Burbury Consulting

New Bridgewater Bridge Project air emissions assessment

Report No. 5420_AQ_R_R1

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November 2021

Tarkarri Engineering

Air Quality • Acoustics • Environment • Vibration

DOCUMENT CONTROL

NEW BRIDGEWATER BRIDGE PROJECT
AIR EMISSIONS ASSESSMENT

Report No. 5420_AQ_R1	Library Code ACAQ
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Revision History		
Revision No.	**Date Issued**	**Reason/Comments**
1	12/11/2021	DAP comments
Distribution		
Copy No.______	**Revision No.**	**Location**
1	1	Project/Client File
2	1	Client
3	1	Tarkarri Engineering Library
Keywords	Dispersion, 99.9 percentile, 1 hr, 8 hr and 24 hour average, annual average, background, glc	

Table of Contents

List of figures

List of tables

References

[1] Department of Primary Industries, Water and Environment (2005) *ENVIRONMENT PROTECTION POLICY (AIR QUALITY) 2004.*

[2] NSW Environment Protection Authority (2016) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

[3] Transport Energy/Emission Research (2021) *Simulation of the Tasmanian on-road fleet mix with the Australian Fleet Model (AFM)*.

[4] Austroads (2019) Guide to Pavement Technology Part 4K: Selection and Design of Sprayed Seals. Publication No. AGPT04K-18.

[5] Australian Government, Dept of Sustainability, Environment, Water, Population and Communities (January 2012) *National Pollutant Inventory Emission Estimation Technique Manual for Mining Version 3.1*.

[6] United States Environmental Protection Agency AP-42 *Compilation of Air Emissions Factors, Fifth Edition, Volume I, Chapter 13: Miscellaneous Sources,* (2006) *13.2.2 Unpaved Roads*.

Executive summary

Tarkarri Engineering was commissioned by Burbury Consulting on behalf of the Department of State Growth to conduct an air emission assessment for the New Bridgewater Bridge Project. The assessment is a requirement of the Assessment Criteria for the project developed by Development Assessment Panel for the Tasmanian Planning Commission.

Air emissions modelling of the operational phase of the project from both the existing and new crossing are well below criterion levels by an order of magnitude or more. The new crossing options provide traffic flows at higher speeds resulting in typically a significant decrease in predicted ground level concentrations for the air constituents of concern. Modelling of future traffic shows a further reduction in predicted levels despite increased traffic flows due to improvement in the Tasmanian road fleet. The modelling results suggests that the New Bridgewater Bridge Project when completed and operational should result in improved outcomes with regard to air emissions from vehicle traffic within the Project Land.

Modelling of the construction phase of the project indicates areas of concern, particularly, on the southern side of the Derwent River. Additional controls (over and above watering of exposed surfaces at 2 litres/m^2/h) are likely to be require. These include:

- Minimising exposed surfaces through construction planning and progressive rehabilitation.
- Higher watering rate for exposed surfaces on the southern side of the Derwent River, nominally >2 litres/m^2/h.
- Provision of adequate water supply to maintain watering rates (except during rain events) and provide water for spray systems.
- Locating stockpiles in wind protected areas and either covering or using water sprays to control dust generation.
- Covering of all haul loads.

A dust management plan should be prepared prior to the commencement of construction and would include a program of monitoring to allow for management to be adjusted.

1 Introduction

Tarkarri Engineering was commissioned by Burbury Consulting on behalf of the Department of State Growth (DSG) to conduct an air emission assessment for the New Bridgewater Bridge Project. Assessment Criteria for the project developed by Development Assessment Panel for the Tasmanian Planning Commission are applicable under section 5.1.1 of the criteria document and detailed in Schedule 2. The detailed section relevant to air emissions is provided below.

S2.2.1 Air emissions

The following information requirements and matters must be addressed for clause 5.1.1 Air emissions:

(a) identification of air emission constituents of concern and sensitive receptors during construction and operational phases, include the following details:
   (i) location of sensitive receptors;
   (ii) sources of air emissions and their locations; and
   (iii) constituents of emissions for each source, their quantities, and rates of emission to the atmosphere.

(b) assessment of construction and operational phase emissions with respect to the likelihood of causing environmental nuisance or environmental harm, including:
   (i) establishing a baseline for air quality in the vicinity of sensitive receptors prior to the commencement of construction by implementing an air monitoring program to determine ambient concentrations of pollutants associated with construction emissions and with vehicle emissions;
   (ii) continued operation of the air monitoring program to monitor air quality in the vicinity of sensitive receptors during construction and operational phases of the project;
   (iii) air dispersion modelling of the potential impact of emissions from the construction and operational phases of the project using a conservative approach and appropriate input data; and
   (iv) assessment of the potential of emissions from the construction and operational phases of the project to cause environmental nuisance or environmental harm; and

(c) development of construction and operational phase design, management and mitigation strategies, if required.

2 Site description

The Project objective is to provide a new river crossing for motor vehicles between Granton and Bridgwater, with connections to the Lyell Highway and other surrounding roads.

The existing causeway and bridge currently provide single lane traffic flow in either direction and no grade separation of road junctions at either end. The Project when complete would provide dual carriageway in both directions and grade separation at both the southern and northern interchanges.

Two options for the new crossing are assessed here with Option 1 incorporating the existing causeway into the north bound traffic lanes and a new bridge for south bound lanes (also called the Reference Design) while Option 2 is a separate bridge for both directions of traffic. Tenderers will develop their own designs and as such the options assessed here are example designs only for assessment purposes.

Figure 2-1 provides an aerial view with the extent of The Project Land shown.

Figure 2-1: Aerial view with The Project Land extent marked.

2.1 Terrain

Figure 2-2 below provides an aerial view of the terrain surrounding the Bridgewater Bridge site (3D view with X2 exaggeration). The terrain overlay is from the CALMET model (see Section 4.2 of this report for details) and was processed from the SRTM-1 digital elevation model (30 m resolution) data produced by NASA.

The Bridgewater Bridge is located at a major bend in the Derwent River Valley where the river transitions from a west to east flow direction to a north-west to south-east direction. Platform Peak and Mt Faulkner are significant topographic features locally and minor tributary valleys system are present to the north.

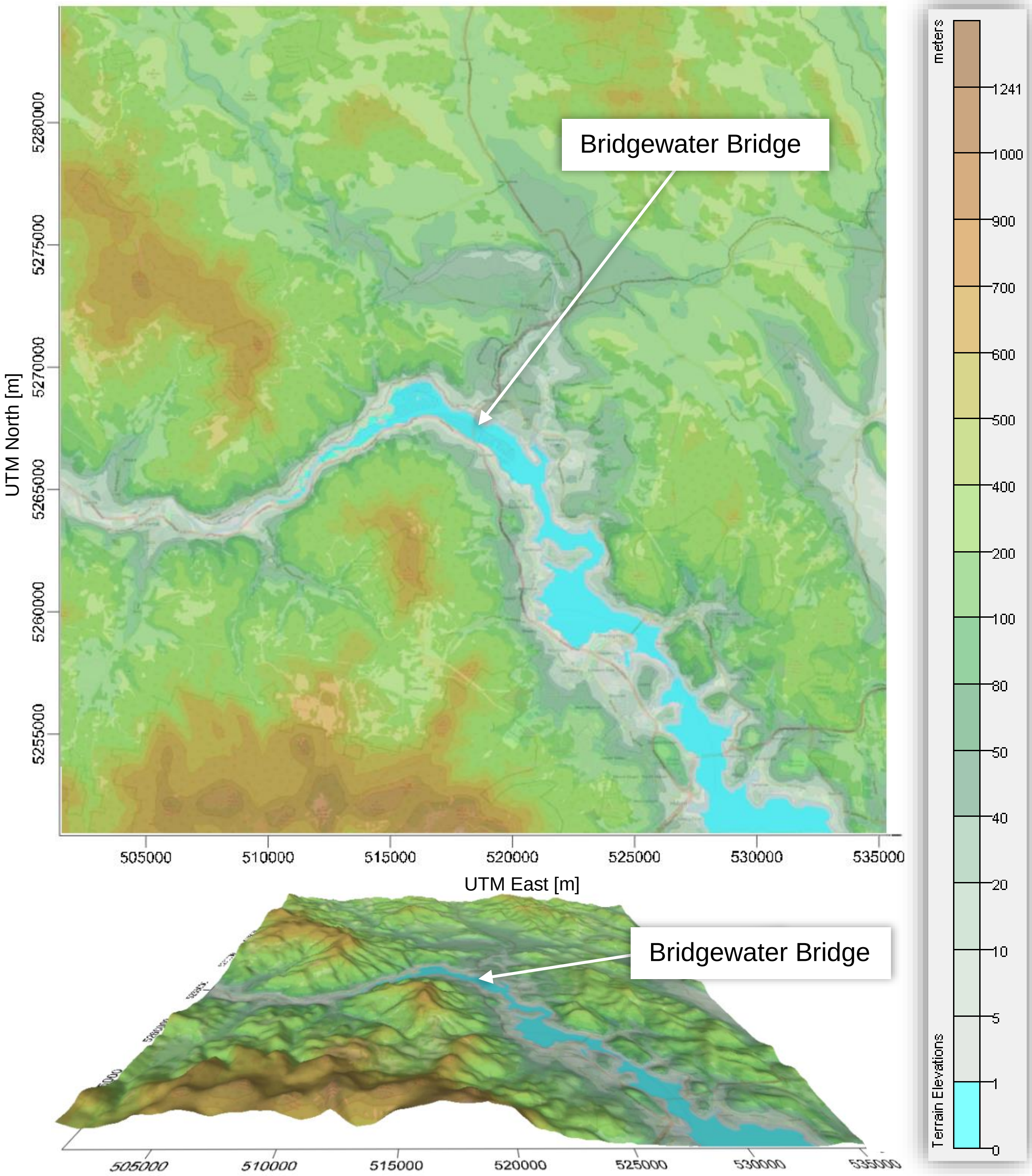


Figure 2-2: Aerial view of the Bridgewater Bridge site and surrounds with terrain overlay.

3 Criterion

Under the *Environment Protection Policy (Air Quality) 2004*[1] the following is stated with regard to the management of diffuse air emission sources (road emission sources are considered diffuse in nature)

Part 5 - MANAGING DIFFUSE SOURCES OF AIR CONTAMINANTS

Management of diffuse sources of air pollution

16. **(1)** Regulatory authorities should manage and regulate diffuse sources of air pollution that have the potential to cause material or serious environmental harm or an environmental nuisance in such a manner as will protect the environmental values identified in this Policy.

(2) Diffuse sources of air pollution should be managed using best practice environmental management so as to:

(a) minimise emissions; and

(b) manage those emissions that are unavoidable in a manner that minimises impacts on health, safety or amenity.

(3) Diffuse sources of air pollution should be managed in accordance with any relevant guidelines published, adopted or endorsed by the Board for the purposes of this clause.

(4) Diffuse sources of air pollution must be managed in accordance with any regulations made under the Act.

For the purposes of this assessment the modelling of fugitive road emissions will be modelled in accordance with the Schedule 2 – Design Criteria with the '...99.9 percentile peak concentration for averaging periods of one hour or less and the 100 percentile peak concentrations otherwise' considered.

Criteria for air constituent for the assessment of potential environmental harm / nuisance are taken from the National Environment Protection (Ambient Air Quality) Measure (Air NEPM), and NSW Environment Protection Authority (EPA). Concentrations are reported for gas volumes at 0°C and 1 atmosphere.

3.1 Operational phase

The constituents of concern for the operational phase are those identified in Air NEPM as providing a measure that allows for the adequate protection of human health and well-being along with the addition of volatile organic compounds (VOCs).

3.1.1 CO

Carbon monoxide is produced through the incomplete combustion of fossil fuels. CO combines with haemoglobin in the body to form carboxyhaemoglobin that can deprive the body of oxygen. Short-term effects of CO can also include headaches and nausea.

Air NEPM standard.

Averaging period	Maximum concentration
8 hour	11,254 µg/m^3

3.1.2 NO_2

Oxides of nitrogen are emitted by motor vehicles and are comprised mainly of nitrogen oxide (NO) and nitrogen dioxide (NO_2). Nitrogen oxide is produced by the high temperature combustion in the presence of nitrogen and oxygen. NO is converted to NO_2 in the atmosphere. Exposure to high concentrations of NO_2 can result in decreased lung function.

Air NEPM standard.

Averaging period	Maximum concentration
1 hour	164.3 µg/m^3
1 year	30.8 µg/m^3

3.1.3 SO_2

Sulphur dioxide is released during the combustion process of fuels. With modern fuel standards the release is relatively small from vehicles when compared to other gases. Sulphur dioxide can affect lung function and cause eye irritation.

Air NEPM standard.

Averaging period	Maximum concentration
1 hour	286 µg/m^3
1 day	57.2 µg/m^3

3.1.4 Particulate matter

In the atmosphere, particles range in size from 0.1 to 50 µm. Health impacts relate to the extent to which they can penetrate the respiratory tract. Particles with an aerodynamic diameter greater than 10 µm, are generally screened out in the upper respiratory tract by adhering to mucus in the nose, mouth, pharynx and larger bronchi and are removed by either swallowing or expectorating. Very fine particles, in particular those less than 2.5 µm, can be deposited in the pulmonary region. It is these particles that are of greatest concern to health.

3.1.4.1 PM_{10}

Air NEPM standard.

Averaging period	Maximum concentration
1 day	50 µg/m^3
1 year	25 µg/m^3

3.1.4.2 $PM_{2.5}$

Air NEPM standard.

Averaging period	Maximum concentration
1 day	25 µg/m^3
	20 µg/m^3 *
1 year	8 µg/m^3
	7 µg/m^3 *

* 2025 goal.

3.1.5 VOCs

VOCs, and specifically here non-methene VOCs, encompass a wide range of chemical compounds that behave in a similar fashion in the atmosphere. They are emitted during combustion activities, solvent use and production processes. Some species or species groups including benzene and 1,3 butadiene are considered potentially toxic to human health.

NB: Non-methane VOCs concentrations will be predicted here with specification of the predicted levels provided in the Appendix to allow comparison with impact assessment criteria provided in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*[2], this document should be referenced for these criteria.

3.2 Construction phase

For the construction phase constituents of concern relate to the fugitive emission of particulates during construction activities with the criteria for the project from the Air NEPM and the NSW EPA criterion for nuisance deposition.

3.2.1 PM_{10}

Air NEPM standard.

Averaging period	Maximum concentration
1 day	50 µg/m^3
1 year	25 µg/m^3

3.2.2 TSP

Total Suspended Particulate Matter (TSP), NSW EPA criteria in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*[2].

Averaging period	Maximum concentration
1 year	90 µg/m^3

3.2.3 Deposition

Deposition of insoluble solids, NSW EPA criteria in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*[2].

Maximum rate
4 g/m^2/month

4 Modelling methodology

CALPUFF was utlised here for the modelling of air emissions from the New Bridgewater Bridge Project. This is a non-steady-state Lagrangian Gaussian puff model. CALPUFF employs the three-dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of the three within the modelling domain.

4.1 TAPM

To generate the broad scale meteorological inputs to run CALPUFF, this study has used The Air Pollution Model (TAPM), a 3-dimensional prognostic model developed by CSIRO. The output from TAPM is used to generate the appropriate meteorological data for the CALPUFF modelling system. TAPM (v 4.0.4) was configured as follows:-

- Centre coordinates – 42˚ 44.500 S, 147˚ 13.500 E (UTM coordinates 518416, 5267847)
- Dates modelled – 1st January 2015 to 31st December 2015.
- Four nested grid domains of 30 km, 10 km, 3 km and 1 km.
- 41 x 41 grid points for all modelling domains.
- 30 vertical levels from 10 m to an altitude of 8000 m above sea level.
- The default TAPM databases for terrain, land use and meteorology were used in the model, including the *TasVeg250m* land use file.

4.2 CALMET

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micrometeorological modules for overwater and overland boundary layers. The model is the meteorological preprocessor for the CALPUFF modelling system.

Version 6.5.0 of CALMET was used with the following key settings utlised:-

- Domain area of 170 by 170 grid cells at 200 m spacing, SW corner coordinates 501416, 5250847.
- Ten vertical levels: 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1,200 m, 2,000 m, 3,000 m and 4,000 m.
- Dates modelled – 1st January 2015 to 31st December 2015.
- No observations mode, full prognostic wind fields from TAPM (1 km domain) input as MM5/3D.dat at surface and upper air for "initial guess" field.
- No extrapolation of surface winds observations.
- All other wind field options default.
- Mixing height parameters default.
- Terrain radius of influence 7.0 km.
- 3D Relative humidity and temperature from prognostic data.
- Gridded cloud cover from prognostic RH at all levels.
- Land use data was created using generic land use codes, with editing based on comparison with aerial photographic imagery.

- Terrain data from SRTM-1 digital elevation model (30 m resolution) data produced by NASA (see figure 2-2 for details).
- No data assimilation.
- All other options default.

Figure 4-1 provides an aerial view of the study area with an overlay of generic land use categories as assigned in CALMET.

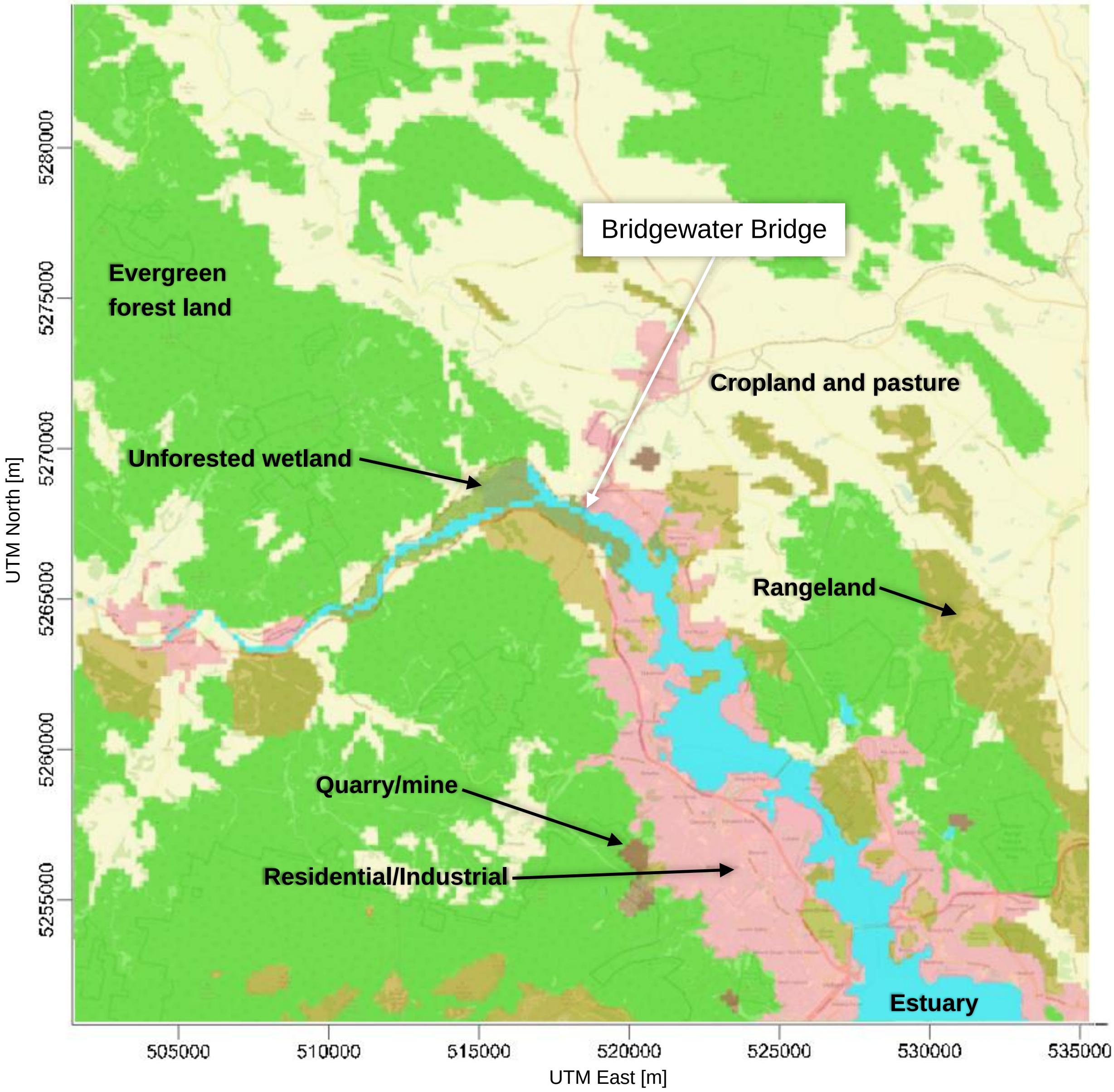


Figure 4-1: Aerial view of study area with land use overlay.

4.3 CALPUFF

Version 7.2.1 of CALPUFF was used with the following key settings utlised:

- Domain as for CALMET model
- Dates modelled – 1st January 2015 to 31st December 2015.
- Modelled species: CO, NOx, SO2, VOCs type: gas, concentration modelled.
  PM10, PM2.5, type: particle, concentration modelled (no deposition).
  TSP, type: particle, concentration and deposition modelled.
- Gridded 3D hourly-varying meteorological conditions generated by CALMET
- No chemical transformation modelled.
- Dispersion coefficients calculated using turbulence computed from micrometeorology with the PDF method used for sigma-z in the convective boundary layer.
- All other options default.

5 Meteorology

NB: Please note the use of letter designations for wind directions in the following subsections.

The nearest representative Bureau of Meteorology (BoM) weather station is located at Hobart (Ellerslie Road) (Station number 094029), approx. 18 km SSW of the bridge.

Figure 5-1 provides an aerial view showing the location of the Hobart (Ellerslie Road) BoM station and the Bridgewater Bridge.

