Coast and Country Association of Queensland Inc. & Ors ats Hancock Coal Pty Ltd,

Land Court of Queensland Proceeding MRA713-13 & EPA714-13

Objection to Mining lease and Environmental Authority for Kevin's Corner Coal Mine

Supplementary expert report on groundwater impacts to the Land Court by Dr John Webb

Date: 29 April 2015

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1. Introduction

[1] This supplementary report revises the conceptual geological model for the Kevins Corner lease area in Dr Webb's expert report dated 23 December 2014, based on additional evidence provided during the Joint Experts' Meeting on 27 February 2015, and the interpreted seismic lines within the Kevins Corner lease; these seismic lines were only made available on 22 April 2015 after the Joint Experts Report had been submitted on 2 April 2015. The Bridge Oil (1983) and Velseis (2011) references were provided by Mr Stewart at the Joint Experts' Meeting. Seismic line CAR 82-49 was referred to by Mr Stewart in the Joint Experts' Report but not illustrated; it was supplied by Romana Thefs, Geological Survey of Queensland (Department of Natural Resources & Mines). The interpreted seismic lines within the Kevins Corner lease were provided through Ashurst Australia.

[2] In addition, a new long section has been constructed using the data provided in Figure 3 of the Joint Experts' Report, and additional data from bores within the Alpha and Kevin's Corner leases. There was insufficient time to construct this before the Joint Experts' Report was submitted.

[3] Several points of clarification are made with respect to new material in the matters of disagreement; this new material was not previously provided in Dr Webb's expert report or Mr Stewart's previous reports.

2. Conceptual geological model

[4] Some revisions to the conceptual geological model for the Kevin's Corner lease area were needed to incorporate stratigraphic data of which I was previously unaware, and which Mr Stewart brought to my attention in the Joint Experts' Report, in particular the bores drilled by Bridge Oil (Bridge Oil 1983). The Wendouree bores (Carr 1973), which Mr Stewart also refers to in the Joint Experts' Report, had been used to construct the cross-sections across the mine area, but were not previously plotted explicitly on the cross-sections.

[5] The Permian strata on seismic sections through the Carmichael area (Velseis 2011) initially dip westwards at ~5º and then flatten out, i.e. monoclinal folding **(Figure 1**). A seismic section to the south of the Alpha lease (**Figure 2**) shows that the Permian strata are subhorizontal to the west of the cross-sections constructed here, consistent with the presence of a monocline to the east; the resolution through the area to the east (south of the Alpha lease) is too poor to show any details of the Permian strata there.

[6] Seismic lines within the Kevin's Corner lease show that the strata are affected by minor folding (**Figure 3).**

[7] The additional bore and seismic information has been incorporated into the cross-sections; the revised cross-sections are shown as Figure 5. The locations of the fold axes affecting the Triassic strata have also been slightly revised (**Figure 6**).

[8] In the revised cross-sections, the folding of the Triassic formations (identified using the reinterpretation of the geology based on remote sensing) is virtually unchanged. The seismic data to the north (**Figure 1**) shows a monocline present within the underlying Permian strata, and the seismic line to the south indicates that this monocline probably extends southwards.

[9] However, its location cannot be determined with any certainty, so the extent of the Permian strata to the west of the lease has not been mapped on the cross-sections. The stratigraphic data from the Bridge Oil bores (southern cross-section) indicates that the Permian coal measures may dip more steeply to the west of the lease, as noted by Bridge Oil (1983). However, the western Bridge Oil bores did not intersect any of the main coal seams, so the change in dip is uncertain.

[10] The Permian strata must be affected by the folding in the overlying Triassic formations, so that on the eastern flank of the Great Dividing Range they are likely to dip shallowly eastwards (as stated in para 38 of Dr Webb's expert report), but this is not shown on Figure 5 due to the uncertainty as to the depth of the coal measures. The recognition of the unconformity at the base of the Rewan Formation (described above) means that although the coal seams may lie at a greater depth beneath the Great Dividing Range than previously envisaged, along the Great Dividing Range the upper surface of the Bandanna/Colinlea

aquifer (i.e. the base of the Rewan Formation) is probably still topographically higher than the subcrop of the CD sandstone (para 45 of Dr Webb's expert report). As a result, the folding identified in the Triassic strata still helps to explain the eastwards groundwater flow in the Bandanna/Colinlea aquifer.

[11] The change in the cross-sections does not alter the fact that recharge to the Bandanna/Colinlea aquifer must be occurring beneath the ranges, as shown by the recharge pathways on the cross-sections, which are identical to those on the previous cross-sections.

[12] The seismic lines within Kevin's Corner clearly show evidence for faulting (**Figure 7**).

[13] Faulting is common in the central Galilee Basin (Moya et al. 2014), and one of the faults (Thomson River Fault) has a vertical displacement of up to 650 m and traverses several aquitards, so that it apparently forms a conduit for vertical groundwater flow to the surface.

[14] Mr Stewart notes in para 78 of the Joint Experts Report that "possible folding is thus thought by Dr Webb to only occur within the remnant outcrop, an area of ~400 km^2 of elevated terrain to the west of the MLAs". Fig. 4d of Dr Webb's expert report shows that the folding extends over much of the area to the west of the leases; the broken topography along the anticline crests, which represents only part of this area, covers ~400 km^2.

