INDEPENDENT AIR QUALITY REVIEW

F6 EXTENSION STAGE 1

NSW Department of Planning & Environment

30 September 2019

Job Number 18020798

Prepared by
Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
Phone: (02) 9874 2123
Fax: (02) 9874 2125
Email: info@airsciences.com.au

Independent Air Quality Review
F6 Extension Stage 1

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 01	30/09/2019	K Trahair/A Todoroski	A Todoroski
FINAL	30/09/2019	K Trahair/A Todoroski	A Todoroski

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 SUMMARY

Todoroski Air Sciences reviewed each stage of the F6 Extension Stage 1 Air Quality Technical Report (**RMS, 2018**). The consistency review and preliminary review found a number of potential issues that may affect the estimated impacts, however, these issues are unlikely to alter the key conclusions reached in the assessment. This arises due to the generally sound approach whereby the modelling was used to make a relative comparison between the "do minimum case" and the Project case. Such a relative comparison effectively minimises the influence of the modelling assumptions made, apart from the predicted traffic numbers which govern any predicted relative change between the two cases being compared.

How the model calculates air emissions using the traffic numbers, and how it then predicts the dispersion/ pollutant levels that arise due to these emissions is done in the same fashion for each case, using the same assumptions, apart from traffic numbers. These assumptions primarily affect the model accuracy at predicting an absolute pollutant level, but as they are applied in the same way in each case there is only a small effect on the predicted relative difference between each case. Thus whilst the modelling may be predicting an absolute pollutant level in each case that will be higher or lower than may actually occur, the model would still provide a reasonable estimate of the relative change in the pollutant levels that would arise due to the Project at any one location. As this change is small, it is unlikely that the predicted outcomes would change greatly due to the issues found in the modelling.

In responding to the issues raised, the Proponent provided additional information at meetings held on 29 August 2019. The Proponent also provided a detailed written response to agency and public submissions that included further clarification in regard to the assessment of elevated receptors.

Thus in regard to making a valid assessment, the model is used appropriately to provide a convincing assessment of the likely relative change in pollutant levels that may be experienced at any one location. Clear and informative graphs are provided to illustrate that the relative change in pollutant levels would be generally small, and for most receptors, this change would be a reduction in pollutant levels, but for a minority of receptors there would be a small increase.

Overall, this indicates that there would be reduced exposure to air pollutants for the local population, and for the receptors where there may be an increase, this would be relatively small and hence within acceptable bounds. On this basis the proposed Project can be considered sound.

Issues with the modelling in so far as the predicted absolute levels of air pollutants remain unresolved, and hence provide uncertainty in this regard. This review outlines many of these issues in detail, and for every issue it is noted that it would not change the fundamental finding that there would be a small relative change in impact, that is generally positive. These underlying issues have been identified by other agencies and the public as being of concern. To minimise such issues, it is suggested that DPI&E, EPA and RMS consider developing an agreed approach for assessing future major roadway and road tunnel projects.

To ensure that the air quality predictions are met in practice, in-tunnel air quality limits, including ventilation stack limits have been developed to be applied in the conditions of approval for the Project. These conditions also set out monitoring and reporting requirements which will demonstrate that the required limits are being met.

2 INTRODUCTION

Todoroski Air Sciences (TAS) has been engaged by the New South Wales (NSW) Department of Planning & Environment (DP&E) to review and provide independent advice in relation to air quality matters associated with the proposed F6 Extension (hereafter referred to as the Project). The NSW Roads and Maritime Services (RMS) is the Proponent of the Project.

This report summarises the review of the air quality technical report (AQTR) for the Project, the Proponent's response to the preliminary review and also agency comments. The key technical issues are discussed in the body of the report, and the complete list of technical issues examined in the review is summarised in **Table A-1** in **Appendix A**.

2.1 Scope of the review

The independent review covers the following key tasks:

1. Consistency Review to comment on completeness with the air quality impact assessment requirements documented in the Secretary's Environmental Assessment Requirements (SEARs)

2. Preliminary Review to comment on the technical adequacy of the air quality assessment (AQTR) in the Environmental Impact Statement (EIS)

3. Review of the responses to the preliminary review, agency comments, and additional RMS reports, participate in meetings and provide technical input and comments.

4. Review of draft consent conditions.

5. Prepare a Final Report on the assessment conducted in Tasks 1 to 3.

The following documents were considered in the independent review:

- Appendix E Air Quality Technical Report (**ERM, 2018**) which forms part of the Environmental Impact Statement for the F6 Extension Stage 1;

- Agency comments related to the air quality impact assessment;

- F6 Extension Stage 1 Submissions Report (**RMS, 2019**); and,

- F6 Extension Response to Submissions Report (**ERM, 2019**).

3 PROJECT OVERVIEW

The Project involves the development of a multi-lane road between the New M5 Motorway at Arncliffe and President Avenue at Kogarah. At the north, the project would connect underground with the New M5 Motorway tunnel and at the south, to a new surface-level intersection at President Avenue, Kogarah.

One new ventilation facility is proposed as part of the Project located at Rockdale (Rockdale ventilation facility). The Project would also use the ventilation facility at Arncliffe currently being constructed as part of the New M5 Motorway project (the Arncliffe ventilation facility).

Figure 3-1 presents the location of the Project and key features.

The AQTR for the Project includes assessment of the following scenarios:

The in-tunnel air quality scenarios included:

- Expected traffic scenarios;
- Congestion (down to 20 km/hr on average);
- Ramp metering;
- Breakdown or minor incident;
- Accident closing a tube; and,
- Free-flowing traffic at maximum capacity.

The ambient air quality scenarios included:

- Traffic scenarios above for:
  - 2016 – Base year
  - 2026 – Do minimum (no Project)
  - 2026 – Do something (with Project)
  - 2036 – Do minimum (no Project)
  - 2036 – Do something (with Project)
  - 2036 – Do something cumulative (with Project and full F6 extension, Western harbour Tunnel and Beaches Link).
- Regulatory worst case scenarios – theoretical maximum from tunnel ventilation outlets.

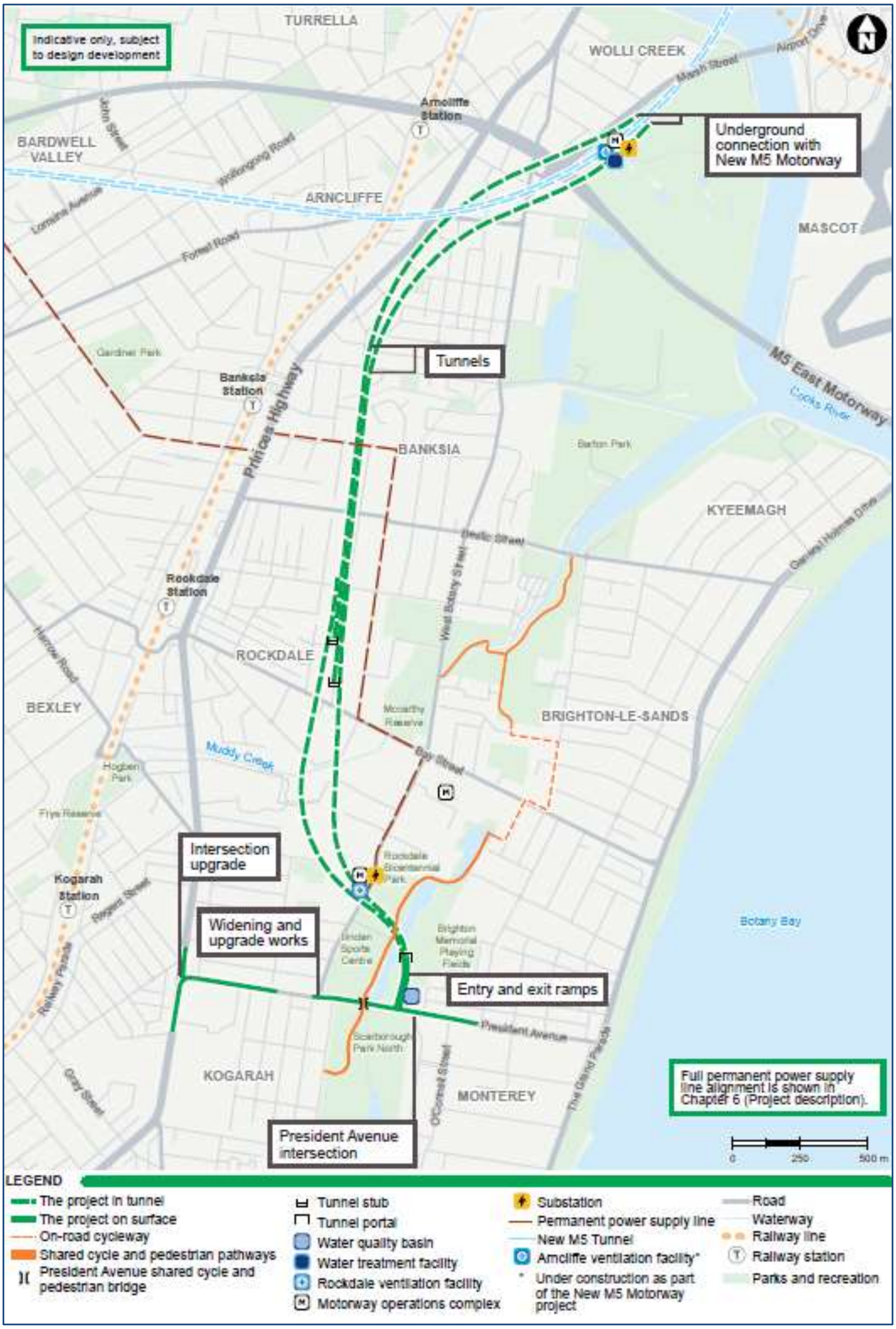

Figure 3-1: Project location and context

4 FINDINGS OF CONSISTENCY REVIEW

The key findings of the consistency review of the Air Quality Technical Report for the F6 Stage 1 (**RMS, 2018**) are outlined below. Generally the Air Quality Technical Report was found to address the majority of SEARs requirements.

4.1.1 Management or offset of residual impacts

A limited number of receptors will experience a small level of increased impact, beyond impacts (above criteria) that would also otherwise occur irrespective of the Project.

The ventilation design and control is assumed to be sufficient to avoid impacts, but it is not clear what specific considerations were made in the road design to minimise any specific impacts at the most affected receptors.

4.1.2 Compliance with in-stack criterion

Compliance with adopted in-stack limits is assumed in the assessment, some explanation of the process/steps/physical mechanisms that will be adopted to ensure compliance occurs in practice may be warranted.

4.1.3 Assessment of BTEX

While the criteria for BTEX is provided in Annexure B and a brief summary of modelling results is found in Annexure J, modelling results for ethylbenzene appear to be omitted and 1-hr average results required for assessment against the NSW EPA criteria are not provided for toluene and xylenes.

