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Via email

Re: Menangle Sand and Soil - groundwater management

1 Introduction

Menangle Sand and Soil propose to extend their current operations to extract sand and soil from an additional stage of the quarry (Stage 8) (the 'Extension Project'). Stage 8 would extend approximately 2.8 km along the Nepean River, within Lot 203//DP590247 on the eastern side of the Hume Highway. Approximately 700,000 tonnes of sand and soil would be extracted over about 15 years.

Extraction would be in sequential substages so the active extraction area will be a small proportion of the total Stage 8 extraction area at any given time.

The modification application for the Extension Project (85/2865 MOD 1) was refused by the Department of Planning and Environment (DPE) on 25 October 2018 (now the Department of Planning, Industry and Environment (DPIE)). Amongst other matters, the DPE *Menangle Sand and Soil Quarry Section 75W Modification Assessment (DA 85/2865 MOD 1)* report (25 October 2018) states that "[t]he Department accepts DoI [Department of Industry] Water's advice that the proposal would constitute an aquifer interference activity and the groundwater assessment has not been carried out in accordance with the AIP [Aquifer Interference Policy]."

The application is now before the NSW Land and Environment Court (2018/342158).

I discussed the proposal in relation to groundwater with Mr Greg Russell, DoI Water, at the onsite Section 34 conference on 14 June 2019. This letter re-examines the groundwater issues in light of these discussions and redefining the water that seeps into the quarry areas as groundwater and therefore subject to the AIP.

2 Site hydrogeological setting and conceptual model

The Stage 8 area contains undulating and thin Quaternary sand and alluvial deposits immediately adjacent to and underlying the Nepean River. The Triassic Wianamatta Group Ashfield Shale outcrops away from the alluvial deposits and the river (Wollongong 1:250,000 Geological Series Sheet, NSW Department of Mines 1966). The Wianamatta Group shales form a thin cap (up to 20 m in thickness) over the Triassic Hawkesbury Sandstone. In some locations, the Nepean River has eroded the Wianamatta Group entirely and the alluvium directly overlies the Hawkesbury Sandstone (Parsons Brinckerhoff 2014).

The Wianamatta Group shales generally have low permeability and yields, and act a regional aquitard (Parsons Brinckerhoff 2015). Rainfall recharge is typically low to this unit; the majority of rainfall that falls on the shale runs off to creeks and rivers (McKibbin and Smith 2000).

The Hawkesbury Sandstone forms an extensive confined to semi-confined regional aquifer within the Sydney Basin sequence (Ross 2014). Recharge to the Hawkesbury Sandstone is greatest where it outcrops, which is not in the vicinity of Stage 8. Within the Stage 8 area, the Hawkesbury Sandstone is likely to be receiving the majority of groundwater via lateral throughflow from up-gradient areas of sandstone.

The alluvial deposits support local, discontinuous and unconfined local groundwater systems in direct connection with the Nepean River. The alluvial groundwater system is permeable and is recharged via direct rainfall and runoff and possibly through connection with the river (Parsons Brinckerhoff 2016). Where underlain by Wianamatta Group shale, the alluvial systems are unlikely to be connected with the regional groundwater table. Where underlain directly by the Hawkesbury Sandstone, these systems may be hydraulically connected with the regional groundwater table, although their contribution is considered minor given their inherent discontinuity and small extent.

A review of DPI Water's registered groundwater bore database (DPI Water 2016) confirms the presence of shale as the surficial geological unit, intersected 2–22 meters below ground level (mBGL) in a bore 1 km from the Stage 8 area and approximately 500 m from the Nepean River. Slightly further down the river, at an AGL Camden Gas Project groundwater monitoring site, the alluvium directly overlies the Hawkesbury Sandstone and the Wianamatta Group has generally been eroded (Parsons Brinckerhoff 2014). At this site, groundwater levels have been typically observed to closely reflect the river level height, within 1-3 meters.

During periods of high rainfall, flooding can occur in the Nepean River. During this time, groundwater levels in the shallow alluvium rise and may become indistinguishable from the flood water. This has been observed at AGL's groundwater monitoring bores downstream of Stage 8 (Parsons Brinkerhoff 2015).

There are two hydrogeological units identified for the site are summarised as:

- thin alluvial Quaternary sand and alluvial deposits immediately adjacent to and underlying the Nepean River. Alluvial deposits contain discontinuous, unconfined local groundwater systems in direct connection with the Nepean River; and

- Hawkesbury Sandstone forms an extensive confined to semi-confined regional groundwater source within the Sydney Basin sequence with permeability from both the rock mass itself and fractures within the rock mass.

