TO THE LAND COURT OF QUEENSLAND

Further Supplementary Individual Expert Report
Groundwater Modelling

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REGISTRY: Brisbane

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Applicant:	**NEW ACLAND COAL PTY LTD ACN 081 022 380**
	AND
Respondents:	**FRANK AND LYNN ASHMAN & ORS**
	AND
Statutory Party:	**CHIEF EXECUTIVE, DEPARTMENT OF ENVIRONMENT AND HERITAGE PROTECTION**

1. Introduction

[1] In reference to the letter of engagement dated 8 February 2017 (see **Attachment A**), from the Environmental Defenders Office (**EDO**) on behalf of Oakey Coal Action Alliance Inc. (**OCAA**), I have undertaken a review of new materials pertaining to the New Acland Coal Stage 3 expansion project (**mine**) hydrogeology investigations and groundwater modelling, as listed in Attachment A (**Additional Documents**). The following materials provided by the EDO served as the principal materials on which my opinions that follow were reached:

1. IESC 2016, Advice to decision maker on coal mining project. IESC 2016-081: New Acland Coal Mine Stage 3 (EPBC 2007/3423) – Expansion (**IESC 2016 Advice**).
2. SLR, 2016a. NAC03 Fault Hydrogeological Investigation Program, October 2016 Status Report. Report for New Hope Group 24 October 2016 (**SLR 2016a**).
3. SLR, 2016d. New Acland Stage 3 Project Groundwater Model Update, Phase 1 Completion Report (Numerical Model Scoping Report). Report for New Hope Group: 24 October 2016 (**SLR, 2016d**).
4. SLR, 2017. New Acland Stage 3 Project Fault Hydrogeological Investigation Program, Drilling & Testing Report. Report for New Hope Group: 9th January 2017 (**SLR 2017**).
5. Further Statement of Evidence to the Land Court by Brian Barnett dated 20 February 2017 (**Barnett Report**).

[2] My evidence is based on a review of the references listed above, focussing mainly on aspects related to groundwater modelling elements, and is additional to evidence given previously in:

a) the Joint Expert Report, dated 16 February 2016;[1]

b) my Individual Expert Witness Report, dated 24 February 2016 (**IER**);[2]

c) my Supplementary Individual Expert Witness Report, dated 5 May 2016 (**SIER**);[3]

d) the Supplementary Joint Expert Report, dated 11 May 2016;[4]

e) the Second Supplementary Statement of Evidence prepared with Dr Currell, dated 2 June 2016.[5]

[3] I have read Dr Matthew Currell's Further Supplementary Independent Expert Report (Groundwater conceptualisation and quality), dated 9 March 2017 (**Currell Report**). My views are consistent with those expressed in the Currell Report. To avoid duplicating the assessment contained therein, my report is intended to cover extensional concepts

[1] Exhibit 405, [NAC.0033].
[2] Exhibit 436, [OCA.0022].
[3] Exhibit 833, [OCA.0071].
[4] Exhibit 825, [OCA.0070].
[5] Exhibit 1116, [OCA.0116].

relating primarily to groundwater modelling, notwithstanding the inherent links between hydrogeological conceptualisation and groundwater modelling.

2. My Qualifications

[4] My qualifications and experience are outlined in paragraphs 4-5 and Attachment A to my IER.

3. Summary of My Conclusions

[5] I support the views presented in the Currell Report. Additional conclusions arising from my review of the Additional Documents include:

a) The current knowledge of mining impacts is based on the AEIS model, plus an additional modelling exercise completed by SLR (2016a) that uses a modified form of the AEIS model. While NAC have expressed plans to address a selection of the issues raised previously regarding the AEIS model, the vast majority of previous issues raised in relation to the AEIS model persist. Therefore, I conclude that the models' predictions are highly uncertain, in contradiction to the AEIS model documentation,[6] and are not able to reliably predict future mine impacts.

b) The proposed methodology for developing a new model of the project lacks sufficient detail to demonstrate that critical short-comings of the AEIS model (i.e., that led me to conclude that its predictions were highly uncertain in my IER) will be overcome. Some of the important misconceptions that were evident in the earlier AEIS model report are still found in the latest reports. New reports offer little if any acknowledgement of the majority of misconceptions that were identified through the court proceedings. Significant short-comings in the conceptual model of the study area seem likely to remain despite recent fieldwork that provides useful new information. Required improvements to the understanding of mine pit lakes, regional groundwater conditions, surface-subsurface interaction, the representation of faults, and valid approaches to calibration and uncertainty analysis are lacking, both in terms of substantial new knowledge and the proposed strategies for future conceptualisation and computer model improvements. On this basis, and given that the same modellers are engaged in the new modelling effort, I hold sincere reservations as to whether the new model will provide adequate levels of reliability.

c) The conclusion by the IESC that the issues raised by them have been dealt with or that there are strategies for dealing with them seems to dismiss important concerns raised in their previous evaluations, and is surprising given the lack of detailed methodologies and limited forward progress on improving the conceptual and numerical models in the intervening period.

[6] Exhibit 111, [EHP.0111] soft page 165.

4. My Opinion

[6] Regarding additional groundwater modelling by NAC:

a) The only new modelling reported by NAC is the revised sensitivity analysis of the effect of faults, contained in SLR (2016a). In the March 2016 IESC Response Report,[7] Durick undertook an earlier sensitivity analysis of the effects of faults by removing faults from the AEIS model and comparing predictions of mining impacts from *with-faults* and *without-faults* versions of the model. The sensitivity analysis of SLR (2016a) differs to Durick's approach because it involved re-calibration of the *without-faults* version of the model. Barnett briefly describes[8] the modelling methodology that is otherwise missing in SLR (2016a).

b) Barnett (2017) reports[9] that Durick's (2016) sensitivity analysis is superior to that of SLR (2016a), because calibrating the *without-faults* model changes model parameters such that the *with-faults* and *without-faults* models have different parameters – i.e. more than one parameter type changed when the faults were removed. I disagree with Barnett's (2017) assertion in this regard. While it is true that re-calibration during sensitivity analysis complicates the identification of "sensitivity" (i.e. the difference in model outputs arising from a parameter change), the two approaches to sensitivity analysis - without calibration (Durick, 2016) and with calibration (SLR, 2016a) - are complementary and each provides useful insights in its own right, as explained in the following points.

c) Unfortunately, there is not enough detail provided by SLR (2016a) or from Barnett's subsequent explanation to know the degree to which Durick's sensitivity analysis and the new sensitivity analysis can be validly compared. Whether or not the SLR (2016a) calibration and the AEIS calibration involve the same number of calibrated models is unknown. How many of the 18 'calibrated' models from the AEIS study remain calibrated even without faults is not stated. These are critical aspects to know before a thorough evaluation of SLR's (2016a) modelling is possible. Unfortunately, these sorts of reporting short-comings are consistent with earlier weaknesses in the reporting of NAC's modelling efforts. Despite an under-developed appreciation of the new sensitivity analysis results, it nonetheless appears that the additional calibration step in SLR's (2016a) modelling produced modified predictions of drawdown relative to Durick's analysis.

d) Notwithstanding the limited reporting on SLR (2016a) modelling, it provides some insight into the effect of conceptual errors (e.g. the implementation of unfounded geological faults) on model predictions when the calibration

[7] Exhibit 721 [OCA.0037].
[8] Barnett Report, paragraph 4.17.
[9] Barnett Report, paragraph 4.16.

process is taken into account. That is, the change in predicted drawdown from simply removing faults from the model (Durick's approach in the 2016 IESC Response Report) is modified when a calibration step is introduced. This is due to parameter surrogacy – i.e. where some parameters adopt values that account for errors, which are often unknown, in the model. Or, in other words, by taking faults out of the model, some of the parameters changed so that calibration was still achieved. The increased uncertainty in model predictions that arises from changing a conceptual element of the model (e.g. faults) is not clear from the sensitivity analysis undertaken by Durick (2016), but is more likely to be revealed from the type of sensitivity analysis undertaken by SLR (2016a).

e) Additional explanation of the modelling results of SLR (2016a), beyond the discussion provided by Barnett (2017), is warranted, as given below:

   i) Durick's (2016) sensitivity analysis considered the difference between *calibrated* and *uncalibrated* models. However, in general terms, predictions using *uncalibrated* models are less reliable than predictions from *calibrated* models. This is a limiting factor in traditional sensitivity analyses where re-calibration does not occur. For example, one cannot assert that two different models – one with faults and one without – provide the range of mining impacts that is possible if faults are considered or not. The reasoning is that if fault representation changes in a model, and the models are recalibrated (as they must be to produce predictive models), then the (stochastic) process of calibration chooses different models with which to make predictions. The degree to which this occurred in the SLR (2016a) analysis is unclear. In any case, the representation or not of particular faults, or the creation of faults that have little geological basis, may have a more profound effect on the prediction of mining impacts relative to Durick's (2016) sensitivity analysis, due to the calibration part of the methodology. Given that calibrated models are more reliable models, there is clear motivation to undertake the analysis that SLR (2016a) has completed.

   ii) In taking faults out of the AEIS model, and recalibrating the models, the resulting predictions of drawdown obtained by SLR (2016a) are different to those from the sensitivity analysis of Durick (2016). This reveals an important message about the uncertainty in NAC's model results presented to the court to date: *Calibration does not necessarily produce the right answer if the conceptual model has significant errors in it.* This contradicts Barnett's earlier assertions that faults can be added to a model without a firm geological basis (i.e. direct geological evidence) because it will "help achieve model calibration"[10] (i.e., getting the model to match the water level measurements but not

[10] Exhibit 826, [NAC.0083], page 2 at paragraph 5.1(b); p28.