[15] Mr Stewart (para 78 of the Joint Experts Report) refers to "inselberg features" in the area of elevated terrain to the west of the MLAs, but an inselberg is an isolated hill or outcrop that rises abruptly from a gently sloping or virtually level surrounding plain (Wikipedia); Uluru is a good example of an inselberg. The sandstone ranges to the west of the mine leases could not be regarded as inselbergs.

3. Albro Springs

[16] Using the potentiometric surface data from Figure 3 in the Joint Experts' report and the topography from the Shuttle Radar DEM (processed by Geoscience Australia at 1 second resolution and hydrologically enforced), a long section was constructed from southwest of Alpha, through both the Alpha and Kevin's Corner leases to the northernmost data point on Figure 3; this is **Figure 8** below. This figure clearly shows that the potentiometric surface in the Colinlea Sandstone becomes artesian north of Albro Springs, and the change from non-artesian to artesian conditions occurs at approximately the location of the springs (there is a lack of data points in this area, so the precise location of the change from non-artesian to artesian conditions is uncertain).

[17] Mr Stewart considers that the dissolved silica in the Albro Springs water is derived from silicates such as kaolinite in the Tertiary saprolite (para 154, Joint Experts' Report). It is more likely that the dissolved silica is derived from weathering of feldspars in the Permian sandstones; feldspars are readily weathered, whereas kaolinite is stable in most groundwater (Drever 1997), and feldspar grains are known to be present in the Colinlea Sandstone (Day et al. 1983).

4. Recharge

[18] Mr Stewart notes in para 81 of the Joint Experts Report that additional modelling using increased recharge resulted in a model that could not be calibrated. This modelling used a recharge value of 1% of rainfall; current estimates of recharge using the Chloride Mass Balance method are ~0.3% of rainfall (para 55 of Dr Webb's expert report).

[19] Mr Stewart attributes the bulk of recharge into the Bandanna/Colinlea aquifer to be derived from outcrops of Permian strata to the south rather than recharge along the Great Dividing Range (paras 95 and 166 in the Joint Experts' Report). The relative contribution of recharge from the south and from the Great Dividing Range to the west can be derived from the relative amounts of groundwater flow within the aquifer from the south and west. The groundwater flow per unit cross-sectional area in the Colinlea Sandstone can be calculated from hydraulic conductivity x hydraulic gradient (Darcy's Law). The hydraulic gradient is given by the spacing of the contours on the potentiometric surface; in Figure 3, the spacing between contours indicating flow to the northeast from the Great Dividing Range is approximately the same as the spacing between the contours indicating flow from the south, i.e. the hydraulic gradient is about the same in both directions. If the hydraulic conductivity of the aquifer is approximately the same across the area of the mining leases, then groundwater flow per unit area in the Colinlea Sandstone is approximately the same from the west and south, i.e. the contribution of recharge from the Great Dividing Range is about the same as that from the south.

[20] Mr Stewart notes that "rainfall events in the order of 200 mm per month or more are required for preferred pathway flow to be initiated" (para 107 of the Joint Experts' Report). It is uncertain how this figure was derived; no reference is given.

[21] Mr Stewart notes that application of the Chloride Mass Balance method to calculate recharge may be inaccurate due to the assumption of negligible runoff, lack of long term data for rainfall composition, recycling of dried salt by wind and uptake by harvested plants (paras 118 and 119 of the Joint Experts' Report). In this area most rainfall events do not generate significant runoff, so that the percentage of rainfall that becomes runoff is, overall, very small. The measurement of the salinity of rainfall takes into account salt dryfall (windblown dust), in that the collection containers for rainfall automatically collect both dryfall and rainfall. Any loss of chloride due to uptake by harvested plants would be very small in this area, as there is virtually no cropping. Variability of chloride content of rainfall is likely to occur; however the rainfall chloride level used in the calculation (0.5 mg/L) is typical of areas of Australia that lie similar distances from the coast. As a result, the calculated recharge using the Chloride Mass Balance method is likely to be approximately correct, i.e. around 0.1-0.3% of rainfall; no great accuracy is claimed for this value. The recharge used in the modelling was 1.14×10^{-8} m/day (para 17, Joint Experts' Report); this is equivalent to 4.16×10^{-3} mm/yr, i.e. 0.000629 % of rainfall (using a mean annual rainfall of 662 mm).

5. Confined/unconfined aquifer

[22] Mr Stewart considers the Colinlea Sandstone within the Kevin's Corner MLA to be confined (paragraphs 86-89, Joint Experts' Report). There is no doubt that within the area of outcrop along the eastern edge of the MLA, the aquifer is unconfined (**Figure 9**). However, within the main part of the MLA it is overlain by the Tertiary cover, which is an aquitard. Whether the Colinlea Sandstone is confined or unconfined in this area depends on whether its potentiometric surface lies within the Tertiary cover (in which case it is confined) or within the aquifer itself (in which case it is unconfined). Mr Stewart states that the Tertiary saprolite is ~40 m thick and that in bore KMB-03A the potentiometric surface of the coal is ~13.5 m below the surface; therefore in this area the Colinlea Sandstone is confined (**Figure 9**). However, the conceptual hydrogeological cross-sections within the EIS reports show the potentiometric surface of the CD sandstone to lie with the Bandanna/Colinlea aquifer to the west of the mine site, implying that it is unconfined in this area (**Figure 9**).

