MAJOR ROAD PROJECTS AUTHORITY

SEPTEMBER 2018

# MORDIALLOC BYPASS

## GREENHOUSE GAS IMPACT ASSESSMENT

**Report Number:** 2135645A-SE-26-ENV-REP-0012 REV0

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# Mordialloc Bypass
## Greenhouse Gas Impact Assessment

Major Road Projects Authority

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# EXECUTIVE SUMMARY

In late 2017, the Minister for Planning made the decision that an Environment Effects Statement (EES) was required for the Mordialloc Bypass, with the Department of Environmental, Land Water and Planning (DELWP) managing the EES process. This report is provided for the Environment Effect Statement (EES) process as an overview of greenhouse gas (GHG) impacts associated with the proposed Mordialloc Bypass project. This assessment has been completed in response to legislation, policy and community queries raised through this process.

This report provides an assessment of greenhouse gas emissions associated with the initial phase, construction, operation and maintenance of the Mordialloc Bypass project. Utilising a materiality assessment process, emission sources likely to contribute to more than 5% of project greenhouse gas emissions have been estimated for both construction and operational phases. The initial project phase emissions was considered as part of this materiality assessment and has been excluded on the basis that these activities generate a very small quantity of the greenhouse gas emissions associated with the road project's life cycle.

The Mordialloc Bypass is a proposed new 9 km freeway linking the end of the Mornington Peninsula Freeway at Springvale Road to the Dingley Bypass. The proposed road will have two lanes in each direction with a posted maximum speed of 100 km/hr. The reservation and roadway planning allows for a future upgrade to a six lane freeway. Once the EES has been finalised, and after planning and environmental approvals, works are expected to begin by mid-2019 with project completion due by late 2021.

In addition to the policy and legislative context associated with greenhouse gas emissions, this report responds to feedback received during the consultation phase of the EES from both members of the local community and DELWP who requested information on how the construction and operation of the Mordialloc Bypass aligns with GHG emission reduction targets within Victoria.

## METHODOLOGY

The methodology for this greenhouse gas impact assessment involved the following steps:

- Establishing project context: review of the design, legislation and policy documents
- Calculation of the greenhouse gas impact for constructing and operating this road compared to the "without-project" scenario
- Development of potential requirements to control and mitigate project-related GHG emissions.

This impact assessment methodology includes GHG emissions from construction and operation (including maintenance and scope 3 road users) activities of this bypass. GHG emission impacts were estimated using emissions factors and calculation methodologies from the following references:

- "National Greenhouse Accounts", published by the Commonwealth Department of Environment, July 2017.
- *Greenhouse Gas Assessment Workbook for Road Projects*, published by the Transport Authorities Greenhouse Group, February 2013 and its supporting calculator, *Carbon Gauge*.

# KEY FINDINGS

Greenhouse gas emissions will be released because of the construction and operation of the Mordialloc Bypass including from the traffic that uses the road network. Greenhouse gas emissions from Scope 1, 2 and 3 construction activities of the proposed Mordialloc Bypass project are estimated to be 68.5 kT $CO_2$-e, with most emissions associated with the manufacture and transportation of construction materials (Scope 3 – 45.7 kT $CO_2$-e).

Direct emissions (Scope 1 and 2) account for 22.8kT $CO_2$-e over a 24-month construction period. This equates to approximately 11.4 kT $CO_2$-e p.a. (for Scope 1 and 2) and is equivalent to 0.01 per cent of Victoria's total 2016 greenhouse gas emissions. The construction phase of the project is therefore, unlikely to exceed the National Greenhouse and Energy Reporting (NGER) Scheme threshold for a facility or be considered a significant project risk.

Once the bypass is in operation, annual Scope 1 and 2 emissions are estimated to be 0.96 kT $CO_2$-e pa with the majority (81%) of these emissions relating to electricity consumption for road lighting. This is well below the reporting threshold for a facility within the NGER Scheme and of very low significance to transport emissions in Victoria.

To assess the impact of the Mordialloc Bypass project on greenhouse gas emissions from vehicle traffic (Scope 3), modelling of speed and trip time has been undertaken for two major existing routes (based on modelled volumes), used for journeys between Thompson Road and the Dingley Bypass.

Utilising traffic modelling data, vehicle average speeds were extracted for these routes to determine fuel efficiencies for morning and afternoon peak periods. These were then converted to average fuel efficiency rates for each route with and without the Mordialloc Bypass project. The outcomes of this modelling are summarised in the table below.

Table ES.1 Daytime peak fuel efficiency associated with major route options "without" and "with" project

| ROUTE DESCRIPTION | | | VEHICLE TYPE | WITHOUT PROJECT (2031) | WITH PROJECT (2031) | % CHANGE |
|---|---|---|---|---|---|---|
| | | | Light/heavy | Average fuel efficiency (L/100 km) | | |
| Major Route 1 | Thompson Road – Boundary Road – Dingley Bypass | AM Peak (North Bound) | LCV | 15.3 | 14.4 | 6% improvement |
| | | | HCV | 81.5 | 74.9 | 8% improvement |
| | | PM Peak (South Bound) | LCV | 16.3 | 14.3 | 12% improvement |
| | | | HCV | 88.3 | 74.3 | 15% improvement |
| Major Route 2 | Thompson Road – Springvale Road – Dingley Bypass | AM Peak (North Bound) | LCV | 15.0 | 14.3 | 5% improvement |
| | | | HCV | 79.0 | 73.8 | 7% improvement |
| | | PM Peak (South Bound) | LCV | 15.7 | 14.7 | 5% improvement |
| | | | HCV | 84.1 | 77.0 | 8% improvement |

"Without project" – A scenario where the Mordialloc Bypass is **not** in operation

"With project" – A scenario where the Mordialloc Bypass is in operation

For the two major routes assessed, the "with project" scenario indicates vehicle fuel efficiency improvements as a result of the Mordialloc Bypass project due to reduced road congestion and increased average vehicle speeds. In general, for driving speeds up to 70 km/hour, fuel efficiency improves significantly as average speeds increases.

To holistically assess the impact of the Mordialloc Bypass on road user greenhouse gas emissions, the Victorian Integrated Transport Model (VITM) has been applied. The VITM is an interactive model of Victoria's road network which forecasts travel to assess response to various transport infrastructure and land use planning scenarios including induced demand responses. As part of this impact assessment, greenhouse gas emissions from vehicle traffic (Scope 3) were modelled for light commercial vehicles (LCV) and heavy commercial vehicles (HCV) for 2031 from the VITM under the "without-project" and "with-project" scenarios. The results calculated indicate that approximately 13 kT of CO2 -e will be reduced annually on the basis of improved road network efficiency as a result of the Mordialloc Bypass project.

Table ES.2 Summary of overall Victorian network road user GHG emission impact with and without the project

| GREENHOUSE GAS EMISSIONS (KILOTONNES OF $CO_{2}$-E P.A.) | WITHOUT PROJECT (2031) | WITH PROJECT (2031) | CHANGE (%) |
|---|---|---|---|
| VITM | 26,988 | 26,975 | -0.05% |

VITM – Victorian Integrated Transport Model – A interactive model of the entire Victorian road network that enables the impacts of projects to be understood at a state scale

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| $CO_2$-e | Carbon dioxide equivalent gases. This unit normalises greenhouse gasses per their global warming potential (GWP). For example, 1 kg of methane is equal to 25 kg $CO_2$-e as it has a GWP of 25 (Department of the Environment, 2015). |
| EES | Environment Effects Statement |
| EMF | Environmental Management Framework |
| EMP | Environmental Management Plans |
| EMS | Environmental Management System |
| EPR | Environmental Performance Requirements |
| GHG | Greenhouse Gas Emissions |
| ISCA | Infrastructure Sustainability Council of Australia |
| IS Rating | An independent sustainability rating system operated by ISCA |
| LCV | Light commercial vehicle |
| HCV | Heavy commercial vehicle |
| NGER Scheme | National Greenhouse and Energy Reporting Scheme |
| PEM | Protocol for Environmental Management |
| SEPP | State Environment Protection Policy |
| TAGG | Transport Authorities Greenhouse Group |
| VITM | Victorian Integrated Transport Model |

# 1 INTRODUCTION

## 1.1 BACKGROUND

The Mordialloc Bypass is a proposed new 9 km freeway linking the end of the Mornington Peninsula Freeway at Springvale Road to the Dingley Bypass. The proposed road will have two lanes in each direction with a posted maximum speed of 100 km/hr. The reservation and roadway planning allows for a future upgrade to a six lane freeway. Once the EES has been finalised, and after planning and environmental approvals, works are expected to begin by mid-2019 with project completion due by late 2021. In late 2017, the Minister for Planning made the decision that an Environment Effects Statement (EES) was required for the Mordialloc Bypass, with the Department of Environmental, Land Water and Planning (DELWP) managing the EES process.

In addition to the policy and legislative context around greenhouse gas emissions, this report responds to feedback received during the consultation phase of the EES process, from members of the local community and DELWP who requested information on how the construction and operation of the Mordialloc Bypass aligns with GHG emission reduction targets within Victoria. The purpose of this assessment is to understand the impact of this project on Victoria's greenhouse gas emissions and to utilise these outputs to establish appropriate Environmental Performance Requirements (EPRs) to provide controls to monitor and mitigate these impacts.

## 1.2 THE IMPORTANCE OF GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions are a key contributor to the changing climate. Continued increases in global GHG emissions are projected to cause more extreme weather events and their associated impacts to assets and the communities they support. Longer term climate changes include higher average temperatures and sea level rise.

The Australian National Greenhouse and Energy Reporting (NGER) Scheme requires reporting of six greenhouse gas emissions; carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), sulphur hexafluoride ($SF_6$), hydrofluorocarbons and perfluorocarbons.

Greenhouse gases are measured as tonnes or kilo tonnes (kT) of carbon dioxide equivalence ($CO_2$-e). This represents the amount of greenhouse gases emitted as an equivalent amount of $CO_2$ which has a global warming potential of one.

Activities relevant to the Mordialloc Bypass project that would cause the release of greenhouse gases into the atmosphere include:

- Burning fossil fuels in vehicles, plant and equipment
- The use of electricity produced from burning fossil fuels (such as coal or natural gas)
- Manufacturing processes (for concrete, for example).

Rather than having a direct impact on the local environment, once released from a project, greenhouse gases contribute to the global concentration of greenhouse gases in the atmosphere, influencing changes in the climate across the world.

### *1.2.1 GREENHOUSE GAS EMISSION SCOPE*

Greenhouse gas emissions are categorised into direct and indirect emission sources as defined by the NGER Act and the Greenhouse Gas Protocol (WRI and WBCSD, 2012). NGER Scheme and the Greenhouse Gas Protocol classify direct emissions into Scope 1 and indirect emissions into Scopes 2 and 3 as follows:

- **Scope 1:** Direct greenhouse gas emissions released into the atmosphere as a result of the project. These emissions consider construction and operation activities such as emissions from burning diesel fuel within trucks or equipment used to build or maintain the road.

- **Scope 2:** Indirect greenhouse gas emissions are released into the atmosphere from indirect consumption of energy as a commodity. An example of these would be purchased electricity for the project activities such as construction activities or operational phase lighting.
- **Scope 3:** Other indirect greenhouse gas emissions that are indirectly influenced by the project but are generated within the wider economy. Whilst these emissions are a consequence of the project – they are not controlled by the project operators. Scope 3 emissions would include greenhouse gas emissions associated with road users or the embodied energy within a material used for the project construction.

See Section 5.1 Boundary and Scopes for the Greenhouse Gas Impact Assessment summarising the scoping of greenhouse gas sources as part of this impact assessment.

### *1.2.2 LIFECYCLE GREENHOUSE GAS EMISSIONS*

Greenhouse gas emissions may be emitted from the project at different times within its lifecycle including during its design and construction, operation and decommissioning. In general, this assessment considers the performance of the project in terms of all material Scope 1, 2 and 3 greenhouse gas emissions across the construction and operational phases of this asset.

In developing this assessment a 'whole of life' approach was taken and all major activities in the life cycle, from design through to operation and maintenance, were considered. Decommissioning of roads was excluded as this rarely occurs.

This report outlines a process for estimating the GHG emissions for all of the major activities that were found to contribute significantly to the overall greenhouse gas emissions arising from this road project. The operation of road infrastructure includes operation of lights, signals and ventilation systems. The maintenance of the infrastructure comprises activities which are categorised as reactive, planned/routine and/or major maintenance.

## 1.3 REPORT PURPOSE

This report on GHG emissions:

- Identifies and assesses potential risks to GHG emission target levels as a result of this project
- Estimates existing GHG emissions associated with road users across the Victorian road network *without* the project in 2031
- Estimates existing GHG emissions associated with road users across the Victorian road network *with* the project in 2031
- Assesses potential GHG emissions released directly associated with the *construction* of this road project
- Assesses potential GHG emissions released directly associated with the *operation* of this road project
- Describes the methodology utilised to provide these estimations of impact and risk
- Addresses the requirements of the Victorian Climate Change Act 2017 and the *State Environment Protection Policy (Air Quality Management)* and the implications of these policies for the project
- Identifies proposed measures to avoid, mitigate and manage any potential effects, including techniques and methods to be used during construction and operation to reduce direct GHG emissions.

# 2 EES SCOPING REQUIREMENTS

## 2.1 EES OBJECTIVES

The following EES objective relating to GHG emissions has been extracted from the Scoping Requirements for the Mordialloc Bypass Environment Effects Statement (May 2018). The Scoping Requirements objectives provide a framework in which potential impacts from the project can be assessed in accordance with the *Ministerial guidelines for the assessment of environmental effects under the Environment Effects Act 1978.*

The *evaluation objective* is to protect the health and wellbeing of residents and local communities, and minimise effects on air quality, noise and the social amenity of the area, having regard to relevant limits, targets or standards.

## 2.2 EES SCOPING REQUIREMENTS

The following table contains extracts from the Scoping Requirements relevant to GHG emissions, and corresponding sections of this report addressing each requirement.