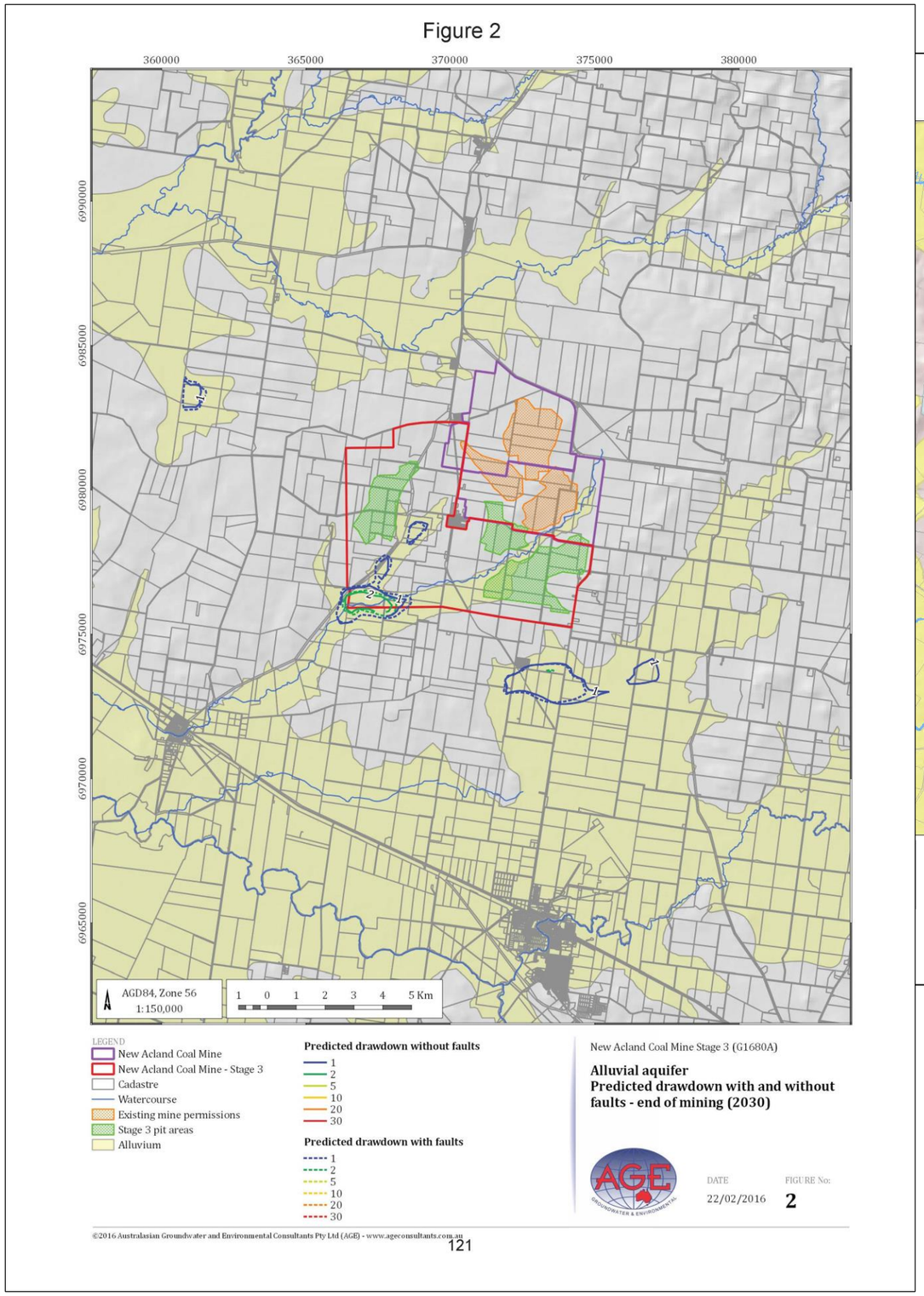
necessarily the location of mapped faults). Rather, if key aspects of the conceptualisation are unfounded, or simply wrong, then the predictions by the model are more likely to be wrong, despite achieving a 'reasonable' standard of model calibration. The results of SLR (2016a) show this effect to some degree.

iii) In the SLR (2016a) sensitivity analysis, both greater and lesser mining impacts were obtained relative to Durick's (2016) results. This is evident by comparing SLR (2016a) to corresponding maps by Irvine and Durick (2016).[11] Figures A9, A10, A11, A12 (Alluvium, Basalt, Upper Walloon Coal Measures and Marburg Sandstone, respectively) of SLR (2016a) can be compared to Irvine and Durick's (2016) Figures 2, 3, 4 and 5, respectively.[12] See below (reproduced as Figures 1 to 4) for this comparison.

iv) As an example, in the case of the alluvium (Figure 1), drawdown within the project area from Durick's analysis is absent in SLR's (2016a) results. (However, it is noteworthy that the alluvium drawdown maps reportedly obtained from the AEIS model are not consistent across the reports by Jacobs (2014), Irvine and Durick (2016), and SLR (2016a), when they ought to be the same. This discrepancy seems prima facie to be an error, and further justification is warranted.) SLR's (2016a) approach leads to a region of drawdown in the Basalt that extends beyond the outer margin of surveyed properties, whereas Durick's approach does not show this. The sensitivity analyses differ most in their predictions of drawdown in the Upper Walloon Coal Measures and the Marburg Sandstone where, in places, the region of properties that may be impacted has not been included in the survey area.

v) An important outcome of the SLR (2016a) sensitivity analysis is the comparison between 50th and 84th percentile drawdown extents, which are not reported by Durick. For example, SLR (2016a) show considerably larger 84th percentile drawdown extents in the alluvium and the basalt aquifers (Figures 1 and 2 below) than have been reported previously. For example, the 84th percentile drawdown in the alluvium reaches the town of Jondaryan. Unfortunately, both the number of calibrated models achieved from this new calibration effort, and the degree of calibration misfit are not reported, and therefore, it is unclear whether the 84th percentile is more or less statistically significant compared to the AEIS model.

[11] Exhibit 418, [NAC.0046].
[12] Exhibit 418, [NAC.0046], pages 121-124.



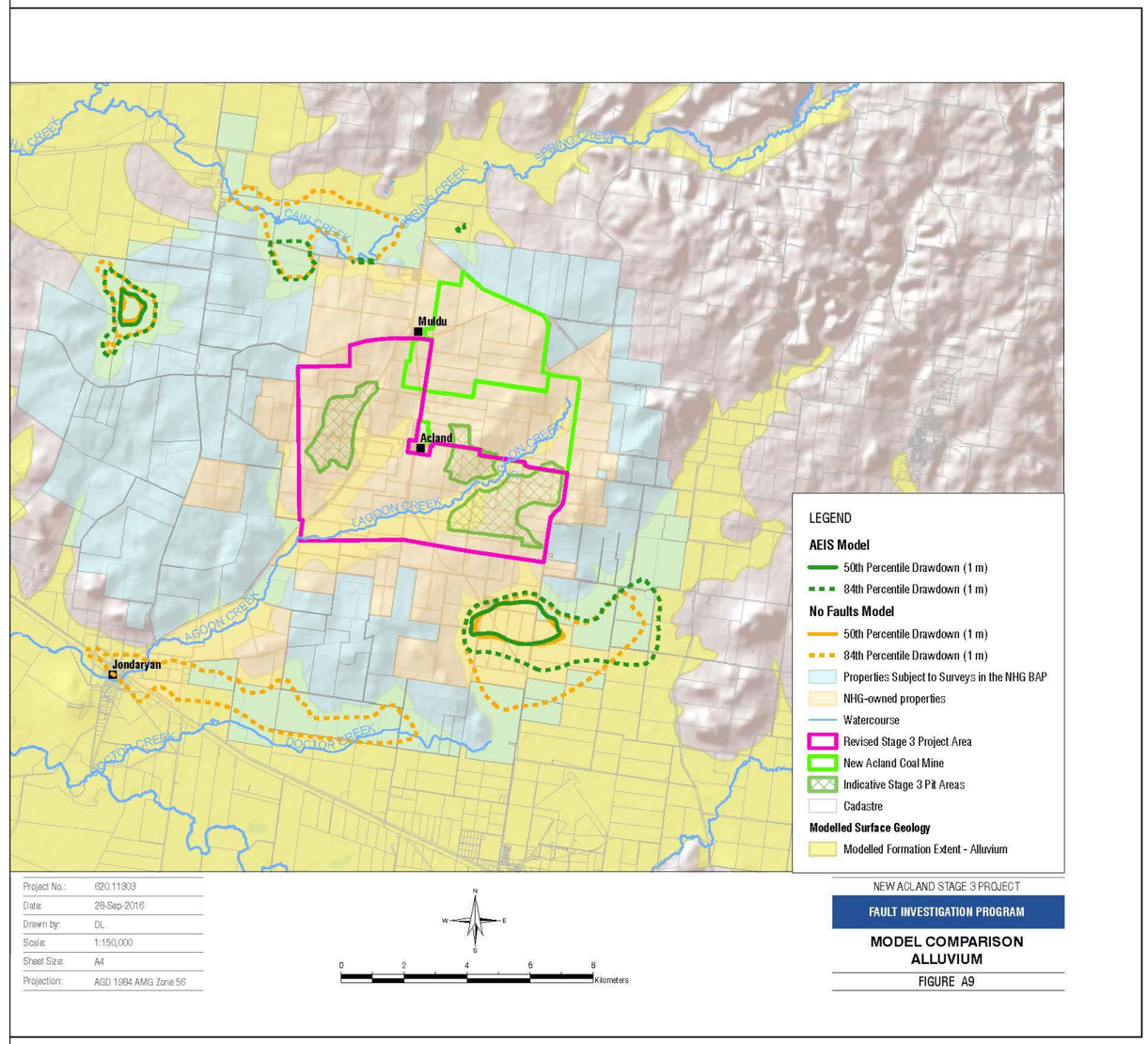
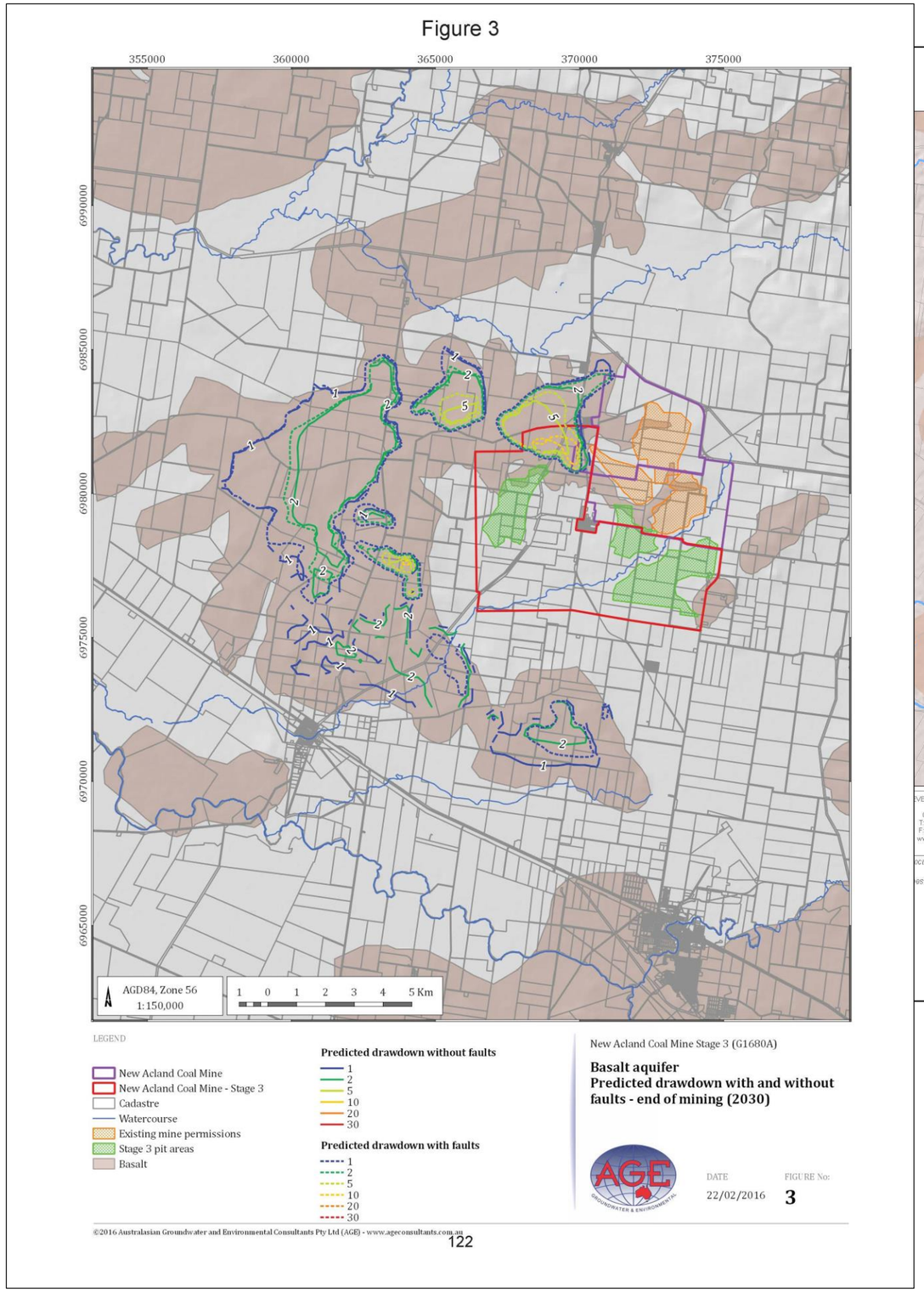


