Appendix K

AIR QUALITY ASSESSMENT

Air Noise Environment
Environmental Monitoring and Assessment

Cowra Heavy Vehicle Bypass - Air Quality Review - FINAL

Geolyse Pty Ltd

July 2015

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Table of Contents

1	Introduction	6
1.1	Purpose	6
1.2	Key Ambient Air Pollutants	6
1.3	Assessment Methodology	7
2	Cowra Heavy Vehicle Bypass	9
2.1	Background	9
2.2	Nearby Receptors	9
2.3	Road Attributes and Geometry	13
2.4	Estimated Traffic Flows	13
2.5	Emissions Estimates	15
3	Assessment – Construction Phase	16
3.1	Air Quality Goals	16
3.2	Sources of Emissions	16
4	Assessment – Operational Phase	18
4.1	Air Quality Goals	18
4.2	The Ausroads Model	18
4.3	Meteorological Inputs	19
4.4	Atmospheric Chemistry – NOX Conversion	21
4.5	Topography, Landuse and Receptor Grids	21
4.6	Summary of Key AusRoads Inputs	21
4.7	Cumulative Air Quality Analysis	21
4.8	Air Dispersion Modelling Results	22
5	Conclusion	27
	Appendix A - Air Quality Glossary	28

Index of Tables

Table 2.1: Estimated traffic volumes (vehicles / day)	15
Table 2.2: Summary of Emissions Estimates (g/km/v)	15
Table 4.1: NSW EPA Air Quality Goals	18
Table 4.2: Summary of Key Ausroads Model Inputs	21
Table 4.3: Estimated Existing Ambient Concentrations	22
Table 4.4: Maximum Predicted Cumulative Receptor Concentrations	22

Index of Figures

Figure 2.1: Alignment for proposed Cowra Heavy Vehicle Bypass Road 11
Figure 2.2: Alignment for proposed Cowra Heavy Vehicle Bypass Road 12
Figure 2.3: Alignment for proposed Cowra Heavy Vehicle Bypass Road 14
Figure 4.1: Comparison of Predicted and Observed Wind Speed and Direction 20
Figure 4.2: Scenario 1 – Maximum predicted 1 hour average cumulative NO2 concentrations for the year 201518 (µg/m3) 23
Figure 4.3: Scenario 1 – Maximum predicted 1 hour average cumulative NO2 concentrations for the year 203528 (µg/m3) 24
Figure 4.4: Scenario 2 – Maximum predicted 1 hour average cumulative NO2 concentrations for the year 2018 (µg/m3) 25
Figure 4.5: Scenario 2 – Maximum predicted 1 hour average cumulative NO2 concentrations for the year 2028 (µg/m3) 26

1 Introduction

1.1 Purpose

Cowra is a rural town in the Central West region of New South Wales. It has a population of around 10,000 people and is situated on several major trucking routes including the Mid-Western Highway, Lachlan Valley Way, Olympic Way and Canowindra Road. Currently heavy vehicles use the State Highways and Main Roads to travel through Cowra. In order to reduce congestion and improve safety for the Cowra CBD precinct, a heavy vehicle bypass is proposed to be constructed thereby minimising the heavy vehicle traffic through the town.

Air Noise Environment Pty Ltd has been commissioned to provide specialist air quality advice in relation to the Cowra Heavy Vehicle Bypass project. Specifically, predictive dispersion modelling has been undertaken to assess the potential impacts of the proposed bypass road on existing sensitive landuses. The advice contained in this report is to form part of the Review of Environmental Factors being prepared for the project by Geolyse Pty Ltd.

The purpose of the air quality assessment is to provide confirmation that the expected ambient air quality concentrations as a result of emissions from vehicles using the bypass remain within appropriate air quality goals.

1.2 Key Ambient Air Pollutants

The ambient air contains a mixture of naturally occurring substances and pollutants. Substances not naturally found in the air, or found at greater concentrations or in locations remote from natural background sources are generally referred to as ‘pollutants’. Sources of these pollutants include a range of human activities, such as industry and transportation.

‘Criteria pollutants’ is a term used internationally to describe air pollutants that have been regulated and are used as indicators of air quality. The following criteria pollutants have been identified as key indicators of air quality in urban environments:

- Particulate matter
- Photochemical oxidants (particularly ozone, O_3)
- Nitrogen Oxides (NO_x)
- Carbon monoxide (CO)
- Lead (Pb)
- Sulphur dioxide (SO_2)

Motor vehicles (cars, trucks, buses and motorcycles) are the major emitters of air pollutants in urban Australia, and are a significant influence on ambient concentrations of the criteria pollutants. For example, traffic is estimated to contribute more than 75% of the overall carbon monoxide emissions in Australia[1].

Most of the pollutants from combustion engines are emitted through the exhaust. The power to move motor vehicles comes from burning fuel (most commonly diesel or petrol) in an engine. Pollution comes from by-products of this combustion process (exhaust emissions) and from evaporation of the fuel itself.

Carbon monoxide is a product of incomplete combustion and occurs when carbon in the fuel is partially oxidised rather than fully oxidised to carbon dioxide. Oxides of nitrogen are formed by the interaction between nitrogen and oxygen under the high pressure and temperature conditions found in an engine. Particulate matter, soot and smoke (microscopic suspended particles primarily comprising carbon, condensed water vapour, hydrocarbons metals and acid droplets) are produced by internal combustion (particularly diesel) engines.

Other pollutants such as sulphur dioxide (SO_2) and lead (Pb) are also emitted from motor vehicles, but because of the low sulphur content of motor vehicle fuels in Australia the resulting ground-level concentrations of sulphur dioxide are too low to justify detailed analysis. Similarly, since the introduction of unleaded petrol in 1986 (and further mandated changes to fuel composition and engine technology), emissions of lead from traffic have now decreased to levels which are often hard to detect.

Analysis of photochemical oxidants is a regional issue related to the overall chemistry and chemical processes in the atmosphere. For this reason, analysis of the potential impacts on atmospheric chemistry and photochemistry is not appropriate for individual projects.

For the purposes of the assessment air dispersion modelling has been undertaken for the principle components of emissions from the proposed vehicle movements being PM_{10}, nitrogen dioxide (NO_2) and carbon monoxide (CO).

1.3 Assessment Methodology

The assessment of the proposed bypass has considered the potential for environmental impacts associated with both the construction and operation of the roadway. For the purposes of the assessment, potential impacts have been assessed against the air quality guidelines provided in the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW' (2005) published by the Department of Environment and Conservation (NSW).

