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Dear Karen,

As requested at the M4 East pre-PIR lodgement update meeting on 3 December, please find attached comments from the ACTAQ reviewers of the air quality components of the M4 East EIS.

These comments are in relation to the M4 East Submissions Report and apply specifically to the comments in the NSW Chief Scientist & Engineer section 4.1.

The comments were prepared by Dr Ian Longley from NIWA and Mr Ake Sjodin from IVL Swedish Environmental Research Institute on behalf of the ACTAQ.

If you have any questions about these comments, please let me know asap.

Warm regards
Carrie

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Review and comments on the WestConnex M4 East Response to key stakeholders

Åke Sjödin, IVL Swedish Environmental Research Institute
Ian Longley, National Institute of Water & Atmospheric Research, New Zealand

Issue description – justification for use 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.

Response

The model selection reflects the complexity of the project. There was a need to assess both surface roads (with complex changes to road network over a large area) and tunnel ventilation outlets (point sources). In addition, large numbers of real-world receptor locations were affected, to a greater or lesser extent, by the project. In a number of previous assessments separate models have been used for different types of source (eg CALINE for roadways and CALPUFF for ventilation outlets). This approach makes the interpretation of results more difficult, as each model involves different treatments, inputs and assumptions (eg meteorology, terrain, buildings). In addition, Gaussian models for roadways, such as CALINE, do not allow the effects of terrain and buildings to be taken into account. An alternative approach is to use a single model which includes different types of source. Examples of such models include ADMS in the UK and, the model used in the M4 East assessment, GRAL from Austria.

Comments regarding the performance of the GRAMM/GRAL model are noted. In response to these comments sensitivity testing has been undertaken to determine the potential consequences of changes to the assumptions, data and calculations used in the air quality assessment. Sensitivity testing is detailed in section 8.8 of the Air Quality Assessment Report in Appendix H of the environmental impact statement (EIS), with additional sensitivity testing of the meteorological data detailed in **section 4.3.2** of this report.

Comments on proponent's response

I am satisfied with the extra commentary and sensitivity testing provided regarding GRAL. I find that GRAL is an appropriate model to use for this EIS.

Issue description – evaluation of dispersion model (GRAL)

We do not find that the use of GRAL has introduced any large errors. Unfortunately though, the evaluation of GRAL provided (Appendix J of the Air Quality Assessment Report) 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.

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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.

Response

The intention of the GRAL evaluation was more to test the performance of the whole model chain, rather than GRAL specifically. In this respect, and given the limited number of roadside monitoring sites in Sydney, the model chain is considered to perform as well as could be expected, allowing for the fact that there is probably some inherent conservatism in the approach (eg background concentrations, emissions).

Concentrations were modelled using a ten metre grid. Whilst this could be viewed as being coarse given the large concentration gradients for some pollutants near busy roads, it is very fine given the size of the domain, and much finer than most previous assessments of this type.

An addendum to the NSW Chief Scientist and Engineer's submission by the peer reviewer appointed by the Advisory Committee on Tunnel Air Quality was received on 30 November 2015, as provided below.

"Evaluation of GRAL performance:

- Upon further inspection of the data provided to me, I would like to withdraw my previous observation that "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."*
- Model evaluation is particularly difficult when using data that was not explicitly designed to be captured for this purpose. Through closer inspection of the data I have gained a deeper appreciation of the complexity involved in attempting to evaluate both GRAL and the background estimates, and that this is not the purpose of the EIS*
- I now believe that GRAL is generally performing well but cannot be so specific as to quantify under or over estimation*
- The roadside site data available is far from ideal for model evaluation. Site F1 is affected by features (barriers, trees) which are not easily included in the model and thus F1 should ideally not be included in an evaluation (or this limitation noted). Site M1 is also very complex and challenging for the model (and not representative of the great majority of receptors where good model performance is required). The M4E:04 site ("Concord Oval") is better but only a short period of data was available which may be insufficient to cover a typical range of meteorological conditions*
- However, through this extended analysis I have become more confident that the GRAMM/GRAL modelling suite are appropriate for this assessment, have been used correctly and that their performance is good*
- In my original review I stated:*

"On a long-term basis, GRAL (as used) appears to slightly under-estimate the higher concentrations at roadside locations. This effect counter-acts the nighttime over-prediction to give apparently improved performance overall."

Upon further analysis I would like to withdraw this statement as I no longer believe it to be true."

