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By Email: Lauren.Rose@planning.nsw.gov.au

Dear Lauren

M12 MOTORWAY (SSI-9364)
INDEPENDENT REVIEW OF HYDROLOGY AND FLOODING ASSESSMENT FOLLOWING EXHIBITION OF OCTOBER 2020 AMENDMENT REPORT (AR)

The M12 Motorway is a proposed east-west motorway to service the Badgerys Creek Airport by providing a linkage between the M7 Motorway in the east at Cecil Hills and The Northern Road in the west at Luddenham.

The M12 is part of the Western Sydney Infrastructure Plan (**WSIP**) which is an initiative of the Australian and NSW Governments. As well as the road, rail and airport infrastructure that is proposed, extensive commercial, industrial and residential development is planned in the area. The existing land uses are typically low density residential and rural activities.

The proponent for the M12 Project is Transport for NSW (**TfNSW**) who was formerly the NSW Roads and Maritime Services (**RMS**).

The NSW Department of Planning, Industry and Environment (**Department**) has identified hydrology and flooding as some of the key environmental issues associated with the M12 Motorway Project. Accordingly it has commissioned this current review to provide independent advice on the flooding and hydrology assessment which TfNSW has presented for the Project.

The Project and its Amendments in 2020

The Environmental Impact Statement (**EIS**) for the Project was exhibited from mid-October to mid-November 2019 (the **Project**).

The EIS states that the road will be a dual-carriageway with two-lanes in each direction and a central median facilitating future expansion to six lanes in the future. The Motorway will cross four major waterways being Kemps Creek, South Creek, Badgerys Creek and Cosgrove Creek. Each of these crossings will require large bridges in addition to other bridges required for traffic separation. It will also require widening of the existing M7 bridge over Ropes Creek.

As a result of the exhibition, various submissions were received from the general public, local councils and government agencies. TfNSW subsequently issued a Submissions Report in June 2020 which described and responded to these submissions. An Amendment Report (**AR**) was then issued and exhibited in October 2020.

As described in the AR, TfNSW proposes to amend the project to respond to the submissions but also to include various functional improvements (the **Amended Project**). The main

changes to the project that was previously described in the EIS relate to the M12/M7 interchange and nearby intersections and connections with Elizabeth Drive, Cecil Road and Wallgrove Road, and two new signalised intersections into the new Airport from a widened and realigned Elizabeth Drive, as well as additional ancillary facilities to support the delivery of the Project. Having regard to flooding and hydrological impacts, the most significant of these changes concern the potential flood impacts within the Badgerys Creek floodplains due to the re-aligned Elizabeth Drive near the new Airport.

Specific Objectives of this Review

This review was commissioned in August 2019. The specific matters about which the Department sought independent advice comprise:

- the technical adequacy and conclusions of the Proponent's assessment of flooding and hydrology impacts included in the environmental impact assessment documents for the proposal;
- the appropriateness and effectiveness of flood management and mitigation measures the Proponent has recommended for the proposal; and
- recommendations for conditions for construction and operation of the proposal (in regard to flooding and hydrology management) should the Department recommend approval of the proposal.

Our advice on the first two matters is presented in this letter. The remaining item, which relates to potential conditions, has been separately provided to the Department.

Documents Reviewed and Site Inspection Undertaken

Various documents have been provided for review. Of those documents the following are the most relevant:

i. *M12 Motorway – State Significant Infrastructure Scoping Report*, prepared by RMS, May 2018;

ii. *Secretary's Environmental Assessment Requirements* (**SEARs**), issued October 2018;

iii. *M12 Motorway – Environmental Impact Statement*, Main Report. RMS. October 2019;

iv. *EIS Appendix L, Flooding Assessment,* Parts 1 and 2. RMS. October 2019;

v. *EIS Appendix M, Surface Water Quality and Hydrology Assessment*. RMS. October 2019;

vi. *M12 Motorway*. *Submissions Report.* TfNSW. October 2020;

vii. *M12 Motorway*. *Amendment Report.* TfNSW. October 2020;

viii. *M12 Motorway*. *Amendment Report - Appendix H. Flooding supplementary technical memorandum.* Prepared by Jacobs and Arcadis for TfNSW. October 2020;

ix. *M12 Motorway*. *Amendment Report - Appendix I. Surface water quality and hydrology supplementary technical memorandum.* Prepared by Jacobs and Arcadis for TfNSW. October 2020.