4.1.4 Comparison with existing conditions

The change compared directly with the existing conditions “base year” is not shown.

4.1.5 Monitoring details

While it has been stated that monitoring will occur, specific details of monitoring including frequency and criteria, are not provided.

4.1.6 Best practice

While best practice is referred to variously, some clear and specific commentary (a comparison table etc.), on best practice design would be warranted to explicitly address this requirement.

4.1.7 Construction odour

While odour from landfill gas has been assessed, no management or mitigation measures are provided.

4.1.8 Elevated receptors

It is noted that the predicted impacts for elevated receptors near ventilation outlets do not cover heights above ground level at which the maximum likely impacts from the outlets may arise. Due to this, it may not presently be possible to evaluate if the assessment has adequately considered the potential air quality impacts at all existing and likely future receptor locations.

5 RESPONSE TO CONSISTENCY REVIEW

The following is a summary of the responses to each issue raised in the preliminary review. Our comments are shown in *italics* immediately below each response.

5.1.1 Management or offset of residual impacts

Not specifically addressed in response, but indirectly addressed in response to other issues raised, e.g. elevated receptors.

5.1.2 Compliance with in-stack criterion

The in-stack limit for NO_x is 20 mg/m^3 which is approximately equivalent to 10ppm. This should equate to around 1.6ppm for in-stack NO_2. The in-tunnel limit (tunnel average) for NO_2 is 0.5ppm and levels within the tunnel will be managed by the real-time monitors and the ventilation management system operated from the tunnel control room. Monitors will be provided in the stack in accordance with the relevant monitoring and data capture standards to ensure compliance with the EPA ventilation outlet licence requirements.

Noted.

5.1.3 Assessment of BTEX

In Section 8 it is stated: 'Four air toxics - benzene, PAHs (as BaP), formaldehyde and 1,3-butadiene – were considered in the assessment. These compounds were taken to be representative of the much wider range of air toxics associated with motor vehicles, and they have commonly been assessed for road projects'. Annexure D (section D.6.6) presents the monitoring results for BTEX, which show that concentrations are very low. In our view there is not much point in evaluating every one of the 130 single compounds. The AQIA is focused on the more relevant compounds that are representative of motor vehicle emissions.

However since assessment of ethylbenzene is required by the SEARs we will therefore add the 1-hour results for ethylbenzene to the main report and Annexure J.

An assessment of toluene and xylene is not provided in the BTEX assessment because they are odour criteria (same applies to acetaldehyde). Refer to text from Section 5.5.5: For each of the RWR receptors, the change in the maximum 1-hour THC (Total Hydrocarbon Compounds) concentration as a result of the project was calculated. The largest change in the maximum 1-hour THC concentration across all receptors was then determined, and this was converted into an equivalent change for three of the odorous pollutants identified in the Approved Methods (toluene, xylenes, and acetaldehyde). These pollutants were taken to be representative of other odorous pollutants from motor vehicles. For the operational assessment the results are presented in Section 8.6.

Noted.

It may be helpful to provide information that makes a clear link between compliance with criteria for the assessed pollutants and all other pollutants, in terms of overall health impact.

5.1.4 Comparison with existing conditions

This is not done because it does not show the effects of the project. It shows the combined effects of the project and changes in the traffic volume and fleet composition.

This is a fairly standard distinction for air quality assessments of road projects (see, for example, DMRB in the UK: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/ha20707.pdf)

As stated in Table 5.1 of the air quality report:

'2016 Base Year. This scenario represented the current road network with no new projects/upgrades, and was used to establish existing conditions. The main purpose was to enable the dispersion modelling methodology to be verified against actual air quality monitoring data.' [see the results of this in section 8.4.10]

The inclusion of a base year does also provide a more extensive picture of the changes in emissions in the study area with time (see Table 8-9, Table 8-10 and Figure 8-6), taking into account both improvements in emission-control and growth in traffic. This provides more context for the potential changes in regional air quality with time. However, the predicted concentrations for the base year are not presented in the report, mainly so that the effects of the project in each future year can be understood more clearly, but also to simplify the presentation of results.

Nevertheless, the SEARs seek a qualitative assessment of the redistribution of ambient air quality impacts compared with existing conditions, due to the predicted changes in traffic volumes.

Whilst it is not clear that any part of the assessment directly addresses this requirement explicitly, the intent may possibly be met.

The link/ password to open the draft document has expired and thus we cannot consider Tables 8-9, 8-10 or Figure 8-6.

Please ensure the qualitative assessment requested in the SEARS is provided in a clearly identifiable part(s) of the assessment.

5.1.5 Monitoring details

Detailed design of the in-tunnel monitoring system will be undertaken in future project development phases and will comprise the following; NO_x NO_2 CO and visibility: Monitoring of each pollutant will be undertaken throughout the tunnel. Locations for monitoring equipment will generally be at the beginning and end of each ventilation section. For example, at each entry ramp, exit ramp, merge point, diverge point and ventilation exhaust and supply points. The location of monitors will be governed by the need to meet the in-tunnel air quality criteria for all possible journeys, especially in the case of NO_2 this will require sufficient monitors to calculate a journey average exposure and they will be integrated with the monitoring system for the adjoining WestConnex tunnels for this purpose.

Velocity monitors will be placed in each tunnel ventilation section and at portal entry and exit points. The velocity monitors in combination with the air quality monitors will be used to modulate the ventilation system to manage air quality and to ensure net inflow at the tunnel portals.

Noted. Full details would be provided at the detailed design stage, and it is not possible to make binding commitments at this time on any specific details that may change at the detailed design stage.

However, it may be useful to mention $PM_{2.5}$ and any link to visibility, and to expand on the details provided.

Nominally a page outlining the general principles of how the controls would work, and some examples from other projects etc may be useful.

5.2 Best practice

Not addressed.

5.3 Construction odour

A section on odour management will be added. Text to be added to describe the use of on-site odour measurements to remodel site specific emission rates during construction. This will be included in the odour management measures.

Noted.

5.4 Elevated receptors

Additional contour plots at 45m elevation which approximates the maximum permissible building height in the locality have been prepared. Land in the immediate vicinity of the Rockdale ventilation facility is zoned industrial with a building height limit of 14.5 metres in the Rockdale LEP 2011. The low density zoned residential land which surrounds the industrial zoned land has a building height limit of 8.5m. At this height there would be minimal influence from the ventilation outlets and the local air quality is influenced by emissions from the surface road which diminishes at heights towards 10m.

A high density residential zoned area with a building height provision of 14.5 metres is located approximately 250 metres to the west of the ventilation facility. Another high density zoned residential area with a building height limit of 31 metres is located approximately 280 metres to the sites north east.

Therefore the previously modelled heights of 10, 20 and 30 metres provide the data to assess the impacts at these heights.

Development patterns and height restrictions for developments in the area of the Arncliffe ventilation facility area are regulated under the Rockdale LEP 2011 and SREP 33. The areas to the site's immediate north and north east are zoned for low density residential development and have maximum building heights of 8.5 metres. At this height there is minimal influence from the ventilation outlets and the local air quality is influenced by emissions from the surface road which diminishes at heights towards 10m. However, the Bayside West Draft Land Use and Infrastructure Strategy (2016) identifies a large portion of this area of land for future high density residential development (priority area for rezoning). Any future planning controls for this area would need to be developed (based on detailed modelling) to ensure air quality and health risks to elevated receptors are in the tolerable/acceptable range or better.

Further north towards Cahill Park, building heights are significantly higher and range between 17.5 metres and 29.5 metres in the high density residential zoned area and 46m in the mixed use zoned areas. This area is located approximately 260m away (at its closest point) and again the air quality and health risks are considered to be in the acceptable/tolerable range. The closest elevated receptors to the Arncliffe Ventilation facility are in the area bounded by Marsh St, Innesdale Road and Levey St, approximately 240m away and they are less than the 46m mixed use height restriction in the LEP.

There are no current building height controls for the land to the south/south east of the site under SREP 33. However the Bayside West Draft Land Use and Infrastructure Strategy (2016) also identifies the surrounding land in this area for high density mixed use development (priority area for rezoning). This land would also be subject to the building height restriction in the Sydney Airport Protection of Prescribed Air Space limitations, as is the height of the Arncliffe ventilation outlet. Any future planning controls for this area would need to be developed (based on detailed modelling) to ensure impacts on the elevated receptors are in the tolerable/acceptable range.

The future year modelling for 2036 DSC, as the worst case, is done to provide guidance for future planning of developments in the area. Due to the difficulty of calculating the background air quality at elevations ie there are no long term elevated monitoring stations, the assessment used the change in $PM_{2.5}$ which is an important pollutant for health generally has a similar dispersion to the other pollutants.

The draft response does not fully consider likely future receptors, as it is based on existing planning height controls.

Such controls can be relaxed, for example, in February 2018,TAS and PEL/ ERM were involved with a project for many, up to 29 storey residential towers (approx. 90m tall) next to the Arncliffe ventilation outlets.

Please re-consider providing the requested information.

As a minimum, tabled data for incremental $PM_{2.5}$ and NO_2 should be provided.

6 FINDINGS OF THE PRELIMINARY REVIEW

The key findings of the preliminary review of the Air Quality Technical Report for the F6 Stage 1 (**RMS, 2018**) are outlined below.

6.1.1 Modelling approach

Similar to the air quality assessments for the WestConnex M4 East (**Pacific Environment, 2015a**), New M5 (**Pacific Environment, 2015b**), and WestConnex M4-M5 Link (**Pacific Environment, 2017a**) the AQA used the GRAL model to predict operational impacts on ambient air quality. Modelling scenarios included the expected traffic scenarios and regulatory worst case scenarios (an artificially exaggerated case to assess the effects that may occur if emissions were released at the permissible concentration limits for tunnel ventilation outlets at all times).

It is noted that zero portal emissions have been assumed in the AQA, with all vehicle emissions assumed to be dispersed from tunnel ventilation outlets. This is consistent with recent project approval conditions for road tunnels that prevent portal emissions, but it is noted that in reality some minor fugitive portal emissions would occur from time to time, and that minor such emissions or portal emissions at night time/during very low traffic flows are unlikely to be a tangible issue.

No building wake effects were included in the AQA due to time constraints, and to save time a large model grid resolution was used. A sensitivity analysis with buildings included was conducted and found an increase in concentrations by a maximum of 32 percent and an average increase of 20 percent. It was however considered that the conclusions in the assessment would not change significantly with the inclusion of buildings. It is not clear if this considered that in general the selected receptor locations used in the AQA tend to represent the centre of large buildings or building complexes and there may be higher levels at the sections of the buildings closer to the roadway.