Comments on proponent's response

My additional comments reproduced stand as a summary of my opinion. Some of the issues raised would have been easier to address had monitoring data been available at an earlier stage (i.e. 6 – 12 months earlier). This should be borne in mind for future projects of this nature. Furthermore for West Connex projects beyond the New M5 East it should be noted that a substantially greater air quality monitoring dataset will be available which should be used to better quantify background air quality and verify dispersion modelling, reducing uncertainties relative to this project.

Issue description – 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.

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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.

Response

Noted. The aim of using this approach was to make it easier for complex plots to be interpreted. A number of different options were considered, and the final approach was considered to be the most suitable.

Comments on proponent's response

Noted. However the reason why the final approach was considered most suitable has not been stated.

Issue description – 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.

Response

We agree that the 'stop-start' nature of the driving cycle, as well as overall speed, determines emissions. However, while the emission factors are stated as a function of the average speed of a driving cycle, this incorporates all the elements of a driving cycle, including accelerations, decelerations and periods of idle. As the average speed of a driving pattern decreases, then naturally the amount of stop-start driving increases, and this is reflected in the emission factor. However, what a single average speed emission function cannot address is the effect of speed variation for a given average speed. For example, an average trip speed of 20 kilometres per hour can be arrived at in many different ways, with different combinations of acceleration, deceleration and idle in the driving cycle. The term 'driving dynamics' is sometimes used to describe the nature of the driving cycle. For example, a cycle with 'high' dynamics would include more pronounced accelerations and decelerations than one with 'low' dynamics, and would tend to have higher emissions, even though both cycles have the same average speed. An average-speed emission function represents, more or less, average driving dynamics for each average speed. The effects of driving dynamics can be taken into account using other types of emission model, but this is academic for the M4 East assessment as the inputs for such an emission model were not available from the traffic model. This is a very common situation for an air quality assessment.

Comments on proponent's response

I agree that the data or modelling to address variations in emissions with fluctuations in speed may not be available. This supports my intended point that there is some uncertainty involved with modelling emissions of congested traffic in particular as a function of average speed and that this uncertainty is unstated in the assessment. I accept that some protection from this uncertainty is provided by the conservatism introduced into the assessment in general.

Issue description – assessment of construction air quality impacts

The construction impact assessment is based on a semi-quantitative (ie 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.

An attempt to quantify the emissions of some critical air pollutants, eg NO₂/NO_x, PM₁₀ 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

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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.

Response

The Air Quality Assessment Report in Appendix H of the EIS was prepared in accordance with the SEARs that were issued by the DP&E. The SEARs do not specify a requirement for a quantitative assessment of air quality for construction. The reasons for not undertaking a quantitative assessment are provided in section 5.5.1 of the Air Quality Assessment Report in Appendix H of the EIS. A quantitative assessment would not provide any additional benefits given the comprehensive management measures already recommended.

Comments on proponent's response

I agree that the SEARs do not explicitly require that the EIS should include a quantitative assessment of the air quality impacts of the construction activities. However, I do not agree that – as expressed in section 5.5.1 of the Air Quality Assessment Report in Appendix H of the EIS – *“Exhaust emissions from on-site plant and site traffic are unlikely to have a significant impact on local air quality”, and therefore “in the majority of cases ... will not need to be quantitatively assessed”*. Does this phrasing mean that the proponent agrees that a quantitative assessment is needed in the (minority of) cases representing worst case situations (as has been done for the assessment of air quality impacts during the operational phase of the M4 East)? If so, then the conclusion drawn by the proponent in the final sentence is somewhat contradictory. Furthermore, I agree with the proponent (section 5.5.1 in Appendix H) that in particular dust emissions from construction activities are difficult to quantify, and therefore - in this case - that a qualitative assessment may be the only practical way forward. However, since dust emissions potentially are associated with the largest health and environmental impacts from construction activities, an attempt to quantify a worst case scenario would have been desirable.

Issue description – implementation of necessary management measures

Chapter 10.1 Air Quality Assessment Report (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 (annoyance due to dust soiling) and 2 (risk of health effects due to an increase in exposure to PM₁₀) 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.

Response

The management measures identify a range of opportunities to reduce the risk of impact. The applicability of these measures would depend on the detailed design and construction methodology, in light of any approval and conditions provided through this EIS process. Management measures have been refined through construction planning and refinement of the project's design. The management measures (as amended in **Chapter 8** (Revised environmental management measures) of this report) would be implemented during construction and operation of the project.