6. Baseflow to Sandy Creek

[23] Because the potentiometric surface of the Permian strata becomes closer to the surface northwards, in his Expert Report (para 60) Dr Webb stated that groundwater could potentially contribute baseflow to Sandy Creek to the north of the mine area.

[24] Mr Stewart has demonstrated that this is unlikely (paras 142-145, Joint Experts' Report).

[25] Mr Stewart notes that "the Carmichael River is ephemeral" (para 146, Joint Experts' Report), but its upper reaches flow permanently due to inflow from Doongmabulla (Joshua) Spring.

7. References

Bridge Oil Ltd, 1983. Authority to Prospect 245C. Report for 20 sub-blocks relinquished 14 December 1982.

Carr, A.F., 1973. Galilee Basin exploratory coal drilling – Wendouree area. Geological Survey of Queensland Record 1973/12.

Day, R.W., Whitaker, W.G., Murray, C.G., Wilson, I.H. and Grimes, K.G., 1983. Queensland geology. Geological Survey of Queensland Publication 383.

Drever, J.I., 1997. The geochemistry of natural waters. Third edition.

Moya, C.E., Raiber, M. and Cox, M.E., 2014. Three dimensional modelling of the Galilee and central Eromanga Basins, Australia. New insights into aquifer/aquitard geometry and potential influence of faults on inter-connectivity. Journal of Hydrology: Regional Studies, 2, 1119-139.

Velseis, 2011. Galilee Basin reprocessed 2D seismic survey. Final report.

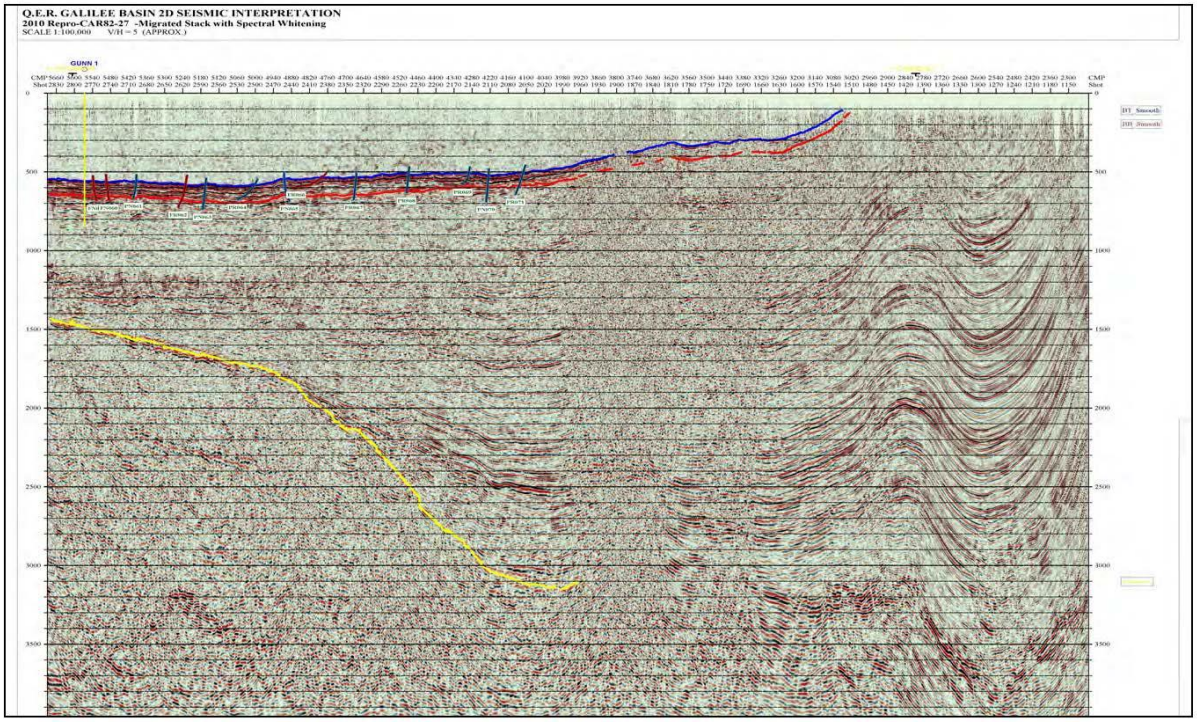


Figure 24. Seismic Line CAR82-27

Figure 1. Seismic line from Velseis (2011), showing in blue the top of the Permian coal measures; line runs southwest-northeast through the centre of the Carmichael lease. See Figure 4 for location.

