4th December 2020

Prof Hugh Durrant-Whyte
NSW Chief Scientist & Engineer
Chair: Advisory Committee on Tunnel Air Quality

Dear Prof Durrant-Whyte

We received from you a request to review aspects of the EIS for the Beaches Link and Gore Hill Freeway Connection, specifically relating to tunnel ventilation on behalf of the Advisory Committee on Tunnel Air Quality. Please find below our review.

Yours sincerely

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Review of the Beaches Link EIS – Tunnel Ventilation

Written by Ian Longley and Åke Sjödin on behalf of the Advisory Committee on Tunnel Air Quality

4th December 2020

The review is based on the documents "Beaches Link and Gore Hill Freeway Connection - Technical Working Paper: Air Quality", October 2020.

In detail we consider those sections relating to emissions from the ventilation stacks only.

Background

Tunnel ventilation stacks work by moving the vehicle emissions from ground level to points higher in the atmosphere, which result in longer time and distance for emissions to disperse before reaching ground level. In Sydney, stacks are assisted by ventilation fans that are used to direct the emissions higher into the atmosphere. Dispersion is improved by winds that tend to become stronger higher up into the atmosphere, while wind and turbulence increase mixing of the emitted and background air resulting in dilution.

In developing Environmental Impact Statements for future infrastructure such as roads, proponents rely on modelling for future scenarios, both expected and worse case. Modelling for road tunnels draws on measurements of background air quality, projections of future vehicle emissions on roads, information on tunnel operations, and utilises meteorological and dispersion models. This results in estimations of the maximum concentrations of different pollutants at different locations, including in the vicinity of ventilation stacks and locations in the surrounding area. Therefore, key to a scientific review of a project's air emissions from ventilation stacks is consideration of the data use and modelling approach.

In considering the future impacts of ventilation stacks a number of elements are assessed including the overall methodology, the approach used to calculate the nature and concentration of emissions within the tunnel and thus exiting the stack, and finally the dispersion from the stack. These are discussed in the following sections.

Main findings of the review

Our overall conclusion of these documents is that they constitute a thorough review of high quality. Noting that our review focuses only on tunnel ventilation, they cover all of the major issues and areas that an EIS for a project of this scale should. The information presented is of suitable detail and logical in order. The choices made regarding data used and methods followed have been logical and reasonable and it is our view that the benefit of exploring alternative approaches would be questionable or marginal.

Specific issues

1. Modelling
    a. General comments on assessment methodology

We find that the assessment methodology is sound and represents best practice. All of the models and data used are appropriate and expertly used. We have found no significant errors nor important omissions.

b. Emission modelling

The methodology used to estimate in-tunnel emissions to assess in-tunnel air quality and further being used as input to the dispersion modelling of exhaust emitted through the tunnel ventilation stacks, is thoroughly and clearly described in the EIS. A major improvement in the emission modelling was made starting with the Western Harbour Tunnel (WHT) EIS in late 2019 by implementing the new PIARC approach for calculating vehicle emissions in tunnels, published in 2019. The new PIARC approach builds on the European Handbook Emission Factors for Road Transport (HBEFA), version 3.3, launched in 2017. HBEFA can be considered state-of-the-art in describing real-world emissions and is well suited for traffic conditions typical for tunnels. It may be worth notifying here that a new version of HBEFA was launched in late 2019 (version 4.1[1,2]). Of particular interest for this review is the update of emission deterioration factors for both petrol and diesel light-duty vehicles (i.e. passenger cars and light-duty commercial vehicles). The main difference between the HBEFA 4.1 and HBEFA 3.3 mileage corrections for NO_X (and CO) is that the deterioration continues up to a mileage of 300,000 km, after which they remain constant (in HBEFA 3.3 no further deterioration of emissions was assumed to occur above 150,000 km). Further, for the first time, emission deterioration factors for NO_X are presented for Euro 5 and Euro 6 diesel and gasoline light-duty vehicles. See Figure 1.

