1. Expert's Details & Qualifications

1.1 Name

My name is Iain Donald Hair.

I am Principal Hydrogeologist at Douglas Partners Pty Ltd.

1.2 Address

My business address is:

439 Montague Road,

West End Qld 4101.

1.3 Qualifications

I hold the following qualifications:

(a) Bachelor of Science (Hons.) Geology, University of Queensland;

(b) Grad. Diploma Applied Hydrogeology, Queensland Institute of Technology; and

(c) Master of Science (Environmental Science), Griffith University.

Annexure **A** to this report is my curriculum vitae, which sets out my professional qualifications.

Annexure **B** to this report is a listing of groundwater conditions set by the Coordinator-General, by the Federal Minister for the Environment, and conditions outlined in the draft Environmental Authority.

Annexure **C** to this report is a glossary of hydrogeological terms used in this report.

2. Introduction / Background to the Issues Examined

Hancock Coal Pty Ltd is proposing to develop the Alpha Coal Project, which includes the Alpha Coal Mine. The Alpha Coal Mine is proposed to be an open cut operation within Mining Lease Application (MLA) 70426. MLA 70426 is located approximately 50 km north of the Township of Alpha in the Galilee Basin in Central Queensland.

The Alpha Coal Mine has transitioned through the EIS Process, has been assessed by the Coordinator-General (subject to conditions) and has received approval from the Commonwealth Government (subject to conditions). The MLA and draft Environmental Authority are the subject of proceedings in the Land Court. Several parties have objected to the MLA and draft Environmental Authority, citing concerns over the level of impact on groundwater resources, the adequacy of groundwater investigations undertaken as part of the EIS Process, and other issues.

3. Instructions and Summary Response to Questions

I have been instructed by Allens on behalf of Hancock Coal Pty Ltd to provide a report in response to the following questions:

1. **Is the methodology used in the reports and studies to assess the potential impacts of the proposed Alpha Coal Mine on groundwater in accordance with standard professional practice for this type of project?**

   In my opinion, yes. The groundwater investigations undertaken throughout the EIS Process and since, to assess dewatering requirements for the mine and the subsequent potential impact of the mine on groundwater resources, are appropriate, of a high quality, and consistent with standard professional practice for a mine of this scale and nature.

2. **To the extent that opinions and conclusions are expressed in the reports and studies regarding the conditions and nature of the aquifers described in the reports and studies, in your opinion are those opinions and conclusions reasonable?**

   In my opinion, yes. The opinions and conclusions expressed regarding the nature and extent of aquifers in the vicinity of the proposed Alpha Coal Mine are reasonable, based as they are on an appropriate analysis of available hydrogeological information.

3. **In your opinion, does the information contained in the reports and studies evidence a sufficient, adequate and accurate level of study and assessment, taking into account standard professional practice for similar projects, to enable the assessment of the proposed Alpha Coal Mine's potential impacts on groundwater?**

   In my opinion, yes. The level of investigations applied to assessing the potential impact of the proposed Alpha Coal Mine on local and regional groundwater resources has been detailed and is in keeping with standard professional practice for such projects. It is always possible to undertake further investigations, but there is a point at which additional investigations will not add significantly to a better understanding of the groundwater system.

4. **In your opinion, is there is a sufficient, adequate and accurate level of information to conclude with an acceptable level of certainty, taking into account standard professional practice for similar projects, that the findings of the report in terms of impacts on groundwater are correct?**

   In my opinion, yes. Investigations undertaken to date have been thorough and in accordance with standard professional practice. The collation and analysis of hydrogeological data has resulted in a high quality characterisation of the groundwater system. Numerical modelling of the groundwater system which been used to assess the impact of the proposed Alpha Coal Mine on the groundwater system is of a high standard.

5. **In relation to the advice of the Interim Independent Expert Scientific Committee to the Commonwealth Environment Minister, in your opinion have:**

- **the matters raised in that advice been appropriately assessed by the information in the EIS, SEIS and supplementary documentation to date? and**

- **the matters raised in that advice been adequately addressed by the conditions of the *Environment Protection and Biodiversity Act* 1999 approval, the Coordinator-General's conditions and the conditions of the draft Environmental Authority?**

In my opinion, yes. I consider that the matters raised in Point 2 of the advice of the IIESC Committee to the Commonwealth Environment Minister (IIESC, 2012) have been adequately addressed in the EIS, SEIS and supplementary documentation.