In addition to a review of the documentation referred to above, the reviewer also undertook a site inspection in October 2019 from the various public roadways in the vicinity of the proposed Motorway alignment.

Background to these Review Comments following our November 2020 Advice

We have written to the Department on occasions over the last 18 months to provide our comments on the hydrology and flooding assessment for the Project. Most recently this occurred on 6 November 2020.

Since preparing that advice late last year we have become aware that Infrastructure NSW (**INSW**) has recently released a new flood study of the South Creek catchment which includes the area occupied by the Project and other development associated with the Badgerys Creek Airport (**INSW Flood Study**). In addition we have been advised that work is currently underway to expand the INSW Flood Study to consider the future land uses in the catchment and the potential cumulative impacts on the hydrology and flooding behaviour.

Because of the strategic importance of this work it was important that our November 2020 advice be updated to reflect this new flood study. Accordingly the review comments provided in this letter include all the matters discussed in our November 2020 advice with additional commentary on the INSW Flood Study.

REVIEW COMMENTS

The following provides the reviewer's assessment of the key hydrological and flooding issues associated with the Project and which are presented in the above documentation.

1. Summary and Conclusions

1.1. The reviewer considers the documentation relating to hydrology and flooding to be of a reasonable standard.

1.2. With some exceptions, generally all the pertinent issues have been canvassed and addressed and an appropriate level of analysis, including hydrologic, hydraulic and water quality modelling, has been undertaken. Some deficiencies and outstanding matters are listed below.

1.3. If the Department intends to grant approval to the Project, the reviewer believes the deficiencies and outstanding issues can likely be addressed by way of conditions. Correspondence about the potential wording of these conditions has been separately forwarded to the Department.

1.4. In the reviewer's opinion, the most significant issue which remains to be addressed is the need for a strategic hydrological and flooding assessment for the wider area within which the M12 Motorway is to be located. This strategic assessment would be undertaken with additional modelling with all planned (or likely) infrastructure and land use changes included, and would facilitate coordination of the various water quantity and water quality mitigation structures and measures that are proposed in the area including within the M12 Project area.

1.5. The need for the preparation of this strategic assessment is discussed in paragraphs 10.1 to 10.6 below. The INSW Flood Study for the wider catchment, which released results for the existing flood behaviour in November 2020 and is currently assessing cumulative flooding and hydrology impacts, has the potential to provide the strategic assessment which is needed for the design of the Project.

1.6. It is recommended that TfNSW commence immediate liaison with INSW and that results from the INSW Flood Study and the assessment of cumulative impacts be utilised within the design of the Project, subject to the timely availability of the INSW information.

2. Australian Rainfall and Runoff (ARR) – Hydrological Procedures

2.1. Australian Rainfall and Runoff (**ARR**) is the practitioner's principal guide to hydrology and flood estimation in Australia. Various revisions and updates to ARR have been made since it was first released in 1958. These occurred in 1977, 1987, 2016 and 2019. The latter update in 2019 is almost identical to the 2016 update and so it is referred to as ARR (2016/2019) in this review.

2.2. The Bureau of Meteorology (**BoM**) publishes estimates of the intensity-frequency-duration (**IFD**) of rainfall across the country. As these rainfall IFDs are based largely on the recorded rainfalls, as time has progressed, there has been an opportunity to improve the accuracy of the rainfall IFD data. These revisions have coincided generally with the major revisions to ARR being those in 1987 and 2016.

2.3. ARR(1987) used 1987 IFD data in many of its procedures. Similarly ARR(2016/2019) uses 2016 IFD data.

2.4. The revisions made to ARR(1987) to produce ARR(2016/2019) are significant as they utilise, amongst other matters:

(a) changes to rainfall temporal patterns

(b) changes to initial and continuing rainfall losses;

(c) 2016 IFD data, and

(d) revised hydraulic procedures including allowance for blockage of cross drainage structures.

2.5. In the opinion of the reviewer, it is unfortunate and short-sighted that the hydrologic analyses undertaken for the EIS have been based on ARR(1987).

