‘stable’ for about one third of the time. Neutral would be the most often occurring stability category during construction hours. The wettest months occur in spring (September – November) with greater rain fall expected at the south-eastern end of the Study Area, leading to the conclusion that impacts from construction dust would have potential to be slightly higher at the north-western end.

The air quality impact of the Project is influenced from two main emission sources, which are the dust emissions resulting from the construction activities and the vehicle emissions resulting from the operational condition. Modelling of both construction and operation emissions was carried out in order to determine the emissions levels and their impact on the local environment.

In summary, the assessment identified the following potential impacts and risks:

- Construction impacts to air quality are expected to extend beyond the construction corridor with greater effects noted to the west of the road than to the east due to meteorological behaviour. Construction dust is predicted to be greatest during the first stage (set out and preparation) of the construction as opposed to the second stage (surface preparation and compaction), with the predicted maximum impact zone of up to 520 metres (m) from the western edge of the construction zone and up to 470 m from the eastern edge of the construction zone. Based on the results, there are 117 potential sensitive receptors located within the construction dust impact zone. Any potential sensitive receptors located within the construction dust impact zone would require additional dust management control (Section 7) to minimise impacts on amenity;
- Operational air quality impacts are expected to be no more than minor. The assessed air pollutants from vehicles on the Project are predicted to be below the Intervention Level for Air Quality Management used in Victoria at the edge of the outer road lane (outer boundary of carriageway – section 4.3.2);
- Potential sensitive receptors relating to intensive agricultural practices or farms growing primary produce, such as vineyards or olive groves, were identified to be within the construction dust impact zone. Additional dust management control (Section 7) would be required to effectively reduce dust impacts to a minimum. The operational air quality impacts on vineyards or olive groves are considered to be negligible as it is predicted that any future increases in emissions are likely to be negligible; and
- Both construction and operational emissions are not expected to affect domestic water supplies.

All of the identified impacts are considered to be negligible or low provided that the identified mitigation measures (outlined in Section 7) are implemented. The proposed Section 3 Alignment would provide the benefit and opportunity of improving traffic flows which would lower travel times and may decrease vehicle emissions to the environment, resulting in an improvement in air quality.

This Report is subject to, and must be read in conjunction with, the limitations set out in the Report, and the assumptions and qualifications contained throughout the Report.

Glossary of Terms

Abbreviation	Definition
Aeolian Transport	The term is used to describe particles transported by the wind. Dust becomes airborne when winds traversing arid land with little vegetation cover pick up small particles such as sand, dust and soil, and send them skyward. Aeolian transport may occur through *suspension*, *saltation* or *creep* of the particles. (Heidorn, 2002)
AMP	Access Management Policy
AUSRAODS	Australian road modelling software
AUSPLUME	Australian dispersion modelling software
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
˚C	Degree Celsius
CEMP	Construction Environmental Management Plan
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EES	Environmental Effects Statement
EETM	Emission Factor Estimation Techniques Manual
EPA	Environment Protection Act
g/cm^3	Grams per cubic centimetre
g/VKT	Grams per Vehicle Kilometre Travelled
GHD	GHD Pty Ltd
HV	Heavy Vehicle
ID	Identification
IRR	Initial Risk Rating
kg	Kilogram
$kg/m^2/h$	Kilograms per metre square per hour
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LV	Light Vehicle
m/s	Metres per second
mm	Millimetre

Abbreviation	Definition
NEPM	National Environment Protection Measures
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NEPC	National Environment Protection Council
NPI	National Pollutant Inventory
PAH	Polycyclic Aromatic Hydrocarbon
PEM	Protocol for Environmental Management
PEPS	Project Environment Protection Strategy
PFI	Persistent Feature Identifier
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 µm
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 µm
RRR	Residual Risk Rating
SEPP (AAQ)	State Environment Protection Policy Ambient Air Quality
SEPP (AQM)	State Environment Protection Policy Air Quality Management
SO_2	Sulphur Dioxide
TSP	Total Suspended Particulates, or all particles that are suspended in the atmosphere at a particular time. In practice this would refer to particulates up to 30 µm (i.e. diameter of 30 micrometres), but may include particles up to 50 µm in aerodynamic diameter under extreme (in this case higher wind speed) conditions.
$\mu g/m^3$	Micrograms per cubic metre
veh	Vehicle
VicRoads DC1	VicRoads Design and Construct
VKT	Vehicle Kilometres Travelled
VR	VicRoads

1. Introduction

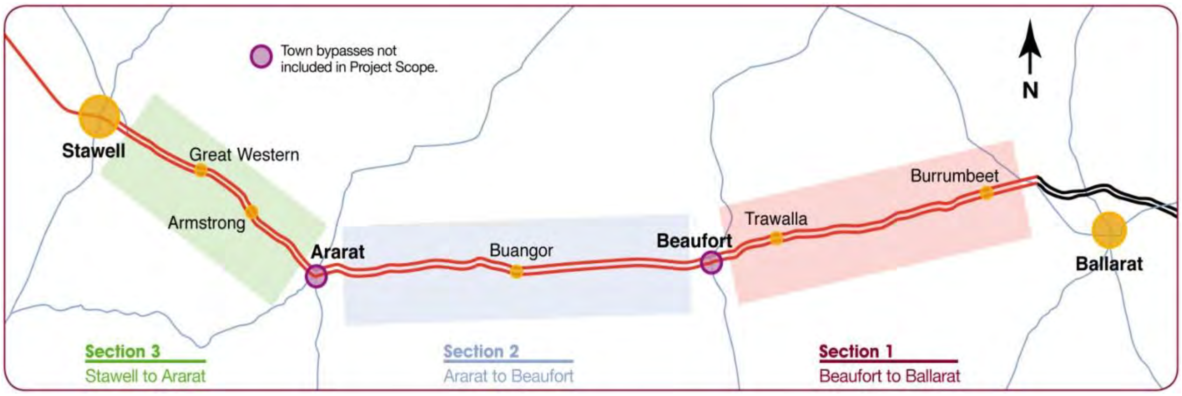
1.1 Background

The Western Highway (A8) is being progressively upgraded as a four-lane divided highway for approximately 110 kilometres (km) between Ballarat and Stawell. As the principal road link between Melbourne and Adelaide, the Western Highway serves interstate trade between Victoria and South Australia and is the key corridor through Victoria's west, supporting farming, grain production, tourism and a range of manufacturing and service activities. Currently, more than 5500 vehicles travel on the highway west of Ballarat each day, including 1500 trucks.

The Western Highway Project (here within referred to as 'the Project') consists of three stages, illustrated in Figure 1:

- Section 1: Ballarat to Beaufort
- Section 2: Beaufort to Ararat
- Section 3: Ararat to Stawell

Figure 1 The Western Highway Project



Works on an initial 8 km section between Ballarat and Burrumbeet (Section 1A) commenced in April 2010 and will be completed in 2012. Construction for Section 1B (Burrumbeet to Beaufort-Carngham Road) commenced in early 2012 and is expected to be completed by June 2014. The last 3 km section from Beaufort-Carngham Road to Smiths Lane in Beaufort (Section 1C) commenced in late 2011 and will finish in 2012. Separate Environment Effects Statements (EESs) and Planning Scheme Amendments (PSAs) must be prepared for both Sections 2 and 3. It is expected that Sections 2 and 3 will be completed and opened in stages through to 2016, subject to future funding.

Section 2 of the Project commences immediately west of the railway crossing (near Old Shirley Road) west of the Beaufort township and extends for a distance of approximately 38 km to Heath Street, Ararat.

Section 3 of the Project commences at Pollard Lane, Ararat and extends for approximately 24 km to Gilchrist Road, Stawell.

The EES will focus on assessment of the proposed ultimate upgrade of the Western Highway between Beaufort and Stawell to a duplicated highway standard complying with the road category 1 (freeway) of VicRoads Access Management Policy (AMP1). The project includes a duplicated road to allow for two lanes in each direction separated by a central median.

The EES has also considered a proposed interim upgrade of the Western Highway to a highway standard complying with the VicRoads Access Management Policy AMP3. When required, the final stage of the project is proposed to be an upgrade to freeway standard complying with AMP1.

The proposed interim stage of the Project (AMP3) would provide upgraded dual carriageways with wide median treatments at key intersections. Ultimately, the Western Highway is proposed to be a freeway (AMP1) where key intersections would be grade separated, service roads constructed and there would be no direct access to the highway.

To date $505 million has been committed for the Western Highway Project by the Victorian Government and the Australian Government as part of the Nation Building Program.

Highway improvements for the three sections between Ballarat and Stawell would involve:

- Constructing two new traffic lanes adjacent to the existing highway, separated by a central median.
- Converting the existing highway carriageway to carry two traffic lanes in the opposite direction.
- Constructing sections of new four-lane divided highway on a new alignment.

In addition to separating the traffic lanes, highway safety would be improved with sealed road shoulders, safety barriers, protected turning lanes, intersection improvements, and service lanes for local access at some locations.

Town bypasses of Beaufort and Ararat are not included in the current proposals. Beyond Stawell to the Victorian border, ongoing Western Highway improvements would continue with shoulder sealing works, new passing lanes and road surface improvements.

The aims/objectives of this Project are to:

- Provide safer conditions for all road users by:
  - Reducing the incidence of head-on and run-off-road crashes;
  - Improving safety at intersections; and
  - Improving safety of access to adjoining properties.
- Improve efficiency of freight by designing for High Productivity Freight Vehicles.
- Provide adequate and improved rest areas.
- Locate alignment to allow for possible future bypasses of Beaufort and Ararat.

1.2 Project and Study Areas

1.2.1 Project Area

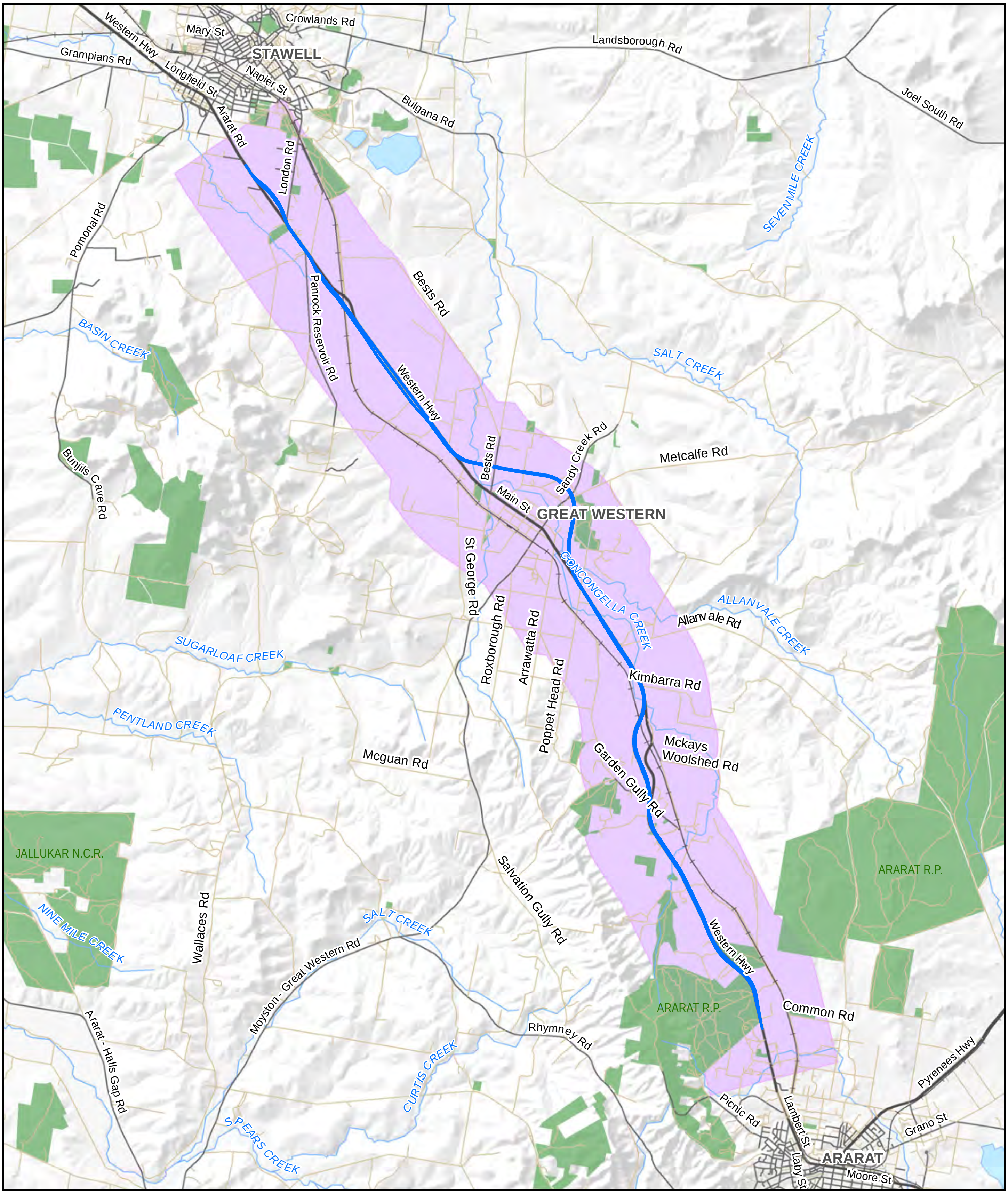
The Project Area was defined for the purposes of characterising the existing conditions for the Project, and to consider alignment alternatives. The Project Area encompasses a corridor extending generally up to 1500 metres (m) either side (east and west) of the edge of the road reserve, except around Great Western where the Project Area extends up to 1800 m (encompassing the extent of new alignment possibilities).

1.2.2 Study Area

The Study Area for this Air Quality assessment is the same as the Project Area described above and is approximately 24 km long, commencing at Pollard Lane, Ararat and finishing at Gilchrist Road, Stawell and extends outward to the east and west of the centreline, see Figure 1 and Figure 2.

1.3 Proposed Alignment

A multi-criteria assessment of alignment options was conducted based on information from the existing conditions assessments. The outcome was the selection of a proposed alignment for further consideration in the EES for Section 3. The proposed alignment and associated construction area is the subject of the risk and impact assessment presented in this report and are described in more detail in Section 6. The assessment of alignment options and selection of the proposed alignment is documented in Chapter 5 of the EES, and in the Options Assessment Paper (Technical Appendix to the EES).



LEGEND

- Proposed Alignment
- Study Area
- Highway
- Sealed road (arterial & local)
- Unsealed road
- Parks

Paper Size A4

0 0.5 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

CLIENTS | PEOPLE | PERFORMANCE

vicroads

VicRoads
Western Highway Project

Job Number | 31-27558
Revision | C
Date | 30 Oct 2012

Ararat to Stawell
Study Area

Figure 2

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

G:\31\27558\GIS\Maps\Deliverables\Stage 3\RISK AND IMPACT ASSESSMENT\08_CONTAM\3127558_S3_001_Study_Area_A4P.mxd

Data source: DSE, VicMap, 2012; VicRoads, 2011; GHD, Design, 2012. Created by:splaird

2. EES Scoping Requirements

2.1 EES Objectives

For the air quality aspects of the Western Highway Project, the relevant draft evaluation objective outlined in the EES Scoping Requirements is:

- To avoid or minimise air emissions, noise, visual, landscape, and other adverse amenity effects on local residents, during the development and operation of the proposed duplicated highway to the extent practicable.

2.2 EES Scoping Requirements

The EES Scoping Requirements for air quality aspects are:

- Characterise ambient air quality (in terms of dust) and identify sensitive receptors in the Project Area;
- Identify and assess potential effects of road construction activities on sensitive receptors due to an increase in dust or other emissions;
- Identify proposed measures to avoid, mitigate and manage any potential effects including any relevant techniques or methods to be used during construction to manage dust and odour and any residual effects; and
- Address any relevant requirements of *State Environment Protection Policy (Air Quality Management)* and *State Environment Protection Policy (Ambient Air Quality)* and assess any implications for the Project.

3. Legislation, Policy and Guidelines

3.1 Commonwealth

The National Environment Protection (Air Quality) Measure ('AQ NEPM') defines the Commonwealth requirements for national standards for criteria air pollutants in Australia which aims to establish (equivalent protection) for population exposure to selected air pollutants. The six key air pollutants are:

- Carbon monoxide;
- Ozone;
- Sulphur dioxide;
- Nitrogen dioxide;
- Lead; and
- Particulate matter.

Similarly, the National Environment Protection (Air Toxics) Measure ('Air Toxics NEPM') establishes 'monitoring investigation levels' for five air toxics:

- Benzene;
- Formaldehyde;
- Benzo(a)pyrene as a marker for Polycyclic Aromatic Hydrocarbons;
- Toluene; and
- Xylenes.

The above measures set standards for the achievement of ambient air quality goals but are legislated separately in each state jurisdiction. The section below outlines the Victorian legislation relevant for air pollutants from road projects.

3.2 State

3.2.1 Transport Integration Act (2010)

The *Transport Integration Act 2010* sets out a vision, objectives and principles for transport in Victoria. It makes clear that the transport system needs to be integrated and sustainable - in economic terms, in environmental terms and in social terms. It requires all Victorian transport agencies - including the Director of Public Transport, VicRoads, VicTrack, V/Line and the Linking Melbourne Authority to work together towards the common goal of an integrated and sustainable transport system.

Part 2 of the Act includes a vision statement, objectives, principles and a statement of policy and principles. Part 2, Division 2, Section 10 of the Act outlines the transport objectives with regard to environmental sustainability, these are:

"The transport system should actively contribute to environmental sustainability by—

(a) protecting, conserving and improving the natural environment;

(b) avoiding, minimising and offsetting harm to the local and global environment, including through transport-related emissions and pollutants and the loss of biodiversity;

(c) promoting forms of transport and the use of forms of energy and transport technologies which have the least impact on the natural environment;

(d) improving the environmental performance of all forms of transport and the forms of energy used in transport."

3.2.2 Air Quality Legislation

Air quality in Victoria is managed by the *Environment Protection Act (1970);* and the relevant State environment protection policies made under Section 16 of the Act:

- State environment protection policy (Air Quality Management) (2001) - SEPP(AQM); and
- State environment protection policy (Ambient Air Quality) (1999) – SEPP(AAQ).

Construction dust emissions and operational vehicle emissions (gases and particulates) would be managed by and need to comply with provisions of the SEPP(AQM). SEPP(AQM) in Clause 40 (2) (c) flags the development of a Protocol of Environmental Management (PEM) for 'road construction and operation' but this is not available to date. In the interim, EPA Victoria has adopted the intervention levels (specified in Schedule B of SEPP – AQM) for specific roadway projects, such as EastLink (constructed), PenLink (under construction) and WestLink (planned and to be constructed).

These intervention levels are applied in this instance as criteria by which to gauge both construction dust and operational vehicle exhaust emissions.

SEPP(AAQ) adopts the Air Quality requirements of the National Environment Protection Measures (NEPMs) and is to operate in conjunction with SEPP(AQM) with the two policies to be read together.

Table 1 describes the intervention levels for air quality indicators found in Schedule B of the SEPP (AQM) in micrograms per cubic metre ($\mu g/m^3$) (Victorian Government, 2001). Table 1 also displays dust deposition values extracted from the Mining Protocol for Environmental Management (PEM) (Environment Protection Authority (EPA), 2007) which are of use as indicators of the nuisance dust, Total Suspended Particulate (TSP), which is likely to be generated to some degree during the construction of the proposed alignment.

Table 1 Intervention Levels for Air Quality Indicators and Dust Deposition Guidelines

Criteria/Guideline	Contaminant	Concentration	Averaging Period
SEPP (AQM)	PM_{10}	60 µg/m^3	24 hour
	$PM_{2.5}$	36 µg/m^3	24 hour
	NO_2	263 µg/m^3	1 hour
	CO	33222 µg/m^3	1 hour
	SO_2	550 µg/m^3	1 hour
	Benzene	75 µg/m^3	1 hour
	Toluene	1880 µg/m^3	1 hour
	Xylenes	2080 µg/m^3	1 hour
	PAH (particle bound)	0.5 µg/m^3	1 hour
	Formaldehyde	15 µg/m^3	1 hour
	1,3-Butadiene	110 µg/m^3	1 hour
Mining (PEM)	Deposited Particulate Matter	4 g/m^2/month Maximum total deposited dust level	30 days
		2 g/m^2/month Maximum increase above background	30 days

Note: [1.] NO_2 and CO conversions from ppm to µg/m^3 have been carried out as per Schedule A, table note 8 of the SEPP AQM.

[2.] Mining PEM deposition criteria used as a guide to effectiveness of management plans.

4. Methods

4.1 Existing Conditions

To provide a firm and reliable basis for the prediction of environmental effects as they relate to air quality, the general climate and atmospheric dispersion characteristics of the Study Area need to be characterised. By use of site representative data, the entire Study Area is represented and this includes the initial options and the final preferred alignment. The Alignment only was the subject of the risk and impact assessment outlined in Section 6 of this Report.

An overview of the regional environmental setting includes the prevailing climate and any variations across the extent (northwest to southeast in this instance) of the Study Area. Rainfall does not have a direct influence on dispersion but is an important aspect during construction as it would affect dust generation and contingencies for lost days during construction.

A more detailed description of local atmospheric dispersion requires knowledge of wind and stability patterns, both of which are important for distribution of pollutants such as dust (construction) and gases (vehicle emissions during operation).

Background ambient levels of pollutants are used in the modelling of air quality impacts as SEPP(AQM) requires these levels to be considered so that the addition of any project-generated emissions do not cumulatively exceed the policy levels. The Project Area is a rural location somewhat removed from any routine ambient monitoring, however, reasonable estimates for ambient (default background) levels are available for rural Victorian locations.

Climatic data is used to define the relevant meteorology that has a potential to influence the air quality of the area, and includes temperature, wind and rainfall:

- Bureau of Meteorology (BoM) long-term climatic sites are used to define meteorological elements including at different places within the Study Area;
- Dispersion meteorology is defined by examining the local wind patterns and derived parameters inclusive of atmospheric stability classification and mixing height determination; and
- The BoM Automatic Weather Station (AWS) site at Stawell Airport was utilised for the dispersion meteorology determination, as it is representative of prevailing winds for the Project Area.

4.1.1 Assumptions

The following assumptions have been made during the course of this Air Quality study:

- BoM data used in meteorological analysis is accurate; and
- Air quality monitoring by EPA Victoria at Ballarat is representative of areas to its north-west to the South Australian border, such as around Ararat and Stawell.

4.2 Impact and Risk Assessment

The following impact assessment methodology was used to determine the air quality impact pathways and risk ratings for the Project:

1. Determine the ‘impact pathway’ (how the Project impacts on a given air quality value or issue).
2. Describe the ‘consequences’ of the impact pathway.