The conceptual groundwater model would be expanded in the Groundwater Modelling and Management Plan as described in Section 5.

3 Water management

The *Menangle Quarry Extension Project* EA (EMM 2017a) The identified the aquifer water level, within the alluvium overlying the Hawkesbury Sandstone, as reflecting the typical Nepean River level (61 m Australian Height Datum (AHD) as regulated by Menangle Weir, about 1 km downstream from the Stage 7 area).

The EA was prepared on the basis that sand and soil will be extracted such that base of the pit will remain at least 1 m above the normal water table (ie extraction is not to occur below 62 mAHD). Additional groundwater monitoring and depth controls were proposed in *Menangle Quarry Extension Project DA 85/2865 MOD1, Response to DOI-Water comments of 21 February 2018* (EMM 20 March 2018).

Proposed Water management in the Stage 8 area is summarised in the *Menangle Quarry Extension Project Briefing Paper* (EMM 2019) as follows:

> A range of management measures are presented in the Menangle Quarry Extension Environmental Assessment (EA) (EMM 2017[a]). Water management measures are detailed in EA Section 6.2.2 and described in more detail in the Flooding, Geomorphology and Onsite Water Management report (EA

Appendix G). They have been designed in accordance with the appropriate guidelines and were informed by the erosion and sediment controls adopted successfully by the quarry to date.

Importantly, the extraction in the Stage 8 area would occur in stages along the river over 15 years, with cleared areas of approximately 1 ha at any one time. The sediment erosion and control plan (ESCP) would progressively advance with these stages and be self-contained for each stage.

Menangle Sand and Soil have committed to additional water management measures since the preparation of the EA, including:

- Any water in the pit will not be dewatered using a pump. Rather, it will flow to a sedimentation basin in the base of the pit or will be allowed to infiltrate to the water table under gravity (*Response to Submissions* (RTS), EMM (14 September 2017) [EMM 2017b] Section 5.2.3).
- If the water level in the pit rises to a level where operations need to cease, operations will only recommence when the water level has dropped sufficiently to be safe (ie no operations within standing water will be allowed) (RTS Section 5.2.3).
- A new staging plan that would further reduce the potential for the project to impact the Nepean River was provided in Appendix E of *DA 85/2865 MOD1, Response to DOI-Water comments of 21 February 2018* (EMM 20 March 2018) with each stage moving progressively upstream. This plan would:
  - ensure that there is uncleared vegetation upstream of the active extraction area that will slow water velocities during flooding when the water level is greater than 64 m AHD and has the potential to flow across the cleared area or the downstream stabilised area and rehabilitation area;
  - slow water velocities further as water enters the extraction area, which will be deeper (ie have a greater cross-sectional area) than the area immediately upstream;
  - reduce the scour potential in the active extraction area through this reduction in water velocity; and
  - allow suspended solids to deposit into the active extraction area during flooding;
  - ensure that the face of the active extraction area faces downstream, and not into the main current, reducing the potential of erosion at the face.
- Additional water monitoring was proposed (see below).

In addition to these measures, a 0.5-m deep swale is proposed to be formed upslope of the setback bank during creation of the final landform.

Amendments to the proposed setback are addressed elsewhere.

4 Aquifer Interference Policy

The DPE assessment report (DPE 2018) broadly refers to the DoI Water (now DPIE Water) identifying that the aquifer interference policy (AIP) is triggered during high rainfall and flood events when groundwater inundates the pits. Under this literal reading of the AIP, the pits will be an aquifer interference activity and therefore trigger assessment under this policy.

During the Section 34 Conference, Mr G. Russell informed me that DoI Water are no longer accepting of the concept traditionally adopted for sand operations on riverbanks of 'staying 1 metre above the water table' and managing and mitigating as required. Rather, DoI Water are interpreting the AIP as applying to any water in the operations as being an 'aquifer interference activity', as the alluvium is a 'water source' (even if unsaturated (dry) much of the time), and if water is intercepted by a work within a 'water source' as defined in a Water Sharing Plan, then it triggers assessment under this policy. DoI stated that they expected an assessment of the water 'intercepted' by the works (both groundwater and surface water) volumetrically as per the requirements of the AIP. We do not concede that we agree with this interpretation. However, in the interest of advancing the application, it is proposed to accept that the position that the Extension Project is an aquifer interference activity.

