OUT15/30347

30 October 2015

Ms Carolyn McNally
Secretary
Department of Planning & Environment
GPO Box 39
Sydney NSW 2001

Dear Ms McNally

Comments on the air quality aspects of the EIS of the WestConnex M4 East proposal (SSI 6307)

I refer to your Department's recent requests for comment from the Advisory Committee on Tunnel Air Quality on the Environmental Impact Statement (EIS) that was submitted in September 2015 for the WestConnex M4 East project.

Because of the conflicts of interest that several Committee members have in this matter, the non-conflicted members of the Committee agreed that I commission a report by the expert non-conflicted member of the Committee, Dr Ian Longley from NIWA in New Zealand, and another suitably qualified independent expert to work with Dr Longley. As a result my office commissioned Dr Åke Sjödin, from IVL Swedish Environmental Research Institute, Gothenburg, Sweden, to work on the report.

I attach the report by Dr Longley and Dr Sjödin.

Should you have any questions, please contact Dr Chris Armstrong, Director, Office of the Chief Scientist & Engineer, on 02 9338 6745 or chris.armstrong@chiefscientist.nsw.gov.au.

Yours sincerely

Mary O'Kane
NSW Chief Scientist and Engineer

cc. Ms Mary Garland, Infrastructure Projects, Department of Planning & Environment

28th October 2015

Prof Mary O'Kane
NSW Chief Scientist & Engineer
Chair: Advisory Committee on Tunnel Air Quality

Dear Prof O'Kane

We received from you a request to review aspects of the WestConnex EIS on behalf of the Advisory Committee on Tunnel Air Quality. Please find below our draft review. As with the review of the WestConnex EIS we have included in our scope all sections of the EIS relating to air quality. We have made brief comment on the use of the air quality assessment in the Health Risk Assessment, but do not comment on the health science as this lies outside our area of expertise.

Yours sincerely

On behalf of himself and Åke Sjödin

Dr Ian Longley

Independent Expert: Advisory Committee on Tunnel Air Quality
Programme Leader: Impacts of Air Pollutants
National Institute of Water & Atmospheric Research (NIWA) Ltd
Auckland
New Zealand

Åke Sjödin

Senior Project Manager
Air Pollution and Abatement Strategies Unit
IVL Swedish Environmental Research Institute
GothenburgGothenburg
Sweden

Review of the West Connex EIS

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

28th October 2015

The review is based on the WestConnex Environmental Impact Statement (EIS) published in September 2015. In detail the air quality relevant parts of volumes 1a and volume 2b.

Main findings of the review

Our overall conclusion of the WestConnex EIS is that it constitutes a thorough review of high quality. It covers all of the major issues and areas that an EIS of this scale should. The information presented is of suitable detail and logical in order. Supplementary information and data requested have allowed more indepth scrutiny of the issues described below. For the most part, 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. Firm recommendations for improvements are in **bold** font.

Key Issues

This project, as we understand it, largely duplicates an existing road corridor, thereby adding total road capacity along the corridor. Although induced traffic might be expected, it is anticipated that the project will draw substantial amounts of traffic underground leading to a net relief of traffic volumes on many surface roads, particularly the existing A4 Parramatta Road.

The tunnels are relatively long, especially for urban tunnels, and intended to carry a large volume of traffic. This means that the total emissions in the tunnels will be relatively high, yet the tunnel is required to meet a very stringent but appropriate internal pollutant concentration limits, particularly for NO_2.

The tunnel is being designed to operate without portal emissions, with removal of all emissions via tall ventilation stacks. Our review of the topographical environment suggests no obvious concerns regarding local dispersion conditions, or the ability of the selected modelling tools to assess them.

Consequently the design comes with the following expectations, which we believe the EIS must address to the reader's satisfaction:

- The EIS should show that the tunnel's length and traffic capacity does not prevent the tunnel ventilation from being able to meet in-tunnel concentration limits for all pollutants set out in the Secretary's Environmental Assessment Requirements (SEARs) in all reasonable scenarios. The pollutants to be assessed are CO, PM_{10}, $PM_{2.5}$, NO_2 and other nitrogen oxides (NOx) and volatile organic compounds (VOCs)

- The EIS should give confidence that the impact of stack emissions on local air quality and health will be effectively undetectable
- It is to be expected that most receptors would experience an improvement in local air quality, whereas some areas would experience a worsening. Although these areas will broadly be correlated with areas experiencing reductions or increases in surface traffic, precise quantification of the location and magnitude of these effects is likely to be challenging due to highly localised variations in dispersion and emissions, some of which cannot be accurately modelled. The EIS should ideally convey the uncertainty associated with this part of the assessment, and implications for health and mitigation.