The consultant’s modelling strategy/ assessment approach with the selected model appears to be too computationally large and is not set up to deliver the most accurate results where most relevant. Consequently it appears that it was necessary to use the model in a less than ideal manner.

In the reviewer’s opinion, it would have been preferable to have developed a more focussed, detailed model near to the major roadways (or at least those localities with changes in traffic volumes that are large) and to expend less effort on modelling receptors well removed from the roads. This would have made use of the model’s known strengths in representing emissions near to roads and overcome its limitations in representing potential pollutant dispersion (affected by meteorological conditions) over a large spatial area.

It is noted that the *Optimisation of the application of GRAL in the Australian context* report **Pacific Environment, (2017b)** was prepared by the same consultant. This study indicates that the model does not provide superior performance to established models and that the meteorological component is poor at representing spatial variations in meteorology.

Overall, given that;

- there is no need to assess non-permissible portal emissions;
- other models perform as accurately as the chosen model but are much less complex or computationally demanding to operate;

- other models perform considerably better at representing the prevailing meteorology; and,
- the "effort" required to conduct the chosen modelling approach would appear similar or greater than that needed to operate well established models that are able to conduct chemical transformation calculations, whereas significant additional work was necessary in this case to develop an empirical approach as the model cannot do such calculations. It would seem that other models or approaches may have been used to overcome the difficulties encountered with the model per the assessment approach which was used.

Potentially, more accurate results could have been obtained with similar effort by changing the approach, the model that was used, or how the model was applied. Also, it is considered that results which are at least as accurate and sufficiently adequate could have been obtained with less effort, using a simplified approach and/or model.

Overall, the rationale for the consultant's modelling approach and selection of the model is unclear and unconvincing. However, for the reasons previously considered, this would not change the overall outcome, and the overall approach is considered adequate for assessing impacts due to the Project.

6.1.1.1 Use of multiple modelling approaches

While the operational impacts of the Project were assessed using GRAMM/ GRAL, to model potential odour from construction the CALMET/CALPUFF models were used. It is unclear why the same modelling approach was not used for construction impacts as the operational impacts. It is unclear why GRAL was not used, given the model is claimed to be suitable for assessing odour emissions. Whilst there is no issue with the selection of CALPUFF for assessing odour, why CALPUFF was selected for the assessment of odour impacts from construction in preference to the GRAL model being used for all other parts of the project is unclear, and this erodes confidence in the GRAL modelling approach adopted for the assessment of operational impacts. It appears to be at odds with the rationale for the use of GRAL over other dispersion models.

With regard to the assessment of construction impacts arising from excavation of a historical landfill, the use of a mass emission rate of only sulfur gas emissions from coastal acid sulfate soils to represent H_2S, which in turn is used as an indicator of actual odour (OU) from a historical landfill is not reasonably justified. As such, the recommendation in the assessment to take on-site measurements and re-model with site-specific emission rates would be important, and necessary to verify the potential for odour impact.

Due to this situation, it is not known what, if any, risk of odour impacts may arise. It is thus recommended that a summary be provided to outline the considerations given to possible contingency measures in the result that the verification study finds potential for unacceptably high levels of emission or impact.

6.1.2 Meteorological modelling

A broad, meteorological analysis was conducted in Appendix F of the AQA.

The 2016 meteorological year was selected in the AQA to allow use of the available 2016 data from roadside monitoring stations for dispersion model evaluation. Whilst is noted that the air quality assessments for the M4 East and New M5 projects used 2014 meteorological data and the M4-M5 link used 2015, it is agreed that it is important to have used a year in which there are suitable air quality monitoring data, however there does not appear to be any good reason provided as to why the modelling would take more than 9 or 10 months to complete and thus why 2017 could not be used. The 2017 data would provide more recent data at more locations (and hence appears better than 2016 in this regard) but was not used.

In the reviewer's opinion, the assessment has applied a suitably adequate year of meteorological data in the modelling as it permits important verifications to be made with actual measured pollutant levels. These comparisons are considered by the reviewer to be more important than the effects which may arise due to variability in meteorological data between years, especially as the meteorological data do not appear to be a critical factor (see further below) and also because the chosen model has relatively poor spatial meteorological performance.

Nevertheless, per the potentially applicable EPA Approved Methods guidelines (**NSW EPA, 2017**) the AQA should also evaluate the representativeness of the year chosen against other years, as would be expected in most other assessment situations in NSW in recent years. By doing this, any bias in 2016 relative to the overall trends in the weather data can be identified, quantified and considered when interpreting the assessment findings.

However the overall meteorological data analysis does not provide a technically robust justification that the 2016 data used in the modelling are representative of the typical meteorological conditions for the area. Further quantitative analysis would normally be required for a range of meteorological parameters including wind direction to demonstrate the meteorological representativeness of the year selected.

Data from the OEH Randwick and OEH Earlwood monitoring stations were chosen for use in the modelling. The use of meteorological data from multiple stations is likely to result in more realistic wind fields over the modelling domain.

An interpolation of wind speed presented in Figure F-1 of the AQA is used as part of the justification for the selection of the OEH Randwick and OEH Earlwood monitoring station data in GRAMM. Interpolation of wind speed is not considered to be a valid means of evaluating weather data in this case for reasons including that it uses invalid data affected by the presence of trees etc., there are not enough data points to make the interpolation plausible (given the terrain and other land features that affect the wind speed), and it is questionable given that there are recognised meteorological models that factor in terrain, land use etc. which can be easily applied to provide a more reliable representation of winds across the area (and were applied for the construction assessment).

It is acknowledged in the AQA that the OEH Earlwood monitoring station has siting issues due to nearby trees and as such has been assigned lesser weighting factors in GRAMM than the OEH Randwick station. The weighting factor does diminish the influence of the invalid data for the Earlwood monitor, but it would be better practice to not use invalid data at all, or if necessary to remove the portions of the wind directions affected by the presence of trees etc., and only use the parts containing valid data, or to do this and use a meteorological model to input the missing invalid data (ETC) rather than to simply include invalid data (albeit at a lower weighting).

Similarly, some of the wind data from the RMS and SMC monitoring stations are likely to be compromised by nearby trees. The inclusion of these stations in the interpolation would magnify the difference between the Project location and the Sydney Airport AWS.

The BoM Sydney Airport AWS data were not included in GRAMM, due to high wind speeds.

The Sydney Airport station is the closest meteorological station to the Project with long term data available and which is not impacted by structures or trees. Thus it is considered that it should have been included in the modelling and assessment. Specifically, there is no evidence to support the statement in the AQA that at this location "higher wind speeds are driven by airport activities", in fact an analysis of the data suggests that this is not the case and that the measured data at this location reflect the actual wind conditions at the weather station.

It is not considered to be good practice to omit reliable and accurate data on the basis of invalid assertions without robust quantifiable evidence and to use known, compromised data in the model when there is no need to.

However, as outlined at the outset, the model performance in regard to its representation of the spatially varying meteorological conditions is relatively poor, which is primarily due to limitations inherent to the model used (GRAMM) and possibly due to the modelling approach and data quality control/ selection.

The meteorological model used is relatively unresponsive to the likely actual spatial (and temporal) variations in the meteorological conditions and tends to apply very similar meteorological conditions at all points in the modelling domain as those in the meteorological input data.

The model set up classifies meteorological data into discrete categories according to wind speed etc. These weather parameter categories are generally related to atmospheric dispersion but do not incorporate all of the factors which actually affect the dispersion at any time. This limitation inherently prevents the model from considering the hour by hour atmospheric dispersion conditions which may be occurring differently in different spatially separated places in the modelling domain. This results in poor spatial and temporal meteorological performance, and by extension, poor capacity for the overall model to predict short term, place and time specific pollution levels at a distance from sources.

The critical question is whether or not these inherent limitations are significant for assessing the Project impacts.

In the reviewer's opinion, the limitations are not critical in this case. The fundamental reason is that for roads, the dominant effects occur within tens of metres from the road. Pollution from the road takes seconds or a few minutes to reach the nearest receptors which may experience the most significant effects. In this situation, there is insufficient opportunity for the weather (air dispersion) conditions to have a big effect so close to the source. From a most impacted receptor's point of view, the wind is either blowing the pollution from the road towards it, or not. If it is, the level of pollution arriving is mostly affected by the (short) distance from the road and any intervening terrain or buildings and less by the dispersion conditions (over short distances).

For the ventilation outlets (stacks), the meteorological effects on the modelled dispersion pattern of emissions would be significant but are not important as the emissions from the stacks can only be released at relatively low pollutant levels, generally low enough for the safety of tunnel users breathing the air when in the tunnel. (It is noted that tunnel air pollution increases as one moves along the tunnel and hence the air vented from the stacks is at almost the worst/ highest in-tunnel pollutant concentrations, but the level of pollution ramping up within the tunnel is much less than the level of dispersion achieved with a stack once the air is released). In this regard the stacks can only have low impacts and any inaccuracy spatially due to the model limitations in already low levels would be insignificant.

Overall, whilst the relatively poor spatial performance of the model is not critical, and would not change the conclusions reached, the use of the model set up in this case is incongruous with the level of detail adopted in the approach, particularly as a key feature of the assessment approach is modelling potential impacts at many thousands of residential, workplace and recreational (RWR) receptors which are positioned well away from the road and which cannot be accurately represented using the model per the adopted set up.

It is noted that the meteorological data used in the modelling of the construction period is significantly different to that used in the assessment of operations. While data from the OEH Earlwood and Randwick were used in GRAMM, the BoM stations Sydney Airport, Randwick, Fort Denison and Manly were used in the CALMET generated meteorological file. No justification for the use of different meteorological data sets is provided.

Furthermore details of the CALMET meteorological modelling have not been provided such as critical CALMET parameters, windroses, wind vector plots or analysis of CALMET generated meteorological parameters and so the adequacy of the meteorological file cannot be evaluated. (There are also cross-referencing errors in Appendix F of the AQA which hinder the review of what was done).

6.1.3 Modelled receptors

The RWR receptors are defined as "discrete points in space - where people are likely to be present for some period of the day".

The "simpler statistical approach" used in this AQA and in previous assessments to assess the RWR receptors remains unclear and unexplained despite requests in the reviews of previous assessments that further clarification be provided in future. It is recommended that the approach used be clarified and explained.

Despite using essentially the same RWR receptor approach in several previous assessments, the actual technical or scientific purpose of the RWR receptors still remains unclear. It is stated that the RWR receptors are not designed for the assessment of changes in total population exposure, however this is at odds with the results presented in Section 8.4.11 for example Figure 8-62 presents the change in annual mean $PM_{2.5}$ concentration at RWR receptors that represent the population with potential effects from the project.