3. Determine the maximum credible ‘consequence level’ associated with the impact. Table 2 provides guidance criteria for assigning the level of consequence. The method for defining these criteria is described in Section 4.2.1.
4. Determine the likelihood of the consequence occurring to the level assigned in step 3. Likelihood descriptors are provided in Table 3 below.
5. Using the Consequence Level and Likelihood Level in the Risk Matrix of Table 4 to determine the risk rating.

Table 2 Air Quality Impacts Consequence Table

Insignificant	Minor	Moderate	Major	Catastrophic
Applicable air quality standards met at all sensitive receptors (e.g. dwellings), at all times.	*Isolated temporary exceedance of air quality standards at a sensitive receptor.*	*Minor temporary exceedance of applicable air quality standards in a local area.*	*Exceedance of applicable air quality standards in a number of local areas.*	*Widespread exceedance of applicable air quality standards.*

Table 3 Likelihood Guide

Descriptor	Explanation
Almost Certain	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances
Possible	The event could occur
Unlikely	The event could occur but not expected
Rare	The event may occur only in exceptional circumstances

Table 4 Risk Matrix

Likelihood	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Negligible	Low	Medium	High	High
Unlikely	Negligible	Low	Medium	Medium	High
Rare	Negligible	Negligible	Low	Medium	Medium

4.2.1 Consequence Criteria

Consequence criteria (Table 2) range on a scale of magnitude from “insignificant” to “catastrophic”. Magnitude was considered a function of the size of the impact; the spatial area affected and expected recovery time of the environmental system. Consequence criteria descriptions indicating a minimal size impact over a local area, and with a recovery time potential within the range of normal variability were considered to be at the insignificant end of the scale. Conversely, catastrophic consequence criteria describe scenarios involving a very high magnitude event, affecting a State-wide area, or requiring over a decade to reach functional recovery.

Consequence criteria for air quality were selected for each level of magnitude based on whether an exceedance of an applicable standard (outlined in Section 3) would occur at a sensitive receptor such as a residential dwelling, school or hospital and if an exceedance occurred, what the spatial spread of that exceedance would be. Generally, a more localised exceedance would incur a lower penalty (magnitude) than an exceedance over a larger region.

4.3 Dust Dispersion Modelling

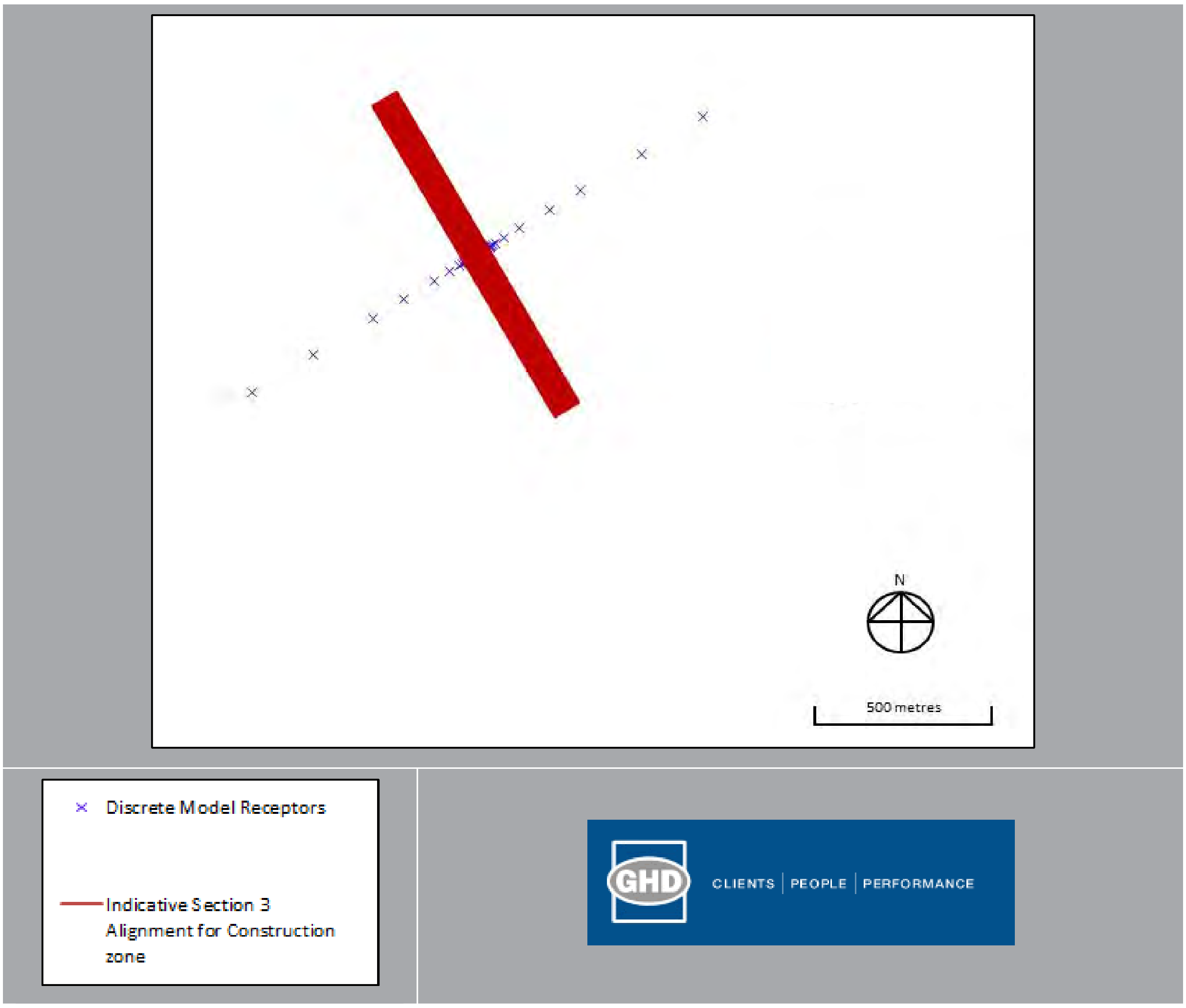
The air quality impact of the Project is influenced from two main emission sources, which are the dust emissions resulting from the construction activities and the vehicle emissions resulting from the operational condition. Modelling of both construction and operation emissions was carried out in order to determine the emissions levels and their impact on the local environment. The construction activities emissions were modelled using the EPA approved model 'AUSPLUME v6.0' as predicted area source emissions, while the vehicle emissions were modelled using 'AUSROADS' as predicted line source emissions.

4.3.1 Construction Phase Modelling Methodology

The modelling was carried out using the AUSPLUME v6.0 dispersion model to predict the PM_{10} (Particulate matter with an aerodynamic diameter of less than 10 micrometres) dust impact on health. It is found that if this key element is used as the dominant indicator of downwind impact, then amenity issues due to dust fall out would also be controlled. The meteorological file used for the modelling was the Stawell data as discussed in section 5.1. As a further consideration to likely construction, the days used in modelling were the likely construction period excluding the "too-wet-to-work" period of the Autumn break (in this instance 25 May 2009) to when it dries out (evaporation rate exceeding rainfall intensity) near the end of Spring (in this case 27 September 2009).

In modelling the construction dust emissions with AUSPLUME, the source release geometry was taken to be an area source (up to 1000 m x 80 m sub-area sources for the construction corridor, representative of the main carriageway or the Alignment of the Project) at ground level. The total emission rate per kilometre was proportioned between the evenly spaced sub-area sources for the worst case scenario, with discrete receptors set at 2, 5, 10, 20, 50, 100, 200, 300, 500 and 700 m intervals in a lateral direction away from both sides of the edge of the construction corridor. This modelling alignment, including the transect receptor locations are graphically reproduced in Figure 3.

Figure 3 Western Hwy Section 3 – Modelled Representative Construction Alignments and Transects Receptors Locations.



The following equipment and processes were considered as being indicative of the road construction project, and were used within the AUSPLUME model parameter for this Project:

- Site Wind Erosion;
- Front end loaders on Overburden (top soil);
- Unpaved Haul Roads – Trucks;
- Unpaved Haul Roads – Light Vehicles;
- Scrapers (travel mode);
- Scrapers (removing topsoil);
- Graders;
- Bulldozer (not on coal); and
- Vibrating rollers and Compactors.

The dust emissions from the road construction activities are dependent on the following factors:

- Type of construction equipment;
- Number of construction equipment ;
- Typical usage pattern;
- Duration of construction activities; and
- Meteorological behaviour.

For a worst case scenario, the modelling was focused on the two dustiest construction phases, which are:

- Set out and Preparation Stage of the road corridor (earthworks); and
- Surface Preparation and Compaction Stage (pavement preparation).

Two models were run to give indicative dust impacts to the east and west side of the Project Section 3 alignment. A single indicative alignment orientation was chosen as the bearing between the two ends of the Project.

Construction Emission Rates

An emission inventory for the identified dust sources was derived based upon wind erosion and mechanically induced sources of dust. The derived emissions rates are characterised using emissions factors published in the National Pollutant Inventory (NPI) Emission Factor Estimation Techniques Manual (EETM) for Mining V 3.1, January 2012 (Commonwealth Australia, 2012).

It is anticipated that work for the Project would be undertaken during the standard recommended hours for construction work as set out in Section 1150.01 of the VicRoads DC1 contract specification (VicRoads, April 2012).

Thus, for worst case scenario, the heavy construction equipment operates from 8:00 am to 6:00 pm, while the site wind erosion occurs during all hours.

Table 5 summarises the NPI-EETM emission factors, and the calculated emission rates for each item of equipment and activity within the construction area. The default emission factors addressed by NPI assume only for dry conditions, however dust control method and emission reduction techniques were proposed, as per indicated in the NPI-EETM section 5.3, and have been applied to these sources where appropriate.

Note that control measures have been allowed for graders, scrapers, trucks and light vehicles, vibrating rollers and compactors as these would be operating on material where water is applied as part of the process.

Table 5 Summary of Construction Equipment Dust Emission Inventory

Operation/Activity	PM_{10} Default Emission Factor	Unit	Operating Hours	Control Method	PM_{10} Emission Rate (kg/hr)
Graders	0.085	kg/VKT	08:00 – 18:00	50 per cent control for water spray	0.4
Scrapers (travel mode)	0.52	kg/VKT	09:00 – 17:00	50 per cent control when soil is naturally or artificially moist (i.e. applicable for winter and spring seasons)	10.7
				-	21.4
Scrapers (removing topsoil)	0.0073	kg/tonne	09:00 – 17:00	50 per cent control when soil is naturally or artificially moist (i.e. applicable for winter and spring seasons)	1.1
				-	2.2
Bulldozer on material other than coal	4.1	kg/h/vehicle	08:00 – 18:00	-	8.2
Front-end loader (on overburden)	0.012	kg/tonne	08:00 – 17:00	-	5.8
Wheel generated dust from unpaved roads at industrial sites (Trucks)	1.25	kg/VKT	08:00 – 17:00	75 per cent for level 2 watering (>2 litres/m^2/h)	10.4
Wheel generated dust from unpaved roads (used by light duty vehicles)	0.33	kg/VKT	08:00 – 09:00 and 17:00 – 18:00	50 per cent for level 1 watering (2 litres/m^2/h)	5.0
			09:00 – 17:00	75 per cent for level 2 watering (> 2 litres/m^2/h)	0.4
Vibrating Rollers and Compactors	0.785*	kg/VKT	08:00 – 18:00	75 per cent for level 2 watering (>2 litres/m^2/h)	2.0

*The PM_{10} emission factor for vibrating rollers and compactors is assumed to be the average between the heavy and light vehicles emission factors (i.e. 0.785 kg/VKT).

The PM_{10} dust emission resulted from the wind erosion was modelled based on the NPI Default Emission Factor of 0.2 kg/ha/h over an exposed surface area of up to 1000 m x 80 m (with some sub-area sources). Then using the nearest meteorology data available (Stawell Airport), the dust emission rates of the wind erosion were set for each wind speed category proportional to the wind speed cubed. The rates per wind speed category are shown in Table 6.

Table 6 Wind Erosion Dust Emission Rates

Wind Speed Category (m/s)	Specific PM_{10} Emission Rate ($kg/m^2/h$)
0 - 1.54	0
1.55 - 3.09	0.0000034
3.10 - 5.14	0.0000174
5.15 - 8.23	0.0000669
8.24 - 10.80	0.0001819
> 10.80	0.0001819*

* As there is no wind speed that falls within the wind speed category based on the used meteorological data, it is assumed that the PM_{10} emission rate to be identical with the previous wind speed category.

Modelling Configuration

The following settings were used in the model:

- Meteorological data from Stawell Airport (1 December 2008 to 30 November 2009);
- Output type: Concentration with dry depletion;
- Wind Erosion source height and initial vertical spread are 0 m and 1 m respectively;
- Front-end loader source height and initial vertical spread are 3 m and 2.5 m respectively;
- Truck source height and initial vertical spread are both 2 m;
- Light vehicle source height and initial vertical spread are both 1 m;
- Scraper (travel mode) source height and initial vertical spread are 0 m and 2 m respectively;
- Scraper (removing topsoil) source height and initial vertical spread are 0 m and 3 m respectively;
- Grader source height and initial vertical spread are 0 m and 1 m respectively;
- Bulldozer source height and initial vertical spread are 0 m and 1 m respectively;
- Vibrating roller and compactor source height and initial vertical spread are 0 m and 1 m respectively;
- Irwin Rural wind profile exponent scheme; and
- Dust particle deposition or surface scavenging parameters are detailed in Table 7 below.

Table 7 Dust Particle Deposition/Scavenging Parameters

Fraction No.	Mass Fraction	Particle Size (micron)	Particle Density (g/cm^3)
1	0.7	8	2.4
2	0.3	2	2.4

Modelling Assumptions

The following assumptions were made in determining the emission rates for the construction activities:

- *Scraper* – Two of scrapers were used for 1000 m x 40 m section in the construction corridor with 10 minutes of duration per one complete activity (6 minutes of scraping and 4 minutes of return trip). The operating speed during the travel mode is constant at 51.5 km/h, as per CAT 623G Scraper maximum gear speed specification. The operating speed during soil removal activity is constant at 10 km/h, as per CAT 623G Scraper 3rd gear speed specification. Also, there would be no scraper used in the first and last hour of the construction hours due to preparation and site securing respectively.
- *Grader* – Two of graders were used for 1000 m x 40 m section in the construction corridor for all construction hours per day. The operating speed of the grader is assumed to be constant at 5 km/h, as per CAT 140M Grader 2nd gear speed specification.
- *Bulldozer* – Two of bulldozers were used for all of the 1000 m x 80 m section in the construction corridor for all construction hours per day.
- *Haul truck* – Construction of similar duplication projects typically generates the greatest traffic volumes during earthworks and pavement construction phases. These two phases could be expected to generate in the order of up to 150 trucks trips per day across the workday, doing two circuits (accounting 'in' and 'out' activities) per 1000 m x 40 m section in the construction corridor (i.e. a total of 300 truck movements per day per section). There is no truck used in the last hour of the construction day.
- *Light vehicle* – Out of 100 total number of daily vehicle movements, 30 vehicles are expected to operate within the first hour and last hour of the construction day, with the 8 remaining hours to be 5 vehicles in operation per hour. All 100 daily light vehicle movements were modelled over an area source of 1000 m x 80 m section.
- *Front-end loader* – Based on the individual truck loading capacity of 27 m^3 with soil density of 1,073 kg/m^3 (SImetric, 2012) and 150 truck trips per day, the required front end loader loading capacity is 32 tonnes per load, assuming loading rate of 15 loads per hour. One front end loader was used over an area source of 10 m x 5 m section with assumption that there is no front end loader used for the last hour of the construction day.
- *Vibrating rollers and compactors* – The PM_{10} emission factor for vibrating rollers and compactors is assumed to be the average between the heavy and light vehicles emission factors (i.e. 0.785 kg/VKT). Two rollers/compactors were used over an area source of 1000 m x 40 m, with operating speed of 2.5 km/h.

- Construction equipment used during the Set-out and Preparation Stage include graders, dozers, loaders, scrapers, haul trucks and other equipment, but excluding compactors. These would be used for earthworks such as scraping, removing vegetation, stripping topsoil, stockpiling, excavation of cut material, transporting and disposing unsuitable cut material, etc.
- Construction equipment used during the Surface Preparation and Compaction Stage includes graders, dozers, haul trucks, compactors and other equipment, but excluding loaders and scrapers. The heavier stripping and land formation plant have completed this task while the rest are involved in tarmac laying.

4.3.2 Operational Phase Modelling Methodology

Operational emissions comprises of air contamination from the motor vehicle exhaust which could be expected to contribute to the local air shed in the near field, where isolated residential receptors are present. AUSROADS was used to model line-source representative of the proposed alignment of the Project to predict the emission factors for each of the following constituents:

- Carbon monoxide;
- Oxides of nitrogen;
- PM_{10};
- $PM_{2.5}$;
- Benzene;
- 1,3 Butadiene;
- Formaldehyde;
- Toluene;
- Xylenes; and
- PAH (particle bound).

The above constituents are the adopted Class 1 indicators from SEPP (AQM), excluding lead which is not carried forward into the intervention levels found in Schedule B of the SEPP (AQM), as well as the BETEX constituents.

The Class 1 indicator Sulphur dioxide (SO_2) was also excluded from modelling as modelling the impact of this pollutant has not been required by the EPA in some of the more recent road projects, such as the M80 Upgrade and WestLink Projects. Further, fleet averaged emission factors for SO_2 have not been provided by EPA Victoria whereas they have been for the other constituents outlined above.

GHD believes SO_2 can safely be excluded as the low-S fuel standard now used in Australia results in emissions of this constituent from vehicles having very low environmental impact, particularly as the Project describes an uncongested motorway with a relatively small volume of traffic using it on a daily basis (~ 6000 to 9000 vpd, see Table 8).

The emissions data for Oxides of Nitrogen (NO_x) include both NO and the assessment pollutant of NO_2. For traffic emissions, NO_2 is approximately five per cent at the point of emission (Holmes Air Sciences, 2001) but the proportion changes with time due to chemical reaction and ambient atmospheric influences (temperature and ultraviolet light for example). Fifteen per cent is regarded as a conservative estimate for near road impact assessments. This is confirmed by Holmes Air Sciences in their assessment of ambient NO_x monitoring in the heavily trafficked environment of downtown Sydney (Holmes Air Sciences, 2001). Here it was found that for the ten highest measurements of hourly NO_x the proportion of NO_2 in the total NO_x was 14.9 per cent.

The fleet emission inventory was provided by EPA Victoria for the Frankston Bypass Project (GHD Pty Ltd, 2008) and consisted of a matrix of emission data based on:

- Year (2011 and 2021);

- Vehicle type (car, truck, petrol, diesel, LPG etc); and
- Speed (10 km/h increments from 10 to 110 km/h).

The EPA notes that:

- The emission factors do not include re-entrained road dust. It is the EPA Victoria's technical opinion that the contribution from re-entrained road dust for a heavily-used freeway/ bypass/ highway would be very small, except perhaps for entry/exit ramps, and that the standard method used in Australia for re-entrained road dust contains too many uncertainties to be of any practical use (Commonwealth Australia, 1999); and
- The PAH (Polycyclic Aromatic Hydrocarbon) emission factor is calculated as PAH (Particle Bound). More specifically, it includes all PAHs with a vapour pressure lower than that of Pyrene. Wherever PAH is mentioned in the assessment, it should be taken as PAH (Particle Bound).

VicRoads provided traffic data of year 2012 of the existing Western Highway (see Table 8 and Appendix B). The traffic data were used to forecast years 2016, 2026 and 2040 along with 1.59% traffic growth, including the hourly traffic volume per day, the number of heavy and light vehicles per day and the speed distribution for the existing Western Highway, between Harvey Lane and Panrock Reservoir Road, which would be used within this modelling prediction (Refer to Table 8).

This information was then utilised in the following manner:

- Fleet emission inventory data from 2011 to 2021 supplied by EPA was interpolated to give emission rates for the year 2016. This was based on the approximate opening time for the completed Project.
- The years of assessment included are 2016, 2026 and 2040 model years. The emission rates for year 2021 were used for years 2026 and 2040, as there is no emission data available beyond year 2021, and it is assumed that there is no further emission control in year 2040.
- Speed was maintained at 110 km/h for a freeway standard road.
- Seven-day average traffic count data was used for simulating the worst case scenario. This was used instead of the five-day (weekday) average traffic count data due to a high number of traffic volumes on an average Sunday.

Table 8 Western Highway Traffic Count Data (Two Way Traffic between Harvey Lane and Panrock Reservoir Rd)

Description	Unit	Year of Traffic Count				
		2011	2012	2016*	2026*	2040*
7-Day Average of all Vehicles	Vehicle per day	5979	6074	6470	7575	9447
Percentage of Heavy Vehicle (7-Day)	%	29	29	29	29	30
7-Day Average of Heavy Vehicles	Vehicle per day	1718	1748	1875	2232	2850
5-Day Average of all Vehicles (weekday)	Vehicle per day	6361	6462	6883	8059	10051
Percentage of Heavy Vehicle (weekday)	%	32	32	32	33	33
5-Day Average of Heavy Vehicles (weekday)	Vehicle per day	2026	2061	2210	2631	3359

Data sourced from VicRoads 2012.

* Traffic growth rate of 1.59% was used in forecasting of year 2016, 2026 and 2040 traffic volumes.

Vehicle Mix

The traffic model data provided information on 'light' and 'heavy' vehicle categories only. A 'standard' fleet mix representative of major roads (arterial and freeways) in Victoria was provided by EPA Victoria. These data were grouped according to vehicle type with weighting according to the 'standard' vehicle mix.

Vehicle type was split into either 'light' (LV) or 'heavy' (HV) (Refer to Table 9). Petrol passenger vehicles dominate the 'light' vehicle type (more than 70% of all LV), while diesel rigid and articulated trucks dominate the 'heavy' type (near 42% of all HV). Motorcycles were ignored as there was no traffic data to distinguish these and their g/km emissions are low compared to all other vehicle types.

Table 9 Vehicle Mix

'Light' Vehicle types	'Heavy' Vehicle types
Passenger vehicle – petrol	Rigid truck – petrol
Passenger vehicle – diesel	Rigid truck – diesel
Passenger vehicle – LPG	Rigid truck – LPG
Light commercial vehicle – petrol	Rigid truck – CNG
Light commercial vehicle – diesel	Articulated truck – petrol
Light commercial vehicle – LPG	Articulated truck – diesel
	Non-freight carrying truck – petrol
	Non-freight carrying truck – diesel
	Non-freight carrying truck – LPG
	Bus – petrol
	Bus – diesel
	Bus – LPG
	Bus - CNG

Modelling Configuration

In modelling the worst case scenario, GHD adopted 'Duplication (Narrow)' cross sectional layout (see Figure 4), due to a higher concentrated emission formed with closer road lanes before dispersion. Thus, for a more conservative approach, the modelled centreline can be described as the total length of all lanes (i.e. 4 lanes for both ways), excluding the median strip, modelled as a single line source to achieve worst case concentrated emissions. The distance between the edge of the 'outer lane' and the edge of the 'outer boundary of the carriageway' is 32 m for typical 'Duplication (Narrow)' cross sectional layout (see Figure 4).