Table 2.1 Scoping requirements for GHG emissions impact assessment

| ASPECT | SCOPING REQUIREMENTS | REFER |
|---|---|---|
| Key Issues | Potential for increased emissions of greenhouse gases to result from the project. | Section 6 to 7 (Impact assessment) |
| Priorities for characterising the existing environment | Monitor and characterise background levels of air quality (e.g. dust and greenhouse gas emissions from equipment), noise and vibration in the vicinity of the project, including the established residential areas and other sensitive urban receptors along the road corridor. | Section 7 (Impact Assessment) |
| Design and mitigation measures | Identify potential and proposed design responses and/or other mitigation measures to avoid, reduce and/or manage any significant effects for sensitive receptors during the project construction and operation arising from specified air pollution indicators, greenhouse gases, noise, vibration and lighting, in the context of applicable policy and standards. | Section 8 (Environmental Performance Requirements) |
| Assessment of likely effects | Estimate direct and indirect emissions of greenhouse gases resulting from the project. | Section 7 (Impact assessment) |
| Approach to manage performance | Measures to manage other potentially significant effects on amenity, environmental quality and social wellbeing (including access to open spaces) should also be addressed in the EES, including a framework for identifying and responding to emerging issues, as part of the EMF (Section 5). | Section 8 (Environmental Performance Requirements) |

# 3 LEGISLATION AND POLICY

This section provides an overview of the key legislation and policies that forms the regulatory framework relating to greenhouse gases.

## 3.1 COMMONWEALTH

### *3.1.1 LEGISLATION*

#### *NATIONAL GREENHOUSE AND ENERGY REPORTING ACT 2007*

The National Greenhouse and Energy Reporting Act 2007 (NGER Act) outlines the national reporting framework for corporations and facilities required to report their energy use and greenhouse gas emissions. Under the Act, a corporation is the entity that has operational control. Controlling corporations that exceed the following thresholds are required to report their energy and greenhouse gas emissions under the Act:

- For facilities, consumption of more than 100 terajoules (TJ) of energy annually or emissions over 25,000 tonnes $CO_2$-e annually
- For corporations, consumption of more than 200 TJ of energy annually or emissions over 50,000 tonnes $CO_2$-e annually.

A road is considered a facility for the purpose of this impact assessment.

## 3.2 STATE

### *3.2.1 LEGISLATION*

#### *CLIMATE CHANGE ACT 2017*

The Climate Change Act 2017 (Vic) sets the legislative foundation to manage climate change risks, and drive Victoria's transition to net zero emissions by 2050. This Act embeds a 2050 net zero emissions target and provides for the setting of 5-yearly interim greenhouse gas emissions reduction targets, climate change strategies, and adaptation action plans to ensure the 2050 target is achieved and vulnerabilities to climate change impacts are reduced while potential opportunities are realised.

The Act requires the relevant Minister to prepare an emissions reduction pledge for the transport sector every five years from 2020. The pledges must include actions that will reduce emissions from the transport sector and the expected emissions reductions from these actions. The Act also requires decision makers to take climate change into account as aligned with policy objectives and the guiding principles. One of the policy objectives is to reduce the State's greenhouse gas emissions consistently with the long-term emissions reduction target.

This Act requires decision-makers to take climate change into account when making specified decisions under the Catchment and Land Protection Act 1994 (Vic), Coastal Management Act 1995 (Vic), Environment Protection Act 1970 (Vic), Flora and Fauna Guarantee Act 1988 (Vic), Public Health and Wellbeing Act 2008 (Vic) and Water Act 1989 (Vic).

More specifically, the Environment Protection Agency (EPA) must regulate the potential impacts of climate change and greenhouse gas emissions in relation to Victoria's long-term and interim emissions reduction targets as part of the works or other development approvals process.

### ENVIRONMENT PROTECTION ACT 1970

Under the Environment Protection Act 1970 (Vic) (EPA Act), greenhouse gases are defined as a waste. The Act authorises the EPA Victoria to issue works or other development approvals and licenses to regulate the State Environment Protection Policies (SEPP).

## 3.2.2 POLICY

### VICTORIA'S CLIMATE CHANGE FRAMEWORK

Victoria's Climate Change Framework is Victoria's long term plan to 2050, with the overarching goal of limiting warming to 1.5°C above pre-industrial levels while safeguarding Victoria's economic competitiveness. This Framework contains a 2020 emissions reduction target of 15–20 per cent below 2005 levels and achieving net zero emissions by 2050. This Framework sets out actions in four areas: energy efficiency and productivity, grid decarbonisation, economy electrification and switch to clean fuels, and carbon capture and storage and non-energy emissions reduction. Investment in the public transport system is identified as a priority including the following initiatives: purchasing renewable energy to power Melbourne's trams and supporting projects including the Metro Tunnel, High Capacity Metro Trains and Regional Network Development Plan. Other priorities for the transport sector include supporting walking and cycling, and encouraging the manufacturing and development of electric and autonomous vehicles.

### STATE ENVIRONMENT PROTECTION POLICY

The State Environmental Protection Policy (SEPP) Air Quality Management (AQM) 2001 is a framework for managing emissions to the air environment. Objectives of this SEPP are supported through protocols for environmental management (PEM) relating to greenhouse gas emissions and energy.

### PROTOCOL FOR ENVIRONMENTAL MANAGEMENT (PEM): GREENHOUSE GAS EMISSIONS AND ENERGY EFFICIENCY IN INDUSTRY

This PEM aims to ensure that entities subject to an EPA Victoria works approval or licence, manage greenhouse gas emissions and energy associated with their activities. The PEM stipulates a range of thresholds based on the annual predicted, or actual amounts of gigajoules of energy used or tonnes of energy-related $CO_2$-e. Where a works approval is required or a licence is in place under the EPA Act and Environmental Protection (Scheduled Premises and Exemption) or regulations and the thresholds are exceeded, the proponent would be required to implement greenhouse gas emissions and energy use reduction best practice and/or complete a Level 2 energy audit as outlined in the PEM.

# 3.3 LOCAL

Several local projects or frameworks demonstrate the importance of reducing greenhouse gas emissions from construction and operation of the Mordialloc Bypass project. These include:

- The South East Councils Climate Change Alliance (SECCCA) 2016–19 Strategic Plan, which includes actions to produce zero net emissions and have highly adaptive capacity to climate change
- Draft Climate Change Strategy 2018–2025 for the City of Kingston includes targets to become a carbon neutral council by 2050 and reduced emissions by 30 percent by 2020
- Greater Dandenong Sustainability Strategy 2016–2030
- VicRoads Sustainability and Climate Change Strategy 2015-2020, which guides the delivery of activities contributing to the environmental sustainability objectives under the Victorian Transport Integration Act 2010.

## 3.4 TRANSPORT AUTHORITIES GREENHOUSE GROUP (TAGG)

The *Greenhouse Gas Assessment Workbook for Road Projects* published by the Transport Authorities Greenhouse Group (TAGG), February 2013 and its supporting calculator, *Carbon Gauge* are key tools to assessing construction and operational impacts of road projects.

The TAGG workbook provides a process for estimating greenhouse gas emissions for major activities of a road project. It was developed by a group of Australian state road authorities (including VicRoads) and the New Zealand Transport Agency to provide a common methodology and calculation factors for estimating greenhouse gas emissions using a whole-of-life approach. This workbook includes a process to determine material GHG emissions associated with the construction of a road project.

# 4 PROJECT DESCRIPTION

## 4.1 OVERVIEW

The Mordialloc Bypass project is the proposed construction and operation of a new freeway between Dingley Bypass in the north and Mornington Peninsula Freeway at Springvale Road in the south. The project corridor is approximately 9.7 km in length, comprising two two-lane 7.5 km long carriageways (with a shared use path) along the greenfield alignment, and 2.2 km of roadworks required to integrate the project with the Mornington Peninsula Freeway as illustrated in Figure 4.1. It is expected that each carriageway will provide for two 3.5 m wide lanes, with a 3.0 m wide outside shoulder and 1.0 m wide inside shoulder. The Mordialloc Bypass will also provide connections from the freeway onto the Dingley Bypass, Centre Dandenong Road, Lower Dandenong Road, Governor Road, Springvale Road and new north facing ramps at Thames Promenade. There will also be an overpass at Old Dandenong Road. Mordialloc Creek and the associated Waterways Wetlands will be spanned by twin 400 m long bridges.

The proposed alignment allows for a future upgrade of the project to a six-lane freeway standard road within the construction footprint.

The main elements of the proposed project are as follows:

- Four lane freeway road with two lanes in each direction and a divided centre median
- 3.5 metre wide lanes
- 100 km/h posted speed
- A signalised T-intersection at Dingley Bypass
- A bridge over Old Dandenong Road
- Full diamond, grade separated interchanges at Lower Dandenong Road, Governor Road and Springvale Road
- A half-diamond south facing grade separated interchange at Centre Dandenong Road
- Redirection of Woodlands Drive to Lower Dandenong Road via a new connection to Tarnard Drive and Bell Grove
- An elevated bridge structure over the Mordialloc Creek Wetlands and Bowen Parkway, between the Waterways Estate and Aspendale Gardens
- New north-facing ramps at Thames Promenade, connecting to the Mornington Peninsula Freeway; and
- A shared user path along the entire length of the Mordialloc Bypass to provide connection from Springvale Road to Dingley Bypass.

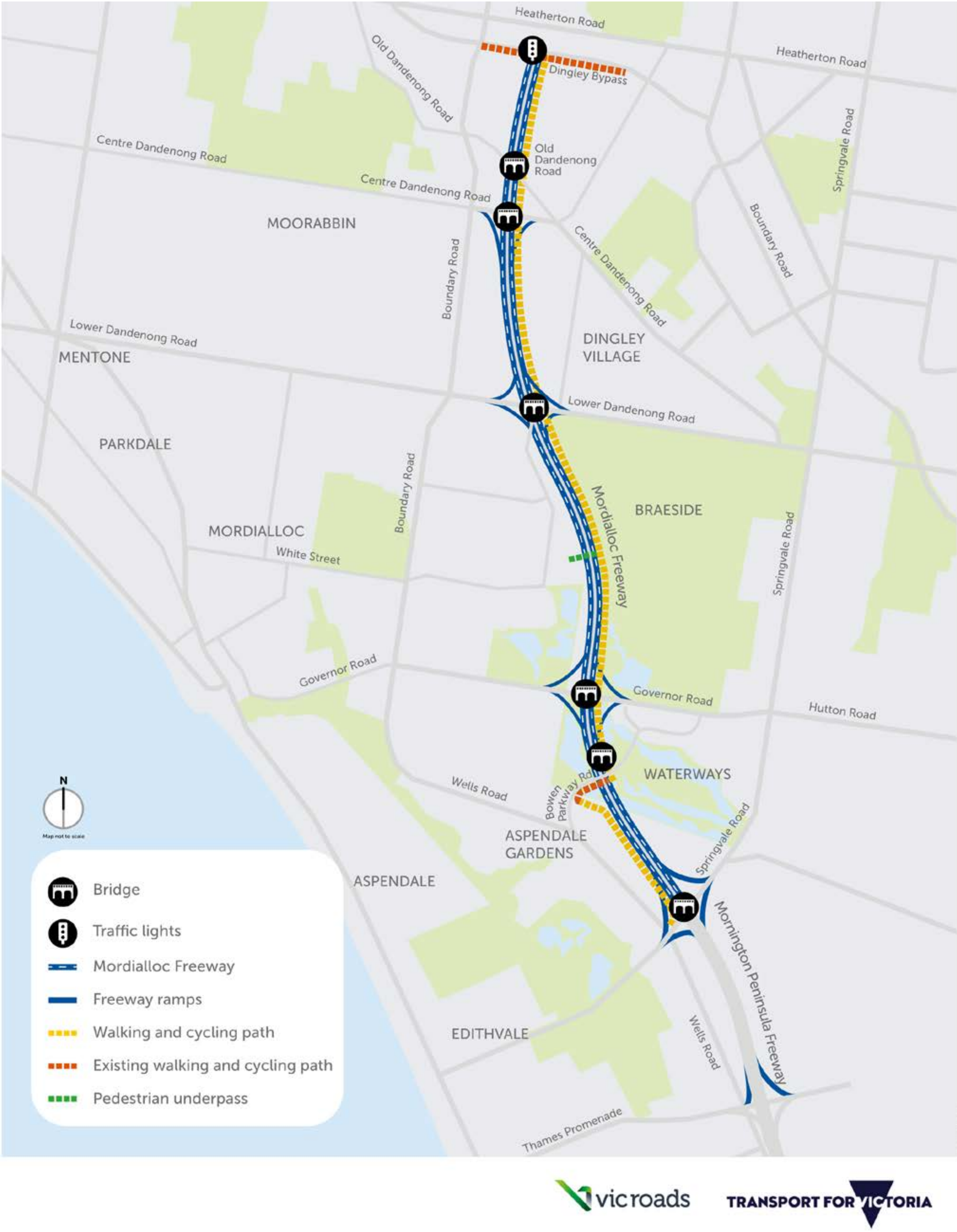



Figure 4.1 Mordialloc Bypass Project location (source: VicRoads May 2018)

## 4.2 CONSTRUCTION

The key components of the Mordialloc Bypass project that need to be constructed include elevated structures and surface roads requiring typical civil and structural works normally associated with major freeway projects. There will be small areas of clearing and the importing of fill materials for site preparation. The main construction activity anticipated to be required for the project is the construction of bridges.

### 4.2.1 BRIDGES

The Mordialloc Bypass project will involve the construction of a number of structural elements. The bridge and structural reference designs have been produced in conjunction with the road design and show all road bridges, major culverts, earth retaining structures, major sign structures, off structure barriers and other structural elements. The major structural elements are as follows:

- Structure over landfill area and Old Dandenong Road drain
- Old Dandenong Road bridge
- Centre Dandenong Road bridge
- Lower Dandenong Road bridge
- Braeside Park pedestrian underpass
- Governor Road bridge
- Waterways bridge; and
- Springvale Road bridge.

All bridges, except for Waterways bridge will be single structures, with width between barriers of 12.5 m. In the interim, this provides 2 x 3.5 m traffic lanes, a 3.5 m outer shoulder and 2.0 m inner shoulder. The intent of this solution is to both reduce the future construction costs, and provide flexibility to add a third future lane via re-linemarking without the need to add additional structural width. The future configuration will provide 3 x 3.5 m lanes with 1.0 m inner and outer shoulders.

# 5 METHODOLOGY

This section describes the methodology used to assess the potential greenhouse gas impacts of the Mordialloc Bypass during construction and operation. The methodology describes the specific data, methods and tools used to undertake the impact assessment.