The representation of high density dwellings such as apartments as a single, central receptor can underestimate the exposure of the affected population. The AQA does not apply a population weighting to assess impacts, but rather a population weighting is considered in the human health risk assessment (HRA) section of the EIS. It is noted that the HRA appears to use results for receptor locations that may not accurately represent the population being considered in the HRA. A detailed analysis of the HRA is beyond the scope of this review.

The scientific validity of the relative RWR assessment approach is questionable without first and independently of the assessment, justifying the spatial and/ or impacting extent to be considered as the

RWR bounds and giving a population weighting to RWR receptors. This is because the outcomes can be altered by the spatial extent of RWR receptors selected alone, (as this governs the fraction that are negatively or positively impacted) and can be biased without considering population density within the RWR bounds.

Where results are presented as the change in concentration at RWR receptors, (without the application of population weighting), this increases the uncertainty of the findings when assessing any net benefit or detriment. The outcome of these relative analyses is thus significantly influenced by the spatial extent of the receptors selected, with a more favourable balance being obtained when selecting greater numbers of more distant (less affected) RWR receptors and a less favourable result where fewer RWR receptors nearer to the surface roads are considered. This is not to say there is any issue with the spatial extent of the RWR receptors chosen in this case, however it highlights the need for a pre-defined guideline to be established. Indeed it is noted that this issue is one of only four key air quality issues raised by **The World Bank (1997)** for consideration when assessing road projects in its Roads and the Environment Handbook.

The geographical midpoint chosen to represent high density dwellings, particularly those along main roads, may also underestimate exposure for residents closest to the road and overestimate the exposure of those residents in the apartment complex with greater setback from the road. The pollutant level with distance away from a road does not reduce linearly, hence for a residential apartment/ complex with an even spread of people, the number of more impacted people (between the receptor point and road) will not be balanced out by the number of less impacts people further away from the receptor point and road, hence the net effect of using a central point to represent the effects at a large apartment/ complex is a potential underestimation of pollution impact and the number of people who may be more affected at that location.

In total 17,509 RWR receptors are considered in the assessment. This represents significantly fewer RWR receptors than in previous assessments, and is viewed favourably as it reduces the scope for potential bias due to including more of the less-affected receptors than necessary. It is also noted that in some cases, the extent of negative impact for the RWR receptor comparisons is approximately similar to the positive impact. It is not clear if this was done deliberately (as it would be key part of removing potential bias in the approach, the other part factor being the use of population weightings).

It is suggested that a more demonstrably objective means of assessing the net relative project impact would be to consider all of the receptors where the effect of the project is above a pre-defined, tangible value (e.g. > ±0.5μg/m^3). This would obviate the present bias that arises from selecting a (too large or too small) spatial extent for the RWR receptors, and would make the evaluation of Project benefits more objective by answering the question of whether any tangible effects due to the project is positive or negative, on balance.

6.1.4 Tall buildings near ventilation outlets

The depiction of tall buildings near ventilation outlets, the potential wake effects associated with buildings and impacts on receptors within the building is considered below.

As outlined in Section 8.4.7 of the AQTR, building data were not included in the simulation due to issues associated with impractically long model run times. (As noted previously, there are numerous means to accommodate this, but the options do not appear to have been considered).

The AQTR comments "*there are only a small number of tall buildings in proximity to the proposed ventilation outlets, and therefore the effects of building downwash (refer to **Annexure B**) would probably have been rather limited*". Note that the reference to Annexure B appears to be erroneous.

Annexure A acknowledges the effect of building induced turbulence and its effects on pollutant dispersion and how this is an important consideration for the design of tunnel ventilation outlets. However the assessment focuses on vehicle-induced turbulence as this is likely to be more significant than that caused by buildings.

As previously stated, the sensitivity test indicated that concentrations associated with the ventilation outlet on average increased by 20 percent. As the predicted impacts are low, it was determined that buildings effects are unlikely to represent a large source of uncertainty in the overall predictions.

Modelled concentrations for the Project effects on surface roads were predicted at three elevated receptor heights (10 metres (m) 20m and 30m) for annual and 24-hour average $PM_{2.5}$. The results indicate the influence of surface roads reduced with increasing height, and that near the ventilation outlets pollutant levels from the outlets were greater at 30m height than at 10m.

Recommendations for building height restrictions in the vicinity of the ventilation facilities are made in the assessment. The development of suitable planning controls would likely need to be supported by detailed modelling addressing all relevant pollutants and averaging periods. In this regard, the model used in this Project (and indeed most commercial air dispersion models) is not suitable for detailed design evaluation of the interaction of ventilation stack plumes and any new, tall buildings and thus significantly more advanced approaches may be needed.

6.1.5 Background data

Background concentrations applied in the assessment are developed from selected OEH and RMS monitoring sites. It is understood that the two project specific monitoring stations F6:01 and F6:02 were established in late 2017, but not used in the assessment due to insufficient data availability. However there would now be approximately 12 months of data available for this review and it is therefore requested that these data be provided in an hourly format, along with all other monitoring data (air quality and meteorological).

Some of the background data presented in Section D.5 appears to be erroneous. **Table 6-1** provides the AQA data and the OEH data for the Earlwood, Randwick Rozelle and Chullora OEH PM_{10} and $PM_{2.5}$ annual average monitoring data for the 2016 period. The inconsistency may have resulted where data from extreme events reported by the OEH were not included in the averages. As per the National Environment Protection (Ambient Air) Measure (**2016**) "*For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$ 1 year average standards, jurisdictions shall include all measured data, including monitoring data that is directly associated with an exceptional event*".

Consideration should be given to reviewing the OEH monitoring data and updating the report to reflect the correct values.

Table 6-1: Example of background data inconsistencies – 2016

Station	Pollutant	Averaging period	Air technical report concentration (µg/m³)	OEH reported concentration (µg/m³)
Earlwood	$PM_{2.5}$	annual	7.7	8.1
	PM_{10}	annual	17.2	17.6
Randwick	PM_{10}	annual	17.7	18.0
Rozelle	$PM_{2.5}$	annual	6.9	7.4
	PM_{10}	annual	16.4	16.8
Chullora	$PM_{2.5}$	annual	7.6	8.0
	PM_{10}	annual	17.7	18.1

The annual average pollutant levels measured in 2016 at OEH and SMC monitoring stations were interpolated in order to map the background concentration over the GRAL domain. The use of the correct background values would generally act to increase the annual background PM_{10} and $PM_{2.5}$ gradients used in the GRAL domain from which the spatially varying profile applied in the assessment is derived.

Also, the review was unable to find what data were used in the interpolation, for example actual annual average values used do not appear to be presented in the AQA, instead data from other RMS stations are presented, but these data were not used to create the interpolation maps. Furthermore, the interpolated map appears to contain more data, or utilise off-map data, or to have been interpolated or created differently to what is stated in the AQA.

It is therefore requested that all of the data and information used to create the interpolation maps be provided, including precise co-ordinates for the stations and if relevant, a brief note outing why some data was not used in the interpolation.

For short-term background pollutant concentrations a synthetic background file was developed based on the maximum level of the selected monitoring stations for each time period, although it is unclear from where this maximum originates. Nevertheless the approach is considered likely to be conservative, although a more transparent description would be appropriate.

The background "grid" used for PM_{10} indicates low points at the RMS monitoring sites compared with OEH data at Liverpool, Prospect and Chullora, and also provides gradients that do not appear to be likely to actually occur. It is not clear what data quality checks have been conducted on the road-side data.

For $PM_{2.5}$, the mapped background level applied (Figure-26) at receptors exceeds the 8µg/m^3 NSW EPA impact assessment criterion and the NEPM standard. This means that all predictions at all locations would exceed the criterion value, however this would not actually occur in practice.

Overall, the spatial interpolation of a few data points, some which are closely spaced and others well apart and the subsequent extrapolation of these data across an area with large expected variations in pollutant levels is challenging to accept as being realistic, especially as represented in Figure D-24 and Figure D-25. The figures show a diagonal graduation in NO_X levels and a very different graduation in PM_{10} levels across the modelling domain, neither of which is likely to actually occur in reality when considering the factors affecting background pollution across the mapped area.

In the reviewer's opinion, the graduations presented in the figures arise primarily due to the available data and the locations at which the data are collected, rather than any strong influence due to any actual likely tend in the prevailing background levels. For these reasons, using interpolation is not considered appropriate in situations with limited information, as in this case, and where the potential errors in the interpolated background levels may be as high. For example bias of approximately 25%, arises between the differing instrument measurement technologies and similarly due to other factors, thus variations as high as up to approximately 50% for NO_x and approximately 30% for PM_{10} and $PM_{2.5}$, may exist, depending on how the data are applied in the assessment.

However, these issues make little difference to the relative change in impact (at any one point) upon which the assessment of project effects is mainly is based, and although the issues are significant in regard to the absolute accuracy of the assessment predictions, this would only matter if there were criteria applicable for compliance or assessment purposes (which there are not).

The approach taken does not allow scope to evaluate the possible issue of the Project potentially leading to levels above a criteria or standard in some specific locations. This is a moot point at present as the EPA criteria and NEPM standards do not apply to road projects. The issue may be relevant should any future road project assessment guideline set out an applicable criterion.

In this regard, it is notable that the adopted modelling approach would not most accurately represent the likely absolute cumulative impacts for $PM_{2.5}$, one of the key pollutants associated with motorway operations Furthermore, a contemporaneous assessment method for short-term impacts, and also statistical method, is applied, but does not appear to be fully explained.

6.1.6 Assessment of Impacts

As the selected model cannot conduct chemical transformation calculations, an empirical method was used to evaluate NO_x effects based on an analysis of selected ambient monitoring data. The approach appears to be conservative (unlikely to underestimate results).

It is also noted that an evaluation of model performance can only be conducted at locations with known (measured) levels of pollutants and these known pollutant levels (background data) are used as an input to the assessed (predicted) cumulative total pollutant levels (variously). However, there is inherent uncertainty in the background levels that may occur between locations with known pollutant levels, for example due to the background interpolation approach applied (or other such approaches which could potentially be used). It was requested that an outline of any such inherent variability or uncertainty as far as it may affect the final results be provided as the broad, generic discussion of uncertainty in the AQA does not tackle this issue specifically.

It is noted that the background data dominate the total level predicted in the assessment and it is thus relevant to consider the background data in detail when considering total cumulative pollutant levels at any location. However, as the background data are assessed to be the key determinant of the total cumulative pollutant levels, the assessment results are not governed by modelling the impacts from the roads, but by a simple interpolation map of a limited data set.

As outlined previously, the simple interpolation used in the AQA to determine the background levels is not considered to be realistic and appears to incorporate large anomalies.