For the construction phase of the project, the review has considered the potential for adverse impacts on air quality as a result of construction activities. In particular, the potential impacts of nuisance dust emissions are considered and appropriate mitigation measures for incorporation into the development recommended.

The assessment of emissions to air from vehicles utilising the bypass roadway during the operational phase are assessed through predictive air dispersion modelling. Emissions from vehicles expected to utilise the roadway are estimated based on the NSW motor vehicle fleet. In order to assess the

1 Environment Australia, Australian State of the Environment Report, 2001.

potential impacts associated with these emissions, air dispersion modelling has been undertaken using the Ausroads model developed by the Victorian Environmental Protection Agency.

Chapter 2 of this report provides an overview of the proposed project, the nearby sensitive receptors, estimated traffic flows and emissions.

Chapter 3 of this report provides an assessment of the potential imapcts associated with the construction phase of the project.

Chapter 4 of the report provides the methodology and results of the air dispersion modelling and an assessment of the potential operational impacts associated with the project.

A glossary of terms is presented in Appendix A to assist the reader.

2 Cowra Heavy Vehicle Bypass

2.1 Background

In 2012, Cowra Shire Council engaged GHD Pty Ltd to undertake an evaluation of alternative routes for heavy vehicle traffic passing through Cowra. Specifically, the process undertaken included identification of alternative routes, identification of movements (origin and destination) for heavy vehicles moving through Cowra, community and stakeholder consultation and assessment of the cost-benefit of each of these options. The final report of this study (issued in June 2013[2]) identified the preferred option as incorporating a ring road around the southern side of the town of Cowra to provide a link between the Mid Western Highway at Campbell Street and Grenfell Road via Airport Road.

The preferred route as shown in Figure 2.1 below has been considered in this air quality review. The assessment forms a component of the Review of Environmental Factors (REF) being prepared for the project.

2.2 Nearby Receptors

A review of existing landuses along the proposed route has identified a total of 63 sensitive receptors within 100 m of the alignment. For the purposes of the assessment, this review has not incorporated any site inspection. Rather, potential sensitive receptors (residences, schools, medical facilities) have been identified through review of aerial photography. It is therefore possible that some of these receptors, which are located in predominantly industrial areas, are in fact not used for residential purposes. To be conservative, where the landuse is not clear, the assessment has considered it to be sensitive (i.e. residential).

Figure 2.2 presents the proposed alignment of the Cowra Heavy Vehicle Bypass Road along with the identified sensitive receptors within 100 m of the alignment. Previous experience suggests that impacts beyond this distance from the roadway are extremely unlikely. Despite this, the assessment of potential impacts includes consideration of all receptors within 250 m of the roadway alignment (being the maximum distance from the roadway for which the model is validated).

It is noted that the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW' guideline defines a sensitive receiver as:

> *"...a location where people are likely to work or reside; this may include a residential dwelling, school, hospital, office or public recreational area etc. An air quality assessment should also consider the location of known or likely future receptors."*

For the purposes of considering sensitive receptors, it is expected that this incorporates premises including residential, commercial or other 'sensitive' land uses such as hospitals, child care centres, schools, churches, public recreational areas, retail outlets and commercial office uses. Industry (or

2 'Cowra Heavy Vehicle Bypass Study Draft Report' prepared by GHD on behalf of Cowra Shire Council

industrial premises) however are generally not considered to be sensitive receivers[3]. The activities undertaken in these areas are often inherently emit a range of compounds to air. For example, the surface preparation undertaken in a panel shop often results in particulate emissions beyond the boundary of the facility. Despite this, these compounds would not usually be considered as harmful for the surrounding uses given the shorter potential exposure time for workers in the receiving environment. It is also noted that industrial uses are not mentioned in the Approved Methods in defining Sensitive receptors.

It would therefore be an unreasonable proposition that the Glossary term be interpreted in a way whereby adjoining industrial land uses (existing or proposed) would be considered in the same way as when applied to 'sensitive' land uses such as a dwelling, school, hospital, office or public recreational area – given industrial uses are clearly and significantly less 'sensitive' in their nature. To otherwise consider adjacent industrial land as being as sensitive a land use is considered inappropriate and likely sterilizes the land for its intended (industrial) purpose.

