The potential for significant impacts to groundwater availability to neighbouring properties, specifically what is the probability that the project will have an adverse impact on the availability of groundwater to neighbouring properties and what the "worst-case" scenario would be, taking into account climate change factors?

As outlined in the Department's Preliminary and Final Assessment Reports, the project is predicted to have a very low probability of significantly impacting groundwater availability from bores on neighbouring privately owned properties. There are a number of factors that support this conclusion.

Location of privately owned bores

KEPCO has acquired all agricultural properties in the Upper Bylong and the Lee Creek catchments, with remaining private landowners located predominantly in the adjoining Growee River catchment which flows into the Bylong River downstream of Bylong village (see Figures 1 and 2 below).

This is an important consideration, as the exploration test program and geological conceptual modelling shows that the targeted open cut and underground coal seams do not extend under the Growee River alluvium, apart from an area around the confluence of the Bylong and Growee rivers.

That is, as the coal seams to do not directly underlie and are therefore not directly hydraulically connected to the Growee River alluvium, any drawdown within the Growee River alluvium would occur through direct extraction from the mine borefield, combined with induced take from coal seam depressurisation and bore water supply for agricultural activities undertaken by KEPCO within the upper Bylong Valley/ Lee Creek valley.

The groundwater modelling drawdown results are consistent with this model conceptualisation with the worst case predicted drawdown largely confined to the upper Bylong Valley with little drawdown predicted within the Growee River valley, as shown in Figure 3 below, with drawdown exceeding 2m predicted to be exceptionally unlikely to occur within the Growee River alluvium (1%ile likelihood based on uncertainty analysis from 140 model runs), near the confluence of the Growee and Bylong rivers.

This is due to the potential for depressurisation of the coal seam which sub-crops under the alluvium – however, this is the prediction from only 1 model run out of 140 due to adopting highly permeable hydraulic properties in the uncertainty analysis, considered unlikely by AGE based on field measurements.

The prediction also includes borefield pumping for mine water supply and agricultural and induced take from depressurisation of mining in the coal seams. The majority of uncertainty modelling runs (from 1-10%ile very unlikely to occur to >99%ile virtually certain to occur) confine predicted drawdown impacts exceeding 2m to the Upper Bylong Valley.