Figure 1: Comparison of modelled drawdown in SLR (2016a) Figure A9 and Irvine and Durick (2016) Figure 2 - Alluvium



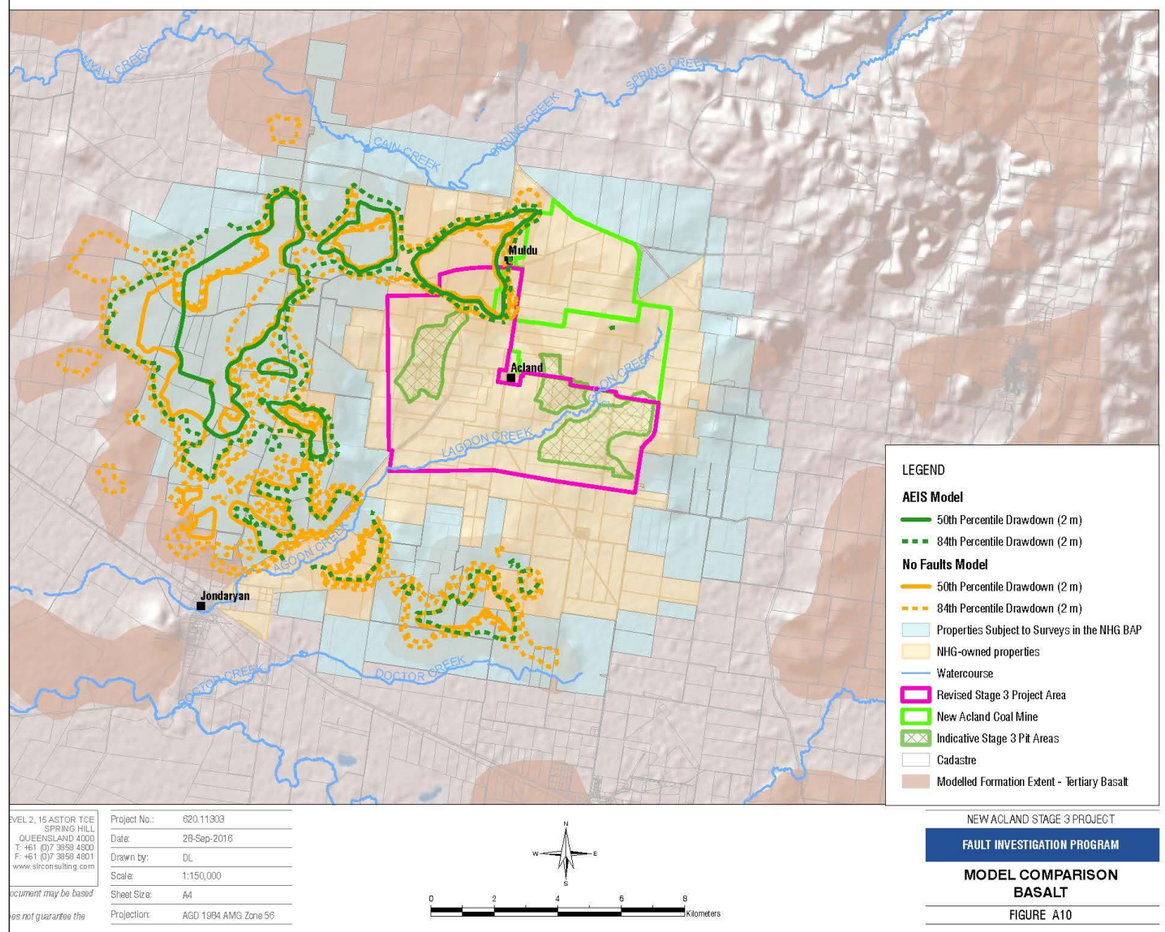
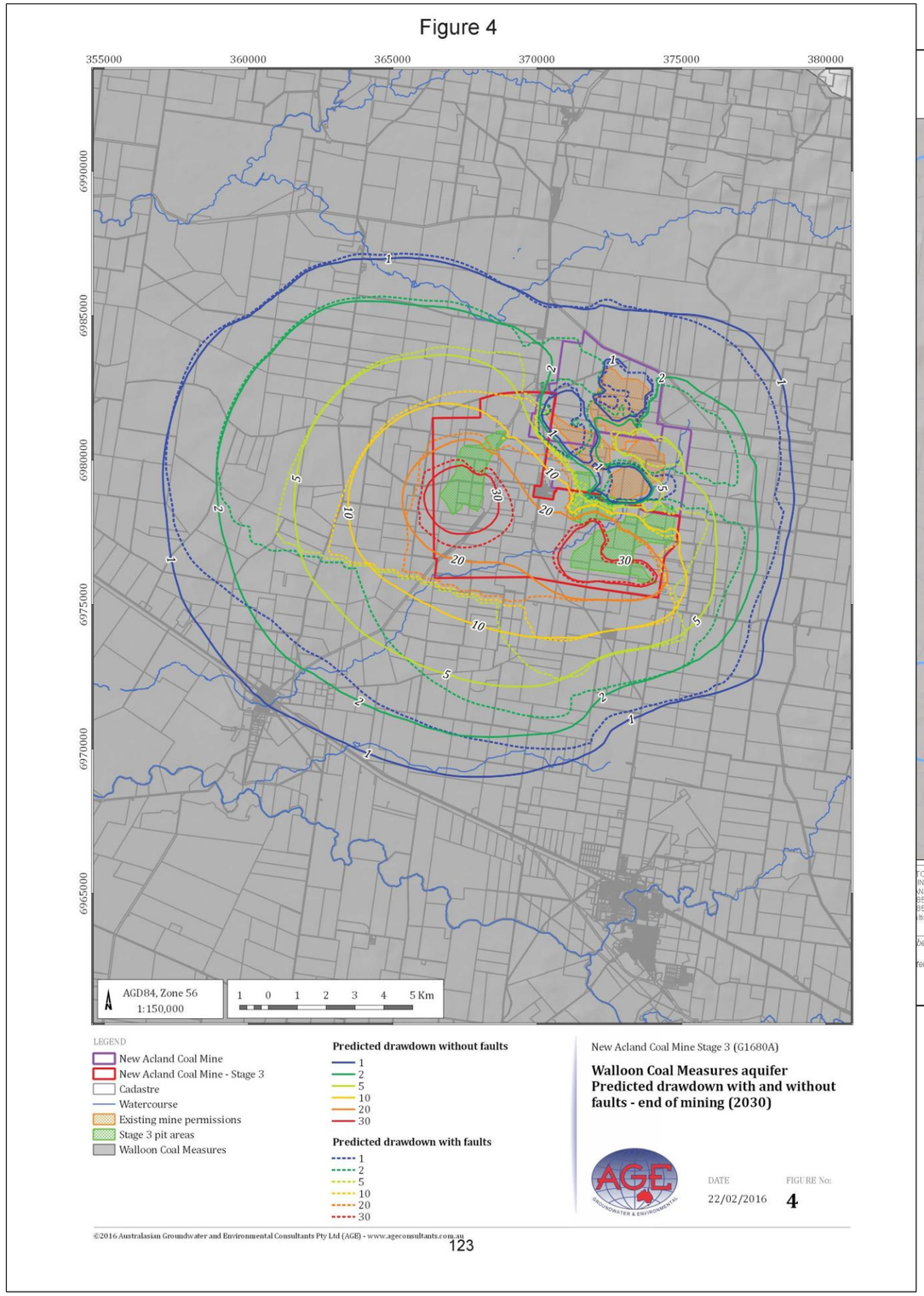