Contrary to the claim in the AQA, a level 2 contemporaneous assessment method for short-term impacts at community receptors has not been conducted per the NSW EPA Approved Methods (**NSW EPA, 2017**) as only the maximum impact is presented. The Approved Methods require the frequency at which the 1-hr or 24-hr impact assessment criteria are exceeded to be determined, with and without the subject source. The frequency of any exceedances is not shown, hence it is not possible to tell how many additional exceedances may occur as a result of the Project. (It is noted that a level 2 contemporaneous assessment can only be reasonably conducted at a small number of representative receptor locations).

Table I-50 indicates that there would be an additional exceedance of the $PM_{2.5}$ 24-hr average criterion with the Project (2026-DS) at CR269 but not without the Project (2026-DM). This additional impact has not been discussed in the AQA.

Regardless of the above, the key analysis that should be, and is generally well set out in the assessment, is the relative change which may result in road traffic (and ventilation outlet) emissions. The results for this analysis are governed by the modelling predictions generally near the roads. The model has been shown to perform adequately in such locations and consequently the assessment of impacts due to the Project is considered to be adequate.

With regard to the assessment of construction dust impacts, the assessment concludes that receptors in the immediate vicinity of the construction zone, might experience some occasional dust soiling impacts but that construction dust is unlikely to represent a serious ongoing problem.

Other than offer an opinion, (potentially at odds with the experience of some in the community), the conclusions in regard to construction impacts do not well acknowledge or discuss how the proposed mitigation measures would transform the “Step 3” unmitigated “high risk” of dust impact to human health for receptors in the Zone 2 area identified in Table 7-11 of the AQA to a low level of risk that would be consistent with the conclusion. The report appears to jump a step between “Step 3” and “Step 4”of the risk assessment. For example it would normally be expected that the assessment outline the available options or contingency measures that could be used to mitigate the risks if the proposed controls and how they are applied turn out to be inadequate for achieving the claimed outcomes.

6.2 Recommendations

The AQTR is adequate and indicates that no major air quality issues would arise if the Project is approved. The primary recommendation therefore is that the typical approval conditions applied to recent such projects be applied if the Project proceeds.

It is also recommended that any future assessment consider using an alternative modelling approach to address the issues identified in this review, or if the GRAL model is used, consider the following:

- Apply the building features of the model and use a finer scale resolution near to the roadways (to improve modelling precision where it is most relevant);
- Focus modelling near the roadways and localities along the roadways where there is a tangible change in effects, for example a change in annual average $PM_{2.5}$ greater than ± 0.5µg/m^3 (to allow a more accurate and more clearly objective analysis of the net benefits to be made);

- Improve meteorological inputs (where a large modelling domain is used), for example by:
    - Pairing the model with a more reliable meteorological model than GRAMM;
    - Use more meteorological categories;
    - Use more metrological station inputs with a correspondingly greater number of smaller modelling domain(s).
- Apply the findings of the GRAL validation study.

Irrespective of the modelling approach taken, it is also recommended to:

- Ensure all key vehicle types are accounted for in the emissions inventory and that the trends in future emissions are sensible.

Consideration by state authorities should also be given to developing a Major Road Infrastructure Air Assessment guideline, or in the interim, adapting a suitable guideline from another jurisdiction for application to future projects.

6.3 Response to the preliminary review

The proponent prepared a Submissions Report (**RMS, 2019**) to respond to issues raised by stakeholders.

The preliminary review prepared by TAS does not appear to be directly considered in the submissions report, hence the issues raised by TAS regarding the modelling approach, meteorological modelling, modelled receptors, background data and recommendations do not appear to be addressed by the proponent in the submissions report. However, the NSW EPA raised similar issues.

With regard to tall buildings near ventilation outlets, the assessment of air quality impacts for elevated receptors is discussed in Section B2.3.3 of the Submissions report with further detail provided in Appendix B.

A review of the further assessment of air quality impacts for elevated receptors is set out in **Section 7**.

7 REVIEW OF SUBMISSIONS REPORT

This section outlines the key findings of the review of the Submissions Report (**RMS, 2019**).

7.1 Assessment at elevated receptors

The review of the Submission Report primarily focuses on the assessment at elevated receptors.

7.1.1 Building height details

Specific receptor building heights within proximity to the ventilation outlets should be provided, instead of only a description of general heights in the general area.

It is noted that a 2015 aerial image is presented for identifying tall buildings, however there are additional existing tall buildings in the vicinity of the ventilation outlets which were approved but not yet built.

7.1.2 Worst-case scenarios

In the proponent's response, only one of the Regulatory Worst Case scenarios is considered. The (RWC) scenario which is for emissions from only the ventilation outlet (at the approval limit) is presented, and this does not include the combined effect of the road emissions. The RWC-2036-DSC scenario which considers combined impacts of the ventilation emissions (at the permitted maximum level) and the emissions from surface roads, is presented elsewhere in the AQTR.

EPA appear to be asking that the results of the RWC-2036-DSC scenario be presented at varying heights in the vicinity of the ventilation outlets. This would be reasonable and necessary to allow an assessment of the potential project impacts to be made at the actual and likely future receptors which are at varying heights.

7.1.3 Methodology

The methodology uses scaling factors to determine 1-hr average impacts at four height intervals up to 45m. The scaling factors for the 2036-DSC scenario do not intuitively appear to be correct. This needs to be explained in detail. For example, the following potential issues are identified:

- The actual worst case scenario does not appear to have been assessed, only an "assumed worst case scenario". The RWC scenario in the AQA shows maximum ventilation impacts at 45m, whereas the profile for the assumed worst case scenario, which includes traffic emissions indicates ventilation impacts are worst at lower heights. This anomaly needs to be explained or corrected.

- The GRAL settings are not shown to be suitable for the requisite modelling in and around these tall buildings, nor is any evidence provided to display how the model performs, such as wind fields or pollutant concentration profiles at various heights amongst the buildings. As stated previously by TAS, the settings used in GRAL do not appear to be ideal, even when the time and computing limitations are considered.

- The scaling factors for the ventilation outlets cease at 45m, where the highest impacts arise for the RWC scenario. It is not demonstrated that greater impacts would not occur at greater heights or a height closer to 40m. This needs to be justified.

7.1.4 Background concentrations

In the absence of specific data, reasonable nearby background monitoring data may be used represent the background concentration in this case, including at various heights. OEH or other appropriate monitoring data are generally used to represent a wide spatial area, and not only the immediate vicinity of the monitoring station.

The EPA seeks that total predicted concentrations should be presented, rather than only be presenting the change in concentration between the "do something cumulative" and "do minimum" scenarios. The practice for the WestConnex Projects generally have been to present only incremental changes in order to determine risk due to the changes caused by the Project. The approach was developed and agreed with Health officials as in many cases the measured background levels already exceed the EPA criteria. Nevertheless, some type of cumulative assessment is still warranted alongside an assessment of the incremental risk posed by the actual project

7.1.5 Assessment of impacts

The predictions for the 2036-DSC scenario appear to be inconsistent between the main response to submissions report and Appendix B. This should be explained or corrected.

The maximum NO_x predictions in the main response to submissions report and Appendix B appear to be based on different maximum predicted increments which affect the NO_x/NO_2 ratio. This should be explained or corrected.

TAS considers that only $PM_{2.5}$ and NO_2 need to be considered at this time as these are the only traffic related pollutants with any tangible scope to cause impact. However the potential impacts for air toxics at receptors should be considered for the worst case ventilation outlet and surface road scenario combination which is RWC-2036-DSC.

7.2 Response to Submissions Report Review

The following is a summary of the responses to the submissions report review. Further comments by TAS are italicised.

7.2.1 Building height details

This has been closed out in previous submissions.

The reviewer was not involved in resolving this issue.

7.2.2 Worst-case scenarios

Plots attached. Contour plots show 24-hour and annual $PM_{2.5}$ and 1-hour NO_2 concentrations due to emissions from the outlets for the 2036-DSC Regulatory Worst Case (RWC) scenario.

No plots are attached.

7.2.3 Methodology

Clearly this method is an approximation, as discussed in the original responses, as only modelling for $PM_{2.5}$ was carried out at these heights. These issues around the use of the GRAL and its limitations have been discussed at length and in various forums. The methodology is explained in Appendix B. Regarding the comment about not modelling at 40m, I believe 45m was agreed upon (at the reviewers request) to be an appropriate height to model. Obviously not all heights can be modelled so a representative selection was chosen. Recent work has been done for previously approved projects (such as the M4 East) where further, more detailed, modelling work is done around outlets once the final design is decided on and built. It is likely that this will also be the case for the F6.

The response does not address the issue about apparent errors in the methodology utilising various factors to multiply the ground level value in order to determine the values at various heights. A factor of more than one indicates levels higher than at ground level and a factor of less than one indicates values lower than at ground level. However, the response presents negative factors (see Table 5), which is taken to mean negative emissions from the road and or ventilation outlet. Also, the variability in the factor with height does not appear to be reasonably likely. Please either correct the apparent errors, or if there are no errors please clearly explain what was done and why it is correct, for example by explicitly showing the calculations at every step.

The reviewer agrees that in other previously reviewed cases, the GRAL settings were not crucial to the overall findings and those settings have been examined and discussed at length elsewhere. However, in this case there is a plume-rise constrained stack, major surface roads and tall nearby buildings, and the results will be more sensitive to the GRAL set-up and settings. The GRAL settings for this specific case have not been discussed in reasonable detail. There are many settings in GRAL that can be used to model pollutant concentrations in and around buildings, and presently it is not clear if the settings are critical to the findings. Given the apparent errors in the scaling factors (or possibly in the modelling and settings), the more recent changes in CASA plume rise guidelines, and that it is reasonably possible that some changes may be necessary in the final design, it is agreed that more detailed modelling is warranted, but as part of the final construction design work, rather than after finalising the design.

7.2.4 Background concentrations

Data are only available up to heights of 45m - as previously agreed with the reviewer. Additional modelling would be required for heights above this so no, it isn't possible to provide this information.

Providing modelling up to heights of 70m when we know there are no current or approved buildings close to the outlets, would have little value. As discussed in relation to comment #59 above, this kind of detailed analysis is something that could be done for proposed developments once the final outlets are constructed.

It is noted that the reviewer's own modelling for hypothetical proposed tall buildings very near the ventilation outlet shows maximum effects (from only the vent) at approximately 45m above ground level. The height of maximum effect may be different for the actual buildings that are further away, but the indications are that considering a height of 45m would be prudent. The assessment has not identified the maximum impacting height (for the worst case for roads and ventilation outlet combined) at likely future receptors. The trend with height from the scaling factors indicates maximum impacts may arise above 45m. The EPA Approved Methods outlines the need to consider likely future receptors, not just current or approved receptors as assessed by the proponent.