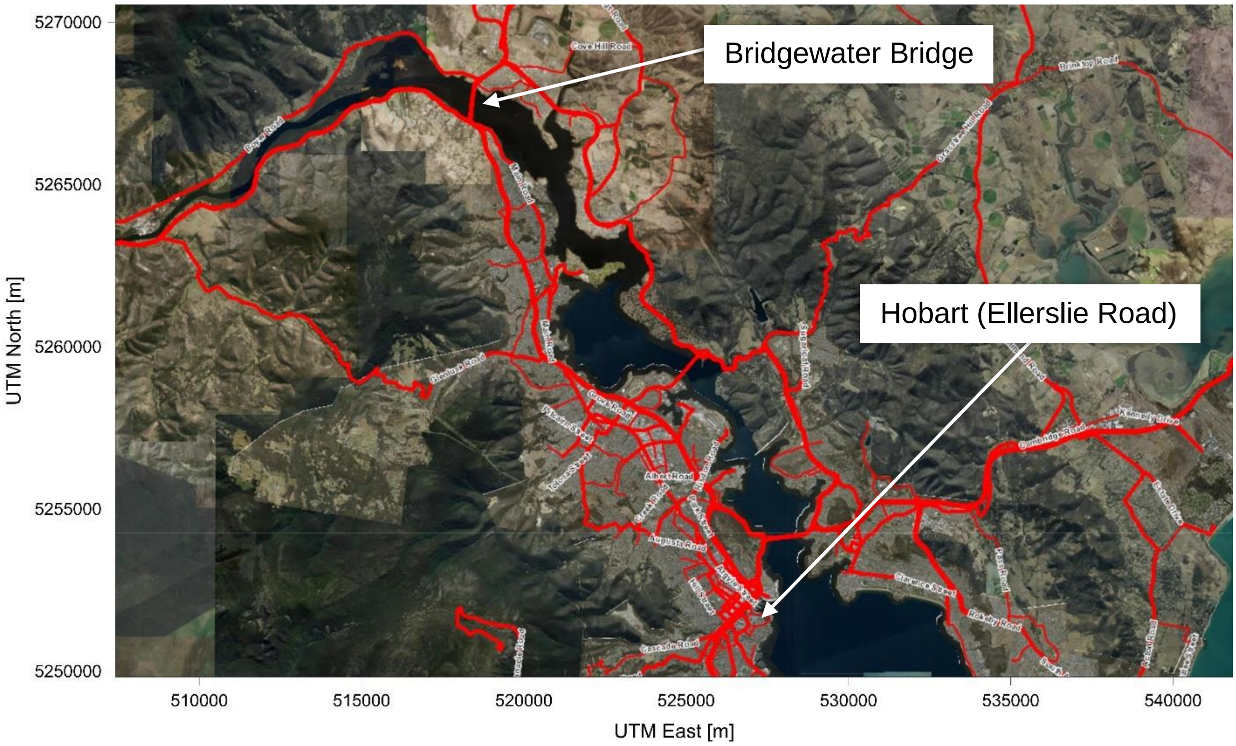


Figure 5-1: Aerial view showing the location of Hobart (Ellerslie Road) and the Bridgewater Bridge.

Long term weather data was obtained from the BoM weather station at Hobart (1882 – present) and presented in Table 5-1. The mean temperature range is between 5 and 22 °C with the coldest month being July and the hottest months being January and February. The rainfall in the region is relatively evenly distributed through the year. The mean annual rainfall is approx. 612 mm.

Climate stats - HOBART (ELLERSLIE ROAD)									
Month	Mean temp (°C)		Rainfall (mm)	9 a.m. conditions			3 p.m. conditions		
	Max.	Min.		Temp (°C)	RH (%)	Wind speed (km/h)	Temp (°C)	RH (%)	Wind speed (km/h)
Jan	21.8	12.0	46.9	16.6	60	13.5	19.5	54	19.0
Feb	21.7	12.1	39.4	16.4	64	12.0	19.7	55	17.7
Mar	20.2	11.0	44.7	14.7	67	12.3	18.3	56	16.2
Apr	17.4	9.0	50.0	12.4	71	12.7	15.8	59	14.5
May	14.5	7.0	47.0	9.7	76	11.8	13.2	63	12.6
Jun	12.0	5.2	53.8	7.4	79	11.4	10.8	67	12.2
Jul	11.8	4.6	52.0	6.9	78	12.1	10.6	65	13.2
Aug	13.1	5.2	54.2	8.1	73	12.6	11.9	60	14.5
Sep	15.2	6.5	52.7	10.5	66	14.8	13.5	56	17.0
Oct	17.0	7.8	61.2	12.5	63	15.0	15.1	56	18.0
Nov	18.8	9.4	53.8	14.2	60	14.2	16.5	56	18.9
Dec	20.4	10.9	56.4	15.8	60	13.8	18.1	56	19.1
Annual	17.0	8.4	612.2	12.1	68	13.0	15.2	58	16.1

Table 5-1: Long term climate statistics, BoM weather station HOBART (ELLERSLIE ROAD): 094029.

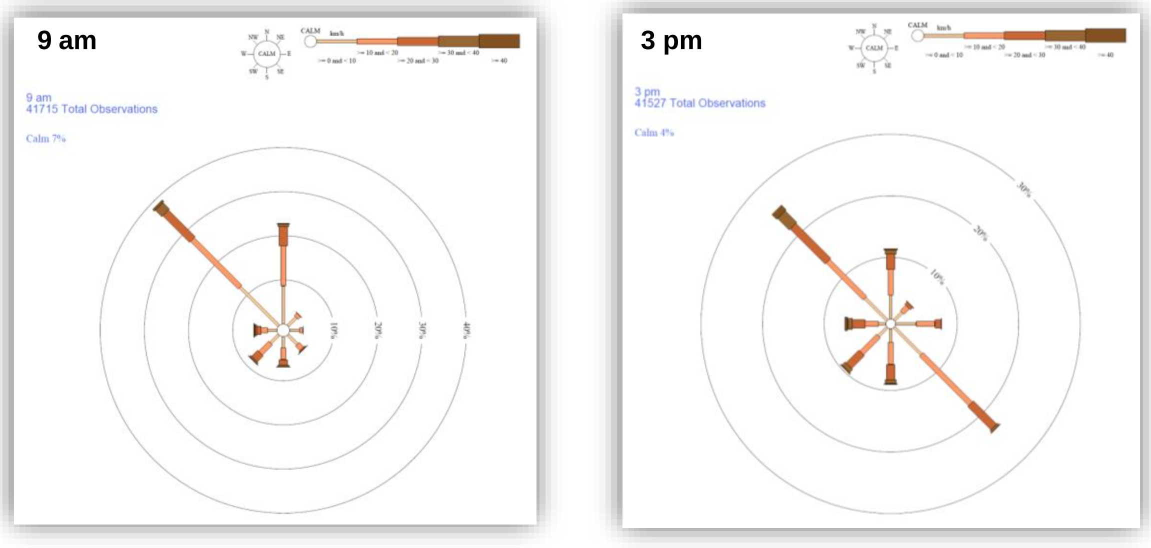
5.1.1 Wind rose comparison

Figure 5-2 presents average 9 am and 3 pm wind roses for the Hobart location from both the BoM weather station and CALMET model.

The 9 am BoM wind rose at Hobart shows strong NW and N wind signals with lower wind speed components from the W, SW and S. The 9 am CALMET wind rose shows a similar NW component with the N component lesser and the W, SW and S slightly more prominent.

The 3 pm BoM wind rose from Hobart shows strong NW and SE wind sector components and lesser N, W, SW and S components. A similar pattern is seen in the 3 pm CALMET wind rose with the N component lesser and the W, SW and S slightly stronger.

BoM



CALMET

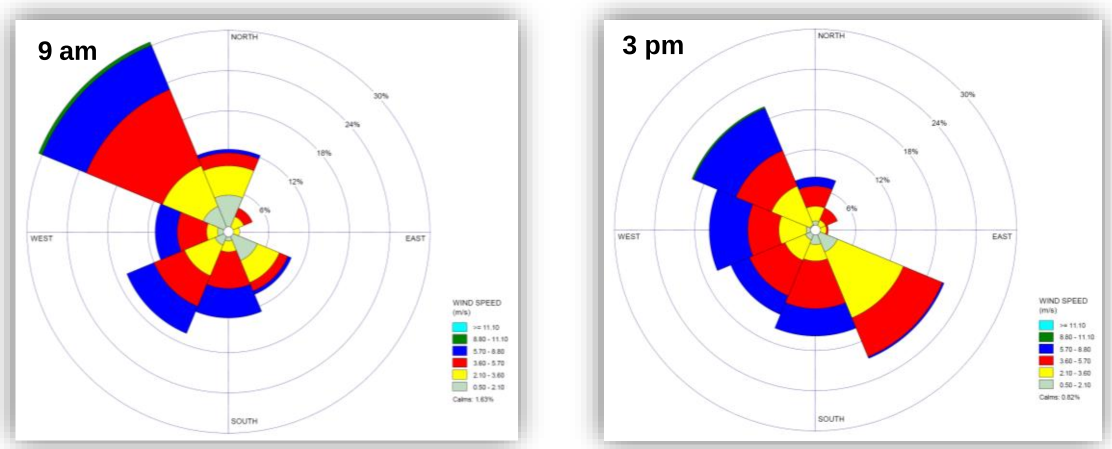


Figure 5-2: 9 am and 3 pm wind roses for Hobart.

5.1.2 CALMET meteorological outputs

5.1.2.1 Wind fields

Figure 5-3 presents an annual and seasonal CALMET wind roses from the Bridgewater Bridge site. Winds from the NW are dominant with the significant SE component present. This suggests a strong valley influence on directing winds. This is most pronounced in Autumn and Winter, westerly winds more prominent in spring and summer. High wind speeds are most frequent from the W while low wind speeds and most common from the N and NW.

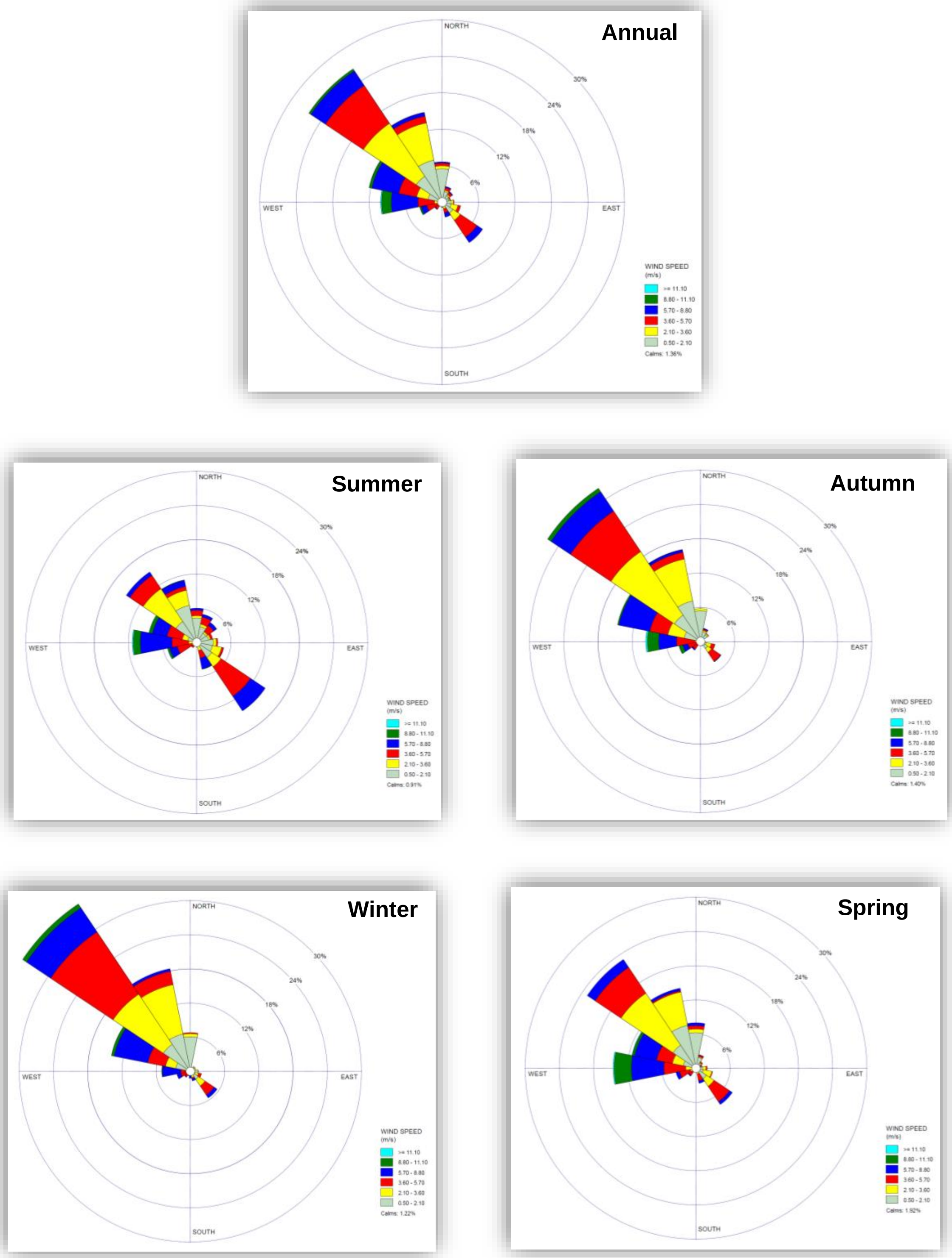


Figure 5-3: Annual and seasonal CALMET wind roses for the Bridgewater Bridge site.

Figures 5-4 and 5-5 present CALMET diurnal variation in wind speed and direction respectively at the Bridgewater Bridge site. Wind speeds are stronger and more variable during the day while the wind direction data shows winds are absent from the S and SW during the night.

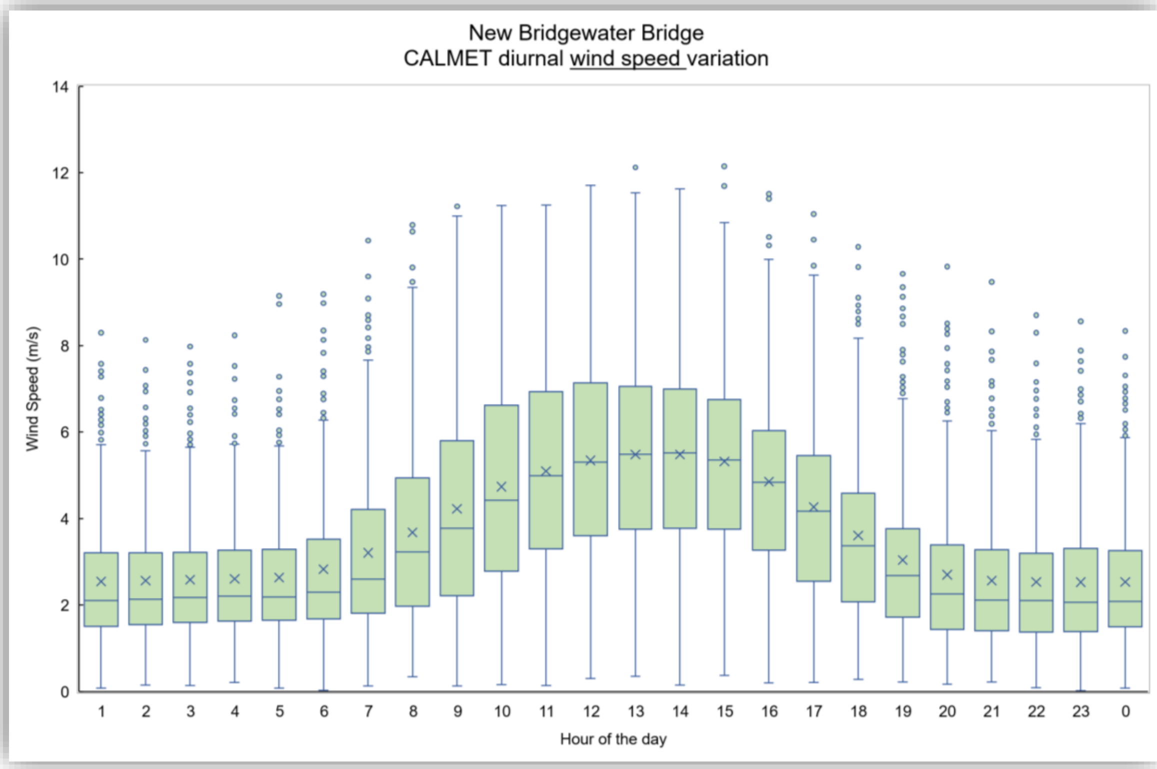


Figure 5-4: CALMET diurnal <u>wind speed</u> variation at the Bridgewater Bridge site.

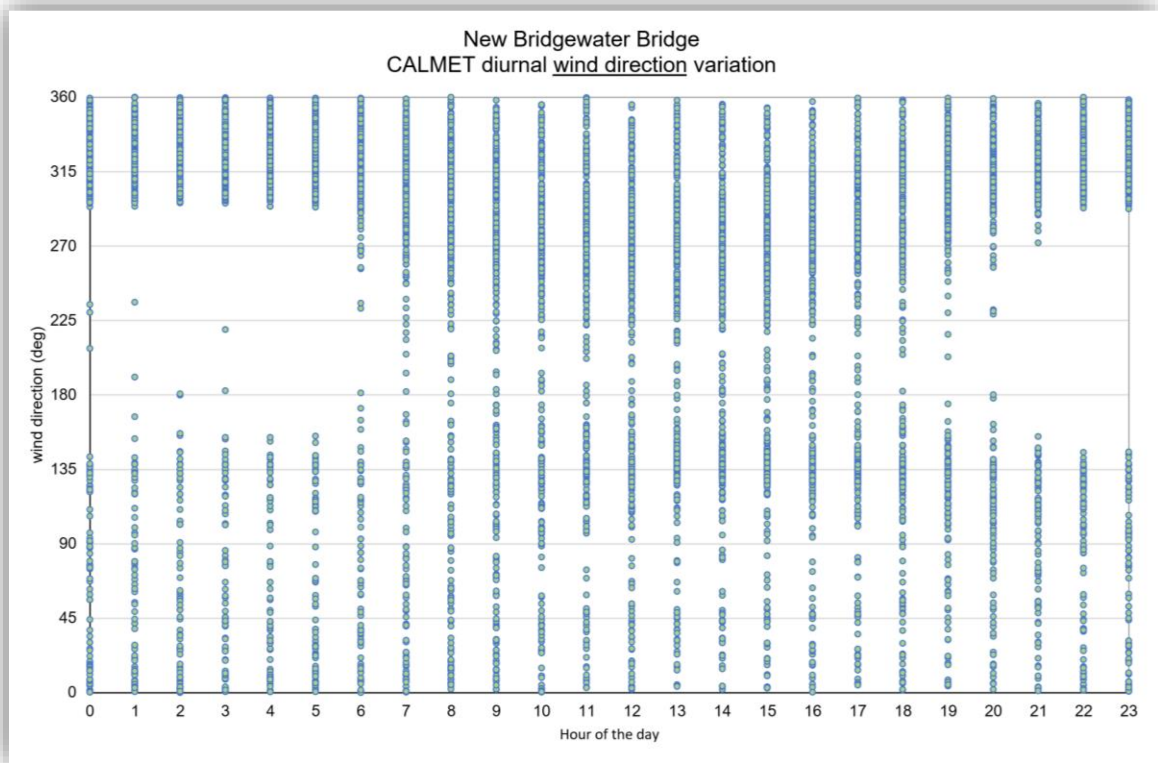


Figure 5-5: CALMET diurnal <u>wind direction</u> variation at the Bridgewater Bridge site.

5.1.2.2 Mixing height

The mixing height determines the height above ground that a pollutant emitted will be mixed by turbulent air flow, i.e. lower mixing height, less potential dispersion. CALMET diurnal variation in mixing height at the Bridgewater Bridge site is shown in Figure 5-6.

An increase in the mixing height is observed during the morning due to the increase in solar radiation following sunrise. Typically, maximum mixing heights occur in the mid to late afternoon and descend in the early evening. The mixing height is low during the night and higher and slightly more variable during the day under the influence of incoming solar radiation. Under these conditions dispersion is likely to generally be poor at night.

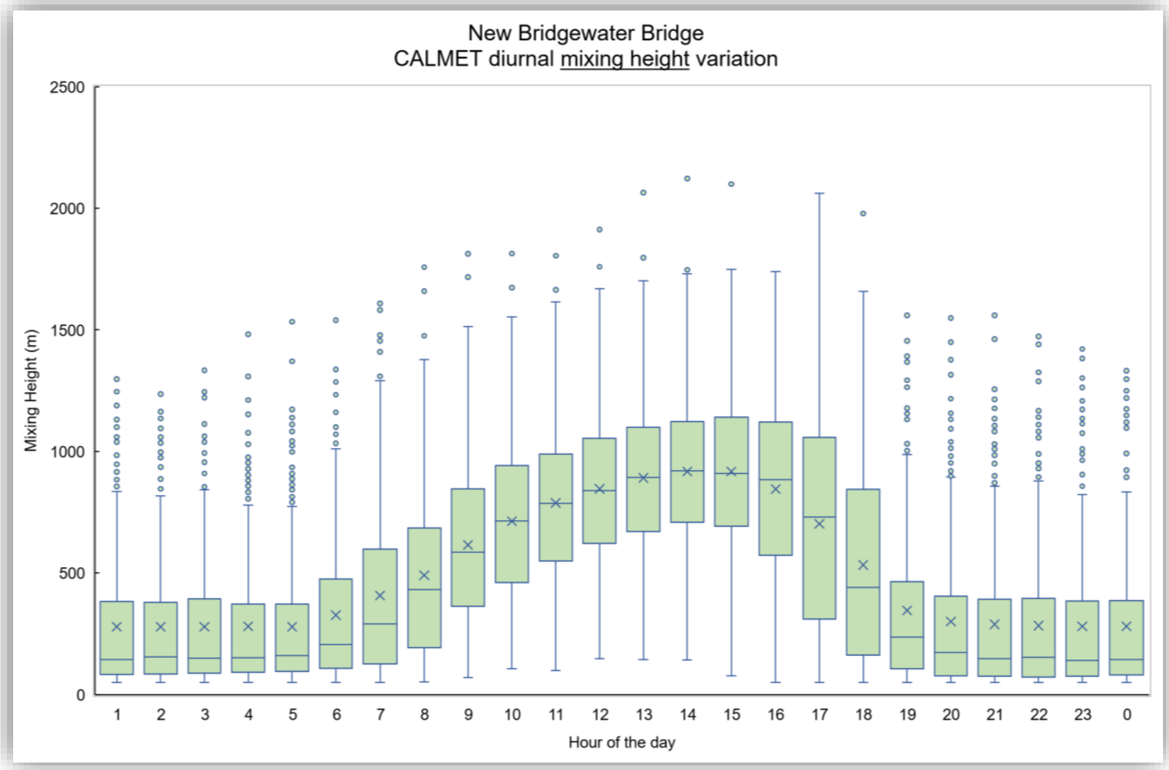


Figure 5-6: CALMET diurnal mixing height variation at the Bridgewater Bridge site.

5.1.2.3 Atmospheric stability

Atmospheric stability refers to the tendency of the atmosphere to lesson or augment vertical motion. Pasquill Stability Classes (stability classes A to F) categorise the degree of atmospheric stability. These classes characterise prevailing meteorological conditions and are an input into the air dispersion model. Figure 5-7 presents CALMET diurnal variation in atmospheric stability at the Bridgewater Bridge site. Table 5-2 provides the percent occurrence of each class across the modelled year along with a brief description of the class with regard to atmospheric stability.

The results in Figure 5-7 show that relatively unstable conditions are normal during the day, whilst stable to neutral conditions typically occur at night (i.e. less dispersive conditions at night). The data from Table 5-2 identifies that stability class D, representing neutral atmospheric conditions, as the most commonly occurring stability class throughout the year modelled and in combination with stability class F accounting for approx. 70 % the hours modelled.