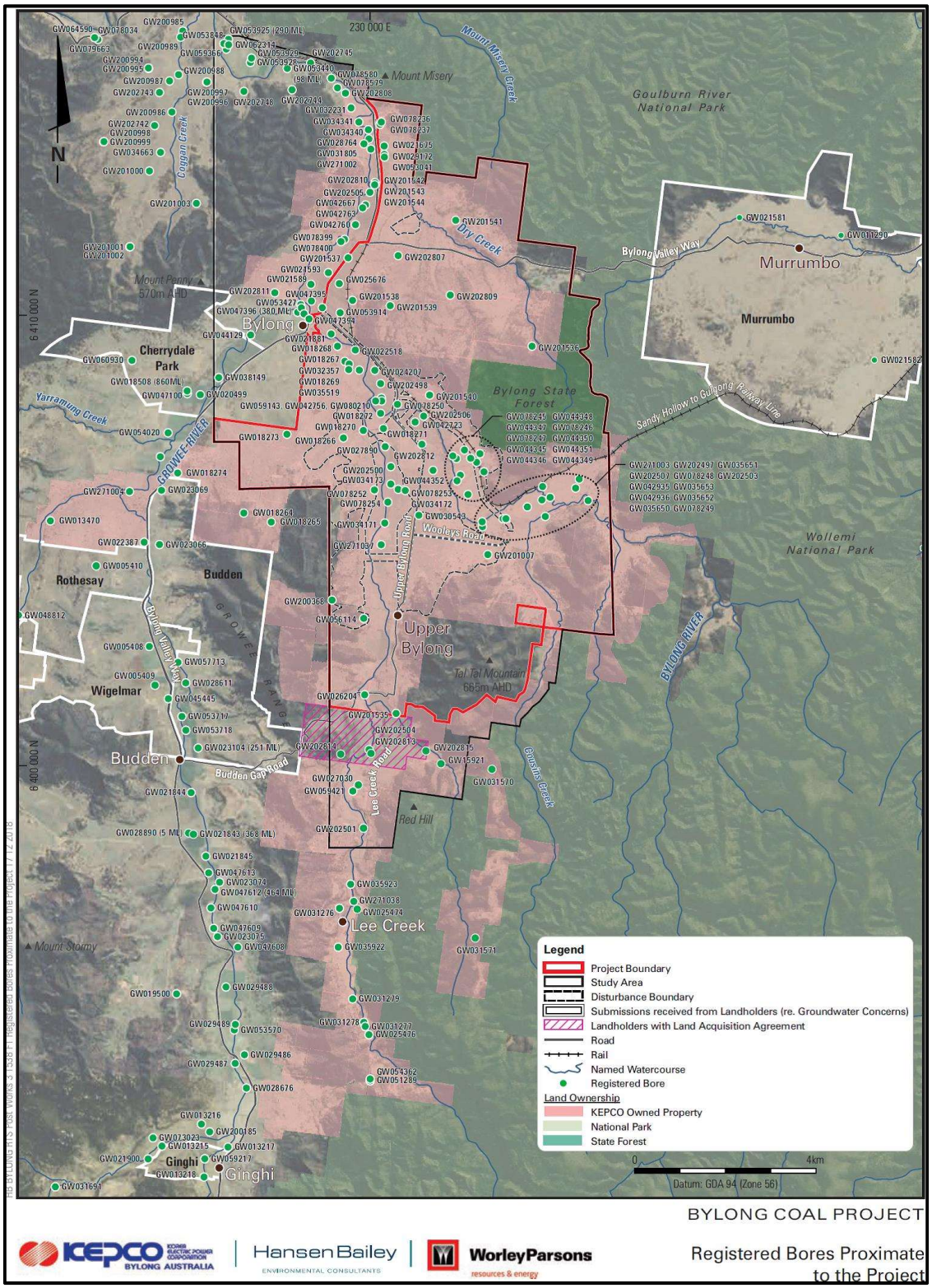

Figure 1: Registered Bores

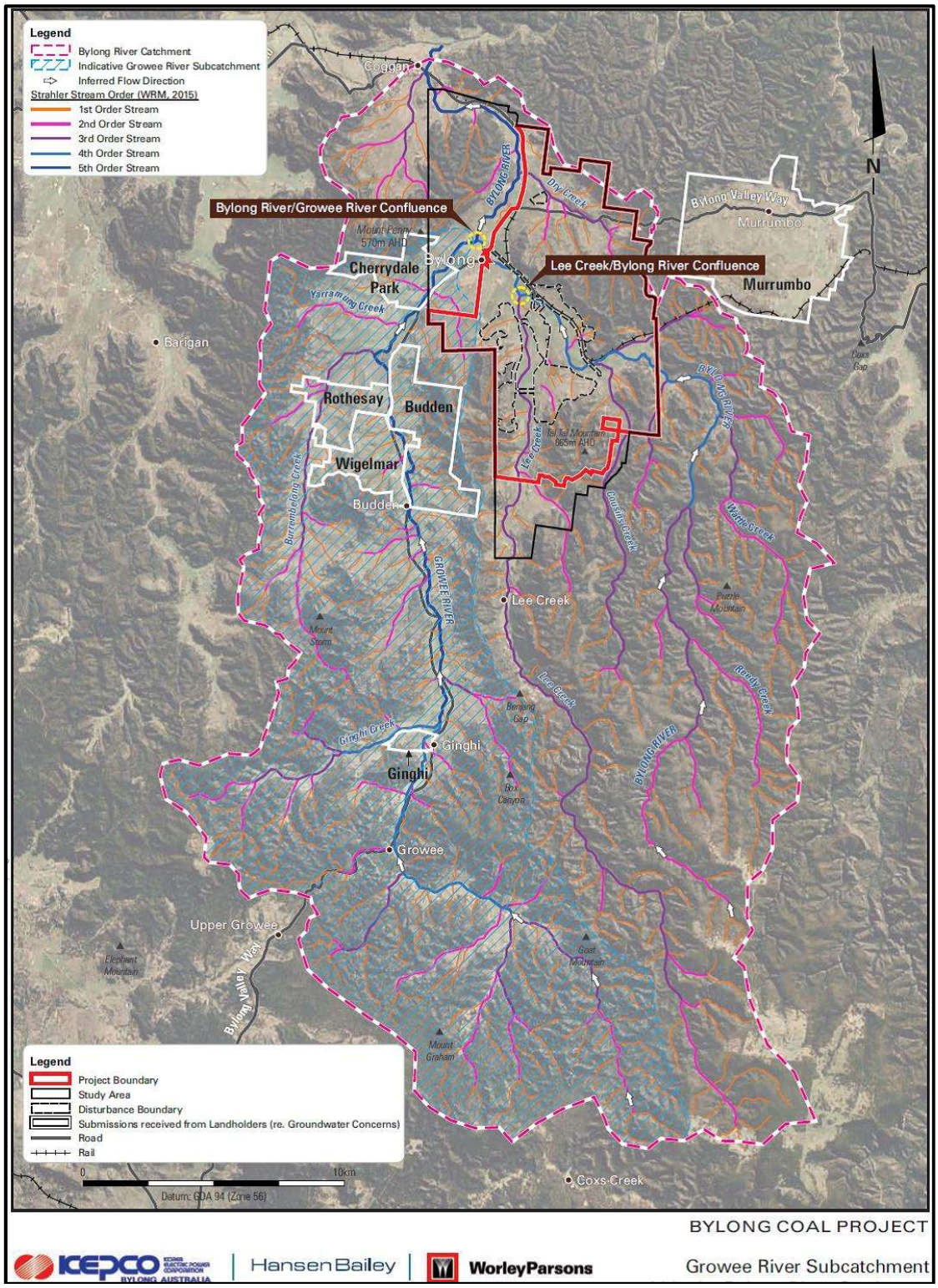

Figure 2: Growee River sub-catchment within Bylong River

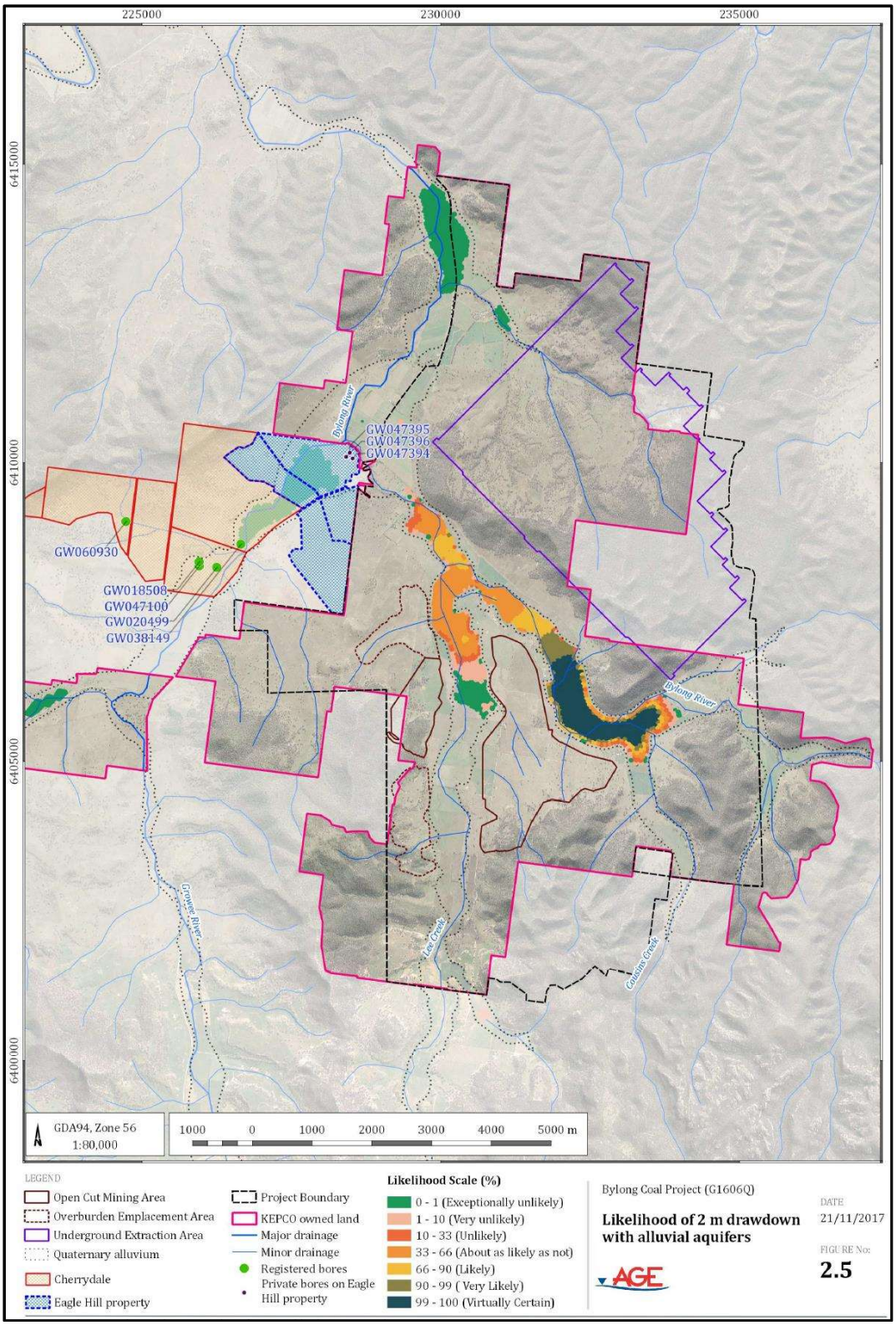

Figure 3: Likelihood of drawdown exceeding 2m in the alluvial aquifer

Bore-field take vs. Coal Seam dewatering

The predicted drawdown in the Bylong alluvium due to the project is mainly from the take of alluvial water from the proposed mine bore-field, with only a small component (up to 0.5 m based on uncertainty analysis range 5%ile to 95%ile results) of drawdown predicted to be from induced take from the depressurisation of the targeted coal seams (see Figure 4).