Figure 4 Typical Cross Section Layout – 'Duplication (Narrow)'

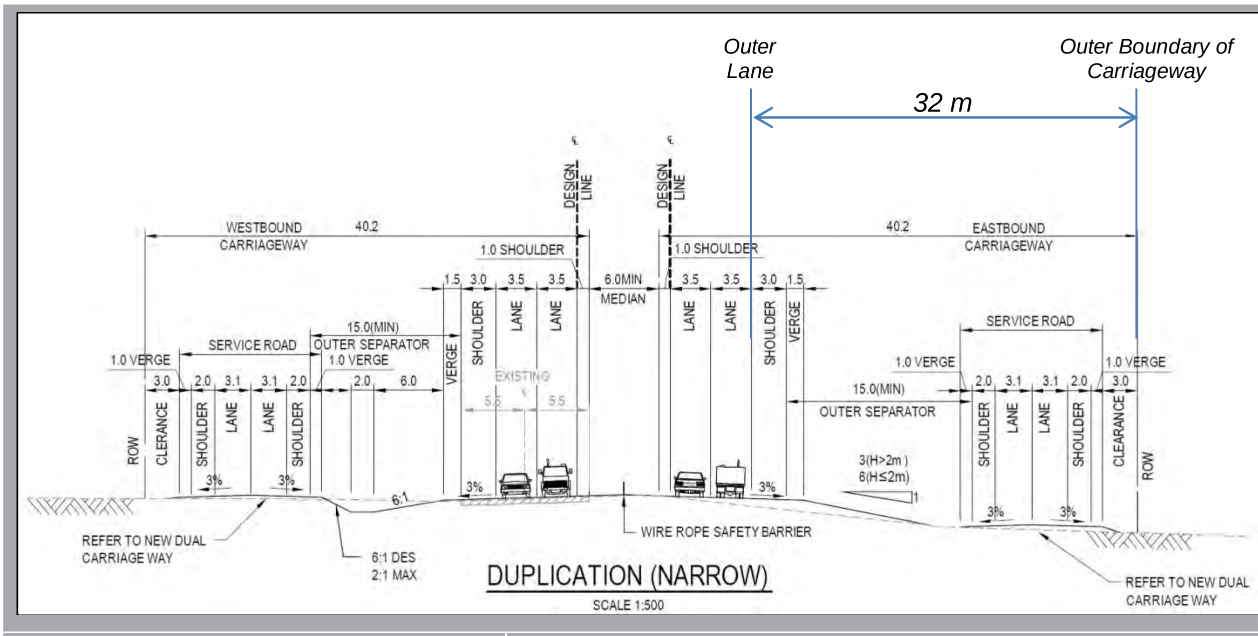


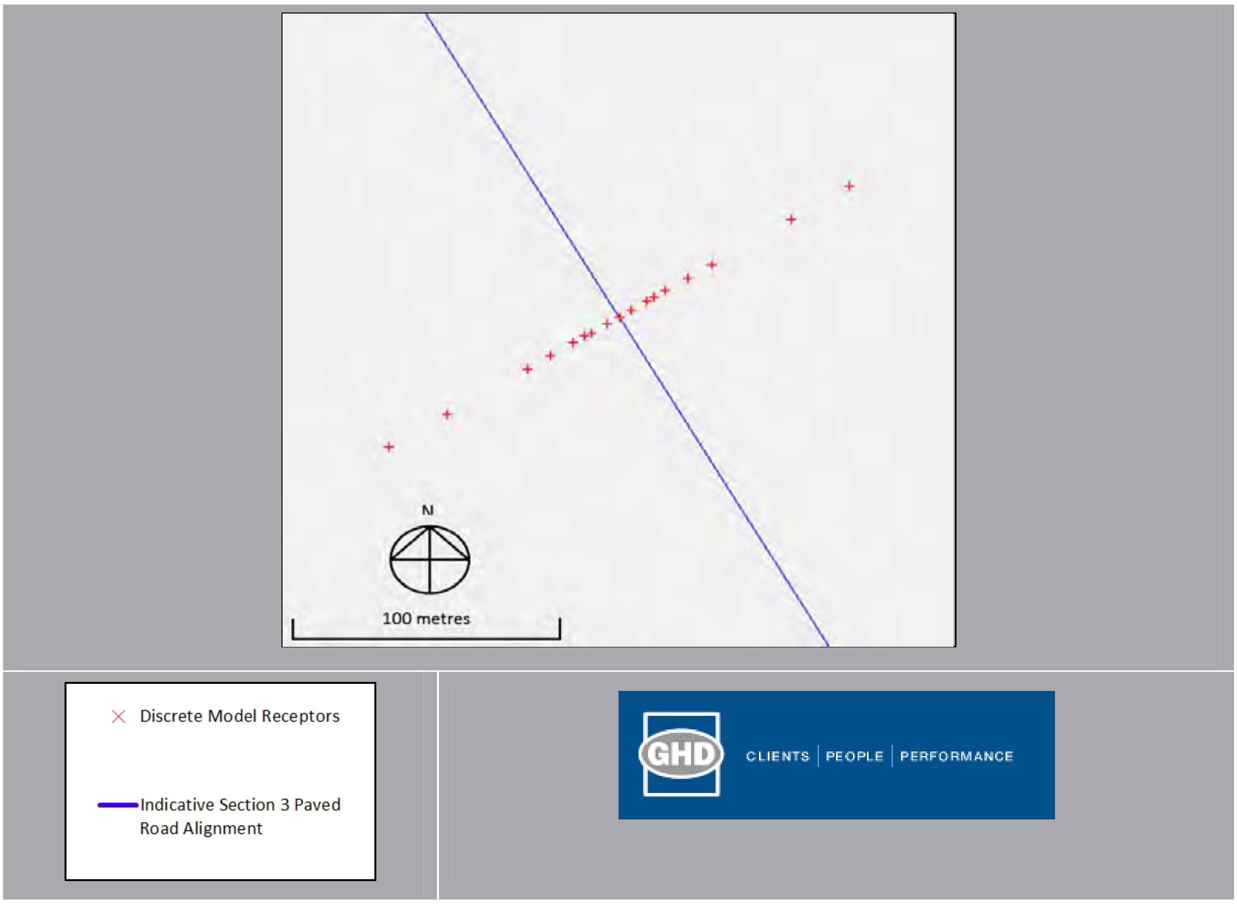
Figure not to scale

Figure sourced from GHD Pty Ltd

Configuration of the AUSROADS model required the following inputs:

- Local meteorology that includes hourly information on temperature, winds, atmospheric stability and mixing depth through the atmosphere;
- Meteorological data from Stawell Airport (1 December 2008 to 30 November 2009);
- Anemometer height of 10 m;
- Background concentration is as shown in section 5.2;
- Pasquill Gifford horizontal dispersion;
- Irwin rural wind exponent;
- Sigma Theta averaging period of 60 minutes;
- Emission data derived from the traffic model, emission estimation and hourly diurnal influences; and
- Receptor locations were placed on both east and west facing transects with interval distances of 5, 12, 15, 20, 30, 40, 75, 100 m away from the road alignment (i.e. from the edge of the 'outer road lane' – see Figure 4). This modelling alignment, including the transect receptor locations are graphically reproduced in Figure 5.

Figure 5 Western Hwy Section 3 - Modelled Representative of Paved Road Alignment and Transects Receptors Locations.



Operational Emission Factors

Emission factors used in the AUSROADS model are summarised in Table 10, Table 11 and Table 12, while diurnal traffic volumes are displayed in Figure 6.

Table 10 Emission Factors Used in AUSROADS Modelling for Year 2016 (g/VKT) (Two Way Traffic)

Constituents	Emission Factor – Section 3 Western Highway (g/VKT)		
	HV	LV	HV+LV
CO	1.902	5.150	4.208
NOx	8.550	0.969	3.168
PM_{10}	0.176	0.024	0.0679
$PM_{2.5}$	0.127	0.019	0.0504
Benzene	0.00611	0.01223	0.01046
1,3 Butadiene	0.00086	0.00128	0.00116
Formaldehyde	0.00578	0.00216	0.00321

Constituents	Emission Factor – Section 3 Western Highway (g/VKT)		
	HV	LV	HV+LV
Toluene	0.00681	0.01806	0.01480
Xylenes	0.00557	0.01113	0.00952
PAH (Particle Bound)	0.00000630	0.00000262	0.00000368

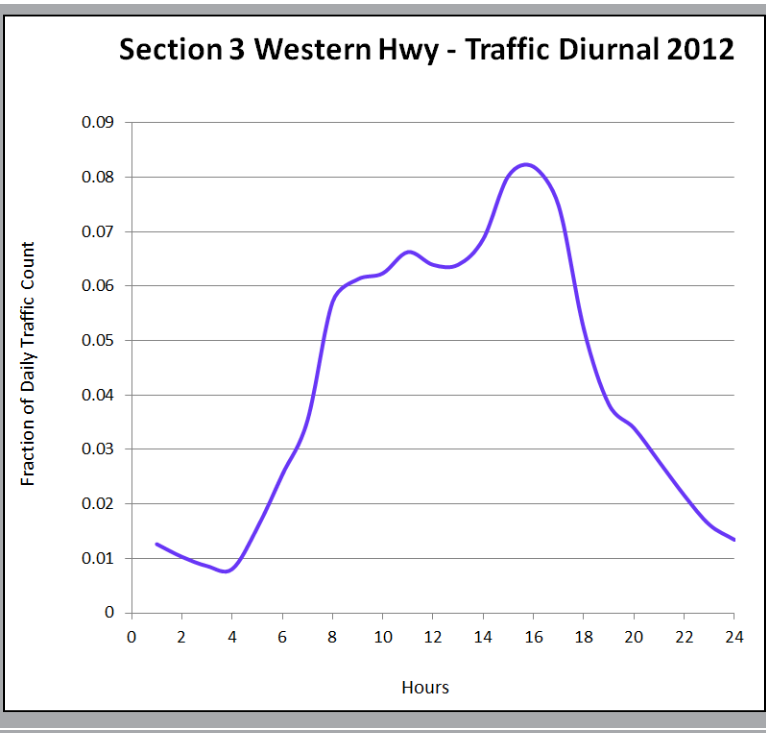
Table 11 Emission Factors Used in AUSROADS Modelling for Year 2026 (g/VKT) (Two Way Traffic)

Constituents	Emission Factor – Section 3 Western Highway (g/VKT)		
	HV	LV	HV+LV
CO	1.140	4.352	3.421
NOx	6.545	0.816	2.477
PM_{10}	0.067	0.016	0.0307
$PM_{2.5}$	0.050	0.014	0.0244
Benzene	0.00386	0.00811	0.00688
1,3 Butadiene	0.00057	0.00086	0.00077
Formaldehyde	0.00443	0.00161	0.00243
Toluene	0.00413	0.01200	0.00972
Xylenes	0.00379	0.00743	0.00638
PAH (Particle Bound)	0.00000236	0.00000162	0.00000183

Table 12 Emission Factors Used in AUSROADS Modelling for Year 2040 (g/VKT) (Two Way Traffic)

Constituents	Emission Factor – Section 3 Western Highway (g/VKT)		
	HV	LV	HV+LV
CO	1.140	4.352	3.389
NOx	6.545	0.816	2.534
PM_{10}	0.067	0.016	0.0312
$PM_{2.5}$	0.050	0.014	0.0248
Benzene	0.00386	0.00811	0.00683
1,3 Butadiene	0.00057	0.00086	0.00077
Formaldehyde	0.00443	0.00161	0.00246
Toluene	0.00413	0.01200	0.00964
Xylenes	0.00379	0.00743	0.00634
PAH (Particle Bound)	0.00000236	0.00000162	0.00000184

Figure 6 Section 3 Western Highway Diurnal Traffic Volume as a Fraction of Daily Traffic Count for each Hour of the Day, Assumed in AUSROADS Model for Year 2016, 2026 and 2040.



Data sourced from VicRoads

Assumption

Traffic count data provided did not differentiate motorcycles from light vehicles. It is assumed these were counted as if a light vehicle and emissions treated as if the same.

5. Existing Conditions

For a road project, air quality considerations are emissions from both the construction phase and operational phase. The prevailing meteorology and climate affects both the generation of emissions and the dispersion of generated gasses and particulates. Ambient air quality needs to be defined as background levels are required in the modelling assessments.

5.1 Meteorology

Two stations were identified as having climate data relevant to the study, namely Stawell airport and Ararat prison. The latter site has a sparser recording of winds (spot reading at 9 am and 3 pm only) and does not record cloud cover, so that the Stawell climate data was used for detailed characterisation of wind climate and incidence of atmospheric stability.

5.1.1 Climate

In order to describe the climate of this area, meteorological data was used from either end of the Study Area. The first site is situated at the Stawell Airport, which is located approximately 124 km west northwest of Ballarat, and has been used as a weather data collection site by the Bureau of Meteorology (BoM) for approximately 15 years. The second site is the Ararat Prison, where BoM data has been collected for approximately 42 years.

The climate in and around both the Stawell Airport and Ararat Prison areas is classified as 'temperate' with 'no dry season (warm summer)'. This classification is based on the Australian objective classification system set out on the BoM website (Stern, Hoedt, & Ernst, 2000). Therefore, the climate of the entire Project Area can be considered as having the same classification.

5.1.2 Meteorological Site Descriptions

The Stawell Airport has been a Bureau of Meteorology (Site number: 079105) climatic observing site since 1996, located at Latitude 37.45°S and Longitude 142.4428°E (elevation: 228 m). The rainfall record dates back for 15 years while the temperature record spans 16 years.

The Stawell Airport area averages 504 mm of rainfall annually, with monthly mean temperatures ranging from 4 (winter mornings) to 29.1 (summer afternoons) degrees Celsius. Annual average 9 am and 3 pm relative humidity values are 73 and 47 per cent respectively. Wind speeds are on average slightly higher in the afternoon, averaging 16 km/h at 3 pm compared to 10.5 km/h in the morning (9 am).

The Ararat Prison has been a Bureau of Meteorology (Site number: 089085) climatic observing site since 1969, located at Latitude 37.1639°S and Longitude 142.5852°E (elevation: 295 m) with the rainfall and temperature records both dating back 42 years.

The Ararat area has a higher average rainfall (595 mm) compared to Stawell, in part due to its slightly higher elevation and more open exposure to moist south-westerly winds during winter. Monthly mean temperatures range from 3.3 to 27 degrees Celsius with annual average 9 am and 3 pm relative humidity values of 79 and 53 per cent respectively. This results in the Ararat region being a slightly cooler and more humid environment compared to Stawell. Wind speeds are similar to those measured at Stawell, averaging 16 km/h at 3 pm and 11.3 km/h in the morning (9 am).

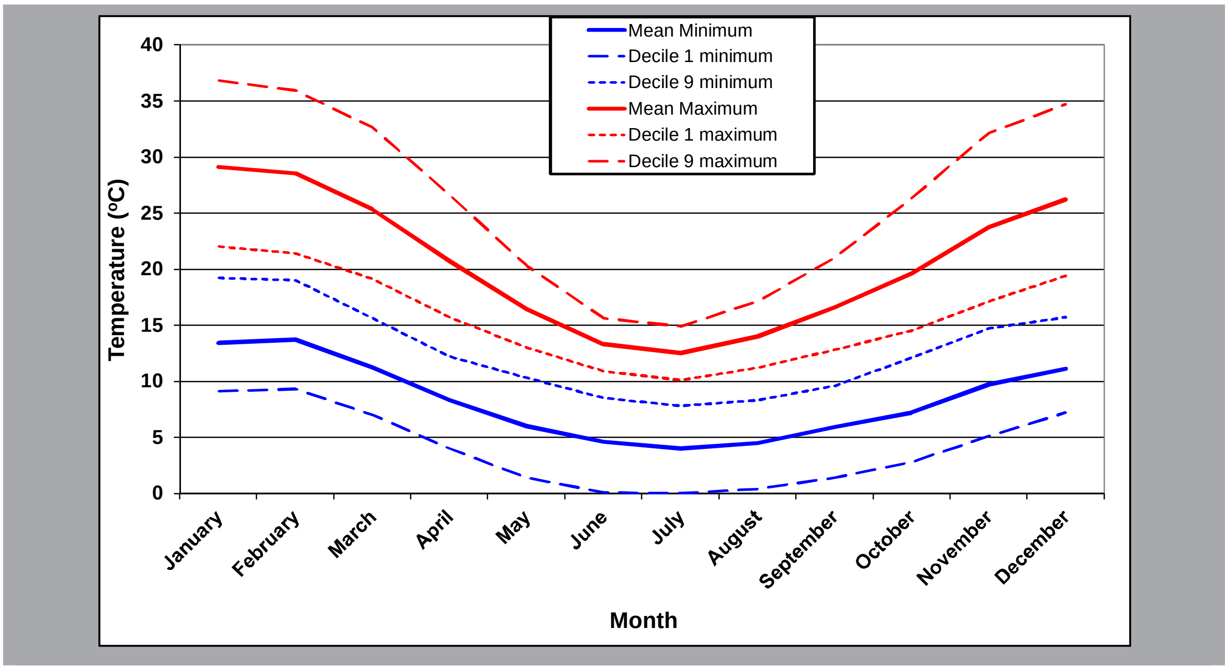
5.1.3 Temperature

Monthly mean temperatures for Stawell Airport and Ararat Prison are displayed in Figure 7 and Figure 8 respectively, these show the seasonal variation one would expect for the temperature range of a temperate climate. Monthly mean minimums with their associated upper and lower 10 percentiles (deciles 1 and 9) are shown in blue while monthly mean maximums with their associated deciles are shown in red.

Monthly mean temperatures for Stawell Airport show daytime summer temperatures are between 22 and 37 degrees with winter overnight temperatures most commonly between 0 and 8 degrees. The temperature record of approximately 16 years shows values ranging from -3.7 to 45.4 degrees. 'Hot days', with temperatures exceeding 35 degrees, can be expected on average up to 14 days per year. 'Frost days' with screen temperatures[1] below 2 degrees occur on average 34 days per year.

Monthly mean temperatures for Ararat show daytime summer temperatures are between 20 and 35 degrees with winter overnight temperatures most commonly between -1 and 7 degrees. The temperature record of approximately 42 years shows extreme values ranging from -7.3 to 44.7 degrees. 'Hot days', with temperatures exceeding 35 degrees, can be expected on average up to 8 days per year. 'Frost days' with screen temperatures below 2 degrees occur on average 52 days per year. These extreme frost days for Ararat occur more frequently than at Stawell as Ararat is situated within a basin associated with Green Hill Lake, in contrast to the rolling hills just west of Stawell.

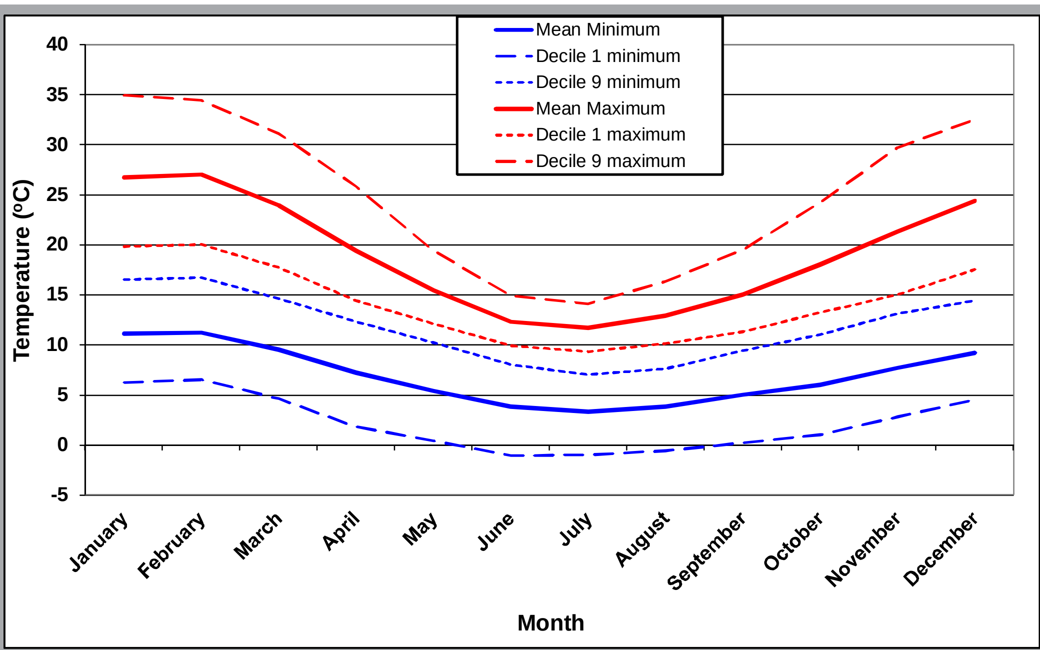
Figure 7 Monthly Mean and Decile (10% and 90%) Maximum and Minimum Temperatures (˚C) at Stawell Airport (site number 079105)



[1] The 'screen temperature' is measured in a double louvered Stevenson screen (white wooden box) between 1.0 and 1.2 m above the ground. The ground temperature during calm pre-dawn morning conditions can be up to two degrees lower than the minimum temperature measured in the screen. So two degrees can be considered the 'frost' point, see: http://www.bom.gov.au/climate/cdo/about/definitionstemp.shtml

Data sourced from Bureau of Meteorology (BoM) Australia

Figure 8 Monthly Mean and Decile (10% and 90%) Maximum and Minimum Temperatures (˚C) at Ararat Prison (site number 089085)



Data sourced from Bureau of Meteorology (BoM) Australia

5.1.4 Rain

Rain is important during the construction phase of the Project as during and after rain events, construction dust would be reduced. Additionally, if it is too wet, construction may be required to halt for the day. As such, the contractor should have sufficient contingency days built into the construction timeline.

The annual mean rainfall at Stawell Airport is just over 503 mm and is relatively evenly spread throughout the year, which is consistent with a temperate climate. However, there is a slight bias toward a pattern of heavier winter and early spring rainfall occurring. A similar even spread with a very slight pattern of heavier winter and early spring rainfall occurs at Ararat. However the annual average rainfall of just over 594 mm is significantly higher than Stawell.

The wettest month at the Stawell Airport on average is August, with a mean of 56.9 mm and the driest month is March, with a mean of 21.1 mm. The wettest month in Ararat is also August, with a mean of 69.5 mm and the driest month is also March with a mean of 31 mm. The annual rainfall from the Stawell site ranges from 263 to 712 mm while the range in Ararat is 302 to 909 mm. The mean numbers of rain days per year are 120 and 146 for Stawell and Ararat respectively.