Figure 2: Comparison of modelled drawdown in SLR (2016a) Figure A10 and Irvine and Durick (2016) Figure 3 - Basalt



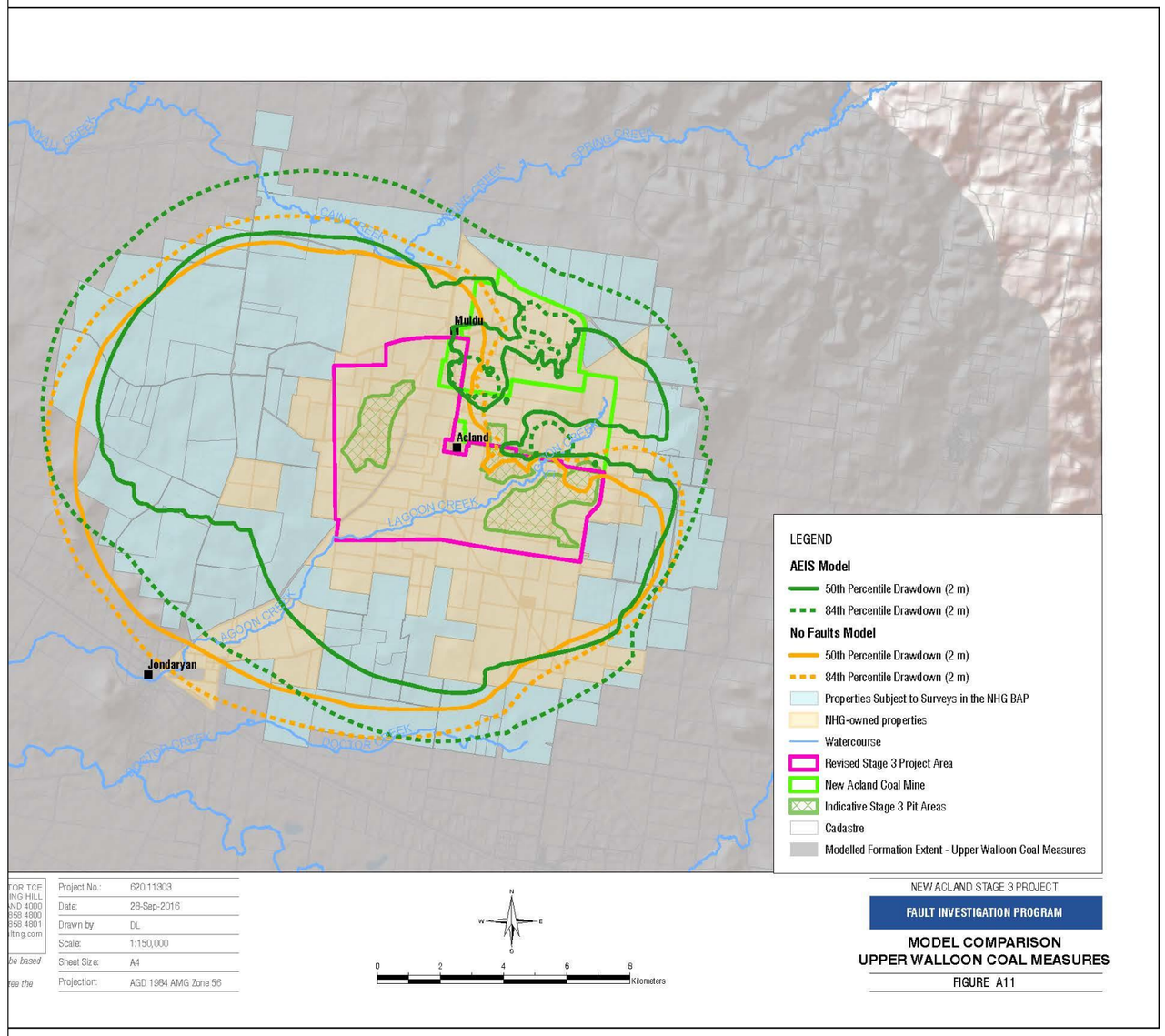
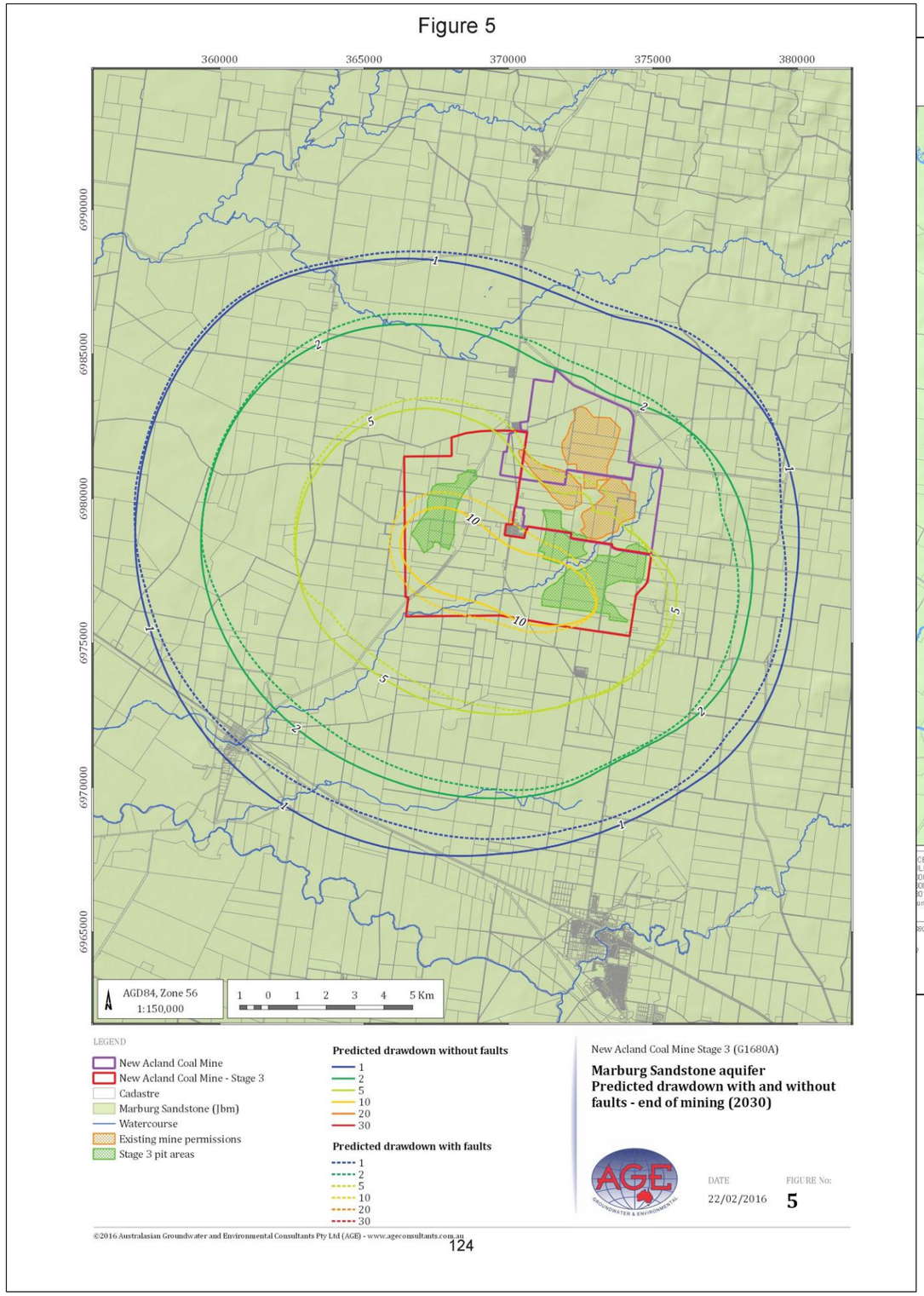


Figure 3: Comparison of modelled drawdown in SLR (2016a) Figure A11 and Irvine and Durick (2016) Figure 4 - WCM