2.6. The EIS states that the use of ARR(1987) was undertaken in anticipation that "*this was a slightly conservative approach compared to the data and methods of the new edition of Australian Rainfall and Runoff 2016…*".[1] Further the EIS states that the "*expected difference between the methods was a 10 per cent increase in flows by using ARR 1987*".[1]

2.7. ARR(2016/2019) is a significant update of the techniques and base information provided in ARR(1987). ARR(2016) and the BoM's 2016 IFDs were under development for many years prior to 2016. Whilst the industry recognised that there would be (and still is) a period of transition from ARR(1987) to ARR(2016/2019), it is poor practice for the EIS to be placed on exhibition in 2019 without directly utilising the new procedures and the new IFD data.

2.8. The reviewer agrees that in many cases the application of ARR(2016/2019) has resulted in small decreases in flows and flood levels in parts of the Sydney area. However the differences may be quite variable when the influence of the new temporal patterns and losses are considered. The presence of numerous small farm dams and existing/proposed basins in the catchment make it much more difficult to predict the outcome of using ARR(2016/2019).

2.9. The reviewer also notes that use was made of ARR(1987)'s Probabilistic Rational Method (**PRM**) when establishing the TUFLOW model of the minor waterways in the M12 Project area. However ARR(2016/2019) no longer recommends use of the PRM for determining runoff flows from ungauged rural catchments.

[1] Appendix L of EIS. Section 3.4.2, page 23.

2.10. For the reasons outlined above it was unwise for TfNSW to have neglected to directly apply the ARR(2016/2019) procedures when preparing the EIS (in 2019 and over the years between 2016 and 2020).

2.11. In the reviewer's opinion all future hydrologic assessments need to be carried out with ARR(2016/2019) and the existing impact assessments will need to be reviewed. Further the previous NSW Office of Environment and Heritage (**OEH**) has released a guide for incorporating ARR(2016/2019) into flood studies and all future hydrologic assessments for the Project will also need to comply with this guide.[2]

2.12. ARR(2016/2019) hydrologic procedures and rainfall intensities relating to climate change also need to be included.

3. Australian Rainfall and Runoff (ARR) – Hydraulic Procedures

3.1. ARR (2016/2019) also includes updated requirements for hydraulic procedures including hydraulic modelling.

3.2. All future hydraulic assessments for the Project need to be carried out with ARR(2016/2019) not ARR(1987). This includes making allowances for blockage of cross drainage structures consistent with the guidance in ARR (2016/2019) where these blockage allowances exceed those already assumed in the EIS documentation.

4. Climate Change

4.1. The potential impact of climate should be considered when assessing the environmental impacts of the Project. This is a requirement of the SEARs and it is also consistent with normal practice.

4.2. Whilst consideration has been made in the EIS, there is conflicting reporting of how the climate change assessment was carried out. For example, Table 3-1 of Appendix L suggests that a 10% increase in rainfall intensity was used whereas Section 3.5 indicates that increases in intensities between 10% and 30% were used. Further still, Section 7.2.8 indicates that the 2000 year average recurrence interval (**ARI**) flood flow was used to carry out a conservative climate change assessment.[3]

4.3. Whilst it appears that the vertical alignment of the Motorway presented in the EIS has a large factor of safety against achieving a nominal 100 year ARI flood immunity, and is therefore likely to be able to accommodate increased flows from climate change without overtopping, this confusion over the climate change approach in the documentation should be clarified.

4.4. The application of the ARR(2016/2019) procedures which are recommended to be undertaken in paragraph 2.12 above will also update the range of possible rainfall intensity increases which could occur in the future under various Representative Concentration Pathways (**RCP**s).

5. Flood Immunity

5.1. The EIS reports that the Project will have a flood immunity of at least 100 year ARI. The reviewer agrees that this is an acceptable standard for the Motorway although it would be more appropriate for the standard to include for climate change.

5.2. The EIS also states that the "*current design of the project exceeds the minimum 1 in 100 year ARI* [sic] *flood immunity requirement (due to the design having been*

[2] Refer *Floodplain Risk Management Guide – Incorporating 2016 Australian Rainfall and Runoff in studies*. 2018 (released 21 January 2019). Published by NSW Office of Environment and Heritage.

[3] It appears that the 2000 year ARI flows were approximately estimated by assuming they were double the 100 year ARI flows. (Refer Appendix L of EIS. Section 3.6, page 26).

governed by road geometry and other design requirements) and therefore provides some excess capacity to accommodate larger flows as a result of future development within the catchment. However, the design can be further optimised during detailed design and the minimum design requirement (1 in 100 year ARI [sic] *flood immunity) would apply*".