There is a clear pattern of higher rainfall and frequency in the Ararat region decreasing north-westward to Stawell. This has implications for the Project as over an extended construction period (greater than the annual cycle) wet weather contingencies may be required, however less construction dust generation, would be expected to the south-east as compared to the north-west.

Figure 9 Monthly Mean Rainfall (mm) Proportions at Stawell Airport (site number 079105)

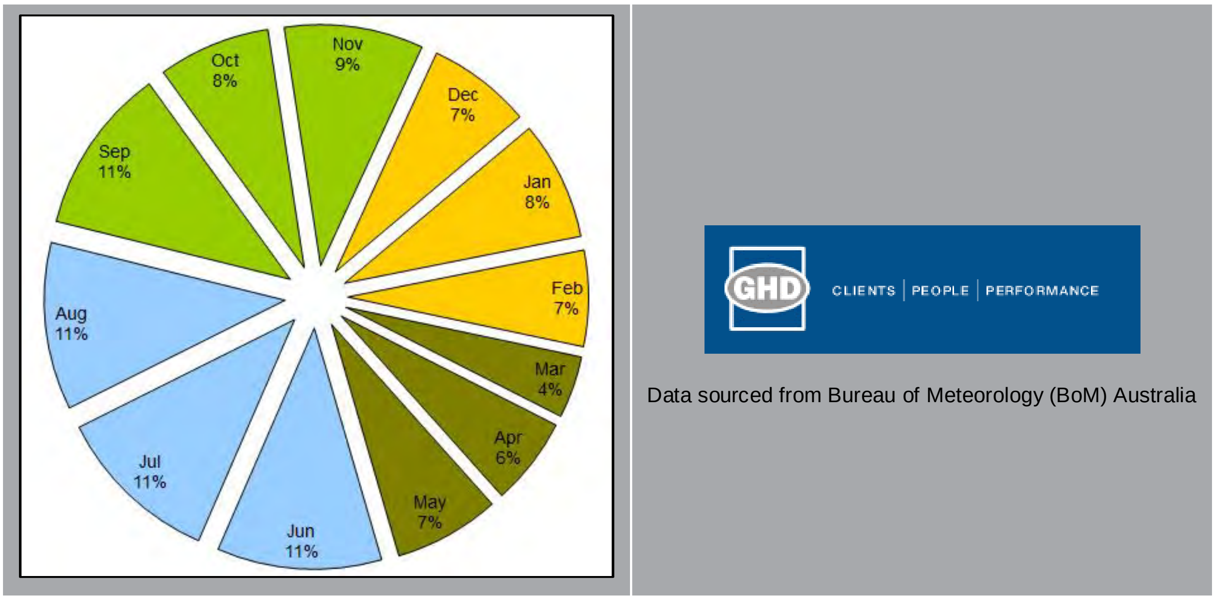
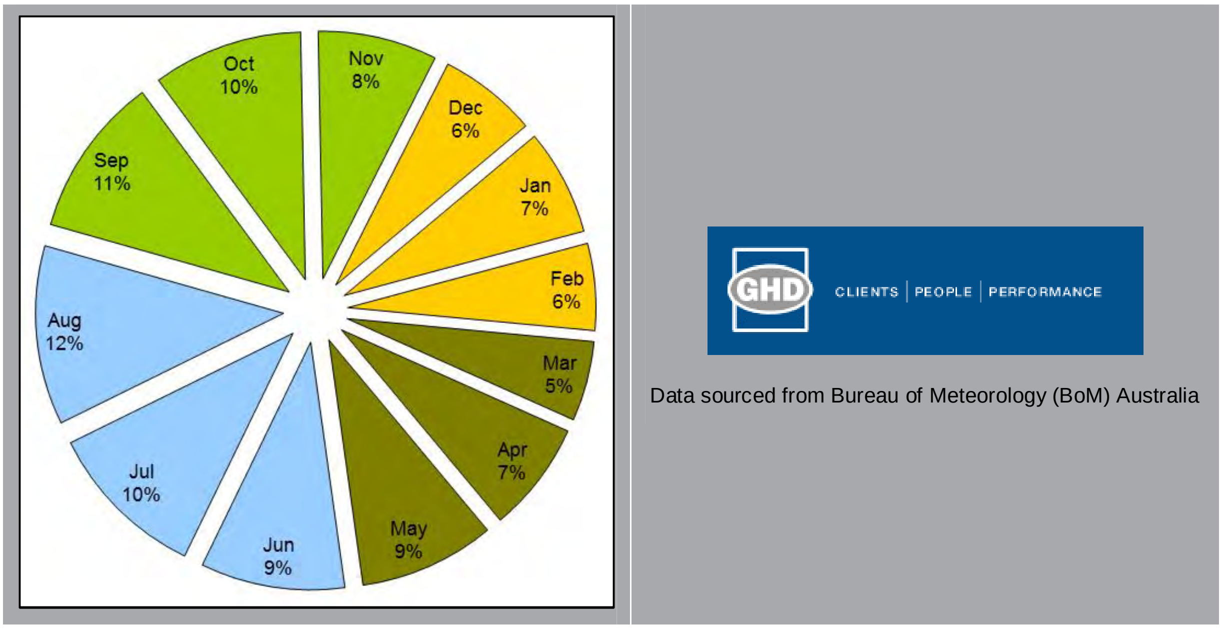


Figure 10 Monthly Mean Rainfall (mm) Proportions at Ararat Prison (site number 089085)



5.1.5 Wind

In order to describe the wind and atmospheric dispersion pattern of the Western Highway area between Ararat and Stawell, a meteorological data file was constructed from regional weather observations including temperature and winds from the BoM Automatic Weather Station at Stawell Airport.

Figure 11 shows the average annual wind rose for the Stawell site for the period 01 December 2008 to 30 November 2009 with an annual average wind speed of 3.24 m/s. It can be seen that the distribution of these flows are predominantly from the south. South and south-southeast wind directions (S - SSE) make up 27 per cent of incident winds. The observed wind speed distribution indicates the largest proportion of high wind speeds (> 7.5 m/s) are from the prevailing south and south-south-east.

Figure 11 Annual Wind Rose for Stawell

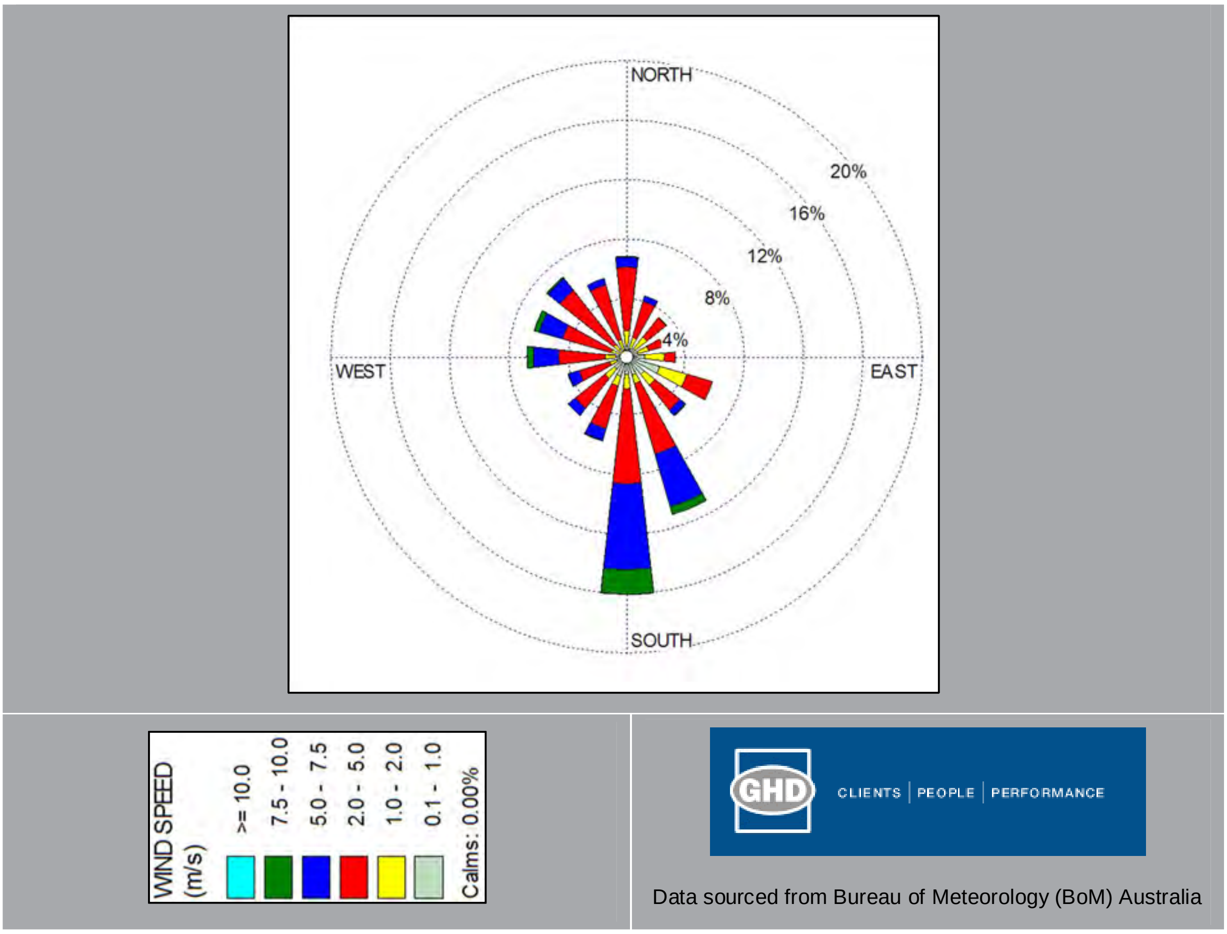
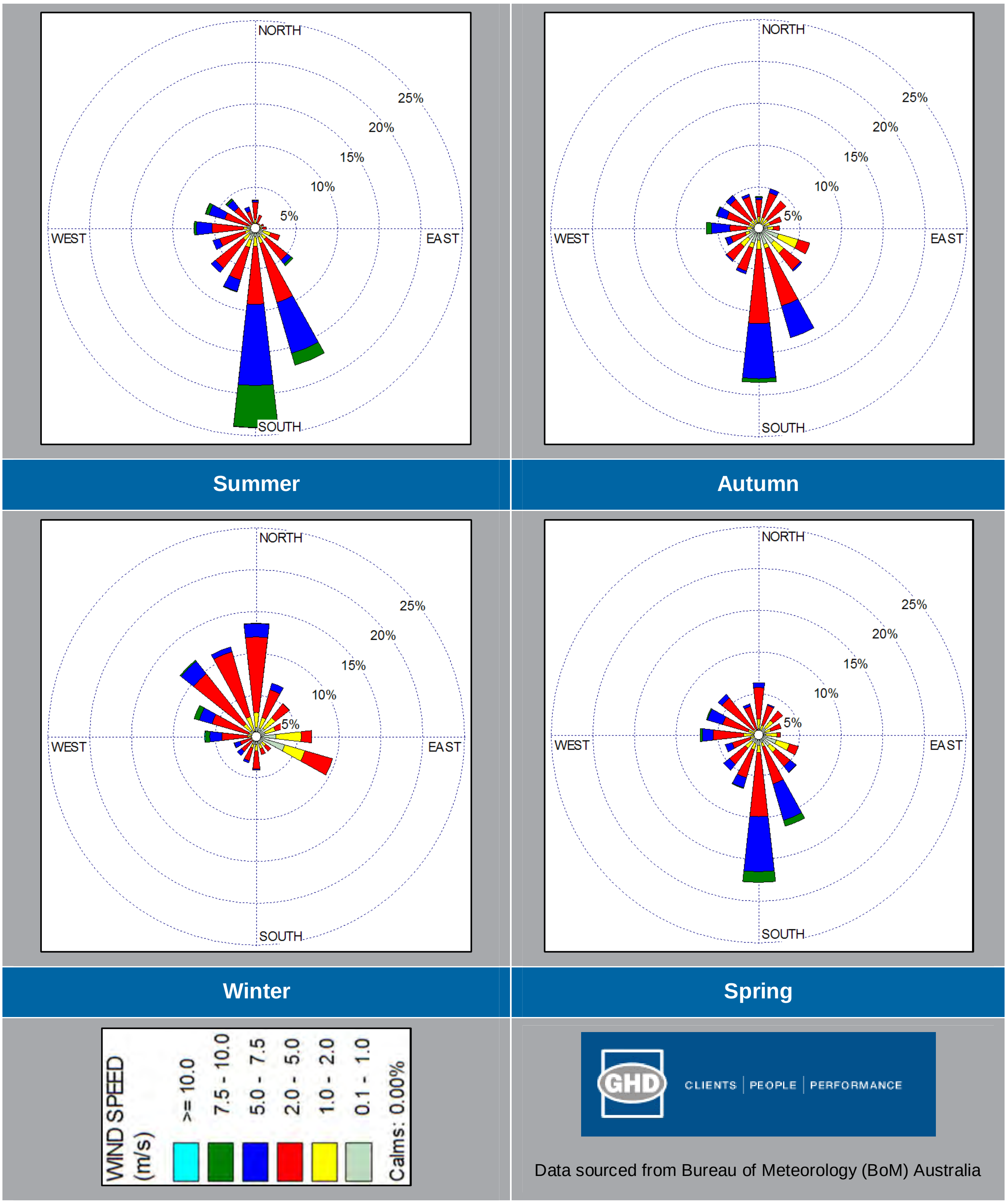


Figure 12 presents seasonal wind roses for Stawell showing the average wind distribution over the 2008/09 years. Prevailing wind directions, from the south switch to the north during winter. Winds are lightest during late autumn and winter. Northeast sector winds are rare.

Figure 12 Seasonal Wind Roses for Stawell



5.1.6 Stability

Atmospheric stability describes the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a function of the amount of turbulent energy in the atmosphere. For a road project, dust from construction activity and gases from vehicle emissions need to be assessed for their environmental impact away from the source.

There are six Pasquill–Gifford classes (A-F) used to describe atmospheric stability, and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and solar insolation are used to define the stability category as shown in Table 13, and as these parameters vary diurnally, there is a corresponding variation in the occurrence of stability category. Stability is most readily displayed by means of stability rose plots, giving the frequency of winds from different directions for various stability classes A to F.

Table 13 Stability Category Relationship to Wind Speed, and Stability Characteristics

Stability Category	Wind Speed Range (m/s) [a]	Stability Characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud.
B	0 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud.
C	0 – ≥6	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud.
D	any	Neutral atmospheric conditions. Occur during the day or night with stronger winds. Or during periods of total cloud cover, or during the twilight period.
E	1.9 – 5.4 [b]	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds.
F	0 – 3.3 [b]	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds.

a. Data sourced from the Turner's Key to the P-G stability categories (US EPA, 2000), assuming a net radiation index of +4 for daytime conditions (between 10:00am and 6:00pm) and –2 for night-time conditions (between 6:00pm and 10:00am)

b. Assumed to only occur at night, during net radiation index categories of –2.

Figure 13 below shows the average annual stability rose for Stawell for the period 01 December 2008 to 30 November 2009. Further information can be gained by looking at a frequency histogram of the same data such as in the lower portion of Figure 14 below.

From both figures it can be seen that annually Stawell's average atmospheric stability lies within the neutral condition (class D) at 46 per cent of the time with the remaining preferred stability classes of E and F for 31.9 per cent of the time. Atmospheric instability does occur however, with classes A to C seen for 22.1 per cent of the year. Categories E and F denote slightly and moderately, respectively, stable atmospheres when dispersion is poorest for ground based emissions (such as road construction and operation) as vertical mixing of air is suppressed. Stable atmospheric conditions occur in the absence of strong gradient winds, and mostly on nights with clear skies. They are often associated with ground-based radiation forced temperature inversions, sometimes with frost, mist or fog.

Mechanically generated dust emissions from road construction plant would have a larger extent of impact under these stable conditions. However, construction activity is most likely to occur during daytime hours.

Figure 13 Annual Stability Rose for Stawell

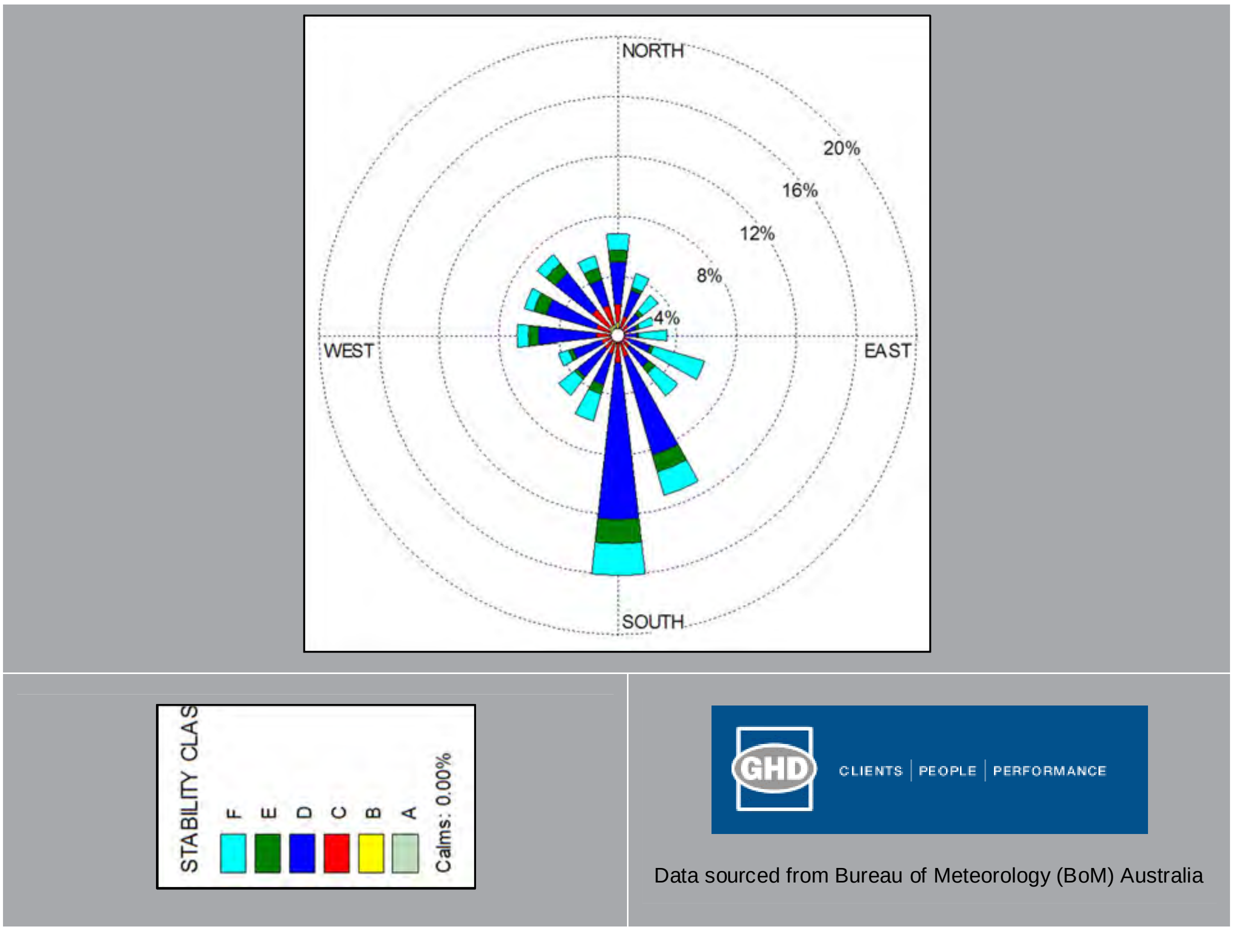
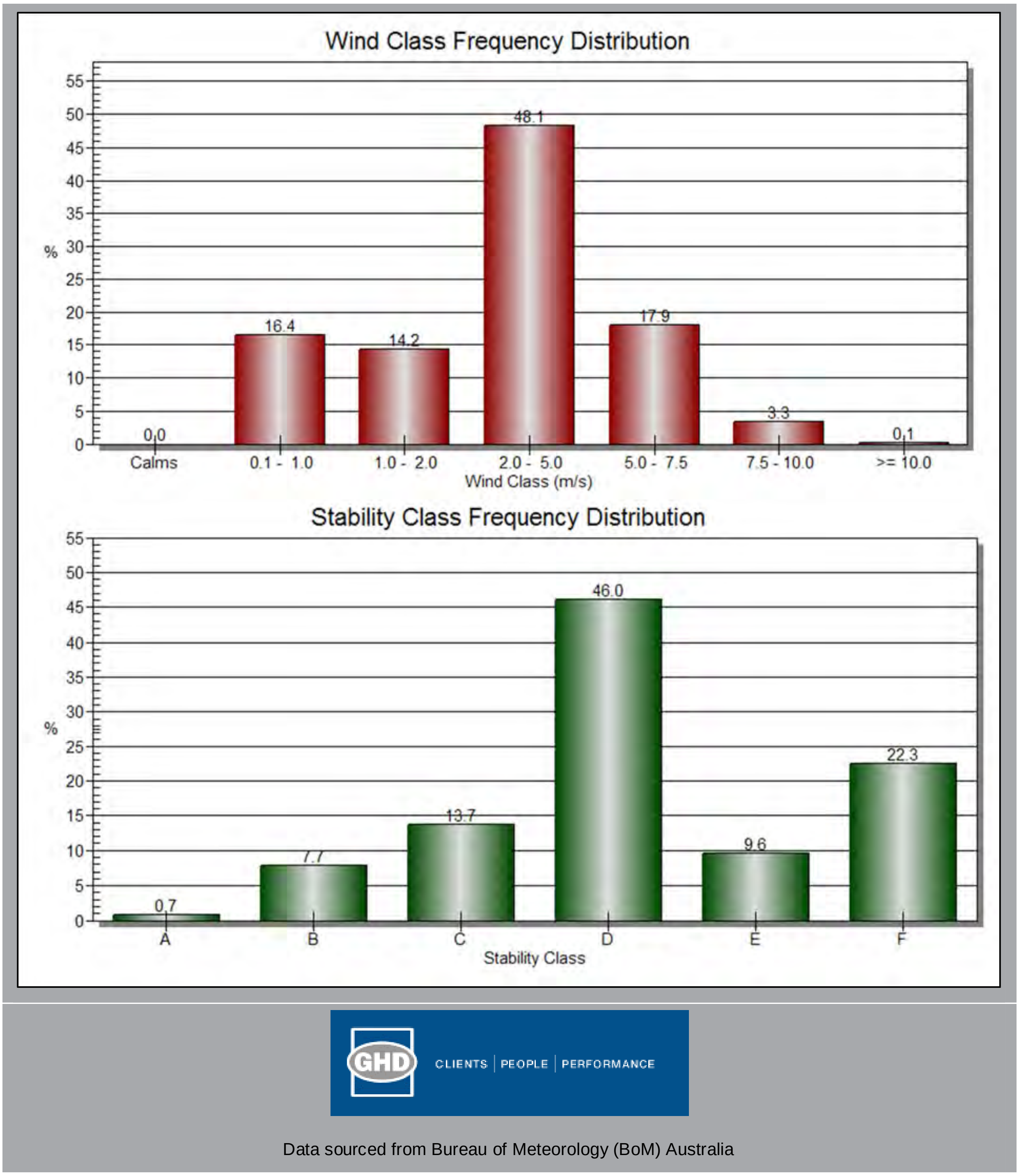


Figure 14 Annual Frequency Distributions for Stawell



5.2 Ambient Air Quality

The SEPP(AQM) requires road projects to be assessed under Part D of Schedule C which concerns modelling of emissions to air from proposed transport corridors. Background pollutant concentration levels are used in the modelling of air quality impacts as these levels need to be considered so that the addition of any project-generated emissions does not exceed the policy criteria.