In our view the first two points are most sensitive to the correct specification and treatment of vehicle emission factors. The third point is most sensitive to the selection of emission factors for surface traffic, the treatment of congested traffic flow, the way that background air quality data is derived and integrated into the assessment and the validity of dispersion models in the near-field (i.e. within 50 m of emission sources). Whereas the models used will most likely have undergone external validation (i.e. outside the context of this project), evaluation of the models using data specific to the WestConnex area or the Sydney vehicle fleet is an important step, to improve validity of findings and reduce and/or quantify uncertainties. The evaluation undertaken by the proponents is discussed in Key Question 2 and the Appendix.

Key Questions

1. In-tunnel emission factors

For a ~9 km tunnel with high traffic volumes, the stack emission rates and peak concentrations are notably lower than for NorthConnex (which is designed to carry significantly less traffic). To give confidence in the assessment this should be explainable. A short statement explaining this has been provided to us:

"NorthConnex is producing higher NO_2 output when compared per vehicle-hour. The ratio is about 2. The NorthConnex fleet has 28% HGVs. The WestConnex fleet has 6 – 12% HGVs. Taking the average WestConnex fleet, the average vehicle mass in NorthConnex is greater than in WestConnex by a factor of 1.9, accounting for almost all the difference in NO_2 production per vehicle."

At this point we have not been able to independently verify this claim, nor reproduce the calculated fleet-average emission factors for NO_2 used in the assessment (Appendix L, table 9.4). However, the values calculated appear to be in a plausible range. We have reproduced the emission factors for CO and find them to be correct.

2. Evaluation of dispersion model (GRAL)

GRAL has not been used in a project of this nature in Australia before. An accounting of any relevant strengths, weaknesses or errors in the modelling will help with the model's acceptance and provides important context for the health risk assessment.

On a positive note we do not find that the use of GRAL has introduced any large errors. Unfortunately though, the evaluation of GRAL provided (Appendix J) has some weaknesses.

In brief, the performance of GRAL has not been illustrated independently of the background estimates, which are deliberately conservative. This is not unreasonable where the project is to be judged on absolute impacts alone, but this is not the case for this project. This is because relative impacts are as important (if not more so) in this case as the primary differential outcomes of the project, as described in the Health Risk Assessment, are redistribution of risk which are positive in most areas (reduction in risk), but compensated by increased risk classed as negligible in some areas and tolerable in a minority of locations.

We independently find that GRAL, as used in this assessment, is slightly (~10%) under-representing the spatial variation in concentrations related to different proximities to major roads. This means that the relative changes in predicted concentrations might be slightly under-predicted by this approximate magnitude. We consider this error small enough to be non-critical and we do not believe re-modelling is necessary. The reasons for the under-prediction are not known at this time. However they may be due to the coarse resolution of the GRAL modelling grid, not using the buildings module or under-prediction of vehicle emissions in congested traffic conditions.

We recommend that the proponents comment on and confirm (or refute) our claim that GRAL is slightly under-estimating, why that might be, and the implications for the health risk assessment.

Further details on this issue are provided in the Appendix.

3. Method to estimate NO_2 concentration

We find the empirical approach of estimating NO_2 concentrations using observational NO_2 and NOx data to be sound, appropriate and preferable to the alternatives presented.

4. Presentation and visualisation of cumulative results

For the most part the tables, distributions and plots appear adequate. An exception may be the plots in Appendix K (Figure K-30 for example) which map the change in concentration of pollutants between modelling scenarios. The minimal changes are uncoloured and thus not represented on the map. While this is reasonable in light of the modelling uncertainties upon which the results are predicated, it serves to make invisible potential concentration increases across the area. This may be interpreted by the public as misleading and hiding negative impacts.

5. Selection and use of emission models

We believe that the split of using PIARC emission factors for the tunnel and NSW EPA factors elsewhere is appropriate, justified and approved.

6. Sensitivity of findings to traffic modelling

Congestion is parametrised in the traffic modelling by reductions in speed, which is the standard approach and acceptable. However, it should be noted that the increase in emissions related to congestion comes from the stop-start nature of the drive cycle, not the decrease in overall speed. The level of increase anticipated by congested conditions and also during the breakdown scenario may be under-estimated.

7. Future projections of emissions and background air quality

In-tunnel emissions

PIARC 2020 emission factors are used throughout, which is acceptable.

Surface roads emission

NSW emissions factors are used throughout, which is acceptable.

Background air quality

The background concentration is assumed constant across all scenarios into the future. Although there is no evidence to support this assumption, a more reasonable assumption is not readily available. This introduces an extra degree of uncertainty into the projected scenarios, but this is non-critical given the degree of current compliance with the NEPM in this part of Sydney.