Points 3, 4 and 5 of the advice of the IIESC Committee relate to regional cumulative impacts on the groundwater system. I consider that the work done in in the EIS, SEIS and supplementary documentation adequately covers the cumulative potential impact of the proposed Alpha and Kevin's Corner Coal Mines. Cumulative impacts for other proposed projects in the Galilee Basin are covered by conditions set by the Coordinator-General (C-G, 2012).

The potential for the Alpha Coal Mine to impact on groundwater resources of the GAB to the west (IIESC (2012), Point 6a) is minimal in my opinion.

In my opinion, matters raised in the advice of the IIESC (IIESC, 2012) have been adequately addressed by the conditions of the *Environment Protection and Biodiversity Act* 1999 approval, the Coordinator-General's conditions and the conditions of the draft Environmental Authority.

6. **Based on your review of the reports and studies, do you consider that the potential impacts the proposed Alpha Coal Mine will have on groundwater to be significant?**

   In my opinion, dewatering for the mine will have a considerable local impact on groundwater resources. Some local bores will become unduly affected. The mine will have a long term impact on local groundwater resources due to the post-mining existence of final voids, which will act as "sinks" in the groundwater system. Eventually, a new equilibrium between water levels in final voids and groundwater levels in the region will be established.

7. **In relation to the obligations imposed upon Hancock Coal Pty Ltd as conditioned by the:**

   - **Coordinator-General;**

   - **the draft Environmental Authority; and**

   - **the *Environment Protection Biodiversity and Conservation Act* 1999 (Cth) approval,**

   to undertake groundwater investigations:

   (a) In your opinion, are the obligations reflective of industry standards and adequate regarding the potential impacts to groundwater given the scale and nature of the proposed Alpha Coal Mine?; and

   (b) To the extent that there may be a degree of scientific uncertainty regarding any conclusions about the impacts of the proposed Alpha Coal Mine on groundwater,

do you consider that the conditions imposed upon Hancock Coal Pty Ltd adequately address and mitigate the risk of any such uncertainty?

In my opinion, yes to each question. The conditions are considered to be industry standard, appropriate for a mining project of this size and nature, and sufficient to mitigate the risk of uncertainty associated with the groundwater impact assessment for the proposed mine.

4. Facts and Assumptions

In producing this report, I have relied on facts and assumptions contained within the following reports and documents:

1. Hancock Alpha Project Initial Advice Statement (HPPL, 2008);
2. Terms of reference for an environmental impact statement for the Alpha Coal Project (C-G, 2009);
3. Alpha Coal Project Environmental Impact Statement (HPPL, 2010), Volume 2, Section 12 – Groundwater;
4. Alpha Coal Project Groundwater Technical Report (JBT Consulting, 2010);
5. Alpha Coal Project Supplementary Environmental Impact Statement. Volume 1, Section 4 (HPPL, 2011a);
6. Alpha Coal Project Supplementary Environmental Impact Statement. Volume 2, Appendix N. Groundwater and Final Void Report (HPPL, 2011b);
7. Alpha Coal Project Supplementary Environmental Impact Statement. Volume 2, Appendix O. Groundwater Bore Survey Report (HPPL, 2011c) and 4T Consultants (2011);
8. Alpha Coal Project Supplementary Environmental Impact Statement. Volume 2, Appendix T. Alpha Coal Tailings Storage Facility – Concept Design Report (HPPL, 2011d) and PB (2011);
9. Alpha Coal Project Supplementary Environmental Impact Statement Addendum. Section 1. Introduction (HCPL, 2011a);
10. Alpha Coal Project Supplementary Environmental Impact Statement Addendum. Appendix C. Out-of-Pit Tailings Storage Facility: Hydrogeological Assessment (HCPL, 2011b) and URS (2011);
11. Alpha Coal Project. Coordinator General's Evaluation Report on the environmental impact statement (C-G, 2012);
12. Alpha Coal Mine Environmental Management Plan (HCPL, 2012);
13. Groundwater Modelling Report - Alpha Coal Project (URS, 2012);
14. Advice to Decision Maker on Coal Mining Project – Alpha Coal Mine, QLD (EPBC 2008/2648), IIESC (2012); and
15. Federal Approval Decision by Hon Tony Burke MP. Minister for Sustainability, Environment, Water, Population and Communities (DSEWPC, 2012).