5.3. There is no assessment of the actual flood immunity standard achieved by the vertical alignment that has been adopted in the EIS. There is a suggestion in Section 7.2.8 of Appendix L that the vertical alignment of the Motorway is "*well above the 0.05 per cent AEP flood levels*" but it is unclear from other statements in the EIS whether this is the flood immunity of the Project or not.

5.4. The reduction in flood immunity that will occur under climate change has also not been assessed.

5.5. The Amended Project includes two new signalised intersections into the new Airport from a widened and re-aligned Elizabeth Drive. Parts of the eastern intersection and the re-aligned Elizabeth Drive occur within the floodplains of Badgerys Creek and one of its unnamed tributaries. Elizabeth Drive in this area currently has a very low flood immunity of 5 year ARI and this will not be changed by the Amended Project.[4]

5.6. The AR states that "*There is an opportunity to improve the flood immunity of Elizabeth Drive through further raising of the road, although it is noted that there are other flood prone locations along the road outside of the project area*". The extent to which the existence of these other flood prone locations provides justification for failing to improve the flood immunity within this part of the Amended Project requires further justification.

5.7. In the reviewer's opinion, the Amended Project should not prelude or impede the future raising of Elizabeth Drive, given the low flood immunity currently in place.[5] Future increased traffic volumes may necessitate that this occurs sooner than currently expected.

6. Hazard Assessments

6.1. Flood safety hazard assessments in the EIS should utilise and reference the *Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, 2017* in addition to the *NSW Floodplain Development Manual* and ARR(2019).

7. Use and Review of Hydrologic and Hydraulic Models

7.1. TfNSW have made use of existing models developed by the local councils for the South Creek catchment.[6] These comprise hydrologic models and a 5m grid two dimensional (**2D**) hydraulic model known as TUFLOW. In addition TfNSW developed other finer grid 2D models on smaller creek systems not adequately covered by the main South Creek models.

7.2. The councils' models have generally been through a process of technical assessment by NSW Government flood specialists and have been subject to public consultation and scrutiny. This gives added confidence in the use of these models.

[4] Nevertheless the AR states that "*There is an opportunity to improve the flood immunity of Elizabeth Drive through further raising of the road, although it is noted that there are other flood prone locations along the road outside of the project area*".
[5] Note that with implementation of the Amended Project, the AR states that Elizabeth Drive would only have a flood immunity up to and including the 5 year ARI flood event and during the 20 year ARI event, it would be overtopped by about 160mm above the crown of the road and elsewhere by up to 350mm, on the west-bound carriageway. (However as noted under paragraph 8.3 below, a greater depth of overtopping may occur).
[6] Updated South Creek Flood Study (WorleyParsons, 2015)

7.3. There has only been limited additional data collection to supplement and improve the existing models. In particular it is noted that additional ground survey and bathymetric survey of creeks and dams were not made available for the hydrologic and flooding assessments presented in Appendices L and M of the EIS, or Appendices H and I of the AR.

7.4. There is very limited information presented in Appendix L of the EIS or Appendix H of the AR about the manner in which the hydrologic and hydraulic details have been used. It is therefore not possible to rigorously confirm that the modelling is fit for purpose. For example it appears the 36 hour duration storm has been used on each of the four main creek systems. Whilst this may be appropriate for South Creek itself, on smaller systems such as Cosgroves Creek and possibly the other main creeks, shorter duration storms are likely to be appropriate and these would lead to higher flows than have been used in the EIS.

7.5. Nevertheless when these revisions are undertaken, in addition to the application of ARR(2016/2019) procedures referred to earlier, whilst there will be changes to the baseline hydrological and hydraulic characteristics, and in some cases these may be significant, the reviewer considers that the hydrology and flooding impacts will be able to be appropriately managed during detailed design. Accordingly the reviewer suggests that these deficiencies in the EIS could be addressed by conditions, should the Department determine to grant approval to the Project.

7.6. It is normal practice to report the calibration and validation of models in order to establish the credentials of the models. These details are absent from Appendix L of the EIS and Appendix H of the AR and will need to be rectified in further stages of the Project. This applies to the use of existing councils' models as well as the new models that have been established. This additional information should validate the use of the models having regard to the existing flood levels that have been established from the councils' models, past historical events (if available) and consistency with established model parameters and procedures.