3 Vincenzo Belgiorno, Vincenzo Naddeo and Tiziano Zarra (2012) 'Odour Impact Assessment Handbook', John Wiley & Sons.

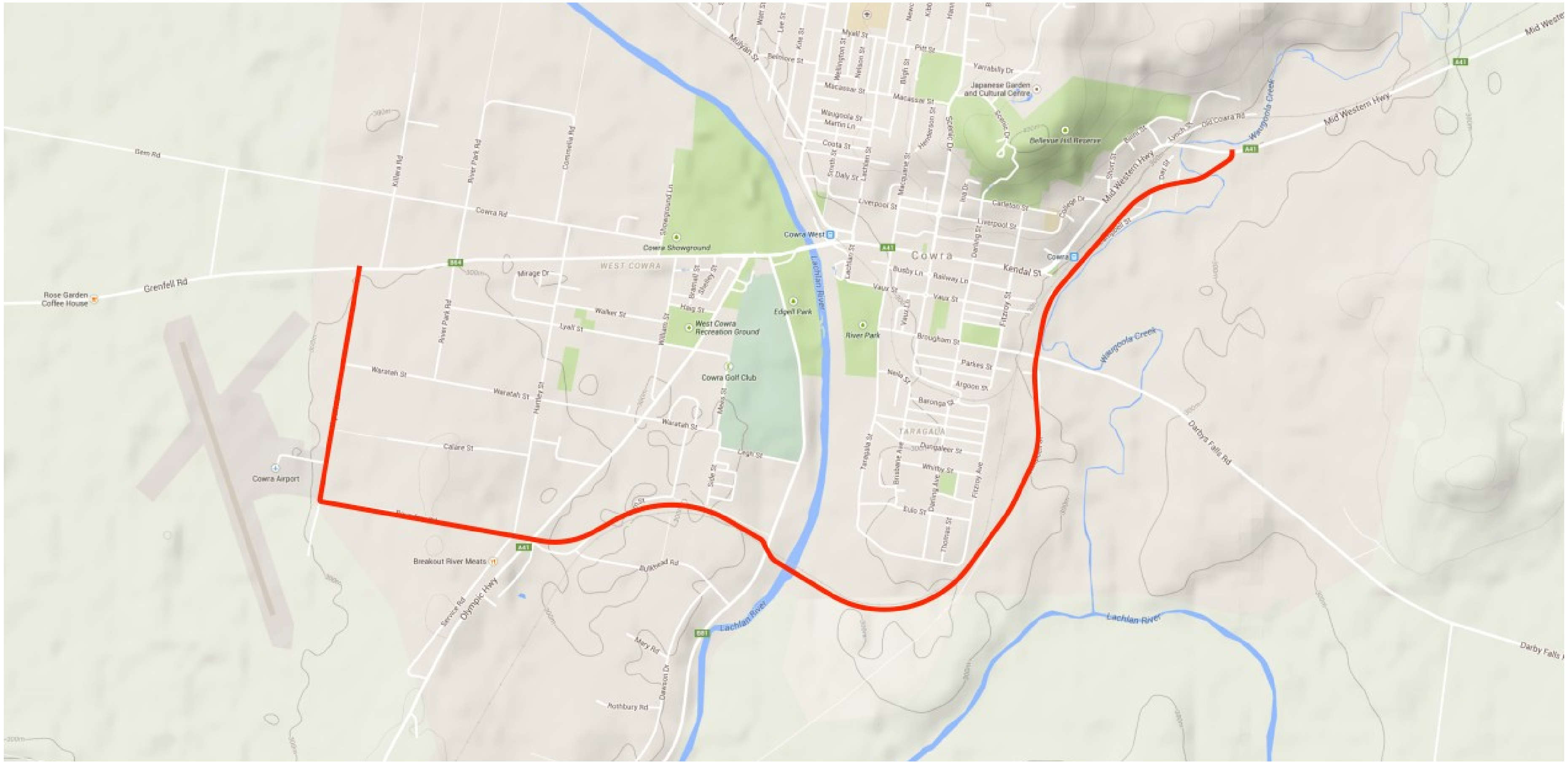


Figure 2.1: Alignment for proposed Cowra Heavy Vehicle Bypass Road

Note: alignment shown as red line

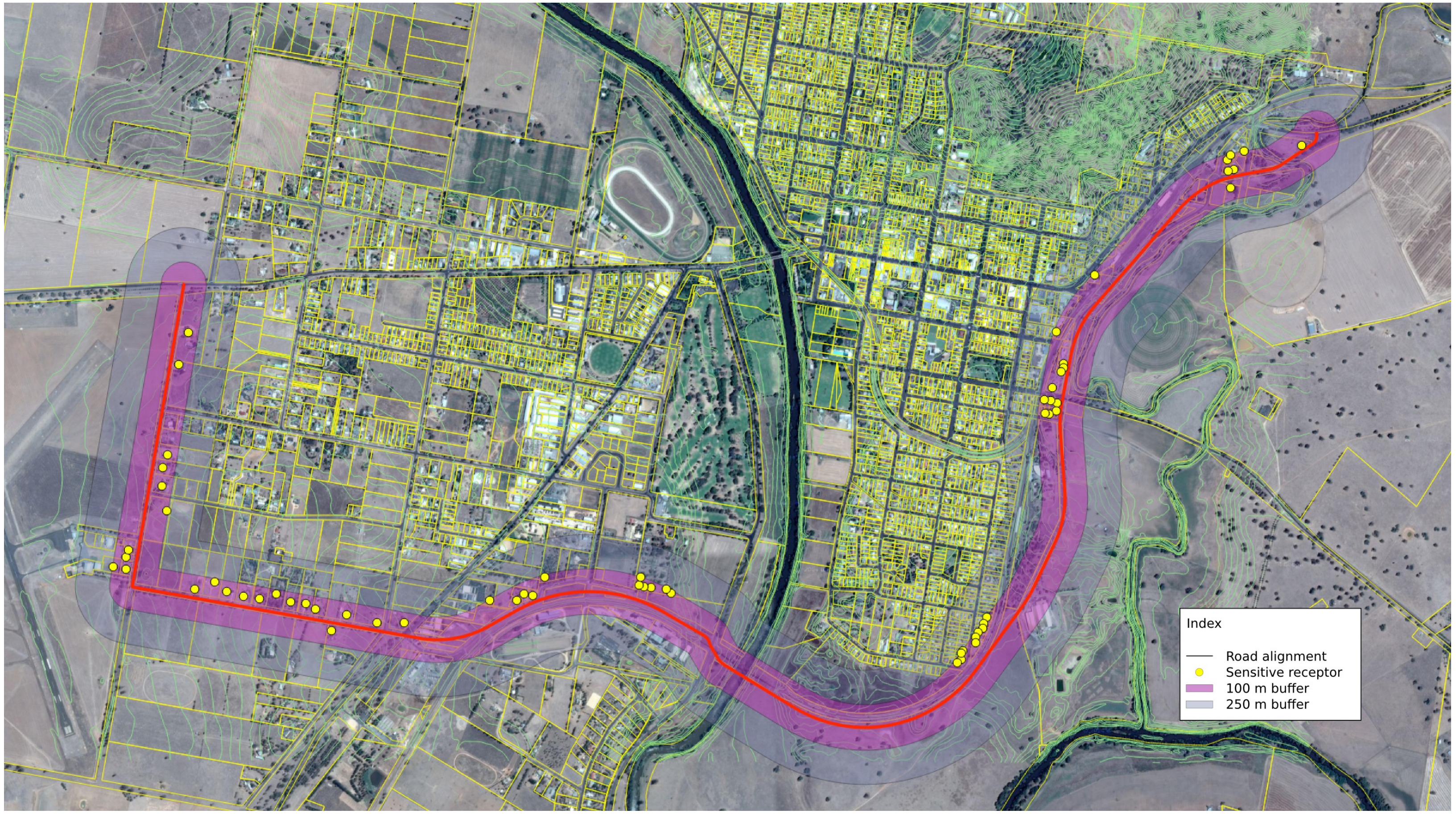


Figure 2.2: Alignment for proposed Cowra Heavy Vehicle Bypass Road

2.3 Road Attributes and Geometry

The road geometry for the surface roads considered in the AusRoads modelling was sourced from design drawings prepared for the original options selection study. The co-ordinates of the roads were determined by importing the road alignment into digital mapping software.

In order to provide a conservative estimate of pollutant concentrations, all road sections have been modelled as “At Grade”. The model provides the ability to consider road segments of other types that may be applicable (e.g. Depressed). The mixing zone algorithms adopted for these types tends to result in greater concentrations near to the roadway (due to an increase in the residence time within the mixing zone). Adoption of the “At Grade” algorithm provides a more conservative approach and has, therefore, been adopted for the screening modelling analysis of the roadway emissions.