## 5.1 BOUNDARY AND SCOPES FOR THE GREENHOUSE GAS IMPACT ASSESSMENT

To estimate the greenhouse gas emissions for the impact assessment, greenhouse gas emission factors and calculation methodologies were obtained from the following references:

- "National Greenhouse Accounts", published by the Australian Department of Environment, August 2017
- *Greenhouse Gas Assessment Workbook for Road Projects* published by the Transport Authorities Greenhouse Group (TAGG), February 2013 and its supporting calculator, *Carbon Gauge*.

Utilising assessment boundaries as defined within the *Greenhouse Gas Assessment Workbook for Road Projects*, the Materiality Checklist in the *Carbon Gauge* calculator (TAGG, 2013 – refer to Appendix B) was completed and the greenhouse gas impact assessment boundaries were determined to include all Scope 1 and Scope 2 greenhouse gas emission sources and select Scope 3 greenhouse gas emission sources. As per this workbook, if a particular greenhouse gas emission source contributes less than 5% of the total emissions of a major activity (i.e. construction, operation, maintenance), it has been considered to be not significant and subsequently has been excluded from the assessment boundary for that major activity.

A summary of the construction and operational greenhouse gas emissions sources that were assessed is provided in Table 5.1.

Table 5.1 Greenhouse gas emission sources and relevant emissions scope for project activities

| EMISSION SOURCE CATEGORY | EMISSION SOURCE | EMISSION SCOPE 1 (DIRECT) | EMISSION SCOPE 2 (INDIRECT) | EMISSION SCOPE 3 (DOWNSTREAM) |
|---|---|---|---|---|
| **Construction** | | | | |
| Fuel Use | Mobile construction equipment | ✓ | | ✓ |
| | Site vehicles | ✓ | | ✓ |
| | Delivery of plant, equipment and construction materials (local) | | | ✓ |
| | Spoil and waste removal | ✓ | | ✓ |
| Electricity Consumption | Electricity used to power construction plant (road headers, lighting towers etc) and site offices | | ✓ | ✓ |
| Vegetation Removal | Clearance of vegetation because of the project | ✓ | | |
| Materials | Embodied energy of construction materials | | | ✓ |

| EMISSION SOURCE CATEGORY | EMISSION SOURCE | EMISSION SCOPE 1 (DIRECT) | EMISSION SCOPE 2 (INDIRECT) | EMISSION SCOPE 3 (DOWNSTREAM) |
|---|---|---|---|---|
| **Operation (including Maintenance)** | | | | |
| Electricity consumption | Electricity used to power lighting of road | | ✓ | ✓ |
| Fuel Use | Operational road use by light and heavy vehicles | | | ✓ |
| | Mobile construction equipment used for maintenance activities | ✓ | | ✓ |
| Materials | Materials used for maintenance activities | | | ✓ |

The following Scope 3 construction greenhouse gas emission sources were excluded from the assessment as they were deemed to be immaterial in accordance with the framework set out in the NGER Act and TAGG Workbook:

- Fugitive emissions (such as from intentional or unintentional leaks or evaporative sources)
  - Landfill gases will continue to be released in the project's northern portion in the former Enviromix site area at the same rate as if the road was not built and most likely at a lower rate following the adoption of the proposed bio-treatment blanket. The LandGEM Modelling for this site indicates that no more than the current 10 tonnes per annum of methane emissions are likely to be maintained over the operational phase of the Bypass whilst disruption to landfill matter during construction will be mitigated by using driven piles (refer to Contaminated Land Impact Assessment report) and is not expected to contribute to more than 1% of construction phase GHG emissions (from materials and equipment use).
- Employee travel to and from site.
- International delivery of plant, equipment and materials.
  - Whilst this can be significant source of scope 3 emissions – as a road project – specialist, international plant equipment is unlikely to be required to any major extent. In addition, the Victorian Industry Participation Policy (VIPP) will apply to this project, further limiting the extent of international deliveries associated with this project.
- Emissions from disposal of site waste other than spoil
  - As this project, will generally involve importing fill there will be minimal disruption to acid sulphate soils that will require treatment through liming.
- The transportation of maintenance materials.

Design work has been excluded from the assessment as it only generates a small quantity of the GHG emissions associated with the road project's life cycle.

## 5.2 GREENHOUSE GAS EMISSIONS CALCULATIONS

### 5.2.1 EMISSIONS CALCULATION METHODOLOGIES

Greenhouse gas emissions from the construction and operation (including maintenance) of the project were estimated using two calculation methodologies. The primary methodology was the use of the *Carbon Gauge* calculator, which was developed to support the Transport Agencies Greenhouse Gas (TAGG) Workbook. This Workbook was established by road transport authorities around Australia to enable consistent modelling of greenhouse emissions for road projects. Scope 3 emissions from vehicles using the proposed bypass were estimated manually using Microsoft Excel. The calculation approach used for each emission source is outlined in Table 5.2.

Table 5.2 Greenhouse gas emissions calculation methodologies for construction and operational activities

| EMISSION SOURCE CATEGORY | EMISSION SOURCE | SOURCE OF DATA | CALCULATION APPROACH |
|---|---|---|---|
| **Construction** | | | |
| Fuel Use | Mobile construction equipment | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| | Site vehicles | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| | Delivery of plant, equipment and construction materials (local) | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| | Spoil and waste removal | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| Electricity Consumption | Electricity used to power construction plant (road headers, ventilation, lighting towers etc) and site offices | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| Vegetation Removal | Clearance of vegetation because of the project | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| Materials | Embodied energy of construction materials | Mordialloc Freeway Reference Design drawings | *Carbon Gauge* |
| **Operation (including Maintenance)** | | | |
| Electricity consumption | Electricity used to power lighting of road | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| Fuel Use | Operational road use by light and heavy vehicles | Data from transport engineer | Manual calculation |
| | Mobile construction equipment used for maintenance activities | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |
| Materials | Materials used for maintenance activities | Mordialloc Freeway Reference Design Report | *Carbon Gauge* |

To estimate emissions for the project's construction and operation (including maintenance), data relating to the project was sourced from design documents listed and inputted into *Carbon Gauge*. Assumptions were made to address data gaps to estimate the potential energy consumption and greenhouse gas emissions as some detailed quantities were not provided or available. Screen shots of the *Carbon Gauge* data inputs and outputs of this assessment are provided in Appendix A and Appendix B.

### *5.2.2 ESTIMATING OPERATIONAL EMISSIONS FROM VEHICLE TRAFFIC*

This section summarises the methodology applied to estimate the impact of the proposed Mordialloc Bypass project on greenhouse gas emissions from road user vehicles. The preliminary calculations for the indirect Scope 3 emissions associated with the fuel combustion of users of Mordialloc Bypass were based on the following methodology.

To assess the impact of the Mordialloc Bypass project on greenhouse gas emissions from vehicle traffic (Scope 3), a series of impact calculations has been performed that assess the predicted fuel consumption of cars, light commercial vehicles (LCV) and heavy commercial vehicles (HCV) for the year 2031 under "without project" and "with project" scenarios as follows:

- **Major route 1** – Thompson Rd – Boundary Road – Dingley Bypass.
- **Major route 2**– Thompson Road – Springvale Road – Dingley Bypass.
- **Victorian Integrated Transport Model (VITM)** – A model of the entire Victorian transport system that can account for net impacts across the road network
    - Data from the latest available VITM forecast modelling scenarios (2031) was used to determine the total Vehicle Kilometres Travelled and Average Speeds
        - Operation "without-project" assumes that users would continue to follow the same road routes as in 2018, with transport networks including future road projects and public transport services to reflect the likely road network capacity and public transport services and frequency in the future in the 2031 scenario without the project being built.
        - Operation "with-project" utilises the VITM incorporating the Mordialloc Bypass within the network. Transport networks also include future road projects and public transport services to reflect the road network capacity and public transport services and frequency in the 2031 scenario with the project being built.
- Due to improved travel time for "driving" mode as a result of enhanced infrastructure provided by the new road, there will be a slight mode shift from public transport to car travel and thus increasing the number of total trips. These behaviours are accounted for in the VITM model which was used as the basis of the Scope 3 road user emissions calculations.
- The preliminary calculations do not account for future changes in fuel efficiency and alternative fuels to vehicles, however these are expected to significantly reduce vehicle related GHG emission.
- The Austroads Guide to Project Evaluation Part 4: Project Evaluation Data, Part 6 (2008) was used for fuel consumption coefficients. This is an accepted standard by the Standing Council on Transport and Infrastructure (SCOTI) as the appropriate parameter values to be applied for the economic evaluation of road projects in Australia.

The adoption of the VITM to evaluate the impact of this project is considered appropriate given the interconnected nature of a road network system. Evaluation of greenhouse gas emissions at a route or local scale does not provide adequate consideration of pass through impacts of a major road project throughout a region.

See Appendix C for further details regarding the calculation of greenhouse gas emissions from road users.

The following inputs in Table 5.3 were utilised to determine GHG emissions.

Table 5.3 Calculation inputs and their sources for the operational vehicle traffic emission

| INPUT | SCOPE | SOURCE |
|---|---|---|
| Average Speed | Light & Heavy Vehicles | VITM Traffic Forecasting Report, April 2018, VicRoads<br>Alternative route Origin to Destination data provided by the Transport Engineer as part of the Mordialloc Bypass Traffic Impact Assessment |
| Vehicle Kilometres Travelled | Light & Heavy Vehicles | Transport Engineering Data from the VITM and Origin to Destination route alternatives |
| Rate of Fuel Consumption | | The Austroads Guide to Project Evaluation Part 4: Project Evaluation Data, Part 6 (2008) for freeway and non-freeways |
| Type of Fuel Consumed | Petrol, Diesel and LPG | Australian Bureau of Statistics 2017 Motor Vehicle Census 9303.9 |
| Type of Vehicle | Cars, Light Commercial Vehicles, Buses, Rigid Trucks and Articulated Vehicles | Australian Bureau of Statistics 2017 Motor Vehicle Census 9303.9 |

### 5.2.3 RISK ASSESSMENT METHODOLOGY

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

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

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

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

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

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

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

### *SCOPE AND BOUNDARIES*

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

### *RISK IDENTIFICATION*

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

Environmental impact pathways were identified under two categories:

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

GHG emission impacts are evaluated at a global scale and as such considering local off-site projects is not considered a useful undertaking. Consequence ratings of GHG impacts during project phases have been considered as a percentage of Victorian and National annual threshold values to enable a holistic assessment of the contribution to global concentrations of GHG in the atmosphere. As such, a cumulative assessment is inherent in the greenhouse gas emission impact assessment and are included in the reported residual risks, whilst specific cumulative impacts for secondary and external projects are not possible to accurately separate out.

### *RISK ANALYSIS*

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

### *RISK EVALUATION*

The ERA process developed for the project is based on the risk analysis matrix used on recent and similar VicRoads projects, as presented in Table 5.4. It follows the standard industry semi-quantitative risk analysis methodology that utilises pre-defined consequence and likelihood criteria as the factors to arrive at a risk rating.

Table 5.4 Risk assessment matrix

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

Based on the project objectives and context, a set of project-specific and appropriate likelihood and consequence criteria were developed in consultation with VicRoads, the TRG and technical specialists, see Table 5.5.

Table 5.5 Risk assessment likelihood categories

| LIKELIHOOD | | | |
|---|---|---|---|
| **Rare (A)** | Less than once in 12 months<br>OR<br>5% chance of recurrence during course of the contract | The event may occur only in exceptional circumstances | It has not happened in Victoria but has occurred on other road projects in Australia |
| **Unlikely (B)** | Once to twice in 12 months<br>OR<br>5-10% chance of recurrence during course of the project | The event could occur but is not expected | It has not happened in the greater Melbourne but has occurred on other road projects in Victoria |
| **Possible (C)** | 3 to 4 times in 12 months<br>OR<br>30% chance of recurrence during course of the project phase of works as detailed in Section 6.2 | The event could occur | It has happened in metropolitan Melbourne |
| **Likely (D)** | 5 to 6 times in 12 months<br>OR<br>50% chance of occurrence during course of the project phase of works as detailed in Section 6.2 | The event will probably occur in most circumstances | It has happened on a road project in metropolitan Melbourne in the last 5 years |
| **Almost Certain (E)** | More than 6 times in 12 months<br>OR<br>100% chance of occurrence during course of the project phase of works as detailed in Section 6.2 | The event is expected to occur in most circumstances | It has happened on a road project of similar size and nature in metropolitan Melbourne within the last 2 years<br>OR<br>It has happened multiple times on a road project in the region within the last 5 years |

Table 5.6 Risk assessment consequence categories

| CONSEQUENCE | | | | | |
|---|---|---|---|---|---|
| **Aspects** | **Insignificant** | **Minor** | **Moderate** | **Major** | **Catastrophic** |
| **Rating** | **1** | **2** | **3** | **4** | **5** |
| **Construction and operational effects Greenhouse gas emissions** | Annual Scope 1 and Scope 2 GHG emissions are below 5,000t CO2-e p.a.<br>AND<br>No legal obligation to monitor and report emissions under the National Greenhouse & Energy Reporting (NGER) scheme. | Annual Scope 1 and Scope 2 GHG emissions are below the threshold required to report as a separate facility in NGER scheme (<25,000t CO2-e p.a.)<br>AND<br>No additional obligation to monitor and report emissions. | Annual Scope 1 and Scope 2 GHG emissions are above the threshold required to report as a separate facility in NGER scheme (<25,000t CO2-e p.a.)<br>AND<br>Requirement to monitor and report emissions. | A major level of GHG emissions as defined by annual Scope 1 and Scope 2 GHG emissions, representing:<br>- a non-negligible proportion of national emissions (0.01 to 0.1%),<br>OR<br>- a non-negligible proportion of State emissions (1-5%)<br>AND<br>Requirement to monitor and report emissions | A significant level of GHG emissions defined by annual Scope 1 and Scope 2 GHG emissions, representing:<br>- >1% of national emissions,<br>OR<br>- >5% of State emissions<br>AND<br>Requirement to monitor and report emissions |
| **Cumulative Effects** | **Scope and Boundaries:**<br>GHG emission impacts are evaluated at a global scale and as such considering local off-site projects is not considered a useful undertaking. Consequence ratings of GHG impacts during project phases have been considered as a percentage of Victorian and National annual threshold values to enable a holistic assessment of the contribution to global concentrations of GHG in the atmosphere. | | | | |

For all risks rated medium, high or extreme in the initial risk rating, technical specialists were required to identify additional controls which could be implemented to further reduce risk and to perform the residual risk rating. Additional controls specify management measures over and above those considered as Standard Controls to ensure the residual risk has been effectively avoided or mitigated to as low as reasonably practicable.