Accepting this interpretation, consideration of the AIP then requires the development of:

- a more detailed conceptual model that is locally specific (ie not generic) and based on local site data (ie from monitoring bores);
- development of a fit-for-purpose monitoring and modelling plan in accordance with the online guideline;
- an assessment of the volume of water intercepted (via calculations/ analytical model); and
- calculation of the 'water take' in the pit that is predicted to occur as a result of elevated groundwater levels during flooding; and
- purchasing sufficient water access licences (WALs) to account for the 'intercepted' groundwater.

Measures to address each of these are summarised below and would be detailed in a Groundwater Management Plan that would be prepared for the project and submitted to Department of Planning, Industry and Environment (DPIE).

Given that each of these steps is clearly feasible and that the objective of the monitoring and modelling is to quantify the volume of water licenses that would be required rather than to determine if the level of impact is acceptable, it is proposed that these measures would be taken following approval of the project should this occur.

5 Modelling and monitoring

The proposed modelling and monitoring approach is summarised in Table 1. This lists that activities that are proposed to address the AIP requirements listed above.

Table 1 Modelling and monitoring outline

Activity	Details	Rationale
Conceptual groundwater model and plan development		
Prepare a more detailed conceptual groundwater model	The detailed conceptual groundwater model would consider: • the groundwater dynamics within the two main hydrogeological units; • flow changes during quarry activities; and • groundwater table and piezometric pressures of underlying, potentially unconfined, groundwater systems.	To address Section 3.2.3 of the AIP and demonstrate the conceptual understanding of the connected water sources as per the of the AIP licensing framework. The detailed conceptual groundwater model would be used to refine the groundwater monitoring program described below.

Table 1 Modelling and monitoring outline

Activity	Details	Rationale
Develop groundwater modelling and monitoring plan	A groundwater modelling and monitoring plan would be developed with reference to the NSW Monitoring and Modelling Plan Guidelines (GMMP Guidelines) and in consultation with DPIE.	To address the staged approach with obtaining necessary data as per the GMMP Guidelines so that the project has the relevant information to allows an assessment within the AIP framework. The development of a project specific GMMP will provide a platform for consultation and agreement on groundwater monitoring locations, defining water sources connections and the conceptualisation of the system.
Groundwater monitoring		
Bore licencing	Apply for a *Water Act 1912* licence to drill and construct groundwater monitoring bores.	
Bore installation and logging	Install nested monitoring bores at four locations along the stage 8 area. The shallow bore at each site would be approximately 5–10 m deep, and the deeper bore would be approximately 15–25 m deep. Final depths will depend on the geology at each location. Prepare drill logs. Indicative locations are shown in Figure 1.	To address Section 3.2.3 of the of the AIP whereby information on groundwater levels, flow, hydraulic parameters can be estimated.
Slug tests	Undertake in-bore aquifer tests (slug tests).	To address Section 3.2.3 of the AIP, estimating the potential groundwater flow (permeability), potential drawdown, and potential groundwater inflow volumes. This is critical in establishing the hydraulic parameters to use in calculating the volume of water and the timing of groundwater flow into and out of the pits during high river stage events.
Install piezometers/loggers	Install piezometers/loggers in each bore.	To allow continuous groundwater level monitoring.
Recording	Record instantaneous groundwater levels across the site following construction of all bores on site, and develop a groundwater table map for the alluvium and the underlying Hawkesbury Sandstone groundwater system. This will provide data for confirming the initial conceptual model. Continuous (6-hourly intervals) water levels to be modelled in all bores, with quarterly downloads and manual dips. Data will be compiled and analysed following 12 months of recording.	The monitoring results will progressively provide data for the groundwater inflow calculations to be refined and the conceptualisation of connectivity between the water sources (ie the river, the alluvium and the underlying sandstone) to be further confirmed.