2.4 Estimated Traffic Flows

For the purposes of the assessment traffic scenarios have been considered in the air dispersion modelling. Traffic volumes for three road segments as identified on Figure 2.3 below have been determined based on information provided by the project traffic engineers. For the purposes of the modelling it is assumed that peak 1 hour traffic volumes are equivalent to 10 % of the daily estimated traffic flow. The modelling considers that this peak 1 hour traffic volume occurs continuously throughout the day (ie for each of the 24 hours, peak traffic volumes are assumed to occur). This methodology ensures that the impacts of the worst-case meteorological conditions determined for the project site coincide with peak traffic flows.

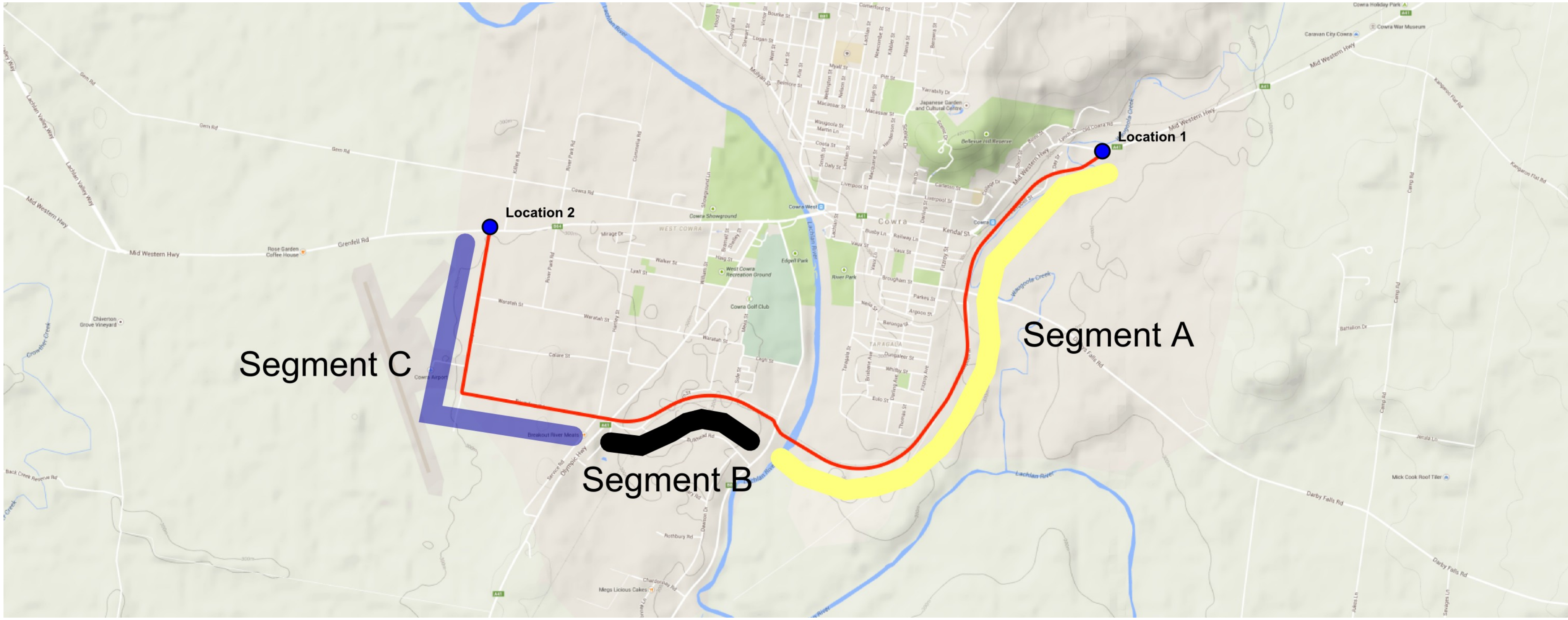


Figure 2.3: Alignment for proposed Cowra Heavy Vehicle Bypass Road

Table 2.1 below presents a summary of estimated traffic volumes utilised for the air dispersion modelling.

Table 2.1: Estimated traffic volumes (vehicles / day)

Year	Link A		Link B		Link C	
	AADT	% HV	AADT	% HV	AADT	% HV
2015	1801	12.3	1835	13.9	1432	12.3
2035	2185	12.3	2277	13.9	1738	10.5

2.5 Emissions Estimates

For the purposes of the assessment, vehicle emissions estimates were based on the data provided in the MVEPS (Motor Vehicle Emission Projection System) provided in the Tool for Roadside Air Quality (TRAQ) developed on behalf of the NSW Roads and Traffic Authority (RTA). Emission factors were determined for the year 2016 based on vehicle fleet age structures, fleet turnover, implementation of new emission standards and major changes in relevant fuel characteristics. It is noted that for future years, reductions in emissions are expected as a result of fleet renewal and implementation of emissions reductions through vehicle design standards. As such, the adopted emission estimates are considered to be conservative for the assessment of impacts associated with traffic flows in 2035. In most cases, the renewal of the NSW road fleet combined with improvements in vehicle design standards beyond 2016 are expected to offset increases in traffic growth rates. Table 2.2 below presents a summary of the emissions estimates adopted for the assessment.

Table 2.2: Summary of Emissions Estimates (g/km/veh)

Segment	CO	NO_x	PM_{10}
1	3.53	1.59	0.04
2	3.50	1.68	0.04
3	3.56	1.48	0.03

3 Assessment – Construction Phase

3.1 Air Quality Goals

The NSW EPA identify nuisance dust impacts as occurring when annual average dust (insoluble solids) deposition levels exceed 4 g/m^2/month with unacceptable levels. In assessing the impact of dust emissions from a specific project or construction activity, the NSW EPA uses a level of 2 g/m^2/month as an acceptable increase over existing dust deposition levels for residential areas.

3.2 Sources of Emissions

The construction of the Cowra Heavy Vehicle Bypass is expected to involve a number of activities with the potential for emissions to air including:

- clearing of vegetation and moving topsoil;
- bulk earth works including construction of embankments and cuttings;
- trenching for installation of structures and services;
- road construction including surfacing; and
- operation of construction equipment.