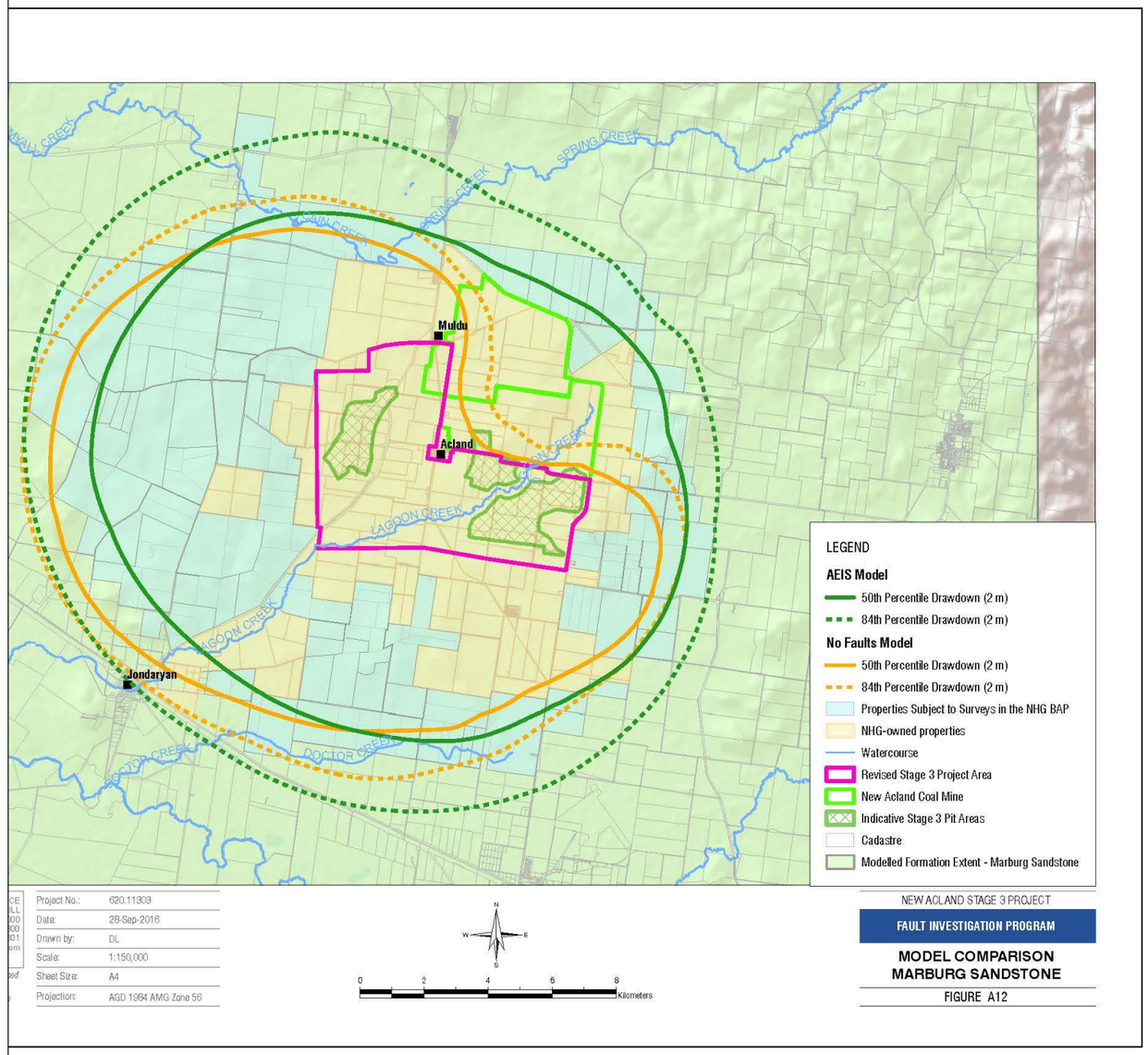


Figure 4: Comparison of modelled drawdown in SLR (2016a) Figure A12 and Irvine and Durick (2016) Figure 5 - Marburg

[7] Groundwater modelling predictions of mining impacts obtained by the AEIS model have effectively not been updated.

a) Predictions of mining impacts using the AEIS model remain the most up-to-date knowledge of mining impacts. That is, the model is effectively unchanged because the attempt at recalibration made in SLR (2016a) is poorly documented. Certainly, the vast majority of model shortcomings revealed through the proceedings to date have not been addressed, at least based on available documentation. An expression of intent to rebuild the model, starting effectively from the beginning, is described in SLR (2016d). However, a detailed modelling strategy, revised conceptual model and evidence of progress towards building a new model is presently not available.

b) Therefore, the results of the AEIS model (and the modified AEIS sensitivity analysis of the effects of faults in SLR 2016a) remain as the primary basis for decision-making regarding NAC mining impacts to surrounding water users and the environment.

c) Previous statements about model uncertainty (e.g. the AEIS modelling report states "Given that calibration is considered within acceptable limits and the level of uncertainty in the predictive results is considered minor, in hydrogeologic modelling terms…"[13]) appear at odds with new information described in recent reports. That is, aside from the limited progress on addressing modelling methodology problems raised during the proceedings of this case, some of NAC's new findings add to the known shortcomings with the AEIS model. For example, the pump test of a section of a large-offset fault (SLR 2017) shows significant leakage, and yet modelled faults use parameters that represent impermeable structures (aside from the ones that have 'gaps'). Given that most of the faults have smaller offsets than the tested fault, most faults will probably exhibit even more leakage than that produced within the pump test results (see SLR 2017). Added to this, it is now confirmed that faults in the AEIS model do not align with known fault locations. Also, as discussed above, the previous sensitivity analysis of faults by Durick potentially under-represented the likely influence of faults on drawdown predictions. SLR's (2016a) sensitivity analysis offers initial indication of this, although the SLR (2016a) documentation is insufficient to be able to draw clear and defensible conclusions. Certainly, the evidence to date suggests that rather than using unrealistic faults, as Barnett did in his 2009 model, it is important to represent faults that are consistent with field knowledge, despite that Durick's sensitivity analysis showed only moderate sensitivity.

d) According to SLR (2016d), revisions to the hydrogeological investigation of mining impacts require reconceptualization and a model rebuild, which will include such fundamental aspects as, model layering, boundary conditions, grid cell size, parameters, etc. This process is very likely to produce a

[13] Exhibit 111, [EHP.0111] soft page 165.

distinctly different model compared to the current AEIS version, thus superseding previous model predictions. The timeframes offered by SLR (2016d) indicate that by the end of February 2017 both reconceptualization and remodelling will be completed. On this basis, an entirely new set of mining impact predictions ought to be soon available. However, I have reservations that reconceptualization and remodelling is achievable in the timeframes proposed by SLR (2016d), at least to obtain a reasonable understanding of model uncertainty, and to produce an outcome of significantly better reliability than the previous EIS and AEIS projects. Additionally, it will be necessary for the modelling team (i.e. Derwin Lyons, Brian Rask and Brian Barnett, who were significant members of the modelling team that constructed the previous EIS and AEIS models) to overcome fundamental misconceptions expressed within the documentation they produced to accompany the EIS and AEIS models.

e) In the Statement of Reasons by the Department of the Environment and Energy (DEE, 2017): "the Coordinator-General has recommended a condition which would require the proponent to determine the volume of groundwater removed from the Oakey Creek Alluvium…". Given bias in the AEIS model in estimating alluvium water levels (see IESC, 2015 at pp2 and 3), the AEIS model is not well suited to this prediction. Thus, at the present time, there are no reliable estimates of the volumetric take from the Oakey Creek alluvium caused by mining activities, and yet knowledge of volumetric losses from the Oakey Creek alluvium are clearly an important issue.

[8] Critical issues with the model, raised during court proceedings and/or via the IESC, have not been addressed.

a) Issues raised by the IESC (2015) persist.

i) The IESC (2015) recommended that "A number of key matters raised in the IESC's advice of April 2014 remain unresolved…" and that included hydrogeological conceptualisation and the approach to model calibration. The IESC (2015) stated that these: "…may be contributing to bias and over-prediction of groundwater heads, result in continued uncertainty in the proponent's groundwater model and hence impact assessment." Also, IESC (2015) recommended that "there is a high degree of uncertainty regarding the scale of potential impacts associated with the proposed voids."

ii) In my view, these issues persist in NAC's model, particularly given that the AEIS model, which was the basis for IESC's (2015) advice, effectively remains the sole device (with slight modification by SLR, 2016a) for making predictions of mining impacts. Reasons include:

1. Recalibration is known to produce different predictions of drawdown (e.g. see comments above regarding the results

shown in SLR 2016a), and therefore, an entirely new conceptual model and recalibration (as proposed in SLR 2016d) will no doubt modify the current knowledge of likely drawdown impacts, by an unknown degree.

2. The issues of bias and uncertainty raised by IESC (2015) do not appear to have been addressed in the available reports produced by NAC.
3. The impacts of mining now include the volumetric take from the Oakey Creek alluvium (DEE, 2017), and thus far no assessment of that has been made. Given this, there is no way to know the level of uncertainty accompanying the model's prediction of this aspect of impacts. Hence, a "high degree of uncertainty in regarding the scale of potential impacts associated with the proposed voids" must surely remain.

b) There are important aspects of the IESC (2016, 2017) advice that warrant discussion, in particular, relative to the question of whether or not NAC have addressed the issues raised previously by the IESC. I refer specifically to the IESC (2016) response to Question 2 ("Does the proponent's revised groundwater modelling provide a reasonable prediction of the expected maximum range of groundwater drawdown for the proposed mine?"), stating that the "methods and data used… are appropriate for this stage of the proposed project and consistent with industry standards". And subsequently, "IESC considers that [sensitivity analysis in SLR 2016a] encompass the likely range of groundwater drawdown that would be realised by the proposed project."

   i) Firstly, in response to Question 2, the IESC (2016) suggests that the model encompasses the "likely range of groundwater drawdown". However, Question 2 is seeking whether "the expected maximum range" of drawdown has been provided. I question whether the IESC (2016) has adopted the precautionary principle that is inferred in the wording of Question 2, because "likely range" and "maximum range" are two different views of drawdown uncertainty.

   ii) On the basis of the IESC (2014, 2015) recommendations and in my view, the AEIS model contains significant uncertainties, to the degree that the predictions should not be considered to reliably inform the maximum likely extent of drawdown. In my view, the current situation regarding the modelling to date is consistent with text within the 2012 Guidelines: "…documentation of an agreement to target a Class 1 or 2 confidence level classification is important as the model can be considered <u>fit for purpose</u> [emphasis added], even when it is rated as having a relatively low confidence associated with its predictions." My view is that the Guidelines' message is consistent with the current

situation. That is, while the IESC's (2016) assertion that the model is "consistent with industry standards" is perhaps reasonable (albeit only if one considers the project area to be a greenfield site and adopts Class 2 model expectations; see (iv) below), I have relatively low confidence in modelling predictions, which I do not expect have captured "the maximum likely extent of drawdown". I believe that it is unreasonable to expect a model of this class (see the Guidelines' description of classes) to reliably predict the "likely range" (or "maximum range") of drawdown without considerably more effort to impart conservatism into the modelling approach.

iii) The IESC's (2016) inference that the modelling predictions are reliable, at least in terms of capturing the likely drawdown range, is hard to defend on the basis of recommendations in the Guidelines, which includes:

1. "if the time frames and stresses used in a prediction are close to those of the calibration, the confidence of the prediction will be higher than when predictive time frames and stresses are significantly different from those of calibration."[14] Clearly, both the time frames and the stresses of model predictions depart considerably from those of the model calibration, and therefore the confidence in the predictions is reduced.