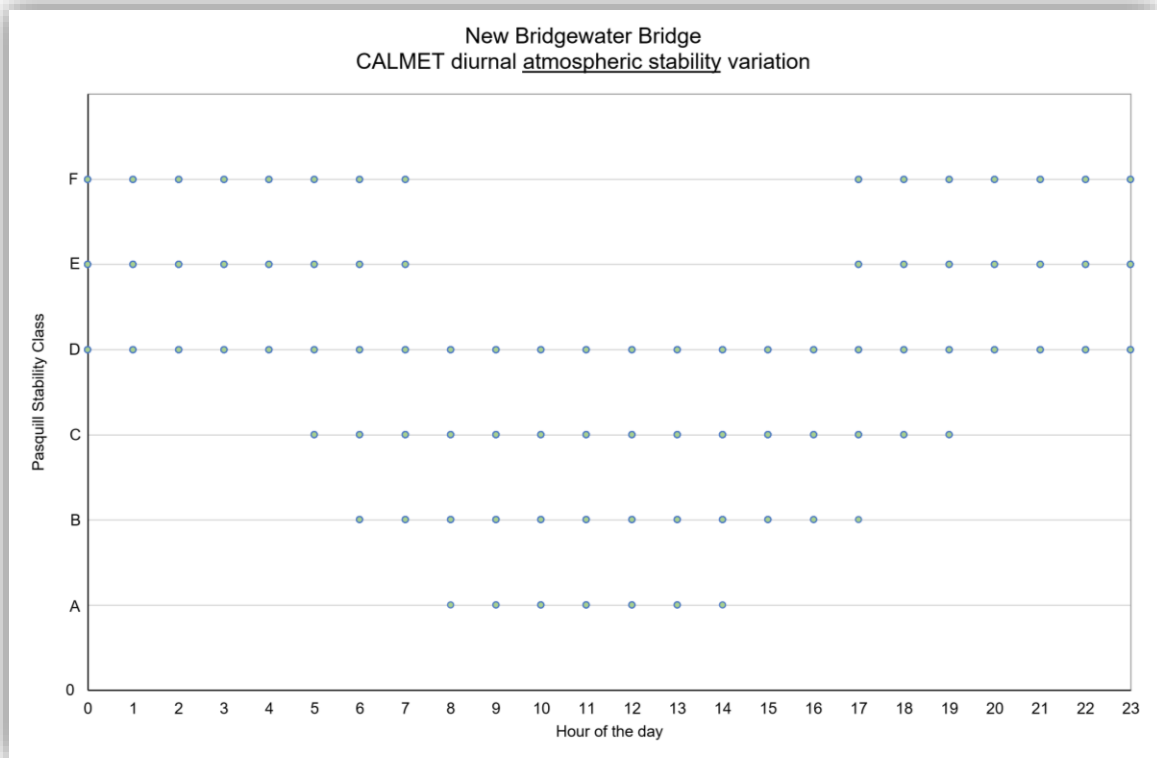


Figure 5-7: CALMET diurnal atmospheric stability variation at the Bridgewater Bridge site.

Pasquill stability class annual occurrence		
Stability class	Description	Percent occurrence (%)
A	Very unstable low wind, clear skies, hot daytime conditions	0.4
B	Unstable clear skies, daytime conditions	5.6
C	Moderately unstable moderate wind, slightly overcast daytime conditions	13.6
D	Neutral high winds or cloudy days and nights	41.1
E	Stable moderate wind, slightly overcast night-time conditions	10.5
F	Very stable low winds, clear skies, cold night-time conditions	28.7

Table 5-2: CALMET annual percent occurrence of atmospheric stability classes at the Bridgewater Bridge site.

6 Background concentrations

Information relating to the background constituent concentrations in the Derwent Valley is, to the best of Tarkarri Engineering's knowledge, not available. As such background concentration is not included in the predicted results presented here. Given this interpretation of the results should be considered in this context. Other potential sources of air emissions in the valley include transport emissions from outside of the project area; combustion processes at industrial facilities to the west at New Norfolk and to the south in Hobart; local agricultural activities; and biomass burning for heating and during bushfires.

7 Model input information

7.1 Operational phase

Vehicle emissions for the Tasmanian vehicle fleet were predicted utilising the vehicle emission modelling software package COPERT Australia, version 1.3. Input files for the current fleet (based off the most recent available data from 2018) and predicted fleet for 10 years after the completion of the project (2035) were developed by Transport Energy/Emission Research (TER). A report is available detailing the development of the input files is provided in the Appendix to this report[3].

Vehicle speeds of 35 km/h, 75 km/h and 100 km/h were modelled to represent average vehicle speeds on roads assigned speed limits of 60 km/h, 80 km/h and 100 km/h respectively (speed limits for the new crossing options were provided by Burbury Consulting). Weighted average emissions in g/s/vehicle for an aggregation of all light vehicles (LVs) and an aggregation of all heavy vehicles (HVs) were calculated for each speed. Weighting is based on the total km travelled per year for each vehicle class within the LV and HV vehicle types (calculated from km/yr travelled by an individual vehicle of the vehicle class by the population of that vehicle class) as proportion of the total km travelled by all vehicles in the LV and HV vehicle types.

Tables 7-1 and 7-2 present weighted average emission rates for LVs and HVs from the 2021 and 2035 outputs from the COPERT model at 35 km/h, 75 km/h and 100 km/h speeds.

Weighted average emissions per vehicle (g/s) by vehicle type, **2021**				
Constituent	Vehicle type	g/s/vehicle at		
		35 km/h	75 km/h	100 km/h
CO	LVs	2.0×10^{-2}	3.0×10^{-3}	2.4×10^{-3}
	HVs	1.9×10^{-2}	6.0×10^{-3}	3.7×10^{-3}
NO_X	LVs	2.0×10^{-3}	9.3×10^{-4}	3.7×10^{-4}
	HVs	8.4×10^{-3}	7.3×10^{-3}	5.1×10^{-3}
SO_2	LVs	3.7×10^{-5}	1.6×10^{-5}	4.9×10^{-6}
	HVs	2.4×10^{-5}	1.6×10^{-5}	1.0×10^{-5}
PM_{10}	LVs	2.0×10^{-4}	8.8×10^{-5}	1.7×10^{-5}
	HVs	5.2×10^{-4}	2.8×10^{-4}	1.3×10^{-4}
$PM_{2.5}$	LVs	1.2×10^{-4}	5.5×10^{-5}	1.3×10^{-5}
	HVs	3.8×10^{-4}	2.1×10^{-4}	1.1×10^{-4}
VOCs (Non-methane)	LVs	2.5×10^{-3}	3.9×10^{-4}	8.1×10^{-5}
	HVs	1.8×10^{-3}	4.6×10^{-4}	1.8×10^{-4}

Table 7-1: Weighted average emissions per vehicle by, vehicle type, 2021.

Weighted average emissions per vehicle (g/s) by vehicle type, **2035**				
Constituent	Vehicle type	g/s/vehicle at		
		35 km/h	75 km/h	100 km/h
CO	LVs	4.8×10^{-3}	1.8×10^{-3}	2.0×10^{-3}
	HVs	1.1×10^{-2}	3.1×10^{-3}	2.3×10^{-3}
NO_X	LVs	6.4×10^{-4}	2.5×10^{-4}	1.1×10^{-4}
	HVs	2.7×10^{-3}	2.2×10^{-3}	1.4×10^{-3}
SO_2	LVs	3.1×10^{-5}	3.7×10^{-6}	2.0×10^{-5}
	HVs	1.4×10^{-5}	4.4×10^{-7}	1.6×10^{-5}
PM_{10}	LVs	2.0×10^{-4}	8.7×10^{-5}	1.6×10^{-5}
	HVs	2.9×10^{-4}	1.7×10^{-4}	5.9×10^{-5}
$PM_{2.5}$	LVs	1.1×10^{-4}	5.2×10^{-5}	1.2×10^{-5}
	HVs	1.6×10^{-4}	9.7×10^{-5}	3.9×10^{-5}
VOCs (Non-methane)	LVs	1.4×10^{-3}	2.9×10^{-4}	6.3×10^{-5}
	HVs	3.0×10^{-4}	8.8×10^{-5}	3.9×10^{-5}

Table 7-2: Weighted average emissions per vehicle, by vehicle type, 2035.

Emissions rates were calculated for each road section based on the number of LVs and HVs present on a road section per second multiplied by the per vehicle rates presented in tables 7-1 and 7-2 above. The LV and HV road section rates were then summed to form a single rate for the road section.

Traffic data for the years 2021 and 2031 (future traffic modelled year available for the project) was provided by Burbury Consulting and is presented in the Appendix. A 2:1 ratio for day and night traffic flows was assumed (from Austroads[4]) and day flows outside of the am and pm peaks determined to allow for the calculation of emission rates per road section in g/s. Emissions were scaled on a weekly/diurnal basis in the model to account for night and am and pm peak traffic flows.

5 modelling scenarios were developed as follows:-

- Existing (2021 traffic data, 2018 emission data)
- New bridge, Option 1 (2021 traffic data, 2018 emission data)
- New bridge, Option 2 (2021 traffic data, 2018 emission data)
- New bridge, Option 1 (2031 traffic data, 2035 emission data)
- New bridge, Option 2 (2031 traffic data, 2035 emission data)

Traffic data utilisation, source configuration and emission rate information is provided in the subsequent report subsections. Discrete receptor locations identified for the prediction of ground level concentrations (glcs) are detailed in subsection 7.3 while subsection 7.4 presents aerial views with model overlays. The extents of road emission sources are within the Project Land with the exception of some minor road sources that extend slightly beyond.

7.1.1 Configuration data

Table 7-3 presents a table detailing the traffic count data utilisation in calculating emission rates for each road source. Emission source configuration data for Existing road sources and Option 1 and 2 road sources for the New Bridgewater Bridge are provided in Table 7-4. Location coordinates for the sources are provided in the Appendix to this report.

Traffic count data utilisation	
Emission source	Traffic count data utilised (provided in Appendix)
Existing	
Midland Hwy	E + F+ G
Midland Hwy_Bridge	E
Brooker Hwy	A
Boyer Rd	F + G
Lyell Hwy	D
Main Rd, Brooker Hwy off	C
Main Rd	B
Main Rd to Brooker Hwy on	E - D
Options 1 and 2	
Midland Hwy	E + F + G
Midland Hwy_Bridge_sth	E*
Midland Hwy_Bridge_nth	
Brooker Hwy	A
Old Main Rd on	G/2
Old Main Rd off	G/2
Midland Hwy sth off	F
Lyell Hwy on	D/2
Lyell Hwy off	D/2
Lyell Hwy	D
Brooker Hwy sth off	C
Main Rd / Sake Rd link	B

* Split for Option 1, aggregated for Option 2.

Table 7-3: Traffic count data utilisation.

Model input source configuration data						
Line volume sources						
Emission source	Relative height (m)	Length of side (m)	Speed (km/h)	Initial sigma Z (m)	Config	Type
Existing						
Midland Hwy	1.19	16.5	75	2.38	Separated	Surface-based
Midland Hwy_Bridge		13	35			
Brooker Hwy		16.5	100			
Boyer Rd		13	35			
Lyell Hwy		13	35			
Main Rd, Brooker Hwy off		9.5	35			
Main Rd		13	35			
Main Rd to Brooker Hwy on		13	35			

Emission source	Relative height (m)	Length of side (m)	Speed (km/h)	Initial sigma Z (m)	Config	Type
Option 1						
Midland Hwy	1.19	16.5	75	2.38	Separated	Surface-based
Midland Hwy_Bridge_sth	1.19 to 11.19	13	75			
Midland Hwy_Bridge_nth		13	75			
Brooker Hwy	1.19 to 10.33	16.5	75			
Old Main Rd on	1.19	9.5	35			
Old Main Rd off		9.5	35			
Midland Hwy sth off		9.5	35			
Lyell Hwy on		9.5	35			
Lyell Hwy off		9.5	35			
Lyell Hwy		13	35			
Brooker Hwy sth off		9.5	35			
Main Rd / Sake Rd link		13	35			
Option 2						
Midland Hwy_Bridge	1.19 to 20.02	20	75	2.38	Separated	Surface-based

Table 7-4: Emission model input source information.

7.1.2 Emission rates

Tables 7-5 to 7-7 presents road source emission rates calculated for Existing road sources and Option 1 and 2 road sources for the New Bridgewater Bridge (both 2021 and 2031 rates for the new crossing options).

Model input source emission data, **Existing (2021)**						
Line volume sources						
Emission source	g/s					
	CO	NO_X	SO_2	PM_{10}	PM2.5	VOCs*
Midland Hwy	4.9×10^{-2}	2.3×10^{-2}	2.4×10^{-4}	1.6×10^{-3}	1.1×10^{-3}	5.8×10^{-3}
Midland Hwy_Bridge	1.1×10^{0}	1.5×10^{-1}	1.9×10^{-3}	1.3×10^{-2}	8.2×10^{-3}	1.3×10^{-1}
Brooker Hwy	3.5×10^{-2}	1.4×10^{-2}	7.5×10^{-5}	4.3×10^{-4}	3.4×10^{-4}	1.3×10^{-3}
Boyer Rd	6.1×10^{-2}	6.9×10^{-3}	1.1×10^{-4}	6.6×10^{-4}	4.0×10^{-4}	7.5×10^{-3}
Lyell Hwy	8.1×10^{-2}	9.7×10^{-3}	1.5×10^{-4}	9.1×10^{-4}	5.6×10^{-4}	1.0×10^{-2}
Main Rd, Brooker Hwy off	1.9×10^{-2}	2.3×10^{-3}	3.4×10^{-5}	2.1×10^{-4}	1.3×10^{-4}	2.3×10^{-3}
Main Rd	3.8×10^{-2}	1.9×10^{-2}	1.8×10^{-4}	1.2×10^{-3}	8.3×10^{-4}	4.4×10^{-3}
Main Rd to Brooker Hwy on	1.2×10^{-1}	1.4×10^{-2}	2.1×10^{-4}	1.3×10^{-3}	8.1×10^{-4}	1.4×10^{-2}

* Non-methane VOCs.

Table 7-5: Emission model source emission rates, Existing (2021).

Model input source emission data, **Options 1 & 2 (2021)**						
Line volume sources						
Emission source	g/s					
	CO	NO_X	SO_2	PM_{10}	PM2.5	VOCs*
Midland Hwy	4.4×10^{-2}	2.1×10^{-2}	2.2×10^{-4}	1.4×10^{-3}	9.5×10^{-4}	5.3×10^{-3}
Midland Hwy_Bridge[h]	1.1×10^{-1}	5.4×10^{-2}	5.3×10^{-4}	3.6×10^{-3}	2.4×10^{-3}	1.3×10^{-2}
Brooker Hwy	8.3×10^{-2}	4.4×10^{-2}	4.0×10^{-4}	2.8×10^{-3}	1.9×10^{-3}	9.6×10^{-3}
Old Main Rd on	1.3×10^{-2}	1.5×10^{-3}	2.3×10^{-5}	1.4×10^{-4}	8.5×10^{-5}	1.6×10^{-3}
Old Main Rd off	1.6×10^{-2}	1.8×10^{-3}	2.8×10^{-5}	1.7×10^{-4}	1.0×10^{-4}	2.0×10^{-3}
Midland Hwy sth off	1.2×10^{-2}	1.4×10^{-3}	2.2×10^{-5}	1.3×10^{-4}	8.0×10^{-5}	1.5×10^{-3}
Lyell Hwy on	3.6×10^{-2}	4.3×10^{-3}	6.4×10^{-5}	4.0×10^{-4}	2.5×10^{-4}	4.4×10^{-3}
Lyell Hwy off	3.2×10^{-2}	3.8×10^{-3}	5.7×10^{-5}	3.6×10^{-4}	2.2×10^{-4}	3.9×10^{-3}
Lyell Hwy	9.1×10^{-2}	1.1×10^{-2}	1.6×10^{-4}	1.0×10^{-3}	6.3×10^{-4}	1.1×10^{-2}
Brooker Hwy sth off	1.1×10^{-2}	1.3×10^{-3}	1.9×10^{-5}	1.2×10^{-4}	7.3×10^{-5}	1.3×10^{-3}
Main Rd / Sake Rd link	2.4×10^{-2}	2.9×10^{-3}	4.2×10^{-5}	2.6×10^{-4}	1.6×10^{-4}	2.9×10^{-3}

* Non-methane VOCs. [h] Option 2, split between north and south directions for Option 1.

Table 7-6: Emission model source emission rates, Options 1 & 2 (2021).

Model input source emission data, **Options 1 & 2 (2031)**						
Line volume sources						
Emission source	g/s					
	CO	NO_X	SO_2	PM_{10}	PM2.5	VOCs*
Midland Hwy	3.2×10^{-2}	7.5×10^{-3}	5.7×10^{-5}	1.6×10^{-3}	9.5×10^{-4}	4.5×10^{-3}
Midland Hwy_Bridge[h]	6.0×10^{-2}	1.6×10^{-2}	1.0×10^{-4}	3.0×10^{-3}	1.8×10^{-3}	7.9×10^{-3}
Brooker Hwy	7.9×10^{-2}	1.9×10^{-2}	1.4×10^{-4}	3.9×10^{-3}	2.3×10^{-3}	1.1×10^{-2}
Old Main Rd on	4.0×10^{-3}	5.7×10^{-4}	2.4×10^{-5}	1.6×10^{-4}	8.8×10^{-5}	1.0×10^{-3}
Old Main Rd off	4.9×10^{-3}	7.0×10^{-4}	2.9×10^{-5}	1.9×10^{-4}	1.1×10^{-4}	1.3×10^{-3}
Midland Hwy sth off	3.6×10^{-3}	5.2×10^{-4}	2.1×10^{-5}	1.4×10^{-4}	7.9×10^{-5}	9.1×10^{-4}
Lyell Hwy on	1.2×10^{-2}	1.8×10^{-3}	6.9×10^{-5}	4.7×10^{-4}	2.6×10^{-4}	2.9×10^{-3}
Lyell Hwy off	1.1×10^{-2}	1.6×10^{-3}	6.1×10^{-5}	4.1×10^{-4}	2.3×10^{-4}	2.6×10^{-3}
Lyell Hwy	3.1×10^{-2}	4.5×10^{-3}	1.7×10^{-4}	1.2×10^{-3}	6.6×10^{-4}	7.5×10^{-3}
Brooker Hwy sth off	2.9×10^{-3}	4.3×10^{-4}	1.6×10^{-5}	1.1×10^{-4}	6.2×10^{-5}	7.0×10^{-4}
Main Rd / Sake Rd link	7.8×10^{-3}	1.2×10^{-3}	4.4×10^{-5}	3.0×10^{-4}	1.7×10^{-4}	1.9×10^{-3}

* Non-methane VOCs. [h] Option 2, split between north and south directions for Option 1.

Table 7-7: Emission model source emission rates, Options 1 & 2 (2031).

7.2 Construction phase

Construction methods for the project are not known at the time of writing. Tarkarri Engineering was provided estimates of cut and fill volumes and areas of pavement removal and new pavement areas. From this Tarkarri Engineering calculated emissions rates for earth moving equipment utilising emission factor equations from the *National Pollutant Inventory Emission Estimation Technique Manual for Mining Version 3.1*[4]. The following assumptions were made:-

- 0700 to 1900 hrs weekday operations (emission estimation based on 10 hrs of operation to move relevant material volumes to add level of conservatism).

NB: 24 hr hour construction operation isn't considered here. If this is proposed, then additional modelling analysis may be required to assess potential impact and this should be conducted as part of the development of any dust management plan.

- Earthworks completed in a 24-month period (project works estimated to be 32 – 34 months)
- Approx. 60 % of pavement removal and new pavement areas exposed with additional area for cut and fill operations.
- Movement of approx. 800 t of material per day.
- Average of 10 % moisture content for all materials moved.
- NPI level 1 watering of exposed surfaces (2 litres/m^2/h)[4] providing 50 % reduction in emission rates for trucks, dozers, graders and wind erosion (operating times only).
- 10 % silt content in all materials moved and 8 % for haul routes.

Table 7-8 presents source input information. Source name designations denote the following:

- Exca: excavator.
- FEL: front end loader.
- Dozer: bulldozer operations.
- Trucks: haul trucks.
- Wind: wind entrainment from exposed surfaces.

NB: Stockpile location and volume information wasn't available and were therefore not modelled. Stockpiles can generally be well managed if appropriately located and treated during works. It is assumed here that stockpile would be located within the Project Land at locations that provide shielding from strong winds and for fine grade materials that covering, or water sprays would be provided to minimise the potential for entrainment such that their omission from the modelling is not significant.

Deposition was calculated from the annual average deposition results for TSP and converted from µg/m^2/s.

Model input emission source data						
Volume sources						
Emission source	Effective height (m)	Length of side (m)	Initial sigma Y (m)	Initial sigma Z (m)	Emission rate (kg/hr)	
					TSP	PM_{10}
Exca_N_1	3	8	1.86	0.7	0.0002	0.0001
Exca_N_2	3	8	1.86	0.7	0.0002	0.0001
FEL_N_1	4	8	1.86	0.93	0.0002	0.0001
FEL_N_2	4	8	1.86	0.93	0.0002	0.0001
Exca_S_1	3	8	1.86	0.7	0.0002	0.0001
Exca_S_2	3	8	1.86	0.7	0.0002	0.0001
FEL_S_1	4	8	1.86	0.93	0.0002	0.0001
FEL_S_2	4	8	1.86	0.93	0.0002	0.0001

<table>
<tr><th colspan="7">Line volume sources</th></tr>
<tr><th rowspan="2">Emission source</th><th rowspan="2">Effective height (m)</th><th rowspan="2">Length of side (m)</th><th rowspan="2">Initial sigma Z (m)</th><th rowspan="2">Configuration and type</th><th colspan="2">Emission rate (kg/hr)</th></tr>
<tr><th>TSP</th><th>PM_{10}</th></tr>
<tr><td>Trucks_N^</td><td>3.19</td><td>13</td><td>6.38</td><td rowspan="6">Adjacent, surfaced-based</td><td>4.6724</td><td>1.4303</td></tr>
<tr><td>Dozer_N</td><td>2.55</td><td>9.5</td><td>5.1</td><td>1.0326</td><td>0.2140</td></tr>
<tr><td>Grader_N</td><td>2.55</td><td>9.5</td><td>5.1</td><td>0.4752</td><td>0.2125</td></tr>
<tr><td>Trucks_S^</td><td>3.19</td><td>13</td><td>6.38</td><td>4.6724</td><td>1.4303</td></tr>
<tr><td>Dozer_S</td><td>2.55</td><td>9.5</td><td>5.1</td><td>1.0326</td><td>0.2140</td></tr>
<tr><td>Grader_S</td><td>2.55</td><td>9.5</td><td>5.1</td><td>0.4752</td><td>0.2125</td></tr>
<tr><th colspan="7">Area sources</th></tr>
<tr><th rowspan="2">Emission source</th><th rowspan="2">Area (m^2)</th><th rowspan="2">Release height (m)</th><th rowspan="2" colspan="2">Initial sigma Z (m)</th><th colspan="2">Emission rate ($kg/m^2/hr$)</th></tr>
<tr><th>TSP</th><th>PM_{10}</th></tr>
<tr><td>Wind_N</td><td>22,771</td><td>0</td><td colspan="2">1</td><td>0.00002</td><td>0.00001</td></tr>
<tr><td>Wind_S</td><td>43,007</td><td>0</td><td colspan="2">1</td><td>0.00002</td><td>0.00001</td></tr>
</table>

^ Adjustment for days of rain > 0.25 mm applied in accordance with USEPA AP42[3] with rainfall data from Low Head BoM station. On-site speed limit of 20 km/hr.