The reviewer considers that it is a poor use of industry and state resources to not define the limitations on future buildings in the area around the ventilation outlet at this time, and to leave this type of relatively *complex modelling to be done ad-hock per the local government approvals process which is not suitably resourced to deal with the likely issues. This will lead to unnecessary work, costing time and money for government and industry, and potentially resulting in poor planning, environmental or health outcomes for the community. There is no sound reason that ground level data should not be used in the absence of any actual monitoring data at height. The reviewer recommends that the proponent define the exclusion volumes around the ventilation outlet in three-dimensional space (e.g. specify a clear sky angle from the top of the ventilation outlet, above which no building may penetrate). The reviewer is aware that additional modelling will be necessary to do this, and recommends that this be done as part of the final construction design for the ventilation outlet.*

7.2.5 Assessment of impacts

$PM_{2.5}$ incremental values are the same in both the main report (p B2-15) and Appendix B (p8). Values in Appendix B are correct.

Whilst $PM_{2.5}$ may be correct, this does not appear to be the case for NO_x CO and other substances and this error needs to be either confirmed and corrected or explained. If the values in Appendix B are correct, then it must be the case that the values in the main body of the response are incorrect. Please correct this issue.

An evaluation of the worst case ventilation outlet and surface road scenario for air toxics at elevated receptors cannot be done without additional modelling, and adds little value as it has been shown there is very little contribution from surface roads at elevated heights.

This issue is part of the general issues which include, a lack of clarity on the suitability of the model settings used to predict pollutant levels in and around tall buildings for both surface roads and ventilation outlets, apparent errors in the assessment of the combined effects of the ventilation outlets and surface roads at heights and locations, and no adequate consideration of likely future receptors. This issue could potentially be clarified by additional commentary in the response addressing the other related issues, or as part of the additional modelling for the final construction design of the ventilation outlet.

8 AGENCY COMMENTS

8.1 NSW EPA

8.1.1 Initial review

This section identifies the issues raised and recommendations by the NSW EPA in their initial review.

Uncertainty with assessment of odour from landfill excavation

It is recommended that the proponent carefully consider the risk of potential odour emissions and odour impacts during construction. Potentially affected receptors should be adequately consulted on this issue.

TAS agrees with the EPA comment stating that there is uncertainty as "it is not known what, if any, risk of odour impacts may arise" and similarly recommends that the Proponent "outline the considerations given to possible contingency measures in the event that the verification study finds potential for unacceptably high levels of emission or impact".

In our experience forewarning a community that detectable odour may potentially arise at some stage, but also clearly communicating that there are/will be systems in place to ensure the odour cannot cause harm, and would be minimised in terms of odour strength or duration, leads to greater acceptance, if in fact such odours do arise.

We thus recommend that not just the risk of odour amenity effects needs to be understood in this case, but in addition, a means to confirm and ensure any odorous air does not contain pollutants at levels harmful to people will be needed, along with a means to communicate this and also ensure that any odour will be minimised in terms of the strength of odour and duration.

Assessment of Particulate Matter impacts during Construction

The proponent needs to carefully consider the risk of potential dust emissions and dust impacts during construction. Potentially affected receptors should be adequately consulted on this issue.

The proponent should develop management plans detailing robust best practice, proactive and reactive particulate matter mitigation measures to prevent and minimise particulate matter emissions

TAS agrees with the recommendations of the EPA, and TAS has previously stated that "the conclusions in regard to construction impacts do not well acknowledge or discuss how the proposed mitigation measures would transform the "Step 3" unmitigated "high risk" of dust impact to human health for receptors in the Zone 2 area identified in Table 7-11 of the AQA to a low level of risk that would be consistent with the conclusion. The report appears to jump a step between "Step 3" and "Step 4"of the risk assessment. For example what options are available to mitigate the risks if the proposed controls, or how they are applied, turn out to be inadequate?"

Assessment of impacts at elevated receptors has only been considered for $PM_{2.5}$ for the 2036-DSC scenario and there is a lack of clarity on the existence of receptors at a height where notable increases in pollutant concentrations are predicted.

It is recommended to:

- Confirm receptor heights located in proximity to ventilation outlets given the significant data gaps on building height described within the Air Quality Technical Report.
- Present predicted impacts for all pollutants and averaging periods for receptors located at height in proximity to ventilation outlets. This includes 1-hr average air toxics and for relevant pollutants accounting for background air quality.
- Present predicted impacts for all pollutants and averaging periods for receptors located at height in proximity to ventilation outlets, for the regulatory worst-case scenario.

TAS agrees with the recommendations of the EPA, but considers only $PM_{2.5}$ and NO_2 need to be considered at this time, as these are the key pollutants with any scope for impact.

TAS notes that *"the development of suitable planning controls would likely need to be supported by detailed modelling addressing all relevant pollutants and averaging periods. In this regard, the model used in this Project (and indeed most commercial air dispersion models) is not suitable for detailed design evaluation of the interaction of ventilation stack plumes and any new, tall buildings and thus significantly more advanced approaches may be needed."*

<u>Discrepancy between proposed emission limits and emission concentrations derived from information presented in Annexure G for the regulatory worst-case scenario</u>

It is recommended that the proponent verify the pollutant emission rates in the regulatory worst-case scenario are consistent with the proposed emission limits.

The EPA comments need to be addressed by the proponent.

<u>Assessment of total 1-hour air toxic impacts not clearly presented for the regulatory worst-case scenario</u>

It is recommended to provide a transparent review of predicted air toxic concentrations, it is recommended that the proponent provide predicted impact (ventilation outlet and surface road) at receptors for speciated air toxics for both the expected traffic and regulatory worst-case scenarios.

TAS agrees and similarly noted in the consistency review "*while the criteria for BTEX is provided in Annexure B and a brief summary of modelling results is found in Annexure J, modelling results for ethylbenzene appear to be omitted and 1-hr average results required for assessment against the NSW EPA criteria are not provided for toluene and xylenes.*"

<u>Analysis of model evaluation does not include site specific monitoring data</u>

It is recommended that the assessment include a model evaluation with the site-specific monitoring data and that Project specific monitoring be compared against the NO_2/NO_x function adopted for the project.

TAS agrees and has requested the site specific monitoring data for model evaluation as follows:

"It is understood that the two project specific monitoring stations F6:01 and F6:02 were established in late 2017, but not used in the assessment due to insufficient data availability. However there would now be

approximately 12 months of data available for this review and it is therefore requested that these data be provided in an hourly format, along with all other monitoring data (air quality and meteorological)."

Implications of ventilation design on air quality assessment outcomes

Should the project design be modified as a result of the plume rise assessments, then reassessment of air quality impacts will need to be undertaken.

TAS agrees with the EPA's recommendation, noting that ventilation outlets near the airport may require very detailed design work to be completed, and hence modification may be necessary.

8.1.2 Response to EPA initial review

RMS has prepared a response to the EPA review in the submissions report (**RMS, 2019**).

8.1.3 Additional advice

The NSW EPA provided additional comment/recommendations regarding the Submissions Report (**RMS, 2019**). TAS largely agrees with the NSW EPA recommendations.

The following outlines the NSW EPA recommendations:

- Confirm receptor heights located in proximity to ventilation outlets given the significant data gaps on building height described within the Air Quality Technical Report;
- Present predicted impacts for all pollutants and averaging periods for receptors located at height in proximity to ventilation outlets. This includes 1-hr average air toxics and for relevant pollutants accounting for background air quality;
- Present predicted impacts for all pollutants and averaging periods for receptors located at height in proximity to ventilation outlets, for the regulatory worst-case scenario;
- Explicit advice on the heights of the receptors where additional assessment was conducted;
- Clearer information on the methodology adopted for assessing receptors at height;
- Accounting for background concentrations. Omission of background concentrations is not considered appropriate, for those pollutants where background concentrations should be considered. In the absence of data available at height, the proponent should assume a worst-case scenario. The EPAs impact assessment criteria do not apply on a predicted concentration change;
- Explanation or re-evaluation of why some pollutant concentrations (assessed at elevated receptors) are predicted to be higher for the 2036-DSC scenario compared with the regulatory worst-case scenario;
- Clarification on conflicting information presented in the main report and Appendix B regarding assessment of NO_x and treatment of potential exceedances; and,

- To provide a transparent review of predicted air toxic concentrations, it is recommended that the proponent provide predicted impact (ventilation outlet and surface road) at receptors for speciated air toxics for both the expected traffic and regulatory worst-case scenarios.

8.1.4 Response to Submissions

In responding to the issues raised, the Proponent provided additional information at meetings held on 29 August 2019. The Proponent also provided a detailed written response to agency and public submissions that included further assessment of elevated receptors (**ERM, 2019**), specific to the TAS and NSW EPA request for additional advice.

Subsequently, the only unresolved issue pertaining to the TAS review is the clarity provided in regard to what was done to arrive at the presented impacts at elevated receptor locations. In this regard, the above meeting and written response clearly sets out what was done, and the examples provided can be easily followed and are clear. However, the results provided in Table 1 of Appendix B of the Submissions report cannot be reconciled by the reviewer to have originated by following the methodology provided.

The issue is that the effects of the roads diminish with increasing height, and the effects of the ventilation outlet diminish with decreasing height, thus when combined, only one change in the relative slope of the impact is reasonably possible, however the results show many reversals in the relative slope with height, which does not appear to be possible.

Nevertheless, as it is reasonable to conclude that the relative impacts due to the Project would be reasonably low or perhaps modest at worst, this is not a greatly significant issue. But it does mean that the reviewer cannot be certain how small or not the impacts at elevated receptors may be.

To resolve this, and to also deal with a more pressing issue of residential planning and encroachment, the review has recommended that as part of the design work for the Project the Proponent clearly defines the actual areas where no new elevated receptors (buildings) can be constructed.

8.2 Independent Scientific Review

The NSW Chief Scientist & Engineer was unable to make comment on the F6 Extension air quality technical report. A review report was conducted by non-conflicted suitably qualified experts, Ian Longley and Åke Sjödin (Reviewers).

This review provides a generally positive assessment of the technical aspects of the modelling. While TAS agrees that the methodology is adequate, it is not agreed that it represents best practice (as generally outlined on this report).

TAS does not consider that the GRAMM - GRAL set up used is able to deliver spatially accurate results across the modelling domain, as demonstrated in various previous validations, and previously outlined in this review. Specifically TAS does not agree that adequate performance of a model set up for roads will automatically translate into similar performance further afield for ventilation outlets. However, and importantly, given the low levels that would occur at increasing distance from the sources, TAS does not consider this issue is significant or that it would alter the conclusions and findings

It is unclear how the approach and methodologies for the assessment of odour could be described as sound by the Reviewers. The approach is not based on known facts and to put it simply is speculative and uncertain, as previously highlighted by TAS and EPA.

The Reviewers note that there is weakness in the background AQTR. It is agreed that whilst it is not ideal that the assessment did not consider the measured local data, these data are unlikely to significantly alter the conclusions of the assessment. It is also noted that the independent reviewer's recommendation to ensure the most relevant background data are used in future was previously made by TAS and the NSW EPA for prior assessments.