2. "As pointed out in section 5.5, uncertainty analysis builds upon, but is distinct from, sensitivity analysis. Whereas sensitivity simply evaluates how model outputs change in response to changes in model input, uncertainty analysis is a more encompassing assessment of quality of model predictions. In uncertainty analysis, sensitivities of predictions to model parameters are combined with a statistical description of model error and parameter uncertainty. Thus, the uncertainty associated with a prediction depends on both the sensitivity of the prediction to changes in the model input, and on the uncertainty of the inputs, parameters, observations and conceptual model itself."[15] I consider that the uncertainties within inputs, parameters, observations and the conceptual model itself have not been properly considered in NAC's modelling to date. On this basis (and considering the Guideline's text above), the sensitivity analysis contained in SLR (2016a), even considering the recalibration that was undertaken, is not adequate to inform the drawdown range with the high level of certainty that the IESC (2016) has reported.

[14] Exhibit 720 [OCA.0036], p93.
[15] Exhibit 720 [OCA.0036], p107.

The SLR (2016a) analysis exceeds in a small way the expectations of a sensitivity analysis, but with limited associated reporting and/or interrogation of the results. Thus, it is unreasonable to attribute "likely" or "maximum" ranges of predictions to the results of this analysis. This is consistent with the advice on sensitivity analyses within the Guidelines.

iv) Where the IESC (2016) refer to "industry standards", it is not clear whether they consider the project *greenfield*, *brownfield* or *mine site* exploration, and this has significant bearing on their expectations of modelling. Barnett (2017) infers that the project can be compared to a greenfield operation. I disagree with Barnett (2017) that the project area can be usefully compared to a greenfield site, and suggest that the implications of his greenfield comparison are profound. Firstly, considering that NAC have been mining this area for a significant period of time, it must surely be within "industry standards" that their operations have called for some level of investigation of the local groundwater conditions, including their potential impacts on other users. If not due to the requirements of legislation, at least in the interests of their water management activities. Thus, the area adjoining their current mining activities can hardly be considered "greenfield". Moreover, Schodde and Guj (2012) state the following (in relation to the mining of non-ferrous metals): "The terms greenfield, brownfield and mine site exploration as defined by Bartrop and Guj (2009) are frequently used in exploration literature. Greenfield exploration targets areas of conceptual potential where, however, the particular type of target is currently not or poorly represented and there is a relative paucity of mining infrastructure. Brownfield exploration, by contrast is carried out in terranes where the type of mineralisation targeted has already been discovered and where there is a reasonable level of existing infrastructure. Mine site refers to exploration conducted within a relatively close radius from an existing operation and attendant mining infrastructure." I argue that the current project is not greenfield exploration, consistent with Schodde and Guj's (2012) definition, and in opposition to the inference by Barnett (2017). In this regard, IESC's reference to industry standards warrant further scrutiny, and is central to the question of whether the model is "fit for purpose". That is, "industry standards" and "fit for purpose" must surely depend on the scope of the mining project, whereby mining projects involving sites that are advanced beyond greenfield exploration warrant significantly more reliable estimates of groundwater impacts, i.e. commensurate with the greater understanding of the hydrogeology. In other words, an investigation of a mine-site expansion should be considerably more advanced than a greenfield investigation. The lack of clarification on

this important project classification within IESC's reports to date leaves open the question as to whether their statements relating to "fit for purpose" and "industry standards" are based on reasonable expectations.

v) Based on the points raised above, the assertion by the IESC (2017) that modelling to date has produced a reasonable prediction of groundwater drawdown appears premature.

c) Barnett (2017; 4.52) comments on changes to the membership of the IESC. Barnett (2017) fails to recognise that Dr Jane Coram has left the IESC during the course of the project's investigation. I challenge remarks by Barnett (2017) that the addition of Dr Wendy Timms and Dr Glen Walker brings stronger practical experience in groundwater modelling to the IESC, relative to the knowledge of Prof. Craig Simmons and taking into account the loss of Dr Coram. A review of their respective publication track records (and from my personal experience) indicates that Prof. Simmons is vastly more experienced on the topic of groundwater modelling than the combined experiences of Dr Timms and Dr Walker, whose respective excellent research careers have focussed primarily on other facets of hydrology. There appears to be an inference from BB that the change of IESC membership has perhaps modified the views of the IESC on the project's hydrogeological investigations. I agree with this, but I disagree that changes to the IESC membership have led to IESC evaluations that are more practical and formed from greater experience of groundwater modelling, model uncertainty, and regional-scale groundwater investigation.

d) A sensitivity analysis of the DRN package (and the representation of groundwater-surface water interaction and evapotranspiration more generally) should be undertaken with some urgency using methods that reflect both the Durick (2016) and SLR (2016a) methodologies, because the DRN package and other surface-subsurface interaction parameters potentially artificially mitigate the impacts of mining within the model. The proposal by NAC to revise the AEIS model does not address issues relating to the considerable but unexplored quantities of discharge to the land surface within the AEIS model (I raise the problem of high flow rates to the land surface in my IER[16]).

e) A more thorough exploration of model sensitivity, and model uncertainty more generally, is required taking into account the concepts given above. Otherwise, the modellers have failed in their duty to inform decision-makers of the likelihood that model predictions are within a range of reasonable expectations.

f) Given the Coordinator-General's condition relating to volumetric take from the alluvium, and the high uncertainty in predictions of alluvium drawdown

[16] See Exhibit 436, [OCA.0022] at para 13(a).

(e.g. see SLR 2016a), further work is warranted to assess uncertainty of alluvium impacts (both in terms of water levels and flow rates). The lack of uncertainty analysis on this aspect of model predictions is addressed in the Guidelines: "Guiding Principle 7.6: Uncertainty should be presented to decision-makers with visual depictions that closely conform to the decision of interest."[17] With the addition of alluvium volumetric losses as a prediction of interest, it is critical to provide uncertainty in this model prediction.

g) Important issues raised during the expert groundwater evidence in this case to date have not been addressed, and no strategy to address them is evident in recent reporting. These include, but are not limited to:

   i) The method of assigning mapped faults to the model is unclear. The disparity between mapped and modelled faults has persisted throughout the EIS and AEIS process; however, NAC has employed much the same modelling team, who have access to much the same field-based fault interpretation as they had previously (see section 4.1.5 of the Currell Report, paragraphs [35] to [46]) to proceed with new modelling efforts. It is not clear what will differ from previous methods for translating (or not) mapped faults into modelled faults. Additionally, there is no evidence that the modellers are aware of the previous misconception and miscalculation of the HFB conductance (SEIR; [20a] and [20b]).

   ii) An approach to ensure that model boundaries will provide reasonable representation of regional flow directions is lacking (IER; [10b] and [12a]).

   iii) No efforts or strategy to deal with the potentially excessive rates of discharge to the land surface though the DRN package have been discussed or are planned. Whether or not the DRN package is limiting drawdown is unclear (IER; [13a]).

   iv) No efforts to improve the estimation of recharge have been undertaken or are planned (IER; [14a], [15a] and [15b]). In SLR (2016), it is unclear whether recharge under stockpile areas or other water-affecting activities will be included in the new modelling efforts.

   v) No plans to use multiple calibration statistics are in place, despite the Guidelines' recommendation to do this. Discrete steps within the model calibration approach have not been provided, and so it is unclear how the calibration method will be modified to avoid relying on highly uncertain calibration objectives (e.g., mine pit inflows) (IER; [19]). Other misconceptions persist, including in SLR (2016; page 2), which wrongly indicates that the 50th percentile is the most probable case, whereas it is rather the model/s with minimum error variance (i.e., the

[17] Exhibit 720 [OCA.0036], p115.

model/s that produce the best calibration). Also, the reference to the 84th percentile as the "upper bound of uncertainty" in SLR (2016; page 2) has the potential to mislead others. Even if the model was 100% accurate, there is a 16% chance (≈1 in 6) that mining impacts are in fact higher than this "upper bound". In SLR (2016; pages 7-8), it is concerning that a strategy to include expert knowledge of aquifer parameters into the modelling process is not provided. The parameters of "calibrated models" should be compared to those from aquifer testing, and in particular, this comparison should inform the calibration process. Furthermore, the degree of calibration (of individual models) needs to be incorporated into the evaluation of drawdown predictions, because the reliability of predictions is linked to the degree of calibration.

vi) In SLR (2016d; page 7), the new model will apparently adopt "the same methodology for replicating ET and recharge as previously used". However, on page 8, the model is meant to provide "best replication of historic water levels, including… seasonal fluctuations". These two notions are incongruent, given that seasonal fluctuations in the recharge and evapotranspiration (ET) of early versions of the model were not considered. Therefore, while there is some mention of seasonality being a consideration in future modelling, there is no description of how this will be achieved. Whether or not the model will be used to assess seasonal impacts on stream flow is unclear (IER; [23b] and [24a]).

vii) There is no mention of a method to allow streams to recharge the aquifer (IER; [20c]). In SLR (2016d; page 8), the lack of information regarding stream base flow is problematic if future models are intended to inform the impacts on surface water systems. This is also recognised by the IESC (2016; paragraph 2b)

viii) The IESC (2016; paragraphs 2a and 8) have reiterated the issue raised during the court proceedings in regards to mine pit modelling. However, in SLR (2016d), the method for simulating mine pit lakes, including both quantity and water quality, has not been considered (IER; [25a]).