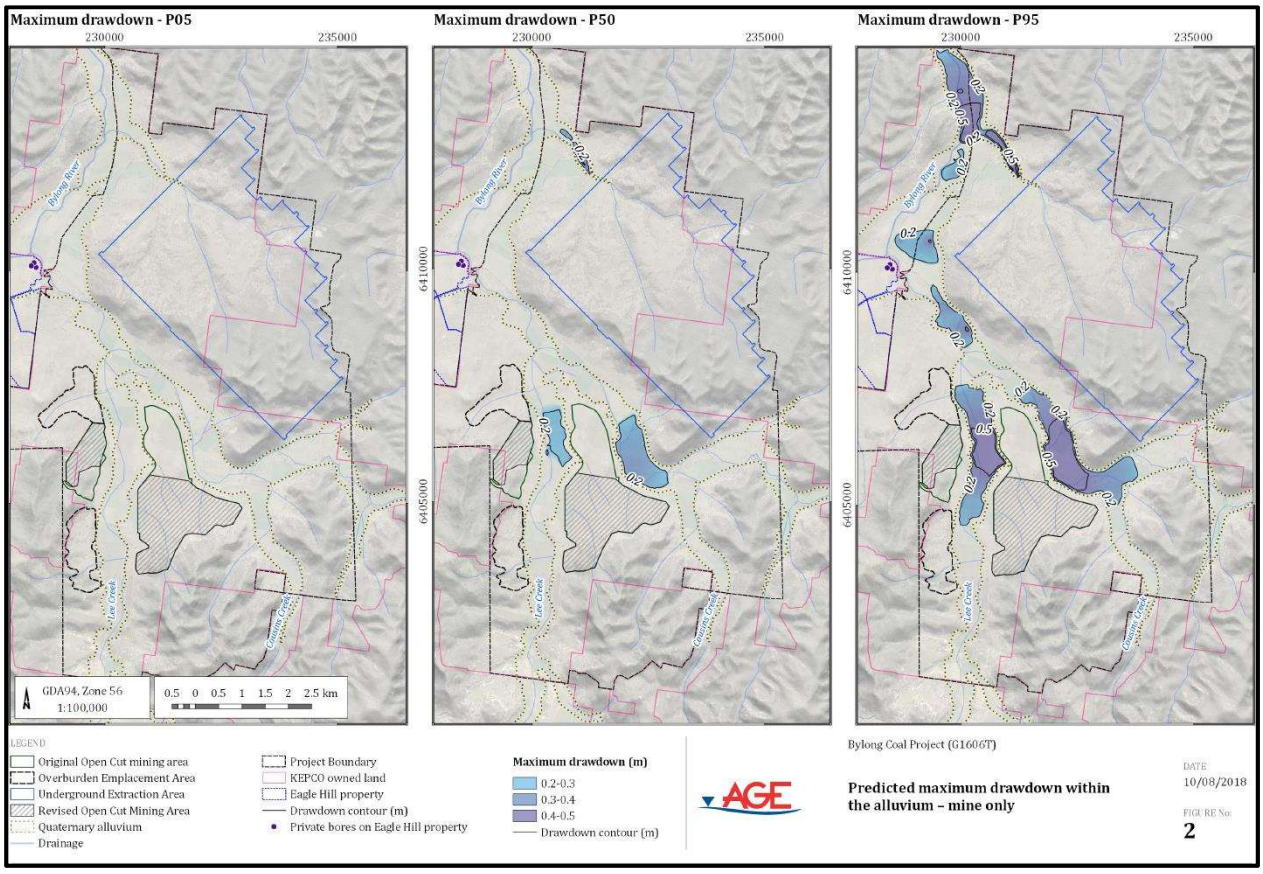

Figure 4: Drawdown in alluvial aquifer due to induced take from mining the Permian coal seam

This is an important consideration, as the volume of water extracted from the proposed bore-field would be directly regulated under the relevant statutory provisions under the *Hunter Unregulated and Alluvial Water Sharing Plan* (Hunter WSP) and the *Water Management Act* (WM Act) to ensure that the Bylong alluvial water source is managed sustainably in the long term – given annual climatic variability.

For example, this could be done through reduced water allocations, cease to pump provisions (when available) and/or orders under the WM Act to restrict the take of water that account for equitable allocation for all users of the relevant water source.

Extensive groundwater modelling and hydrogeological investigations

The groundwater modelling has been progressively developed over a 7-year period and has been informed by extensive field data collection, including alluvial pump tests of proposed borefield completed as requested by Department of Industry – Water. The modelling includes uncertainty and sensitivity analysis of key hydraulic parameters and has been extensively peer reviewed, including peer review by Dr Noel Merrick (on behalf of KEPCO) and Dr Frans Kalf, on behalf of the Department, who recommended changes to the model subsequently adopted for the project.

The extent of model development and data collection for a greenfield site prior to determination and active mining commencing is exhaustive, consistent with best practice and undertaken in

accordance with groundwater modelling guidelines, and has been progressively developed following expert and NSW government agency input.

The Department has recommended ongoing model validation and monitoring to be undertaken during mining operations to confirm the predictions.

