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Mr Greg Piconi
Director Operations
Ku-Ring-Gai Council
818 Pacific Highway Gordon NSW 2072

27 August 2014 EN04518

Dear Greg

Air quality assessment and review of EIS for the NorthConnex Project

I have completed an independent review of air quality impacts relating to the NorthConnex Environmental Impact Statement (EIS). This report provides outcomes of the review, to assist Ku-ring-gai Council with their submission on the EIS.

The following items were the subject of the review:

- *Appendix G – Technical Working Paper: Air Quality*. Prepared by AECOM Australia Pty Ltd for the Roads and Maritime Services, report dated 1 July 2014.
- NorthConnex EIS Chapter 5 Project Description and Section 7.3 Air Quality.
- Issues raised in the Ku-ring-gai Council NorthConnex information session, held 18 August 2014.
- Emails from residents to Council, and forwarded to Jacobs.

The scope of the review was to:

- Analyse and assess the proposed ventilation system and air quality data.
- Consult with local community, including local residents, Councillors and staff and consider the issues raised.
- Report on the outcomes.

Review of the potential health effects of air pollutants was outside the scope of this review.

Section 1 summarises the Project in terms of the potential air quality impacts as described by AECOM. The key conclusions from AECOM's assessment have been identified.

Section 2 documents the main outcomes of the independent review, including elements of the study which have found to be acceptable as well as those which need more information or correction. This section collates the key air quality issues (and reasons for each issue) to be addressed by the proponent or to be considered by the Department of Planning and Environment.

Section 3 describes the potential air quality impacts of an alternative Project option, as identified by the community. This alternative involves moving the proposed northern tunnel ventilation outlet approximately one kilometre to the north of the existing location.

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Section 4 provides a summary of the key air quality issues, to assist Council with their submission.

Please contact me on 4979 2663 if you have any questions on the outcomes of this review.

Yours sincerely

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1. Background

The Roads and Maritime Services (RMS) is seeking approval to construct and operate a tolled motorway linking the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at the Pennant Hills Road interchange at West Pennant Hills. This project is referred to as the "NorthConnex M1-M2 Project". The EIS for the Project was placed on public exhibition on 15 July 2014, via the Department of Planning and Environment Major Projects website.

AECOM prepared the air quality impact assessment (AECOM 2014) for the EIS, which is the focus of the current review. The main objective of this assessment was to address the Director-General's Requirements relating to air quality and, to quantify potential impacts, the assessment referred to the EPA's *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005).

AECOM's assessment was based on the use of air dispersion models (CALPUFF and CAL3QHCR) to predict ambient concentrations of key air pollutants during operation. These models used estimates of emissions from surface roads and tunnel ventilation outlets with local meteorological and topographical data to predict ambient air pollutant concentrations. The significance of the model predictions was determined by comparing the predicted concentrations with assessment criteria noted by the EPA. Construction impacts were assessed qualitatively.

The air pollutants considered by AECOM were:

- Carbon Monoxide (CO);
- Oxides of nitrogen (NO_x, including nitrogen dioxide (NO_2) which is linked to adverse health effects);
- Particulate matter (as PM_{10} and $PM_{2.5}$);
- Volatile organic compounds (VOC) and
- Polycyclic aromatic hydrocarbons (PAH);

In summary, AECOM concluded:

- *"For all the scenarios assessed, all predicted pollutant concentrations were well below their respective impact assessment criteria except for particulates. Exceedences of the assessment criteria were predicted to occur for PM_{10} concentrations for the 24 hour averaging period and $PM_{2.5}$ concentrations for both the 24 hour and annual averaging periods. The project's predicted contributions to the exceedences were, however, very minor, with the exceedences attributable to elevated background concentrations of these pollutants. No additional exceedences of the PM_{10} or $PM_{2.5}$ criteria were predicted to occur as a result of the project. Furthermore, analysis of the modelling results predicted that the project would reduce annual concentrations of $PM_{2.5}$ along Pennant Hills Road, and result in only slight increases in the annual $PM_{2.5}$ concentrations around the ventilation outlets, which would not be discernible from the background concentrations of this pollutant. As such, the project is expected to result in a net improvement in air quality, taking into account improvements in air quality along the Pennant Hills Road corridor balanced with very low levels of increases in $PM_{2.5}$ concentrations around the northern and southern ventilation outlets".*

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2. Review Outcomes

This section documents the main outcomes of the independent review, including elements of the study which have found to be acceptable as well as those which need more information or correction.