h) While cumulative impacts have been mentioned in the AEIS modelling report,[18] there remains no analysis of the combined effects of NAC's previous mining activities (on future water levels) in combination with the effects of their proposed Stage 3 mining. The IESC (2014; paragraph 7) has called for an evaluation of cumulative impacts, but NAC have not reported the effects of their own earlier stages of mining. Instead, they appear to evaluate only the

[18] Exhibit 111, [EHP.0111], soft page 38.

impacts of other miners in the area, while seemingly ignoring that the impacts of their existing mine will combine with the impacts of the proposed mine. In contrast to this approach, the National Water Commission's report on the cumulative impacts of mining[19] suggests "When assessing CE (cumulative effects), all present, past and foreseeable actions have to be taken into consideration". They also recommend: "…any assessment of CE specific to mining projects would require the following aspects to be considered: identify other existing or proposed activities in the area with similar environmental impacts or which are likely to impact on the same elements of the environment (eg. clearance of the same type of habitat); assess the extent to which the environment affected by the proposal is already stressed." Considering that this document was developed some 8 years ago, and involved key mining stakeholders, it seems reasonable to assume that its recommendations reflect industry standards. It thus seems relevant that NAC produce a combined impact assessment that accounts for all stages of mining, if the "industry standard" is the measure by which IESC and others are assessing their investigation. Without reliable analysis of NAC's current and future groundwater impacts arising from all mining activities in this region, there is limited ability to properly assess the extent of impacts from their proposed expansion operations.

[9] It is unclear how, and whether, the recent fault-testing investigation will lead to modelling improvements.

a) It is unclear how the fault pump-test results (SLR 2017) will be used to inform the modelled properties of the tested fault.

b) It is unclear how the fault pump-test results (SLR 2017) will be used to inform the modelled properties of other faults in the area. In particular, NAC have tested a fault with a (locally at least) large offset relative to most other faults, and therefore the permeability of this fault is likely lower than most others in the study area. I disagree with statements in SLR (2016d; P7) that imply that the pump test will allow for parameterisation of all faults in the study area. The IESC (2016; point 3a) appear to indicate that the testing of more than one fault is warranted.

[19] National Water Commission (2009) *Report 1: Report on the inclusion and implementation of NWI objectives and consideration of cumulative effects, Framework for Assessing Local and Cumulative Effects of Mining on Groundwater Resources*, Sinclair Knight Merz Pty Ltd, Project VE23097, 93 pp.

6. References

Barnett B (2017) Further Statement of Evidence to the Land Court by Brian Barnett dated 20 February 2017 (**Barnett Report**).

Barnett B, Townley LR, Post V, Evans RE, Hunt RJ, Peeters L, Richardson S, Werner AD, Knapton A and Boronkay A (2012) Australian Groundwater Modelling Guidelines, Waterlines report, National Water Commission, Canberra.

Department of the Environment and Energy (2017a) *Decision of Minister for the Environment and Energy, Stage 3 Expansion of New Acland Coal Mine, Queensland (EPBC 2007/3423).*

Department of the Environment and Energy (2017b) *Statement of reasons for approval of a proposed action under the Environment Protection and Biodiversity Conservation Act 1999 (Cth).* 18th January 2017.

IESC (2014) *Advice to decision maker on coal mining project IESC 2014-045: New Acland Coal Mine Stage 3 (EPBC 2007/3423) – Expansion*, 10 April 2014.

IESC (2015) *Advice to decision maker on coal mining project – IESC 2015-073: New Acland Coal Mine Stage 3 (EPBC 2007/3423) – Expansion*, 10 December 2015.

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Johnson A (2016) *Letter from Chair of the IESC to Department of the Environment and Energy*, dated 21 December 2016.

National Water Commission (2009) *Report 1: Report on the inclusion and implementation of NWI objectives and consideration of cumulative effects, Framework for Assessing Local and Cumulative Effects of Mining on Groundwater Resources*, Sinclair Knight Merz Pty Ltd, Project VE23097, 93 pp.

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SLR (2016a) *NAC03 Fault Hydrogeological Investigation Program, October 2016 Status Report*. Report for New Hope Group 24 October 2016.

SLR (2016b) *NAC03 GMIMP [Groundwater Monitoring and Impact Management Plan], October 2016 Status Report*. Report for New Hope Group: 24 October 2016.

SLR (2016c) *NAC03 Landholder Make Good, October 2016 Status Report*. Report for New Hope Group: 24 October 2016.

SLR (2016d) *New Acland Stage 3 Project Groundwater Model Update, Phase 1 Completion Report (Numerical Model Scoping Report).* Report for New Hope Group: 24 October 2016.

SLR (2017) *New Acland Stage 3 Project Fault Hydrogeological Investigation Program, Drilling & Testing Report*. Report for New Hope Group: 9th January 2017.

7. Expert's Statement – Additional Facts

[10] The opinions set out above are based on the available reporting. No additional evaluation of groundwater modelling files was undertaken.

8. Declaration

[11] In accordance with rule 24F(3) of the *Land Court Rules 2000* (Qld), I confirm the following:

a) the factual matters stated in the report are, as far as I know, true;
b) I have made all enquiries considered appropriate;
c) the opinions stated in the report are genuinely held by myself;
d) the report contains reference to all matters I consider significant;
e) I understand the duty of an expert to the court and have complied with that duty;
f) I have read and understood the *Land Court Rules 2000* on expert evidence; and
g) I have not received or accepted instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.

……..

Signature

10 March 2017

ATTACHMENT A

EDO Qld.
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Using the law to protect our environment.
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8 February 2017

Professor Adrian Werner
School of the Environment
Flinders University

Sent by email: adrian.werner@flinders.edu.au

Dear Professor Werner

Oakey Coal Action Alliance Inc. – Reopening of groundwater evidence

Following an application by New Acland Coal (**NAC**) and the decision delivered by His Honour last Thursday 2 February, the parties have leave to reopen their cases to call fresh evidence in response to:

- the IESC advice entitled "Advice to decision maker on coal mining project (IESC 2016-081: New Acland Coal Mine Stage 3 (EPBC 2007/3423) - Expansion" dated 14 December 2016 (**2016 IESC Advice**); and
- reports provided by NAC to the IESC as referred to in the 2016 IESC Advice.

NAC has provided the following additional material (**Additional Material**):

- SLR, 2016a. NAC03 Fault Hydrogeological Investigation Program, October 2016 Status Report. 24 October 2016;
- SLR, 2016b. NAC03 GMIMP [Groundwater Monitoring and Impact Management Plan], October 2016 Status Report. Report for New Hope Group: 620.11303-L03-v1.0.docx. 24 October 2016;
- SLR, 2016c. NAC03 Landholder Make Good, October 2016 Status Report. 24 October 2016;
- SLR, 2016d. New Acland Stage 3 Project Groundwater Model Update. Phase 1 Completion Report (Numerical Model Scoping Report). 24 October 2016;
- New Acland Stage 3 Project Fault Hydrogeological Investigation Program Drilling & Testing Report 9 January 2017;
- Decision of Minister for the Environment and Energy under sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth);
- Statement of reasons of Minister for the Environment and Energy for the decision;

- Letter from Chair of the IESC to Department of the Environment and Energy dated 21 December 2016;
- BMT WBM, 2016a. Receiving Environment Monitoring Program for New Acland Mine. February 2016; and
- BMT WBM, 2016b. New Acland Mine – Receiving Environment Monitoring Program - Pre-Release Survey 2015. February 2016.

1. Instructions

1.1 Further to the evidence you have prepared in these proceedings to date, you are instructed to review this letter and accompanying documents and prepare a supplementary report in response to the 2016 IESC Advice and the Additional Material, to the extent it is relevant to groundwater modelling issues in these proceedings.

1.2 We note that Dr Currell has also been instructed to prepare a supplementary report with respect to the groundwater conceptualisation and quality issues raised in the 2016 IESC Advice and the Additional Material.

2. Timing

2.1 The parties have agreed that evidence be prepared on the following timetable:

(1) By 4.00pm on Monday, 20 February 2017, the NAC must file and serve any supplementary statements of evidence of their relevant expert witnesses;

(2) By 4.00pm on Friday, 10 March 2017, OCAA must file and serve any supplementary statements of evidence of their relevant expert witnesses, responding to the Additional Documents including any reply to NAC's statements of evidence filed on 20 February 2017.

(3) By 4.00pm on Monday, 20 March 2017, the NAC must file and serve any statements of evidence of their relevant expert witnesses, limited to matters in reply to the statements of evidence filed by OCAA and the other Objectors.

2.2 Further groundwater evidence is scheduled to be heard for 3 days commencing on 3 April 2017, and a further 2 days to be fixed in the week commencing 10 April 2017.

2.3 While we recognise you were not anticipating having to prepare further evidence, we would appreciate if you are able to prepare your supplementary report as soon as possible.

3. Your duty to the Land Court

3.1 We enclose as **Annexure A** Part 5 of the *Land Court Rules 2000* (rules 22 to 24I) which govern expert evidence in the Land Court.

3.2 In particular we note that rule 24C of the *Land Court Rules 2000* provides that you have a duty to assist the Land Court which overrides any obligations you may have to our client.

3.3 We also emphasise that we and our client do not seek to influence your views in any way and we ask for your independent opinion to assist the Land Court. Consequently, please note that any statements of fact or opinion in this letter of instructions, the above documents, or anything given or said to you by us relevant to the issues in your report do not constrain you in any way and are not intended to influence your views. We ask you to form your own opinion about the relevant facts and circumstances for the purposes of your report.

3.4 Your supplementary report and any joint report you prepare should confirm that you understand your duty to the court and have complied with that duty.