The reviewers found the empirical approach of estimating NO_2 concentrations using observational NO_2 and NO_x data to be sound, appropriate and the approach most suited to the purposes of the EIS. This is agreed and as previously stated by TAS "the approach appears to be conservative (unlikely to underestimate results)."

9 FURTHER TECHNICAL REVIEW OF THE AIR QUALITY ASSESSMENT

The key technical issues related to the assessment are discussed in the body of the report, and a complete list of technical issues examined in the review is summarised in **Table A-1** in **Appendix A**

These matters are largely technical or administrative in nature, and mostly stem from the lack of a specific AQTR assessment methodology for road projects in NSW. These issues are not of great significance to the assessment as the current NSW methodology is not technically applicable to road projects. For this reason, it is suggested that DP&E, RMS and EPA consider developing an agreed, methodology for modelling and assessing future major road and road tunnel projects.

Based on the review of the assessment approach applied in this Project, there is clearly ample scope to develop a better approach that is more robust and efficient. This would reduce the complexity, cost and time needed for such assessments, and provide the community, government and proponent with more confidence in the likely outcomes.

10 CONCLUSIONS

The assessment applies an unconventional modelling approach for the assessment of major road projects. A key benefit of the approach is its ability to consider a large number of receptors.

Like any air dispersion model, the model used is powerful at making relative comparisons, and this aspect of the assessment is done well.

The assessment convincingly shows that the proposed Project would result in reduced air quality impacts at most nearby receptors, but some increased impacts would arise at a minority of receptors, generally on side roads related to the Project.

Due to a number of shortcomings inherent to the selected model and the modelling approach and assumptions applied, the assessment is less convincing in its estimation of the potential concentration of pollutants in the air. However, this is not seen as a major issue in light of the clear evidence that the Project would only change existing pollutant levels by a small degree, and that for the majority of receptors this would result in lower pollutant levels.

On this basis, the Project can be expected to reduce the levels of air pollution experienced by the majority of the residents living in the vicinity of the Project.

Due to some shortcomings in the assessment approach, it is suggested that RMS, DP&E and EPA consider developing an agreed, standardised methodology for the assessment of air emissions arising from future major road and road tunnel projects.

The outcomes of the assessment are largely dependent on the predicted traffic emissions and hence the predicted traffic numbers. To ensure that the Project is able to achieve the claimed air quality outcomes for the operation of the tunnel, in-tunnel air quality limits, including ventilation stack limits have been developed to be applied in the conditions of approval for the Project. These conditions also set out monitoring and reporting requirements that will demonstrate that the required limits are being met.

11 REFERENCES

ERM (2019)

"F6 Extension Response to Submissions", prepared by ERM, September 2019.

NEPC (2016)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", National Environment Protection Council, February 2016.

NSW EPA (2017)

"National Environment Protection (ambient Air Quality) Measure", NSW Environment Protection Authority, January 2017.

Pacific Environment (2015a)

"WestConnex M4 East Air Quality Impact Assessment", prepared by Pacific Environment for WestConnex Delivery Authority, September 2015.

Pacific Environment (2015b)

"WestConnex New M5 Air Quality Assessment Report", prepared by Pacific Environment for WestConnex Delivery Authority, November 2015.

Pacific Environment (2017a)

"WestConnex M4-M5 Link Technical Working Paper: Air Quality", prepared for Roads and Maritime Services by Pacific Environment, August 2017.

Pacific Environment (2017b)

"Optimisation of the Application of GRAL in the Australian Context", prepared by prepared for Roads and Maritime Services by Pacific Environment, August 2017.

RMS (2018)

"F6 Extension Stage 1 Air Quality Technical Report", prepared by Roads and Maritime Services, September 2018.

RMS (2019)

"F6 Extension Stage 1 Submissions Report", prepared by Roads and Maritime Services, June 2019.

The World Bank (1997)

"Roads and the Environment: a Handbook". World Bank technical paper; no. WTP 376. Washington, D.C., Tsunokawa, Koji; Hoban, Christopher 1997. http://documents.worldbank.org/curated/en/904041468766175280/Roads-and-the-environment-a-handbook

Appendix A

Technical Review of Adequacy of Air Assessment in regard to the Air Modelling Regulatory Requirements

It is noted that the Approved Methods applies to Stationary Sources, which does not include emissions from motor vehicles. Technically it would appear that the Approved Methods is not applicable to the Project, but the existing industry practice is to adopt the Approved Methods for the assessment of road tunnel stack emissions and as a means of assessing the effects of a Project on road side pollutant concentrations.

Table A-1: Technical Review of Adequacy of Air Assessment in regard to the Air Modelling Regulatory Requirements

Requirements per Approved Methods/ Contemporary Practice	Appendix G – Technical working paper: Air Quality (AQIA)	AQIA reference	Adequate? (Y/N)
2. Methodology	Broadly, a Level 2 (refined dispersion modelling technique using site-specific input data) assessment was applied. Assessment methodology is described in Section 8 of AQIA. Methodology comparison with the regulatory requirements is addressed in more detail below for specific components of the approach.	Section 5 & 8	Y
3. Emissions inventory			
3.1 Identify all sources of air pollution and potential emissions	Traffic pollutants are identified in Section 3.2.2. Section 4.6 presents the ambient air quality standards and criteria of pollutants. Section 8.2 identifies all road traffic sources in the Project domain.	Section 8.2	Y
3.2 Determine source release parameters	Source parameters of the proposed and anticipated future ventilation outlets are presented in Section 8.4.7 and Annexure G. Some of the source parameters from the surface roads emissions are not presented, although these are less important. Some of the source parameters from the surface roads emissions are presented in Section 8.2.3.	Sections 8.4.7, 8.2.3 and Annexure G	Y
3.3 Estimate emission rates	Emissions from traffic on surface roads were estimated by using an emission model developed by NSW EPA as outlined in Section 8.2.2. Estimated emission rates from the ventilation outlets are presented in Annexure G. Regulatory worst case emission rates were estimated from the NorthConnex conditions of approval and are presented in Section 8.4.8. The emission rates depend on the traffic numbers predicted to occur, and also the emissions estimation approach. It is somewhat unclear why three different approaches are used, but each approach applies acceptable methods.	Sections 8.4.4, 8.2.2 and Annexure G	Y

TODOROSKI AIR SCIENCES | info@airsciences.com.au | O2 9874 2123

3.3.4 Accounting for variability in emission rates	Diurnally varying emissions were taken into account in the assessment through the use of source groups. The average estimated emission rates for each source group were determined and the 'modulation factors' (ratios relative to the average) were used to take into account the varying emissions within each time period. No seasonal variation was accounted for the proposed ventilation outlets and surface roads emissions.	Sections 8.2.2, 8.2.3 and 8.2.4 and Annexure G	Y
3.4 Calculate emission concentration for point sources i. Actual concentration of a pollutant emitted from a source (mg/Am^3) calculated using the actual gaseous volumetric flow rate (Am^3/s) and measured emission rate in Equation 3.1 ii. Concentration of a pollutant emitted from a source corrected to the reference conditions as specified in the Regulation (mg/Nm^3 @ O_2%). This is calculated using the gaseous volumetric flow rate corrected to normal conditions (dry, 273K, 101.3kPa) and the measured emission rate in Equation 3.1. The emission concentration (in mg/Nm^3) is then corrected to the appropriate oxygen reference condition. Further guidance on correcting to reference and equivalent values is provided in DEC (2005)	Emission concentrations from the ventilation outlets are presented in Annexure G. Emission concentrations for regulatory worst case are presented in Section 8.4.8. Note that an Oxygen correction is not applicable to the stack emissions in this situation as the tunnel is not a combustion source and is designed to operate with a normal level of oxygen in the air.	Section 8.4.8 and Annexure IG.	Y
3.5 Assess compliance with the Protection of the Environment Operations (Clean Air) Regulation.	N/A. The stack emissions were not assessed against the Regulation limit, but in any case it is noted that emissions would be well below the Regulation limits applicable to stack emissions from industrial plant.	N/A	N/A

3.6 Presentation of emissions inventory			
i. all release parameters of stack and fugitive sources (e.g. temperature, exit velocity, stack dimensions, flow rate, moisture content, pressure, carbon dioxide and oxygen concentration) (Table 3.1)	Source parameters of the proposed and anticipated future ventilation outlets are presented in Annexure G. Source parameters of the ventilation outlets for regulatory worst case scenarios are presented in Section 8.4.8. Some of the source parameters from the surface roads emissions are not presented, although these are less important. Some of the source parameters from the surface roads emissions are presented in Section 8.2.3.	Sections 8.2.3 and 8.4.8 and Annexure G	Y
ii. Pollutant emission concentrations and a comparison against the relevant requirements of the Regulation (Table 3.2)	Emission concentrations from the ventilation outlets are presented in Annexure G. Emission concentrations for regulatory worst case are presented in Section 8.4.8. Comparison against the relevant requirements of the Regulation was not undertaken. But in any case it is evident that the emissions would be well below any regulatory requirements for the emissions from any scheduled or non-scheduled premises.	Section 8.4.8 and Annexure G.	N/A
4. Meteorological data			
4.1 Minimum data requirements	A quasi - Level 2 impact assessment was conducted. Data from two OEH and four BoM meteorological stations located within the chosen domain were analysed to determine suitability as input into the model. The Proponent has chosen to use 2016 data from only the OEH Randwick and OEH Earlwood stations with varying influence. These stations do not record representative meteorological data, and are affected by large trees near the station. The selection of the 2016 data for the purpose of the modelling assessment is consistent with the Approved Methods in terms of the completeness of data, however only limited parameters were examined in deriving the correlation of the 2016 data set against at least five years of data. In this latter regard the approach is scant and unconvincing. It is not clear whether the data from OEH Randwick and OEH Earlwood are representative of the meteorology experienced in the F6 Extension Project as there are significant variations in meteorology across the modelling domain. This is exacerbated by the GRAMM model which produces little variation in the meteorology across the	Sections 6.5, 8.4.5 and Annexure F	Y

	modelling domain, masking any actual significant variations in the prevailing meteorology across the domain. However, as previously noted, this is not a major issue overall as the largest effects occur nearest the road, and the relative change in impact at each point is the key measure for making the assessment (and neither is greatly affected by the meteorology used).		
4.2 Siting and operating meteorological monitoring equipment	The AQIA applies meteorological data from the OEH Randwick and OEH Earlwood. These are ambient air quality monitoring sites and do not record representative meteorological data as the locations are affected by large trees, and do not conform with the requirements for meteorological monitoring sites.	N/A	N
4.3 Preparation of Level 1 meteorological data	N/A. A quasi-level 2 assessment was conducted	N/A	N/A
4.4 Preparation of Level 2 meteorological data	Stability class was calculated using the temperature at 10m and the cloud content data from the BoM Sydney Airport AMO. The Approved Methods enumerate the methods of determining stability class in order of preference as: Turner's 1964 method, solar radiation-delta temperature method and sigma theta method. The method used by the Proponent is not mentioned in the Approved Methods. As there is no justification provided for an alternative method, a method per the Approved Methods, should have been used in this assessment, given that there are available data to determine stability class using an approved method.	Section 8.4.5	N
4.5 Developing site-representative meteorological data using prognostic meteorological models	N/A. A prognostic meteorological model was not used for this assessment. It is however noted that the prognostic model CALPUFF was used to assess odour from construction activities.	-	N/A
5. Background air quality data, terrain, sensitive receptors and building wake effects			
5.1 Background air quality data	Data from OEH, SMC and RMS monitoring sites were analysed to determine background air quality data to be used for the assessment.	Annexure D and Section 8.4.11.	N

For annual mean background data, spatial variation of background data was determined by mapping the available annual mean background data from monitoring sites. Data from a major roadside monitoring location was included and skews the mapped results.