There are no known Air Quality monitoring data for this area as it is too far west of Ballarat. For a rural area remote from large urbanised of industrial sources, background ambient air quality values can be assumed to be zero, except for particulate matter. For background PM_{10} measurements, EPA Victoria had two monitoring campaigns at Ballarat with 2005/06 shown to be similar to 2002/03 (EPA, 2007). From the earlier data of the 2002/03 monitoring campaign, the 70^{th} percentile of 1 in 6 day high volume sampling was 16.9 $\mu g/m^3$ (EPA, 2004). The Project Area has less urbanised sources than that of Ballarat, but the 70^{th} percentile was adopted in this instance as being the nearest monitoring site to the Project as well as being the best representative data for monitoring condition away from the Coast of South Western Victoria (i.e. minimum oceanic aerosol impact). For the respirable particle fraction of $PM_{2.5}$, it is assumed that a background $PM_{2.5}$ level can be based on a ratio to the background PM_{10} level. However, even with well documented studies involving co-located instruments, the ratio has been shown to vary “depending on season and location, and can range from 0.3 to 0.9” (NPEC, 2002) across a range of conditions within Australia. Since the Project Area is remote from urban populations, involving high emission contributions from vehicle and other combustion process, the ratio of $PM_{2.5}$ to PM_{10} used in this report is at the lower estimate from the NEPC work of 30 per cent. The adopted $PM_{2.5}$ background level for the Project is therefore set at 5.1 $\mu g/m^3$.

5.3 Summary

The entire Study Area from Ararat to Stawell can be classified as having a climate of ‘temperate’ with ‘no dry season (warm summer)’. Extreme values in temperature occur, with hot days more frequent at the north-western end and frosty mornings occurring more often at the south-eastern end.

The wettest months occur in spring (September – November) with greater rain fall expected at the south-eastern end of the Study Area, leading to the conclusion that impacts from construction dust would be relatively higher at the north-western end.

Annual average wind directions are predominately from the south. The Project Area experiences seasonal variations to the wind climate, with a shift from south during the warmer months and then to the north with a north-west sector tendency during winter. Winds are lightest during late autumn and winter, so that predicted impacts are likely to be greater in these seasons.

Stawell’s atmospheric stability class is site-representative for the Project Area and is predominately ‘neutral’ for about one half of all hours but ‘stable’ for about one third of the time. Neutral conditions would be the most often occurring stability category during construction hours.

Background air pollutant level for the particulate matter has been adopted from the 70^{th} percentile of the 2002/03 air monitoring campaign data at Ballarat, as it is the nearest monitoring site to the Project. All other constituents can be assumed to be zero.

6. Impact Assessment

The detailed impact assessment documented in this report addresses the potential impacts of the construction and operation of the proposed alignment of Section 3 of the Project. The alignment assessed is a culmination of progressive refinement of the design and consideration of potential impacts. The process for assessment and rationale for selection of the proposed alignment assessed in the EES is described in the ‘Western Highway Project Section 3 Options Assessment Report’ (February 2012) (Technical Appendix B of the EES).

The Existing Conditions section of this report covers an area encompassing the long list of alignment options considered for the Project. Potential impacts of each option in the long list of alignments were considered in Phase 1 of the options assessment process, and were used to reduce the initial long list to a short list of alignment options.

The potential impacts of each option in the short list of alignment options were considered in more detail in Phase 2 of the option assessment process. A single proposed alignment was selected for further detailed assessment in the EES. The impacts of the proposed alignment, together with potential mitigation measures, were considered in detail through the environmental risk assessment process. The outcomes of the risk assessment process were used to finalise the proposed alignment assessed in the EES. The environmental risk assessment methodology and complete risk register for all specialist disciplines is presented in ‘Western Highway Project Section 3 EES Environmental Risk Assessment’ (November 2012) report.

The proposed alignment assessed in this impact assessment report is the outcome of progressive refinement through each phase of the options assessment process. The proposed alignment was also refined following the initial consideration of the environmental risk assessment.

Extracts form the environmental risk register prepared for the EES are provided in this report and the identified impacts of the proposed alignment are considered in detail in the following sections.

6.1 Project Description

The Project provides two lanes in each direction, and associated intersection upgrades to improve road safety and facilitate the efficient movement of traffic. It commences at Pollard Lane, Ararat, and extends northwest for approximately 24 km to Gilchrist Road, Stawell. The upgrade assessed in this impact assessment is a combination of freeway standard (AMP1) and duplicated highway standard (AMP3). The first length is proposed to be upgraded to duplicated highway standard (AMP3) from Pollard Lane to the Majors Road. Then the upgrade is proposed to be freeway standard (AMP1) from Pollard Lane to Gilchrist Road on the outskirts of Stawell.

From Ararat the existing carriageway is duplicated to the north-west, crossing the railway via a new bridge adjacent to the existing Armstrong Deviation bridge. A new dual carriageway highway provides for a north-eastern bypass of Great Western, commencing north-west of Delahoy Road and passing through part of the former Great Western landfill and a quarry, meeting the existing highway alignment again near Briggs Lane. The existing carriageway is then duplicated to the north-west until Harvey Lane. Oddfellows Bridge at Harvey Lane would be upgraded to accommodate one carriageway crossing of the railway, and a second bridge would be constructed for the other carriageway further west.

Overall, the proposed alignment involves two crossings of the Melbourne to Adelaide railway, eight crossings of major waterways and 26 minor waterways (tributaries, drainage lines and irrigation channels), and bypasses of both Armstrong and Great Western townships.

The topography is undulating, and the surrounding land use predominately agricultural (grazing, cropping, viticulture), apart from the forested Ararat Regional Park and other smaller remnants.

Apart from the Melbourne to Adelaide railway line, which carries both freight and passenger services, no State significant infrastructure, such as major pipelines or powerlines, is located within the Study Area.

6.2 Key Issues

The Alignment presented for consideration for this Project has the following potential positive benefits:

- Improved traffic flows, decreasing vehicle emissions;
- Shorter travel times;
- Reduced emissions 'hot spots' through town centres and at intersections; and
- Transposing traffic a greater distance from sensitive receptors, improving dispersion and lowering vehicle emission concentrations at receptor sites.

The Alignment presented for consideration for this Project has the following potential adverse impacts:

- Construction emissions;
- Operational emissions;
- Domestic water supplies, and;
- Agriculture and Horticulture.

These potential impacts are discussed below. Mitigation measures are discussed in Section 7 of this report.

6.2.1 Construction Emissions

Substantial civil engineering works are required to construct the Project. Construction dust has the potential to cause minor health impacts such as asthmatic exacerbation and nuisance effects from dust settling on windows, laundry and other surfaces. The most credible risk pathway is therefore to amenity, which can be indicated through an exceedance of the applicable air quality standard PM_{10} (above the intervention level of the SEPP (AQM)) as controlling the finer fractions would in turn control the coarser fractions found in nuisance dust. An exceedance may occur in either a localised area such as Great Western or at individual more isolated sensitive receptor sites along and nearby the construction corridor.

Sensitive Receptor issues, additional to human impact, include potential dust impact on agricultural practices. Dustfall on sensitive agriculture such as vineyards and olive groves is to be considered (see section 6.2.4). Impact on animals such as cattle and horses is considered less critical[2], particularly since the pasture grows in the very material being disturbed by the construction activity.

[2] Studies cited by Connell Hatch (Connell Hatch, 2008) found that feed preference, palatability, quantity of feed eaten and quantity of milk produced were not affected when livestock were exposed to feed containing coal dust at rates of no dust, 4,000 and 8,000 $mg/m^2/day$ (120 and 240 $g/m^2/month$ respectively). Generally, construction dust (crustal dust) can be considered to be of lower toxicity than coal dust. Since the amenity criteria addressed in section 3.2 set the maximum total deposited dust level of no more than 4 $g/m^2/month$, the amenity criteria is at least 30 times more stringent than the maximum limit of dust exposure level of livestock. Hence, the amenity criteria is the critical constraint – when it is met, the criterion for livestock would also automatically be met.

6.2.2 Operational Emissions

The operation of the proposed alignment would result in generation of dust and gaseous pollutants due to traffic movement. This would involve exhaust emissions; tyre and engine wear as well as re-entrained road dust. The latter involves the movement of traffic producing mechanical grinding of any dust on the roads and 'lifting' this dust away from the road surface. However, it should be noted that these types of operational emissions are already present along the existing Western Highway and any future increases in emissions are likely to be negligible.

6.2.3 Domestic Water Supplies

Construction and operational emissions have the potential to fallout onto residential roofs during rain events and run-off into domestic water supplies. Many sections of the Project are through rural areas without reticulated water supply, resulting in housing being reliant on domestic rainwater tanks for potable water.

As in Section 6.2.1, construction dust emissions are generally in the medium to higher size fractions greater than PM_{10} (Total Suspended Particulate as nuisance dust) and as such, would fall out of the air column more readily than the smaller size fractions during construction. Hence, through management of the smaller particle size fractions (equal and less than PM_{10}), it follows that the nuisance dust would also be managed.

Operational emissions from roadways are principally gaseous and these are unlikely to deposit on roofs as the environmental fate of a gas being converted to an aerosol that then deposits on a roof is a slow atmospheric process, and therefore has limited local impact. The particulate emissions from cars are largely controlled at the source (exhaust) and particulate emissions from trucks (diesel engine) are almost exclusively in the very fine sub $PM_{2.5}$ range. Hence, there are negligible sources of coarse particulates in the operational phase (road pavement dust and poorly tuned cars are the only plausible sources). It should also be noted that to the extent that these types of operational emissions are present, they are unlikely to increase above the existing levels from traffic on the Western Highway.

6.2.4 Agriculture and Horticulture

Construction emissions have the potential to fallout onto the foliage and/or fruit of farms growing primary produce such as olive groves and vineyards, potentially settling and causing leaf/fruit damage or reduced growth rates. For instance, construction dust could potentially have impact on vines such as blockage on photosynthesis and excessive dust on grapes at harvest.

As in Section 6.2.1, construction dust emissions are generally in the medium to higher size fractions greater than PM_{10} (Total Suspended Particulate as nuisance dust) and as such, would fall out of the air column more readily than the smaller size fractions during construction.

Dust particles released into the air tend to fall back to ground at a rate proportional to their size (settling velocity). For a particle 10 microns in diameter, the settling velocity is about 0.5 cm/sec, while for a particle 100 microns in diameter it is about 45 cm/sec, in still air. In a 5 m/sec wind, the 100-micron particles have the potential to travel about a kilometre. Fine particles can therefore be widely dispersed, while the larger particles simply settle out most readily onto exposed surfaces within the immediate vicinity of the source (Ministry of the Environment, September 2001).

As such, it is the larger dust (construction dust) particles that are generally responsible for nuisance effects on agriculture/horticulture, in particular vineyards and olive groves. However, through management of the smaller particle size fractions (equal and less than PM_{10}), it follows that the nuisance dust impact on primary produce farms would also be managed.

Potential locations of farms growing primary produce such as olive groves and vineyards within the Study Area have been identified through the use of aerial mapping techniques, and they are shown in Table 14 below. Issue concerning dust fallout onto sensitive produce farm is not uncommon with road construction activities and is practically best addressed by the implementation of dust management controls (see Sections 6.6.1 and 7.1) to be incorporated in the Construction Environmental Management Plan (CEMP) for the Project. Construction dust management measures have been recommended and are outlined in Section 7.1 of the report. However, any sensitive primary produce farms, including vineyards and olive groves, should be identified on-site during the construction phase of the Project and ensured that any potential construction dust impact is suitably managed.

Table 14 Western Highway Section 3 – Potential Locations of Primary Produce Farms within the Study Area

No.	Chainage	VicRoads (VR) Property ID	GHD Property ID	Alignment Side from Main Carriageway	Approximate Distance from Construction Footprint (m)	Property Description
1	1600	2533	295	WEST	0*	Potential vineyards or olive groves
2	2200 – 2500	2544	73	EAST	0*	Potential vineyards or olive groves between Western Hwy and Railway Loop Rd
3	2800 – 3000	2584	293	WEST	0*	Potential vineyards
4	3400 – 3700	2546	154 and 155	EAST	0*	Potential vineyards or olive groves between Western Hwy and McDonalds Park Rd
5	3800 – 4200	2552	104	EAST	960	Potential vineyards or olive groves
6	4600	2571	106	EAST	650	Potential vineyards or olive groves along Old Brewery Rd and Concongella Creek
7	4600	2564	N/A	EAST	600	Potential vineyards or olive groves along Concongella Creek
8	5200	2620	273	EAST	424	Potential vineyards or olive groves at Military Bypass Rd and
9	5200 – 5500	2678 – 2680	N/A	WEST	1,065	Potential vineyards or olive groves at Eaglehawk Rd
10	5400 – 5600	2698 – 2700	N/A	WEST	1,033	Potential vineyards or olive groves
11	6000 – 6400	2710 and 2712	289 and 290	WEST	0*	Potential vineyards or olive groves at the corner of Western Hwy and Garden Gully Rd

No.	Chainage	VicRoads (VR) Property ID	GHD Property ID	Alignment Side from Main Carriageway	Approximate Distance from Construction Footprint (m)	Property Description
12	6600	2636	92	EAST	305	Potential vineyards or olive groves at the corner of Military Bypass Rd and McKays Woolshed Rd
13	6700 – 7200	2720 and 2721	N/A	WEST	765	Potential vineyards or olive groves at Garden Gully Rd and Westgate Rd
14	6800 – 7000	2719 and 2722	N/A	WEST	499	Potential vineyards or olive groves at Yellow Box Lane
15	8000	2731	N/A	EAST	1,340	Potential vineyards or olive groves at Kimburra Road
16	10500 – 11200	2806	110	WEST	0*	Garden Gully Grampians Wine and Food Pty Ltd
17	11900 – 12400	2824, 2825, 2829, 2831, 2833-2847, 2905	195	WEST	83	Beringer Blass Wine Estate Ltd
18	12200 – 12400	2871-2874	272	WEST	58	Donovan Vineyards Pty Ltd
19	14700 – 16200	2899-2904, 2923, 2928-2929, 2934-2940	268	EAST	0*	Bests Wines Pty Ltd
20	16200	2915	N/A	WEST	1,600	Potential vineyards or olive groves adjacent to Cobeys Creek
21	20400 – 20600	2963	130	EAST	128	Potential vineyards or olive groves
22	20900 – 21800	2965	145	EAST	0*	Potential vineyards or olive groves
23	22200 – 22700	3024	90	WEST	391	Potential vineyards or olive groves at Stawell Park Caravan Park Pty Ltd
24	24200 – 25000	3045	N/A	WEST	0*	Potential vineyards or olive groves at the corner of Western Hwy and Gilchrist Rd

* Zero distance indicates that the property locations of the vineyard or olive grove have common boundary with the Project's construction footprint or construction zone.

The operation of the proposed alignment would result in generation of dust and gaseous pollutants, due to traffic movement, that would potentially impact on nearby farms growing primary produce. However, as there are already vehicles travelling along the existing Western Highway, there are already vehicle emissions being emitted in the Study Area. Due to the prediction that any future increases in emissions are likely to be negligible (see section 6.5), thus operational emissions impacts on intensive agricultural practices are considered to be negligible.

6.3 Impact Pathways

This section identifies and describes air quality cause and effect pathways associated with the construction and operation of the Project.

Five pathways were chosen based on potential impacts from the construction stage of the Project, as well as, its subsequent operation. Air quality pathways were further separated spatially by sensitive receptor and location. Pathways are summarised as follows:

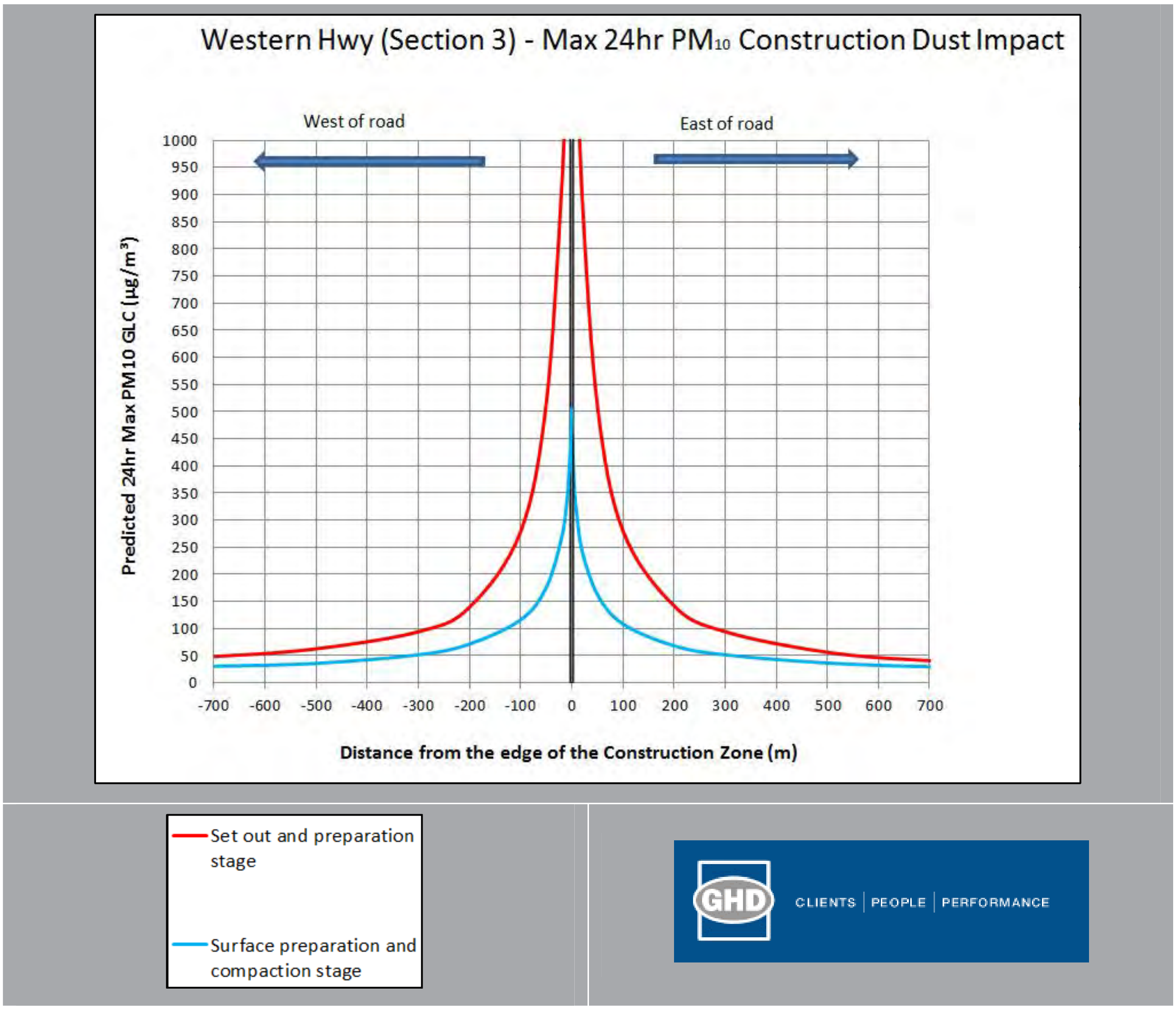
- Construction emissions impact on an individual sensitive receptor;
- Construction emissions impact a local area (community);
- Construction/operational emissions deposit on dwellings that drain into domestic water supplies (i.e. tank water);
- Construction emissions deposit on agricultural/horticultural businesses at an individual sensitive receptor location; and
- Operation of the Western Highway generates air emissions from vehicular traffic.

6.4 Construction Dust Assessment

This section addresses the modelling results for construction dust emissions from the Project (Section 3 Ararat to Stawell).

The modelled maximum construction dust (PM_{10}) as a 24 hour average for the Project is presented in Figure 15 below. It shows that even with dust control applied (use of water carts for example), downwind dust impact is predicted to extend a fair distance beyond the construction corridor. This is evident primarily from the surface preparation and compaction stage where the heaviest equipment would be in operation.

Figure 15 Max 24hr PM_{10} Dust Impacts from Construction Activities (inclusive background concentration).

