18th September 2019

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Water Research Laboratory

Dear Sirs,

PROC-200202: SSI No. 17_8931
F6 Extension Stage 1 Independent Groundwater Review
Final Assessment Report

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney has completed the peer review of the F6 Extension Stage 1 Environmental Impact Statement (EIS) and supplementary materials as provided by NSW Department of Planning, Industry and Environment (DPIE). This work was completed by Mr Doug Anderson (previously of WRL) and has been summarised by Mr Brett Miller (of WRL). Mr Anderson is considered by his peers to be an expert in groundwater processes and modelling.

Summary of Communications

This letter provides a final summary. However communications and advice from WRL has been provided in the previous formal communications.

Letter Dated	Regarding
24th September 2018	SEARs Consistency Review
26th November 2018	Preliminary Assessment Report
11th April 2019	Review of New M5 Groundwater Monitoring Data
10th May 2019	Additional Sensitivity Testing Requirements
19th July 2019	Review of Additional Groundwater Modelling Sensitivity Testing

Assessment Summary

The EIS groundwater assessment for Stage 1 of the F6 project was developed with the aid of a 3D numerical groundwater model peer reviewed by Dr Noel Merrick of HydroSimulations who declared this model fit for purpose. As detailed in WRL's letters of the 24th September 2018 and 26th November 2018, the modellers adopted various simplification hypotheses to arrive at a prediction of operational tunnel inflow and ground water drawdown impact.

WRL's reviewer considered that the simplification hypotheses employed for assessment were broadly consistent with historical industry practice and that the assessment workflow demonstrably improved upon assessments undertaken for previous tunnelling assessments. However, when inspecting the public EIS documents in isolation, in the opinion of WRL's reviewer, some aspects of the assessment

were not considered leading practice. In particular, it was observed that the EIS conceptual and numerical model predicted spatially averaged impacts using spatially averaged parameter inputs.

To address this issue NSW DPIE Water requested clarification on several aspects of the assessment, including additional geological information and numerical modelling. In response, the proponent provided numerous geological and hydrogeological cross-sections and maps to improve the communication of the field investigation data and the numerical modelling results, including sensitivity analyses. The cross sections and maps were provided to NSW DPIE Water along with a written response (28 pages).

Subsequently, WRL's reviewer requested additional modelling sensitivity analyses to clarify the likely construction related impacts of the project. This information was requested because of the geological simplifications employed to model groundwater flow and because a similarly simplified model developed for the New M5 motorway had not predicted the groundwater drawdown observed during construction (WRL's letter of the 11th April 2019).

The request for additional information was made in WRL's letter of the 10th May 2019. The proponent provided model simulation outputs that quantify the potential uncertainty in the base case EIS model predictions on the 13th June 2019. WRL responded on the 19th July 2019.

WRL's reviewer inspected the model outputs and has formed an opinion based on the reported data that sufficient quantitative groundwater information had now been provided to inform environmental assessment and to progress detailed design, including the development of draft construction and groundwater management and monitoring plans to avoid, minimise and mitigate the impacts of the development.

In summary, the short-term draw down impact predictions of the model are very sensitive to the assumption of when drain conductance of 1L/s/km is achieved and also current knowledge of geological structures and their hydraulic properties. The sensitivity test model predictions predict larger temporary construction (excavation) drawdowns underneath some buildings, wetlands and green space. The models with increased permeability in mapped geological structures predict larger long-term drawdown impacts near those structures. These scenarios could be considered to provide a potential worst-case prediction of impact in the locations where increased bedrock permeability is observed.

The provided model sensitivity test results highlight the groundwater drawdown consequences of uncontrolled tunnel inflows being allowed for certain periods of time and the importance for detailed design and environmental management of identifying the variability in the hydraulic characteristics of bedrock.

Recommendations

The following summary is provided for recommended works to be undertaken throughout the detailed design. These recommendations have been provided in previous correspondence.

1. The development proponent provides a commitment to NSW DPIE to engage a third party expert in structural geology to complete the following work prior to construction of access shafts and tunnels to facilitate a detailed design that avoids, minimises and mitigates the groundwater related impacts of the project:
    a. Consider the available geological logs and the depositional history and geomorphology of the basin in proximity to the proposed tunnel alignment and nearby water receptors;

b. map / interpolate the thickness and extent of shale bodies in sandstone proximal to the tunnel alignment and between the tunnel alignment and surface water receptors;

c. map all potential structures; and

d. provide recommendations for further field work (e.g. additional drilling, geophysics etc.) to be undertaken to identify geological structures in sandstone that should be incorporated into regional and local scale numerical models to improve drawdown predictions.