The review has been carried out by checking the main factors that could affect the conclusions of the assessment, such as the choice of models and model setup, emission calculations, meteorological data, ambient air quality data and interpretation. In addition, the review has checked for consistency with the EPA's *Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) and whether the assessment has addressed the Director-General's Requirements.

Review outcomes are provided below.

2.1 Existing Air Quality Data ("Background" levels)

AECOM quantified background levels by adopting either the maximum predicted roadside concentrations by the CAL3QHCR model or from maximum levels recorded by the Office of Environment and Heritage (OEH) monitoring stations at Prospect and Lindfield. The derived levels were then added to model predictions to determine cumulative impacts, and these cumulative predictions were compared to the EPA's air quality assessment criteria.

Five (5) air quality monitoring stations were also installed in December 2013 specifically for this Project (Headon Sports Park, James Park, Observatory Park, Brickpitt Park and Rainbow Farm reserve). Monitored levels from these sites for the period between December 2013 and March 2014 were reported.

AECOM has adopted a generally conservative approach to the quantification of existing air quality. Based on a comparison between the assumed background levels and the measured concentrations at James Park, the assumed background levels are conservative for NO_2 although potentially underestimated for PM_{10} (and $PM_{2.5}$). The differences between the assumed air quality and the air quality in the vicinity of the northern ventilation outlet (as measured at James Park) are not significant in terms of affecting the conclusions of the assessment.

2.2 Meteorological and Terrain Data

AECOM has used a meteorological model (CALMET) to simulate conditions across an area of 60km by 62.5 km, at a resolution of 250 m. The model used hourly meteorological records from weather stations located at Lindfield, Terrey Hills, Richmond, Prospect and Sydney Airport, in addition to prognostic data from the MM5 model. Terrain data were sourced from the SRTM database. The from weather station to the Project corridor is not necessarily an issue, so long as the modelled local meteorological conditions are representative of measured local meteorological conditions.

Potential issues with the meteorological data, meteorological modelling and terrain data have been identified below.

Issue 1) **Modelled wind speeds:** AECOM has provided wind-roses showing the CALMET simulated wind patterns in the vicinity of the northern ventilation outlet (refer to

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Appendix F of the Air Quality Impact Assessment). From these wind-roses, CALMET has simulated that calm conditions occur at this location for around 1% of the time. At Lindfield, the percentage of calm conditions is 27%. Wind speed is important for determining the amount of dispersion, so it is important that the meteorological data are representative of the area around the modelled emission sources.

Recommendation

The comparison of modelled and measured (Lindfield) wind speeds suggests that the CALMET simulation of conditions in the vicinity of the northern ventilation outlet needs further verification. A comparison between the modelled and measured (for example, James Park) wind patterns is required in order to demonstrate that the CALMET output is representative of local conditions.

Issue 2) **Terrain source and resolution:** Figure 2.1 shows the area around the proposed northern ventilation outlet, overlayed with the SRTM terrain data, and including three assumptions on terrain resolution; 50 m, 150 m and 250 m. CALMET has used the SRTM data, gridded at 250 m resolution. From this figure it can be seen that there are differences between the modelled terrain (250 m resolution) and the “actual” terrain (assuming the 50 m resolution is closest to the actual terrain). Differences are in the order of 5 to 10 m depending on the location. The SRTM data also has a limitation in that the radar imaging technique does not always map the true surface, especially when the ground is covered by dense vegetation.

Recommendation

The differences between modelled and actual terrain need to be explained, in terms of whether the simulated meteorological conditions in the vicinity of the northern ventilation outlet will change because of the data source (SRTM) and selected resolution.