In compiling this report I have also reviewed hydrogeological information held in the Department of Natural Resources and Mines (DNRM) Groundwater Database, the Queensland Springs Database (V4), the CSG Wells Database and the Petroleum Wells Database.

I have also held discussions with Mr Mark Stewart (Principal Hydrogeologist, URS Australia Pty Ltd), the consultant primarily involved in groundwater investigations for the Alpha Coal Mine. Notwithstanding the discussions with Mr Stewart, the opinions expressed in this report were formed by my own research and are genuinely held by me.

5. Opinion and Findings

5.1 Question 1: Methodology in Accordance with Standard Professional Practice

In my opinion, the methodology used in the groundwater investigations to assess the potential impacts of the proposed mine on groundwater resources is in accordance with standard professional practice for a proposed mine of this scale and nature.

The standard methodology in undertaking a groundwater impact assessment for a large scale mining operation includes:

- Collation of available hydrogeological data from various sources to compile a Conceptual Hydrogeological Model (CHM). In development of the CHM, JBT Consulting (2010) followed standard practice in:
    - Reviewing information from previous investigations including AGC (1983) and Longworth & McKenzie (1984);
    - Collating information from coal exploration drilling programs;
    - Assessing published geological and topographic mapping;
    - Sourcing and reviewing data from the DNR&M Groundwater Database;
    - Installing groundwater monitoring bores and vibrating wire piezometers to assess groundwater levels and flow directions;
    - Assessing hydraulic characteristics of identified aquifer units; and
    - Utilising data to assess the thickness and extent of aquifer and aquitard units in both local and regional context.
- Undertaking a thorough landholder bore survey to obtain baseline information on groundwater resources, and to identify groundwater facilities which may be adversely affected by mining operations (4T Consultants, 2011); and
- The construction of a Numerical Groundwater Flow Model, based on the CHM, which is utilised in order to:
    - Assess dewatering requirements and groundwater control measures for mining operations;

- Assess the level of impact on local and regional groundwater resources which may ensue from mine dewatering and groundwater control measures; and
- Identify groundwater use (landholders' bores and groundwater dependent ecosystems) which may become adversely affected as a result of adopted mine dewatering and groundwater control measures.

In the case of the current Numerical Groundwater Flow Model for the proposed Alpha Coal Mine (described in URS (2012)), the opportunity has been taken to calibrate numerical modelling against data obtained during a dewatering trial of the Alpha Test Pit which was constructed over the period November 2010 to July 2011 in order to obtain a bulk sample of coal. The ability of the model to simulate pumping during the Alpha Test Pit trial and replicate measured groundwater level behaviour provides confidence in the capacity of the model to predict the impact that will occur from full scale mining.

Notwithstanding the above, once mining commences, the model will be regularly re-calibrated against monitoring data to confirm and improve its predictive capability.

5.2 Question 2: Reasonableness of Opinions and Conclusions on the Nature of Aquifers

In my opinion the current understanding of the nature of the groundwater system at the proposed Alpha Coal Mine and surrounding areas is reasonable, based on the data available, the conclusions drawn regarding the groundwater system, and the rigour of groundwater investigations undertaken.

Appropriate methodology has been applied in collating geological and hydrogeological data and in obtaining additional data from field investigations. The data have been appropriately analysed in order to achieve a good understanding of the nature and extent of aquifers in the vicinity of the proposed Alpha Coal Mine.

5.3 Question 3: Adequacy of Groundwater Studies and Accuracy of Impact Assessment

Groundwater studies undertaken to assess the potential impact of the proposed Alpha Coal Mine are, in my opinion, of a high standard. The latest numerical modelling is of a very high standard, calibrated as it is against a dataset derived from a long term dewatering trial of the Alpha Test Pit.

It is always possible to do more and more investigations, but there comes a time when further groundwater investigations will not add significantly to a better understanding of the groundwater system.

Investigations completed to date have been collectively sufficient to characterise the groundwater system at the proposed Alpha Coal Mine and in the surrounding region, and to allow for a reasonably accurate assessment of the potential impacts of mining on groundwater resources.

Baseline groundwater monitoring will provide additional data against which to assess the performance of the Alpha Coal Mine Numerical Groundwater Flow Model after a few years of mining and at regular intervals thereafter.