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

# 6 RISK ASSESSMENT

Impacts to greenhouse gas emissions from the Mordialloc bypass project can be summarised into five categories:

- Indirect Scope 3 greenhouse gas emissions from construction materials.
- Indirect Scope 3 greenhouse gas emissions due to changes in travel times associated with the selected road alignment.
- Direct and indirect Scope 1, 2 and 3 greenhouse gas emissions from construction activities.
- Indirect Scope 3 greenhouse gas emissions from the ongoing operational use of the road over its design life (compared to the 'without project' scenario).
- Air quality effects from clearing, earthworks and construction vehicle emissions.

The primary environmental risks identified for greenhouse gas emissions are provided in Table 6.1. The initial risk ratings presented below for both project and cumulative impacts consider standard inherent controls as listed in the Environmental Risk Assessment Report. The additional controls listed in the tables below are those recommended to further mitigate and minimise the primary environmental risks which were risk rated as medium or above. Primary environmental risks which were scored as low did not require additional controls to be applied.

Also included in the table below are any identified on-site project related cumulative risks, including: secondary risks (resulting from the implementation of a risk response in mitigating a primary environmental risk) and on-site aggregate cumulative risks (the aggregate/combined primary environmental risks resulting from diverse project activities having an impact on the same environmental asset.

The assessment of cumulative impacts was competed in two stages, namely the assessment of aggregate project impacts and the assessment of the cumulative impact of multiple off-site projects in addition to the Mordialloc Bypass project for greenhouse gas emissions. Greenhouse gas emissions impacts are evaluated at a global scale. Consequence ratings of greenhouse gas emissions impacts during initial phase, construction, operation and maintenance have been considered as a percentage of Victorian and National annual threshold values to enable a holistic assessment of the contribution to global concentrations of greenhouse gas emissions in the atmosphere.

Table 6.1 Greenhouse gas emissions: environmental risk assessment register

| RISK ID | IMPACT PATHWAY | PRIMARY ENVIRONMENTAL RISK DESCRIPTION | SECONDARY ENV. RISK | INITIAL RISK | | | ADDITIONAL MITIGATION/ CONTROLS | EPR | RESIDUAL RISK | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Consequence | Likelihood | Rating | | | Consequence | Likelihood | Rating |
| R-GHG1 | Greenhouse gas emissions from construction material production. | Indiscriminate selection of construction materials leads to significant levels of scope 3 indirect GHG emissions during the project construction phase. | | Minor | Unlikely | Low | Create a Sustainability Management Plan (SMP) which includes mandatory actions to monitor and report construction phase greenhouse gas emissions and to benchmark predicted operational phase greenhouse emissions in accordance with Mat-1 and Ene-1 credits of the Infrastructure Sustainability (IS) rating tool (v1.2). | GG1 | Minor | Unlikely | Low |
| R-GHG2 | Road alignment effect on vehicle emissions and fuel efficiency. | The project alignment selection deviates from the most efficient route for fuel efficiency considerations leading to an increase in indirect scope 3 road user emissions beyond current. | | Minor | Unlikely | Low | Not required | | Minor | Unlikely | Low |

| RISK ID | IMPACT PATHWAY | PRIMARY ENVIRONMENTAL RISK DESCRIPTION | SECONDARY ENV. RISK | INITIAL RISK | | | ADDITIONAL MITIGATION/ CONTROLS | EPR | RESIDUAL RISK | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Consequence | Likelihood | Rating | | | Consequence | Likelihood | Rating |
| R-GHG3 | Greenhouse gas emission from construction activities. | Construction activities lead to direct and indirect scope 1, 2 and 3 GHG emissions leading to a significant contribution to State greenhouse gas emission levels | | Moderate | Unlikely | Medium | A verifiable improvement in project GHG emissions must be achieved by achieving a minimum of Mat-1 (Level 1) and Ene-1 (Level 2) credits of the Infrastructure Sustainability (IS) rating tool (v1.2).<br>A minimum of 20% of construction phase energy must be purchased from an accredited GreenPower product. | GG2 | Minor | Unlikely | Low |
| R-GHG4 | Greenhouse gas emissions from operational road traffic. | Ongoing use of the road leads to an increase in indirect scope 3 GHG emissions over its design life in comparison to the no project scenario. | | Minor | Unlikely | Low | Not required | - | Minor | Unlikely | Low |
| R-GHG5 | Aggregate Cumulative Effect: Air quality effects from construction activities. | Clearing, Earthworks and Construction vehicles and operations emissions lead to an increase impact on project related GHG emissions beyond NGER annual facility threshold levels | | Minor | Unlikely | Low | A verifiable improvement in project GHG emissions must be achieved by achieving a minimum of Mat-1 (Level 1) and Ene-1 (Level 2) credits of the Infrastructure Sustainability (IS) rating tool (v1.2).<br>A minimum of 20% of construction phase energy must be purchased from an accredited GreenPower product. | GG2 | Minor | Unlikely | Low |

# 7 IMPACT ASSESSMENT

This section outlines the estimated greenhouse gas emission impacts associated with the Mordialloc Bypass project for its construction and operation (including maintenance) phases and its findings.

## 7.1 CONSTRUCTION IMPACTS ROAD CONSTRUCTION

Greenhouse gas emissions from Scope 1, 2 and 3 construction activities of the proposed Mordialloc Bypass project are estimated to be 68.5 kT $CO_2$-e. During construction, the embodied carbon in materials (Scope 3) used during construction represents the largest emissions source of the construction phase (66 per cent). Currently, the use of fossil fuels such as diesel is necessary to operate plant, equipment, to construct all infrastructure elements of the bypass, however the impacts of greenhouse gas emissions and the use of fossil fuels in this phase can be mitigated through environmental controls described in Section 8 of this report.

Greenhouse gas emission impacts from vegetation removal represent less than 1 per cent of the project's construction emissions. This is a minor amount of greenhouse gas emissions and has been achieved through careful consideration of the bypass route and will be enhanced further by avoiding existing vegetation as part of the construction footprint.

The greenhouse gas emissions for risks relating to the accidental release of greenhouse gas emissions from utility works, or from the additional energy use from inefficient works were unable to be quantified in this assessment. However, their likely contribution to the project's total greenhouse gas emissions is considered immaterial when evaluated as part of the materiality assessment.

Direct emissions (Scope 1 and 2) account for 22.8 kT CO2-e associated with the 24-month construction period, which equates to approximately 11.4 kT CO2-e p.a. (for Scope 1 and 2) and is equivalent to 0.01 per cent of Victoria's total 2016 greenhouse gas emissions. The construction phase of the project is unlikely to exceed the NGER Scheme threshold for a facility. A breakdown of the project's construction greenhouse gas emissions by source and scope are shown in Table 7.1 and in Figure 7.1.

Table 7.1 Greenhouse gas emissions summary for construction phase by emission source and scope annually

| GHG SUMMARY BY ACTIVITY | SCOPE 1 (TONNE CO2-E P.A) | SCOPE 2 (TONNE CO2-E P.A) | SCOPE 3 (TONNE CO2-E P.A) | TOTAL (TONNE CO2-E P.A) |
|---|---|---|---|---|
| Site office/General Areas | 210 | – | 16 | 226 |
| Demolition and Earthworks | 4,049 | – | 266 | 4,315 |
| Construction – Pavements | 330 | – | 3,504 | 3,834 |
| Construction – Structures | 5,862 | – | 17,694 | 23,556 |
| Construction – Drainage | 751 | – | 588 | 1,339 |
| Construction – Road Furniture | 207 | – | 783 | 990 |
| **Total** | **11,422**[1] | – | **22,852** | **34,259** |

(1) The Carbon Gauge calculator assumes all construction phase energy is from diesel sources. The comparisons GHG emissions between diesel fuel and electricity is a factor of 4.0 with higher emissions associated per unit of grid electricity. Electricity is likely to be used for site office areas only resulting in approximately a 5% increase in construction phase emissions as calculated using the *Carbon Gauge* calculator

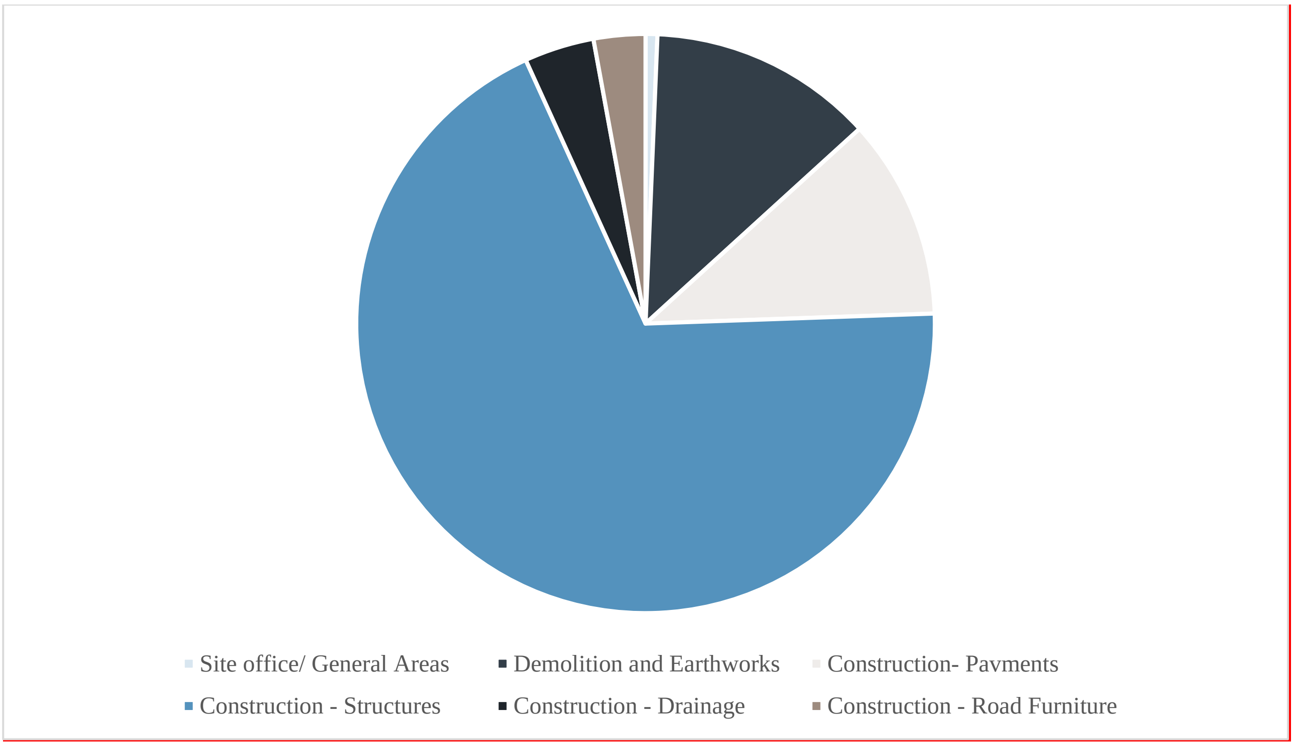



Figure 7.1 Construction greenhouse gas emissions by emission source (kt CO2-e percentage)

## 7.2 OPERATIONAL IMPACTS ROAD OPERATION

Greenhouse gas emissions once the project is operating, including maintenance activities, but excluding road user emissions, are estimated to be 0.96kT $CO_2$-e pa. The majority (81 per cent) of these greenhouse gas emissions relate to electricity consumption for road lighting. Greenhouse gas emissions from the use of fossil fuels to operate plant and equipment and site vehicles are collectively estimated to represent 12 per cent of the total operational greenhouse gas emissions.

The operation and maintenance phase of the project is very unlikely to exceed the NGER Scheme threshold for a facility. These impacts can also be mitigated through the identified environmental project controls. A breakdown of the annual greenhouse gas emissions source and scope from the project's operation (including maintenance) are summarised in Table 7.2 and Figure 7.2.

Table 7.2 Annual greenhouse gas emissions summary for the project's operational activities (including maintenance) by emission source and scope

| GHGe SUMMARY BY ACTIVITY | SCOPE 1 (tonne CO2-e p.a) | SCOPE 2 (tonne CO2-e p.a) | SCOPE 3 (tonne CO2-e p.a) | TOTAL (tonne CO2-e p.a) |
|---|---|---|---|---|
| Maintenance materials | 51 | 0 | 66 | 117 |
| Lighting | 0 | 698 | 81 | 779 |
| LED Traffic Signals | 0 | 58 | 7 | 65 |
| **Total** | **51** | **756** | **154** | **961** |

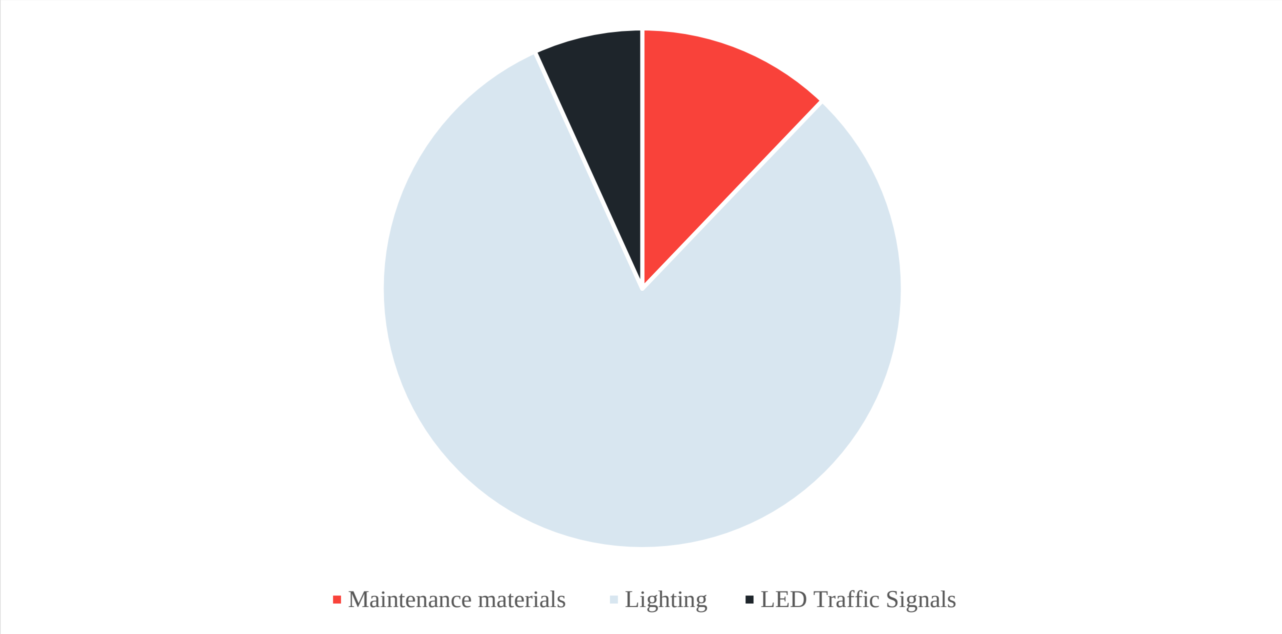



Figure 7.2 Operational phase (including maintenance) greenhouse gas emissions by emission source

### 7.2.1 SUMMARY OF LIFE CYCLE GREENHOUSE GAS EMISSION IMPACTS

The graph below summarises the overall lifecycle greenhouse gas emissions modelled using *Carbon Gauge*. This does not consider road user emission impacts which are evaluated in the following section of this report. This includes Scope 3 emissions that accounts for embodied greenhouse gas emissions within maintenance and construction materials.