8. Assessment of construction impacts

Regarding the assessment of construction impacts on air quality the SEARs for the M4 East project involve:

"An assessment of construction //….. // activities that have the potential to impact on //….. // local and regional air quality. The air quality assessment must provide an assessment of the risk associated with potential discharges of fugitive and point source emissions on sensitive, and include:

- *The identification of all sources of air pollution and assess potential emissions of PM_{10}, $PM_{2.5}$, CO, NO_2 and other nitrogen oxides and volatile organic compounds (e.g. BTEX) //……"*

In the M4 East EIS, the assessment of construction impacts on air quality is based on a semi-quantitative risk-based approach using guidance published by the UK Institute of Air Quality Management (*Guidance on the assessment of dust from demolition and construction*, IAQM 2014). This approach was chosen due to the absence of specific directions for environmental impact assessments of construction projects in NSW. Although the IAQM guidance is primarily designed for use in the UK, it may be applied elsewhere and in this case it was adapted for use in NSW, taking into account factors such as the assessment criteria for PM_{10}. The IAQM approach frequently requires the use of professional or expert judgement. This is considered necessary, because the diverse range of projects that are likely to be subject to dust impact assessment means that it is not possible to be prescriptive as to how to assess the impacts. Also a wide range of factors affect the amount of dust that may arise, and these are not readily quantifiable. The IAQM approach provides a framework to ensure that assessments are more consistent and consider the full range of potential impacts, and where justification cannot be given, a precautionary approach is called for.

It is important to bear in mind that the IAQM approach only considers impacts of dust. These are of three types:

1. Annoyance due to dust soiling
2. The risk of health effects due to an increase in exposure to PM_{10}
3. Harm to ecological receptors

The risk assessment resulted in high risks with regard to impact types 1 and 2 for all the four main activities related to the construction phase (demolition, earthworks, construction and track-out), but low or no risks for harming ecological receptors (type 3). Based on the risk assessment and the possible mitigation measures put forward in the EIS, it states that standard management measures would be sufficient to mitigate the high risks (for impact types 1 and 2) associated with the construction impacts on local air quality.

Now, having summarised the approach, the results and the conclusions as per above, we would like to raise some concerns regarding the assessment of construction impacts on air quality in the EIS:

Lack of quantification

> As mentioned the assessment is based on a semi-quantitative (i.e. semi-qualitative) and precautionary approach involving professional judgement. Thus, the assessment is associated with a high degree of uncertainty, and it is impossible to tell whether the risks assessed may be over- or underestimated. Compared to the assessment of the operational impacts of the project on air quality carried out in the EIS, our view is that the construction impacts assessment has been treated in a disproportionate and rather summary and cursory manner. Even though specific directions for environmental impact assessments of construction projects in NSW appear to be absent, numerous studies have been carried out around the world during the last 10-20 years aiming at quantifying both air emissions from road and similar infrastructural constructions and their impact on local air quality. These studies show that air pollutant emissions during the construction phase may be similar or even higher than the corresponding emissions during the operational phase, i.e. the traffic on the road segment in question, during the first year(s) of operation. Several years of development and progress within the LCA (Life Cycle Analysis) field have resulted in both models and tools to quantify air emissions from transport infrastructure construction works, as well as international standards, such as the PCR (Product Category Rules) and EPD (Environmental Product Declaration) standards.
>
> Thus, an attempt to quantify the emissions of some critical air pollutants, e.g. NO_2/NO_X, PM_{10} and $PM_{2.5}$, during the construction of the M4 East, along with some dispersion modelling to assess the construction works' impact on local air quality, would have been justified and should be part of any future EIS for large road or tunnel construction projects, at least to quantify the emissions of the construction phase and compare these with the emission rates from the operational phase.

Implementation of necessary mitigation measures

> Chapter 10.1 (Appendix H, Volume 2B) describes the mitigation measures available (and "highly recommended") to reduce or ultimately eliminate the risks identified in the preceding assessment of construction impacts on local air quality. Although it is stated that most of these measures are routinely employed as "good practice" on construction sites, many of them are described in wordings containing "ensure", "avoid", "impose", "should", "promote", "encourage", "where practicable", "where possible", "where reasonable and feasible", "minimise", etc., without providing examples of how these measures can be (or have been) successfully entered into force in a real situation (actual cases). This lowers the

credibility of how impact management actually can reduce the high risks assessed substantially or ultimately eliminate them.

For this current EIS, given that the risk assessment resulted in high risks with regard to impact types 1 and 2 for all the four main activities related to the construction phase, **we recommend that the EIS puts stronger emphasis on that the mitigation measures available to reduce these risks must also be put into practice.**

Appendix: Evaluation of dispersion model (GRAL) – Further details

Modelling is used to estimate hourly concentrations of various pollutants at locations where monitoring data exists, both in the WestConnex area, and for nearby Office for Environment and Heritage (OEH) monitoring sites and others associated with the M5 East and NorthConnex. It should be understood that the modelled estimates are the combination of two components:

1. modelling of local road impacts using GRAL and
2. an estimated "synthetic" background.