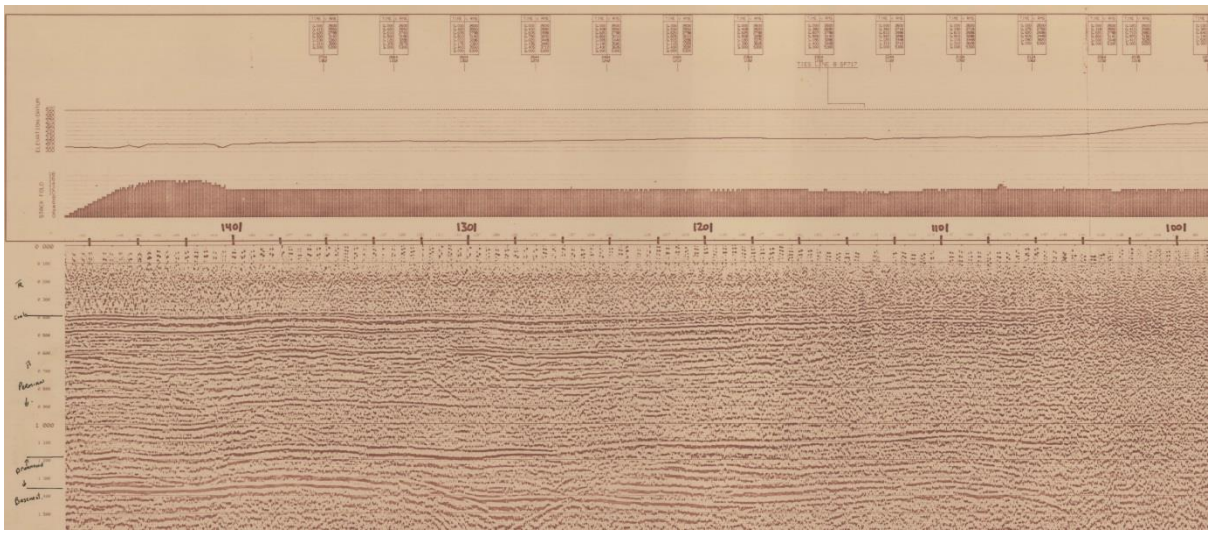


Figure 2. Western part of seismic line CAR 82-49; note top of coal measures marked on left hand side. To the east the resolution is too poor to distinguish the Permian strata. See Figure 4 for location. Image supplied by Romana Thefs, Geological Survey of Queensland (Department of Natural Resources & Mines).

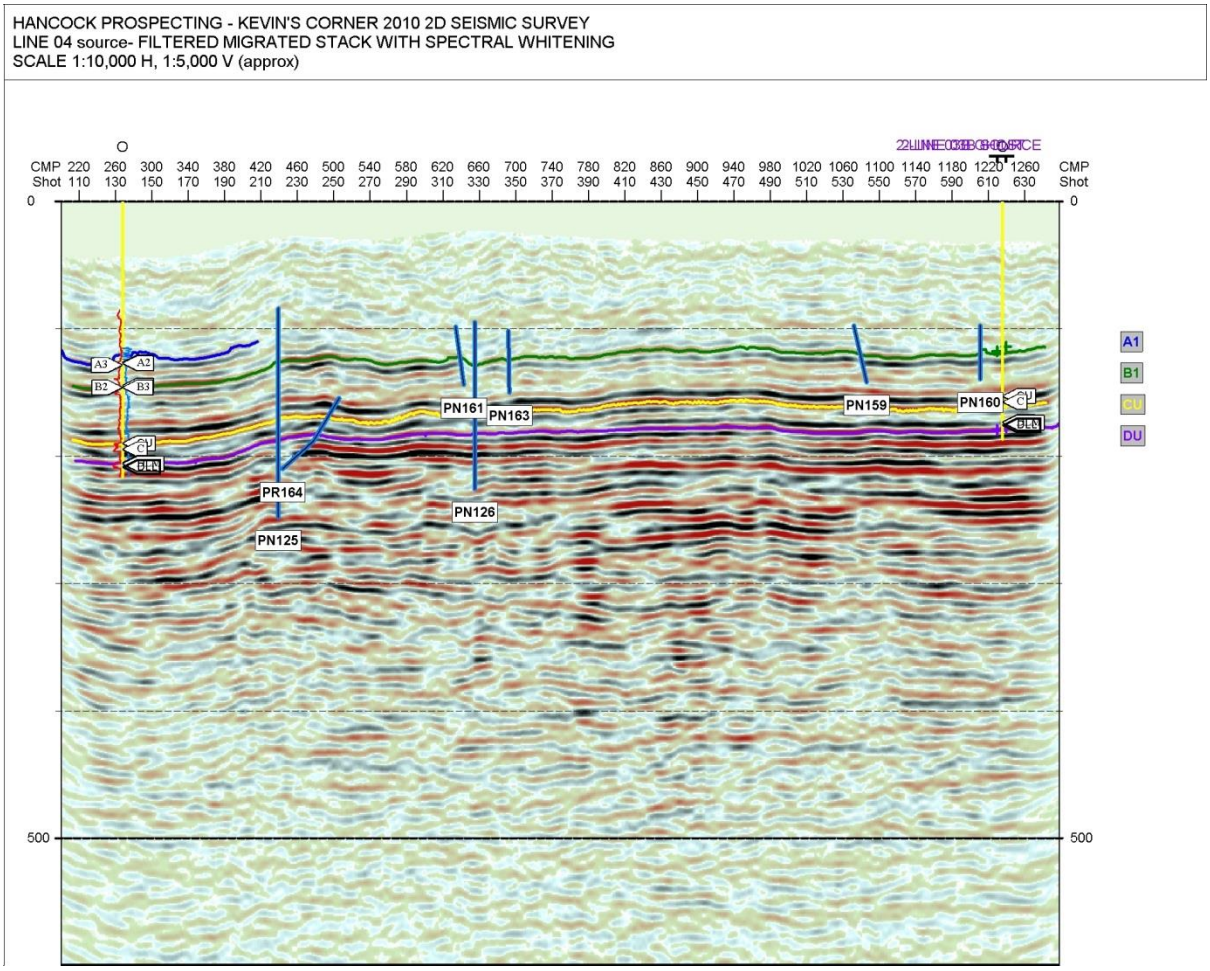


Figure 3. East-west seismic line 04 within Kevin's Corner lease; see Figure 4 for location.