5.4 Question 4: Quantum, Adequacy and Accuracy of Groundwater Information

In my opinion, there is a sufficient, adequate and accurate level of information to conclude with an acceptable level of certainty that the findings of investigations undertaken to date are correct in terms of impacts on the groundwater system at the Alpha Coal Mine and in surrounding areas.

Investigations undertaken for the EIS and subsequent to the EIS, to assess the potential impacts from mining on the groundwater system have been thorough and in accordance with standard professional practice. The collation of available data and obtaining further data through field investigations has resulted in a level of information sufficient to adequately characterise the groundwater system. Numerical modelling of the groundwater system has been calibrated to data obtained during the construction of a trial pit which was developed to obtain a bulk sample of coal. This calibration provides a high level of confidence in the predictive capacity of the model which has subsequently been used to assess the impact of the proposed Alpha Coal Mine on the groundwater system.

5.5 Question 5: Advice of the Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (IIESC) to the Commonwealth Environment Minister

The IIESC (2012) provided advice to the Commonwealth Environment Minister (The Hon. Tony Burke MP) to assist him in his decision to approve or not approve the Alpha Coal Mine. The advice of IIESC (2012) is evident in groundwater related conditions set by Minister Burke in approving the Alpha Coal Mine.

The IIESC (2012) expressed concerns about the potential of the proposed Alpha Coal Mine to adversely affect groundwater resources of the overlying Great Artesian Basin (GAB) which occurs to the west of the mine. I do not share the concerns of IIESC (2012) in this regard. Drawing 1 (attached) shows the spatial relationship between formations of the GAB and MLA70426, which surrounds the proposed Alpha Coal Mine. Outcrop of the Clematis Sandstone (the basal aquifer of the GAB) is to the west of the proposed mine. Between the proposed mine and the Clematis Sandstone is the Rewan Formation, a unit of several hundred metres thickness dominated by mudstone. The Rewan Formation is an aquitard, and forms a natural hydraulic barrier between the Clematis Sandstone and the proposed mine.

Limited mining induced drawdown in the Colinlea Sandstone aquifer beneath the GAB, and the low vertical permeability of the Rewan Formation would preclude loss by drainage of groundwater resources of the Clematis Sandstone aquifer. Drawing 2 (attached) shows the stratigraphic relationship between the Clematis Sandstone and Rewan Formation of the GAB, and the Colinlea Sandstone of the Galilee Basin.

Numerical modelling undertaken by URS (2012) indicates that there is unlikely to be a discernable impact on groundwater levels in the GAB from the Alpha Coal Mine post mining, following the establishment of a quasi steady state water level in final pit voids.

The IIESC (2012) Advice Point 2 states that in relation to relevant water matters, information presented by the proponent could be improved by providing:

(a) Further details of measured hydrogeological data, and groundwater model parameters, uncertainties, confidence and transparency;

(b) A site and regional water balance;

(c) Surface water quantity and quality impacts;

(d) Associated risk assessments; and

(e) Mitigation measures to appropriately address risks.

In my opinion, the hydrogeological data is sufficiently detailed in the EIS, SEIS and supplementary documentation in relation to these matters. The groundwater model of URS (2012) is well documented. A groundwater balance is included with the groundwater model.

Surface water quantity and quality will not be impacted as there is no hydraulic connection between surface water and groundwater within the area of influence on groundwater by the mining operation.

Risks associated with mining impact on groundwater are addressed by conditions set in the *Environment Protection and Biodiversity Act* 1999 approval, the Coordinator-General's conditions and the conditions of the draft Environmental Authority.

The IIESC (2012) Advice points 3, 4 and 5 deal with cumulative regional impacts and a regional water balance. In my opinion, the cumulative impacts of the proposed Alpha Coal Mine and the Kevin's Corner Coal Mine have been adequately addressed by the URS (2012) numerical model. It is to be expected that further development of coal resources in the Galilee Basin is likely to occur in the future. The cumulative impact of all proposed coal projects in the Galilee Basin is not a matter which should or could be addressed solely by Hancock Coal Pty Ltd. Proponents of other projects must contribute to the undertaking of a regional (basin-wide) impact assessment and water balance study.