The Department notes that the Anderson/BVPA submission to the Commission raised some technical concerns with the groundwater modelling, particularly related to assumptions about the hydraulic parameter of specific storage (Ss), a hydraulic parameter related to confined aquifers, based on recent research papers. KEPCO's groundwater expert has provided a response to these concerns (see Attachment B) with the key points being:

- the alluvial aquifer and basalt cap (represented by layers 1 and 2 in the model) along with the weathered zone (layer 3) are unconfined aquifers and therefore the Ss constraints referenced in submissions to the Commission would not apply;
- the more relevant specific yield (Sy) parameter for the alluvial unconfined layers in the groundwater model was updated based on the pump tests requested by DoI Water, to improve the performance of the model and use additional field data to inform the model hydraulic property assumptions;
- the pump testing undertaken also included bores to monitor drawdown response from borefield pumping, which was used to inform the Sy values used in the model; and
- AGE undertook additional sensitivity analysis of impacts on alluvial drawdown using the Ss range suggested, with little change in predicted impacts on drawdown on the alluvial aquifer compared to the base case model run. This is largely due to the Ss changes not affecting the unconfined aquifers in the model and the increased depressurisation in the Permian confined layers does not lead to any significant increase in induced impacts on the overlying unconfined alluvial aquifer (see Figure 5 below).

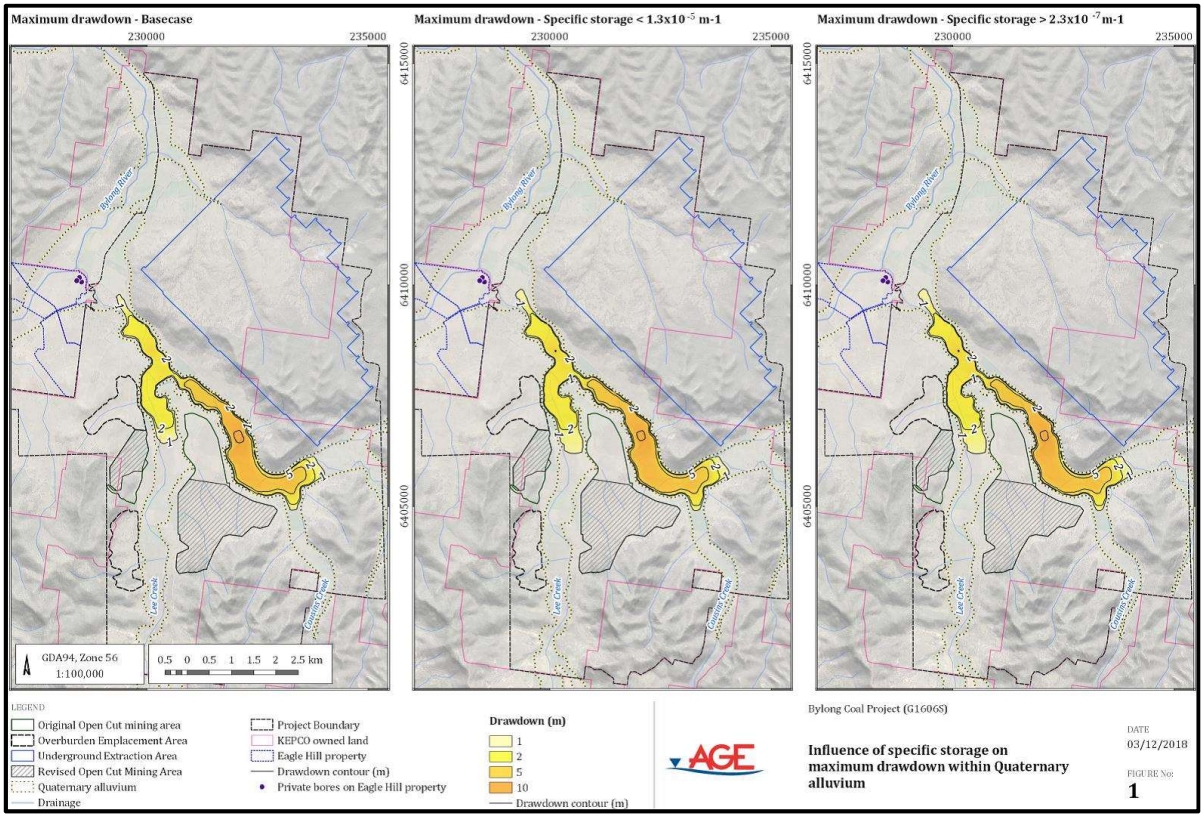

Figure 5: Variation to Specific Storage (Ss) compared to basecase model run

Consideration of drought conditions
The groundwater modelling is conservative in that the modelling period years includes rainfall and recharge to the aquifer incorporating part of the Millenium Drought period in the basecase model and the uncertainty analysis modelling runs. The period 2000-2013 was used and repeated over the project life, effectively incorporating 2 significant drought periods over the project life model output.

As indicated above, the uncertainty analysis model runs include these low rainfall periods in conjunction with variation to the hydraulic parameters and predict that impacts on private bores is extremely unlikely. The uncertainty analysis also included variation to recharge, including reduction by up to x14 compared to the base case, exacerbating the impacts compared to the base case model run.