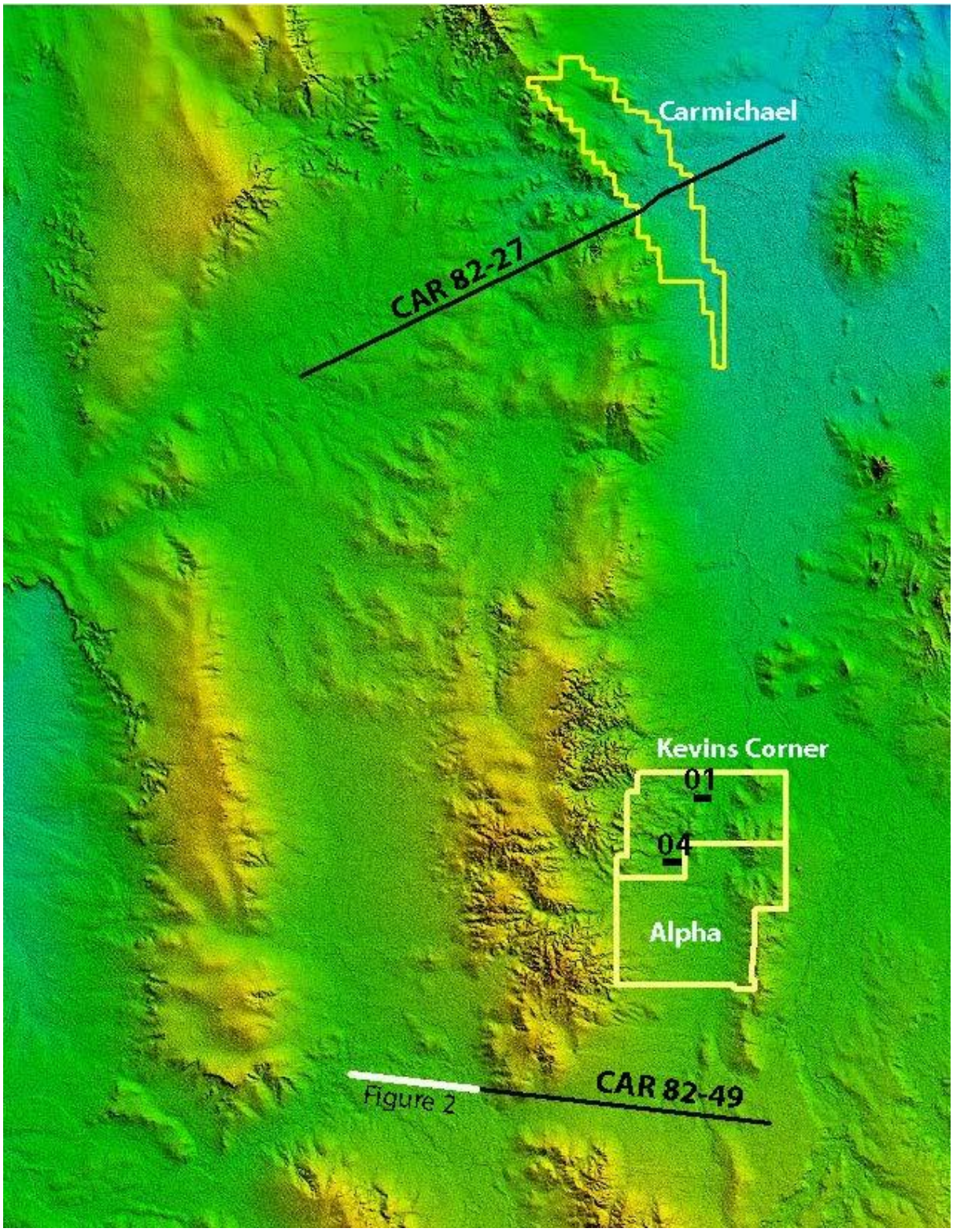
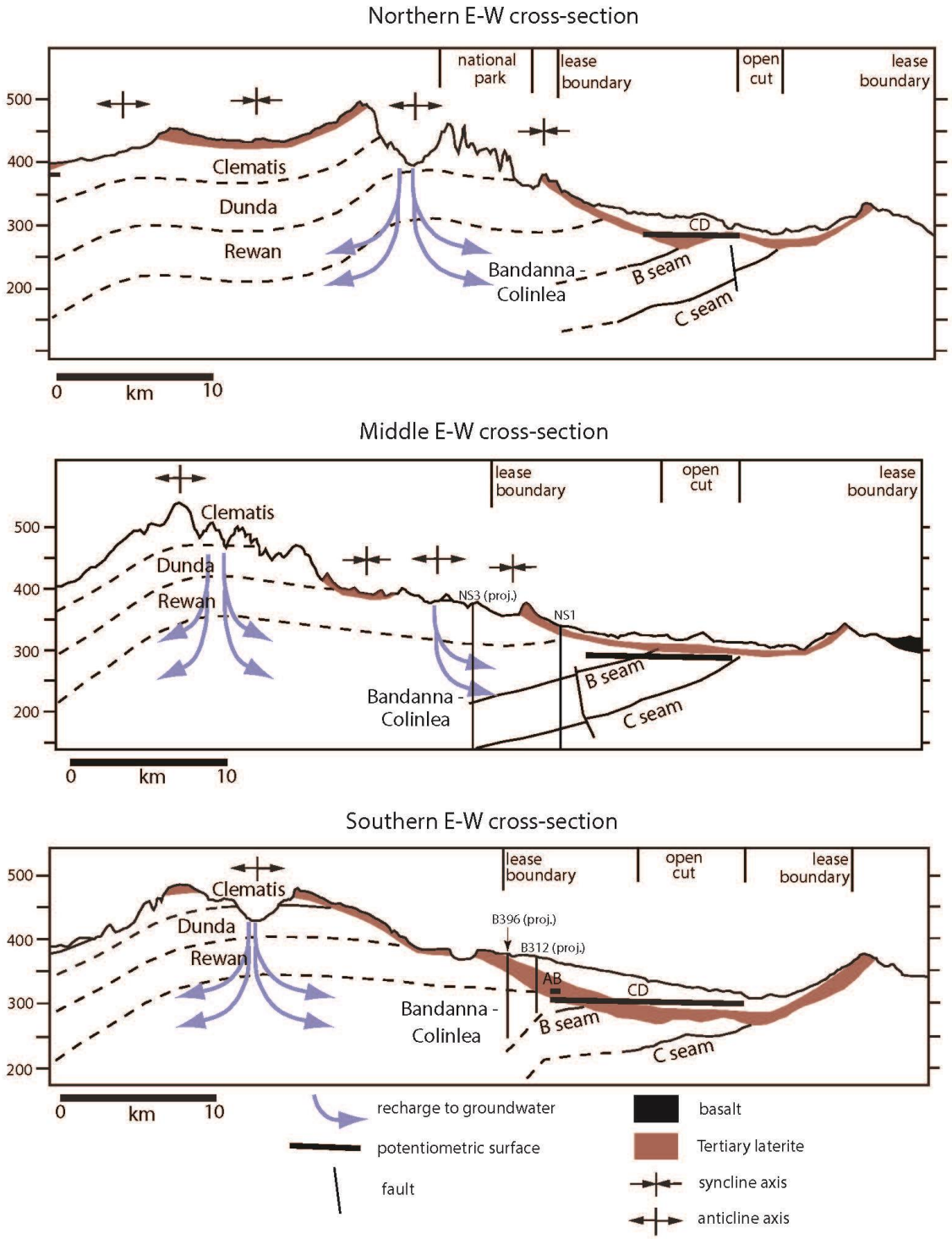