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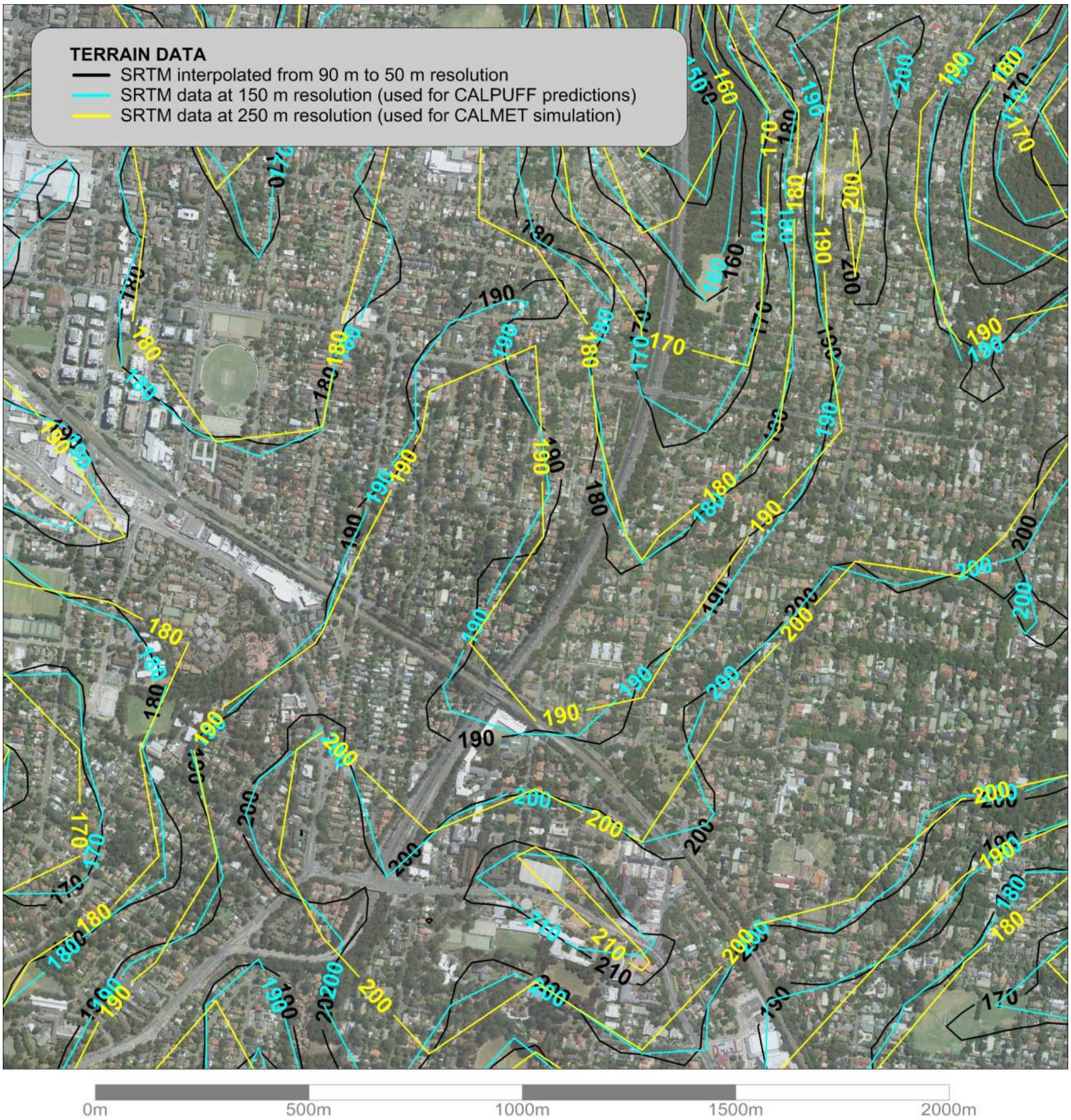

Figure 2.1 : Comparison of assumed SRTM data resolutions

2.3 Emission Calculations

Emissions of key pollutants (CO, NO_x and PM_{10}) from the tunnel ventilation outlets have been estimated using forecast traffic volumes, tunnel grade, vehicle speed, and traffic mix, combined with emission factors from the World Road Association (PIARC 2012). Emissions from motor vehicles using surface roads have also been estimated using the PIARC emission factors. $PM_{2.5}$, VOC and PAH emissions were calculated from the PIARC data using emission factor relationships from the National Pollutant Inventory (NPI).

Pacific Environment Limited undertook independent emission calculations. These calculations were compared to the AECOM calculations and consistency was demonstrated.

Potential issues with the emission calculations have been identified below.

Issue 3) **Pollutant concentrations in the intake air:** Table 18 (from Technical Working Paper: Air Quality) shows the estimated in-tunnel pollutant concentrations at 1 km increments along each tunnel, for peak hours of 9 am and 6 pm. From these data, it appears that the assumed pollutant concentrations of the incoming air are zero. The southern portal of the northbound tunnel is located in the vicinity of the Pennant Hills and M2 Motorway interchange where CO, NO_2 and PM_{10} concentrations will not be zero, and generally higher than at ambient monitoring stations. PIARC (2012) recommends that the concentrations in the ambient air supplied to the tunnel are considered for emission calculations and ventilation requirements.