It is implicit that the use of GRAL will include uncertainties. However, although the background is constructed from observational data, it is still an estimate and itself includes uncertainty and error. In fact, the synthetic background is a deliberate over-estimate, being based on the highest measured concentrations across three OEH sites. This is justified in the EIS in terms of conservatism. However, the degree of conservatism is varying and unstated. In the context of modelling evaluation this is less helpful as it obscures our ability to evaluate GRAL.

The resulting sum of the background and local emissions is then used to calculate period means for those hours in 2014 during which observational data exists. The inference is then that a close agreement is evidence of good model performance, or that a modelled over-estimate of the observed concentrations is evidence of acceptable and appropriate conservatism. Indeed on page 51 (Volume 2B) it is stated:

"*The modelling of the road network gave a non-zero concentration at the locations of air quality monitoring stations, which introduced a small element of conservatism into the approach.*"

Unfortunately this is a flawed interpretation. Observational data is being compared with the sum of two estimates, **both** of which are liable to contain errors - indeed the 'background' is **expected** to be an over-estimate. Thus any error in the background estimate obscures errors in the dispersion modelling.

In an assessment being judged on its **absolute** impact relative to standards and guidelines only this may not be critical. However, this is not the case for this project. The EIS clearly demonstrates how the **relative** performance of the tunnel is a key issue, i.e. the changes in air quality (and health impacts) relative to the "Do Minimum" scenario, and the varying impact within any scenario between different receptors. Indeed the main adverse outcomes from the project (albeit characterised as 'tolerable', as detailed in the Health Risk Assessment), arise from incremental increases in concentrations in some areas. The prediction of relative impact is solely dependent upon the GRAL modelling alone, as the background is taken to be constant for all scenarios. Consequently, the independent performance of the two individual modelling components (GRAL and background) matters.

The purpose of GRAL is to model the spatial variation in the contribution of local surface roads and ventilation outlets independently of the background contribution. Thus it makes more sense to validate its ability to do this, i.e. to model differences between monitoring sites. Ideally this would require monitoring data for the whole of 2014. This was not available for the M4 East area. However, the data that do exist can be used to provide more specific evaluation than is presented in the EIS.

We have been provided with the observational data and GRAL estimates for NOx. Our review of this data has indicated the following features:

- On a long-term basis, GRAL (as used) appears to over-estimate low concentrations, i.e. at less-trafficked sites generally and at all sites in the summer. We suspect this may be largely driven by over-estimation at night (as indicated in Figure J-7 and J-8), and/or the error associated with the “conservative” background.
- On a long-term basis, GRAL (as used) appears to slightly under-estimate the higher concentrations at roadside locations. This effect counter-acts the nightime over-prediction to give *apparently* improved performance overall.
- This is particularly seen at the “Concord Oval” roadside monitoring site. Observed concentrations here are substantially higher than at all other WestConnex monitoring sites, but the GRAL modelling does not reproduce this.
- The net result is that GRAL (as used) attenuates the range of long-term concentrations that are observed. Our estimate, based on M5 East data is that the scale of the attenuation is ~10%.

Monitoring data indicates a large divergence in concentrations between site M4E:04 (Concord Oval) and the other three roadside sites: 01, 02 and 03 (Table J-2). This is not reproduced by GRAL. Overall GRAL appears to predict a smaller range of concentrations between the five monitoring sites than is actually observed. This may indicate that GRAL under-predicts at higher total concentrations (i.e. very close to major roads) and possibly over-predicts at urban background locations. The Concord Oval site differs from the other roadside sites in being closer to the road and potentially, to a major intersection. This phenomenon may also be responsible for the differential performance in GRAL predicting the two M5 East portal sites F1 and M1 (figure J-6).

Note that GRAL is less suited to model near-field impacts (<30 m from kerbside) in urban environments without the use of the building module (which was not used in this assessment due to the domain size – 2B p.109) and thus under-estimation in such locations is not unexpected.

The consequences of this for the modelling results and especially the health risk assessment is to potentially overestimate the longer term averages reported and thus the health risks calculated on those long term averages, whilst conversely under-estimating the worst short-term average concentrations.

Figures J-7 and J-8 indicate that the performance of GRAL is poor at night with systematic over-prediction. This is confirmed in GRAL output provided to us. Figure J-8 also appears to show under-prediction during the day, particularly between peak traffic hours. Over 24 hours these two errors may largely cancel each other out.