Figure 4. Location of seismic lines.



Cross-sections; all constructed using the remotely sensed images, existing geological map, airborne radiometric data, aerial observations during site visit, relevant bore logs and seismic lines 01 and 02 (northern section) and 04 and 05 (middle section)

Figure 5. Revised cross-sections; see Figure 6 for location.

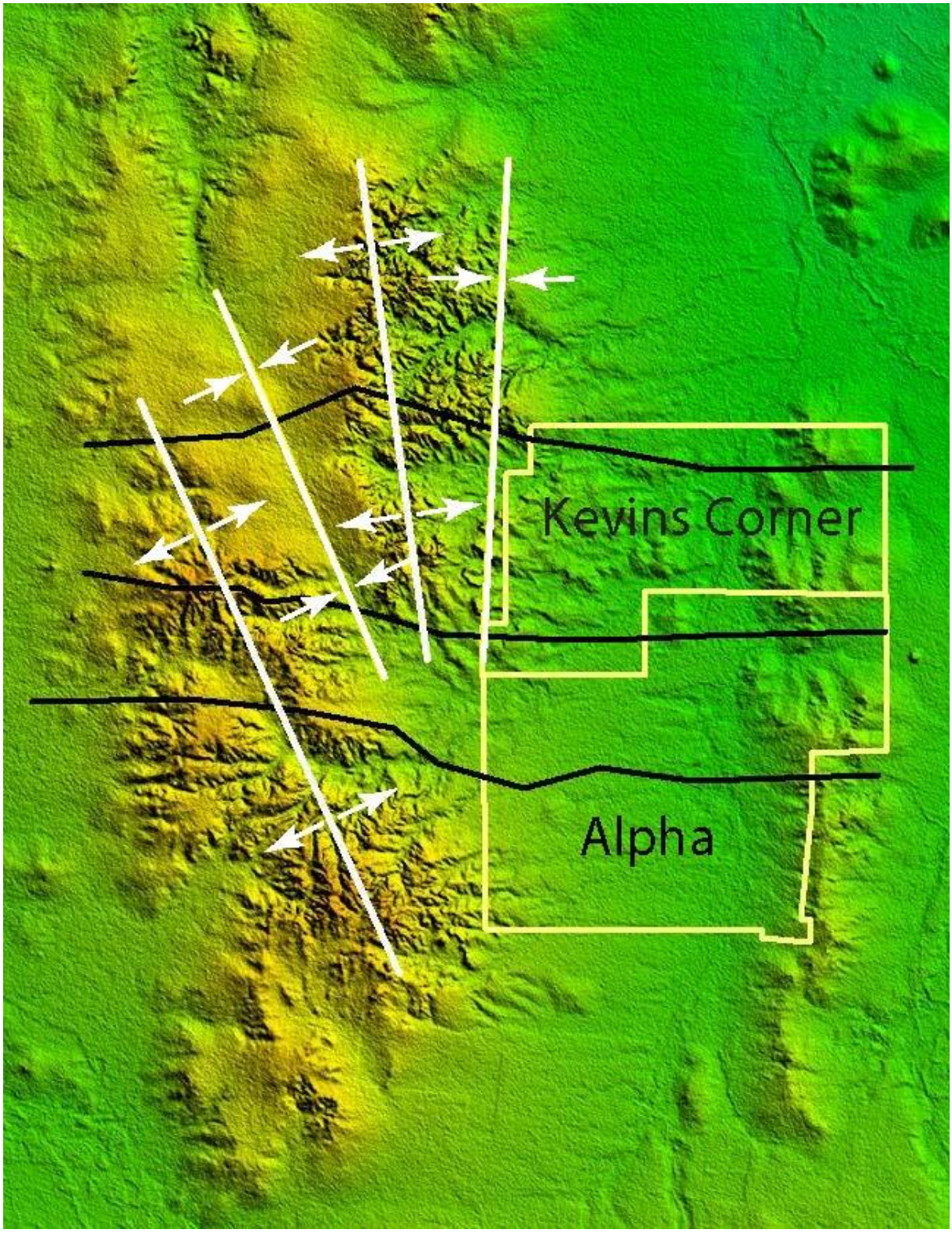


Figure 6. Location of fold axes within Triassic strata west of the mining leases; black lines show locations of sections in Figure 5.

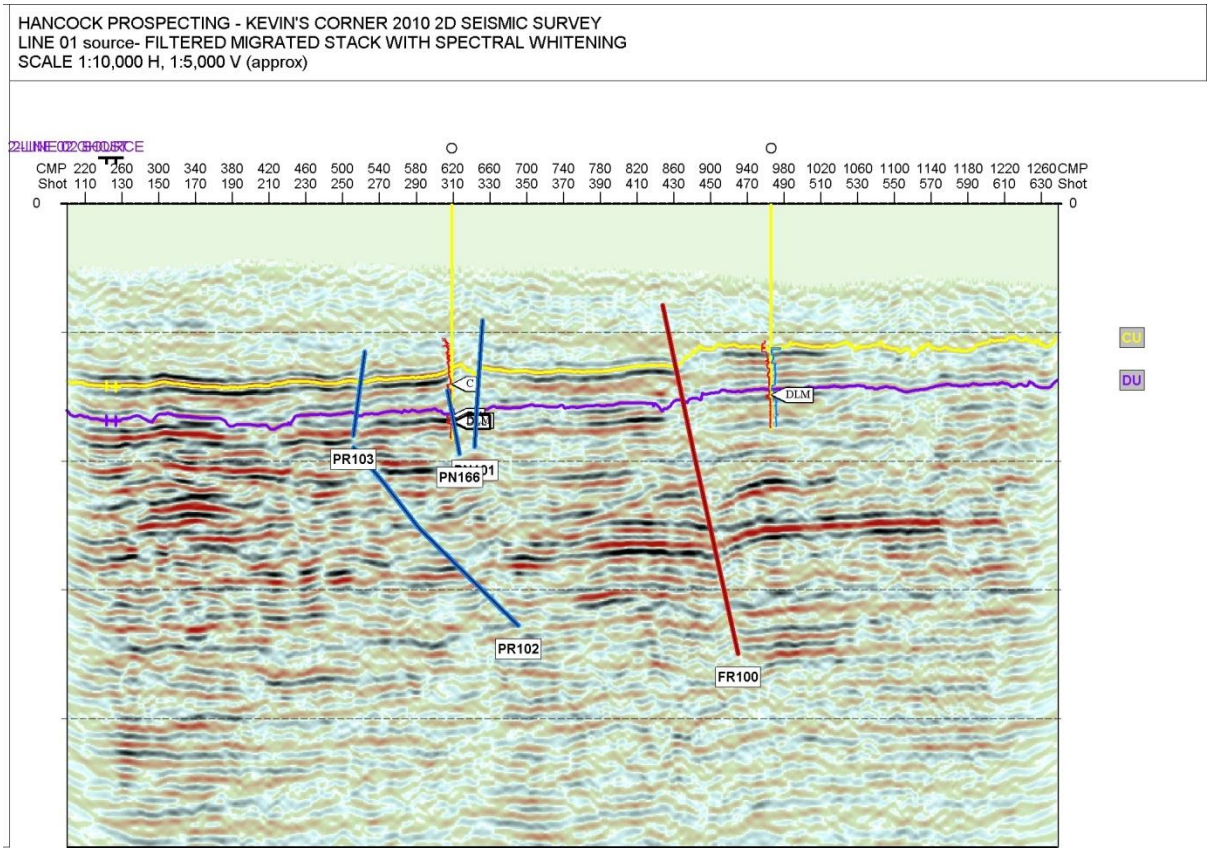


Figure 7. East-west seismic line 01 within Kevin's Corner lease; see Figure 4 for location.