7.7. It is also normal practice for these models to be independently peer reviewed, and for the peer review report to be published in the EIS. However it doesn't appear that a peer review has been undertaken.[7] Such a peer review should be undertaken not only for all the hydrological and hydraulic models, but also for the water quality models.

8. Inadequate Hydraulic Modelling of Badgerys Creek and Elizabeth Drive

8.1. As discussed in paragraphs 5.5 to 5.7, the Amended Project now extends further into the floodplains of Badgerys Creek with the re-alignment of Elizabeth Drive immediately north of the new Airport.

8.2. It appears that the Amended Project area now extends beyond the boundary of the flood model that was used for the EIS. Consequently a proper assessment of the flood impacts has not been carried out. If the Project is to be approved, this deficiency in the flood modelling will need to be rectified early during the detailed design.

8.3. In particular it is noted that neither the culverts under the unnamed tributary of Badgerys Creek nor the Elizabeth Drive bridge over Badgerys Creek were specifically included in the hydraulic model.[8] A proper hydraulic assessment, particularly in

[7] There is a reference to "*incorporating the independent peer review comments*" in Section 3.6 on page 26 of Appendix L of EIS. However there are no further details provided about the timing and this peer review and its terms of reference.

[8] A very coarse approximation of these structures was included by providing 'gaps' in the digital elevation model. This overstates the hydraulic capacity of these structures because obstructions caused by the culvert overburden and the bridge deck, are ignored. The potential blockage of these structures by water borne debris would also be ignored.

relation to the Elizabeth Drive bridge, would likely see the Creek and the tributary channels conveying less flows, resulting in additional overbank flows and increased overtopping of Elizabeth Drive, relative to that currently reported in the AR (refer paragraph 5.7 and footnote 5).

8.4. The design of the amended project was provided as a surface model and only a portion of the Elizabeth Drive upgrade area was incorporated into the flood model

8.5. Further as noted above, the model extent is insufficient to encompass all of the Amended Project area. As a result the flooding impacts in this area extend beyond the boundary of the current flood model and therefore have not been assessed or adequately considered in the EIS and AR.

9. Quantitative Design Limits for Flooding Impacts

9.1. The EIS presents various quantitative flood impact limits for the Project under "*fully developed catchment land use conditions*" within Table 3-2 of Appendix L of the EIS. Their objective is stated to be to "*minimise adverse flooding impact to land, buildings, infrastructure, and public safety as much as practicable, under existing hydrologic conditions*".

9.2. The numerical limits relate to the allowable flood level increase, and to changes in flood velocities and flood inundation durations. Different limits are applied to different land uses. Given the significant land use changes that are likely to occur in the wider area, the reviewer expected to see some discussion about limits under current and proposed land uses.

9.3. These limits are important because they define the maximum acceptable changes in relevant flood parameters such as water level, velocity and duration. Because these limits may be used as a trigger for design modifications, acquisition of additional Motorway land, payment of compensation, etc, the limits need to be carefully formulated, justified and documented. In the reviewer's opinion, the current justification and documentation of these limits are inadequate.

9.4. In their current form, the proposed limits provide inadequate safeguards and need to be made more stringent. The revisions in allowable flood impacts should be undertaken consistent with current best practice and the stated objective which is listed above in paragraph 9.1

9.5. The reviewer's comments on the flood impact limits proposed in Table 3-2 of Appendix L are:

(a) Over the last one to two decades, there have been significant reductions in the flood impact limits which the community (and the courts) consider to be acceptable. The limits in the EIS are no longer current.

(b) Within Sydney a number of local councils consider 10mm to be the maximum increase in flood level (in a 100 year ARI event). This has arisen because improved hydraulic modelling has shown that with careful design, flood level impacts can be minimised to these levels without requiring unreasonable and unrealistic mitigation measures.[9] Consequently, it is the opinion of the reviewer that the EIS' statement that "*flood level increases have been limited to about 100 millimetres under 100 year ARI conditions ... this means that the potential impact of the project is minimal*" is inconsistent with current industry practice.

[9] This has in part occurred because of publication of practices in two dimensional modelling of urban and rural floodplains such as was presented in ARR Revision Project 15 in November 2012.

(c) Further the statement that appears in Section 7.2.1 of Appendix L that "*All areas of afflux are within already flooded land*" is fallacious and can't be used to justify a flood level increase on third party property.[10]

(d) In addition, the EIS' proposal to allow up to 50mm increase in flood level to existing dwelling houses is completely inappropriate in the opinion of the reviewer. It is unlikely that any increase in flood levels above the floor levels of residential or commercial buildings, can be justified. (Although it is unlikely that there are any flooded dwellings in the Project area where this limit would be used, the reviewer considers the flood impact limits still need to be revised to reflect current best practice).