The major emissions to air expected for the above activities relate to dust emissions. These dust emissions typically have a significant component of larger size fraction particulate matter. For receptors near to the activities, these larger particles have the potential to result in discomfort for local residents and workers in the area and may result in nuisance dust impacts due to deposition onto surfaces (including window sills, furniture, clothes, vehicles and floors).

The quantity of emissions from the construction works are dependent on a range of factors including the characterisation of the soil materials (eg silt and moisture content), the construction methods adopted, local wind conditions and the presence and density of vegetation in the area.

It is noted however, that these impacts are likely to be temporary and localised, and best practice management and mitigation measures can adequately address relevant goals for dust deposition and control and minimise potential impacts. Mitigation measures to be considered during development of detailed construction plans include:

- provide hardstands or similar sealed surfaces in compound areas and work sites to minimise the potential for dust emissions;
- where possible, retain existing ground cover undisturbed;
- place and maintain all disturbed areas, stockpiles and handling areas in a manner that minimises dust emissions (including windblown, traffic-generated or equipment generated emissions);
- implement site specific controls including (but not limited to) watering, road sweeping and removal of accumulated material from environmental controls;

- restore disturbed areas progressively at the completion of local works;
- where visible dust emissions occur as a result of increased wind speeds, dust generated works should cease until appropriate additional controls are implemented;
- all plant and equipment should be maintained in good working order in accordance with the manufacturer's instructions;
- onstruction equipment and plant should be maintained in good working order, and maintenance will be carried out where emissions are unacceptable; and
- equipment, plant and construction vehicles will be turned off when not in use.

It is recommended that deposited dust monitoring be undertaken at selected receptor locations throughout the construction works to provide a regular assessment of performance in controlling emissions. Where deposited dust levels exceed the air quality goals, dust management measures should be reviewed and improved as necessary to achieve acceptable amenity for nearby uses.

4 Assessment – Operational Phase

4.1 Air Quality Goals

Table 4.1 presents air quality criteria for air pollutants considered in the assessment based on the requirements of the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW' (2005).

Table 4.1: NSW EPA Air Quality Goals

Compound	Air Quality Goal	Averaging Time	Units
PM_{10}	50	24-hour	µg/m³
Nitrogen Dioxide	246 62	24-hour Annual	µg/m³ µg/m³
Carbon Monoxide	10	8-hour	µg/m³

4.2 The Ausroads Model

Predictions of the dispersion of emissions from the Cowra bypass road have been completed using the AusRoads modelling software. AusRoads is a line source air quality model developed by the EPA Victoria (Australia) based on the algorithms utilised by Caline 4 as developed by the California Department of Transportation (Caltrans). AusRoads utilises the Gaussian diffusion equation and employs a mixing zone concept to characterise contaminant dispersion over the roadway. It is understood that AusRoads has been validated against the results from Caline 4 to ensure that the algorithms have been correctly adopted. The purpose of the AusRoads model is to assess air quality impacts near transportation infrastructure such as major roads. Given source strength, meteorology and site geometry, AusRoads can predict concentrations for receptors located near to the roadway for a range of contaminants.

The AusRoads model is based on the steady state Gaussian dispersion of contaminants under a given wind condition. In the case of the roadway emissions near to the Cowra heavy vehicle bypass, this could result in a significant degree of conservatism in the modelled concentrations, particularly for maximum predicted concentrations which typically occur during calm meteorological conditions. Validation studies of the (Caline 4) (which provides the basis for AusRoads) identified over-predictions of contaminant concentrations during calm periods. These over-predictions were noted to be related to the low probability of achieving steady-state conditions (assumed by the Gaussian model) during near calm winds.

4.3 Meteorological Inputs

Predictions of meteorological parameters for the year 2012 for the Cowra region were undertaken using TAPM (Version 4.04). In accordance with the requirements of the NSW EPA modelling methodology, the selected year of meteorological data is compared with historical data for the Cowra area to confirm its representativeness of the area.

The model was configured with a series of five nested grids chosen to provide an appropriate communication and transfer of information from the broad synoptic to the local scale.

As such, the TAPM predictions of meteorology are likely to be consistent with any larger scale temporal and spatial variations arising from synoptic and other complex events associated with land-sea induced influences, as well as from topographical influences on both a regional and local scale.

For the purposes of the predictions TAPM was run in hydrostatic mode utilising the default deep soil moisture content values. The model was configured to use a domain consisting of 25 × 25 × 25 grid points with nesting spacings of 30 km, 10 km, 3 km, 1 km and 300 m.

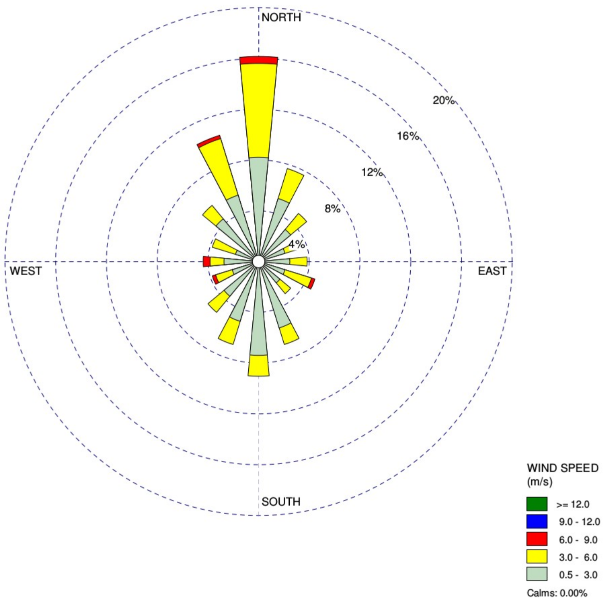
Digital Australian terrain height data on a longitude/latitude grid at 9-second grid spacing (approximately 0.3 km) was included in the meteorological modelling. These data are generated and maintained by Geoscience Australia.

Land use data including Australian vegetation and soil type data was sourced from a database provided by CSIRO Wildlife and Ecology. This dataset has a spatial grid spacing of 3-minutes.