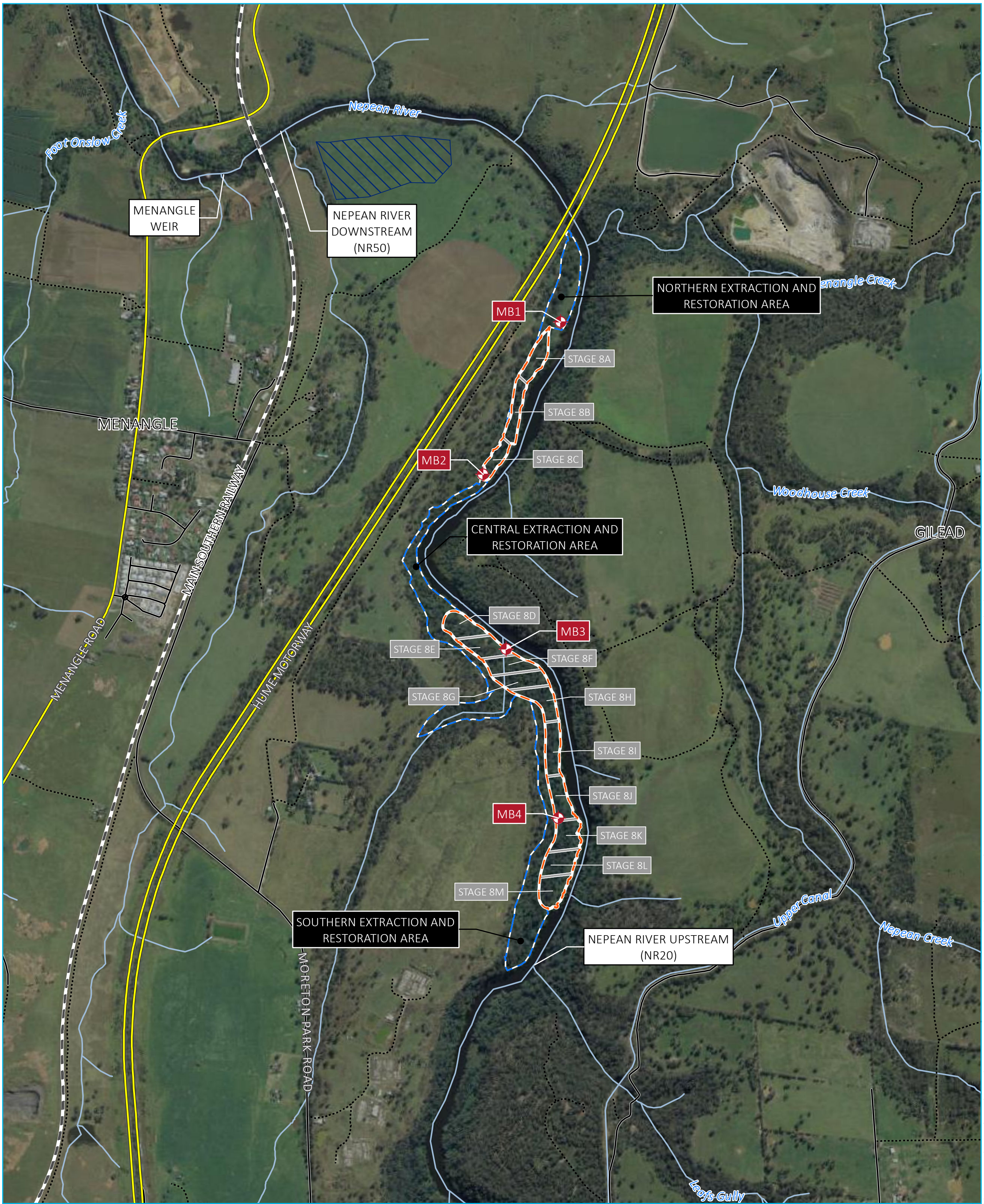
Table 1 Modelling and monitoring outline

Activity	Details	Rationale
Groundwater quality monitoring	Measure water quality field parameters in bores in the alluvium and in the sandstone (quarterly for 12 months): • temperature, pH and electrical conductivity (EC); and • sample and analyse water quality (laboratory analysis) in all bores at completion of drilling program. Measure water quality parameters in bores in the alluvium and in the sandstone during first sampling round: • major ions (inc. hardness); • nutrients; and • metals.	To provide baseline groundwater quality data.
Nepean River monitoring		
River level	River levels from the Bureau of Meteorology gauging station Nepean River at Menangle Weir (Station Number: 568171) would be used. Water level records every 15 minutes are available for this station.	To develop river flow assumptions (see below).
Water quality monitoring	Nepean River upstream and downstream of the Stage 8 area. Quarterly starting at the same time as the groundwater validation monitoring and continuing for at least 12 months after the start of operations in the Stage 8 area. • temperature, pH and EC; • total suspended solids (TSS); • oil and grease; • major ions (including hardness); • nutrients; and • metals.	To provide baseline Nepean River water quality.
Localised conceptual model and analytical calculations		
Develop localised geology and hydrogeology conceptual model	Analyse logs and data from drilling program and prepare a cross sections (conceptual models). Prepare water table contours (if sufficient data) and also consider flux in water table over time (based on monitoring during flood and dry events). Consider the water table for the various water sources (ie the water table in the sandstone, and the alluvium). Analyse and calculate aquifer parameters (using hydraulic conductivity testing results from slug tests). This will include consideration of connectivity between sandstone, and alluvium and alluvium and the river based on AHD levels of the respective bores and river stage heights.	Develop a more localised conceptual model of the geology and hydrogeology in the Stage 8 area (ie for the different sections of the River as the project extends upstream).
Develop river flow assumptions	A number of annual flooding scenarios will be development for use in the analytical groundwater model.	For use in the analytical groundwater model