Table 7-8: Emission model source information, Construction.

7.3 Discrete receptors

28 residential receptors were identified to provide a representation of all sensitive residential premises surrounding The Project Land and location information for each is presented in Table 7-9.

Discrete receptor location coordinates (m)			
Receptor	UTM coordinates		Location
	Easting	Northing	
R1	518963	5268607	52-54 Old Main Rd, Bridgewater
R2	519018	5268465	51 Finlay St, Bridgewater
R3	518704	5268428	32 Old Main Rd, Bridgewater
R4	518801	5268291	16 Hayton Pl, Bridgewater
R5	518511	5268183	1 Old Main Rd, Bridgewater
R6	518758	5268190	10 Hayton Pl, Bridgewater
R7	518617	5268008	6 Neilson Esp, Bridgewater
R8	518230	5266998	2 Forest Rd, Granton
R9	518395	5266807	12 Rusts Rd, Granton
R10	518496	5266794	7 Rusts Rd, Granton
R11	518569	5266574	15 Dickenson Dr, Granton
R12	518897	5266587	9 George Rd, Granton
R13#	518694	5266420	37 Black Snake Rd, Granton
R14	518963	5266307	19 George St, Granton
R15	518826	5266033	53 Black Snake Rd, Granton
R16	519118	5265949	22 Laona Cr, Granton
R17	519211	5268147	7 James Pl, Bridgewater
R18	518214	5268676	15 Serenity Dr, Bridgewater
R19	517455	5267026	40 Turners Rd, Granton
R20	517956	5266093	99 Forest Rd, Granton
R21	519123	5266417	610 Main Rd, Granton
R22	519379	5265834	536 Main Rd, Granton
R23	520248	5267361	6 Broadview Cr, Bridgewater
R24	516954	5267804	46 Atkins Rd, Granton
R25	518301	5269593	50 Cobbs Hill Rd, Bridgewater
R26	518921	5267878	40 Gunn St, Bridgewater
R27	520380	5267892	24 Albion Rd, Bridgewater
R28	518747	5266783	650 Main Rd, Granton

[shaded] Receptors within The Project Land. # Receptor to be demolished.

Table 7-9: Discrete (residential) receptor model location information.

7.4 Aerial views

Figure 7-1 to 7-3 show aerial views with the road emission source locations marked (major highway sources red, minor road sources in orange). Figure 7-4 shows an aerial view with construction emission source locations marked. Figure 7-5 and 7-6 present aerial views with the locations of the 27 discrete receptors marked.

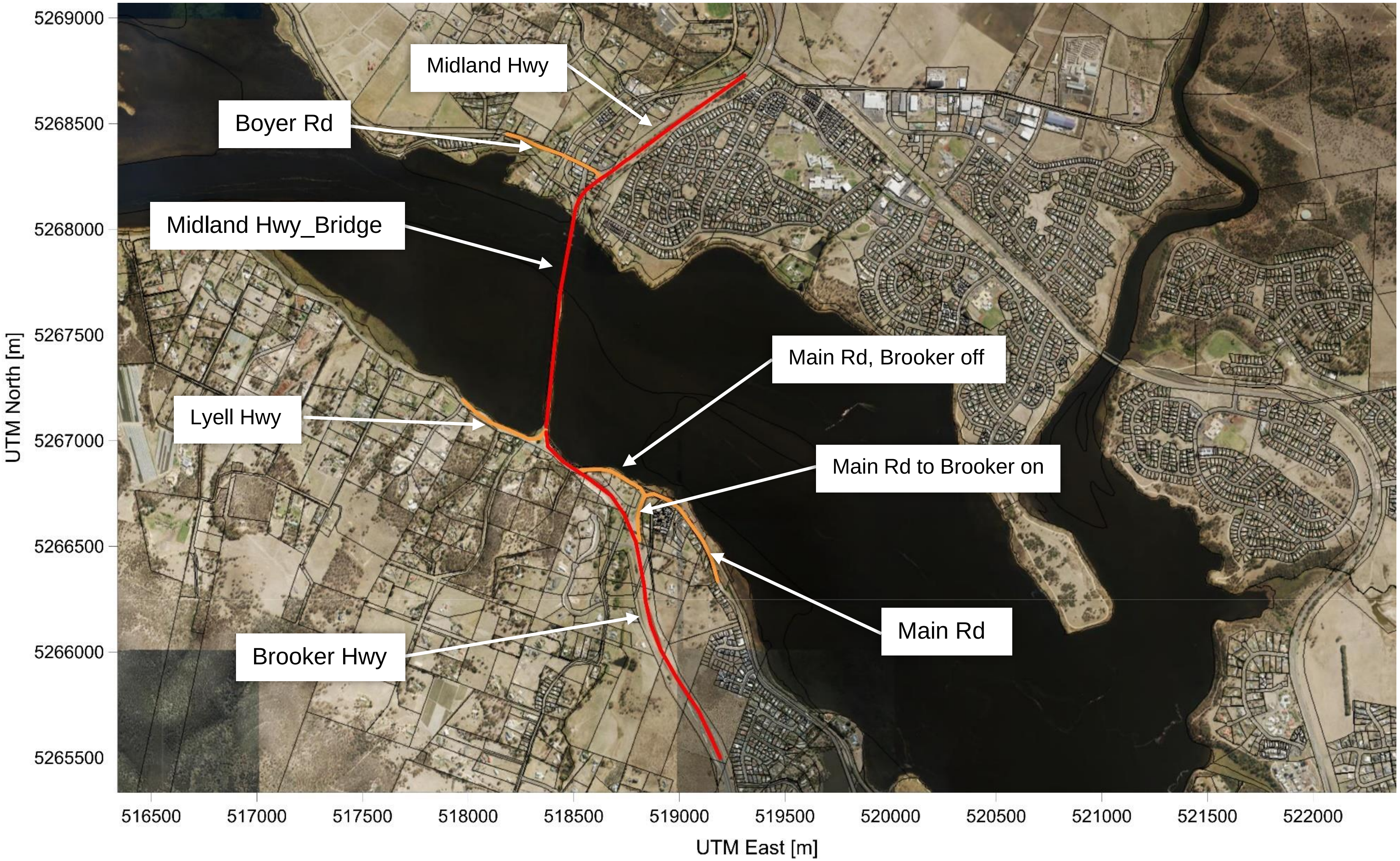


Figure 7-1: Aerial view showing emission source locations, Existing.

Figure 7-2: Aerial view showing emission source locations, Option 1.

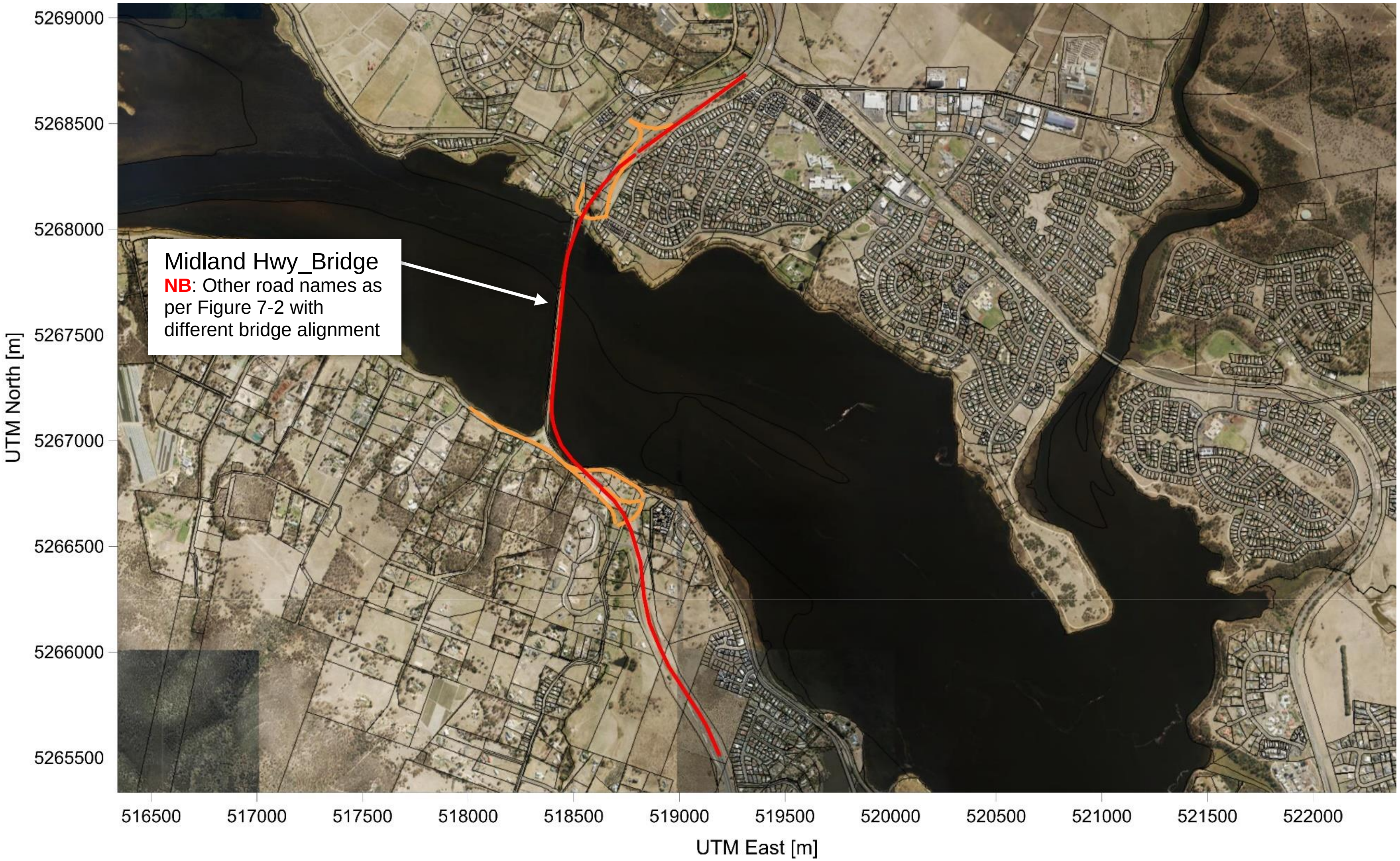


Figure 7-3: Aerial view showing emission source locations, Option 2.

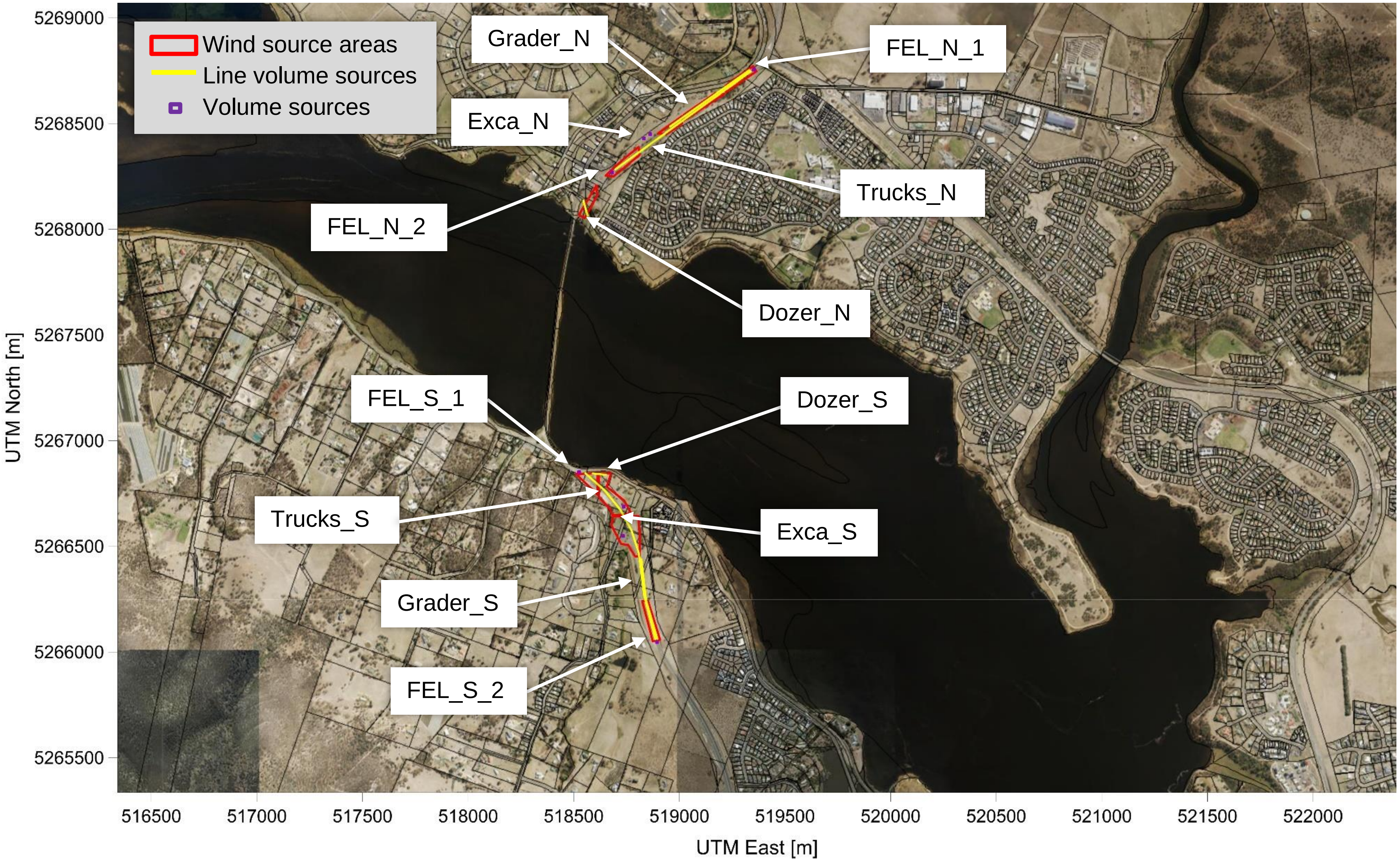


Figure 7-4: Aerial view showing emission source locations, Construction.

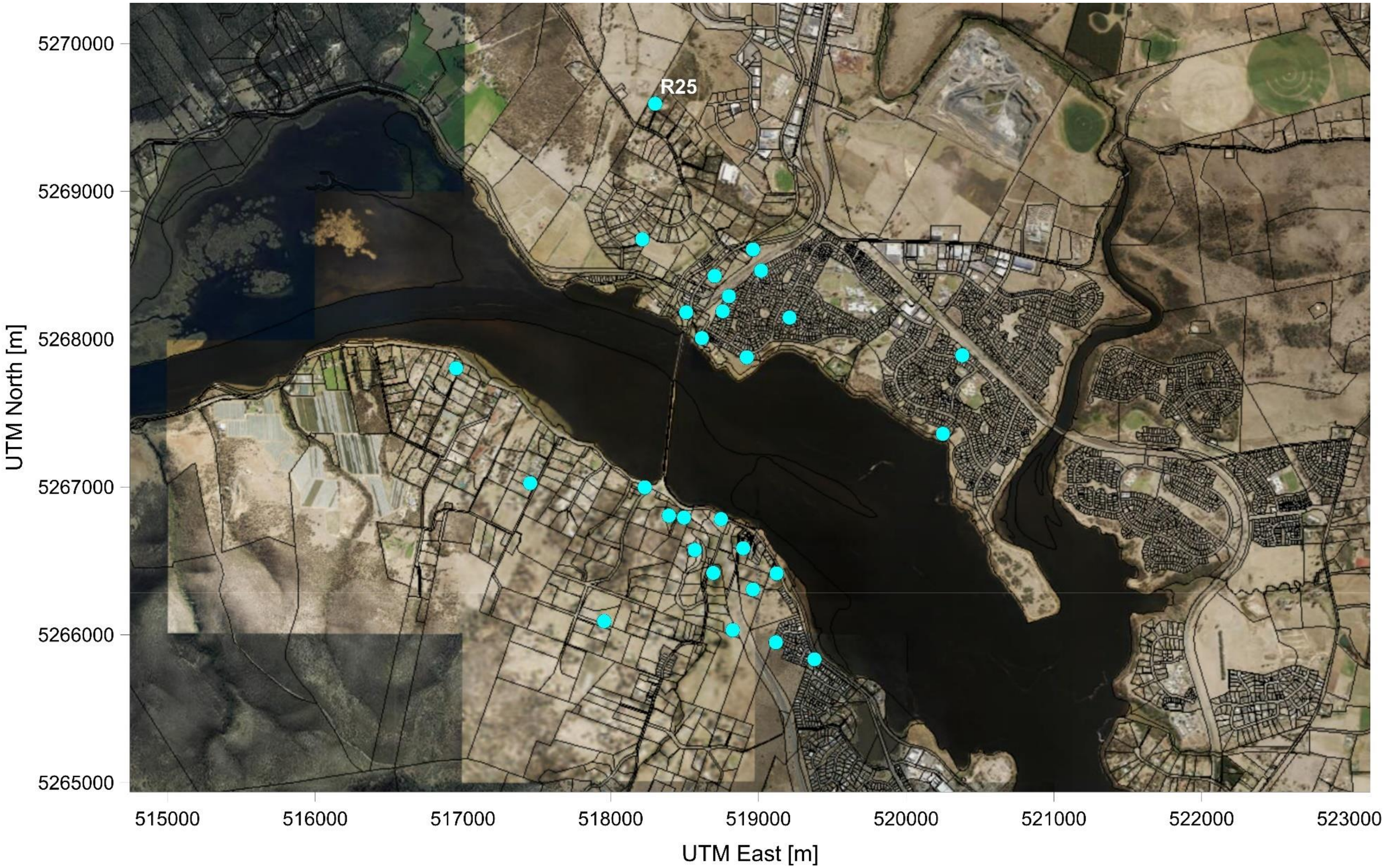


Figure 7-5: Aerial view showing discrete receptor locations.

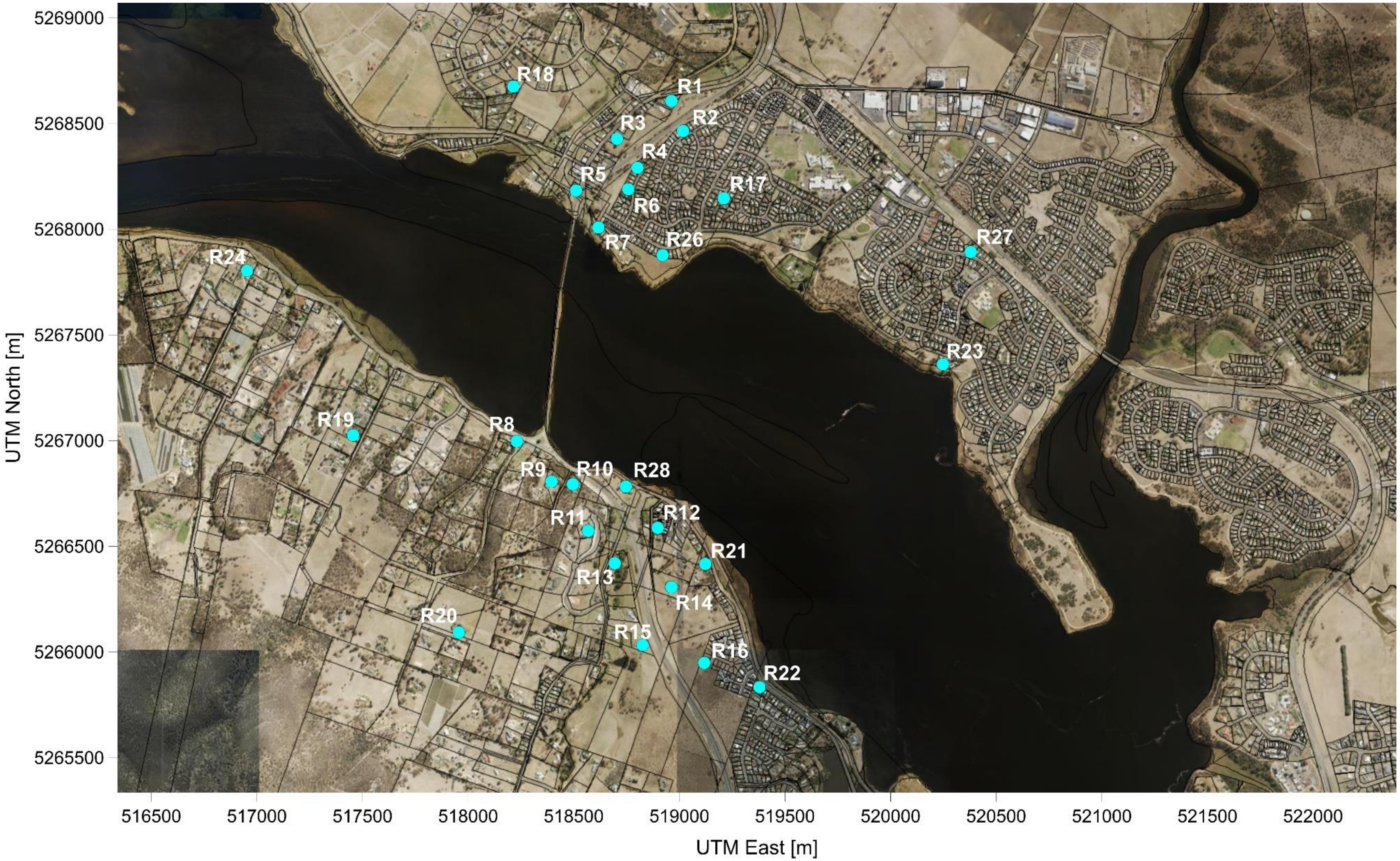


Figure 7-6: Aerial view showing discrete receptor locations

8 Modelling results

Dispersion modelling of air emissions from New Bridgewater Bridge Project has been undertaken in accordance with the *Tasmanian Air Dispersion Modelling Guidelines*, utilising model set up parameters outlined in section 4 of this report, to assess the predicted 99.9th percentile ground level concentrations (glcs) (for averaging periods of less than 1 yr) and annual average glcs.

8.1 Operational phase

Results at each of the 28 discrete receptors are presented in Tables 8-1 to 8-5 in subsections below. Where a criteria level is exceeded, the value predicted is highlighted in pink. Speciation of VOCs for the highest predicted glc at any receptor under each scenario is presented in the Appendix for reference (specification is based on the non-methane VOC speciation in the COPERT outputs).