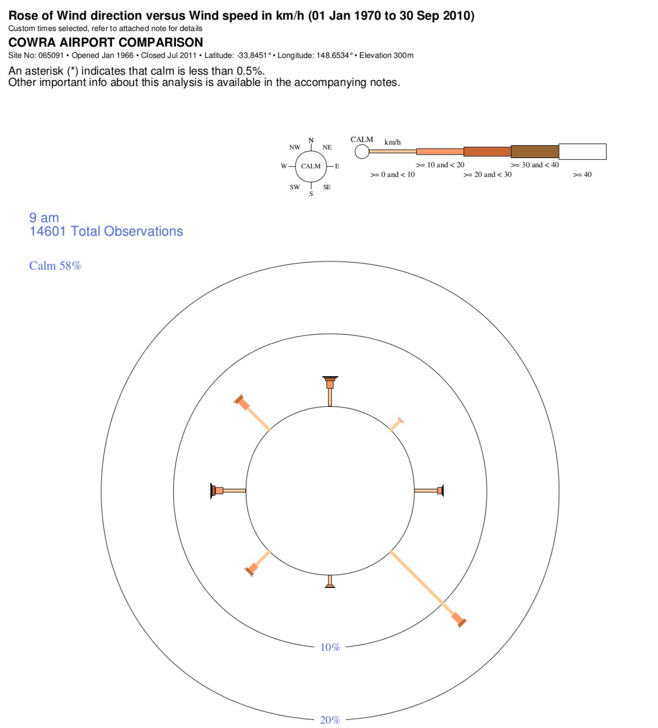
No assimilation of observational meteorological data was included in the TAPM predictions. This approach was adopted to prevent conflicts that can occur when attempting to 'nudge' prognostic predictions with actual monitoring data.

Predicted hourly meteorological data for a location representative of Cowra CBD was extracted from the TAPM model outputs in order to provide a dataset suitable for use in the Ausroads model. Figure 4.1 below presents a comparison of predicted wind speed and direction data for the Cowra CBD with long term historical data collected by the Bureau of Meteorology at the Cowra Airport.

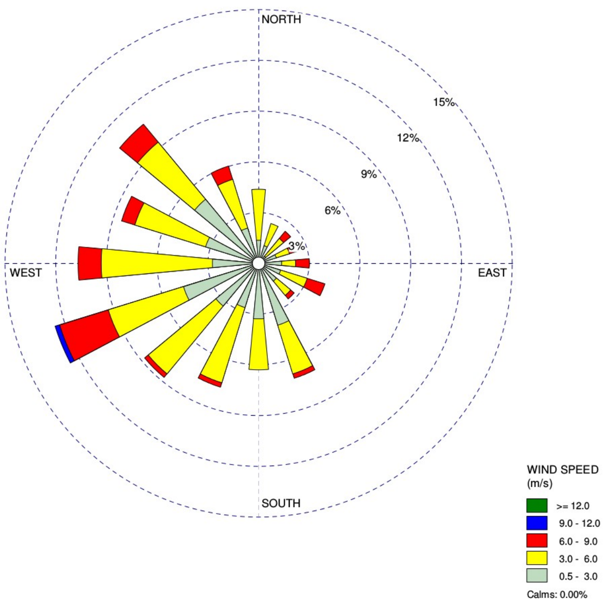
Review of the data presented in Figure 4.1 confirms that the Cowra area is defined by south-easterly winds during morning periods with more westerly (south-westerly through to north-westerly) winds defining the afternoon periods. Further, the comparison of the predicted and observed data indicates that the meteorological dataset is representative of the region and is therefore considered appropriate for the assessment of potential air quality impacts associated with the bypass.



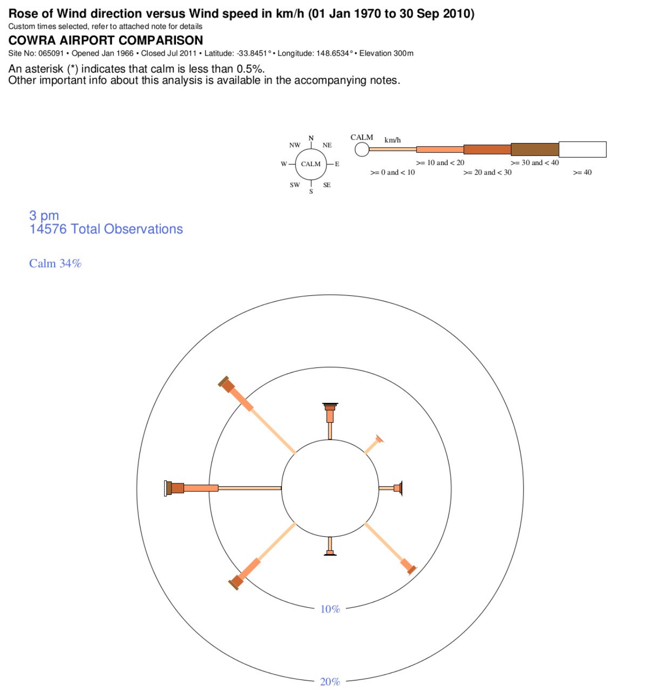
Predicted 9am Windrose



Observed 9am Windrose



Predicted 3pm Windrose



Predicted 3pm Windrose

Figure 4.1: Comparison of Predicted and Observed Wind Speed and Direction

4.4 Atmospheric Chemistry – NO_X Conversion

The assessment of NO_x to NO_2 conversion for the near road sources has adopted a 20 % conversion rate, to prevent significant over-estimation of NO_2 in the near field (within 60 m of the road). Within this distance from a major surface road, conversion rates are generally in the range 5 % to 20 %[4], hence adopting a 20 % conversion ratio remains conservative for near road receptors.

4.5 Topography, Landuse and Receptor Grids

For the purposes of the assessment a receptor grid with 10 m spacing extending to 100 m from the road alignment was considered in the air dispersion modelling. All receptors have been predicted at a height of 1.5 m above ground as representative of the typical breathing zone.

4.6 Summary of Key AusRoads Inputs

A summary of the key inputs and assumptions adopted for the CALPUFF modelling is presented in Table 4.2.

Table 4.2: Summary of Key Ausroads Model Inputs

Parameter	Data
Meteorological data	AusRoads meteorological file formatted from the synoptic site specific data
Receptor grid	10 m grid spacing, within 100 m of alignment
Surface road geometry	At grade
NO_x to NO_2 conversion ratio	20% for surface road near-field impacts

4.7 Cumulative Air Quality Analysis

To allow analysis for the potential impacts of the proposed Cowra Heavy Vehicle Bypass combined with existing ambient background concentrations, a cumulative analysis has been completed. For the purposes of the assessment, existing background concentrations have been derived from the default rural concentrations adopted in the TRAQ model. These concentrations were based on an analysis of 5 years of monitoring data from all stations in the NSW monitoring network operated by the EPA. For each hour of meteorological data considered in the modelling, the existing ambient concentrations presented in Table 4.3 below are added to the contribution from the proposed Cowra Heavy Vehicle Bypass to provide predicted cumulative receptor concentrations.