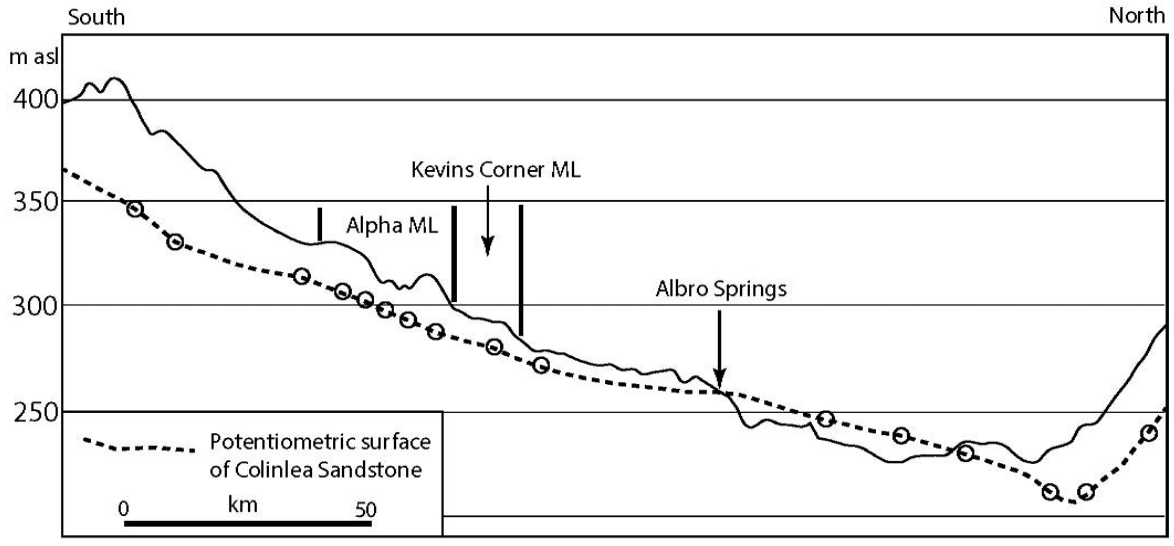


Figure 8. Long section showing relationship between topography and potentiometric surface of the Colinlea Sandstone; circles show data points from Figure 3 in Joint Experts' Report, together with additional data from bores within the Alpha and Kevin's Corner leases. Vertical exaggeration = 430.

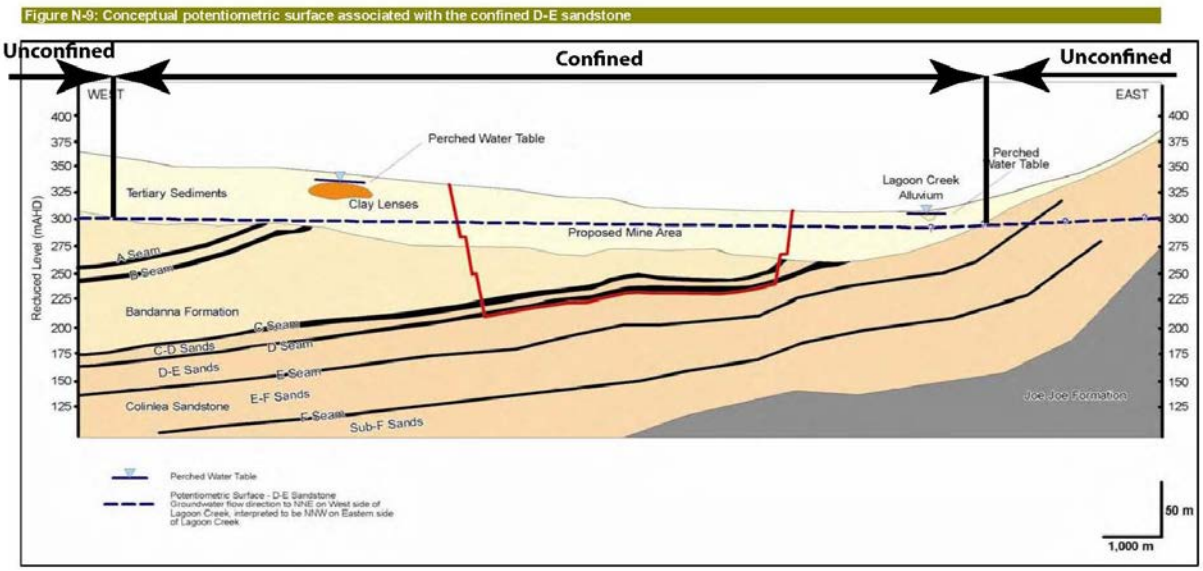


Figure 9. Annotated Figure N-9 from Appendix N, Groundwater and Final Void Report.

Confirmation

I confirm that:

(a) the factual matters stated in the report are, as far as I know, true; and

(b) I have made all enquiries I consider appropriate; and

(c) the opinions stated in the report are genuinely held by me; and

(d) the report contains reference to all matters I consider significant; and

(e) I understand my duty to the court and have complied with the duty; and

(f) I have read and understood the Land Court Rules 2000 as far as they apply to 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.

Assoc Prof John Webb

29 April 2015