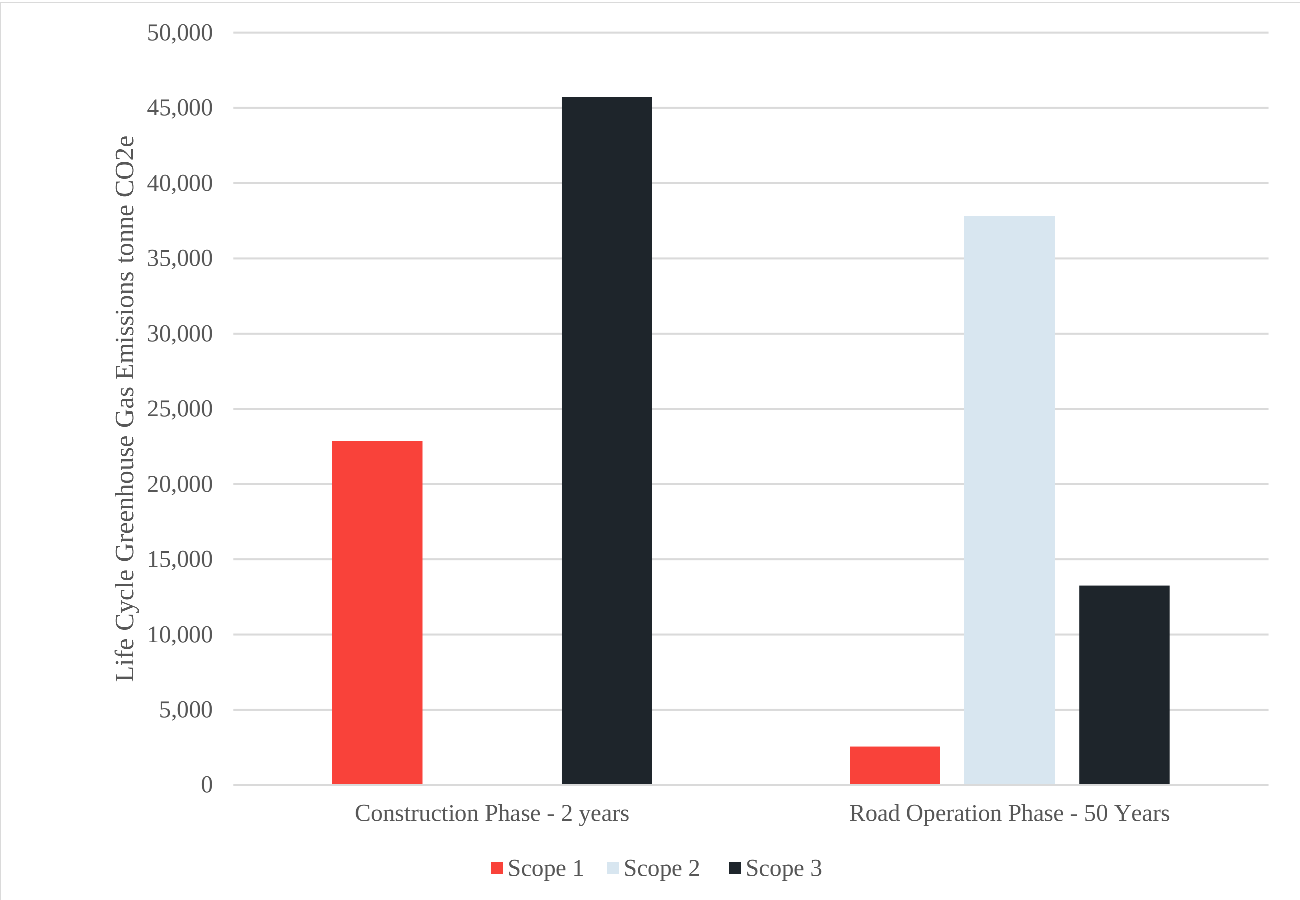



Figure 7.3 Summary of lifecycle greenhouse gas emissions

## 7.3 OPERATIONAL IMPACTS FROM VEHICLE TRAFFIC

### *7.3.1 TRAFFIC MODELLING AND INDUCED DEMAND*

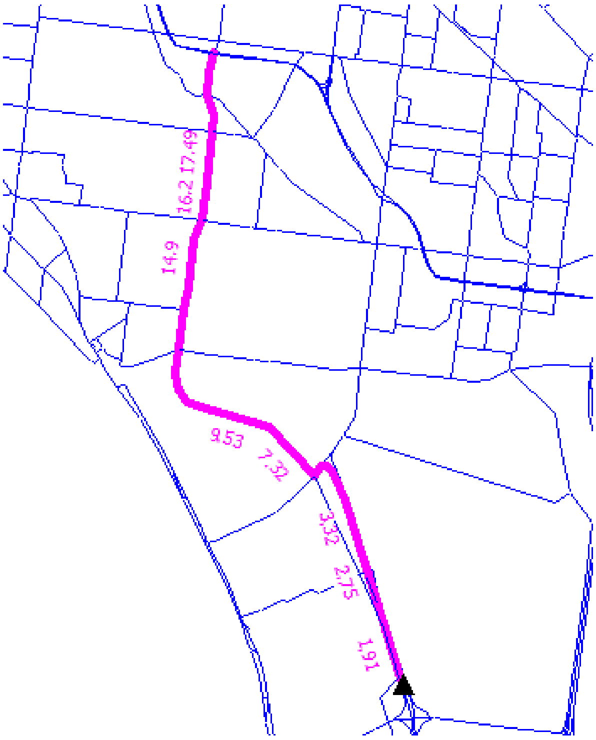
The Victorian Auditor-General's Report (Victorian Auditor-General's Office, 2011) recommends road authorities to assess the significance of induced traffic for all major road projects and consider it when forecasting traffic and estimating the economic benefits. Victorian Integrated Transport Model (VITM) forecast modelling undertaken for the project (Mordialloc Bypass) considers induced travel demand as defined under the Australian Transport Assessment and Planning (ATAP) guidelines – T1 Travel Demand Modelling. Induced travel demand is defined as follows under the ATAP guidelines:

> *Induced travel demand refers to the impacts of new transport projects and services in encouraging some people to switch routes, modes or time of travel to take advantage of the improved travel times and service levels. In addition, induced demand can refer to the tendency of some people to travel more when travel conditions are improved. Longer term effects may include some households and businesses locating close to the new or improved transport infrastructure and services, and/or locating further away from their destinations. Induced travel demand can arise from both road and public transport (PT) projects (DOT, 2011)*

### *7.3.2 MAJOR ROUTE IMPACTS*

Traffic data was used to estimate the net effect that this project would have on traffic using the major alternative routes (based on modelled volumes), assuming users have the same Origin to Destination (OD). These routes are shown in the figures below.

**Major Route 1** – Thompson Road – Boundary Road – Dingley Bypass




**Major Route 2:** Thompson Road – Springvale Road – Dingley Bypass

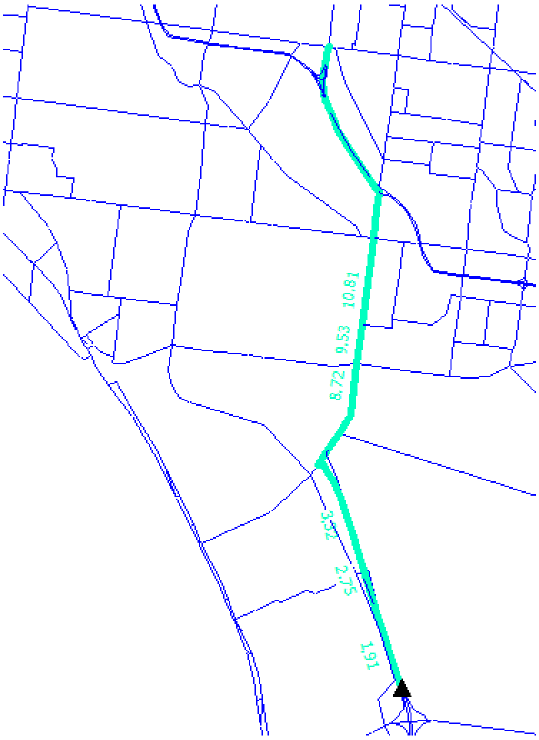



Figure 7.4 Alternative OD routes

Using data from the above routes, calculations were completed to determine the average vehicle fuel efficiency for the "with project" and "without project" traffic scenarios.

The results are summarised in Table 7.3 below.

Fuel efficiency calculations have been completed for these routes to provide a level of local context to the project impact on greenhouse gas emissions. Providing calculations of greenhouse gas emissions of a particular route or locality is not technically viable due to the interconnected nature of the Victoria's Road Network. Calculations of road user annual greenhouse gases are provided in section Table 7.4 which evaluates this impact across the entirety of the Victorian Integrated Transport Model (VITM)

Table 7.3 Daytime peak fuel efficiency associated with major route options "without" and "with" project

| ROUTE DESCRIPTION | | | VEHICLE TYPE | WITHOUT PROJECT (2031) | WITH PROJECT (2031) | % CHANGE |
|---|---|---|---|---|---|---|
| | | | Light/heavy | Average fuel efficiency (L/100 km) | | |
| Major Route 1 | Thompson Road – Boundary Road – Dingley Bypass | AM Peak (North Bound) | LCV | 15.3 | 14.4 | 6% improvement |
| | | | HCV | 81.5 | 74.9 | 8% improvement |
| | | PM Peak (South Bound) | LCV | 16.3 | 14.3 | 12% improvement |
| | | | HCV | 88.3 | 74.3 | 15% improvement |
| Major Route 2 | Thompson Road – Springvale Road – Dingley Bypass | AM Peak (North Bound) | LCV | 15.0 | 14.3 | 5% improvement |
| | | | HCV | 79.0 | 73.8 | 7% improvement |
| | | PM Peak (South Bound) | LCV | 15.7 | 14.7 | 5% improvement |
| | | | HCV | 84.1 | 77.0 | 8% improvement |

As summarised in Table 7.3, for the two major typical routes assessed, the "with project" scenario indicates improved fuel efficiencies during peak travel periods. This demonstrates a favourable impact on greenhouse gas emissions from vehicle traffic as a result of the Mordialloc Bypass project, with a range of improvements in fuel efficiency from 5% to 15%.

Calculations of fuel efficiencies can be found in Appendix C. In general, for driving speeds up to 70km/hour, fuel efficiency improves significantly as average speeds increases. This correlation is described within the *Austroads Guide to Project Evaluation Part 4.*

### *7.3.3 OVERALL NETWORK IMPACTS*

Emissions from the overall Victorian road network associated with road traffic fuel combustion for both the "with project" and "without project" scenarios were calculated, using data obtained from the latest Victorian Integrated Transport Model. The results of these calculations are summarised in Table 7.4 below.

Table 7.4 Summary of overall Victorian network road user GHG emission impact with and without the project

| GREENHOUSE GAS EMISSIONS (KILOTONNES OF $CO_{2-E}$ P.A.) | WITHOUT PROJECT (2031) | WITH PROJECT (2031) | CHANGE (%) |
|---|---|---|---|
| VITM | 26,988 | 26,975 | -0.05% |

The overall network results in Table 7.4 indicate that greenhouse gas emissions of up to 13 kT $CO_2$ -e will be saved annually with the Mordialloc Bypass project. This saving is attributed to an increase in average speed of vehicles across the network, which is most significant for improving the fuel consumption of heavy vehicles due to the overall reduced congestion and wait times.

Based on the findings from this model, it can be concluded that due to improved road network efficiency associated with the proposed Mordialloc Bypass project, a net annual saving in greenhouse gas emissions will be realised across the overall Victorian road network.

Additionally, as described in Section 5.2.2 the estimation of future traffic greenhouse gas emissions does not include changes in the fuel efficiency or type of vehicle fuel over time. Anticipated future improvements in fuel efficiency of vehicles would further reduce greenhouse gas emissions more broadly throughout the transport system in Victoria.

## 7.4 LIMITATIONS AND ASSUMPTIONS

### 7.4.1 PROVIDED DATA

#### VALIDITY OF DATA

This greenhouse gas emissions impact assessment was prepared from information supplied in the design stage including the VITM traffic forecasting report April 2018. This contained the most accurate traffic data and route information available at the time of report production.

#### ROUTE SPECIFIC DATA ASSUMPTIONS

When calculating the route specific impacts of the project, it was assumed that both light and heavy vehicles travelled at the same speed. There would realistically be a lower average speed for heavy vehicles, however it is anticipated this would have a negligible effect on the overall emissions of the route. The speeds calculated for the major routes during peak periods are all within the prescribe limits and within the range of 40–50 kmh. Therefore, there is no breaching of the speed limits. These speeds are summarised within Appendix C.

#### TRANSPORT ENGINEERING DATA

To undertake this impact assessment, data has been provided by the project’s transport engineer. Details of the generation process including assumptions and further limitations are provided within the transport engineering technical assessments provided as part of this EES.