(e) The soils in the Project area are likely to be susceptible to erosion. Therefore allowing increases in velocity without providing scour protection or other mitigation measures, is unlikely to be appropriate unless supported by a geotechnical/soils assessment.

(f) In relation to existing public roads and pathways, changes to the increase in flood hazard (as measured by the product in depth and velocity) also need to be specified.[11]

9.6. Because of the nature of the Project and its interaction with local watercourses, the reviewer considers that revised and more stringent flood impact limits can be developed and implemented without requiring significant design changes. Accordingly these revisions could be conditioned should the Department decide to grant approval to the Project.

10. Cumulative Impacts Associated with the WSIP

10.1. The M12 is part of the Western Sydney Infrastructure Plan (**WSIP**) and there a number of projects and land use changes in the area that are likely to influence the hydrology, flooding and water quality characteristics within the M12 Project area. These include the Western Sydney Airport, the associated upgrades to road and rail infrastructure and the land use changes which will (and are) occurring as part of the Western Sydney Aerotropolis, the South West Growth Area and the Western Sydney Employment Area.

10.2. The changes to the hydrology and flooding characteristics include alterations to peak flows, runoff volumes, runoff hydrograph shapes, runoff timing and water quality. Further, as correctly noted in the EIS, despite upstream developments being designed with detention basins and other mitigation measures to ensure there is no change in peak flow at the downstream boundary of each development, there can still be adverse hydrological impacts further downstream from these developments.[12]

10.3. Consistent with the SEARs and the NSW Floodplain Development Manual (the **Manual**), consideration of the cumulative impacts is an important component of the environmental assessment of any project. Given the context of the M12 within the large and significant development which is occurring in this part of Western Sydney, and the consequential changes to hydrology, flooding and water quality which are

[10] This is because whilst the statement may be true for the AEP's of the flows tested in the model runs, there will likely be other AEPs when flows are smaller and when land that was not previously inundated, is now flooded because of the afflux.
[11] Refer paragraph 6.1 above.
[12] If unmitigated, urban development of a site leads to increased volumes of runoff and increased peak flows, downstream. Detention basins serve generally to reduce this peak flow by broadening the hydrograph and extending the duration of flows at the site's downstream boundary. When multiple sites are developed and the runoff from each site is mitigated in this fashion, the hydrologic routing of these broadened hydrographs into downstream areas produces peak flows that are usually higher than the existing peak flows at locations some distance downstream of the sites. This is largely a result of the increased volumes of runoff from each site which cannot be mitigated using detention basins. In order to address this issue, consideration has to be given to the combined effect of all upstream developments. A whole of catchment approach must be pursued rather than considering subcatchments in isolation.

likely to occur, the reviewer considers that it would be inappropriate for the M12 Project to proceed without a proper assessment of the cumulative impacts.

10.4. The EIS acknowledges that "*these potential cumulative impacts need to be considered through a regional-scale assessment*" however it also states that such an assessment is "*beyond the scope of the design process of any individual proposal*". The reviewer doesn't understand why TfNSW have determined that it is out of scope of the EIS. Further the reviewer doesn't believe the requirements of the SEARs or the Manual can be complied with unless such a cumulative assessment is carried out.

10.5. In this regard the reviewer notes that the local councils' feedback on the EIS has identified the lack of a cumulative impact assessment as a major deficiency in the current documentation.

10.6. The reviewer considers that the cumulative impacts on hydrology, hydraulics and water quality are best addressed via a strategic planning assessment coupled with hydrologic, hydraulic and water quality modelling.[13] This is the process outlined in the Manual for the preparation of a Floodplain Risk Management Study and Plan (**FRMS&P**).

10.7. In November 2020, INSW released the first stage of the *Wianamatta (South) Creek Catchment Flood Study – Existing Conditions* (**INSW Flood Study**) which is being undertaken by the same consultants who previously carried out other FRMS&Ps in the area.

10.8. Most importantly this study is continuing and will be investigating the cumulative hydrological and flooding impacts within the catchment. Therefore it has the potential to investigate not only the impacts on the Project of the proposed development in the wider catchment, but also the Project's contribution to the cumulative impacts within the catchment.