2. The development proponent provides a commitment to NSW DPIE that future groundwater models will be calibrated incorporating the best available geological mapping data with variable horizontal and vertical permeability within model layers to represent all known and inferred geological structures, including faults and significant layers of shale within sandstone above the tunnel alignment and/or between the tunnel and potentially sensitive surface water receptors.

3. The development proponent provides a commitment to NSW DPIE to engage a geochemist to complete the following work prior to construction of any access shafts and tunnels:

    a. conduct repeat baseline water quality and water level sampling at all accessible boreholes. This should include all those boreholes previously sampled, any new monitoring boreholes that have since been added to the network and any other boreholes indicated on maps previously submitted to NSW DPIE that are completed in accordance with minimum requirements for groundwater monitoring.

    b. Analyse the water chemistry results for chemical and isotopic signatures (e.g. very low TDS or chloride) that may indicate the presence of young groundwater at tunnel depth with a risk of surface connectivity that would need to be directly addressed in detailed design.

4. Groundwater monitoring commences prior to any dewatering or excavation.

5. Locations of proposed monitoring be reviewed by NSW Government hydrogeologists.

6. Where wetlands are sensitive or valued and groundwater drawdown from the project poses a potential risk to ecological function through changes in wetland level or water quality (as might naturally occur during periods of dry weather when groundwater baseflow to the wetland could be reduced), an improved understanding of wetland function and project risks to wetland function should be demonstrated via:

    a. A hydrological water balance for the wetland(s) noting the elevations of hydraulic structures controlling inflows and outflows to the wetland and the conditions;

    b. A hydrogeochemical study that documents the baseline water quality of the wetland(s) for different climatic conditions including a very wet period and a very dry period;

    c. A hydrogeological study that monitors the wetland(s) water levels, temperature and electrical conductivity within the wetland and in a groundwater monitoring bore installed in saturated sediments beside that wetland in the direction of the project.

7. A more representative distribution of rock mass permeability in future geological and conceptual numerical groundwater models. Future work should include analysis of the available field data and existing model calibration residuals to infer the differences between rock mass primary permeability (low) and secondary permeability (high) in areas where valley uplift has occurred and where dykes have intruded through weaker rock. The numerical model calibration should then be revised to potentially improve the calibration to observed data and local-scale predictions.

8. Future groundwater predictive modelling work with a revised distribution of rock mass permeability. The transient drawdown predictions from this model during excavation and dewatering should be assessed for sensitivity to assumed values of aquifer confinement and storage (specific storage and specific yield).
9. The updated groundwater modelling predictions and the differences between modelled and observed groundwater impacts for previous tunnelling projects in the Sydney Basin (e.g. New M5, M4E) should then be considered to inform detailed design, including management of project subsidence risks.

Conditions

WRL reviewed DPIE's "Draft Conditions" as supplied on the 29th July 2019 and responded (by email on 12th August 2019). These draft conditions were considered to cover all of WRL's reviewers recommendations and concerns.

The following suggestions were made regarding data collection that would assist groundwater modellers undertaking the revision, update and recalibration of the groundwater model after construction.

1. During excavation a log be kept of all probe holes drilled in advance of the cutting face and a hydraulic description of the water pressure encountered. Where inflow or significant seepage is observed, maps and photographs of the locations, geological descriptions of the rock fabric and structure and the time of observation be reported. A log be kept of the locations and volumes of any grout injected to control inflows.

2. During excavation, construction and operation, a weekly project water balance be maintained inferring tunnel inflows from daily measurement of water treatment plant discharge and underground process water inputs.

3. There should be ongoing deployment and maintenance of instrumentation to measure flows in the groundwater drainage system upstream and downstream of the locations of inflow and significant seepage observed during construction.

Summary

Thank you for the opportunity to provide this assessment. If you have any questions regarding this review, please contact Mr Brett Miller (b.miller@wrl.unsw.edu.au) in the first instance.

Yours sincerely,

Grantley Smith
Manager