### 7.4.2 AUSTROADS GUIDE TO PROJECT EVALUATION PART 4: PROJECT EVALUATION DATA TABLE 7.3

This guide has been used to calculate fuel consumption of vehicles utilising empirically derived formulas for heavy and light vehicle type. As part of the 2005 and 2008 version of this guide, fuel consumption co-efficient for travel speed were provided as part of an empirically derived relationship to enable calculation of greenhouse gas emissions. However, for lower travel speeds these were found to be non-comparable for all vehicle types and were removed as part of the 2012 update to this guide. As the average speeds provided by the project traffic engineers are not low, and at more than 40 kmh, this model has been used for comparative impact purposes for this reporting.

The methodology applied does not make allowance for future changes in fuel efficiency or the petrol/diesel fleet mix. It is anticipated that improvements in fuel efficiency of vehicles would reduce emissions rates and ultimately the relative future emissions under both the “without project” and “with-project” scenarios.

### 7.4.3 CARBON GAUGE

The TAGG Carbon Gauge calculator was used to estimate greenhouse gas emissions for most emission sources for this assessment for project construction and operational phase greenhouse gas emissions. Detail on the assumptions and limitations of the calculator are provided in the Greenhouse Gas Assessment Workbook for Road Projects, February 2013 (TAGG, 2013). Section 3.4 Impact assessment, details which sources of emissions were assessed using *Carbon Gauge*.

For the purposes of this report – the emissions factors included within Carbon Gauge have been utilise as a more conservative view of the greenhouse gas emissions associated with this project where the factors have reduced and are expected to continue to reduce throughout the project life. The following changes to the greenhouse gas emission factors have occurred between 2013 to 2017.

- Purchased electricity – 13% reduction in full scope emissions from 2013 to 2017
- Diesel oil -1.2% change in full scope emissions from 2013 to 2017.

# 8 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

Although preliminary analysis undertaken indicates that neither direct (Scope 1 and 2) or indirect (Scope 3) greenhouse gas emissions associated within the bypass are forecast to be non-significant, it is still proposed to provide control measures to mitigate greenhouse gas emissions associated with the construction and operation phases of this project. The following Environmental Performance Requirements are to be adopted by the project.

Table 8.1 Proposed Environmental Performance Requirements

| EPR NUMBER | EPR | PROJECT PHASE |
|---|---|---|
| GG1 | **Greenhouse Gas Monitoring and Reporting**<br>Minimise and manage greenhouse gas emissions (GHG) arising from construction, operation and maintenance through the integration of sustainable design practices.<br>Create a Sustainability Management Plan (SMP) which includes mandatory actions to monitor and report construction phase greenhouse gas emissions and to benchmark predicted operational phase greenhouse emissions in accordance with Mat-1 and Ene-1 credits of the Infrastructure Sustainability (IS) rating tool (v1.2). | Construction, Operation |
| GG2 | **Greenhouse Gas Emission Reduction**<br>The materials and equipment for the project must be selected with the intent to reduce the project associated GHG emissions during the construction and operational phases.<br>A verifiable improvement in project GHG emissions must be achieved by achieving a minimum of Mat-1 (Level 1) and Ene-1 (Level 2) credits of the Infrastructure Sustainability (IS) rating tool (v1.2).<br>A minimum of 20% of construction phase energy must be purchased from an accredited GreenPower product. | Construction, Operation |

## 8.1 INFRASTRUCTURE SUSTAINABILITY (IS) RATING

Infrastructure sustainability can be defined as infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes in the long term. The achievement of an IS rating for this project is intended to drive sustainability across all infrastructural aspects of the project.

The ISCA IS Rating Scheme was developed and is administered by the Infrastructure Sustainability Council of Australia (ISCA). The IS Rating Tool is a comprehensive rating system for evaluating sustainability across design, construction and operation of infrastructure. This rating system evaluates the performance of an asset throughout its lifecycle. Whilst monitored consumption is utilised for the Design and Construction phases of the asset, operational phase data is based on predictive modelling, planning and reporting.

Categories within this rating tool include:

- Materials (Mat) – This rating tool category rewards design and practice that reduces the lifecycle environmental impacts of materials used within considers the project. This includes embodied greenhouse gas emissions (scope 3). The achievement of level 1 for Mat-1 credit requires the project to monitor and model the lifecycle impacts of materials used in the construction and maintenance of the project.
- Energy (Ene) – This rating tool category rewards the monitoring and minimisation of energy use and greenhouse gas emissions across the project's lifecycle. The achievement of a level 2 for Ene-1 credit requires monitoring and modelling of Scope 1 and Scope 2 energy sources and requires the project to show a minimum reduction of greenhouse gas emissions of 15 per cent compared to a Base Case. The Base Case approach is used to model and measure the performance of the project (in terms of resource consumption or greenhouse gas emissions) and compare it to a business as usual base case.

The Mordialloc Bypass project has chosen to measure sustainability performance using the IS Rating Tool and to benchmark the sustainability features of the design and construction of the project. The use of this tool will provide a consistent method of measuring performance that is recognised and accepted by industry and government agencies.

# 9 CONCLUSION

From the calculations undertaken as part of this assessment, impacts associated with the Mordialloc Bypass project found:

- Minor levels of Scope 1 and 2 greenhouse gases emitted during the project's construction phase at less than half the annual NGERS reporting threshold for a facility
- Very minor Scope 1 and 2 greenhouse gases emitted during the project's operational phase at significantly lower than the annual NGERS reporting threshold for a facility
- A positive impact on road user greenhouse gas emissions during operation of the project due to improved road network efficiencies as a result of this project.

The risk assessment undertaken identified greenhouse gas emissions associated with construction, operation and maintenance of this project as a low risk with no requirement for additional controls.

This assessment indicates that the Greenhouse Gas Emissions impact associated with this project is positive by alleviating traffic congestion and enhancing the fuel efficiency within the Victorian Transport Network. This is supportive of the objectives of the Climate Change Act.

Environmental performance requirements are proposed to be incorporated into the project to further reduce greenhouse gases associated with the construction and operation of the Mordialloc Bypass. These requirements intend to introduce monitoring and reporting of greenhouse gases as well as requiring the integration of strategies to mitigate greenhouse gas emissions as part of the design and construction phases of the project.

# 10 REFERENCES


- Australian Greenhouse Emissions Information System (AGEIS), <http://ageis.climatechange.gov.au/> 2016 National Inventory (date viewed 8 June, 2018).
- Austroads Guide to Project Evaluation Part 4: Project Evaluation, First Edition, 2005, Austroads Ltd.
- Clean Energy Regulator – Reporting Thresholds < http://cleanenergyregulator.gov.au/NGER/Reporting-cycle/Assess-your-obligations/Reporting-thresholds/> 17 January 2018.
- Department of the Environment, Australian National Greenhouse Accounts – National Greenhouse Accounts Factors, Canberra, Australia, 2017.
- Department of Environment and Energy, State and Territory Greenhouse Gas Inventories 2016, Feb 2018.
- Mordialloc Bypass Business Case VITM Traffic Forecasting Report, April 2018.
- Frankston City Council Carbon Neutral Action Plan 2012-2016. 2008.
- Transport Authorities Greenhouse Group (TAGG) 2013, Greenhouse Gas Assessment Workbook for Road Projects, February 2013.

# APPENDIX A

CARBON GAUGE INPUTS

# Construction Report

**Note 1:** This Workbook is designed to enable a consistent methodology for the assessment of significant emission sources and estimation of greenhouse gas emissions. As such it deliberately does not cover activities and emission sources assessed as insignificant, and it is not designed for compliance reporting.

**Note 2:** All emission values shown on this report are in tonnes of carbon dioxide equivalent (t CO2-e) unless otherwise stated.

## Project Description

| | |
|---|---|
| Project title | Mordialloc Bypass |
| Project location | Mordialloc Bypass |
| State | VIC |
| Description | 0 |

| | |
|---|---|
| Project Value ($m) | 300000 |
| Project Duration (Months) | 24 |

## Construction

### Materiality Checklist Options

| Checklist Option | Selection | Details |
|---|---|---|
| Will a diesel generator be used to provide power to the project site office for more than 12 months? | YES | Fuel combusted in powering site offices will be included. |
| Will more than 120 buildings be required to be demolished per 1km of road? | NO | Fuel combusted in demolishing buildings will NOT be included. |
| Will more than 0.5 ha (5,000m$^2$) of vegetation be removed? | YES | Vegetation removal and/or revegetation will be included. |
| Will the project involve tunnelling? | NO | Electricity consumption and explosives used will NOT be included. |
| Is the project located more than 200 km from the nearest material suppliers/quarry/city? | NO | The emissions associated with the transport of materials to site will NOT be included. |
| Will the project utilise on-site batching plants or other continuously operating stationary plant and equipment for more than 6 months? | NO | Fuel combusted in stationary engines will NOT be included. |
| Will the project include road safety barriers along more than 50% of the road length if barriers are used on both sides of a dual carriageway (i.e. 4 sets) or 100% of the road length if used on both side of a single carriageway (i.e. two sets)? | YES | The emissions from the construction and installation of road safety barriers will be included. |
| Will the project include noise walls along more than 75% of the road length? | YES | The emissions from the construction and installation of noise walls will be included. |

## Fuel Types

| | Construction Activity | Fuel Type | GHGe (t $CO_2$-e) |
|---|---|---|---|
| Plant Equipment Fuel | Site Offices | Diesel | 450 |
| | | Petrol | - |
| | Construction | Diesel | 15,388 |
| | Demolition and Earthworks | Diesel | 7,485 |
| | Vegetation Removal | Diesel | 46 |
| | | | 23,370 |

## Pavements

| | Pavement Type | Total Area (m2) | GHGe (t $CO_2$-e) | Pavement Option Selected |
|---|---|---|---|---|
| Pavement 1 | 01. Full Depth Asphalt | 119,087 | 4,562 | No |
| Pavement 2 | 10. Bike path - concrete | 27,561 | 3,106 | No |
| Pavement 3 | 01. Full Depth Asphalt | - | - | No |
| Pavement 4 | 01. Full Depth Asphalt | - | - | No |

| | | | | |
|---|---|---|---|---|
| Pavement 5 | 01. Full Depth Asphalt | - | - | No |
| Pavement 6 | 01. Full Depth Asphalt | - | - | No |
| | | | 7,668 | |

## Structures

| | Structure Type | Total Length (km) | Width/Height (m) | GHGe (t $CO_2$-e) |
|---|---|---|---|---|
| Bridges (including interchanges and overpasses) | Bridge constructed using precast reinforced concrete beams | 0.98 | 24.6 | 28,846 |
| | Bridge constructed using steel beams | - | - | - |
| Reinforced Soil Walls | Reinforced Soil Walls | 18.00 | 4.0 | 18,266 |
| Retaining Walls | Concrete retaining walls | - | - | - |
| | Timber retaining walls | - | - | - |
| | Rock retaining walls | - | - | - |
| | | | | 47,111 |

## Material Transport

| | Truck Size per Load of Material (GVM) | Distance from source to site (km) | GHGe (t $CO_2$-e) |
|---|---|---|---|
| Aggregate | | - | - |
| Asphalt & Bitumen | | - | - |
| Cement and Concrete | | - | - |
| Steel | Medium goods vehicles (3.5t≤GVM≤12t) | 1,100.00 | - |
| Timber | | - | - |
| | | | - |

## Drainage

| | Drainage Type | Total Length (km) | GHGe (t $CO_2$-e) |
|---|---|---|---|
| Kerbing | Mountable Kerb | 29.85 | 366 |
| | Semi-mountable Kerb | - | - |
| | Upright kerb and Gutter (Channel) | - | - |
| | Invert drain | - | - |
| Culverts – pipes or box culverts for water drainage | Small <450 RCP | 9.57 | 1,425 |
| | Medium 450 – 750 RCP | 0.82 | 165 |
| | Large 750 – 1200 RCP | 1.56 | 579 |
| | 375x 600 RCBC | 0.35 | 111 |
| | 600 x 1200 RCBC | - | - |
| Open, Unlined Drains | Form open, unlined drains | 21.80 | 31 |
| | | | 2,677 |

## Road furniture

| | Road Furniture Type | Total Length (km) | GHGe (t $CO_2$-e) |
|---|---|---|---|
| Road Safety Barriers | Wire rope barrier | 7.66 | 343 |
| | W-beam barrier | 9.00 | 475 |
| | F-type (New Jersey) barrier | - | - |
| Noise Walls | Reinforced concrete wall | 3.60 | 1,162 |
| | Hebel noise wall | - | - |
| | Timber wall | - | - |
| | Steel plate wall | - | - |
| | | | 1,979 |

## Vegetation Removal

| | | Selected Biomass Class |
|---|---|---|
| Biomass Class | Potential maximum biomass class | Class 3: 100 - 150 (t dry matter/ha) |

| | Vegetation Class | Area cleared (ha) | GHGe (t $CO_2$-e) |
|---|---|---|---|
| Vegetation Removed | Class A (Rainforest and vine thicket) | - | - |
| | Class B (Eucalypt tall open forest) | - | - |
| | Class C (Open forest) | - | - |
| | Class D (Open woodlands) | - | - |

| | | | |
|---|---|---|---|
| | Class E (Callitris forest & woodland) | - | - |
| | Class F (Mallee & Acacia woodland) | Rare Class | - |
| | Class G (Open shrubland) | Rare Class | - |
| | Class H (Heathlands) | Rare Class | - |
| | Class I (Grasslands) | 10 | 1,146 |
| | | | **1,146** |