Table 1 Modelling and monitoring outline

Activity	Details	Rationale
Develop analytical groundwater model	Develop analytical groundwater model to estimate inflow to pits (annual volumes over time) and also contribution from adjacent water sources annually – ie from the Hawkesbury Sandstone and the River.	
Pit groundwater inflow calculations	Calculate inflow of groundwater to pit annually in accordance with quarrying rates over time. Calculate and estimate contribution of water from adjacent water sources (Hawkesbury Sandstone and alluvial deposits).	To determine WAL volumetric requirements
Operational monitoring		
Extraction area bores	Measure and record water level in bores in the active extraction area daily during active operations.	To ensure that extraction does not occur within 1 m of the water table.
Monitoring bores	Continue groundwater level monitoring via loggers continuously with 6 monthly downloads. Undertake water quality monitoring annually in all bores (field parameters) during operations unless agreed with DPIE to cease.	
Sedimentation basins	Sediment basin within active excavation area. Quarterly starting at the same time as the groundwater validation monitoring and continuing for at least 12 months after the start of operations in the Stage 8 area. • Temperature, pH and EC; • TSS; • oil and grease; • major ions (inc. hardness); • nutrients; and • metals.	To determine if contaminated by operations.

* Subject to confirmation in the groundwater modelling and monitoring plan.



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Source: EMM (2019); DFSI (2017); GA (2011)

KEY

- Proposed nested piezometer
- Amended stage 8 - extraction area
- Amended stage 8 - restoration area
- Amended stage 8 - substage area
- Existing processing area (to be retained)
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line

Proposed monitoring locations

Menangle Quarry Extension
Figure 1

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6 Licensing

The groundwater inflow to the pit is expected to be low but annually highly variable dependent on flood levels in the Nepean River over the year.

Menangle Sand and Soil proposes to obtain WALs and licence shares for a volume equal to the predicted average annual groundwater inflow to the pit over the 15 year life of the quarry from the respective water sources. The likely respective water sources are the Nepean River, and the Sydney Basin Nepean Groundwater Source, which includes both the water within the alluvium and water within the underlying Hawkesbury Sandstone.

Menangle Sand and Soil already hold a licence to take water from the Nepean River and there is unassigned water within the Sydney Basin Nepean Groundwater Source (Zone 2), which is the relevant Zone for the project. Therefore, WAL shares can be obtained via controlled allocation or traded from existing WAL holders. There is a low demand for this water in the market and licences and a clear pathway exists to secure them.

7 Summary

The potential changes to the groundwater system from the extension project are considered very low risk from a volumetric and water quality perspective on beneficial users.

The initial conceptual model provides a good representation of the system and can be enhanced over time by establishment of a groundwater monitoring network and the additional detail that can will enhance the conceptual model. The collection of this data (ie drilling, monitoring calculation of final inflows), can occur in parallel with initial site operations, provided the required licences can be obtained prior to any water inflow to the pits. We therefore believe that the program proposed in this letter should commence following approval of the project.

Yours sincerely

Liz Webb

Director

Liz Webb is a Principal Hydrogeologist with over 20 years' experience in hydrogeology and water resource management in Australia and overseas.

Liz holds a Master of Engineering (Groundwater Management), University of Technology Sydney, 2000 and a Bachelor of Applied Science (Environmental Analysis), Charles Sturt University, 1994. She is a Member of the International Association of Hydrogeologists, Australian National Chapter, and a Member of the Geological Society of Australia.

Liz leads EMM's Water and Land Division working for a diverse range of clients including government, mining and oil and gas companies, water supply authorities and water regulators. Her experience encompasses technical assessment, project management, leading and directing technical research and projects.

She has provided technical and policy advice to government and Ministerial Offices and has a background in drafting and implementing NSW Government legislation. Liz has successfully delivered mining, groundwater supply, water planning/management, and groundwater assessment projects. She has managed major drilling projects for complex water supply jobs within the Sydney Basin and regional NSW.

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