Open Cut vs Underground Mining stages
Pumping from the bore field to support mining activities is at its greatest during the open cut period of mining, which would only occur for 7 of the 23 year mine operational life, for the Revised Mine Plan. Once underground mining commences, there would be a reduced reliance on the take of water from the alluvial aquifer, with water from the Permian aquifer providing the vast majority of the water supply for washing coal and dust suppression requirements.

As the water extraction from the borefield has greater impact on drawdown than the induced take from depressurisation of the coal seam, the drawdown impacts would substantially reduce after years 8-9 of the project, i.e. following the cessation of open cut mining. .

Impacts on mine owned water supply works
The groundwater modelling predicts that the minimal impact considerations of the *NSW Aquifer Interference Policy* (AIP) would be exceeded at water supply works owned by KEPCO. That is, there would be more than a 2 m drawdown on these water supply bores due to project activities.

KEPCO has undertaken an analysis on the impacts on its bores[1] and identified 10 registered bores on its landholdings used for irrigation, with only one of these bores holding a water allocation. There are also 9 bores used for stock and domestic purposes. The impacts on these bores would not be permanent as the drawdown impacts would be mainly due to borefield water extraction during drier periods, with subsequent rainfall recharge replenishing the aquifer.

The water supply borefield extraction would also be required to meet the requirements of the Water Sharing Plan to ensure long term sustainable management of the water source. That is, the project would not impact the long-term viability of these (KEPCO-owned) water dependent assets (water supply bores).

KEPCO has advised in its response that it would manage the impacts on its own bores to manage ongoing agricultural activities on its landholdings. This is consistent with applying make good provisions which, under the AIP, supports a conclusion that impacts on these KEPCO owned water supply works does not require further assessment.

Conclusion
Consistent with the conclusions in the Department's Final Assessment Report, the Department considers that the predicted impacts on neighbouring private bores would comply with the minimal impact requirements of the AIP and therefore the impacts are acceptable.

[1] Refer to Letter to Independent Planning Commission dated 20 December 2018 titled "Bylong Coal Project – Response to Submissions in Relation to Water Resources.

Further, based on the uncertainty analysis which incorporates climatic variation (drought periods) and variation to hydraulic parameters, it is predicted that it would be extremely unlikely that there would be a significant adverse impact from the project on water supply bores on private neighbouring properties, such that make good provisions would be required.

Nevertheless, the Department's recommended conditions and KEPCO's proposed management response include draft water compensatory agreements already offered by KEPCO, monitoring, performance and response measures in the unlikely event that there is an adverse impact that would affect a private water supply, as further outlined below.

In the event of significant adverse groundwater availability impacts to neighbouring properties, do the current and proposed monitoring regimes have adequate sensitivity and demonstrate suitable design to provide pre-emptive notice or warning that groundwater supplies may be impacted? Are the compensatory mechanisms proposed in the draft conditions of consent and the applicant's proposed compensatory scheme suitable to address and significant adverse impacts within a realistic timeframe to prevent financial losses to neighbouring properties as a result of groundwater impacts, including the duration of compensatory water supply?

Firstly, as outline above and concluded by KEPCO's groundwater impact assessment, it is extremely unlikely that compensatory water would be required due to the project.

As outlined in the Department's Final Assessment Report and documented in the draft Water Management Plan, there is already in place a substantive groundwater monitoring program in place including 97 open standpipes and 14 vibrating wire piezometers (VWPs), with 56 of these in the alluvium. KEPCO also proposes to install an additional 17 bores in the alluvium.

The existing and proposed monitoring program would target:

- drawdown due to pumping from KEPCO's water supply bores to monitor the extent of drawdown around each individual water supply works on adjacent bores in the alluvial aquifer; and
- the extent of depressurisation of the Permian coal seam, incorporating nested bores to show the impact of depressurisation on overlying formations, including overlying alluvium in the Upper Bylong valley and around the confluence of the Bylong and Growee Rivers; and
- where agreed by landowners, targeted monitoring of bores on private properties, noting that KEPCO has advised that it has agreement to monitor bores on three private landholdings in the upper Growee river catchment.

In addition, DoI Water has installed monitoring bores in the Bylong River catchment that would inform management decisions within this water source to ensure long term sustainable water take.

While KEPCO has prepared a draft Water Management Plan incorporating current and proposed monitoring, the Department has recommended conditions that the monitoring program be finalised in consultation with Department of Industry – Water, Environment Protection Authority (EPA) and the proposed Community Consultative Committee (CCC).

The Department considers that the proposed targeted monitoring of the alluvium, nested bores in the Permian aquifers and overlying aquifers, basalt cap and monitoring of private bores (subject to landowner agreement) would provide a comprehensive network to validate predicted impacts from the project on private bores. The final monitoring program would be subject to further consultation as outlined above.

The Department considers that its recommended conditions are suitable to afford timely provision of water supply to private landowners, in the unlikely event that the project impacts on private water supply bores. The recommended condition requires that compensatory water supply be provided as soon as practicable after a loss is identified by a landowner, and that the burden of proof that the loss of water supply is not due to the project rests with the Applicant (KEPCO). The recommended conditions also include a dispute resolution process requiring the Secretary to resolve any dispute.