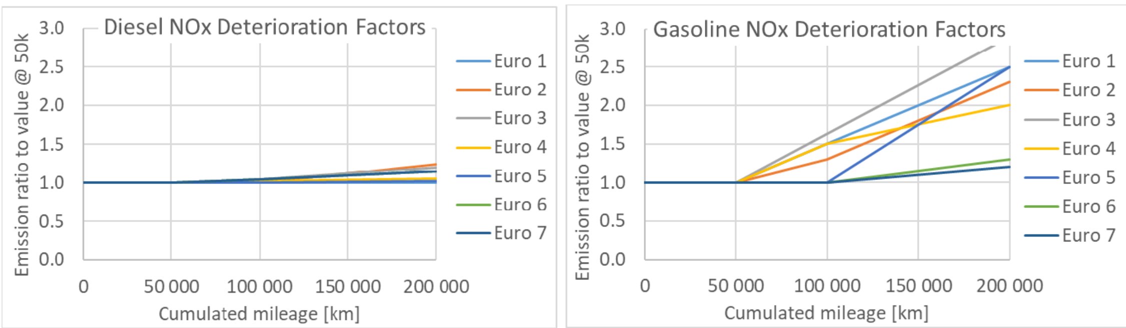

Figure 1: Emission deterioration factors for NO_X (hot emissions) for diesel and gasoline light-duty vehicles by Euro standard applied in the new HBEFA 4.1[1,2]. The deterioration factors are derived from remote emission sensing measurements made in Europe[3].

Since the PIARC-based approach applied to the Beaches Link tunnel does not consider emission deterioration as vehicles age beyond 150,000 km (see chapter 6.2.4.5 in the ventilation report), modelled in-tunnel NO_X emissions may be underestimated. However, it is not considered likely that

[1] https://www.hbefa.net/e/documents/HBEFA41_Development_Report.pdf
[2] https://www.hbefa.net/e/documents/HBEFA41_Report_TUG_09092019.pdf
[3] https://www.ivl.se/download/18.34244ba71728fcb3f3fabb/1591706073882/C387.pdf

the incorporation of deterioration factors in the emission modelling would affect the air concentrations of NO_2 in the tunnel that much, such that the adopted Air Quality Criteria for NO_2 of 0.5 ppm as an average along the tunnel would be exceeded in any of the scenarios. The rationale behind this assumption is that the NO_X emissions in the tunnel by year 2027 will be dominated by diesel vehicles, since the NO_X emissions from petrol vehicles on a g/km basis are much lower than for diesel vehicles up to and including Euro 5, and the deterioration of diesel NO_X emissions is very slow (Figure 1). Also, since the EIS assumes that the Euro 6 emission standard will not be introduced in Australia until after 2027, this yields a conservative estimate of the in-tunnel NO_X emissions (since it is considered likely that some Euro 6 vehicles will have penetrated the Australian fleet before 2027 anyway, regardless of the lack of Euro 6 legislation until then).

Another improvement already introduced in the WHT EIS is the modelling of worst-case traffic operation scenarios, which comprise two types: one considering variable speed traffic operation for a range of average speeds ranging from 20 to 80 km/h, and another considering the emission situation during a breakdown or major incident in the tunnel. For all worst-case scenarios in-tunnel air concentrations of NO_2 were calculated to be well below the threshold of 0.5 ppm.

c. Use and evaluation of meteorological and dispersion models (GRAMM, GRAL)

The EIS has given careful attention to the implications for meteorological modelling of the location of the project which may be impacted by the coast and harbour. Coastal locations are likely to experience higher wind speeds than inland locations and potentially different wind directions due to local land-sea breezes. We find that the approach used to address this using the 'Match-to-Observations' function in GRAMM (as recommended in the recent evaluation study of the GRAMM-GRAL package) is highly appropriate in this situation and are comfortable that this is likely to provide the most representative results whilst retaining slight conservatism.

The GRAMM-GRAL dispersion modelling suite has been used appropriately and appears to be giving credible results. The evaluation of the models provided in the EIS (Annexure H) relates to the model's ability to capture dispersion from open roadways. The model's apparent success in doing this (albeit with some conservatism) may be used to infer that they will perform similarly well in predicting dispersion from a ventilation stack. It is currently not possible to directly verify this observationally. This is because a recent analysis of currently available air quality measurement data from monitoring stations situated near road tunnel ventilation stacks has shown that these stacks have negligible or zero impact on the measurements, with measured concentrations being driven by surface road emissions and other sources (Hibberd, 2019). Since that analysis, data has become available from monitoring around the ventilation stacks of the M4 East tunnel. Dr Longley has seen data for 18 months prior to opening and 6 months post-opening as part of his role on the M4 East Air Quality Community Consultative Committee. I confirm that, to date, no impact of stack emissions has been detected. A better opportunity to re-evaluate the model (albeit one that probably lies outside the scope of this EIS) now arises due to the large amount of additional observational data available.

d. Method to estimate NO_2 concentration

The method used has limitations, which the EIS appropriately acknowledges. However, we find 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.

2. Minor errors

- Tables 5.7 and 5.8 - the meaning of the footnote (1): NO2 Average 0.5 ppm is unclear. Perhaps the term 'limit' was omitted.
- Table 6.3 - the first column in the last row should read 'Do something cumulative **2037**'
- Table 7.1 - footnotes (2) and (3) are not reflected inside the table