In Condition 2, Part B, Appendix 2 of C-G (2012), the Coordinator-General addresses the cumulative impacts on groundwater as follows:

Condition 2. Regional groundwater monitoring and reporting program

To address the potential cumulative impacts on groundwater quality and availability in the Galilee basin, ***the Coordinator-General has imposed the following condition for the Alpha project that will be similarly imposed for other projects in the basin***. DEHP is designated as the agency responsible for this condition.

(a) The proponent must:

(i) before commencing mining activities prepare to the satisfaction of the administering authority and implement a groundwater monitoring and reporting program for aquifers impacted by the project off the mining lease

(ii) design the program to complement the environmental authority requirements and other groundwater management programs in the Galilee basin. The program should aim to enable a ***basin groundwater model*** to be developed to predict, verify and monitor groundwater impacts.

(iii) make monitoring results from the program publicly available on the proponent's web site updated at least annually

(iv) ***contribute to any basin wide collaborative project established by the administering authority to develop a basin groundwater model, including pro-rata funding***

(v) ***contribute to development of a basin wide groundwater model for determining the capacity of aquifers and acceptable extraction rates, including pro-rata funding***

Imposed condition 2, Part B, Appendix 2 would be complemented by DEHP/DNRM as the lead agencies for developing a coordinated basin wide monitoring and assessment program, to organise and collate basin wide monitoring programs, data and reports, and to ensure such outcomes influence the ongoing management of groundwater resources.

In my opinion, this condition is sufficient to address the matters raised in IIESC (2012) Advice points 3, 4 and 5.

5.6 Question 6: Severity of Potential Impacts on Groundwater

The level of mining induced impact on groundwater resources in the vicinity of the proposed Alpha Coal Mine will be substantial. The amount of groundwater to be pumped for dewatering and groundwater control at the proposed Alpha Coal Mine is considerable. Pumping for ~30 years at a continuous rate of ~60 L/s will lower groundwater levels over a wide area.

Several waterbores on surrounding properties will become unduly affected resulting in loss of water supply. Numerical modelling (URS, 2012) indicates the extent of impact, and 4T Consultants (2010) has established baseline conditions for all bores in the region, including those which will become unduly affected.

Hancock Coal Pty Ltd will be required under any *Water Act* licenses to restore any unduly affected water supplies in terms of both yield and quality. The most appropriate means of restoring supply will be by establishing new (deeper) bores in lower sections of the Colinlea Sandstone aquifer which will be largely unaffected by mining operations. The deeper sections of the Colinlea Sandstone Aquifer will be accessible by the proponent to provide an alternate source for restoration of unduly affected water supplies.

Bores should be constructed in accordance with the Minimum Construction Requirements for Waterbores in Australia (NUDLC, 2012). Very few existing landholders' bores would be constructed to the NUDLC (2012) standard; therefore, for any bores which are replaced, the landholder will likely be provided with a better, more efficient bore than the existing facility.

Outside of the area indicated by the numerical modelling of URS (2012), the groundwater system is very likely to remain unaffected.

Investigations completed to date indicate that within the area of influence of the mine (i.e. inside the area indicated by the numerical modeling of URS (2012)), there is no groundwater / surface water interaction; therefore, surface water resources are very unlikely to be affected by the mine.

In addition, the area of influence of the mine does not extend to identified springs or to the GAB. Groundwater resources of the GAB and the identified springs will remain unaffected by the Alpha Coal Mine.

5.7 Question 7: Conditions to be Applied by Regulatory Authorities

I have been asked to comment on the conditions set by the Coordinator-General (C-G, 2012), by the Federal Minister for the Environment (DSEWPC, 2012), and conditions outlined in the draft Environmental Authority, as they relate to monitoring and mitigating the potential impact of the proposed Alpha Coal Mine on groundwater resources.

I have reviewed the conditions set in these documents and consider them to be reflective of industry standards and adequate regarding the potential impacts of this project to groundwater.

As with all mines of this nature and scale, there is a level of uncertainty around the extent of impacts because of limitations in knowledge (data gaps) of groundwater systems. A level of uncertainty is inevitable.

However, I consider that the groundwater monitoring conditions to be applied, and the requirements for restoration of unduly affected groundwater resources, are sufficient to adequately address and mitigate the risk of uncertainty associated with this mine.

A listing of groundwater conditions set by the Coordinator-General, by the Federal Minister for the Environment, and conditions outlined in the draft Environmental Authority is provided in Annexure B.