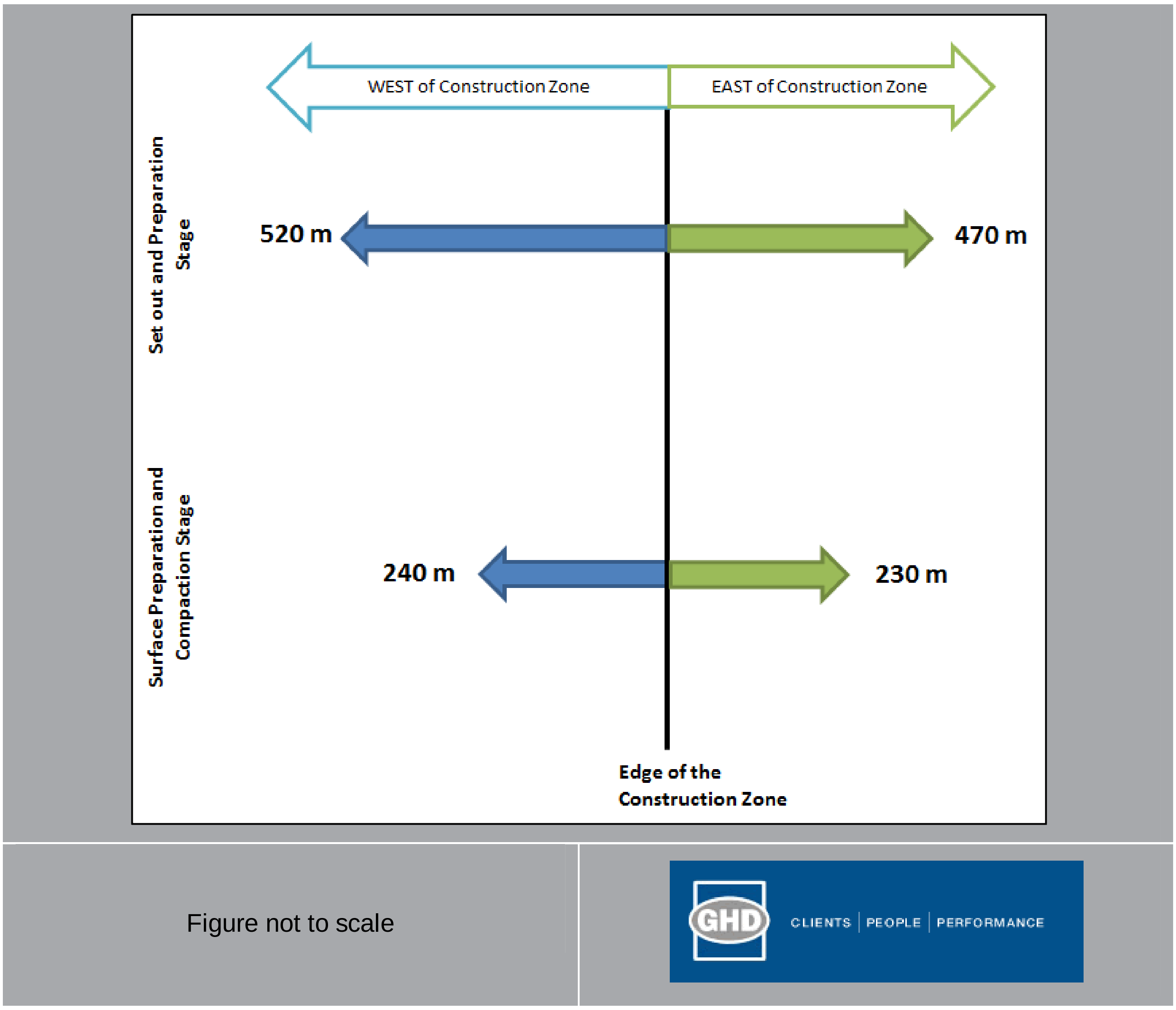


The impact zone to the west of the road alignment is greater than that to the east of the road alignment due to meteorological behaviour.

During the set out and preparation stage, the impact footprint (i.e. when the construction, under a worst-case scenario, dust reaches above the SEPP (AQM) intervention level of 60 µg/m^3) was predicted to be within 520 m from the edge of the construction zone to the west side of the road and 470 m from the construction zone to the east side of the road. On the other hand, during the surface preparation and compaction stage, the impact footprint was predicted to be within 240 m from the construction zone to the west side of the road and 230 m from the construction zone to the east side of the road.

This is diagrammatically illustrated in Figure 16, where it shows the distances to the sensitive receptor locations within the stated distance where further dust management controls would be required when conducting road construction, as outlined in Table 16 and section 7 of this document. These dust management controls would be required so that the VicRoads contractor would be able to meet the requirement of no adverse off-site dust impact. This applies, with slightly different impact zones, for either set out and preparation stage or surface preparation and compaction stage and to subsequently lower the risk (refer to Table 16 and section 7.1).

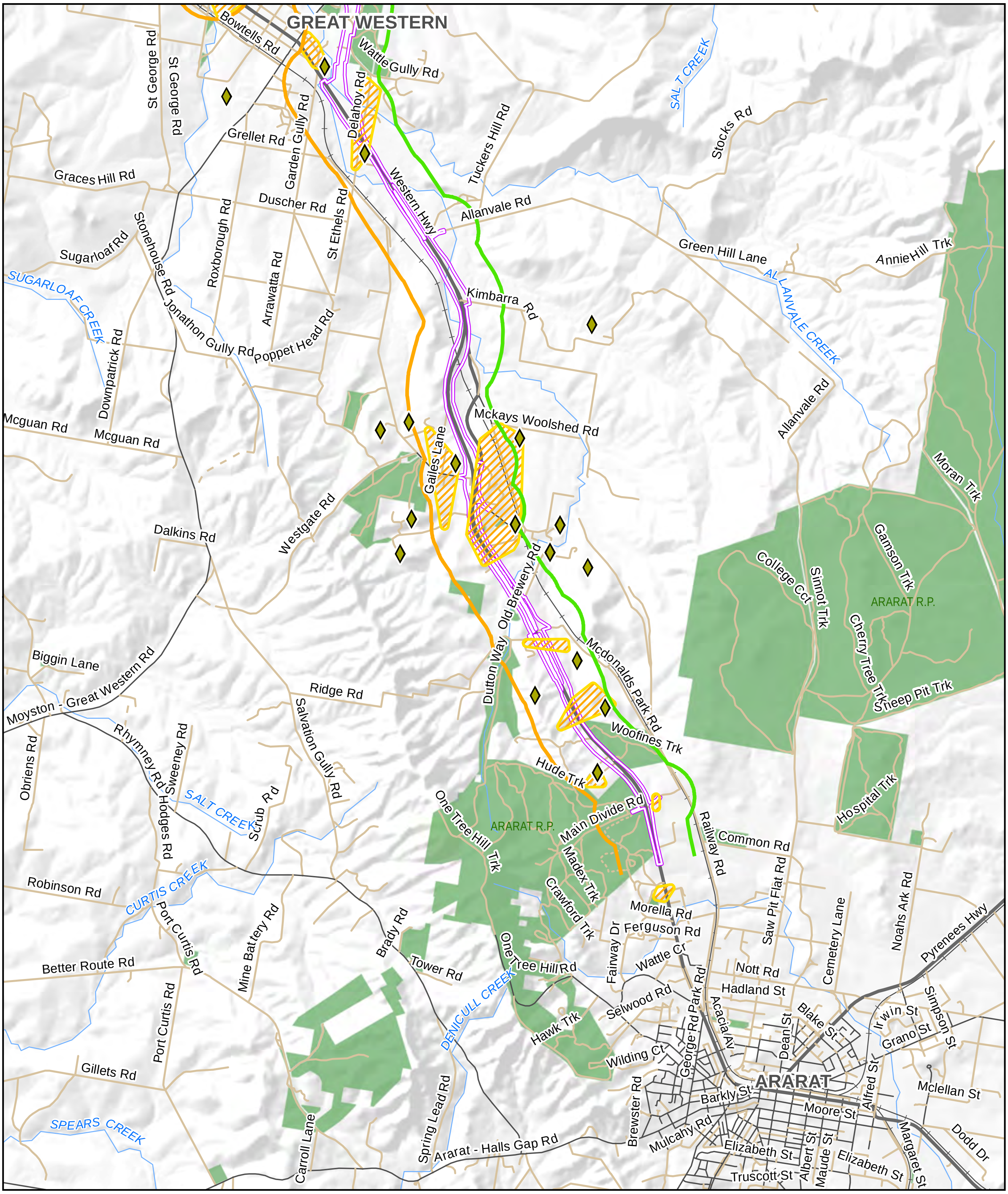
Figure 16 Predicted Impact Zone from PM_{10} Construction Dust for Mitigation Needs.



6.4.1 Potential Sensitive Receptors

Residential and commercial premises are considered to be sensitive locations in regards to health and amenity impacts due to dust. The alignment and maximum construction footprint come close to a number of potential sensitive receptors. Appendix B details the individual potential 117 sensitive receptors, which may potentially be within the construction dust impact zone for the proposed alignment. Note that this issue is not uncommon with road construction activities and is practically best addressed by the implementation of dust management controls (see section 7.1), which to be incorporated in the

Construction Environmental Management Plan (CEMP) for the Project. Figure 17 to Figure 19 show the construction dust impact zones on either sides of the Highway, along with potential locations of primary produce farms. Also shown as shaded areas are local areas with potential for moderate consequence (see Table 2) giving rise to high risk of dust impact without the suggested additional controls (see Table 16).



LEGEND

- Construction Dust Impact Zone, East (470 m)
- Construction Dust Impact Zone, West (520 m)
- Highway
- Sealed road (arterial & local)
- Unsealed road
- Unsealed track
- Sealed walking/bike trail
- Unsealed walking/bike trail
- Major water course
- Major water area
- Maximum Construction Footprint
- Potential Locations of Primary Produce Farms within Study Area
- Local area with potential receptors for high dust impact

Paper Size A4

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Western Highway Project

Ararat to Stawell
PM_{10} Construction Dust Impact Zone **Figure 17**

Job Number	31-27558
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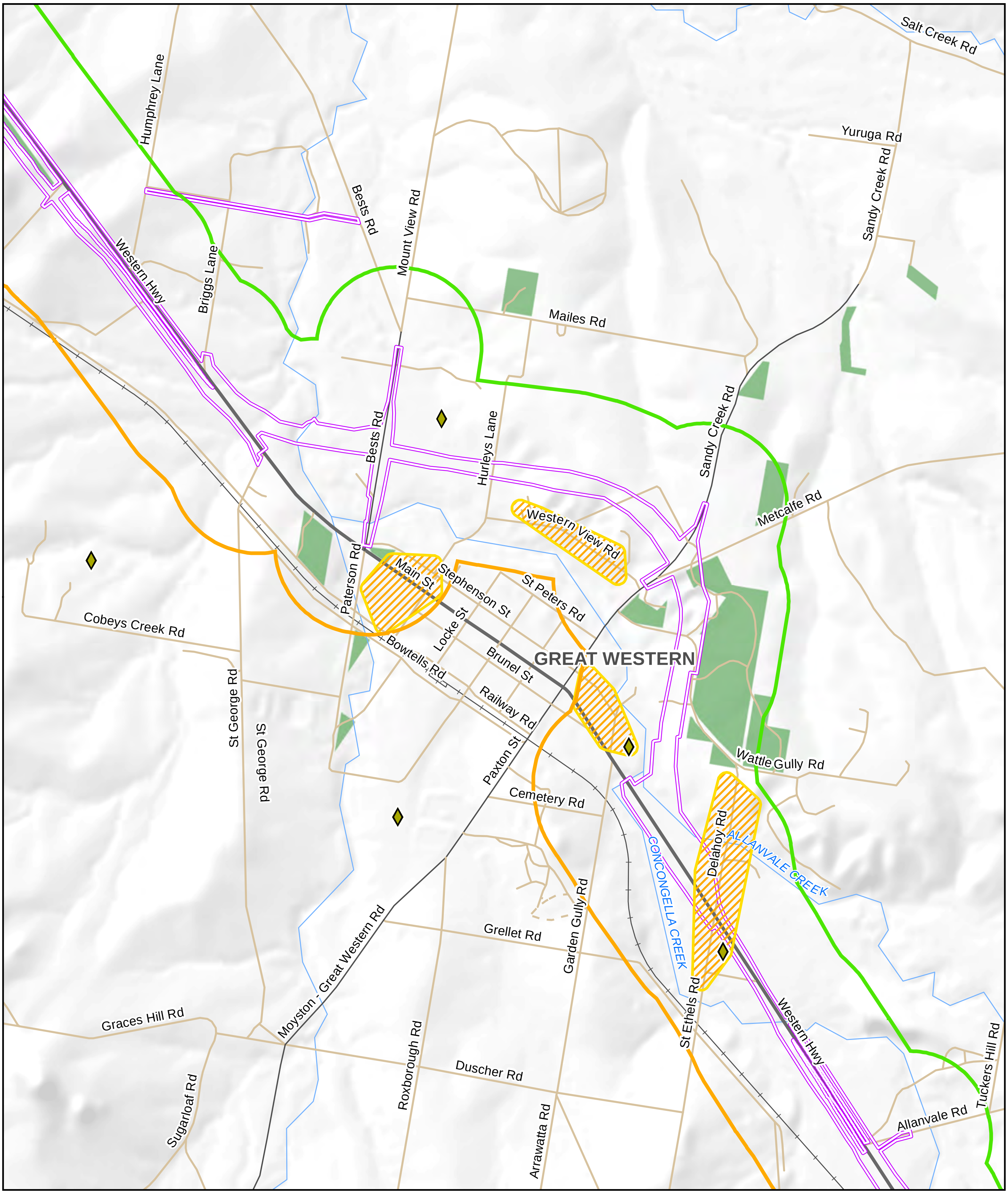
Data source: DSE, VicMap, 2012; VicRoads, 2012; GHD, Design, 2012. Created by:splaird



LEGEND

- Construction Dust Impact Zone, East (470 m)
- Construction Dust Impact Zone, West (520 m)
- Highway
- Sealed road (arterial & local)
- Unsealed road
- Unsealed track
- Sealed walking/bike trail
- Unsealed walking/bike trail
- Major water course
- Major water area
- Maximum Construction Footprint
- Potential Locations of Primary Produce Farms within Study Area
- Local area with potential receptors for high dust impact

Paper Size A4

0 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

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Ararat to Stawell
PM_{10} Construction Dust Impact Zone Figure 18

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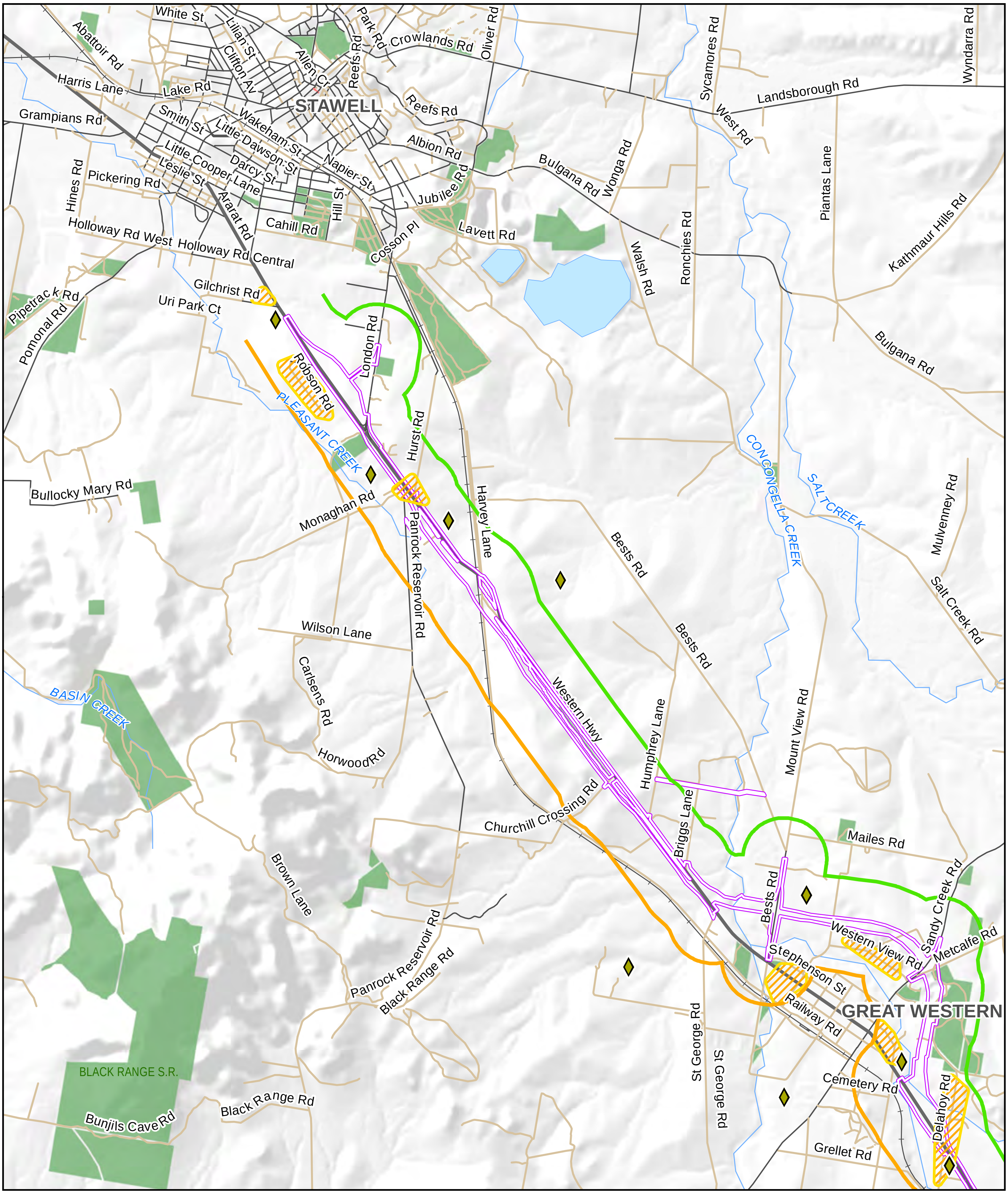
Data source: DSE, VicMap, 2012; VicRoads, 2012; GHD, Design, 2012. Created by:splaird



LEGEND

- Construction Dust Impact Zone, East (470 m)
- Construction Dust Impact Zone, West (520 m)
- Highway
- Sealed road (arterial & local)
- Unsealed road
- Unsealed track
- Sealed walking/bike trail
- Unsealed walking/bike trail
- Major water course
- Major water area
- Maximum Construction Footprint
- Potential Locations of Primary Produce Farms within Study Area
- Local area with potential receptors for high dust impact

Paper Size A4

0 0.5 1 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Western Highway Project

Ararat to Stawell

PM$_{10}$ Construction Dust Impact Zone **Figure 19**

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Data source: DSE, VicMap, 2012; VicRoads, 2012; GHD, Design, 2012. Created by:splaird

6.4.2 Primary Produce Farms

The alignment and maximum construction footprint come close to a number of primary produce farms involving intensive agriculture (refer to Table 14), such as vineyards and olive groves. Any sensitive primary produce farms should be identified on-site during the construction phase to ensure that any potential construction dust impact is suitably managed as an addition to locations identified in Table 14. Special care would need to be taken when construction activity is nearby any commercial vineyards or olive groves, specifically during the most sensitive times. Dust deposition on grapes and olives at their flowering would have the most impact due to the subsequent impact on seed set and therefore yield. Consultation with the grower concerned would identify their most critical periods. Note that this issue is not uncommon with road construction activities and is practically best addressed by the implementation of dust management controls (see Sections 6.6.1 and 7.1) to be incorporated in the Construction Environmental Management Plan (CEMP) for the Project.

6.5 Operational Vehicle Emissions Assessment

This section addresses the modelling results for vehicle emissions predicted for the Project (Section 3 Ararat to Stawell).

The predicted maximum NO2 (1-hour average), PM2.5 and PM10 (24-hour average) air quality levels are presented in Figure 20 to Figure 22 as concentration profile plots for this Project Section. These parameters were selected as NO2 was the closest (see Table 15) to the SEPP (AQM) intervention level, and PM10 and PM2.5 are over the differing averaging period of 24-hour rather than 1-hour.

In modelling the worst case scenario, GHD adopted the 'Duplication (Narrow)' cross sectional layout, as detailed in section 4.3.2.

Based on the predicted precent compliance of each constituent, with their associated intervention levels for both east and west sides of the Project alignment, all pollutants levels were well below the intervention levels set out in SEPP (AQM), Schedule B, at the modelled 30 m receptor distance from the edge of the 'outer lane' (refer to Table 15). The predicted /modelled compliance with SEPP (AQM) intervention levels ranged from 0.01 per cent of the intervention level for xylenes to 7.8 per cent on the NO_2 intervention level of 263 µg/m^3 and 29.9 per cent on the PM_{10} intervention level of 60 µg/m^3, with the inclusion of a background air pollutant level for particulate matter. It is also worth noting that even with the additional 16.9 µg/m^3 PM_{10} background level outlined in section 5.2, it would still be under the intervention level.

Therefore, as all pollutants levels were well below the intervention levels at the modelled 30 m distance receptor from the edge of the 'outer lane', all pollutant levels are predicted to be a minor detriment at any nearby sensitive receptor locations beyond the 32 m distance from the edge of the 'outer lane' (i.e. As per indicated in Figure 4 - just prior to dispersal passing the 'outer boundary of the carriageway').

The impact pathway of vehicle emissions away from the road alignment has been shown to be negligible with the intervention levels set out in SEPP (AQM), Schedule B continuing to be met.