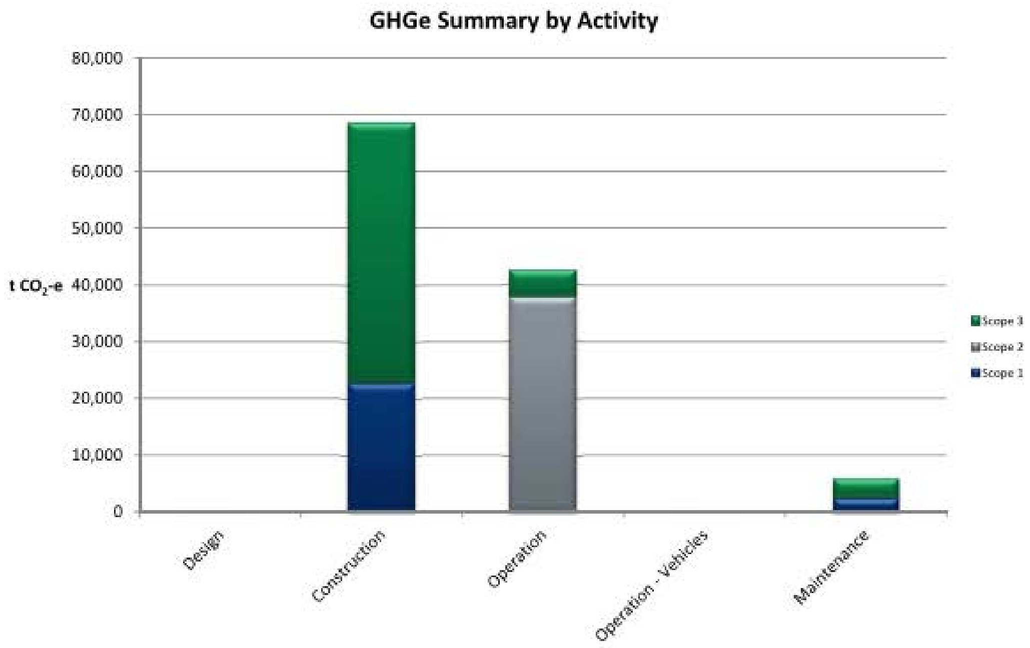
# APPENDIX B

## CARBON GAUGE OUTPUTS

*This data is over a 50 year operation life*

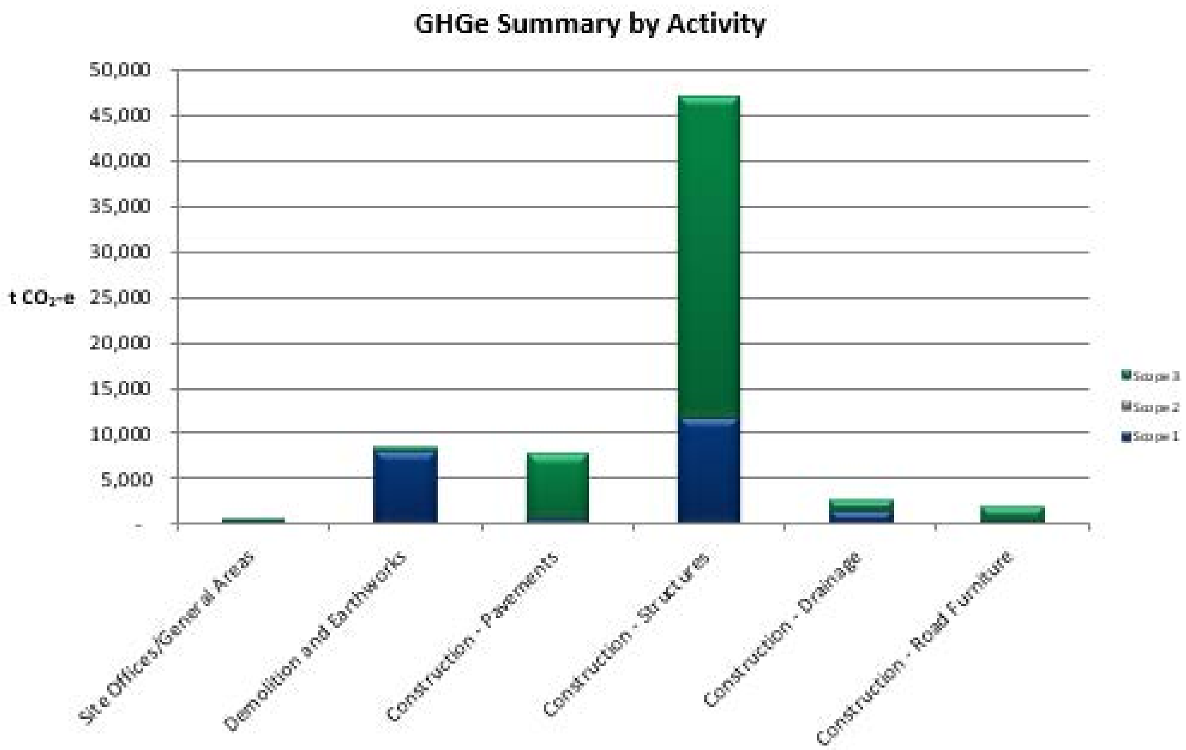
## Project Summary

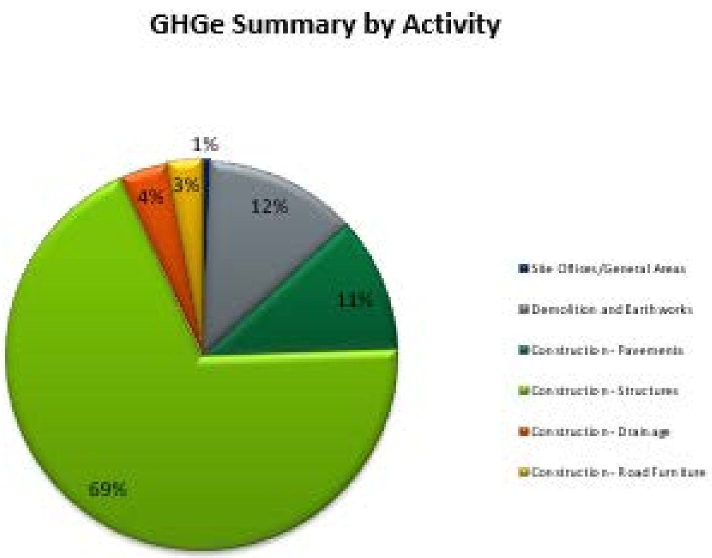
| Major Activity | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| Design | 0 | 0 | 0 | 0 |
| Construction | 22,814 | 0 | 45,704 | 68,518 |
| Operation | 0 | 37,805 | 4,765 | 42,571 |
| Operation - Vehicles | 0 | 0 | 0 | 0 |
| Maintenance | 2,556 | 0 | 3,281 | 5,837 |
| Total | 25,370 | 37,805 | 53,750 | 116,925 |




## Construction Summary

| GHGe Summary by activity | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| Site Offices/General Areas | 419 | 0 | 32 | 450 |
| Demolition and Earthworks | 8,098 | 0 | 534 | 8,632 |
| Construction - Pavements | 660 | 0 | 7,008 | 7,668 |
| Construction - Structures | 11,724 | 0 | 35,387 | 47,111 |
| Construction - Drainage | 1,501 | 0 | 1,176 | 2,677 |
| Construction - Road Furniture | 413 | 0 | 1,566 | 1,979 |
| Total | 22,814 | 0 | 45,704 | 68,518 |

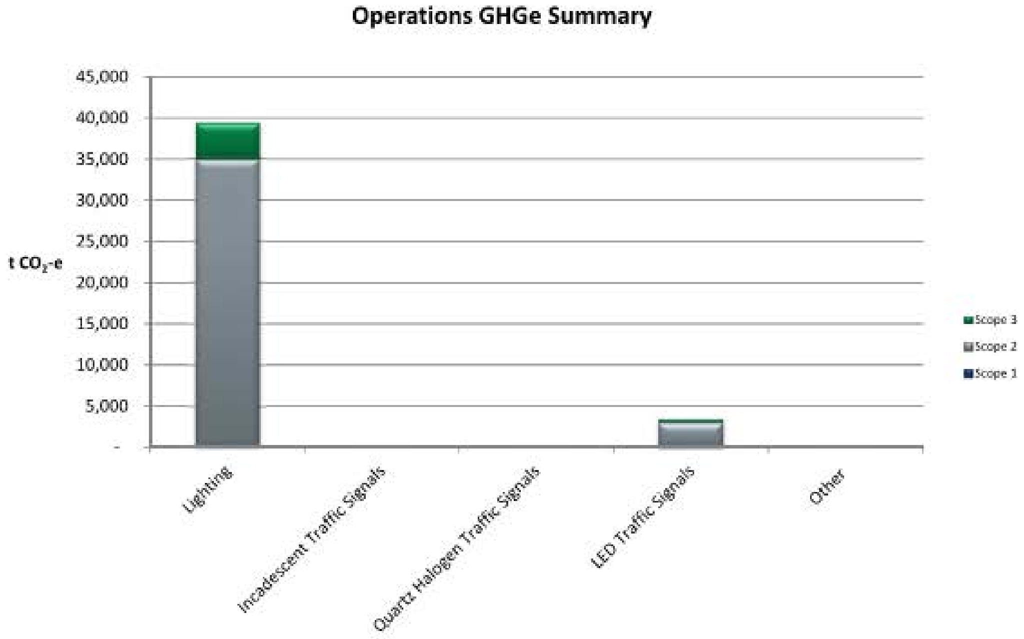

GHGe Summary by Activity
50,000
45,000
40,000
35,000
30,000
t CO2-e
25,000
20,000
15,000
10,000
5,000
-
Site Offices/General Areas
Demolition and Earthworks
Construction - Pavements
Construction - Structures
Construction - Drainage
Construction - Road Furniture
Scope 3
Scope 2
Scope 1


GHGe Summary by Activity
1%
12%
11%
69%
4%
3%
Site Offices/General Areas
Demolition and Earthworks
Construction - Pavements
Construction - Structures
Construction - Drainage
Construction - Road Furniture

## Operations Summary (Emissions are calculated for a 50 year period)

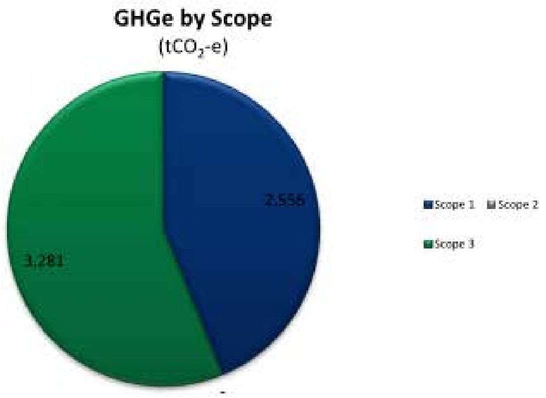
| Summary | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| Lighting | - | 34,918 | 4,401 | 39,319 |
| Incadescent Traffic Signals | - | - | - | - |
| Quartz Halogen Traffic Signals | - | - | - | - |
| LED Traffic Signals | - | 2,887 | 364 | 3,251 |
| *Other* | - | - | - | - |
| Total | - | 37,805 | 4,765 | 42,571 |

| Summary - Vehicles | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| Vehicle Use | - | - | - | - |
| Total | - | - | - | - |



## Maintenance Summary (Emissions are calculated for a 50 year period)

| Summary by Pavement | Scope 1 | Scope 2 | Scope 3 | Total |
|---|---|---|---|---|
| 01. Full Depth Asphalt | 2,555.80 | - | 3,280.92 | 5,837 |
| 02. Deep Strength Asphalt | - | - | - | 0 |
| 03. Granular with Spray Seal | - | - | - | 0 |
| 04. Stablised Pavement | - | - | - | 0 |
| 04. Plain Concrete (PC) | - | - | - | 0 |
| 05. Reinforced Concrete (RC) | - | - | - | 0 |
| *Other* | - | - | - | 0 |
| Total | 2,556 | 0 | 3,281 | 5,837 |



# APPENDIX C

OPERATIONAL PHASE ROAD USERS SCOPE 3 CALCULATIONS

# OPERATIONAL PHASE ROAD USERS SCOPE 3 CALCULATIONS

Calculations of the greenhouse gas emissions associated with the "without project" and "with project" road users scenarios have been completed by the following process:

1. Calculate the average speed on the road network (VITM) or major routes – this information was provided by the project Transport Engineer
2. Convert this average speed to fuel consumption/km travelled – utilising the *Austroad Guide to Project Evaluation, 2005*
3. Convert this to a total fuel consumed based on vehicle type (Heavy or Light) and fuel type – unleaded, diesel and LPG – utilising *ABS 9309.0 2017 Motor Vehicle Census data*
   a. The fuel consumption model coefficients have been incorporated into coefficients for light and heavy vehicles in order to match the VITM data. This has been completed using the census data to provide appropriate weightings for combining light and heavy vehicle types
4. Utilise the Australian National Greenhouse Accounts (Department of Environment, 2017) parameters for fuel type to convert this to greenhouse gas emissions.

The *Austroad Guide to Project Evaluation 2005* has been utilised to undertake this evaluation of fuel consumption on the basis of average speed. Section 6 of this guide describes an Urban Model for calculating the Vehicle Operating Cost (cent/km) determined by average speed and empirically derived model co-efficient – A, B, C and D. The model coefficients vary for vehicle type – Cars, Light Commercial Vehicles (LCV), Heavy Commercial Vehicles (HCV) and buses.

$$\text{Fuel consumption} = A + B/V + C \times V + D \times V^2$$

Where:

A, B, C, D = empirically derived model coefficients
V = average link speed in km/h.

Two models exist within this guide that consider traffic fuel consumption on freeway or non freeway road conditions. The non-freeway road condition has been applied for a more conservative view of fuel consumption and associated greenhouse gases. The structure of all the freeway v non-freeway models is the same as specified in the equation above, only the estimated coefficients change.