8.1.1 2021

Discrete receptor location glcs (µg/m³) Existing, 2021										
Receptor	CO	NO_2*		SO_2		PM_{10}		$PM_{2.5}$		VOCs[ɦ]
	8 hr	1 hr	1 yr	1 hr	24 hr	24 hr	1 yr	24 hr	1 yr	1 hr
R1	10.4	5.7	0.3	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	2.4
R2	14.3	8.7	1.0	0.1	< 0.05	0.2	0.1	0.1	< 0.05	2.7
R3	39.9	11.9	0.4	0.2	< 0.05	0.3	< 0.05	0.2	< 0.05	9.3
R4	61.0	15.2	1.1	0.2	< 0.05	0.3	0.1	0.2	0.1	11.9
R5	138.6	35.7	1.6	0.5	0.2	1.2	0.1	0.7	0.1	32.2
R6	49.4	12.3	0.8	0.2	0.1	0.3	0.1	0.2	< 0.05	9.3
R7	111.9	25.5	2.0	0.3	0.1	0.8	0.2	0.5	0.1	22.9
R8	73.1	16.6	0.9	0.2	0.1	0.5	0.1	0.3	< 0.05	14.1
R9	32.5	8.7	0.4	0.1	< 0.05	0.3	< 0.05	0.2	< 0.05	6.7
R10	37.4	8.7	0.5	0.1	< 0.05	0.3	< 0.05	0.2	< 0.05	6.0
R11	14.2	4.1	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	2.9
R12	41.2	11.8	1.1	0.1	0.1	0.3	0.1	0.2	0.1	8.1
R13[#]	10.2	4.4	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	2.3
R14	16.8	6.3	0.5	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	2.6
R15	7.1	3.0	0.2	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	1.4
R16	10.5	3.6	0.3	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.7
R17	10.9	2.5	0.1	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	1.9
R18	8.5	2.6	0.1	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	2.2
R19	9.3	2.0	0.1	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	1.6
R20	3.1	0.8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.6
R21	28.1	7.4	0.7	0.1	< 0.05	0.2	0.1	0.1	< 0.05	5.4
R22	13.0	3.0	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.9
R23	16.9	3.5	0.1	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	2.8
R24	11.5	2.7	0.1	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	2.1
R25	2.6	0.6	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.5
R26	35.5	8.1	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	7.0
R27	6.1	1.6	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	1.3
R28	45.1	14.7	1.5	0.2	0.1	0.4	0.1	0.3	0.1	9.3

Exceeds criteria level. * As 100 % of NO_x. [ɦ] Non-methane VOCs, speciation provided in appendix.
Receptor within The Project Land. [#] Receptor to be demolished.

Table 8-1: Discrete receptor location glc values, Existing 2021.

Discrete receptor location glcs (µg/m³) Option 1, 2021										
Receptor	CO	NO_2*		SO_2		PM_{10}		$PM_{2.5}$		VOCs[ɦ]
	8 hr	1 hr	1 yr	1 hr	24 hr	24 hr	1 yr	24 hr	1 yr	1 hr
R1	9.2	5.9	0.3	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	2.0
R2	11.6	8.9	1.1	0.1	< 0.05	0.2	0.1	0.1	< 0.05	2.6
R3	18.4	7.1	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	3.6
R4	22.8	9.4	0.9	0.1	< 0.05	0.3	0.1	0.2	< 0.05	3.9
R5	12.0	6.0	0.2	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.7
R6	16.9	6.6	0.5	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.7
R7	16.2	7.1	0.6	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	3.4
R8	44.6	12.3	0.9	0.2	0.1	0.4	0.1	0.3	< 0.05	8.5
R9	19.0	6.8	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	4.3
R10	26.6	8.8	0.5	0.1	< 0.05	0.3	< 0.05	0.2	< 0.05	5.2
R11	8.1	4.4	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.7
R12	27.2	10.2	1.0	0.1	< 0.05	0.3	0.1	0.2	< 0.05	5.7
R13#	9.9	8.3	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.1
R14	14.0	10.1	0.9	0.1	< 0.05	0.2	0.1	0.1	< 0.05	2.5
R15	6.9	5.4	0.3	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.2
R16	7.3	6.2	0.5	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	1.4
R17	3.1	1.5	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.6
R18	2.4	1.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.5
R19	2.7	1.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.4
R20	0.9	0.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.2
R21	11.0	5.4	0.5	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	2.3
R22	5.7	3.6	0.3	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.0
R23	4.4	2.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.8
R24	2.8	1.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.6
R25	0.7	0.3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1
R26	6.8	3.2	0.1	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	1.2
R27	1.7	0.9	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.4
R28	36.7	10.9	1.3	0.1	0.1	0.4	0.1	0.2	0.1	7.7

Exceeds criteria level. * As 100 % of NO_x. ɦ Non-methane VOCs, speciation provided in appendix.
Receptor within The Project Land. # Receptor to be demolished.

Table 8-2: Discrete receptor location glc values, Option 1, 2021.

Discrete receptor location glcs (µg/m³) Option 2, 2021										
Receptor	CO	NO_2*		SO_2		PM_{10}		$PM_{2.5}$		VOCs^ɦ
	8 hr	1 hr	1 yr	1 hr	24 hr	24 hr	1 yr	24 hr	1 yr	1 hr
R1	9.2	5.9	0.3	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	2.0
R2	11.6	8.9	1.1	0.1	< 0.05	0.2	0.1	0.1	< 0.05	2.6
R3	18.2	6.8	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	3.5
R4	22.7	9.4	0.9	0.1	< 0.05	0.3	0.1	0.2	< 0.05	3.9
R5	12.1	5.6	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.7
R6	16.8	6.5	0.5	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.7
R7	16.1	6.1	0.5	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	3.4
R8	40.5	9.2	0.8	0.1	0.1	0.4	0.1	0.2	< 0.05	8.1
R9	18.7	6.9	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	4.1
R10	25.6	8.2	0.5	0.1	< 0.05	0.2	< 0.05	0.2	< 0.05	5.1
R11	8.1	4.4	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.7
R12	27.5	10.3	1.0	0.1	< 0.05	0.3	0.1	0.2	< 0.05	5.8
R13#	9.9	8.3	0.3	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.0
R14	13.9	10.1	0.9	0.1	< 0.05	0.2	0.1	0.1	< 0.05	2.5
R15	6.9	5.4	0.3	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.2
R16	7.3	6.2	0.5	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	1.4
R17	3.2	1.5	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.6
R18	2.5	1.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.5
R19	2.8	1.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.4
R20	0.9	0.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.2
R21	11.2	5.5	0.5	0.1	< 0.05	0.1	< 0.05	0.1	< 0.05	2.3
R22	5.7	3.6	0.3	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.0
R23	4.5	2.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.8
R24	2.9	1.6	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.6
R25	0.7	0.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1
R26	6.5	3.0	0.1	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	1.1
R27	1.7	0.9	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.4
R28	36.7	10.6	1.2	0.1	0.1	0.4	0.1	0.2	0.1	7.5

Exceeds criteria level. * As 100 % of NO_x. ɦ Non-methane VOCs, speciation provided in appendix.

Receptor within The Project Land. # Receptor to be demolished.

Table 8-3: Discrete receptor location glc values, Option 2, 2021.

8.1.2 2031

Discrete receptor location glcs (µg/m³) Option 1, 2031										
Receptor	CO	NO_2*		SO_2		PM_{10}		$PM_{2.5}$		VOCs[ɦ]
	8 hr	1 hr	1 yr	1 hr	24 hr	24 hr	1 yr	24 hr	1 yr	1 hr
R1	6.4	2.1	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.5
R2	7.7	3.2	0.4	< 0.05	< 0.05	0.2	0.1	0.1	< 0.05	2.0
R3	8.9	2.6	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	2.6
R4	11.8	3.4	0.3	0.1	< 0.05	0.3	0.1	0.2	< 0.05	2.9
R5	6.0	2.2	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.9
R6	8.7	2.4	0.2	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	2.0
R7	8.0	2.7	0.2	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	2.4
R8	17.7	4.7	0.4	0.1	0.1	0.5	0.1	0.3	< 0.05	5.6
R9	8.2	2.6	0.1	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.9
R10	11.0	3.3	0.2	0.1	< 0.05	0.3	< 0.05	0.2	< 0.05	3.6
R11	4.8	1.6	0.1	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.2
R12	11.7	3.8	0.4	0.1	< 0.05	0.3	0.1	0.2	< 0.05	3.9
R13[#]	6.8	3.0	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.6
R14	8.8	3.6	0.3	< 0.05	< 0.05	0.2	0.1	0.1	< 0.05	2.0
R15	4.9	1.9	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.0
R16	4.7	2.2	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.1
R17	1.7	0.6	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.4
R18	1.3	0.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.3
R19	1.4	0.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.3
R20	0.4	0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.2
R21	5.6	2.0	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.7
R22	3.2	1.3	0.1	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	0.8
R23	2.3	0.7	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.6
R24	1.5	0.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.5
R25	0.4	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1
R26	3.8	1.2	0.1	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	0.9
R27	0.9	0.3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.3
R28	14.1	4.2	0.5	0.1	< 0.05	0.4	0.1	0.2	0.1	5.2

Exceeds criteria level. * As 100 % of NO_x. ɦ Non-methane VOCs, speciation provided in appendix.

Receptor within The Project Land. # Receptor to be demolished.

Table 8-4: Discrete receptor location glc values, Option 1, 2031.

Discrete receptor location glcs (µg/m³) Option 2, 2031										
Receptor	CO	NO_2*		SO_2		PM_{10}		$PM_{2.5}$		VOCs^ɦ
	8 hr	1 hr	1 yr	1 hr	24 hr	24 hr	1 yr	24 hr	1 yr	1 hr
R1	6.4	2.1	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.5
R2	7.7	3.2	0.4	< 0.05	< 0.05	0.2	0.1	0.1	< 0.05	2.0
R3	8.8	2.5	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	2.5
R4	11.7	3.4	0.3	0.1	< 0.05	0.3	0.1	0.2	< 0.05	2.9
R5	5.9	2.0	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.9
R6	8.7	2.4	0.2	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	2.0
R7	6.9	2.2	0.2	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	2.2
R8	15.0	3.7	0.3	0.1	0.1	0.4	0.1	0.2	< 0.05	5.4
R9	8.0	2.7	0.1	0.1	< 0.05	0.2	< 0.05	0.1	< 0.05	2.7
R10	10.6	3.1	0.2	0.1	< 0.05	0.3	< 0.05	0.2	< 0.05	3.5
R11	4.8	1.6	0.1	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.2
R12	11.5	3.8	0.4	0.1	< 0.05	0.3	0.1	0.2	< 0.05	3.9
R13#	6.8	3.0	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.6
R14	8.9	3.6	0.3	< 0.05	< 0.05	0.2	0.1	0.1	< 0.05	2.0
R15	4.9	1.9	0.1	< 0.05	< 0.05	0.2	< 0.05	0.1	< 0.05	1.0
R16	4.7	2.2	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.1
R17	1.8	0.6	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.4
R18	1.4	0.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.3
R19	1.5	0.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.3
R20	0.4	0.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.2
R21	5.6	2.0	0.2	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	1.7
R22	3.2	1.3	0.1	< 0.05	< 0.05	0.1	< 0.05	0.1	< 0.05	0.8
R23	2.3	0.8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.6
R24	1.6	0.6	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.5
R25	0.4	0.1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.1
R26	3.6	1.1	< 0.05	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	0.8
R27	0.9	0.3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.3
R28	13.9	4.0	0.5	0.1	< 0.05	0.4	0.1	0.2	0.1	5.0

Exceeds criteria level. * As 100 % of NO_x. ɦ Non-methane VOCs, speciation provided in appendix.

Receptor within The Project Land. # Receptor to be demolished.

Table 8-5: Discrete receptor location glc values, Option 2, 2031.

8.2 Construction phase

Results at each of the 27 discrete receptors are presented in Tables 8-6 below. Where a criteria level is exceeded, the value predicted is highlighted in pink.

Discrete receptor location glcs (µg/m^3) Construction			
Receptor	PM_{10}		TSP
	24 hr	1 yr	1 yr
R1	20.9	2.5	2.7
R2	32.4	13.0	20.1
R3	17.9	2.0	2.2
R4	23.8	7.4	11.4
R5	17.4	2.1	3.3
R6	16.6	3.6	3.6
R7	36.8	9.5	13.2
R8	12.8	1.0	0.4
R9	14.7	1.3	0.9
R10	33.6	2.9	2.9
R11	14.7	1.6	1.5
R12	49.9	14.9	16.2
R13#	22.7	2.4	2.8
R14	24.6	5.2	6.6
R15	12.4	1.0	1.3
R16	9.9	1.7	1.0
R17	2.5	0.5	0.3
R18	2.9	0.2	0.1
R19	1.9	0.1	< 0.05
R20	1.8	0.1	< 0.05
R21	20.7	5.7	3.1
R22	7.1	1.2	0.4
R23	2.1	0.2	0.1
R24	2.4	0.2	< 0.05
R25	0.9	0.1	< 0.05
R26	4.6	0.8	0.3
R27	1.1	0.1	< 0.05
R28	77.7	21.8	28.5

[pink] Exceeds criteria level. [green] Receptor within The Project Land. # Receptor to be demolished.

Table 8-6: Discrete receptor location glc values, Construction.

NB: Modelled dust deposition rates were negligible and are not reported here.

9 Discussion and conclusions

9.1 Operational phase

Predicted air emission glcs from both the existing and new crossing are well below Air NEPM standard criterion levels by an order of magnitude or more, including VOCs of concern (see Appendix for predicted values speciation).

The highest predicted levels are apparent at receptors in the immediate vicinity of the highway corridor under all modelling scenarios. Under the Existing model scenario predicted levels at receptors closest the existing bridge and causeway exhibit the highest predicted levels in any of the modelled scenarios. The two new crossing options provide traffic flows at higher speeds resulting in a significant decrease in predicted glcs, in the order of 10 to 90 % reductions on predicted levels under the Existing scenario (for 2021 modelling). Increases from the Existing scenario in some constituents are seen at receptors in the vicinity of the Brooker Hwy section (from very low levels). Speed reduced under the new crossing options result in higher emission rates from this road section under scenarios Options 1 (2021) and Option 2 (2021) than under the Existing scenario.

NB: The Brooker Hwy section, while modelled as a 100 km/h section under the Existing scenario, has the potential to be subject to reduced traffic speeds during peak traffic periods and as such the modelling may underestimate current traffic air emission glcs in the vicinity of this road section. As such the new crossing options may, in reality, result in reduced glcs in the vicinity of this section as a result of improved traffic flows and road gradient.

Further to the above the traffic assessment notes that the following improvements resulting from the project that would act to mitigate the generation of traffic air emissions:

- Reduction in congestion: The introduction of grade-separation to the southern and northern interchanges significantly improves congestion. This is also supported by a change from 2-lanes to 4-lanes of traffic. The removal of the roundabout at the intersection of the Brooker/Lyell Highway and the causeway is the most significant of those changes. Congestion is improved such that free flow traffic conditions are provided by the New Bridgewater Bridge. A reduction in congestion removes vehicles that sit idling for long periods of time, particularly at peak traffic times.
- Increased travel speed / reduced travel time: A reduction in travel time or an increase in average travel speed is provided. The afternoon/evening peak travel time is modelled at 7.6 minutes for northbound traffic at present time. In future years, this is forecast to increase to 27.4 minutes under the current bridge configuration. Travel time with the new bridge is forecast at 1.7 minutes.
- Average speed increases: The posted speed limit will increase from a minimum of 60 km/h through the main crossing to 80 km/h throughout. Average travel speed increases from 24 km/h to 76 km/h (across a year). Rates of air emissions are reduced at higher speeds.
- Alternative modes of transport: Pedestrians and cyclists will now be able to cross the river here in a protected share user path. This is the first time that this is possible at this location, and it is expected to encourage a shift in mode of transport.

Results from the modelling of 2031 traffic levels shows a further reduction in predicted levels despite increased traffic flows. This is due to lower emission level inputs from the COPERT modelling of the Tasmanian 2035 road fleet (details provided in the TER report[3]). Turnover and scrappage of old vehicle technologies and a greater proportion of modern vehicles sees significantly reduced weighted average emissions from LVs and HVs (see Table 7-2).

The above modelling results suggests that the New Bridgewater Bridge Project when completed and operational should result in improved outcomes with regard to air emissions from vehicle traffic within The Project Land while improved vehicle technologies into the future should see a continued reduction in the emission of air emission constituents of concern.

NB: The modelling completed here doesn't account for any potential conversion of the on-road Tasmanian vehicle fleet to electric vehicles (for LVs in particular) or hydrogen vehicles (for HVs in particular) into the future, both of which would act to further reduce traffic emission levels.

9.2 Construction phase

Predicted TSP and PM_{10} levels from the modelling of construction phase operations are typically below criteria levels. This indicates that the controls outlined in section 7.2 are likely to be sufficient in maintaining acceptable air quality conditions for surrounding residences during the project construction phase. The exception is at receptor R28 while at receptor R12 PM_{10} levels are very close to the criteria level. This area is near interchanges for the Lyell Hwy and Main Rd / Snake Rd and on the predominant downwind side of these areas (modelled as areas of significant exposed surface during construction). As such additional controls are likely to be required for works on the southern side of the Derwent River to maintain acceptable air quality conditions near interchange works.

National Pollution Inventory (NPI) level 1 watering of exposed surfaces (2 litres/m^2/h)[4] along with the locating of material stockpiles in wind protected areas and covering or provision of water sprays for fine grade material stockpiles are critical controls for this project. Works on the southern side of the Derwent River are likely to involve the exposure of larger areas of surface during the construction of interchanges. Consideration should also be given to minimising exposed surfaces in this area and progressive rehabilitation (e.g. hydromulching or surface matting to bind surfaces and subsequent revegetation) as works progress. Increased watering rates, particularly for designated haul routes may also need to be considered (i.e. NPI level 2 watering (>2 litres/m^2/h)[4])

A dust management plan should be prepared prior to the commencement of construction. The should set out detailed dust management measures, responsibilities, key personnel, monitoring, adaptive management and community engagement. Management measures are likely to include the following (as a minimum):

- Minimising exposed surfaces through construction planning and progressive rehabilitation (e.g. hydromulching or surface matting to bind surfaces and subsequent revegetation).
- Watering of exposed surface at a minimum rate of NPI Level 1 (2 litres/m^2/h) with some areas on the southern side of the Derwent and along designated haul roads watered at a higher rate, nominally NPI Level 2 (>2 litres/m^2/h).
- Provision of adequate water supply to maintain watering rates (except during rain events) and provide water for spray systems.
- Locating stockpiles in wind protected areas and either covering or using water sprays to control dust generation.
- Covering of all haul loads.

Once the construction approach is known additional management measures may be applicable.

To provide a measure of the effectiveness of dust management measures and to allow for management to be adjusted, a dust monitoring program is proposed. The dust monitoring program would be documented in the dust management plan (or elsewhere in the construction environmental management documentation) and should include:

- Monitoring to continue throughout the active construction period.
- Establishment of performance criteria to be used to inform adaptive management approaches during construction (See section 3 of this report).
- Regular assessment of monitoring results by a suitably qualified professional including comparison against background levels and performance criteria.
- Protocols for adjustments to the dust control measures where dust levels exceed adopted performance criteria as a result of construction activity within the Project Land.

NB: Further detailed on the air quality monitoring program proposed for the project is provided in section 9.3.

With suitable management measures, monitoring and adaptive management in place air emissions during the construction phase can be suitably managed to avoid significant impact on local amenity.

9.3 Air quality monitoring program

Air quality monitoring would be conducted in stages through pre-construction, construction and post construction to allow for compliance assessment; to provide information to the project for the adaptive management of air quality; and allow for model analysis and validation against real data. The monitoring would take the following forms:

- Air quality monitoring station (AQMS) at a fixed location
- Dust deposition monitoring (throughout the entire construction period)

For the AQMS the following sampling periods are proposed:

- Pre-construction: 3 months prior to construction
- Construction: first 3 months and final 3 months
- Post-construction: first 6 months

9.3.1 AQMS

The following constituents would be monitored by the AQMS to reference standards:

- Oxides of Nitrogen – NO_X
(Measured to the standard of *AS 3580.5.1-2011 Methods for sampling and analysis of ambient air Determination of oxides of nitrogen - Direct-reading instrumental method*)
- Particulates - PM_{10} & $PM_{2.5}$
(Measured to the standard of *AS/NZS 3580.9.11.2016 Methods for sampling and analysis of ambient air Determination of suspended particulate matter - PM_{10} beta attenuation monitors* and *AS/NZS 3580.9.12:2013 Methods for sampling and analysis of ambient air Determination of suspended particulate matter - $PM_{2.5}$ beta attenuation monitors*)
- Meteorological parameters:
    - Wind Speed / Wind Direction
    - Ambient Temperature
    - Relative Humidity
    - Barometric Pressure
    - Rain
    - Solar Radiation

The AQMS would be located at the The Project Land at 650 Main Rd, Granton. This location is on the eastern side of the bridge (the predominant down wind side of the bridge) and provides a location with access to power and is free from construction activity.

Figure 9-1 provides an aerial view with the The Project Land extent (in turquoise) and 650 Main Rd, Granton (in red), highlighted.

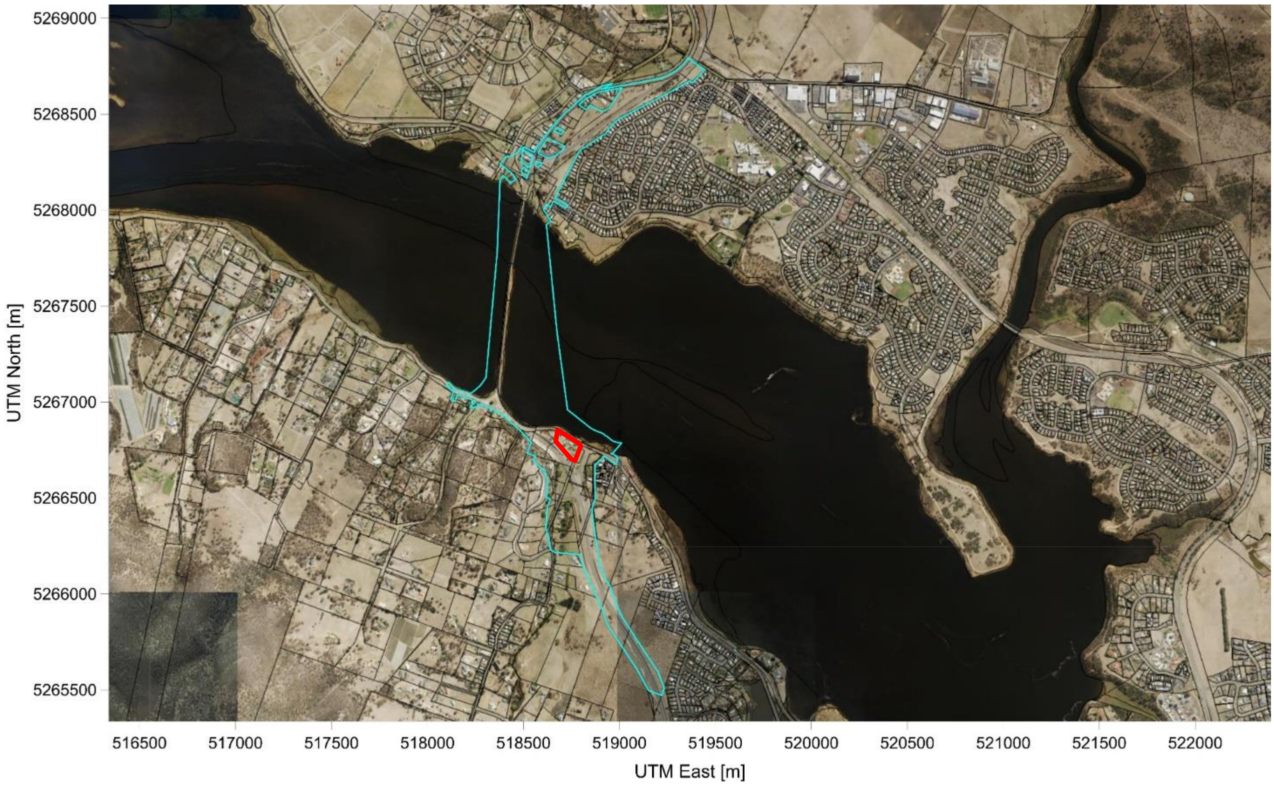


Figure 9-1: Aerial view with proposed AQMS location and The Project Land extent highlighted.