Recommendation

Concentrations of pollutants in the in-coming air should be estimated and included in the emission calculations, with ventilation outlet emission estimates updated as appropriate. Additional information is required to demonstrate that the northern ventilation outlet emissions and resultant concentrations in the vicinity of the northern ventilation outlet are not underestimated because of the assumed concentrations in the intake air.

Issue 4) **In-tunnel concentration comparisons:** From Table 18, the estimated in-tunnel pollutant concentrations in the northbound tunnel (6 pm 2019) are up to 6.26, 0.86 and 0.504 mg/m^3 for CO, NO_2 and PM_{10} respectively. In-tunnel monitoring for the Lane Cove Tunnel (see for example Ecotech April 2014 report from http://www.lanecovemotorways.com.au) shows 30-minute average CO concentrations up to around 25 mg/m^3 during peak hours. Online in-tunnel 15-minute average CO concentration data for the Brisbane Airport Link tunnel (6.7 km long and in the order of 50,000 vehicles per day) are typically[1] 20 to 30mg/m^3. These measurements are higher than the 6.26 mg/m^3 estimated for NorthConnex.

Recommendation

The difference between the estimated in-tunnel concentrations for NorthConnex and measured concentrations from other tunnels should be explained, with consideration

[1] https://www.airportlinkm7.com.au/about-airportlinkm7/environment-sustainability/air-quality-monitoring.aspx

of differences between traffic volumes, ventilation flow rates and tunnel lengths to make sure that modelled emissions for NorthConnex have not been under-estimated.

Issue 5) **Assumed heavy goods vehicle mass:** The emission calculations are based on an average heavy goods vehicle (HGV) mass of 23 tonnes (that is, a typical fleet consisting of single lorries, trailer trucks and coaches). Traffic forecasts for NorthConnex indicate that the proportion of heavies will range from 28 to 28.5 per cent (northbound, 2019) which means that total emissions from the tunnel will be sensitive to the HGV mass assumptions. AECOM has not discussed the variation in different sized HGVs and as the emissions are strongly related to the total vehicle mass, different vehicle masses may need to be considered by using PIARCs vehicle mass factors.

Recommendation

The air quality assessment should document the variation in different sized HGVs (single lorries, trailer trucks and coaches) to support the use of the average HGV mass of 23 t.

Issue 6) **Traffic speed assumptions:** In-tunnel vehicle speed data for each hour of the day, and assumptions on congestion during peak hours, are not documented in the air quality assessment. These assumptions are important for the emission calculations.

Recommendation

These data should be documented in order to verify that the northern ventilation outlet emissions and resultant concentrations in the vicinity of the northern ventilation outlet are not underestimated.

Issue 7) **Emission source concentrations:** Peak hour (6 pm) emissions from the northern ventilation outlet for Design analysis A (2019) are estimated to be 7.31, 10.9 and 0.67 g/s for CO, total NO_x and PM_{10} respectively (refer to Appendix H). Based on a flow rate of 700 m^3/s, these mass emission rates correspond to concentrations of 10, 16 and 1 mg/m^3 for CO, total NO_x and PM_{10} respectively. The same calculations have been done for Design Analysis B, and the estimated concentrations are shown in the table below, and compared to data and limits from the Lane Cove Tunnel (LCT) and Airport Link Tunnel.

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Pollutant	NorthConnex estimated concentrations, (northbound, 2019, 6 pm, hourly, mg/m^3)		Typical maximum measured concentrations (mg/m^3)		Concentration limits (mg/m^3)	
	Design analysis A	Design analysis B	LCT (30 min)	Airport Link (15 min)	LCT	Airport Link tunnel
CO	10	6	~25	20-30	62.5 (50 ppm)	87 (70 ppm)
NO_x	16	8	NA	NA	32.8 (in-stack)	20 (1 ppm NO_2, 10% NOx is NO_2)
PM_{10}	1	0.4	NA	NA	1.6 (in-stack)	None (0.005 m^{-1} visibility)

These calculations show that the modelled in-tunnel concentrations for NorthConnex are lower than typical maximum measured concentrations from the Lane Cove Tunnel and Airport Link Tunnel.

Recommendation

It is recommended that the Department of Planning and Environment consider the predicted ambient concentrations in light of the modelled source concentrations, if concentration limits are to be set.