6. Additional Information Required

To my knowledge, there are no readily ascertainable additional facts that would assist me to reach more reliable conclusions than those outlined in this report.

7. References

4T Consultants Pty Ltd., 2011: Hancock Coal Kevin's Corner and Alpha Coal Projects. Field Report. Historic Data Collation and Field Survey of Surrounding Landholder Bores. Report prepared for URS Australia. July 2011. Included in the HPPL Alpha Coal Project Supplementary Environmental Impact Statement as Volume 2, Appendix O.

Australian Groundwater Consultants Pty Ltd., 1983: Alpha Coal Project (A to P 245C). Surface Water and Groundwater Aspects – Preliminary Evaluations. Report prepared for Bridge Oil Limited..

Coordinator-General (The), 2009: Terms of reference for an environmental impact statement. Alpha Coal Project. Under Part 4 of the State Development and Public Works Organisation Act 1971 and Environment Protection and Biodiversity Conservation Act 1999 (Cwlth). June 2009.

Coordinator-General (The), 2012: Alpha Coal Project. Coordinator General's Evaluation Report on the environmental impact statement. May 2012.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPC), 2012: Approval Decision Alpha Coal Mine and Rail Proposal, Galilee Basin, Queensland (EPBC 2008/2648). August, 2012.

Hancock Coal Pty Ltd., 2011a: Alpha Coal Project Supplementary Environmental Impact Statement Addendum. Section 1. Introduction. November 2011.

Hancock Coal Pty Ltd., 2011b: Alpha Coal Project Supplementary Environmental Impact Statement Addendum. Appendix C. Out-of-Pit Tailings Storage Facility: Hydrogeological Assessment. November 2011.

Hancock Coal Pty Ltd., 2012: Alpha Coal Mine Environmental Management Plan. November 2012.

Hancock Prospecting Pty Ltd., 2008: Hancock Alpha Project Initial Advice Statement. September, 2008.

Hancock Prospecting Pty Ltd., 2010: Alpha Coal Project Environmental Impact Statement. Volume 2, Section 12 - Groundwater. October, 2010.

Hancock Prospecting Pty Ltd., 2011a: Alpha Coal Project Supplementary Environmental Impact Statement. Volume 1, Section 4. Comments and Responses – Coal Mine. August 2011.

Hancock Prospecting Pty Ltd., 2011b: Alpha Coal Project Supplementary Environmental Impact Statement. Volume 2, Appendix N. Groundwater and Final Void Report. August 2011.

Hancock Prospecting Pty Ltd., 2011c: Alpha Coal Project Supplementary Environmental Impact Statement. Volume 2, Appendix O. Groundwater Bore Survey Report. August 2011.

Hancock Prospecting Pty Ltd., 2011d: Alpha Coal Project Supplementary Environmental Impact Statement. Volume 2, Appendix T. Alpha Coal Tailings Storage Facility – Concept Design Report. August 2011.

Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (IIESC), 2012: Advice to Decision Maker on Coal Mining Project – Alpha Coal Mine, QLD (EPBC 2008/2648). July, 2012.

JBT Consulting, 2010: Alpha Coal Project Groundwater Technical Report. Report prepared for Hancock Prospecting Pty Ltd., and included in the Alpha Coal Project Environmental Impact Statement as Appendix G – Groundwater.

Longworth & McKenzie, 1984: Report on Geotechnical and Groundwater Investigation (1984) Area 2, ATP245C, Alpha, Queensland. Report prepared for Bridge Oil Limited.

National Uniform Drillers Licensing Committee (NUDLC), 2012: Minimum Construction Requirements for Waterbores in Australia. 3rd Edition. February, 2012. Australian Government National Water Commission.

Parsons Brinckerhoff Australia Pty Ltd., 2011: Alpha Coal Tailings Storage Facility – Concept Design Report. Report prepared for Hancock Coal Pty Ltd. April 2011. Included in the HPPL Alpha Coal Project Supplementary Environmental Impact Statement as Volume 2, Appendix T.

URS Australia Pty Ltd., 2011: Alpha Coal Project. Out-of-Pit Tailings Storage Facility: Hydrogeological Assessment. Report prepared for Hancock Coal Pty Ltd. September 2011. Included in the HCPL Supplementary Environmental Impact Statement Addendum as Appendix C.