9.3.2 Dust deposition

Dust deposition monitoring would be conducted throughout the construction period in accordance with *AS/NZS 3580.10.1:2016 Methods for sampling and analysis of ambient air Determination of particulate matter - Deposited matter - Gravimetric method*.

It is anticipated that between 8-10 deposition gauge locations would be utilised (this may change depending on the proposed construction program) with the siting of the gauges in accordance with *AS/NZS 3580.1.1:2016 Methods for sampling and analysis of ambient air Guide to siting air monitoring equipment*.

9.3.3 Monitoring results

Monitoring results from the AQMS would be reported to the Department of State Growth on a monthly basis. During the construction phase this information would also be provided to the construction contractor. Dust deposition monitoring would be conducted by the construction contractor with the results provided to the Department of State Growth on a monthly basis also.

The information would be used for the adaptive management of dust emission control during construction where performance criteria are exceeded (e.g. consideration of alternative construction techniques that produce less emission of dust, relocation of dust generating activities away from sensitive locations, increased suppression such as higher water rates of exposed surfaces… etc). Following completion of the monitoring the pre and post construction monitor data would be used to verify the modelling results presented here.

Appendix

Source location coordinates

Operational phase

Emission source location coordinates, **Existing**		
Emission source	UTM node coordinates (line-volume sources)	
	X 10asting	Northing
Midland Hwy	519309	5268729
	519154	5268621
	519038	5268538
	518923	5268455
	518759	5268333
Midland Hwy_Bridge	518754	5268331
	518681	5268275
	518614	5268230
	518561	5268189
	518526	5268144
	518509	5268098
	518485	5267969
	518444	5267746
	518434	5267692
	518374	5267112
	518369	5267059
Brooker Hwy	518809	5266439
	518832	5266322
	518840	5266240
	518865	5266131
	518912	5266009
	518988	5265875
	519093	5265717
	519194	5265499
Boyer Rd	518620	5268255
	518598	5268278
	518542	5268307
	518437	5268356
	518338	5268391
	518248	5268432
	518182	5268451
Lyell Hwy	518367	5267050
	518336	5267011
	518289	5267007
	518194	5267050
	518112	5267083
	518040	5267130
	517974	5267194

Main Rd, Brooker Hwy off	518534 518624 518673 518703 518767 518816 518832	5266862 5266865 5266858 5266841 5266802 5266776 5266750
Main Rd	518369 518378 518447 518569 518678 518740 518793 518809	5267040 5266972 5266902 5266822 5266739 5266649 5266523 5266443
Main Rd to Brooker Hwy on	519182 519152 519110 519049 519001 518952 518909 518879 518842 518828 518815 518802 518805 518812	5266334 5266443 5266528 5266612 5266679 5266718 5266736 5266748 5266742 5266723 5266687 5266635 5266581 5266527

Emission source location coordinates, **Options 1 and 2**			
Emission source	UTM node coordinates (line-volume sources)		Relative height (m)
	X 10asting	Northing	
Midland Hwy	519309	5268729	
	518809	5268369	
Midland Hwy_Bridge_sth (Option 1)	518798	5268356	1.19
	518762	5268328	1.19
	518725	5268295	1.19
	518670	5268240	5.19
	518637	5268200	7.19
	518598	5268144	9.19
	518545	5268053	11.19
	518513	5267976	11.19
	518494	5267922	9.19
	518477	5267850	7.19
	518463	5267753	7.19
	518446	5267584	7.19
	518435	5267479	7.19
	518427	5267396	7.19
	518416	5267290	7.19
	518407	5267193	7.19
	518404	5267146	7.19
	518407	5267104	7.19
	518418	5267055	8.19
	518433	5267013	9.19
	518459	5266964	9.19
	518499	5266914	9.19
	518549	5266864	10.19
	518610	5266803	10.19
	518627	5266785	10.19

Midland Hwy_Bridge_nth (Option 1)	518794	5268364	1.19
	518755	5268334	1.19
	518720	5268304	1.19
	518689	5268275	2.19
	518646	5268228	6.19
	518616	5268193	7.19
	518573	5268131	10.19
	518549	5268092	11.19
	518522	5268041	11.19
	518497	5267983	10.19
	518476	5267929	8.19
	518458	5267862	6.19
	518447	5267797	4.19
	518440	5267744	2.19
	518435	5267695	1.19
	518432	5267670	1.19
	518389	5267248	1.19
	518384	5267201	1.19
	518383	5267162	1.19
	518388	5267108	2.19
	518399	5267057	4.19
	518417	5267009	4.19
	518446	5266958	6.19
	518472	5266923	6.19
	518501	5266893	10.19
	518526	5266869	10.19
	518560	5266836	10.19
	518597	5266801	9.69
	518621	5266777	10.19
Brooker Hwy	518631	5266774	10.33
	518692	5266715	11.93
	518738	5266649	7.53
	518770	5266578	3.15
	518816	5266425	1.19
	518833	5266260	1.19
	518858	5266138	1.19
	518906	5266024	1.19
	518950	5265931	1.19
	519098	5265703	1.19
	519130	5265647	1.19
	519188	5265516	1.19
Old Main Rd on	518768	5268518	
	518780	5268507	
	518841	5268484	
	518882	5268477	
	518933	5268484	
	518962	5268496	

Old Main Rd off	518722	5268317	
	518815	5268427	
	518819	5268460	
	518807	5268486	
	518769	5268511	
Midland Hwy sth off	518770	5268324	
	518736	5268289	
	518707	5268249	
	518685	5268205	
	518667	5268151	
	518658	5268096	
	518654	5268059	
	518627	5268057	
	518583	5268050	
	518558	5268058	
	518535	5268069	
	518520	5268082	
	518514	5268101	
	518518	5268120	
	518532	5268154	
	518542	5268181	
	518545	5268212	
Lyell Hwy on	518828	5266736	
	518817	5266762	
	518804	5266777	
	518743	5266814	
	518684	5266847	
	518651	5266858	
	518628	5266863	
	518600	5266861	
	518562	5266859	
	518523	5266863	
	518477	5266880	
	518464	5266886	
Lyell Hwy off	518461	5266883	
	518502	5266850	
	518542	5266817	
	518612	5266745	
	518655	5266701	
	518680	5266670	
	518691	5266643	
	518695	5266613	
Lyell Hwy	518460	5266887	
	518423	5266918	
	518401	5266938	
	518342	5266976	
	518280	5267005	
	518216	5267032	
	518086	5267098	
	518011	5267154	

Brooker Hwy sth off	518647 518681 518705 518728 518762 518812	5266776 5266746 5266727 5266715 5266709 5266715	
Main Rd / Sake Rd link	518824 518813 518784 518742 518711	5266703 5266670 5266634 5266613 5266600	
Midland Hwy_Bridge (Option 2)	518789 518709 518633 518567 518527 518496 518472 518458 518443 518417 518404 518396 518396 518402 518412 518441 518494 518551 518612 518629	5268351 5268290 5268203 5268112 5268037 5267952 5267881 5267806 5267654 5267397 5267265 5267183 5267139 5267089 5267051 5266978 5266909 5266853 5266795 5266781	1.19 1.19 6.22 10.36 13.59 17.62 18.3 19.63 20.02 20.19 18.19 18.03 17.98 17.78 17.55 16.71 16.26 12.49 8.25 10.35

Construction phase

Dust emission model input location coordinates (m)						
Emission source	UTM centre coordinates (volume sources)		UTM node coordinates (line-volume sources)		UTM corner coordinates (polygonal area sources)	
	Easting	Northing	Easting	Northing	Easting	Northing
Exca_N_1	518832	5268430	-	-	-	-
Exca_N_2	518862	5268451	-	-	-	-
FEL_N_1	518682	5268269	-	-	-	-
FEL_N_2	519353	5268756	-	-	-	-
Exca_S_1	518732	5266550	-	-	-	-
Exca_S_2	518737	5266688	-	-	-	-
FEL_S_1	518525	5266852	-	-	-	-
FEL_S_2	518894	5266047	-	-	-	-
Trucks_N	-	-	519338 518697	5268747 5268284	-	-
Dozer_N	-	-	518546 518566	5268135 5268064	-	-
Grader_N	-	-	519331 518956	5268753 5268487	-	-
Trucks_S	-	-	518555 518648 518722 518773 518808 518833 518886	5266846 5266763 5266671 5266578 5266469 5266269 5266061	-	-
Dozer_S	-	-	518672 518734	5266826 5266820	-	-
Grader_S	-	-	518896 518842 518820	5266063 5266245 5266439	-	-

Wind_N	-	-	-	-	519218 519218 519224 519365 519349	5268679 5268651 5268651 5268748 5268772
	-	-	-	-	519170 519021 519021 519212	5268644 5268541 5268514 5268640
	-	-	-	-	519012 518897 518943 519013	5268535 5268452 5268452 5268501
	-	-	-	-	518608 518524 518551 518611	5268208 5268069 5268052 5268159
	-	-	-	-	518807 518738 518650 518688 518811	5268390 5268334 5268254 5268250 5268352
Wind_S	-	-	-	-	518619 518676 518656 518739 518775 518745 518683 518669 518619	5266845 5266845 5266782 5266717 5266649 5266650 5266649 5266680 5266732
	-	-	-	-	518511 518590 518611 518614 518552	5266842 5266845 5266845 5266743 5266803
	-	-	-	-	518790 518757 518725 518701 518679 518687 518808 518808 518813 518812	5266453 5266507 5266511 5266557 5266599 5266643 5266643 5266600 5266551 5266453
	-	-	-	-	518824 518851 518909 518874	5266241 5266243 5266059 5266051

Traffic data

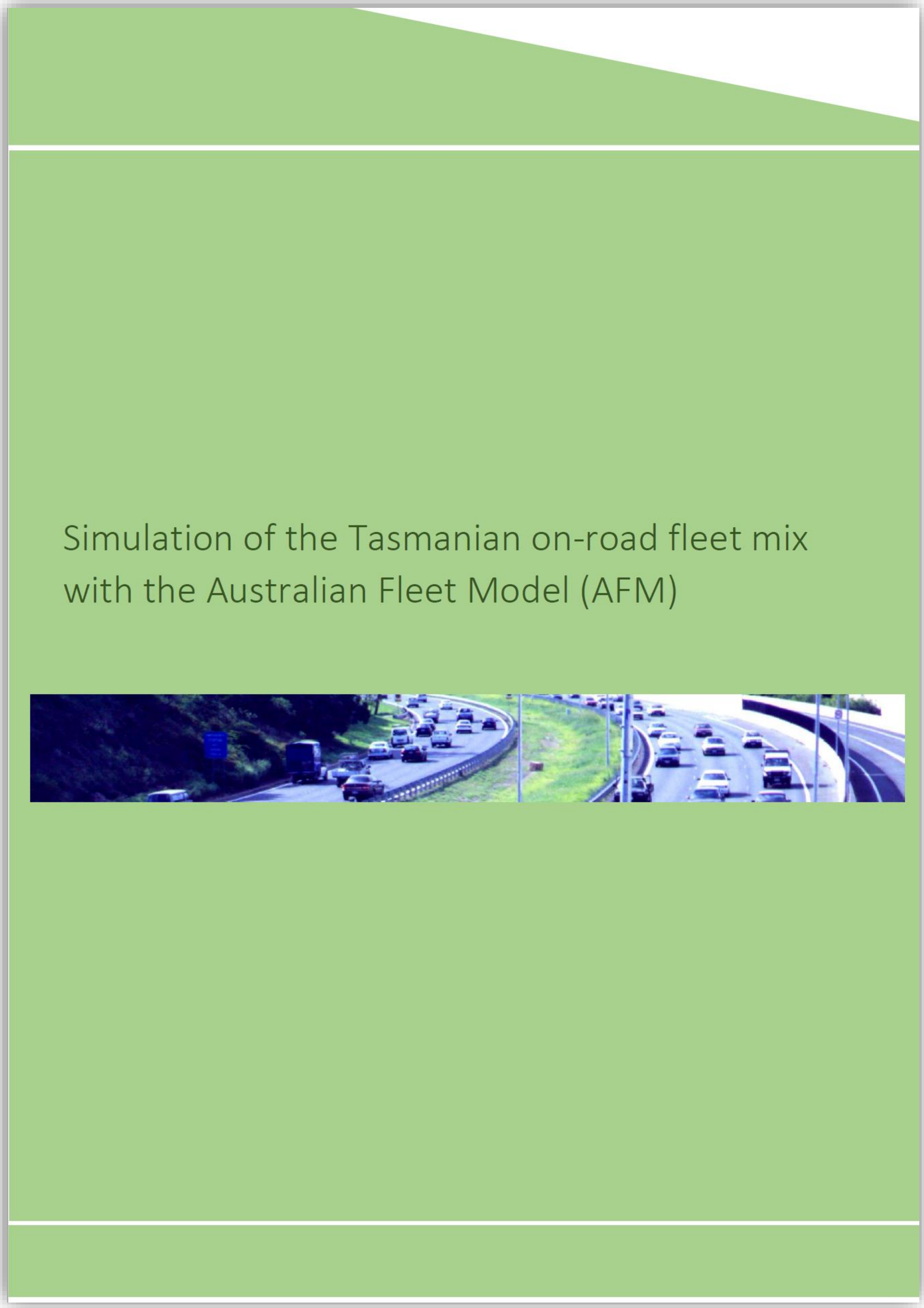
Count location		Unit	Current 2021	+10 years 2031
A	Brooker Highway	AADT Am Peak PM Peak HV%	27,900 vpd 2,900 vph 2,700 vph 13.8%	35,000 vpd 3,650 vph 3,400 vph 13.80%
B	Link road between Main Rd and Black Snake Rd (prior to Brooker southbound on-ramp)	AADT Am Peak PM Peak HV%	4,800 vpd 250 vph 400 vph 7.2%	6,000 vpd 300 vph 480 vph 7.20%
C	Brooker Ave southbound off-ramp	AADT Am Peak PM Peak HV%	2,000 vpd 150 vph 200 vph 7.2%	2,200 vpd 190 vph 250 vph 7.20%
D	Lyell Hwy/ Main Rd corridor	AADT Am Peak PM Peak HV%	5,900 500 vph 400 vph 6.8%	7,500 vpd 620 vph 500 vph 6.80%
E	Bridge	AADT Am Peak PM Peak HV%	26,600 vpd 1,920 vph 2,050 vph 11.4%	33,500 vpd 2,450 vph 2,600 vph 11.40%
F	Midland Hwy southbound off-ramp	AADT Am Peak PM Peak HV%	1,000 vpd 100 vph 200 vph 5.0%	1,200 vpd 125 vph 250 vph 5.00%
G	Old Main Rd connection	AADT Am Peak PM Peak HV%	4,500 vpd 300 vph 500 vph 4.5%	5,500 vpd 370 vph 620 vph 4.50%

VOC speciation

VOC speciation (mg/m^3)							
Category	Species	Existing	2021		2031	
			Option 1	Option 2	Option 1	Option 2
		R5	R8	R8	R8	R8
Alkanes	ethane	5.8×10^{-4}	1.5×10^{-4}	1.5×10^{-4}	6.7×10^{-5}	6.4×10^{-5}
	propane	6.5×10^{-4}	1.7×10^{-4}	1.7×10^{-4}	1.5×10^{-4}	1.4×10^{-4}
	butane	1.4×10^{-3}	3.7×10^{-4}	3.5×10^{-4}	2.5×10^{-4}	2.4×10^{-4}
	isobutane	6.7×10^{-4}	1.8×10^{-4}	1.7×10^{-4}	1.5×10^{-4}	1.4×10^{-4}
	pentane	1.0×10^{-3}	2.7×10^{-4}	2.6×10^{-4}	2.5×10^{-4}	2.4×10^{-4}
	isopentane	2.1×10^{-3}	5.5×10^{-4}	5.3×10^{-4}	4.2×10^{-4}	4.0×10^{-4}
	hexane	4.7×10^{-4}	1.2×10^{-4}	1.2×10^{-4}	8.7×10^{-5}	8.3×10^{-5}
	heptane	2.6×10^{-4}	6.7×10^{-5}	6.5×10^{-5}	5.8×10^{-5}	5.5×10^{-5}
	octane	1.2×10^{-4}	3.2×10^{-5}	3.0×10^{-5}	1.3×10^{-5}	1.3×10^{-5}
	2-methylhexane	2.7×10^{-4}	7.2×10^{-5}	6.9×10^{-5}	3.1×10^{-5}	3.0×10^{-5}
	nonane	3.3×10^{-5}	8.6×10^{-6}	8.3×10^{-6}	3.4×10^{-6}	3.3×10^{-6}
	2-methylheptane	7.4×10^{-5}	2.0×10^{-5}	1.9×10^{-5}	8.1×10^{-6}	7.7×10^{-6}
	3-methylhexane	2.0×10^{-4}	5.3×10^{-5}	5.1×10^{-5}	2.2×10^{-5}	2.1×10^{-5}
	decane	8.6×10^{-5}	2.3×10^{-5}	2.2×10^{-5}	1.4×10^{-5}	1.4×10^{-5}
	3-methylheptane	1.1×10^{-4}	2.9×10^{-5}	2.8×10^{-5}	1.3×10^{-5}	1.2×10^{-5}
	Alkanes C10-C12	2.4×10^{-4}	6.3×10^{-5}	6.1×10^{-5}	2.4×10^{-5}	2.3×10^{-5}
	Alkanes C>13	8.2×10^{-4}	2.2×10^{-4}	2.1×10^{-4}	1.7×10^{-4}	1.6×10^{-4}
	2-methylpentane	1.1×10^{-3}	2.8×10^{-4}	2.7×10^{-4}	3.6×10^{-4}	3.5×10^{-4}
	3-methylpentane	1.9×10^{-3}	5.0×10^{-4}	4.8×10^{-4}	6.5×10^{-4}	6.2×10^{-4}
Cycloalkanes	Cycloalkanes	2.5×10^{-4}	6.5×10^{-5}	6.3×10^{-5}	3.0×10^{-5}	2.9×10^{-5}
Alkenes	ethylene	2.0×10^{-3}	5.2×10^{-4}	5.0×10^{-4}	2.4×10^{-4}	2.3×10^{-4}
	propylene	1.0×10^{-3}	2.7×10^{-4}	2.6×10^{-4}	1.2×10^{-4}	1.2×10^{-4}
	propadiene	6.1×10^{-6}	1.6×10^{-6}	1.5×10^{-6}	6.1×10^{-7}	5.9×10^{-7}
	1-butene	1.9×10^{-4}	5.0×10^{-5}	4.8×10^{-5}	3.3×10^{-5}	3.2×10^{-5}
	isobutene	7.2×10^{-4}	1.9×10^{-4}	1.8×10^{-4}	8.8×10^{-5}	8.5×10^{-5}
	2-butene	4.7×10^{-4}	1.2×10^{-4}	1.2×10^{-4}	9.1×10^{-5}	8.7×10^{-5}
	1,3-butadiene	3.1×10^{-4}	8.2×10^{-5}	7.8×10^{-5}	4.4×10^{-5}	4.2×10^{-5}
	1-pentene	2.2×10^{-5}	5.8×10^{-6}	5.5×10^{-6}	2.4×10^{-6}	2.3×10^{-6}
	2-pentene	2.4×10^{-4}	6.3×10^{-5}	6.1×10^{-5}	6.8×10^{-5}	6.5×10^{-5}
	1-hexene	2.1×10^{-5}	5.4×10^{-6}	5.2×10^{-6}	2.1×10^{-6}	2.0×10^{-6}
	dimethylhexene	1.8×10^{-5}	4.8×10^{-6}	4.6×10^{-6}	1.8×10^{-6}	1.8×10^{-6}
	1-butine	3.0×10^{-5}	8.0×10^{-6}	7.6×10^{-6}	3.1×10^{-6}	3.0×10^{-6}
	propine	8.7×10^{-5}	2.3×10^{-5}	2.2×10^{-5}	1.2×10^{-5}	1.1×10^{-5}
	acetylene	9.1×10^{-4}	2.4×10^{-4}	2.3×10^{-4}	1.1×10^{-4}	1.0×10^{-4}
Aldehydes	formaldehyde	6.8×10^{-4}	1.8×10^{-4}	1.7×10^{-4}	9.8×10^{-5}	9.4×10^{-5}
	acetaldahyde	3.0×10^{-4}	7.8×10^{-5}	7.5×10^{-5}	4.5×10^{-5}	4.3×10^{-5}
	acrolein	1.1×10^{-4}	2.9×10^{-5}	2.7×10^{-5}	1.7×10^{-5}	1.6×10^{-5}
	benzaldehyde	1.2×10^{-4}	3.0×10^{-5}	2.9×10^{-5}	1.7×10^{-5}	1.6×10^{-5}
	crotonaldehyde	4.4×10^{-5}	1.2×10^{-5}	1.1×10^{-5}	8.8×10^{-6}	8.5×10^{-6}
	methacrolein	2.9×10^{-5}	7.6×10^{-6}	7.2×10^{-6}	5.5×10^{-6}	5.2×10^{-6}
	butyraldehyde	3.0×10^{-5}	7.9×10^{-6}	7.6×10^{-6}	5.6×10^{-6}	5.4×10^{-6}
	isobutanaldehyde	3.3×10^{-5}	8.7×10^{-6}	8.3×10^{-6}	5.2×10^{-6}	5.0×10^{-6}
	propionaldehyde	5.8×10^{-5}	1.5×10^{-5}	1.5×10^{-5}	9.7×10^{-6}	9.4×10^{-6}