10.9. As this INSW Flood Study has the potential to address the shortcomings in the EIS and AR which have been identified in paragraphs 10.1 to 10.6 above, the reviewer recommends that TfNSW commence liaison with INSW given the direct relevance of the INSW Flood Study to the Project. This will likely necessitate an exchange of data between both agencies as INSW will need updated details of the Project to include in its flood models, and TfNSW will need the revised flood behaviour and an early indication of INSW's strategy to mitigate cumulative impacts, in order to finalise the design of the Project.

10.10. It is recommended that this liaison between agencies commence immediately and that subject to the availability of INSW information within the timetable for the Project, that TfNSW take the INSW information into consideration in the design of the Project.

11. Ropes Creek Crossing

11.1. The Motorway traverses the Ropes Creek floodplain near the tie-in to the existing M7 Motorway. The proposed design involves bridge widening works on the existing M7 northbound bridge.

11.2. The proposed bridge widening for the M12 adopts the same bridge type, bridge spans and bridge piers as the existing M7 bridge structure. The EIS reports that as a consequence, no assessments of the hydrology and hydraulic impacts at this location were undertaken for the EIS.

[13] The need for this strategic assessment was reported in Section 7.2.7 of Appendix L which stated that "g*overnment stakeholders for developments in the South Creek valley have acknowledged the need for a catchment-wide approach to the hydrological modelling inclusive of the stormwater management plans of upstream major developments*".

11.3. The reviewer does not agree with the approach taken by TfNSW in failing to assess the suitability of the flooding impacts and characteristics of the existing structure before proceeding with this approach.

11.4. It is recommended that this assessment be carried out. If the Project receives approval, this assessment could be undertaken as a condition of approval.

12. Water Quality Control Measures

12.1. The reviewer supports the proposal to use grassed swales and permanent water quality detention basins to control the adverse impacts on water quality which will result from introducing additional runoff from the Motorway into the environment.

12.2. As noted above in paragraph 7.7 it is recommended that the water quality modelling that is being used to design these mitigation works should be independently peer reviewed.

13. Impacts on Farm Dams and Minor Drainage Lines Downstream of the M12

13.1. The analysis presented in Section 5.2.3 of Appendix M of the EIS demonstrates that increases in peak flow rates and volumes of stormwater runoff are likely to impact on minor drainage lines and downstream farm dams at a number of locations.

13.2. Further where the areas are more urbanised and where the Project may increase flows and adversely impact downstream land uses or road safety, the EIS has stated that "*consideration of stormwater detention basins may be warranted*" and will require further analysis during detailed design.

13.3. There are numerous farm dams in the area and a number are located downstream of the Motorway and may have their water supply impacted. The farm structures have been considered with a preliminary analysis in Section 5.2.3 and Table 5-9 of Appendix M of the EIS, and Section 5.2 and Table 5-6 of Appendix I of the AR. These analyses demonstrate that consideration has been given to individual minor drainage lines and the farm dams located on these drainage lines.

13.4. Both increases and decreases in flows directed to these structures may be problematic. An increase in flow may aggravate the stability of the dam walls and their spillways during flood events. A decrease in flow may reduce the water supply yield of the farm dams.

13.5. Special consideration will need to be given to these dams during detailed design should the Department decide to grant approval to the Project. Mitigating against the induced risk of failure to these structures will be problematic because many of the structures may not be properly designed and may only have a short design life. In addition where the Project is reducing water supplies to these dams, it is unclear how the impact can be directly mitigated by works except through provision of a separate water supply.

13.6. The reviewer supports the statement in the EIS that "*During the project's detailed design, further modelling would be conducted to verify the project's impacts on minor drainage lines and to confirm the mitigation strategies being committed to by Roads and Maritime under this assessment. In particular this would apply to measures designed to mitigate impacts downstream and outside of the project's operational boundary. These measures would also be subject to negotiation and agreement with individual affected property owners*".[14]

[14] Refer Section 5.2.3 of Appendix I of the AR.

13.7. The reviewer notes that changes in water supply yields from farm dams have not been directly assessed in the EIS and these will need to be included in the assessments that are proposed during detailed design and referred to in the previous paragraph.

13.8. If the Project is approved, it is recommended that conditions of approval be prepared to address the above matters during implementation of the Project.

Yours sincerely

Drew Bewsher
Director