This highlights the importance of the monitoring program as the results and the interpretation of the monitoring result would be the key evidence for KEPCO to support a conclusion that the loss of water supply is not due to the project. KEPCO is required to prepare and implement a final Water Management Plan, incorporating a groundwater and surface water monitoring program in consultation with DoI Water, EPA and the Community Consultative Committee (CCC) for the project.

The Department notes that the recommended compensatory water condition would not apply if KEPCO and a landowner has agreed to a compensatory water agreement. In this case, based on the (updated) draft compensatory water agreement, KEPCO has advised that it would provide water supply for stock and domestic purposes within 24-hours of receiving landowner notification.

The Department considers that the recommended conditions for compensatory water supply are consistent with NSW government policy (with provision of make good arrangements under the AIP) and is a standard precautionary approach for managing potential impacts on private water supply. This affords additional protection to landowners, noting that the predicted impacts meet the AIP minimum impact considerations.

The geographical relationship and extent of the predicted drawdown, specifically in relation to the potential drawdown impacts on the nearby Greater Blue Mountains World Heritage area, and any cumulative impacts or interactions between the Project and existing mining projects in the regions, including the Wilpinjong Coal Mine and the Moolarben Coal Mine?

There are no groundwater interactions between the western coal precinct mines (Ulan, Wilpinjong and Moolarben Coal mines) which are located more than 20km from the Bylong Coal Project. Based on the detailed modelling for these projects, there is no overlapped zone of influence between these mines and the Bylong Coal Project and there are no cumulative groundwater drawdown impacts.

The Bylong Coal Project adjoins the Wollemi National Park, which is a part of the Greater Blue Mountains World Heritage Area (GBMWHA). As outlined in the Final Assessment Report, concerns were raised by the community about potential impacts on the GBMHA following the release by the Commonwealth of the Northern Sydney Basin – Hunter Subregional Bioregional Assessment.

The bioregional assessment includes predictions of drawdown from the Bylong Coal Project which extended into the Wollemi National Park, predicting that some 137 km^2 area of drawdown would be within the GBMWHA.

As outlined in the Department's Final Assessment Report and Appendix G of the Revised Mine Plan Supplementary Report provided by KEPCO, the modelling undertaken for the Bioregional Assessment is based on coarser regional modelling (500m minimum size grid cell). The Bioregional Assessment makes it clear that further detailed local scale modelling is required to

inform detailed assessment for planning purposes. This detailed local scale modelling was undertaken for the Bylong Coal Project as described above.

KEPCO has provided further analysis of potential groundwater impacts on the GBMWHA[2] noting that:

- while depressurisation of the Permian coal seam aquifer would extend underneath Wollemi National Park, the coal seam is at a depth of 400m below the surface with no induced impacts on surface hydrology within the national park are predicted; and
- predicted drawdown (including from all uncertainty analysis model runs) in the Bylong River alluvium does not extend into Wollemi National Park.

The Department has recommended conditions that include water management performance measures that there should be negligible environmental consequences to the alluvial aquifer or the Bylong River including within the Wollemi National Park, beyond those predicted in the EIS. The conditions also require a comprehensive monitoring program to validate these predictions.

Clarification on modelling considerations and outcomes for the Moolarben Coal Project as raised through public submissions and the public meeting, including any identified factors which may have contributed to the identified disparity between the modelling level of groundwater take and the realised level of groundwater take? Are there any implications for the assessment of groundwater impacts for the Project?

The Moolarben Coal Project is located more than 20km from the Bylong Coal Project and there are no cumulative groundwater impacts associated with the Bylong and Moolarben Coal Projects.

As outlined in the Department's Final Assessment Report, a comprehensive groundwater impact assessment has been undertaken for the Bylong Coal Project. As there are no cumulative groundwater impacts, the groundwater modelling assessment of the Moolbarben Coal Project is not a material consideration for the determination of the Bylong Coal Project.

The Department's assessment report on the recent Moolarben Coal Mine modification, considered submissions raised on differences in groundwater modelling predictions, noting that:

- the Moolarben groundwater model has been revised and recalibrated using current and historic groundwater and drawdown observations;
- the recent modelling considered previous optimisation modifications (Stage 1 Mod 12 and Stage 2 Mod 2) which included changes to the sequence of approved underground mining and dewatering and increased underground mining rate; and
- inclusion of recharge from the Ulan East Pit located at the Ulan Coal Mine.

The Department considers that there are no implications for the assessment of the groundwater impacts for the project based on the Moolarben Coal Project assessment.

[2] Refer Letter to the IPC dated 10 December 2018 Response to Submissions on the Greater Blue Mountains World Heritage Area and Attachment A of this letter.

Clarification on the potential safety risks of water storage in the mine underground goaf, and the relationship and importance of this water storage option on the overall function of the Project's site water balance.