Figure 20 Cumulative NO2 Impact – Section 3 Western Highway

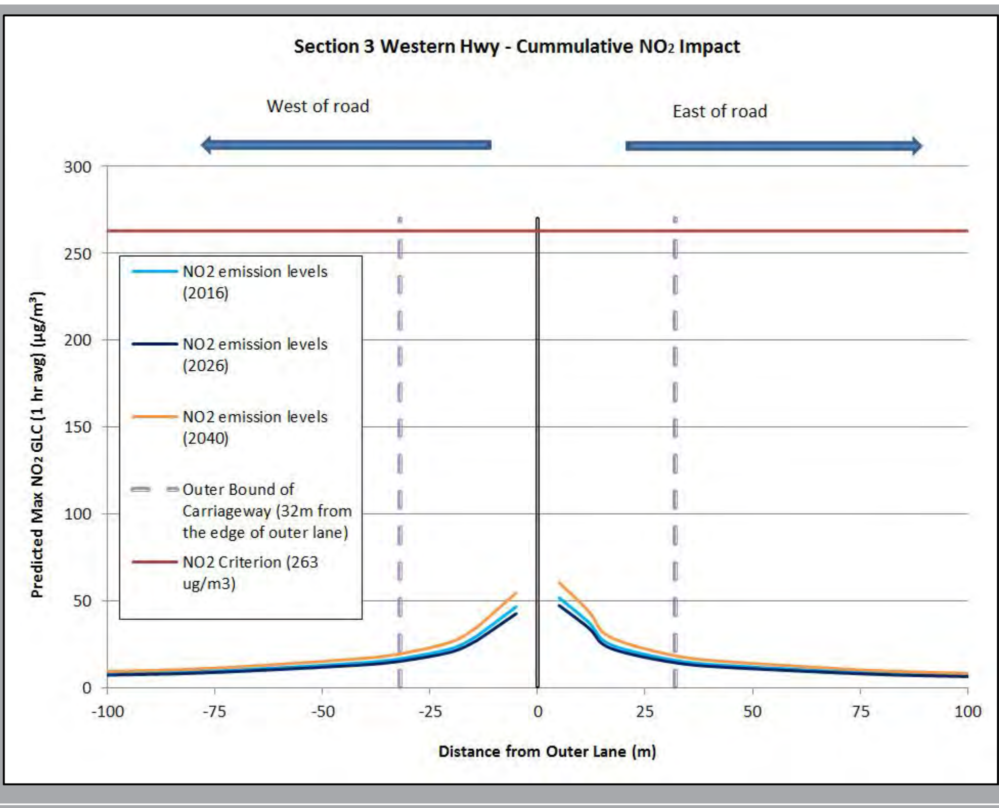

Figure 21 Cumulative PM_{10} Impact – Section 3 Western Highway

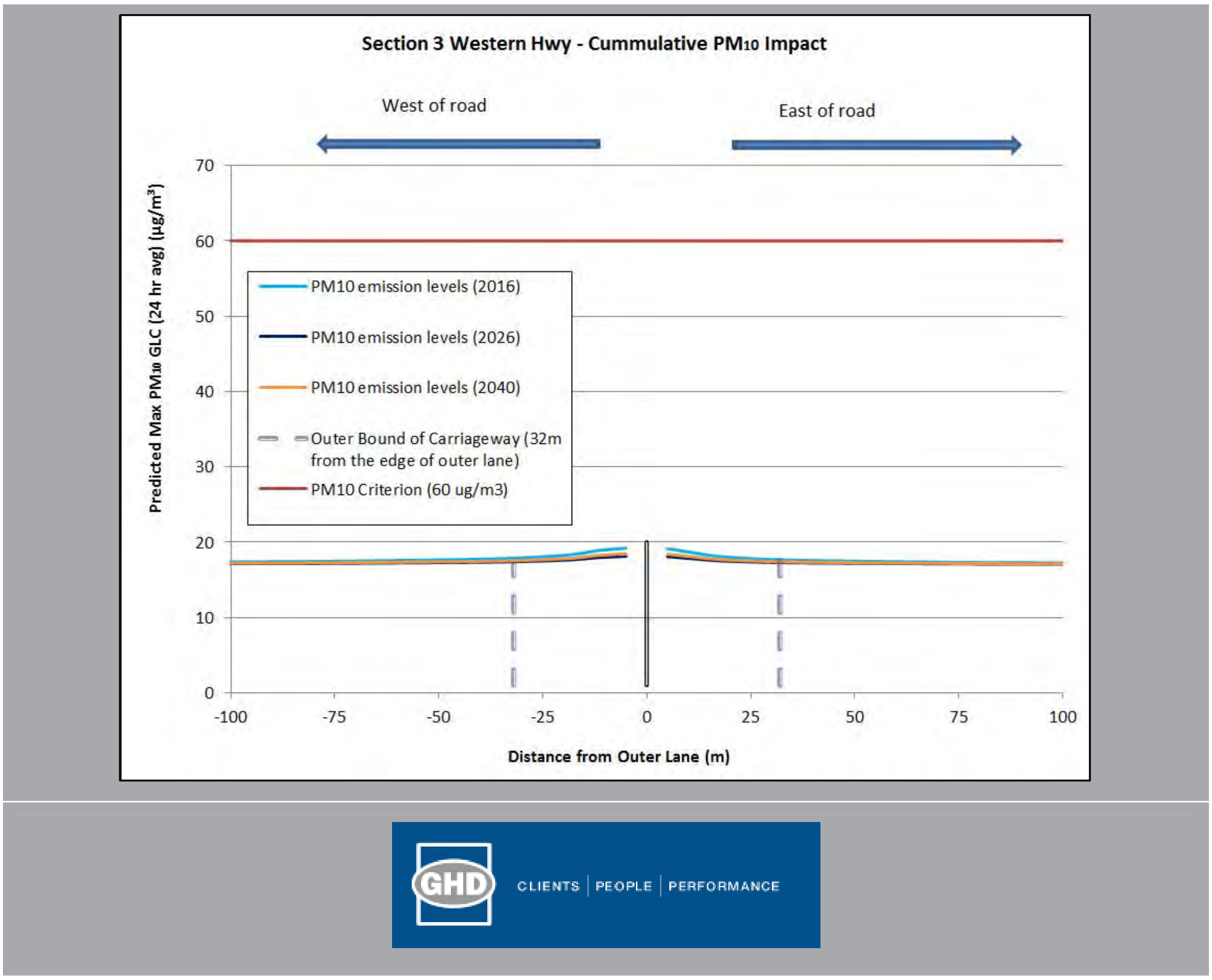

Figure 22 Cumulative $PM_{2.5}$ Impact – Section 3 Western Highway

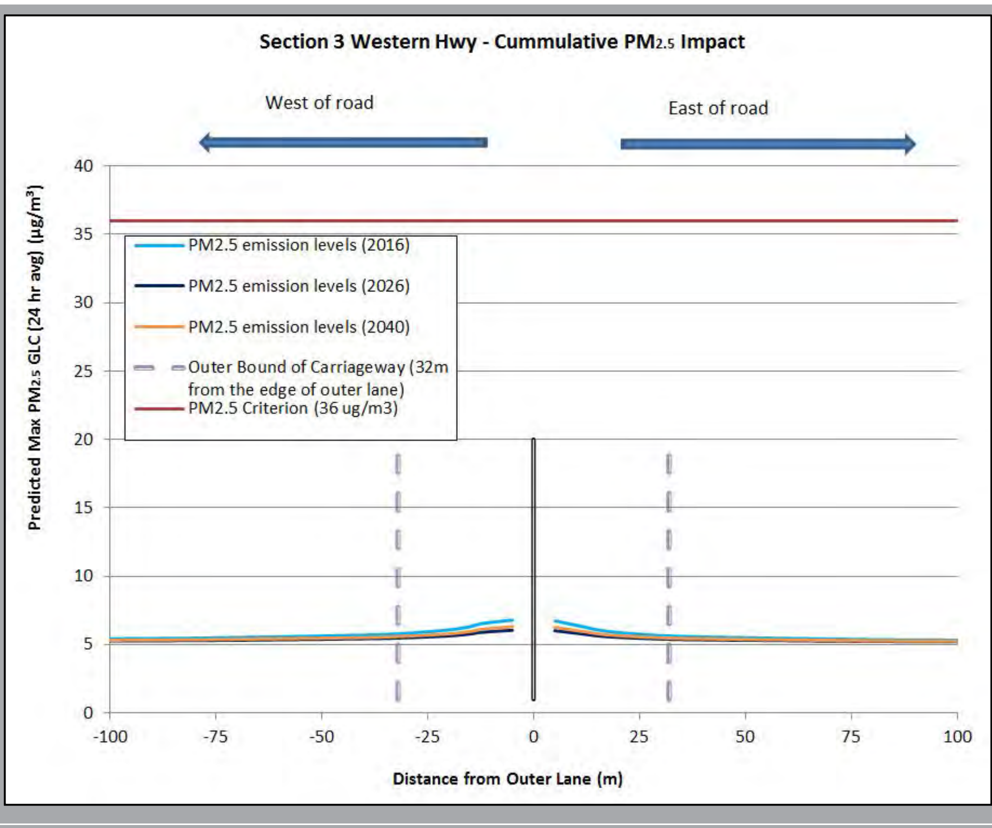

Table 15 **Section 3 Western Highway Modelled Per Cent Compliance with SEPP (AQM) Intervention Levels for year 2016, 2026 and 2040 – at 30 m distance from the edge of the 'outer lane' of the road alignment.**

Constituent	Percentage of Intervention Level (%)						Intervention Level (SEPP-AAQ)
	Western Highway 2016		Western Highway 2026		Western Highway 2040		
	East of Alignment	West of Alignment	East of Alignment	West of Alignment	East of Alignment	West of Alignment	
CO	0.45	0.47	0.43	0.45	0.53	0.56	**33222 μg/m^3**
NO_2	6.41	6.74	5.87	6.17	7.49	7.87	**263 μg/m^3**
PM_{10}	29.48	29.86	28.87	29.07	29.05	29.31	**60 μg/m^3**
$PM_{2.5}$	15.72	16.18	15.01	15.27	15.25	15.59	**36 μg/m^3**
PAH (Particle Bound)	0.03	0.03	0.02	0.02	0.02	0.02	**0.5 μg/m^3**
Benzene	0.49	0.52	0.38	0.40	0.47	0.50	**75 μg/m^3**
1,3 Butadiene	0.04	0.04	0.03	0.03	0.04	0.04	**110 μg/m^3**
Formaldehyde	0.76	0.80	0.67	0.71	0.85	0.89	**15 μg/m^3**
Toluene	0.03	0.03	0.02	0.02	0.03	0.03	**1880 μg/m^3**
Xylenes	0.02	0.02	0.01	0.01	0.02	0.02	**2080 μg/m^3**

Note: Percentage Intervention Levels are the predicted values for each constituent plus the background pollution already present, divided by the associated SEPP AAQ intervention level multiplied by one hundred to give a percentage.

Note: The predicted values above were at 30 m distance from the 'outer lane' of the road alignment.

6.6 Risk Assessment

A risk assessment of the potential air quality impacts likely to occur during both construction and operation of the Project was carried out as per the methodology outlined in section 4.3.

VicRoads has a standard set of environmental protection measures which are typically incorporated into its construction contracts for road works and bridge works. These are described in *VicRoads Contract Shell DC1: Design & Construct, April 2012*, hereafter referred to as the "VicRoads standard environmental protection measures". These measures have been used as the starting point for the impact assessment. Those that are relevant to air quality are included in the "planned controls" column of the risk assessment (Table 16) and outlined in more detail in Section 7 (Mitigation Measures).

As a result of the initial risk assessment, in some cases additional Project specific controls have been proposed to reduce risks. These are outlined in the "additional controls" column of the risk assessment in Table 16, and are described in more detail at the end of this section.

Both the VicRoads standard environmental protection measures and the additional Project specific controls have been included in the Environmental Management Framework for the Project.

Key observations from the risk assessment of the proposed alignment and associated construction corridor are:

- Five impact pathways have been defined for the Project:
    - Construction emissions at single receptors;
    - Construction emissions over local communities;
    - Construction emissions impacting drinking water;
    - Construction emissions impacting primary produce production; and
    - Operational emissions from vehicles on completed highway.
- Six local communities have been defined and are located at:
    - Gilchrist Road - Commercial Properties, Stawell (Ch. 24800);
    - Robsin Road Community, Stawell (Ch. 23200 - 24200);
    - Stawell Park Caravan Park, Monaghan Road, Stawell (Ch. 22200);
    - Great Western Community, Great Western (Ch. 11000 - 16600);
    - Garden Gully Road Community, Armstrong (Ch. 4200 - 7400); and
    - Morella/Kennel Road Community, Ararat (Ch. 0 - Ararat Township).

6.6.1 Risk Assessment Outcome

Outcomes from the risk assessment are described below, firstly assuming just VicRoads standard environmental protection measures and then secondly, incorporating the 'Additional Controls Recommended to Reduce Risk' outlined in Table 16.

Construction Dust on an Individual Sensitive Receptor

Refer to Table 16 Impact (risk) pathway (A1).

The initial consequence rating for construction dust impacting an individual sensitive receptor has been assessed as 'Minor' with the likelihood rated as 'Likely' giving an Initial Risk Rating (IRR) of 'Medium' and is based on the current standard 'Planned Controls' found in the standard VicRoads contractual obligations for the contractor(s) and included such items as (VicRoads, April 2012):

- Emissions of visible smoke to the atmosphere from construction plant and equipment shall be for periods no greater than 10 consecutive seconds;
- Emissions of odorous substances or particulates shall not create or be likely to create objectionable conditions for the public;
- Materials of any type shall not be disposed of through burning;
- Material that may create a hazard or nuisance dust shall be covered during transport;
- Dust generated from road construction activities shall not create a hazard or nuisance to the public, shall not disperse from the site or across roadways, nor interfere with crops, stock or dust-sensitive receptors;
- Implement methods and management systems (including continuous air monitoring) to maintain air quality during construction consistent with State Environment Protection Policy (Air Quality Management) intervention levels for particulates and EPA Best Practice Environmental Management:

'Environmental Guidelines for Major Construction Sites' (Environment Protection Authority (EPA), 1996);

- Monitor PM_{10} close to sensitive receptors using a portable laser light scattering instrument with an alarm provided;
- Minimise land disturbance by using phased approach, rehabilitate cleared areas promptly; and
- Keep vehicles to well-defined haul roads.

The residual consequence rating for construction dust impacting an individual sensitive receptor has been assessed as 'Minor' with the likelihood rated as 'Rare' giving a Residual Risk Rating (RRR) of 'Negligible' and is based on a more comprehensive Construction Environmental Management Plan (CEMP), including an extensive methodology on dust management and going beyond the guidelines such as those principles and techniques relevant to air quality found in the 'Environmental Guidelines for Major Construction Sites' (Environment Protection Authority (EPA), 1996) (see Section 7). The additional control measures are recommended to reduce impact risk, based on experience with linear construction projects (major projects such as the Sugarloaf Pipelines Alliance), and afford a higher level of control than the EPA guidelines, especially for those sensitive receptors located close to the construction footprint. The guidelines protect households to the Intervention Level (extreme limit) of the SEPP(AQM), but good management in this instance is to lower the risk further (same 'Minor' consequence but a likelihood of 'Rare') when dwellings are within the impact zone (see section 6.4.1).

The VicRoads contractor would be legally obliged to ensure "*dust generated from road construction activities shall not create a hazard or nuisance to the public, shall not disperse from the site or across roadways, nor interfere with crops, stock or dust-sensitive receptors*" (VicRoads, April 2012). It is suggested here that this would be more easily achieved when sensitive uses are at greater distances. A higher level of control would be required by the CEMP when nearby isolated rural housing, intensive agriculture and local communities.

Construction Dust Local Areas

Refer to Table 16 Impact (risk) pathway (A2).

The initial consequence rating for construction dust impacting sensitive receptors in a local area (community) has been assessed as 'Moderate' with the likelihood rated as 'Likely' giving an IRR of 'High' and is based on the current standard 'Planned Controls' found in the standard VicRoads contractual obligations for the contractor(s) (VicRoads, April 2012). The consequence rating is higher than for isolated residences (above) as more people are potentially exposed.

The residual consequence rating for construction dust impacting sensitive receptors in a local area (community) has been assessed as 'Moderate' with the likelihood rated as 'Rare' giving a RRR of 'Low' and is based on a more comprehensive CEMP, including an extensive methodology on dust management and guidelines such as those principles and techniques relevant to air quality found in the 'Environmental Guidelines for Major Construction Sites' (Environment Protection Authority (EPA), 1996) (see Section 7.1).

Note that this Section is concerned with a relatively high density of housing, such as in Great Western, which is greater than isolated rural residences discussed in the previous section. An explanation of the impact construction dust would have on sensitive receptors is outlined in Section 6.4.

This impact pathway can be managed by application of the VicRoads Contract Shell DC1 which has contractual obligations for dust impact in the local area of any sensitive receptor location.

Domestic Water Supply

Refer to Table 16 Impact (risk) pathway (A3).

The initial consequence rating for construction dust emissions from the Project entering domestic water supplies has been assessed as 'Minor' with the likelihood rated as 'Rare' giving an IRR of 'Negligible' and is based on the current 'Planned Controls' found in the standard VicRoads contractual obligations for contractor(s) (VicRoads, April 2012).

It is expected that the possibility of exceeding the Australian Drinking Water Guidelines is low as the guidelines have built in safety factors (of orders of magnitude) that protect health. The same guidelines also call for barrier systems and maintenance programs to ensure good water quality "the most relevant being First Flush Devices (It is recommended that you use such devices)" (NHMRC, 2011). Following the installation of first flush devices, if warranted, at dwellings that are considered at risk, it is expected the residual consequence rating for emissions from the Project entering domestic water supplies would be 'Insignificant' with the likelihood rated as 'Rare' giving a RRR of 'Negligible'. It is expected that residents who have rainwater systems would have First Flush Diverters installed as per NHMRC – *Australian Drinking Water Guidelines 6*, 2011 recommendation for rainwater system.

With such a low risk associated with the possibility of contamination to drinking water, no impact assessment has been carried out in Section 6.4 on this risk pathway. Where concerns are raised by land owners and if warranted, sensitive receptors with rain water supplies should be encouraged, at their cost, to have a '1st flust device' installed as is the case for any potential impact on rain water used for domestic purposes.

Agriculture and Horticulture

Refer to Table 16 Impact (risk) pathways (A4).

The initial consequence rating for construction dust emissions from the Project impacting local primary productivity has been assessed as 'Minor' with the likelihood rated as 'Unlikely' giving an IRR of 'Low' and is based on the current 'Planned Controls' found in the standard VicRoads contractual obligations for contractor(s), as listed in pathway A1 above.

The residual consequence rating for construction dust emissions from the Project impacting local primary productivity has been assessed as 'Minor' with the likelihood rated as 'Rare' giving a RRR of 'Negligible' and is based on a more comprehensive Construction Environmental Management Plan (CEMP), as described below:

- Implement methods and management systems (including continuous air monitoring) to maintain air quality during construction consistent with State Environmental Protection Policy (Air Quality Management) intervention levels for particulates, and EPA Best Practice Environmental Management: 'Environmental Guidelines for Major Construction Sites', (EPA, 1996), such as:
    - Minimise land disturbance by using staged approach, rehabilitate cleared areas promptly;
    - Applying dust suppression measures such as water cart sprays on haul roads and exposed areas as required;
    - Keep vehicles to well-defined haul roads, limit vehicle speed and seal haul roads and other exposed areas by means of crushed rock or paving where necessary;
    - Use of dust deposition gauges to judge effectiveness of EMP, and evaluate implementation of further controls such as halting work under certain conditions; and

- Take dust mitigation steps such as reduced activity or additional water application when adverse (hot, dry and/or gusty) winds resulting in visible dust heading towards actively growing or in-fruit vines or olive trees nearby the construction activity, as discussed in Section 6.4.2.

The impact pathway of dust falling on vegetation used in a rural agricultural context is considered no different to impacts from any activity, such as normal farming practices that produce dust. Disturbance of the soil in which the agricultural activity is occurring is unlikely to cause detrimental effects on agriculture/horticulture. The exception is vineyards and olive groves, located nearby (properties with common boundary) the construction activity such that a dust layer accumulates on the fruiting plants. Any sensitive primary produce farms, such as vineyards and olive groves, should be identified on-site during the construction phase of the Project to ensure that any potential construction dust impact is suitably managed using Construction Environment Management Plan (CEMP), as outlined in this section and Section 7 of this Report.

Operational Emissions

Refer to Table 16 Impact (risk) pathway (A5).

The initial consequence rating for vehicle emissions has been assessed as 'Insignificant' with the likelihood rated as 'Unlikely' giving an IRR of 'Negligible' and is based on the current 'Planned Controls' found in the standard VicRoads contractual obligations for the contractor(s) (VicRoads, April 2012).

It is not expected that the residual risk rating would change significantly from the initial rating as it is predicted that generally the pollutants levels, due to the operational condition of the Project, were found to be well below the intervention levels set out in SEPP (AQM) Schedule B, at the 'outer boundary of the carriageway' (see Figure 4), as per detailed in section 4.3.2. Public liaison in the future would be carried out on a complaints basis as required to ensure community concerns, if any, are addressed.

Table 16 Air Quality Risk Assessment

Risk No.	Impact Pathway Description (how the project interacts with assets, values and uses)	Description of consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Contract Shell DC1: Design & Construct (April 2012)).	Initial Risk: Consequence	Initial Risk: Likelihood	Initial Risk: Risk Rating	Additional Controls Recommended to Reduce Risk	Residual Risk: Consequence	Residual Risk: Likelihood	Residual Risk: Risk Rating
A1	Construction emissions impact at an individual sensitive receptor.	Exceedance of State Environment Protection Policy (Air Quality Management) within a small localised area affecting a sensitive receptor, Aeolian transport and deposition potentially affecting human health, flora, fauna, visual and social aspects, and water quality. The impact zone for construction dust where an exceedance of the SEPP (AQM) may occur (and therefore the " recommended controls" should be carried out to reduce risk at individual sensitive receptors) can be described by the following areas around Great Western: • East of the Project, a line 470 m from the construction boundary outer edge and running parallel to the boundary. • West of the Project, a line 520 m from the construction boundary outer edge and running parallel to the boundary.	• Emissions of visible smoke to the atmosphere from construction plant and equipment shall be for periods no greater than 10 consecutive seconds. • Emissions of odorous substances or particulates shall not create or be likely to create objectionable conditions for the public; • Materials of any type shall not be disposed of through burning; • Material that may create a hazard or nuisance dust shall be covered during transport; and • Dust generated from road construction activities shall not create a hazard or nuisance to the public, shall not disperse from the site or across roadways, nor interfere with crops, stock or dust-sensitive receptors. • Implement methods and management systems (including continuous air monitoring) to maintain air quality during construction consistent with State Environmental Protection Policy (Air Quality Management) intervention levels for particulates and EPA Best Practice Environmental Management: 'Environmental Guidelines for Major Construction Sites', (Environment Protection Authority (EPA), 1996). • Monitor PM_{10} close to sensitive receptors using a portable laser light scattering instrument with an alarm provided. • Minimise land disturbance by using phased approach, rehabilitate cleared areas promptly. • Keep vehicles to well-defined haul roads.	Minor	Likely	Medium	• Suitable measures are in the 'Dust Management Protocol Monitoring' table, contained in the EES Air Impact Assessment report (GHD Pty Ltd, 2011) and include: • Applying dust suppression measures (such as water cart sprays on haul roads and exposed areas as required at better than 2 $L/m^2/h$) or a chemical suppressant. •Limit vehicle speed and/or seal haul roads and other exposed areas by means of crushed rock or paving where necessary.	Minor	Rare	Negligible

Risk No.	Impact Pathway Description (how the project interacts with assets, values and uses)	Description of consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Contract Shell DC1: Design & Construct (April 2012)).	Initial Risk			Additional Controls Recommended to Reduce Risk	Residual Risk		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
A2	Construction emissions impact a local area (community) such as: *Gilchrist Road - Commercial Properties, Stawell (Ch. 24800) *Robsin Road Community, Stawell (Ch. 23200 - 24200) *Stawell Park Caravan Park, Monaghan Road, Stawell (Ch. 22200) *Great Western Community, Great Western (Ch. 11000 - 16600) *Garden Gully Road Community, Armstrong (Ch. 4200 - 7400) *Morella/Kennel Road Community, Ararat (Ch. 0 - Ararat Township).	Exceedance of State Environment Protection Policy (Air Quality Management) within a local area, Aeolian transport and deposition potentially affecting human health, flora, fauna, visual and social aspects, and water quality. The impact zone for construction dust where an exceedance of the SEPP (AQM) may occur (and therefore the " recommended controls" should be carried out to reduce risk at sensitive receptors) can be described by the following quadrants surrounding Great Western: • East of the Project, a line 470 m from the construction boundary outer edge and running parallel to the boundary. • West of the Project, a line 520 m from the construction boundary outer edge and running parallel to the boundary.	As for Risk A1.	Moderate	Likely	High	As for Risk A1, and Use of dust deposition gauges to judge effectiveness of EMP, and evaluate implementation of further controls such as halting work under certain conditions.	Moderate	Rare	Low

Risk No.	Impact Pathway Description (how the project interacts with assets, values and uses)	Description of consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads Contract Shell DC1: Design & Construct (April 2012)).	Initial Risk			Additional Controls Recommended to Reduce Risk	Residual Risk		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
A3	Construction/operational emissions deposit on residential housing that drain into domestic water supplies (i.e. tank water).	Exceedance of 2004 Australian Drinking Water Guideline (ADWG) for residential rainwater tanks along the alignment used for residential water supply.	As for Risk A1.	Minor	Rare	Negligible	As for Risk A1, and Where concerns are raised by land owners and if warranted, sensitive receptors on rain water supplies should be encouraged, at their cost, to have '1st flush devices' installed between the water runoff and tank.	Insignificant	Rare	Negligible
A4	Construction emissions deposit on Agricultural/Horticultural businesses at an individual sensitive receptor location such as: • Parcel ID 2533 (Ch. 1600) • Parcel ID 2544 (Ch. 2200-2500) • Parcel ID 2584 (Ch. 2800-3000) • Parcel ID 2546 (Ch. 3400-3700) • Parcel ID 2710 and 2712 (Ch. 6000-6400) • Parcel ID 2806 (Ch. 10500-11200) • Parcel ID 2899-2904, 2923, 2928-2929 and 2934-2940 (Ch. 14700-16200) • Parcel ID 2965 (Ch. 20900-21800) • Parcel ID 3045 (Ch. 24200-25000).	Potential detrimental effects on agriculture/horticulture. In particular vineyards and olive groves nearby (properties with common boundary) the construction activity.	As for Risk A1.	Minor	Unlikely	Low	As for Risk A2, and Take dust mitigation steps such as reduced activity or additional water application when adverse (hot, dry and/or gusty) winds resulting in visible dust heading towards actively growing or in-fruit vines or olives trees nearby the construction activity.	Minor	Rare	Negligible
A5	Operation of the Western Highway generates air emissions from vehicular traffic.	Exceedance of State Environment Protection Policy (Air Quality Management).	Air quality issues during operation determined through existing complaints procedure.	Insignificant	Unlikely	Negligible		Insignificant	Rare	Negligible

6.7 Benefits and Opportunities

This section identifies key potential benefits or opportunities to air quality that the Project could provide, rates the significance of these, outlines measures to enhance and capture these benefits, and weights the proposed alignments based on its potential benefits.