URS Australia Pty Ltd., 2012: Groundwater Modelling Report - Alpha Coal Project. Report prepared for Hancock Coal Pty Ltd. March 2012.

8. Expert's Statement

I confirm the following:

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

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

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

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

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

Iain Donald Hair

29 May 2013

Annexure A

CV Iain Hair – Principal Hydrogeologist,
Douglas Partners Pty Ltd

Douglas Partners
Geotechnics / Environment / Groundwater

Curriculum Vitae

IAIN HAIR
Principal Hydrogeologist

Bachelor of Science (Geology) (Honours), University of Queensland, I977
Graduate Diploma in Applied Hydrogeology, QLD Institute of Technology, I980
Master of Science (Australian Environmental Studies), Griffith University, I988

Memberships: Member, International Association of Hydrogeologists

Experience

2006 - Present **Douglas Partners Pty Ltd,** Brisbane
Principal Hydrogeologist
Senior Associate

2005 - 2006 **Kellogg Brown & Root Pty Ltd (KBR),** Brisbane
Principal Hydrogeologist attached to the Maritime / Environment and Water Resources Group

2004 - 2005 **Coffey Geosciences Pty Ltd,** Brisbane
Principal Hydrogeologist / Australian Groundwater Manager

1998 - 2004 **Coffey Geosciences Pty Ltd,** Brisbane
Principal Hydrogeologist / Groundwater Manager Queensland & NT

1995 - 1998 **Coffey Partners International Pty Ltd,** Brisbane
Senior Hydrogeologist / Groundwater Manager Queensland & NT

1993 - 1995 **Woodward-Clyde Pty Ltd,** Brisbane
Supervising Hydrogeologist

1990 - 1993 **Woodward-Clyde Pty Ltd,** Brisbane
Senior Hydrogeologist

1988 - 1990 **Queensland Water Resources Commission,** Brisbane
Project Hydrogeologist

1977 - 1988 **Geological Survey of Queensland,** Brisbane
Geologist / Hydrogeologist.

1976 - 1977 **Thiess Mining Pty Ltd,** Brisbane
Coal Exploration Geologist

1975 - 1976 **Brigalow Mines Pty Ltd,** Brisbane
Coal Exploration Geologist

IAIN HAIR
Principal Hydrogeologist

Project Experience

- Enterprise Mine Project, Mt Isa, Queensland: Hydrogeological assessment of groundwater inflow problem during pilot hole drilling for 1000 m deep paste fill holes. Temporary securing of inflows in pilot holes, review of hydrogeological data, packer testing and wireline logging to identify inflow zones, assessment of results of testing program, input to design of a grouting program and completion of the paste fill holes. (Client: Tennent, Isokangas Pty Ltd; 2000)
- Yandi Iron Ore Project, via Newman, Western Australia: A major hydrogeological study involving the establishment of a network of monitoring bores, the development of a groundwater monitoring (water levels and quality) program, the design, construction, test pumping and equipping of water supply bores and large diameter dewatering bores, and the design and construction of a borefield reticulation system. The project also involved groundwater exploration for construction water supply for a railway line associated with the project. (Client: BHP Iron Ore; 1992)
- Wirralie Borefield, via Mt Coolon, Queensland: Test drilling and review of hydrogeological information, groundwater level and pumping data to locate an emergency water supply during a prolonged drought coincident with the end of mine life prior to moving processing plant to another mining operation. (Client: Ross Mining NL; 1993, 1994)
- Subera Sapphire Mine, via Emerald, Queensland: Development of a 'regional' scale groundwater flow model for an unconfined alluvial aquifer system to assess the potential for basal sand/gravel aquifers to provide an increased process water requirement. The model was also used to demonstrate the likely impact of increased pumping on groundwater based water supplies for the townships of Sapphire and Anakie. (Client: Great Northern Mining Corporation NL; 1994)
- Narran Vale Sapphire Project, Inverell, New South Wales: Hydrogeological assessment including test pumping of large diameter wells and the development of a 'local' scale groundwater flow model to assess groundwater resources for process water supply. The model was used to evaluate the impact that pumping from wells may have on groundwater levels in bores on neighbouring properties. (Client: Great Northern Mining Corporation NL; 1994)
- Braeside Borefield, via Nebo, Queensland: Regular review of groundwater level, groundwater quality and pumping data to assess the ongoing performance of the Braeside Borefield. Results of review studies are used in the management of the borefield, in varying pumping regimes to maintain borefield production and groundwater quality. (Client: BHP Australia Coal Pty Limited; 1990 to present)
- Century Zinc Project, via Mt Isa, Queensland: Extensive hydrogeological investigations comprising the establishment of a network of groundwater monitoring bores, development of data storage and retrieval systems, groundwater exploration, bore design and construction, long duration test pumping of bores, a 'trial' dewatering program, borefield and reticulation design and groundwater modelling to assess dewatering requirements and a groundwater based water supply for a proposed large-scale open cut mining operation. (Client: Minenco Pty Limited; 1991 to 1994)
- Sun Metals Zinc Refinery, Queensland: Exploration drilling and permeability testing of alluvial/colluvial deposits to assess practicality of wastewater disposal by land irrigation. Assessment of potential impact on groundwater regime and quality. Baseline groundwater quality analysis. (Client: Townsville City Council; 1998)
- South Grafton Landfill, Grafton, New South Wales: Preparation of the section of an EIS dealing with groundwater quality protection. Site hydrogeological assessment including drilling, construction of monitoring bores, groundwater monitoring and permeability testing. Design of an ongoing groundwater monitoring program. (Client: Brian J Mackney & Associates and Grafton City Council; 1997)
- No.1 Underground Mine, Tieri, Bowen Basin, Queensland: The construction of a 2-D vertical 'slice' model using finite element methods to assess the causal factors of a significant water inflow event to the underground mine following heavy rainfall in January 1996. In addition to