	hexanal	2.4 x 10^{-5}	6.4 x 10^{-6}	6.2 x 10^{-6}	6.7 x 10^{-6}	6.4 x 10^{-6}
	i-valeraldehyde	2.7 x 10^{-6}	7.1 x 10^{-7}	6.8 x 10^{-7}	5.4 x 10^{-7}	5.2 x 10^{-7}
	valeraldehyde	1.2 x 10^{-5}	3.2 x 10^{-6}	3.1 x 10^{-6}	2.4 x 10^{-6}	2.3 x 10^{-6}
	o-tolualdehyde	4.2 x 10^{-5}	1.1 x 10^{-5}	1.1 x 10^{-5}	7.0 x 10^{-6}	6.7 x 10^{-6}
	m-tolualdehyde	6.5 x 10^{-5}	1.7 x 10^{-5}	1.6 x 10^{-5}	9.1 x 10^{-6}	8.8 x 10^{-6}
	p-tolualdehyde	2.9 x 10^{-5}	7.7 x 10^{-6}	7.4 x 10^{-6}	3.4 x 10^{-6}	3.2 x 10^{-6}
Ketones	acetone	1.3 x 10^{-4}	3.4 x 10^{-5}	3.3 x 10^{-5}	1.3 x 10^{-5}	1.3 x 10^{-5}
	methylethlketone	3.0 x 10^{-5}	7.9 x 10^{-6}	7.6 x 10^{-6}	3.3 x 10^{-6}	3.2 x 10^{-6}
Aromatics	toluene	2.9 x 10^{-3}	7.5 x 10^{-4}	7.2 x 10^{-4}	3.9 x 10^{-4}	3.7 x 10^{-4}
	ethylbenzene	9.5 x 10^{-4}	2.5 x 10^{-4}	2.4 x 10^{-4}	1.7 x 10^{-4}	1.6 x 10^{-4}
	m,p-xylene	1.8 x 10^{-3}	4.6 x 10^{-4}	4.4 x 10^{-4}	3.0 x 10^{-4}	2.9 x 10^{-4}
	o-xylene	9.0 x 10^{-4}	2.4 x 10^{-4}	2.3 x 10^{-4}	1.5 x 10^{-4}	1.4 x 10^{-4}
	1,2,3 trimethylbenzene	1.7 x 10^{-4}	4.4 x 10^{-5}	4.2 x 10^{-5}	1.9 x 10^{-5}	1.8 x 10^{-5}
	1,2,4 trimethylbenzene	8.1 x 10^{-4}	2.1 x 10^{-4}	2.0 x 10^{-4}	9.8 x 10^{-5}	9.5 x 10^{-5}
	1,3,5 trimethylbenzene	2.9 x 10^{-4}	7.6 x 10^{-5}	7.3 x 10^{-5}	3.3 x 10^{-5}	3.1 x 10^{-5}
	styrene	1.9 x 10^{-4}	5.0 x 10^{-5}	4.8 x 10^{-5}	2.2 x 10^{-5}	2.1 x 10^{-5}
	benzene	1.4 x 10^{-3}	3.8 x 10^{-4}	3.6 x 10^{-4}	1.8 x 10^{-4}	1.7 x 10^{-4}
Aromatics C9	Aromatics C9	8.4 x 10^{-4}	2.2 x 10^{-4}	2.1 x 10^{-4}	9.4 x 10^{-5}	9.0 x 10^{-5}
Aromatics C10	Aromatics C10	3.7 x 10^{-4}	9.8 x 10^{-5}	9.4 x 10^{-5}	3.7 x 10^{-5}	3.6 x 10^{-5}
Aromatics C>13	Aromatics C>13	1.5 x 10^{-3}	3.9 x 10^{-4}	3.7 x 10^{-4}	2.2 x 10^{-4}	2.1 x 10^{-4}
PAHs & POPs	indeno(1,2,3-cd)pyrene	1.3 x 10^{-7}	3.4 x 10^{-8}	3.2 x 10^{-8}	6.3 x 10^{-8}	6.1 x 10^{-8}
	benzo(k)fluoranthene	1.9 x 10^{-7}	5.0 x 10^{-8}	4.8 x 10^{-8}	9.0 x 10^{-8}	8.7 x 10^{-8}
	benzo(b)fluoranthene	2.1 x 10^{-7}	5.5 x 10^{-8}	5.2 x 10^{-8}	1.0 x 10^{-7}	9.6 x 10^{-8}
	benzo(ghi)perylene	2.2 x 10^{-7}	5.7 x 10^{-8}	5.5 x 10^{-8}	1.1 x 10^{-7}	1.0 x 10^{-7}
	fluoranthene	1.8 x 10^{-6}	4.8 x 10^{-7}	4.6 x 10^{-7}	9.1 x 10^{-7}	8.8 x 10^{-7}
	benzo(a)pyrene	1.1 x 10^{-7}	2.9 x 10^{-8}	2.8 x 10^{-8}	5.8 x 10^{-8}	5.6 x 10^{-8}
	pyrene	1.7 x 10^{-6}	4.5 x 10^{-7}	4.3 x 10^{-7}	8.7 x 10^{-7}	8.4 x 10^{-7}
	perylene	3.0 x 10^{-8}	8.0 x 10^{-9}	7.7 x 10^{-9}	1.6 x 10^{-8}	1.5 x 10^{-8}
	anthanthrene	5.9 x 10^{-9}	1.5 x 10^{-9}	1.5 x 10^{-9}	3.1 x 10^{-9}	3.0 x 10^{-9}
	benzo(b)fluorene	7.9 x 10^{-7}	2.1 x 10^{-7}	2.0 x 10^{-7}	4.2 x 10^{-7}	4.0 x 10^{-7}
	benzo(e)pyrene	3.0 x 10^{-7}	7.9 x 10^{-8}	7.6 x 10^{-8}	1.7 x 10^{-7}	1.6 x 10^{-7}
	triphenylene	4.2 x 10^{-7}	1.1 x 10^{-7}	1.1 x 10^{-7}	2.2 x 10^{-7}	2.1 x 10^{-7}
	benzo(j)fluoranthene	2.7 x 10^{-7}	7.2 x 10^{-8}	6.9 x 10^{-8}	1.1 x 10^{-7}	1.1 x 10^{-7}
	dibenzo(a,j)anthacene	1.1 x 10^{-8}	3.0 x 10^{-9}	2.9 x 10^{-9}	5.0 x 10^{-9}	4.8 x 10^{-9}
	dibenzo(a,l)pyrene	5.3 x 10^{-9}	1.4 x 10^{-9}	1.3 x 10^{-9}	2.1 x 10^{-9}	2.1 x 10^{-9}
	3,6-dimethyl-phenanthrene	1.6 x 10^{-7}	4.2 x 10^{-8}	4.0 x 10^{-8}	7.7 x 10^{-8}	7.4 x 10^{-8}
	benzo(a)anthracene	2.0 x 10^{-7}	5.2 x 10^{-8}	5.0 x 10^{-8}	1.0 x 10^{-7}	9.7 x 10^{-8}
	acenaphthylene	9.2 x 10^{-7}	2.4 x 10^{-7}	2.3 x 10^{-7}	5.5 x 10^{-7}	5.3 x 10^{-7}
	acenapthene	1.2 x 10^{-6}	3.3 x 10^{-7}	3.1 x 10^{-7}	7.4 x 10^{-7}	7.1 x 10^{-7}
	fluorene	7.0 x 10^{-7}	1.9 x 10^{-7}	1.8 x 10^{-7}	3.1 x 10^{-7}	2.9 x 10^{-7}
	chrysene	5.2 x 10^{-7}	1.4 x 10^{-7}	1.3 x 10^{-7}	2.5 x 10^{-7}	2.4 x 10^{-7}
	phenanthrene	3.5 x 10^{-6}	9.1 x 10^{-7}	8.7 x 10^{-7}	1.7 x 10^{-6}	1.6 x 10^{-6}
	napthalene	1.1 x 10^{-4}	2.8 x 10^{-5}	2.7 x 10^{-5}	5.4 x 10^{-5}	5.2 x 10^{-5}
	anthracene	3.9 x 10^{-7}	1.0 x 10^{-7}	9.8 x 10^{-8}	1.6 x 10^{-7}	1.6 x 10^{-7}
	coronene	1.8 x 10^{-8}	4.8 x 10^{-9}	4.6 x 10^{-9}	6.1 x 10^{-9}	5.9 x 10^{-9}
	dibenzo(ah)anthracene	2.3 x 10^{-8}	6.1 x 10^{-9}	5.8 x 10^{-9}	1.2 x 10^{-8}	1.2 x 10^{-8}
Dioxins	Dioxins	1.1 x 10^{-12}	2.9 x 10^{-13}	2.8 x 10^{-13}	4.7 x 10^{-13}	4.5 x 10^{-13}
Furans	Furans	2.3 x 10^{-12}	6.1 x 10^{-13}	5.8 x 10^{-13}	9.8 x 10^{-13}	9.4 x 10^{-13}

TER report


Simulation of the Tasmanian on-road fleet mix with the Australian Fleet Model (AFM)

Transport Emission Energy Research

TER (Transport Energy/Emission Research Pty Ltd)
https://www.transport-e-research.com/

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Date: 22 April 2021

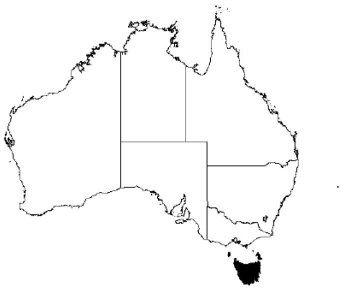

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Table of Contents

1. Introduction

TER was contracted by Tarkarri Engineering on behalf of the Tasmanian Environment Protection Authority to develop COPERT Australia input files for Tasmania (TAS) for base years 2018 and 2035. COPERT Australia software v1.3 will then be used to develop fleet-averaged vehicle emission factors for these base years. These emission factors can then be used in specific projects such as the new bridge at Bridgwater north of Hobart on the Midland Highway.

COPERT Australia includes estimation of cold and hot running exhaust vehicle emissions, as well as non-exhaust emissions. A COPERT Australia input file is already available for the Tasmanian on-road fleet for base year 2010. This file was created for the National MVEI in 2014.[1]

This report discusses the technical background regarding fleet mix modelling for Tasmania. This information is reflected in two new COPERT Australia input files. A fleet model is required to simulate the progressive changes in on-road fleet mix over time. For this project, fleet turnover is simulated with AFM (Australian Fleet Model), a fleet model developed, maintained and owned by TER.

Vehicle classification is an important aspect discussed throughput this report.

This report will use the following terminology:

- '**vehicle type**' is used to describe the overarching vehicle grouping, e.g. truck, bus, car.
- '**vehicle category**' is used to describe a further breakdown of vehicle type by size and fuel type, e.g. large petrol SUV or articulated diesel truck.
- '**vehicle class**' (or similarly '**model class**') is used to describe the most detailed breakdown of the vehicle fleet, and it includes either 'vehicle vintage' or 'vehicle age' (determined by the difference between base year and year of manufacture) or 'technology groups', e.g. 5 year old large petrol SUV or, more aggregated, large ADR79/02 petrol SUV.

Finally, the term '**composite vehicle class**' is used to denote any other *customised* (and often aggregated) vehicle classification that enables linkage of detailed vehicle class emission factors to the level of detail in available traffic activity and traffic performance data. This will be discussed later in the report.

2. Study objective

The objective of this study is to estimate the on-road vehicle population and total (vehicle) kilometres travelled (VKT) in Tasmania for 226 COPERT Australia vehicle classes for base years 2018 and 2035.

3. Fleet simulation in a nutshell

Various engine and vehicle design factors impact on vehicle emissions and fuel consumption. Emission simulation therefore requires a detailed breakdown of the on-road fleet. For instance, in the vehicle emissions software 'COPERT Australia' the fleet mix (on-road population, annual mileage, accumulated mileage) needs to be estimated for 226 vehicle classes.

Fleet mix modelling at this level of detail poses certain challenges and requires various assumptions. Published fleet data are often too aggregated to be useful for the high level of detail required for vehicle emissions modelling. In addition, available fleet data sets often apply different vehicle class definitions.

TER has developed and maintains a fleet mix model called AFM (Australian Fleet Model). The software tool simulates the on-road vehicle population and total (vehicle) kilometres travelled (VKT) for **1,240 vehicle classes** for past, current and future base years. Figure 1 shows a schematic of the fleet modelling process. The first step creates a detailed on-road vehicle **population** table for current and/or past base years using various data sets. The next step is to estimate **total travel** for each vehicle class, which is expressed as total vehicle kilometres travelled per year (VKT/annum).

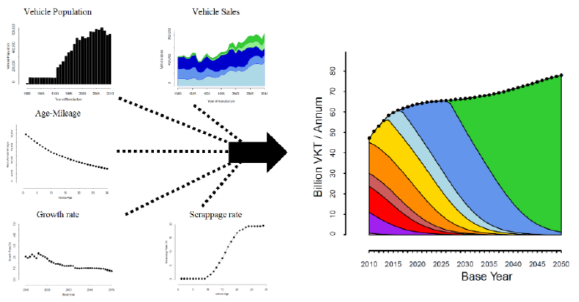

Figure 1 – AFM fleet modelling process.[2]

At a more detailed level, vehicle usage is reflected in mathematical relationships between vehicle age and mean annual mileage and between vehicle age and accumulated mileage.

For future years information regarding on-road vehicle population and vehicle sales is not available. Therefore, assumptions need to be made regarding the on-road fleet population and vehicle use. Fleet growth rate and fleet turnover (scrappage) are used for each vehicle category (40 in total) to simulate the progressive changes in fleet composition over time.

The simulation generates a detailed (future) vehicle population and travel (VKT) data table for 40 vehicle categories and 31 vintage/age categories (i.e. 1,240 model classes) for each base year. The data tables are compressed to 40 vehicle categories and 19 ADR categories. Each ADR category spans a predefined range of vehicle years of manufacture. For instance, small ADR79/02 petrol cars include years of manufacture 2010-2013. Since not all combinations of vehicle class and ADR exist (e.g. some ADRs apply only to heavy-duty vehicles), the result is a set of compressed VKT tables with a total of 360 model classes for each base year.

These data provide a detailed breakdown of the fleet mix population and travel (VKT), which is subsequently used for vehicle emissions modelling. As a final step, the vehicle population, annual mileage and accumulated mileage data are converted to a particular format, for instance, the COPERT Australia input file format, where an input file is created for each base year.

COPERT Australia is then run with the new input files that reflect the on-road fleet mix for different base years. A detailed emission factor database can be extracted from COPERT Australia and fleet averaged (composite) vehicle emission factors can now be computed. Creation of these composite emission factors effectively links COPERT Australia to the level of detail in available traffic data. The input traffic data guides the definition of composite vehicle classes, for instance cars, light commercial vehicles and trucks.

It is noted that different assumptions on e.g. age – mileage or age – scrappage relationships will lead to different estimates of future on-road vehicle population, VKT and accumulated mileage. A sensitivity analysis can be used to quantify the uncertainty in predictions, but is outside the scope for this project.

4. AFM fleet simulation for Tasmania

The following sections discuss the AFM fleet simulation for Tasmania in more detail.

4.1 Aggregated calibration data

AFM simulates fleet turnover for individual base years for 1,240 vehicle classes. At different points in the simulation, intermediate results are verified using aggregated data, collected from reliable sources. They are fuel use data and travel data (total VKT).

4.1.1 – Fuel use (State)

Fuel consumption and energy data are available for road transport from a number of sources.

- The Australian Bureau of Statistics (ABS) publishes the Survey of Motor Vehicle Use or SMVU, which provides a time-series of total fuel consumption expressed as million litres and broken up by State, vehicle type (PV, LCV, MCY, Non-Freight Truck, RT, AT, BUS) and fuel type (petrol, diesel and the somewhat cryptic "LPG/CNG/dual fuel/hybrid") for the base years 1998 – 2016 (excluding 2008, 2009, 2011, 2013, 2015).
- The Department of the Environment and Energy (DEE) provides data on Australian energy supply and consumption for several sectors including "Road Transport" in PJ for the financial years 1973/74 to 2016/17. This dataset is referred to as Australian Energy Statistics (AES).
- DEE also provides fuel sales data of petroleum products in million litres by State and type of fuel based on the financial years 2010/11 to 2017/18. This dataset is referred to as Australian Petroleum Statistics (APS).
- The Bureau of Infrastructure, Transport and Regional Economics (BITRE) provides estimates of total fuel use in billion litres for three fuel types (petrol, diesel, LPG) for all states and for base years 1965-2007. It also includes a full time-series of DRET data for this period.

These data have different levels of detail. For instance, the ABS SMVU combines petrol and E10 together in a category called "petrol" and does not distinguish between ULP and PULP. DEE does distinguish between ULP, PULP and E10, but lumps ACT and NSW together.

To create a consistent dataset, the fuel data sets were first converted to a common base, i.e. volume (million litres) and subsequently mass units (metric tonne) using fuel parameters for each type of fuel (fuel density and lower/higher heating values). Then financial year data were converted to calendar year data by taking the average of the overlapping financial years (e.g. 2010 is the average of 2009-2010 and 2010-2011 financial years). The results for Tasmania are shown in Figure 3 for selected sources of information.

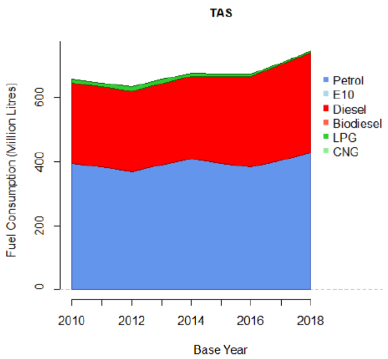

Figure 3 – Fuel use data for Tasmania using SMVU (petrol, diesel) and AES (other fuels).

Petrol/E10

Differences in estimated petrol use (national level) by road transport from the data sources vary with 1-6%, where SMVU consistently reports the lowest consumption of petrol. However, the APS and AES petrol sales and consumption data contain a small fraction that is not used by road transport. BITRE estimated that this fraction has been relatively constant over time (about 5%), which is line with the observed differences between the datasets.[3] It appears that the SMVU data generally provides the most accurate total petrol use data for road transport. It does not provide separate fuel use data for E10, which is not an issue in Tasmania as this type of fuel is not used. However for Tasmania, the APS and AES data both provide a substantially *lower* estimate of petrol fuel use (15-20%). After consideration of this discrepancy, the APS petrol fuel use data were selected for fuel calibration, rather than SMVU. The APS petrol fuel estimate for Tasmania produced the lowest errors in initial (pre-calibration) COPERT Australia simulations.

Diesel

ABS and AES provide similar estimates of diesel use by road transport, where AES is about 0-3% higher for Australia, depending on the financial year. However, differences can be substantially larger at State level. In fact, AES estimates a substantially lower diesel fuel use by road transport in e.g. NSW of about 20% and about 10% lower diesel use in Victoria. In Tasmania the difference between AES and ABS varies year-by-year, with the largest difference in 2018 (AES is 23% lower). The APS reports diesel use up to a factor of 2 higher than the the SMVU for Australia, but contains a substantial fraction that is not used by road transport. It is estimated that this fraction has increased over time, with a value of about 0.45 in 2007.[3] APS also estimates larger diesel fuel use in Tasmania, and the difference with ABS has been growing from about 45% in 2010 to about 65% in 2018. The fuel data analysis suggests that about 60% of diesel fuel in Tasmania is used by road transport. It appears that the SMVU data provides the most accurate total diesel use data for road transport. However it is noted that the uncertainty in this value appears high.

LPG

APS provides automotive and non-automotive (residential heating, forklifts, etc.) use of LPG for Australia, but not at State level. Non-automotive LPG use accounts for a growing proportion of total LPG use in Australia, i.e. approximately 50% in 2010/11 to 60% in 2017/2018. This is mainly due to a substantial reduction of LPG use by road transport of about 60% over this time period (from about 2.0 to 0.9 billion litres). AES reports LPG as well as natural gas (CNG) use by 'road transport' by State, and is generally significantly higher (about 40%) than the value reported by the ABS. This not the case for Tasmania where AES generally reports lower LPG use than the SMVU.

After conversion from PJ to metric tonnes, AES CNG and LPG use for road transport shows that CNG makes up about 5-10% of the combined LPG and CNG consumption, depending on the financial year. So the cryptic category "LPG/CNG/dual fuel/hybrid" used in the SMVU, likely reflects mainly LPG use. Since DRET provides LPG data specifically for automotive use, and given the small sample size of the SMVU, it appears that AES provides the most robust and reliable estimate of LPG (and CNG) use for road transport.

CNG

The only source of CNG use data for road transport was AES. Data are provided in energy units (PJ) and are converted to mass units using a HHV of 52.2 MJ/kg. The data show an increasing use of CNG in the road transport sector, whereas LPG use is decreasing. Nevertheless, CNG use in on-road transport remains marginal with 0.2-0.3% of total fuel use. No natural gas use is reported for Tasmania.

Biodiesel

An estimate of biodiesel fuel use by road transport was derived by subtracting E10 fuel use from 'Liquid/gas Biofuels' reported by AES. CNG use in on-road transport is estimated to be marginal with 0.1 – 0.3% of total fuel use. No biodiesel use is reported for Tasmania.

Fuel consumption in Tasmania

Table 1 shows total fuel consumption in Tasmania for base year 2018.

This information will be used in calibration of the COPERT Australia input files.

Table 1 – Fuel consumption for road transport in Tasmania for base year 2018 (million litres).

Petrol	E10	Diesel	Biodiesel	LPG	CNG	Total
358	0	314	0	5	0	678

4.1.2 – Total vehicle kilometres travelled (State)

VKT cannot be measured directly but can be estimated using different methods including analysis of vehicle odometer databases[1], combination of traffic volume and road length data (either from road-based traffic counts or transport models) and household travel surveys.

In the development of AFM a number of data sources [3-5] were examined, compared and used to create a complete and consistent time-series of total annual VKT for 18 vehicle types by jurisdiction (ACT, NSW, NT, QLD, SA, TAS, VIC) and base year (1965 – 2020).[2]

4.2 On-road vehicle population

The first step in AFM is to create a vehicle population data table for current and/or past base years, using various data sets. The on-road vehicle population for current/past on-road fleets is estimated using Motor Vehicle Census (MVC) data from the Australian Bureau of Statistics (registered vehicles) and motor vehicle sales data compiled from various sources, as will be discussed shortly.

4.2.1 – Basic vehicle population files (State)

The MVC provides information on the number of registered vehicles by state, year of manufacture (YoM) at a particular census date and reporting year (base year) for the following vehicle types: passenger vehicles, light commercial vehicles, motorcycles, light rigid trucks, heavy rigid trucks, articulated trucks, buses, campervans and non-freight carrying trucks.

There are differences between the vehicle group definitions used by the ABS and those used in COPERT Australia. For instance, there is no 'Campervans' or 'Non-freight carrying trucks' vehicle category in COPERT Australia, and the 'Bus' category is more detailed in COPERT Australia, i.e. it is divided into a light and heavy bus category. Although the 'Light Rigid Trucks up to 4.5t GVM' Motor Vehicle Census category appears to fall falls entirely in the MCV category (COPERT Australia), the 'Heavy Rigid Trucks > 4.5t GVM' Motor Vehicle Census category overlaps with the MCV, HCV and AT categories used in COPERT Australia. The 'Passenger vehicle' (PV) category in the Motor Vehicle Census combines passenger cars and sport utility vehicles (SUVs) into a single category, which are separate vehicle types in COPERT Australia.

In order to assign the Motor Vehicle Census vehicle population data to the correct AFM vehicle types, TER has undertaken a detailed analysis of ABS microdata investigating the number of registered vehicles by vehicle type, model year, engine capacity and GVM category. The relative proportions of registered vehicles by make/model/MY within each ABS vehicle type was then used to split, or aggregate, the Motor Vehicle Census data files and combine them into the appropriate AFM vehicle types. For instance, the registered vehicles in the non-freight category in Australia were split into specific proportions and allocated to relevant AFM types (LCVs, MCVs, HCVs and ATs). The category PV was split into two categories, passenger cars (PCs) and SUVs, using annual vehicle sales data.[2,6,7]

[1] An odometer measures distance travelled by a vehicle and it may be electronic, mechanical, or a combination of the two.