The detailed application of the management measures would be contained in the Construction Air Quality Management Plan, which would also undergo an approvals process, providing additional certainty that appropriate measures would be enforceable. Further guidance on assessing and managing construction impacts would be beyond the scope of an EIS.

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Comments on proponent's response

I'm happy with this response, including the changes/amendments made to the environmental management measures presented in Chapter 8 of the M4 East Submissions Report. I have only one additional comment regarding the implementation of necessary management measures for the construction phase. The measure with reference number AQ28 in Table 8.1 states that "*Ensure all construction vehicles comply with their relevant emission standards.*" In my view this is a very passive measure, and ensuring that all construction vehicles comply with their relevant emission standards is not a simple task. An alternative approach, that has been used both widely and successfully the last 10-15 years in large infrastructural projects in Sweden, is to offer contractors providing construction vehicles/machinery that meet emission standards which represent e.g. BAT (Best Available Technology, i.e. meeting stricter emission limits than the existing emission regulation requires) a deduction of the contractor's bidding price for the contract. This has shown to be an efficient way to promote the use of low-emission technology vehicles/machinery (and associated air quality benefits) during the construction phase of major infrastructural projects such as road tunnels and highways.

Issue description – calculate of period means

The resulting sum of the background and local emissions is 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.

Response

It is agreed that the analysis is not demonstrating that the model performance itself is good. It has been presented to demonstrate that the performance of the overall model chain is good (eg background + GRAL + conversion of NO_x to NO₂).

Comments on proponent's response

This is acceptable.

Issue description – uncertainties in dispersion modelling

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.

Response

It is acknowledged that there are uncertainties at all stages (eg traffic, emissions, dispersion, background air quality, post-processing) that affect the overall model predictions, and that some of the errors will reinforce each other whereas others may cancel out. It is beyond the scope of the environmental impact assessment to attempt to address these points in detail, especially where, as in this case, the air quality measurements available for model evaluation are quite limited.

Comments on proponent's response

I accept the general point that evaluation of GRAL is not the purpose of the EIS and that any evaluation conducted is only indicative. The weaknesses in the evaluation are therefore acceptable. The evaluation provided is successful in demonstrating the absence of any large errors in the modelling.

Issue description – testing the performance of GRAL

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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, ie 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.

Response

As noted above, the ability to test the performance of GRAL itself is quite limited on account of the limited number of roadside monitoring sites. In addition, it is necessary to isolate the road increment from the measured concentration, and the method for doing this would need to be established (eg defining a suitable local background monitoring site). Based on the data presented in Appendix J of the Air Quality Assessment Report in Appendix H of the EIS, the interpretation is that GRAL is probably overestimating the road contribution at the F1 and M1 monitoring sites. This is shown more clearly in **Figure 4.1** of this report. Here, the mapped background concentration at the F1 and M1 sites is taken to be the background contribution to the measurements, and the remainder is taken to be the measured road increment. It can be seen that there is a substantial over-prediction of the road component at the F1 site, but the prediction for the M1 site is rather good. There are some known issues with these two monitoring sites which mean that they are not ideal for model evaluation. For example, the F1 site is located behind a noise barrier. However, the options for model validation in Sydney are very limited. It is not known whether similar model evaluation exercises have previously been conducted for road projects in Sydney.

Comments on proponent’s response

I agree that the F1 site is problematic for model evaluation. However, I would also argue that the same may be true for the M1 site such that “the prediction for the M1 site is rather good” may be purely the coincidental effect of opposing errors in the background estimate and dispersion models cancelling out (the data presented does not rule out this possibility). More generally, though I accept that “the ability to test the performance of GRAL itself is quite limited on account of the limited number of roadside monitoring sites”. This situation will improve in time, however, as more roadside data becomes available from WestConnex monitoring sites. For future projects (beyond the New M5 East) it is recommended that options for evaluating dispersion model performance in this area of Sydney are re-visited.

Issue description – GRAL estimates of concentrations at “Concord Oval”

- 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.

Response

The Concord Oval monitoring site is close to Parramatta Road, and is the site that is most influenced by traffic. The GRAL Nitrogen oxides (NO_x) predictions are also the highest at this site. The background and roadside contributions to the measurements at the monitoring sites cannot be separated at present, as the NO_x background maps only relate to annual means, whereas these comparisons are on a monthly basis. It would be feasible to determine separate background NO_x maps for each month of 2014.

However, this is beyond the scope of the EIS.

Comments on proponent’s response

I accept this response.