The proposed alignment for this Project has the following potential environmental benefits (benefit ratings are described in Table 17):

- Reduced gradients on road profile would reduce fuel consumption and therefore exhaust emissions;
- Improved traffic flows have the potential to decrease vehicle emissions to the environment due to lower travel times;
- Improved traffic flows have the potential to decrease vehicle emissions 'hot spots' through town centres and at intersections; and
- Where the proposed option moves traffic a greater distance from sensitive receptors, greater dispersion and lower concentrations at receptor sites can be achieved.

The outcome of the above benefits would be a cleaner air shed for the region through lower overall emissions. In addition, the reduction within the air shed would also contribute to a reduction in greenhouse gas emissions. Note that the phenomenon of induced increases in traffic as a consequence of a new highway/freeway development does not apply in this instance, as the traveller has no option but to use the route (whether improved or not) as a transit to their destination – there would be no garnering of traffic from alternate routes.

In order to enhance and/or capture the above benefits the preferred option would incorporate the following criteria:

- The most efficient traffic flow as possible;
- The option with the shortest total length;
- The least amount of intersections or interchanges; and
- The option that moves the alignment as far away from sensitive receptors as possible.

Table 17 Benefit Ratings

Rating	Potential Project benefits
Very well	Superior benefit to the region Policy consistency with superior positive impact
Well	Significant befit to the region Superior benefit to the locality Policy consistency with significant positive impact
Moderately well	Moderate benefits to the region Significant benefit to the locality Policy consistency with moderate positive impact
Partial	Minor benefits as a local level or significant benefits for a small number of individuals
Negligible	Minimal benefit at any level

In considering the operational vehicle emissions of this Section 3 Project, the proposed alignment option would provide the following benefit and opportunity:

- Improvement in traffic flows which would have the potential to decrease vehicle emissions to the environment due to lower travel times and minimise 'hot spots' emissions at intersections or town centres.

Moreover, the predicted result of the operational vehicle emissions impact shows that generally the pollutant levels were well below the intervention levels set out in SEPP (AQM) Schedule B, at the 'outer boundary of the carriageway' (see Figure 4), as per detailed in section 4.3.2. Thus, the operational air quality impact is expected to be no more than minor.

Based on the above improvement and the predicted impact outcome, these suggest that this Project would altogether provide moderate benefit to the region and significant benefit to locality (community), as it would produce a slightly cleaner air shed through lower overall concentrations of emissions (better traffic flows).

Hence, the proposed alignment would maintain policy consistency along with moderate positive air quality impact.

7. Mitigation Measures

7.1 Construction

VicRoads would require the construction contractor(s) to develop and implement a Construction Environmental Management Plan (CEMP) for the Project. VicRoads standard environmental protection measures and some additional Project specific controls identified below have been incorporated into the Environmental Management Framework for the Project which is documented in the Project Environment Protection Strategy (PEPS). The PEPS is a VicRoads Document that details the environmental management arrangements for the design, construction and operation of the Project. VicRoads would require the construction contractor(s) to incorporate all of these measures into the CEMP. Refer to Chapter 21 of the EES for further explanation of the environmental management framework and documentation proposed for the project.

VicRoads standard environmental protection measures for air quality that would be adopted for this Project include the following clause of the VicRoads DCI contract specification:

- Emissions of visible smoke to the atmosphere from construction plant and equipment shall be for periods no greater than 10 consecutive seconds;
- Emissions of odorous substances or particulates shall not create or be likely to create objectionable conditions for the public;
- Materials of any type shall not be disposed of through burning;
- Material that may create a hazard or nuisance dust shall be covered during transport;
- Dust generated from road construction activities shall not create a hazard or nuisance to the public, shall not disperse from the site or across roadways, nor interfere with crops, stock or dust-sensitive receptors; and
- Monitor PM_{10} close to sensitive receptors using a portable laser light scattering instrument with an alarm provided and dust deposition gauge.

Additional Project specific controls are also proposed to reduce risks to air quality and these are outlined in Table 18. These controls are based on GHD experience as well as from EPA 'Best Practice Environmental Management - Environmental Guidelines for Major Construction Sites' (1996).

Table 18 Project Specific Dust Management Controls (Proposed)

Management Type	Specific Controls
Prevention	Prompt remedial strategies, such as watering, would need to be implemented in the event of visible dust emissions.
	Reduce dust production on site by scheduling work into stages to minimise land disturbance in the planning and design stage, including scheduling installation of control measures for dust prevention, while having regard for seasonal dryness.

Management Type	Specific Controls
Prevention	Include special operations precautions in the CEMP for when work is being carried out near environmentally sensitive areas such as those identified within impact zones found in Appendix A of this report, including site inspections and contingency planning for high wind events and poor water access/availability.
	Prevent the generation of dust in preference to applying dust suppression measures.
	Maintain dust awareness on site and use a reporting system (staff hierarchy of action).
	Identify dust sources prior to carrying out works in a particular area.
	Keep the areas of land cleared to a minimum, and the period of time areas remain cleared to a minimum.
	Minimise working areas and define haul routes to be used wherever it is necessary for vehicles to traverse unformed roads.
	Keep vehicles to well-defined haul roads.
	Seal haul roads and other exposed areas by means of concrete or paving or use gravel where necessary to reduce dust impacts.
	Minimise areas with smooth surfaces through deep ripping to reduce wind velocity at the surface.
	Rehabilitate cleared areas promptly.
	Limit activities during construction that generate dust when wind speeds are greater than 10 m/s.
	Limit vehicle speeds on exposed haul roads and construction areas where dust may become an issue to 10-25 km/h and cease using during periods of high winds.
	Ensure that all trucks transporting soil/fine materials are covered and/or wetted down.
	Minimise the number and locations of stockpiles.
	Keep topsoil separate from under burden when stockpiling topsoil.
	Construct stockpiles with slope no greater than 2:1 (horizontal to vertical) and ensure that all stock piles are covered and kept below 4 m in height.
	Locate stockpiles in areas that are protected from wind, where possible, and/or away from sensitive receptors.
	Use geotextiles or mulch, roughen and seed cleared slopes, stockpiles or on any batter with sterile grasses where no works are planned for more than 28 days. All stockpiles should be kept free of weeds and should not be disturbed unnecessarily.
	Sweep, vacuum or wash sealed areas where appropriate to minimise dust generation.
	Construct wind fences where appropriate.
	Review and adjust, as necessary, the dust management in the CEMP after the first month and six monthly thereafter.

Management Type	Specific Controls
Monitoring	Use alarmed continuous dust sampling (VicRoads agreed terms via "Contact EPA for advice on appropriate … trigger levels that could be used", (Environment Protection Authority (EPA), 2007), p.13) at several locations along the current working area between the construction area and any sensitive receptors (occupied housing) within impact zones of Figure 16.
	Use alarmed continuous wind measurements along the current working area in order to notify if wind speeds exceed 10 m/s.
	Identify all possible dust sources at the beginning of each day and throughout the day. Sources may include: haul roads, earthworks, windblown dust, general construction and stockpiles.
Mitigation	The primary method for controlling dust generated by construction and maintenance activities would be the application of water and/or an approved suppression agent, via water.
	Use of water carts to mitigate dust at source.
	The Site Supervisor should determine the frequency of passes and number of water tankers required, based on the following: ◗ weather conditions; ◗ volume of traffic on exposed or dusty surfaces; ◗ extent of stripped area; and ◗ extent of unprotected areas. The Site Supervisor should monitor the condition of areas on site for factors such as excessive surface undulations, erosion and excessive surface silt content.

7.2 Operation

Operational air quality impacts are expected to be no more than minor, with all of the assessed air pollutants generated by vehicles on completion of the Project predicted to be below the Intervention Level for Air Quality Management (AQM) used in Victoria at the modelled 30 m receptor distance from the edge of the road's 'outer lane' (refer to Table 15). Therefore, all pollutant levels were also predicted to be below the Intervention Level for AQM beyond the 'outer boundary of the carriageway' (i.e. pass 32 m from the edge of the 'outer lane' as per detailed in Figure 4).

However, VicRoads would ensure any air quality issues arising during operation of the Project would be determined through the existing complaints procedure.

7.3 Summary

Appendix A presents a summary of the mitigation measures that have been identified to avoid, reduce or minimise impact risk. The measures comprise both relevant requirements of the VicRoads standard environmental protection measures as well as the additional measures identified by this impact assessment. The aim to achieve the relevant EES Objective described in Section 2.1.

8. Conclusion

The draft EES evaluation objective relevant to the air quality assessment outlined in the Scoping Requirements was:

To minimise air emissions, noise, visual, landscape and other adverse amenity effects, during the development and operation of the proposed duplicated highway to the extent practicable.

Existing Meteorological Conditions

The entire Study Area from Ararat to Stawell can be classified as having a climate of ‘temperate’ with ‘no dry season (warm summer)’. Extreme values in temperature occur, with hot days more frequent at the north-western (Stawell) end and frosty mornings occurring more often at the south-eastern (Ararat) end. The wettest months occur in spring (September – November) with greater rain fall expected at the south-eastern end of the Study Area, leading to the conclusion that impacts from construction dust would be relatively higher at the north-western end. Annual average winds are predominantly from the south, with a seasonal switch to come from the south during the warmer months and then to the north with a north-west sector tendency during winter. The Project Area is represented by Stawell’s atmospheric stability class (site representative) being predominantly ‘neutral’ for about one half of all hours but ‘stable’ for about one third of the time. Neutral would be the most often occurring stability category during construction hours.

Construction and Operational Emission Impact

The air quality impact of the Project is influenced from two main emission sources, which are the dust emissions resulting from the construction activities and the vehicle emissions resulting from the operational condition. Modelling of both construction and operation emissions was carried out in order to determine the emissions levels and their impact on the local environment.

Construction impacts to air quality are expected to extend beyond the construction corridor with greater effects noted to the west of the road than to the east due to meteorological behaviour. Construction dust is predicted to be greatest during the first stage (set out and preparation) of the construction as opposed to the second stage (surface preparation and compaction), with the predicted maximum impact zone of up to 520 m from the western edge of the construction zone and up to 470 m from the eastern edge of the construction zone. Based on the results, there are 117 potential sensitive receptors located within the construction dust impact zone. Any potential sensitive receptors located within the construction dust impact zone would require additional dust management control to minimise impacts on amenity.

Operational air quality impacts are expected to be no more than minor. Predicted compliance with SEPP (AQM) Intervention Levels ranged from 0.01 per cent of the intervention level for xylenes to 7.8 per cent on the NO_2 intervention level of 263 µg/m^3 and 29.9 per cent on the PM_{10} intervention level of 60 µg/m^3, with the inclusive of background air pollutant level for particulate matter. Overall, the assessed air pollutants from vehicles on the Project are predicted to be below the Intervention Level for Air Quality Management used in Victoria at the edge of the outer road lane (outer boundary of carriageway).

Construction and operational emissions are not expected to affect domestic water supplies. Dust from construction emissions are generally in the medium to higher size fractions greater than PM_{10} (Total

Suspended Particulate as nuisance dust) and as such would fall out of the air column more readily than the smaller size fractions during construction. Hence, through management of the smaller particle size fractions (equal and less than PM_{10}), it follows that the nuisance dust would also be managed.

Operational emissions from roadways are principally gaseous and these are unlikely to deposit on roofs as the environmental fate of a gas converting to an aerosol that then deposits on a roof is a slow atmospheric process with limited local impact. It should be noted that these types of operational emissions, are likely to be already present due to the existing Western Highway and any future increase in emissions are likely to be negligible.

Potential sensitive receptors relating to intensive agricultural practices or farms growing primary produce, such as vineyards or olive groves, were identified to be within the construction dust impact zone. Additional dust management control would be required to effectively reduce dust impacts to a minimum.

The operation air quality impacts on vineyards or olive groves are considered to be negligible as it is predicted that any future increases in emissions are likely to be negligible.

All of the identified risks are considered to be negligible or low provided that the identified mitigation measures are implemented. Overall, the proposed alignment would provide the benefit of improving traffic flows which would lower travel times and may decrease vehicle emissions to the environment, resulting in an improvement in air quality.

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Appendix A

Summary of Environmental Management Measures

Summary Table of Environmental Management Measures

Risk No.	Risk Description	Management Measures	Responsibility
A1	Construction emissions impact an individual sensitive receptor	Emissions of visible smoke to the atmosphere from construction plant and equipment shall be for periods no greater than 10 consecutive seconds; Emissions of odorous substances or particulates shall not create or be likely to create objectionable conditions for the public; Materials of any type shall not be disposed of through burning; Material that may create a hazard or nuisance dust shall be covered during transport; Dust generated from road construction activities shall not create a hazard or nuisance to the public, shall not disperse from the site or across roadways, nor interfere with crops, stock or dust-sensitive receptors. Monitor PM_{10} close to sensitive receptors using a portable laser light scattering instrument with an alarm provided and dust deposition gauges; Implement methods and management systems (including continuous air monitoring) to maintain air quality during construction consistent with State Environmental Protection Policy (Air Quality Management) intervention levels for particulates, and EPA Best Practice Environmental Management: 'Environmental Guidelines for Major Construction Sites', (EPA, 1996); Suitable measures are in the 'Dust Management Protocol Monitoring' table, contained in the EES Air Impact Assessment report (GHD Pty Ltd, 2011) and include: Minimise land disturbance by using phased approach, rehabilitate cleared areas promptly. Applying dust suppression measures such as water cart sprays on haul roads and exposed areas as required. Keep vehicles to well-defined haul roads, limit vehicle speed and seal haul roads and other exposed areas by means of crushed rock or paving where necessary.	Contractor(s)

Risk No.	Risk Description	Management Measures	Responsibility
A2	Construction emissions impact a local area (community) such as: *Gilchrist Road - Commercial Properties, Stawell (Ch. 24800) *Robsin Road Community, Stawell (Ch. 23200 - 24200) *Stawell Park Caravan Park, Monaghan Road, Stawell (Ch. 22200) *Great Western Community, Great Western (Ch. 11000 - 16600) *Garden Gully Road Community, Armstrong (Ch. 4200 - 7400) *Morella/Kennel Road Community, Ararat (Ch. 0 - Ararat Township)	As for Risk A1, and Use of dust deposition gauges to judge effectiveness of EMP, and evaluate implementation of further controls such as halting work under certain conditions.	Contractor(s)
A3	Construction emissions deposit on residential housing that drain into domestic water supplies (i.e. tank water).	As for Risk A1, and Where concerns are raised by land owners and if warranted, sensitive receptors on rain water supplies should be encouraged, at their cost, to have '1st flush devices' installed between the water runoff and tank.	Contractor(s)

Risk No.	Risk Description	Management Measures	Responsibility
A4	Construction emissions deposit on Agricultural/Horticultural businesses at an individual sensitive receptor location such as: • Parcel ID 2533 (Ch. 1600) • Parcel ID 2544 (Ch. 2200-2500) • Parcel ID 2546 (Ch. 3400-3700) • Parcel ID 2710 and 2712 (Ch. 6000-6400) • Parcel ID 2806 (Ch. 10500-11200) • Parcel ID 2824, 2825, 2829, 2831, 2833-2847 and 2905 (Ch. 11900-12400) • Parcel ID 2871-2874 (Ch. 12200-12400) • Parcel ID 2899-2904, 2923, 2928-2929 and 2934-2940 (Ch. 14700-16200) • Parcel ID 2965 (Ch. 20900-21800)	As for Risk A2, and Take dust mitigation steps such as reduced activity or additional water application when adverse (hot, dry and/or gusty) winds resulting in visible dust heading towards actively growing or in-fruit vines or olives trees nearby the construction activity.	Contractor(s)
A5	Operation of the Western Highway generates air emissions from vehicular traffic.	Air quality issues during operation determined through existing complaints procedure.	VicRoads

Appendix B

Details of Potential Sensitive Receptors within PM_{10} Construction Dust Impact Zone

Western Highway Section 3 – Potential Sensitive Receptors within the PM_{10} Construction Dust Impact Zone

No.	GHD ID	Property ID (VR ID)[a]	Parcel PFI[b]	Alignment Side from Main Carriageway	Property Type	Chainage
1	63	2497	45013939	WEST	House	0
2	61	2500	45013942	WEST	House	0
3	62	2501	45013943	WEST	House	0
4	66	2505	45512561	EAST	House	0
5	91	2518	45512360	EAST	House	450
6	69	2520	45512358	EAST	House	750
7	70	2527	45512609	EAST	House	850
8	73	2544	5401312	EAST	House	2300
9	71	2574	45371028	WEST	House	2350
10	156	2545*	45371161	EAST	House	2550
11	72	2545*	45371161	EAST	House	2600
12	155	2546*	5401310	EAST	House	3300
13	154	2546*	5401310	EAST	House	3400
14	74	2654	45371003	WEST	House	3600
15	75	1672	45370949	WEST	House	4500
16	96	2591	5401308	EAST	House	4850
17	97	2590*	103149673	EAST	House	4900
18	98	2590*	103149673	EAST	House	4900
19	76	2676	45370934	WEST	House	4900
20	153	2610	100287979	EAST	House	5000
21	100	2621	52941450	EAST	House	5050
22	77	2684	45370928	WEST	House	5300
23	151	2613*	100287962	EAST	House	5450
24	152	2613*	100287962	EAST	House	5500
25	101	2618	123770140	EAST	House	5650
26	78	2616	131003114	EAST	House	5800
27	94	2617	45371072	EAST	House	5950
28	95	2629	100288985	EAST	House	6050
29	93	2633	45371068	EAST	House	6500

No.	GHD ID	Property ID (VR ID)[a]	Parcel PFI[b]	Alignment Side from Main Carriageway	Property Type	Chainage
30	92	2636	5401313	EAST	House	6600
31	107	2776*	45371603	WEST	House	9350
32	79	2776*	45371603	WEST	House	9400
33	150	2778	45371615	WEST	House	9750
34	108	2746	45372187	EAST	House	10550
35	109	2795	45371429	WEST	House	11000
36	110	2806	45371398	WEST	House	11100
37	112	2857	45369614	EAST	House	11900
38	195	2831	5400916	WEST	House	12100
39	251	2860	45369610	EAST	House	12100
40	114	N/A	5400939	WEST	House	12300
41	115	N/A	5400937	WEST	House	12350
42	116	N/A	5400935	WEST	House	12350
43	117	N/A	5400933	WEST	House	12350
44	118	N/A	5400931	WEST	House	12400
45	119	N/A	5400929	WEST	House	12400
46	120	N/A	45369764	WEST	House	12450
47	121	N/A	45369766	WEST	House	12450
48	113	N/A	45369763	WEST	House	12550
49	247	N/A	45369757	WEST	House	12650
50	252	N/A	45369730	WEST	House	13550
51	254	N/A	5401048	WEST	Likely commercial	13750
52	253	N/A	45369728	WEST	House	13850
53	126	N/A	45369727	WEST	House	14050
54	125	N/A	45369726	WEST	House	14250
55	124	N/A	45369725	WEST	House	14300
56	123	2896	5401009	WEST	House	14450
57	122	2897	45369698	WEST	House	14550
58	176	N/A	45369654	WEST	House	14950
59	177	N/A	5400950	WEST	House	15000
60	256	N/A	45369650	WEST	House	15150

No.	GHD ID	Property ID (VR ID)[a]	Parcel PFI[b]	Alignment Side from Main Carriageway	Property Type	Chainage
61	194	N/A	45369661	WEST	House	15200
62	255	N/A	45369649	WEST	House	15200
63	147	N/A	45369658	WEST	House	15300
64	146	2911	45369690	WEST	House	16000
65	129	2947	45371289	WEST	House	16300
66	127	2945	5401407	EAST	House	17050
67	128	2946	5401406	EAST	House	17100
68	88	2954	45371282	WEST	House	17100
69	131	2963*	45379342	EAST	House	20350
70	130	2963*	45379342	EAST	House	20550
71	145	2965	5404397	EAST	House	21450
72	132	2981	45378730	WEST	House	21450
73	133	2966	5404395	EAST	House	21850
74	89	N/A	5404415	WEST	House	22050
75	144	2989	45035740	EAST	House	22150
76	90	3024	129333600	WEST	Commercial	22150
77	135	2992	45035741	EAST	House	22500
78	134	2994	125317302	EAST	House	22850
79	137	3027	45378704	WEST	House	22900
80	136	2995	125317288	EAST	House	23150
81	141	3029	100464600	WEST	House	23250
82	140	3032*	100464592	WEST	House	23400
83	139	3032*	100464592	WEST	House	23450
84	138	3036	100464584	WEST	House	23650
85	142	3039	100464576	WEST	House	23950
86	143	3044	5404971	WEST	House	24150

[a] VR ID denotes VicRoads Identification number.

[b] Parcel PFI denotes Parcel Persistent Feature Identifier number.

* The doubling property ID indicates that the property is owned by the same owner and located in the same chainage, but has different validation type or functionality.

Note that there are a further 31 potential sensitive receptors additional to the list above, which did not have VR ID or Parcel PFI identified.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
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0	Stanley Gunawan	Barry Cook				09/08/12
1	Stanley Gunawan	Barry Cook				14/09/12
Final	Stanley Gunawan	Barry Cook		M Tansley		07/11/12