For short-term concentrations, a synthetic time series of background concentrations was produced by the Proponent by choosing the maximum short-term concentration for each short-term period from among two to three monitoring sites as explained in Annexure D. This would increase the conservatism of the assessment.

The determination of cumulative impacts are presented in Section 8.4.11. The cumulative short-term concentrations were assessed using the methods as presented in Table A-1.1.

Table A-1.1: Methods used for the cumulative assessments of short-term pollutants

Pollutant (averaging period)	Community receptors	RWR receptors
CO (1-hr mean)	Level 2 (synthetic profile)	Level 1
CO (rolling 8-hr mean)	Level 2 (synthetic profile)	N/A
NO_2 (1-hr mean)	Level 2 (synthetic profile)	Level 1
NO_2 (annual)	Level 2 (synthetic profile)	Statistical
PM_{10} (24-hr mean)	Level 2 (synthetic profile)	Level 1
PM_{10} (annual mean)	Level 2 (synthetic profile)	Statistical
$PM_{2.5}$ (24-hr mean)	Level 2 (synthetic profile)	Level 1
$PM_{2.5}$ (annual mean)	Level 2 (synthetic profile)	Statistical

The use of the Statistical method is not compliant with the Approved Methods.

	The Proponent justifies the use of the statistical method by showing a comparison between the results of the contemporaneous and the statistical methods, however this shows a poor correlation.		
5.2 Terrain data and sensitive receptors	Terrain and land use of the Project area are briefly described in Section 6.2. The model does not respond adequately in regard to the terrain and land use data. The sensitivity analysis done for the land use shows that the model varies the meteorology slightly across the domain but does not adequately reflect the observed data.	Sections 6.2 and 8.4.5	Y
5.2 Building wake effects	Building wakes were excluded from the main assessment. A sensitivity test was run for buildings in the model. The validation studies used to justify the selection of the model show poor performance for traffic assessment without considering such effects, but better performance with these effects included.	Section 8.4.15	N
6. Dispersion modelling			
6.3 Advanced air dispersion models for specialist application	The GRAL/GRAMM model is not an Approved Methods. The proponent states that it discussed the use of the model with the EPA, but there is no direct evidence presented to confirm that the EPA approved the model for such use.	-	N (?)
2.4.3 Processing dispersion model output data	Predicted ground level concentrations (glc's) of all pollutants are in the same units and for the same averaging period as the relevant impact assessment criteria.	Section 8.4 and subsections	Y
7. Interpretation of dispersion modelling results			
7.1.2 Application of impact assessment criteria for SO_2, NO_2, O_3, Pb, PM_{10}, TSP, deposited dust, CO and HF. The Approved Methods states that the assessment criteria must be applied as follows:	It is noted that the Approved Methods applies to Stationary Sources, which does not include emissions from motor vehicles. Technically it would appear that the Approved Methods is not applicable to the Project, but the existing industry practice is to adopt the Approved Methods for the assessment of stack emissions and as a means of assessing the effects of a Project on road side pollutant concentrations.	-	-
a. At the nearest existing or likely future off-site sensitive receptor	The maximum predicted glcs at most the sensitive receptors were reported. Some receptors near roads were omitted, and some non-existent receptors away from roads were included, however it is not reasonable or expected that all receptors for such a Project be evaluated. A comprehensive cross-section of representative receptors was	Section 8.3.6	Y

	assessed, albeit with some bias in the number and location of receptors added / omitted. The bias would make the Project more conservative.		
b. The incremental impact (predicted impacts due to the pollutant source alone) for each pollutant must be reported in units and averaging periods consistent with the impact assessment criteria.	Incremental predicted glcs of all pollutants are in the same units and for the same averaging period as the relevant impact assessment criteria. Incremental impacts of rolling 8-hr mean CO concentrations for RWR receptors are not presented. The justification is that these would be "broadly similar to those obtained for maximum one-hour concentrations". The issue is not significant as the assessed CO levels would be well below any possible level that may cause impact, and this is certainly true for the 8-hr values also.	Section 8.4 and subsections	N
c. Background concentrations must be included using the procedures specified in Section 5.	Refer to Requirement 5.1	Annexure D and Section 8.4.11.Annexure	N
d. Total impact (incremental impact plus background) must be reported as the 100th percentile in concentration or deposition units consistent with the impact assessment criteria and compared with the relevant impact assessment criteria.	Non-statistically determined cumulative impacts were reported as 100th percentiles and have units consistent with the relevant assessment criteria and compared against the relevant criteria. Total impacts of rolling 8-hr mean CO concentrations for RWR receptors are not presented. Total impacts for the regulatory worst-case scenarios were not presented. Refer to Requirement 5.1	Section 8.4.11	N
7.2.2 Application of impact assessment criteria for individual toxic air pollutants. The Approved Methods states that the assessment criteria must be applied as follows:			
a. At and beyond the boundary of the facility.	The maximum predicted incremental glcs at all the community receptors (except elevated receptors) were reported.	Section 8.4.11	N

	The maximum predicted incremental glcs at the RWR receptors, which should include receptors at and beyond the boundary of the facility, were not reported. As stated in Section 8.4.11, "the largest increases for the community receptors were also representative of the largest increases for the RWR receptors." Limited evaluation of the impacts from the stacks is provided, but no convincing verification was presented to prove this statement.		
b. The incremental impact (predicted impacts due to the pollutant source alone) for each pollutant must be reported in concentration units consistent with the criteria (mg/m^3 or ppm), for an averaging period of 1 hour and as the: i. 100th percentile of dispersion model predictions for Level 1 impact assessments, or ii. 99.9th percentile of dispersion model predictions for Level 2 impact assessments	The 100th percentile of the predictions for the community receptors were presented. As stated above, the correct format for the results for RWR receptors were not presented.	Section 8.4.11	N
c. Polycyclic aromatic hydrocarbons (PAH) as benzo[a]pyrene (BaP) must be calculated using the potency equivalency factors for PAHs in Table 7.2c.	As stated in the notes below Table 8-23, the PAH was taken from the "PAH fraction of THC from NSW EPA (2012b) and the BaP fraction of PAH from Environment Australia (2003)". There is no explanation as to why only the BaP fraction of PAH from Environment Australia (2003) was used. There is also no statement about the calculation using the potency equivalency factors for the PAH fraction of THC from NSW EPA.	Table 8-18	N
d. Dioxins and furans as toxic equivalent must be calculated according to the requirements of clause 29 of the Regulation.	N/A	N/A	N/A
7.4 Individual odorous air pollutants	Individual odorous air pollutants were assessed and results are presented in Section 8.6	Section 8.6	Y

8. Modelling pollutant transformations			
8.1 Nitrogen dioxide assessment	None of the methods in the Approved Methods was used in the assessment. An empirical conversion method was instead developed for Sydney. Whilst non-compliant, the method is considered to be technically sound, providing significant conservatism.	Annexure E	N
9. Impact assessment report			
9.1 Site plan			
- Layout of the site clearly showing all unit operations	Figure 8-1 indicates the location of the ventilation outlets in the GRAL domain while Figures 8-2 and 8-3 show the road link included in various scenarios	Figures 8-1, 8-2, 8-3	Y
- All emission sources clearly identified	All emissions sources are clearly identified.	Figures 8-1, 8-2, 8-3	Y
- Plant boundary	N/A	N/A	N/A
- Sensitive receptors (e.g. nearest residences)	Sensitive receptors are shown in Figure 8-9.	Figure 8-9	Y
- Topography	Topography is presented in Figure 6-1.	Figure 6-1	Y
9.2 Description of the activities carried out on the site	Chapters 1 and 2 provide an overview of the Project.	Chapters 1 and 2	Y
9.3 Emissions inventory	Emission inventories are presented in Sections 8.2 and Annexure G	Section 8.2 and Annexure G	Y
9.4 Meteorological data	Section 6.5 and Annexure F present a discussion and analysis of available meteorological data from monitoring stations in the modelling domain.	Section 6.5 and Annexure F	Y
9.5 Background air quality data	Data from OEH and RMS monitoring sites were presented and analysed to determine background air quality data to be used for the assessment.	Annexure F	Y
9.6 Dispersion modelling			
- A detailed discussion and justification of all parameters used in the dispersion modelling and the manner in which topography, building wake effects and other site-specific peculiarities that may affect plume dispersion have been treated	Section 6.2 discusses the topography and how it would affect dispersion. Section 8.4.7 presents a discussion on the limited effects of including buildings in the assessment. This contradicts the model developer's evaluation of the model at predicting traffic emissions in an urban environment.	Sections 6.2 and 8.4.7	Y

- A detailed discussion of the methodology used to account for any atmospheric pollutant formation and chemistry	Annexure E presents the methodology used in the assessment to consider the transformation of NO_x to NO_2.	Annexure E	Y
- A detailed discussion of air quality impacts for all relevant pollutants, based on predicted ground-level concentrations at the plant boundary and beyond, and at all sensitive receptors	Section 8.4 and Annexures I and J present a discussion of air quality impacts for all relevant pollutants.	Sections 8.4, Annexures I and J	Y
- Ground-level concentrations, hazard index and risk isopleths (contours) and tables summarising the predicted concentrations of all relevant pollutants at sensitive receptors	Ground-level concentrations isopleths and graphs are presented in Section 8.4. Further results are presented in Annexure I. Plots showing the ventilation outlet impacts are presented in Annexure J.	Sections 8.4 Annexures I and J	Y
- All input, output and meteorological files used in the dispersion modelling supplied in a *Microsoft* Windows-compatible format	N/A.	-	N/A

THIS PAGE IS INTENTIONATELY LEFT BLANK