4. Format of your statement of evidence (other than joint report)

4.1 We suggest for consistency that you adopt a similar format to your previous evpert reports.

4.2 Your report must:

(4) be addressed to the Court;

(5) include your qualifications;

(6) include all material facts, whether written or oral, on which your report is based;

(7) include references to any literature or other material you relied on to prepare the report;

(8) include for any inspection, examination or experiment you conducted, initiated, or relied on to prepare your report—

a) a description of what was done; and

b) whether the inspection, examination or experiment was done by you or under your supervision; and

c) the name and qualifications of any other person involved; and

d) the result;

(9) if there is a range of opinion on matters dealt with in your report, include a summary of the range of opinion, and the reasons why you adopted a particular opinion;

(10) include a summary of the conclusions you reached;

(11) include a statement about whether access to any readily ascertainable additional facts would assist you in reaching a more reliable conclusion;

(12) include a confirmation at the end of the statement of evidence:

a) the factual matters included in the statement are, as far as you know, true; and

b) you have made all enquiries considered appropriate; and

c) the opinions included in the statement are genuinely held by you;

d) the statement contains reference to all matters you consider significant;

e) you understand your duty to the court and have complied with the duty;

f) you have read and understood the rules contained in Part 5 of the *Land Court Rules 2000*, as far as they apply to you;

g) you have not received or accepted instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding;

(13) include your signature.

4.3 You should attach to the report:

(1) a copy of your Curriculum Vitae; and

(2) a copy of this letter.

4.4 Please number all pages and paragraphs of your report. You may wish to include an index.

4.5 If your report includes any photographs, measurements, graphs or illustrations these should be firmly attached to the report, and clearly identified and numbered.

5. Change of opinion

5.1 If for some reason, you change your opinion after delivering your report, please advise us as soon as possible. If that change is material, a supplementary report will need to be prepared, which explains the reasons for the change in your opinion.

6. Confidentiality and privilege

6.1 In accepting this engagement, you agree that:

(1) this letter and all future communications (whether electronically maintained or not) between us are confidential. These communications may be subject to client legal privilege;

(2) you must take **all** steps necessary to preserve the confidentiality of our communications and of any material or documents created or obtained by you in the course of preparing your report;

(3) you must not disclose the information contained in our communications or obtained or prepared by you in the course of preparing your report without obtaining consent from us;

(4) you must not provide any other person with documents which come into your possession during the course of preparing this report, whether created by you or provided to you by us or our clients, without obtaining consent from us.

6.2 The duty of confidentiality continues beyond the conclusion of your instructions.

6.3 If you are ever obliged by law to produce documents containing any of this confidential information (whether by subpoena, notice of non-party discovery or otherwise) please contact us immediately so that we may take steps to claim client legal privilege.

6.4 You should ensure that you retain copies of all drafts of your report together with all documents that you rely on in preparing your report. We will inform you when you are no longer required to retain them.

6.5 If requested, you must return to us all documents and other material (including copies) containing confidential information. Where any confidential information is in electronic form, we may require you to delete this information instead.

6.6 Any internal working documents and draft reports prepared by you may not be privileged from disclosure and may be required to be produced to the opposing parties in the litigation, and to the Court.

6.7 You may be cross-examined about any changes between your working documents and your report. The Court will be interested to understand the reason or reasons for any changes, and you should be prepared to, and able to, explain them.

7. Document management

7.1 Please ensure that all documents created pursuant to this retainer are marked "Privileged and Confidential: prepared for the purpose of the Queensland Land Court objection hearing to Stage 3 New Acland Coal Mine".

If you have any questions regarding your engagement or require further information, please do not hesitate to call us on 3211 4466.

Yours faithfully

Environmental Defenders Office (Qld) Inc

Michael Berkman

Solicitor

Part 5 Evidence

Division 1 Preliminary

22 Definitions for pt 5

In this part—

expert means a person who would, if called as a witness in a proceeding, be qualified to give opinion evidence as an expert witness in relation to an issue in dispute in the proceeding.

joint report, for a proceeding, means a report—

(a) stating the joint opinion of experts in relation to an issue in dispute in the proceeding; and

(b) identifying the matters about which the experts agree or disagree and the reasons for any disagreement.

meeting of experts—

1 A meeting of experts is a meeting at which experts in each area of expertise relevant to a proceeding meet, in the absence of the parties—

(a) to discuss and attempt to reach agreement about the experts' evidence in relation to an issue in dispute in the proceeding as it relates to the experts' area of expertise; and

(b) to prepare a joint report.

2 The term includes

(a) a resumed meeting of experts or further meeting of experts; and

(b) a meeting attended by the experts in either, or a combination, of the following ways—

(i) personally;

(ii) a way that allows contemporaneous communication between the experts, including by telephone, video link or email.

party, for a proceeding, means a party to the proceeding or the party's lawyer or agent.

statement of evidence, of an expert, see rule 24E.

Division 2 Meetings of experts

23 Application of div 2

Unless the court otherwise orders, this division applies in relation to a meeting of experts ordered or directed by the court at any time in a proceeding.

24 Party must ensure expert ready to take part in meeting of experts

Before a meeting of experts, a party to a proceeding must do all things reasonably necessary or expedient to ensure an expert chosen by the party is ready to take part fully, properly and promptly in the meeting, including by giving the expert—

(a) reasonable prior notice that the court has ordered or directed a meeting of experts; and

(b) notice of the contents of any order or direction about the meeting, including the time by which the meeting must be held; and

(c) reasonable notice of the issue in dispute in the proceeding to the extent it is relevant to the expert's expertise; and

(d) enough information and opportunity for the expert to adequately investigate the facts in relation to the issue in dispute in the proceeding; and

(e) written notice that the expert has a duty to assist the court and the duty overrides any obligation the expert may have to the party or any person who is liable for the expert's fee or expenses.

24A Experts attending meeting must prepare joint report

(1) The experts attending a meeting of experts must, without further reference to or instruction from the parties, prepare a joint report in relation to the meeting.

(2) However, the experts attending the meeting may, at any time before the joint report is completed, ask all parties to respond to an inquiry the experts make jointly of all parties.

(3) Despite subrule (1), any of the experts may participate in a mediation involving the parties.

(4) The joint report must—

(a) confirm that each expert understands the expert's duty to the court and has complied with the duty; and

(b) be given to the parties.

(5) The applicant or appellant must deliver to the registry, personally or by facsimile or email, a copy of the joint report received under subrule (4) at least 21 days before the date set for the hearing.

24B Admissions made at meeting of experts

(1) Subrule (2) does not apply to a joint report prepared in relation to a meeting of experts.

(2) Evidence of anything done or said, or an admission made, at a meeting of experts is admissible at the hearing of the proceeding or at the hearing of another proceeding in the court or in another civil proceeding only if all parties to the proceeding agree.

(3) In this rule—

civil proceeding does not include a civil proceeding founded on fraud alleged to be connected with, or to have happened during, the meeting.

Division 3 Evidence given by experts

24C Duty of Expert

(1) A witness giving evidence in a proceeding as an expert has a duty to assist the court.

(2) The duty overrides any obligation the witness may have to any party to the proceeding or to any person who is liable for the expert's fee or expenses.

24D Giving or accepting instructions to adopt or reject a particular opinion prohibited

A person must not give, and an expert must not accept, instructions to adopt or reject a particular opinion in relation to an issue in dispute in a proceeding.

24E Expert must prepare statement of evidence

(1) An expert must prepare a written statement of the expert's evidence (a statement of evidence) for the hearing of a proceeding.

(2) If the expert has taken part in a meeting of experts—

(a) a joint report prepared in relation to the meeting is taken to be the expert's statement of evidence in the proceeding; and

(b) a further statement of evidence in relation to any issue of disagreement recorded in the joint report is to be prepared by the expert.

(3) However, the further statement of evidence must not, without the court's leave—

(a) contradict, depart from or qualify an opinion in relation to an issue the subject of agreement in the joint report; or

(b) raise a new matter not already mentioned in the joint report.

24F Requirements for statement of evidence other than joint report

(1) An expert's statement of evidence, other than a joint report, must be addressed to the court and signed by the expert.

(2) The statement of evidence must include the following information, to the extent the information is not already contained in a joint report prepared for the proceeding—

(a) the expert's qualifications;

(b) all material facts, whether written or oral, on which the statement is based;

(c) references to any literature or other material relied on by the expert to prepare the statement;

(d) for any inspection, examination or experiment conducted, initiated or relied on by the expert to prepare the statement—

(i) a description of what was done; and

(ii) whether the inspection, examination or experiment was done by the expert or under the expert's supervision; and

(iii) the name and qualifications of any other person involved; and

(iv) the result;

(e) if there is a range of opinion on matters dealt with in the statement, a summary of the range of opinion and the reasons why the expert adopted a particular opinion;

(f) a summary of the conclusions reached by the expert;

(g) a statement about whether access to any readily ascertainable additional facts would assist the expert in reaching a more reliable conclusion.

(3) The expert must confirm, at the end of the statement of evidence—

(a) the factual matters included in the statement are, as far as the expert knows, true; and

(b) the expert has made all enquiries considered appropriate; and

(c) the opinions included in the statement are genuinely held by the expert; and

(d) the statement contains reference to all matters the expert considers significant; and

(e) the expert understands the expert's duty to the court and has complied with the duty; and

(f) the expert has read and understood the rules contained in this part, as far as they apply to the expert; and

(g) the expert has not received or accepted instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.

24G Serving statement of evidence other than joint report

(1) This rule applies to a statement of evidence other than a joint report.

(2) A party to a proceeding intending to call evidence by an expert in the proceeding must deliver to the registry, personally or by facsimile or email, and serve on each other party to the proceeding, a copy of the expert's statement of evidence.

(3) A party must comply with subrule (2) at least 21 days before the date set for the hearing or, if the court directs a different time, within the time directed by the court.

24H Matters contained in statement of evidence not to be repeated

During examination in chief, an expert must not, without the court's leave, repeat or expand on matters contained in the expert's statement of evidence or introduce new material.

24I Evidence from only 1 expert may be called

Other than with the court's leave, a party to a proceeding, at any hearing of the proceeding, may call evidence from only 1 expert for each area of expertise dealt with in the hearing.