4 Holmes Air Sciences, RTA Air Quality Monitoring Program, prepared for the NSW Roads and Traffic Authority, 1997.

Table 4.3: Estimated Existing Ambient Concentrations

Pollutant	Background Concentration
CO	0.34 mg/m^3
NO_2	4.7 µg/m^3
PM_{10}	21.8 µg/m^3

4.8 Air Dispersion Modelling Results

Table 4.4 and Figures 4.2 to 4.3 below present a summary of the maximum predicted receptor concentration for the proposed Cowra Heavy Vehicle Bypass. It is noted that the data presented in Table 4.4 represents the highest concentration predicted across the modelling domain and does not necessarily relate to a sensitive receptor. Despite this, for all pollutants, maximum predicted cumulative receptor concentrations are significantly below the air quality goals. Further, the contribution of emissions from vehicles using the proposed Cowra Heavy Vehicle Bypass Road (shown in brackets) are insignificant in terms of the air quality goals. For NO_2, maximum predicted receptor concentration contributions as a result of the proposed bypass road represent less than 16 % of the air quality goal.

Table 4.4: Maximum Predicted Cumulative Receptor Concentrations

Year	Maximum Predicted Cumulative Concentration			
	Carbon Monoxide	Nitrogen Dioxide		PM_{10}
	8 Hour Average mg/m^3	1 Hour Average µg/m^3	Annual Average µg/m^3	24 Hour Average µg/m^3
2015	0.51 (0.17)	33.3 (28.6)	3.9 (3.0)	22.9 (1.1)
2035	0.54 (0.20)	39.1 (34.4)	4.6 (3.6)	23.1 (1.3)
Air Quality Goals	10	246	62	50

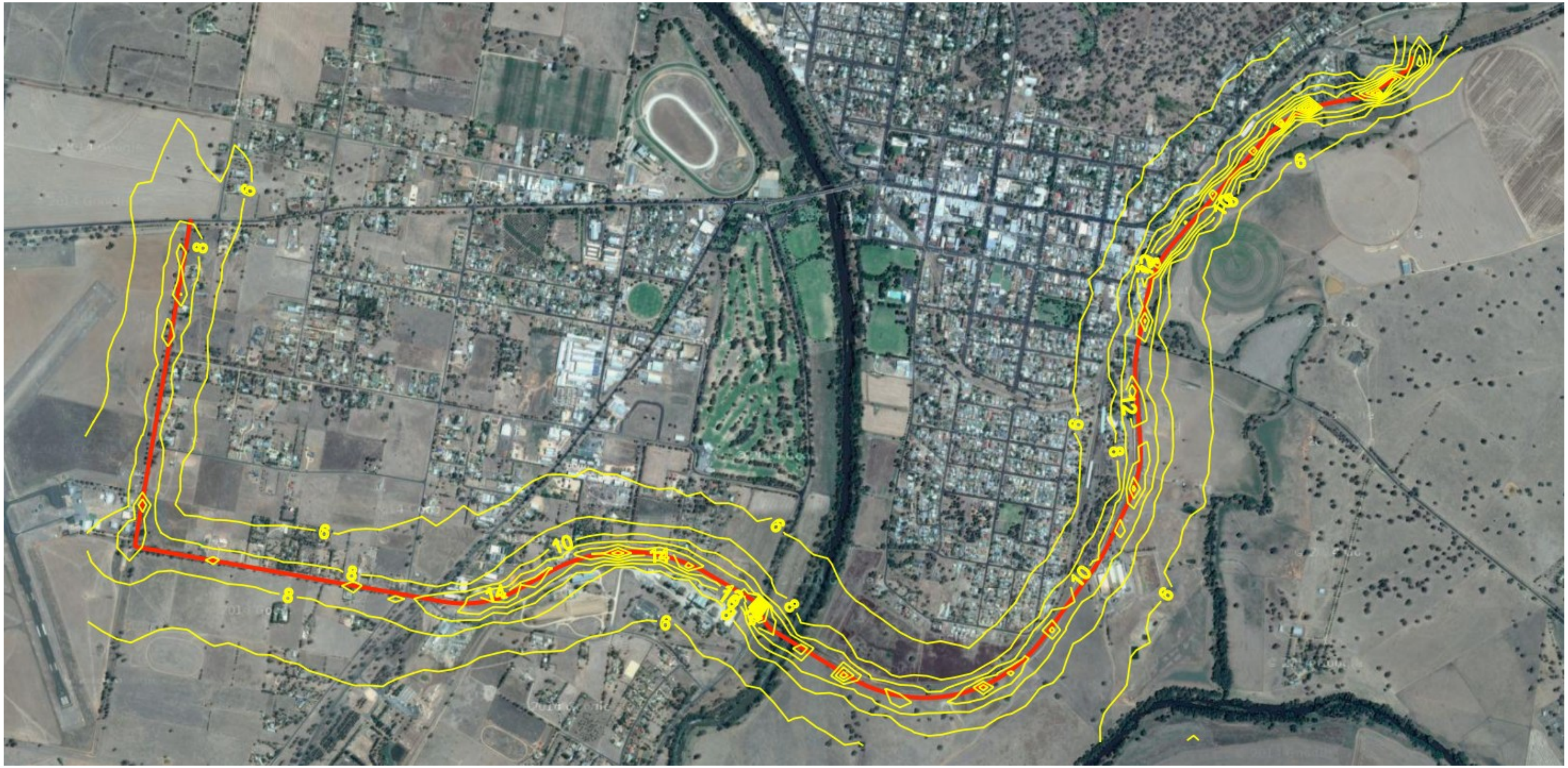


Figure 4.2: Maximum predicted 1 hour average cumulative NO_2 concentrations for the year 2015 (µg/m^3)