As outlined in the Final Assessment Report, KEPCO undertook additional water balance runs including sensitivity analysis to demonstrate that it could manage excess water without discharge to surface waters under a range of conditions. Figure 6 below shows the likely scenarios for site water inventory against available water storage – incorporating very dry (99%ile) to very wet (1%ile) rainfall conditions for the Revised Mine Plan.

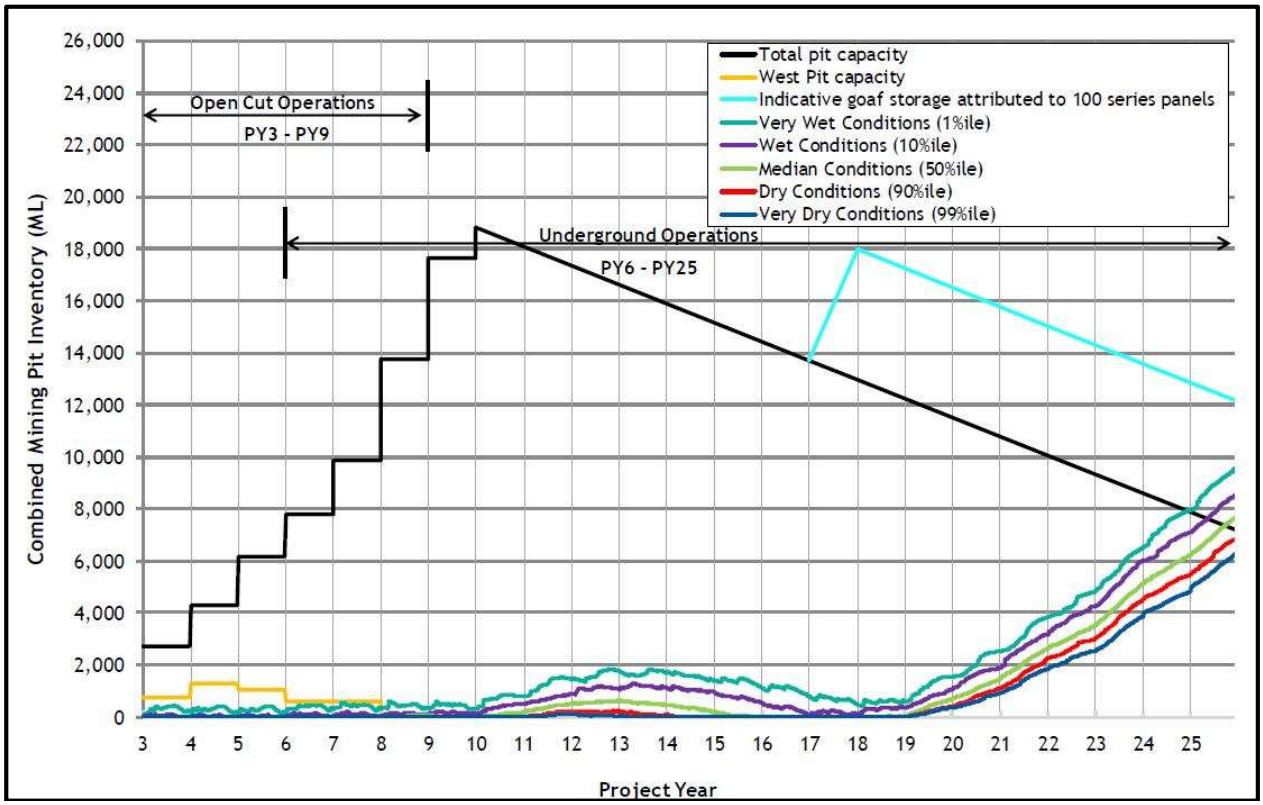

Figure 6: Water Storage Inventory over the project life – Revised Mine Plan

The modelling shows that there would be sufficient storage in the open cut void for most of the project life. Under very wet conditions the goaf storage would be required by year 25 of the project life.

The sensitivity analysis showed that, under worst case model scenarios, this would bring forward the use of the goaf storage to around year 23, with sufficient goaf storage capacity to manage excess water. Only in one (very unlikely) scenario modelled (high groundwater inflow combined with very wet 1%ile rainfall sequence over the life of the mine) would the series 101 goaf storage be insufficient.

Based on the water balance modelling, the Department considers that mine water management can be appropriately managed on site. The Department notes that:

- the recommended conditions do not permit discharge of excess mine water to receiving waters; and

- the predicted excess water mainly occurs from year 18 when mining in the 200 series long wall panels commences, this would allow for ongoing field verification of the water balance to determine whether the goaf storage area would be required.

That is, management of excess water within the goaf area is unlikely to be an issue until towards the end of the mine life, which would allow ongoing validation and calibration of the water balance modelling to confirm whether goaf storage would be necessary, or the extent of goaf storage required.

The use of the goaf area for water management is commonly undertaken in underground mining operations. The design and installation of bulkheads in underground mining operations to manage water inflow risks to active workings would be managed and regulated by the Resources Regulator under the requirements of the *Mining Act 1992* mine safety legislation through the *NSW Work Health and Safety (Mines and Petroleum Sites) Act 2013.*