# MORDIALLOC BYPASS - ROAD USER MODELLING DATA

| Fuel consumption parameter values on freeways – litres/100 km | | | | |
|---|---|---|---|---|
| **Vehicle type** | **A** | **B** | **C** | **D** |
| **Cars** | -18.433 | 1306.02 | 0.15477 | 0.0003203 |
| **Light commercial vehicle (LCV)** | -27.456 | 2060.5 | 0.1911 | 0.000851 |
| **Rigid trucks** | -65.056 | 4156.75 | 0.49681 | 0.0006798 |
| **Articulated vehicles** | -80 | 6342.8 | 0.48496 | 0.0020895 |
| **Buses** | -80 | 5131.63 | 0.60539 | 0.0015775 |

| Fuel consumption parameter values on NON freeways – litres/100 km | | | | |
|---|---|---|---|---|
| **Vehicle type** | **A** | **B** | **C** | **D** |
| **Cars** | 0.361 | 528 | 0 | 0.000785 |
| **Light commercial vehicle (LCV)** | -3.129 | 1017 | 0 | 0.001481 |
| **Rigid trucks** | -10.495 | 2915.7 | 0 | 0.00315 |
| **Articulated vehicles** | -10.495 | 6342.8 | 0 | 0.00315 |
| **Buses** | -10.495 | 5131.63 | 0 | 0.00315 |

**SOURCE: (Austroads Guide to Project Evaluation Part 4: Project Evaluation Data Table 6.3)**

| Fuel type proportions for light and heavy vehicles | | |
|---|---|---|
| **Light Vehicles** | Petrol | 0.675 |
| | Diesel | 0.306 |
| | LPG (assumed | 0.019 |
| **Heavy Vehicles** | Petrol | 0.071 |
| | Diesel | 0.916 |
| | LPG (assumed | 0.013 |

**SOURCE: ABS Victoria Registration Vehicle Type Data (ABS 9309.0 Motor Vehicle Census Data - 31st January 2017)**

**Fuel consumption parameter values for Light and Heavy Vehicles**

| Category | 2017 VIC Registrations | Proportion of Total Vehicles | Heavy/Light Vehicle | Sub-class according to fuel consumption | Proportion Heavy/Light |
|---|---|---|---|---|---|
| Articulated Trucks | 27,472 | 0.57% | H | Articulated ve | 0.16 |
| Buses | 20,626 | 0.43% | H | Buses | 0.12 |
| Heavy Rigid Trucks | 81,460 | 1.70% | H | Rigid Trucks | 0.48 |
| Non-freight carrying trucks | 6,609 | 0.14% | H | Rigid Trucks | 0.04 |
| Light Rigid Trucks | 33,040 | 0.69% | H | Rigid Trucks | 0.20 |
| **TOTAL** | **169,207** | **3.53%** | - | - | **1.00** |
| Light commercial vehicles | 675,606 | 14.08% | L | LCV | 0.15 |
| Motor cycles | 189,217 | 3.94% | L | Cars | 0.04 |
| Passenger vehicles | 3,750,484 | 78.17% | L | Cars | 0.81 |
| Campervans | 13,583 | 0.28% | L | Cars | 0.00 |
| **TOTAL** | **4,628,890** | **96.47%** | - | - | **1.00** |

**SOURCE:ABS Victoria Registration Vehicle Type Data (ABS 9309.0 Motor Vehicle Census Data - 31st January 2017)**

**Estimated proportional makeup of light and heavy vehicles according to vehicle type**

| Category | Cars | LCV | Rigid Trucks | Articulated Ve | Buses |
|---|---|---|---|---|---|
| Light Vehicles | 0.85 | 0.15 | 0 | 0 | 0 |
| Heavy Vehicles | 0 | 0 | 0.72 | 0.16 | 0.12 |

**SOURCE: ABS Victoria Registration Vehicle Type Data (ABS 9309.0 Motor Vehicle Census Data - 31st January 2017)**

| Fuel consumption parameters for light and heavy vehicles on freeways – litres/100 km | | | | |
|---|---|---|---|---|
| **Vehicle type** | **A** | **B** | **C** | **D** |
| **Light** | -19.74994487 | 1416.139535 | 0.160072517 | 0.000397758 |
| **Heavy** | -69.30391239 | 4630.507235 | 0.508121754 | 0.001018103 |

| Fuel consumption parameters for light and heavy vehicles on NON freeways – litres/100 km | | | | |
|---|---|---|---|---|
| **Vehicle type** | **A** | **B** | **C** | **D** |
| **Light** | -0.14838021 | 599.3716105 | 0 | 0.000886584 |
| **Heavy** | -10.495 | 3742.232374 | 0 | 0.00315 |

**SOURCE: ABS Victoria Registration Vehicle Type Data (ABS 9309.0 Motor Vehicle Census Data - 31st January 2017)**

**Fuel type values for Vehicle Categories**

| Category | Percentage Vehicles Petrol | Percentage Vehicles Diesel | Percentage Vehicles Other | Heavy/Light Vehicle | Sub-class |
|---|---|---|---|---|---|
| Articulated Trucks | 0.01 | 0.99 | 0.00 | H | Articulated vehicles |
| Buses | 0.18 | 0.78 | 0.04 | H | Buses |
| Heavy Rigid Trucks | 0.04 | 0.96 | 0.00 | H | Rigid Trucks |
| Non-freight carrying trucks | 0.12 | 0.87 | 0.02 | H | Rigid Trucks |
| Light Rigid Trucks | 0.05 | 0.94 | 0.01 | H | Rigid Trucks |
| Light commercial vehicles | 0.37 | 0.60 | 0.03 | L | LCV |
| Motor cycles | 1.00 | 0.00 | 0.00 | L | Cars |
| Passenger vehicles | 0.87 | 0.11 | 0.02 | L | Cars |
| Campervans | 0.32 | 0.65 | 0.03 | L | Cars |

**SOURCE:ABS Victoria Registration Vehicle Type Data (ABS 9309.0 Motor Vehicle Census Data - 31st January 2017)**

**Fuel type values for Vehicle Sub-Classes**

| Category | Percentage Vehicles Petrol | Percentage Vehicles Diesel | Percentage Vehicles Other | Heavy/Light Vehicle |
|---|---|---|---|---|
| Articulated Trucks | 0.01 | 0.99 | 0.00 | H |
| Buses | 0.18 | 0.78 | 0.04 | H |
| Rigid Trucks | 0.07 | 0.92 | 0.01 | H |
| Light commercial vehicles | 0.37 | 0.60 | 0.03 | L |
| Cars | 0.73 | 0.26 | 0.02 | L |

**SOURCE: ABS Victoria Registration Vehicle Type Data (ABS 9309.0 Motor Vehicle Census Data - 31st January 2017)**

**DATA FROM TRANSPORT PLANNERS**

LV – light vehicles

HV – heavy vehicles

VHT – vehicle hours travelled

VKT – vehicle kilometres travelled

| 3. Overall Road Network VITM data | Daily | | | | | |
|---|---|---|---|---|---|---|
| OD Original Data | LV VHT | LV VKT | LV Speed | HV VHT | HV VKT | HV Speed |
| 2031 Base - Average Daily Use | 2,701,891 | 113,944,153 | 42.17 | 271,874 | 13,373,474 | 49.19 |
| 2031 Project- Average Daily Use | 2,700,941 | 114,174,657 | 42.27 | 271,212 | 13,379,207 | 49.33 |
| 2031 Base - AM Peak Use | 486,843 | 17,612,210 | 36.18 | 46,395 | 1,842,908 | 39.72 |
| 2031 Project - AM Peak Use | 486,726 | 17,650,898 | 36.26 | 46,262 | 1,842,687 | 39.83 |
| 2031 Base - PM Peak Use | 594,711 | 20,000,702 | 33.63 | 40,243 | 1,493,611 | 37.12 |
| 2031 Project - PM Peak Use | 593,994 | 20,039,367 | 33.74 | 40,086 | 1,493,778 | 37.26 |

| 2.a. Alternative Route 1 | Daily | | | | | |
|---|---|---|---|---|---|---|
| Thompson Rd - Boundary Rd - Dingley Bypa | LV VHT | LV VKT | LV Speed | HV VHT | HV VKT | HV Speed |
| 2031 Base - AM Use NB | 1,267 | 53,229 | 44 | 165 | 7,187 | 44 |
| 2031 Project - AM Use NB | 961 | 39,876 | 48 | 134 | 5,590 | 48 |
| 2031 Base - PM Use SB | 1,379 | 54,096 | 40 | 153 | 6,267 | 40 |
| 2031 Project - PM Use SB | 1,051 | 43,770 | 48 | 118 | 4,724 | 48 |

| 2. b. Alternative Route 2 | Daily | | | | | |
|---|---|---|---|---|---|---|
| Thompson Rd - Springvale Rd - Dingley Byp | LV VHT | LV VKT | LV Speed | HV VHT | HV VKT | HV Speed |
| 2031 Base - AM Use NB | 1,271 | 51,729 | 45 | 190 | 7,258 | 45 |
| 2031 Project - AM Use NB | 1,092 | 45,444 | 49 | 148 | 5,923 | 49 |
| 2031 Base - PM Use SB | 1,271 | 45,210 | 42 | 164 | 5,706 | 42 |
| 2031 Project - PM Use SB | 1,172 | 46,683 | 46 | 130 | 4,956 | 46 |

| 1. Direct Comparison | Daily | | | | | |
|---|---|---|---|---|---|---|
| Existing Routes (Yellow) vs Mordialloc (Gre | LV VHT | LV VKT | LV Speed | HV VHT | HV VKT | HV Speed |
| 2031 Base - AM Use NB | 1,001 | 37,658 | 42 | 132 | 5,218 | 42 |
| 2031 Project - AM Use NB | 831 | 51,059 | 73 | 126 | 7,724 | 73 |
| 2031 Base - PM Use NB | 516 | 26,236 | 50 | 70 | 3,474 | 50 |
| 2031 Project - PM Use NB | 409 | 34,819 | 87 | 65 | 5,480 | 87 |
| 2031 Base - AM Use SB | 403 | 19,123 | 49 | 73 | 3,759 | 49 |
| 2031 Project - AM Use SB | 267 | 23,847 | 91 | 66 | 5,932 | 91 |
| 2031 Base - PM Use SB | 1,075 | 40,187 | 37 | 120 | 4,595 | 37 |
| 2031 Project - PM Use SB | 675 | 44,133 | 72 | 96 | 6,372 | 72 |

## GHG EMISSION FACTORS

| Fuel | Energy Content Factor (GJ | | Scope 1 emission factor (kg | | Scope 3 emission factor (kg CO2-e/GJ) | | Emissions per unit quantity (t | | Full Fuel Cycle (t CO2-e per kL) |
|---|---|---|---|---|---|---|---|---|---|
| | | CO2 | CH4 | N20 | | Scope 1 | Scope 2 | Scope 3 | |
| Petrol (gasoline) | 34.2 | 67.4 | 0.5 | 1.8 | 3.6 | 2.38374 | N/A | 0.12312 | 2.50686 |
| Diesel oil | 38.6 | 69.9 | 0.1 | 0.5 | 3.6 | 2.7213 | N/A | 0.13896 | 2.86026 |
| Liquid petroleum gas (LPG) | 26.2 | 60.2 | 0.6 | 0.7 | 3.6 | 1.6113 | N/A | 0.09432 | 1.70562 |

**Source: NGA Factors 2017 Tables 4 and 40**

Source: NGA Factors 2017 Tables 4 and 40

## Alternative Route 1: Thompson Rd - Boundary Rd - Dingley Bypass (Non-Freeway Consumption)

| Without Project 2031 AM NB | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | Units |
| Average Speed | 44 | 44 | kmph |
| Rate of Fuel Consumption | 15.30 | 81.46 | L/100km |

| Without Project 2031 PM SB | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | Units |
| Average Speed | 40 | 40 | kmph |
| Rate of Fuel Consumption | 16.28 | 88.28 | L/100km |

| With Project 2031 AM | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | |
| Average Speed | 48 | 48 | kmph |
| Rate of Fuel Consumption | 14.40 | 74.89 | L/100km |

| With Project 2031 PM | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | |
| Average Speed | 48 | 48 | kmph |
| Rate of Fuel Consumption | 14.32 | 74.26 | L/100km |

## Alternative Route 2: Thompson Rd - Springvale Rd - Dingley Bypass (Non-Freeway Consumption)

| Without Project 2031 AM NB | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | Units |
| Average Speed | 45 | 45 | kmph |
| Rate of Fuel Consumption | 14.95 | 78.96 | L/100km |

| Without Project 2031 PM SB | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | Units |
| Average Speed | 42 | 42 | kmph |
| Rate of Fuel Consumption | 15.67 | 84.06 | L/100km |

| With Project 2031 AM NB | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | |
| Average Speed | 49 | 49 | kmph |
| Rate of Fuel Consumption | 14.25 | 73.75 | L/100km |

| With Project 2031 PM SB | | | |
|---|---|---|---|
| Non-Freeway Consumption | Light Vehicles | Heavy Vehicles | |
| Average Speed | 46 | 46 | kmph |
| Rate of Fuel Consumption | 14.68 | 76.98 | L/100km |

## Overall Road Network - Non-Freeway Consumption - VITM

| Without Project 2031<br>(Non-Freeway Consumption) | Light Vehicles | Heavy Vehicles | Units |
|---|---|---|---|
| Average Speed | 42.17 | 49.19 | kmph |
| Vehicle Kilometers Travelled | 113,944,153 | 13,373,474 | km |
| Rate of Fuel Consumption | 15.64 | 73.20 | L/100km |
| Daily Fuel Quantity Combusted | 17,822,532.72 | 9,789,919.67 | L/day |
| Annual Fuel Quantity Combusted | 6,505,224.44 | 3,573,320.68 | kL/year |
| Petrol Consumed | 4,394,222.18 | 254,702.70 | |
| Diesel Consumed | 1,987,356.78 | 3,272,611.79 | |
| LPG Consumed | 123,645.48 | 46,006.19 | |
| Calculation of GHG Emissions | 16,910,949 | 10,077,494 | t CO2-e |
| **TOTAL EMISSIONS** | 26,988,443 | | |

| With Project 2031<br>(Non-Freeway Consumption) | Light Vehicles | Heavy Vehicles | |
|---|---|---|---|
| Average Speed | 42.27 | 49.33 | kmph |
| Vehicle Kilometers Travelled | 114,174,657 | 13,379,207 | km |
| Rate of Fuel Consumption | 15.62 | 73.03 | L/100km |
| Daily Fuel Quantity Combusted | 17,828,743.34 | 9,771,042.44 | L/day |
| Annual Fuel Quantity Combusted | 6,507,491.32 | 3,566,430.49 | kL/year |
| Petrol Consumed | 4,395,753.44 | 254,211.57 | kL/year |
| Diesel Consumed | 1,988,049.32 | 3,266,301.44 | kL/year |
| LPG Consumed | 123,688.57 | 45,917.48 | kL/year |
| Calculation of GHG Emissions | 16,916,842 | 10,058,062 | t CO2-e |
| **TOTAL EMISSIONS** | 26,974,904 | | |

| | Light Vehicles | Heavy Vehicles | Total |
|---|---|---|---|
| **NET CHANGE** | - 5,893 | 19,432 | 13,539 t CO2-e per year |

## ABOUT US

WSP is one of the world's leading engineering professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors, environmental specialists, as well as other design, program and construction management professionals. We design lasting Property & Buildings, Transportation & Infrastructure, Resources (including Mining and Industry), Water, Power and Environmental solutions, as well as provide project delivery and strategic consulting services. With 36,000 talented people in more than 500 offices across 40 countries, we engineer projects that will help societies grow for lifetimes to come.