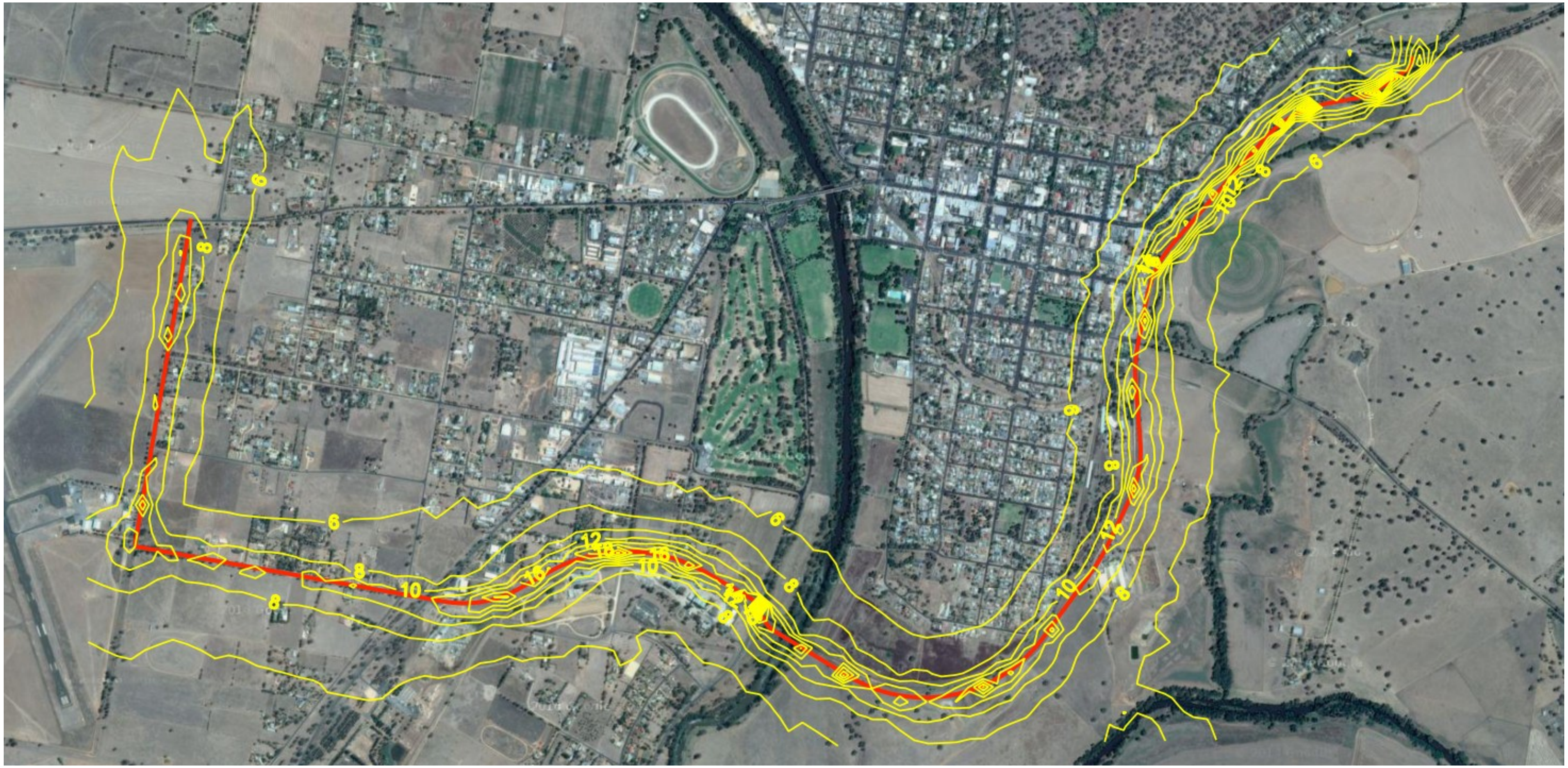


Figure 4.3: Maximum predicted 1 hour average cumulative NO_2 concentrations for the year 2035 ($\mu g/m^3$)

5 Conclusion

To reduce heavy vehicle traffic through the town of Cowra, the Cowra Shire Council are assessing the potential impacts associated with a proposed bypass ring road to be constructed around the southern side of the town of Cowra providing a link between the Mid Western Highway at Campbell Street and Grenfell Road via Airport Road.

This assessment has considered the potential for emissions from vehicles utilising the proposed Cowra Heavy Vehicle Bypass road to have an adverse impact on the air quality for the surrounding landuses. The air dispersion modelling has considered one year of hourly meteorological data with worst-case 1 hour emissions (estimated at 10 % of average daily traffic) being emitted continuously throughout the year. Further, the assessment has assumed that emission factors for vehicles using the roadway will include no improvement in emission standards (legislated through Austrlaian Design Rules) beyond 2016 (ie the vehicle fleet for 2035 are assumed to be equivalent in terms of emissions to those from 2016).

The results of the air dispersion modelling have shown compliance with the air quality goals for the maximum predicted receptor concentrations as a result of emissions from vehicles using the proposed bypass road. As noted above this assessment has considered a worst-case extremely conservative scenario.

On the basis of the results of the air dispersion modelling, adverse air quality impacts as a result of the operation of the Cowra Heavy Vehicle Bypass are considered unlikely.

Appendix A - Air Quality Glossary

APPENDIX A: GLOSSARY OF AIR QUALITY TERMINOLOGY

Conversion of ppm to mg/m^3	Where R is the ideal gas constant; T, the temperature in kelvin (273.16 + T°C); and P, the pressure in mm Hg, the conversion is as follows: $\mu g\ m^{-3}$ = (P/RT) x Molecular weight x (concentration in ppm) $= \frac{P \times \text{Molecular weight} \times (\text{concentration in ppm})}{62.4 \times (273.2 + T°C)}$ For the purposes of the air quality assessment all conversions were made at 25°C.
g/s	Grams per second
mg/m^3	Milligrams (10^{-3}) per cubic metre. Conversions from mg/m^3 to parts per volume concentrations (ie, ppm) are calculated at 25 °C as required by the SEPP(AQM).
µg/m^3	Micrograms (10^{-6}) per cubic metre. Conversions from µg/m^3 to parts per volume concentrations (ie, ppb) are calculated at 25 °C.
ppb	Parts per billion.
ppm	Parts per million.
PM_{10}, $PM_{2.5}$, PM_1	Fine particulate matter with an equivalent aerodynamic diameter of less than 10, 2.5 or 1 micrometres respectively. Fine particulates are predominantly sourced from combustion processes. Vehicle emissions are a key source in urban environments.
50th percentile	The value exceeded for 50 % of the time.
NO_x	Oxides of nitrogen – a suite of gaseous contaminants that are emitted from road vehicles and other sources. Some of the compounds can react in the atmosphere and, in the presence of other contaminants, convert to different compounds (eg, NO to NO_2).
VOC	Volatile Organic Compounds. These compounds can be both toxic and odorous.