2.4 Model Selection

AECOM has used CAL3QHR to model emissions from surface roads and CALPUFF to model emissions from ventilation outlets. CALPUFF is a model which is listed by the EPA as an approved model for these types of assessments (DEC 2005). CAL3QHCR is not listed by the EPA in their *Approved Methods* but is listed by the US EPA as a recommended model for simulating air quality in the vicinity of roadways.

2.5 Receptor Data

AECOM has used CALPUFF to predict ambient pollutant concentrations across an area of approximately 15 km by 10 km (Table 17). Potential issues with the receptor data have been identified below.

Issue 8) **Receptor resolution:** In the vicinity of the ventilation outlets, predictions were made at discrete receptors with a grid resolution of 150 m, up to 2.5 km from each outlet. Additional receptors were added along the project corridor, spaced 10, 35, 60, 105, 160 and 225 m from the road centreline (refer to page 45 of the Technical Working Paper: Air Quality). **Figure 2.2** shows the location of the CALPUFF model receptors in the vicinity of the proposed northern ventilation outlet. From this figure it can be seen that there are areas of very little receptor coverage in the model (see for

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example area circled). This means that maximum ground level concentrations, due to emissions from the 15 m high ventilation outlet, may not be identified by the model.

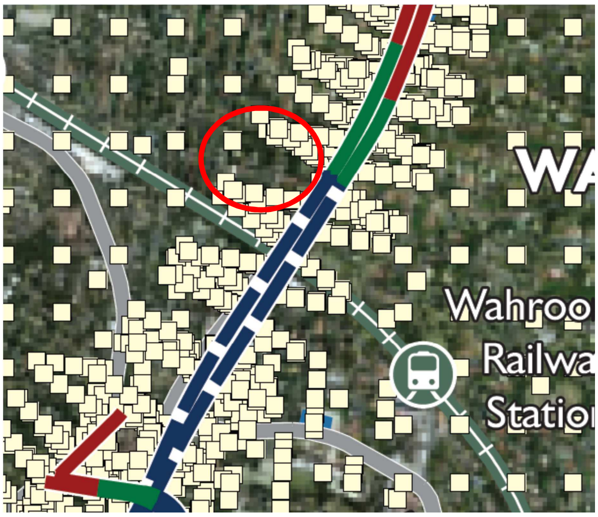

Figure 2.2 : Receiver locations, Figure 8 extract from Technical Working Paper: Air Quality

Recommendation

The proponent should demonstrate that maximum ground level concentrations have not been under-estimated because of the selected receptor resolution around the ventilation outlets.

Issue 9) **Elevated sensitive receptors:** The EPA's air quality impact assessment criteria apply to existing or likely future off-site sensitive receptors. The AECOM assessment provides model predictions for ground-level locations but does not comment on likely future sensitive receptors or elevated locations. A multi (5) storey residential development is proposed for 11-21 Woniora Avenue, approximately 200 m to the south of the proposed northern ventilation outlet. No predictions of concentrations at elevated locations are available in order to check that compliance with air quality criteria can be achieved at this proposed development (for example, at 15 m above ground level).

Recommendation

The air quality impact assessment should demonstrate that air quality criteria will not be exceeded at elevated sensitive receptor locations, such as at the proposed five storey residential development at 11-21 Woniora Avenue.

Assessment Criteria

AECOM has referenced the air quality impact assessment criteria from the EPA's *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). In the absence of air quality impact assessment criteria for PM2.5, AECOM has adopted the $PM_{2.5}$ standards from the National Environment Protection Measure (NEPM). The adopted criteria are appropriate.

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Construction

In terms of construction impacts, the Director General's Requirements state that *"The assessment should provide an assessment of risk associated with potential discharges of fugitive and point source emissions, and include: details of the proposed methods to minimise adverse impacts on air quality during construction, particularly in relation to mobile plant…".*

Sections 5 and 7.1 of the assessment have addressed the Director General's Requirements in relation to construction.

3. Air Quality Impacts of Alternatives

This section provides a discussion on the likely air quality impacts due to two Project alternatives which have been raised by the community.

3.1 Moving Ventilation Outlet to Industrial Area

Moving the northern ventilation outlet to the industrial area located approximately 1.6 kilometres to the north has been raised as an alternative by the community.

Section 6 from AECOM's assessment included predictions of ground level air pollutant concentrations due to emissions from the northern ventilation outlet. The potential air quality impacts of moving the ventilation outlet to the industrial area can be estimated by shifting the isopleths from their current position, to match a shift in the location of the ventilation outlet.