[2] Defined as combinations of main vehicle type (PV, LCV, MCY, RT, AT, BUS) and fuel type (petrol, diesel, LPG).

The final result of this analysis is nine basic AFM population files for each state and the following nine vehicle types for model years 1901 to 2016:

- passenger cars (PC)
- sport utility vehicles (SUV)
- light-commercial vehicles (LCV)
- medium-commercial vehicles (MCV)
- heavy-commercial vehicles (HCV)
- articulated trucks (AT)
- light buses (BUS-L)
- heavy buses (BUS-H)
- motorcycles (MCY)

The basic population files can be verified and refined with an analysis of local vehicle registration data but this work is out of scope for this project.

4.2.2 – National vehicle sales table

TER conducted an in-depth analysis of national vehicle sales time-series data and other information sources.[2,6-8] The result is a national vehicle sales table that assigns relative sale proportions to each year of manufacture (1901 – 2050) for 18 light-duty vehicle categories.[3] This table enables splitting the Australian on-road LDV fleet into a detailed vehicle classification that explicitly considers vehicle size and fuel type.

It is noted that available sales data do not allow for further splitting of the truck, bus and motorcycle population into different fuel types. The impact of this gap in information is expected to be small as trucks, buses and motorcycles mainly use diesel (HDVs) and petrol (motorcycles). Nevertheless, an adjustment is made in AFM to account for a small portion of CNG and LPG usage in HDVs, as will be discussed later. Special attention was given to SUVs and LPG vehicles in the development of the vehicle sales table.

SUVs

The Australian Federal Chamber of Automotive Industries defines SUVs as vehicles with a wagon body style and elevated ride height, often with 4WD/AWD capability, which is further segmented using footprint bins. In COPERT Australia, SUVs are defined as either compact SUVs (engine capacity ≤ 4.0 litres, 4-6 number of cylinders) , denoted as SUV-C, or large SUVs (engine capacity ≤ 6.5 litres, 4-8 number of cylinders), denoted as SUV-L. However, these SUV definitions are not mutually exclusive and the actual designation for a SUV to be either SUV-C or SUV-L is based on a list of particular make/model combinations.

This list was initially (and somewhat arbitrarily) constructed by the second National In-Service Emissions Study (NISE2) Steering Committee, which took into account other factors such as chassis body size.[9] Typical SUV-C vehicles are Honda CRV, Ford Escape, Nissan Pathfinder, Toyota RAV4,

[3] PCs are split into small/medium/large petrol PC, small/medium/large diesel PC and small/medium/large LPG PC. SUVs are split into compact/large petrol SUV, compact/large diesel SUV and compact/large LPG SUV. LCVs are split into petrol/diesel/LPG LCV.

Hyundai Tucson and Subaru Forester. Typical SUV-L vehicles are Landrover Discovery, Mitsubishi Pajero, Nissan Patrol, Holden Jackaroo, Toyota Prado and Toyota Landcruiser.

A list of unique make/model combinations was created in AFM to ensure correct allocation of the SUV sales data to AFM vehicle categories.

LPG vehicles

Special consideration was given to liquefied petroleum gas (LPG) vehicles. LPG vehicles make up a significant albeit diminishing portion of the national on-road fleet, yet there is a lack of detailed data on the actual number of LPG vehicles that have entered the on-road fleet for each year of manufacture.

The main issue is that Australian vehicle sales data only report the sales of dedicated (original equipment manufacturer, OEM) LPG vehicles. The sales data do not include the conversion of petrol vehicles into retrofitted LPG vehicles, which make up the majority of the LPG vehicles entering the market each year (about 60-90%, but almost 100% in 2017).

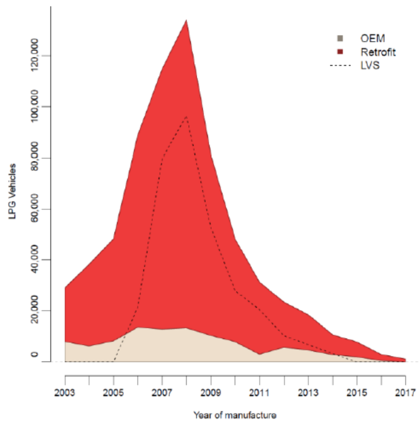

Figure 3 – Reconstructed time-series of LPG vehicles in the on-road Australian fleet.

From 2006 to 2014 the Australian LPG Vehicle Scheme (LVS) provided grants to private vehicle owners for retrofit conversion of cars to LPG. The scheme was designed to support the uptake of LPG as a transport fuel and resulted in a spike in retrofit LPG vehicles entering the fleet in the period 2006-2009 (Figure 3).

However, there has been a substantial drop in dedicated and retrofit LPG vehicles entering the on-road fleet from 2008 onwards. Information from Gas Energy Australia and other sources has been used to reconstruct a time-series of combined dedicated and retrofitted LPG vehicles entering the on-road vehicle fleet (Figure 3).[10-13] This information was incorporated into the vehicle sales table.

Vehicle sales data for individual states

It is assumed that the national vehicle sales table used in AFM is reasonably representative of vehicle sales patterns in individual states. A state-specific vehicle sales table can in principle be developed, but this work is out of scope for this project.

4.2.3 – Population tables for Tasmania

The combination of nine (state-specific) basic vehicle population files with (national) vehicle sales table results in a population table with 24 vehicle categories.[4] A few final refinement steps were applied to correct and expand the AFM on-road population table for Tasmania to 40 vehicle categories.

Nil-use correction (24 vehicle categories)

A vehicle may be registered but not actually used, a situation referred to as 'nil-use'. Percentage of nil-use is typically small in the order of a few percent [14], but significantly higher for particular vehicle types such as motor cycles. A vehicle-category dependent nil-use correction was applied to AFM population tables.

State-specific LPG correction for LDVs (24 vehicle categories)

Australian states have a significantly different use of automotive LPG fuels. To reflect this difference in the AFM population table for Tasmania, a correction is applied to the number of on-road light-duty LPG vehicles. The correction is based on national and state-specific information regarding total travel by these vehicles. Total travel is expressed as vehicle kilometres travelled (VKT).

The correction effectively allocates a portion of the national LPG LDV fleet to individual states using the ratio of state-specific vehicle travel (VKT) to national vehicle travel (VKT) for specific LPG vehicle categories (PVs, LCVs). The underlying assumption is that annual mileage is similar for the LPG LDV fleet in each state.

State-specific expansion to include CNG/LPG and petrol HDVs/buses (34 vehicle categories)

The HDV population file is split into diesel, petrol and LPG/CNG HDV and bus categories (MCV, HCV, AT, BUS-L, BUS-H) using national and state-specific information on total travel by these vehicles.

State-specific expansion to include E10 LDVs (40 vehicle categories)

As a final step, the LDV petrol population is split into petrol and E10 vehicles through consideration and iterative simulation of total E10 fuel use and E10 suitability of vehicles by year of manufacture. It is noted that E10 fuel use in Tasmania is zero, so this expansion step is not relevant for Tasmania.

Final population files (40 vehicle categories)

The on-road fleet population data matrix (registered vehicles by year of manufacture), vehicle category nil-use considerations, and the comprehensive vehicle sales splitting factor matrix are combined to create a detailed population data input file (on-road vehicles by year of manufacture) consisting of 40 vehicle categories.

[4] PC-S-petrol, PC-S-diesel, PC-S-LPG, PC-M-petrol, PC-M-diesel, PC-M-LPG, PC-L-petrol, PC-L-diesel, PC-L-LPG, SUV-C-petrol, SUV-C-diesel, SUV-C-LPG, SUV-L-petrol, SUV-L-diesel, SUV-L-LPG, LCV-petrol, LCV-diesel, LCV-LPG, MCV-diesel, HCV-diesel, AT-diesel, BUS-L-diesel, BUS-H-diesel, MCY-petrol.

It is noted that combination of census data with sales data inherently assumes that the proportions for a particular year of manufacture (model year) in vehicle sales data remain constant as the vehicle population ages and vehicles are scrapped. This seems a reasonable assumption.

4.3 Vehicle use

After the development of a detailed breakdown of the on-road vehicle population by main vehicle type, fuel type, engine capacity, gross vehicle mass and model year, the next step is to estimate vehicle usage for each vehicle category.

Vehicle usage for a particular vehicle category is reflected in a mathematical relationship between 1) vehicle age and mean annual mileage, and 2) between vehicle age and accumulated mileage. These functions are required to estimate total travel (expressed as vehicle kilometres travelled or VKT), and to estimate the impacts of emissions deterioration due to ageing.

The relationships were developed by TER following analysis of Australian and New Zealand odometer data [15,16] and fitting of non-linear models (Figure 4), consideration of published relationships, and calibration to total travel (Section 4.1) and mean annual mileage data published by the ABS SMVU [4], as will be discussed below.

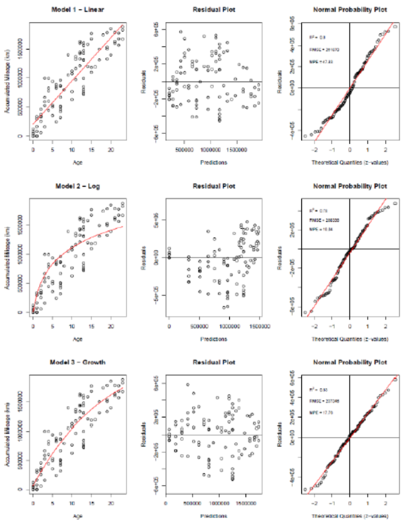

Figure 4 – an example of development of age-mileage algorithms (articulated trucks).

Figure 4 shows an example of fitting different linear and non-linear model algorithms to accumulated mileage data for Australian articulated trucks, regression verification (residual analysis) and assessment of model performance (R^2, RMSE, MPE) to select the best model. The relationship between mean annual mileage and vehicle age is derived from these algorithms by simply computing the differences in accumulated mileage for subsequent years, i.e.

$$\overline{M_i} = \begin{cases} M_i & i = 0 \\ M_{i+1} - M_i & 1 \leq i \leq 30 \end{cases}$$

where *i* indicates the vehicle age. The odometer data suggest that there is a difference between small, medium and large passenger cars for the first 10 years of driving. Small passenger cars drive about 20% less when new as compared with medium passenger cars, and the difference is almost linearly reduced to about zero at 10 years of age. Large (petrol) passenger cars drive about 15% more when new as compared with medium passenger cars, and the difference is almost linearly reduced to about zero at 10 years of age.

AFM age-mileage algorithms are created with a two-tiered calibration and verification step.

1. The vehicle age – mileage relationships were combined with Australian vehicle population files to compute *initial* VKT estimates. The age - annual mileage relationships were then shifted up and down in 10 VKT offset steps, creating a total of 3,500 simulations. These VKT simulations were then compared with state-specific total VKT data (section 4.1) and the optimum offset (i.e. smallest error in total VKT) was determined for each vehicle category. This first calibration step results in *intermediate* calibrated vehicle age – mileage relationships.
2. In the second calibration step, *mean* annual mileage was computed for each vehicle category and compared with (national) mean annual mileage data published by the ABS SMVU. Scaling factors are then computed and used in the second calibration step, which results in the *final* calibrated vehicle age – mileage relationships.

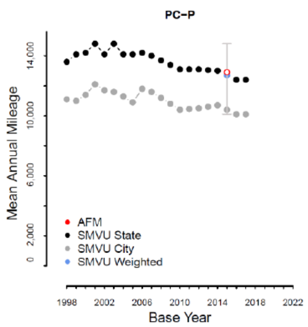

Figure 5 – an example of age-mileage calibration using SMVU data

In AFM there are different options available for calibration of the vehicle age – mileage relationships, and they will lead to different estimates for fleet composition. The first step is to calibrate to state-specific total VKT by vehicle category (step 1), and stop there. The second option is to carry out step 1, and then proceed with step 2, i.e. further calibration using national ABS SMVU data (Figure 5). So a decision is required as to which calibration data are believed to be more accurate, i.e. total VKT or mean annual mileage.

The second option was used in the development of the Tasmanian average age – mileage relationships. However, ABS SMVU mean annual mileage data can vary substantially year by year. Therefore, the simulation was conducted for multiple (recent) years to create more robust results.

The Tasmanian age – mileage relationships reflect averaged values for the last three years. AFM contains age-mileage algorithms for 40 vehicle categories, reflecting, for instance, that small passenger cars drive less and large passenger cars drive more, as compared with medium passenger cars, diesel cars drive more than their petrol counterparts, etc. Figure 6 (next page) shows a few examples.

It is noted that a final (VKT) calibration is conducted using the fuel use data discussed in Section 4.1.1. This is done by using an initial COPERT Australia input file for 2018, run COPERT Australia and then re-calibrate vehicle age – mileage relationships to ensure that total predicted fuel consumption by fuel type is equivalent to reported values.

In addition to estimating total travel (VKT), age-mileage algorithms are also used to estimate *accumulated* mileage for each vehicle category and year of manufacture. This is required to estimate the (adverse) impacts of vehicle ageing on emissions. Emissions of in-service vehicles are higher than those of new vehicles due to 'natural' engine and emission control deterioration, and in some cases defects, poor maintenance or even tampering.

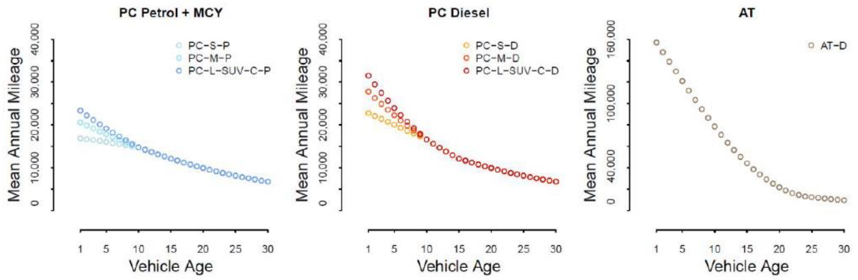

Figure 6 – Examples of calibrated age-mileage relationship for Tasmania for selected vehicle categories.

4.4 Fleet growth and vehicle scrappage

For future years, information regarding on-road vehicle population and vehicle sales is not available. Therefore, assumptions are required regarding the on-road fleet population and vehicle use. Fleet growth rate and fleet turnover (scrappage) needs to be explicitly considered for each vehicle category (40 in total) to simulate the progressive changes in fleet composition over time.

The AFM has developed age-dependent scrappage rates for each model year/vintage within a particular vehicle category. The scrappage rates are based on detailed analysis of ABS Motor Vehicle Census data and consideration of published relationships.

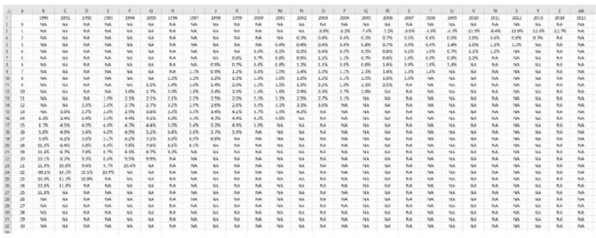

Figure 7 – Example of a scrappage table for a particular vehicle class.

Census data were used compute percent change in the on-road vehicle population for each model year/vintage within a particular vehicle category for subsequent base years (Figure 7).

AFM uses these tables to construct scrappage – vehicle age relationships. An example is shown in Figure 8. Scrappage – age relationships ideally require updates at regular time intervals (say every 5-10 years) to properly reflect changes in consumer behaviour. For instance, faster scrappage rates could result from factors such as increased affordability of vehicles.

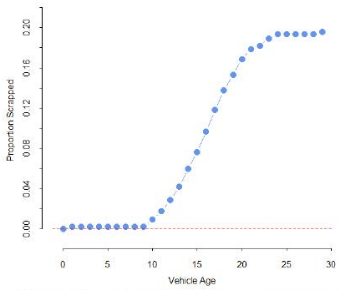

Figure 8 – Example of age – scrappage relationship for a particular vehicle category.

On the other hand slower attrition rates could result from economic downturns affecting businesses, e.g. with owners using their vehicles for longer time periods. Some vehicle types may have quite different scrappage rate profiles. For instance, motorcycles have a high initial scrappage rate, but a rather flat continued rate. This may be due to e.g. higher accident rates for motorcycles and differences in ownership behaviour (e.g. recreational use and periodic de-registering). It is noted that the sensitivity to different scrappage – age relationships can be tested in scenario modelling, but this is outside the scope of this project.

Base year 2015 is the starting point for estimation of Tasmania's on-road vehicle population and VKT tables for subsequent base years. The simulation is conducted in annual time steps using the following procedure.

1. Vehicle population growth rates are applied to 40 vehicle categories to determine the total estimated on-road fleet population in a particular base year, broken down by 31 vintage classes and associated vehicle ages (age 0-30, 30+).
2. The number of vehicles that are scrapped in a particular base year and for a specific vehicle category, are computed using vehicle category specific and age-dependent scrappage algorithms.
3. The number of new vintage vehicles entering the fleet (i.e. age = 0 years) is computed as the the difference between the total on-road fleet population over the previous year and the subsequent year that reflects both vehicle growth and scrapped vehicles.

The procedure generates detailed vehicle population tables for each subsequent base year.

4.5 Fleet turnover simulation

The previous steps result in past, current and future vehicle population data tables for 40 vehicle categories and 31 vintage/age categories (i.e. 1,240 model classes) for each base year. Vehicle category and age dependent annual mileage functions are then combined with these population tables to compute annual VKT for the 1,240 model classes, for each base year. The VKT tables are then compressed to 40 vehicle categories and 19 ADR categories.

AFM results for three vehicle categories are shown in Figure 9 as a few examples.

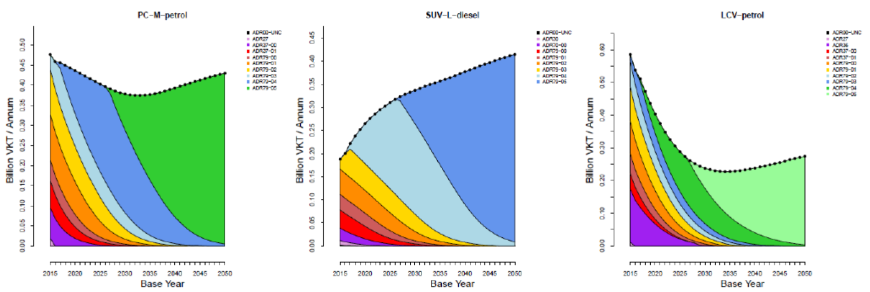

Figure 9 – Total VKT for selected vehicle categories by base year for the Tasmanian on-road fleet.

The charts show the impacts of entry in and exit from the on-road fleet of progressive vehicle technology groups (ADR), as well as different patterns of growth or decline in total VKT, as time progresses from 2015 to 2050. AFM is capable of simulating complex patterns in fleet turnover processes through consideration of vehicle class specific on-road population, vehicle usage, population growth/decline and scrappage rates.

Figure 10 and 11 show the VKT percentages for selected vehicle categories for each ADR category for base years 2018 and 2035, respectively. The bar plots show the changing proportions of individual vehicle classes as time progresses.

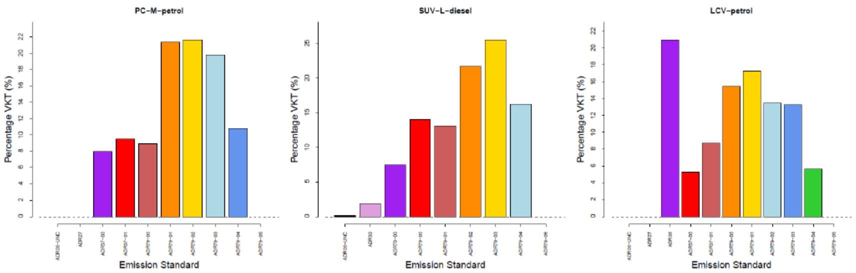

Figure 10 – VKT percentage for selected vehicle categories by ADR for 2018 (Tasmania).

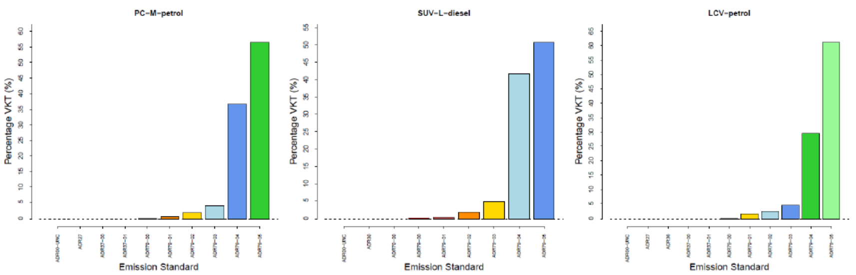

Figure 11 – VKT percentage for selected vehicle categories by ADR for 2035 (Tasmania).

As a final step, the vehicle population, annual mileage and accumulated mileage data are converted to the COPERT Australia input file format, and input files for 2018 and 2035 are created. COPERT Australia v1.3 can be run with the new input files. A detailed emission factor database can then be extracted and fleet averaged (composite) vehicle emission factors can be computed. In order to do this estimated kilometres travelled for all vehicle classes (e.g. small ADR79/04 petrol passenger car) that fall within a composite vehicle category (e.g. small petrol car) are used to compute weighting factors for individual vehicle classes.

5. Conclusions and Concluding Remarks

AFM (Australian Fleet Model) has been used to create COPERT Australia input files for base years 2018 and 2035 for Tasmania. The AFM software tool simulates the on-road vehicle population and total (vehicle) kilometres travelled (VKT) in Tasmania for 1,240 vehicle classes for past, current and future base years. AFM is capable of simulating complex patterns in Tasmania's fleet turnover processes through consideration of vehicle class specific on-road population, vehicle usage, population growth/decline and scrappage rates. Total fuel consumption in Tasmania was estimated for each fuel type (petrol, diesel, LPG, E10, CNG, biodiesel) for base year 2018. These fuel use data were used to calibrate annual VKT estimates for all 226 COPERT Australia vehicle classes.

6. Recommendations for further work

It was noticed that there was a significantly higher level of inconsistency between different fuel use data sets for Tasmania as compared with other Australian jurisdictions. This means that the uncertainty in the vehicle class specific VKT estimates is higher than usual. It would therefore be worthwhile to verify total fuel use by fuel type with other independent (local) Tasmanian data sets, if available.

AFM performs a detailed fleet simulation combining various data sources. A number of assumptions and decisions are required to complete the simulation. The sensitivity of the simulation results to these assumptions and decisions can be explored in a separate analysis. They are:

- Use of other fuel use data sets, if available (out of scope for this project).
- Use of state-specific vehicle registration data, if available (out of scope for this project).
- Use of state-specific vehicle sales table, if available (out of scope for this project).
- Calibration of age – mileage algorithms to total VKT only (sensitivity analysis).
- Use of alternative age – mileage algorithms (sensitivity analysis).
- Use of alternative age – scrappage algorithms (sensitivity analysis).
- Use of an alternative ADR allocation (sensitivity analysis).

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