As can be seen from some of AECOM's model predictions (for example Figure 27), the highest ground level concentrations are not necessarily close to the ventilation outlet. In some circumstances, moving the source to a new location may lead to higher concentrations in the vicinity of the original location. This would need to be confirmed by a quantitative assessment.

In addition, the net effect of changes in ventilation outlet contributions and changes in emissions from motor vehicles using the surface roads needs to be considered. The likely net change in air quality cannot be quantified without detailed modelling but, in a general sense, emissions from motor vehicles using surface roads would continue to be the more significant factor for determining ambient air quality, based on the information provided in AECOM's assessment.

As noted in **Section 1**, AECOM concluded that the Project would not cause any exceedances of ambient air quality criteria (pending responses to the issues raised in **Section 2**). It is likely that moving the ventilation outlet to the industrial area can also demonstrate this outcome, however the level of compliance with air quality criteria would need to be confirmed by site-specific dispersion modelling or similar assessment technique.

3.2 Moving Tunnel Portal to the North

Another Project alternative raised by the community, during the NorthConnex Information session and workshop held 18 Aug 2014, was the relocation of the northern tunnel portals.

Conceptually, the proposed alternative would include:

- Extending the length of the tunnel to the north by approximately one kilometre.
- Relocating the proposed northern ventilation outlet to the north by approximately one kilometre.
- Adjusting the grade of the tunnel to minimise the northbound exit grade, currently at 4%.

The relative effect on total tunnel emissions due to the concept outlined above has been quantified using "TRAQ" (Tool for Roadside Air Quality, developed by the Roads and Maritime Services). TRAQ uses information on the traffic volume, fleet composition, road grade, traffic speed and section length, combined with EPA-derived vehicle emission factors to estimate emissions of CO, NO_x and PM_{10}.

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Two emission scenarios have been compared, as follows:

- **Project scenario:** 1000 vehicles per hour (hypothetical), 8.75 km section of 0% grade and 250 m section of 4% grade. Default fleet mix and peak speeds.
- **Alternative scenario:** 1000 vehicles per hour (hypothetical), 10 km section of 0% grade. Default fleet mix and peak speeds.

The calculated mass emission rates in kilograms per hour (kg/h) are shown in the table below. While these results are based on a hypothetical peak hour traffic volume (1000 vehicles per hour) the relative change in emissions provides a useful comparison. Based on these results it can be seen that the alternative scenario would lead to mass emission rates that are in the order of 5 to 10 per cent higher than the project scenario (because of the longer tunnel), depending on the pollutant. This increase is indicative of the potential change in emissions from the northern ventilation outlet.

Pollutant	Calculated mass emission rate by TRAQ (kg/h)	
	Project scenario (9 km section)	Alternative scenario (10 km section)
CO	7.99	8.43
NO_x	7.96	8.53
PM_{10}	0.57	0.63

From AECOM's modelling, the potential air quality impacts of this alternative scenario can be estimated by shifting the isopleths one kilometre to the north of their current position, to match a shift in the location of the ventilation outlet.

It is likely that this alternative scenario can demonstrate no additional exceedances of ambient air quality criteria (even with some increases in emissions from the northern ventilation outlet). Again, however, the level of compliance with air quality criteria would need to be confirmed by site-specific dispersion modelling or similar assessment technique.

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4. Summary

Based on the assessment of the air quality, it is recommended that the assessment review the following:

- Modelled meteorological conditions and terrain data, in particular, Issues 1 and 2 from **Section 2** above.
- Emission calculations and comparisons between NorthConnex in-tunnel concentrations and measurements from other tunnels. Refer to Issues 3 to 7 from **Section 2** above.
- Model receptor resolution and elevated sensitive receptors in the vicinity of the ventilation outlets. Refer to Issues 8 to 9 from **Section 2** above.

All recommendations should be addressed to make sure that the conclusions of AECOM's assessment remain valid, and that air quality criteria can be achieved at all sensitive receptor locations.

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5. References

AECOM (2014) "*NorthConnex Environmental Impact Statement – Volume 3, Appendix G – Technical Working Paper: Air Quality"*. Prepared by AECOM Australia Pty Ltd for the Roads and Maritime Services, report dated 1 July 2014.

DEC (2005) *"Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales* " August 2005.

PIARC (2012) "*ROAD TUNNELS: VEHICLE EMISSIONS AND AIR DEMAND FOR VENTILATION"* PIARC Technical Committee C4 Road Tunnels Operation.