computer modelling, the project involved collation of climatic, hydrological and hydrogeological data to quantify the inflow event which caused disruption to longwall mining operations. (Client: Oaky Creek Coal Pty Ltd; 1995).

- Biloela Abattoir Upgrade, Biloela, Queensland: Analysis of existing data and assessment of possible impact of abattoir wastes on groundwater quality. Development of a groundwater management plan (including a groundwater quality monitoring program) and an irrigation management plan for licensing and approval of abattoir upgrade by state and local authorities. (Client: Divakarla & Associates; 1999)
- Moranbah North Coal Project, via Moranbah, Queensland: Review of inflow predictions to a planned longwall mining operation. Assessment of dewatering requirements for a Tertiary basalt aquifer overlying the mine. Development of a conceptual hydrogeological model based on coal exploration drilling data, recorded hydrogeological data (levels and water quality), the establishment of monitoring bores and the construction and test pumping of production/dewatering bores. Compilation of bore licence applications for submission to regulatory authorities. (Client: Moranbah North Coal Pty Ltd; 1998, 1999)
- Sun Metals Zinc Refinery, Queensland: Review, analysis and assessment of groundwater monitoring data (levels and water quality) to assess the level of impact of operations on the groundwater regime. (Client: Sun Metals Corporation Limited; 2005)
- Stuart Oil Shale Project, Gladstone, Central Queensland: Assessment of dewatering requirements for open cut excavation and potential for sea water intrusion. Assessment of potential impacts on shallow groundwater regime. (Client: Southern Pacific Petroleum NL; 1998, 1999)
- Noosa North Shore Resort, Noosa, Queensland: Design and implementation of a groundwater investigation to augment resort water supply. Work included review of geological mapping and aerial photography, selection of test drilling sites, completion of monitoring bores, groundwater sampling and analysis, hydraulic testing, analysis of data and reporting. (Client: Cardno MBK; 2004)
- Royal Palm Beach Estate, Tauranga, New Zealand: Numerical modelling of the impact of establishing lakes in a development on the hydrogeology of a coastal dune sands aquifer system. (Client: Burchill Bate Parker & Partners; 1995)
- Stuart Oil Shale Project (Stage 2), Gladstone, Queensland: Development of a conceptual hydrogeological model and management of the development of a numerical groundwater flow model to assess the impact of mining on local groundwater users, and potential inflows to a large scale open cut mining operation. Hydrogeological studies formed part of an EIS submitted to state government and federal government regulatory authorities. Submissions to government on behalf of the project proponent. (Client: Southern Pacific Petroleum (Management) Pty Ltd; 1998 to 2005)
- Reko Diq Copper Project, Baluchistan, Pakistan: Hydrogeological investigations to locate construction water supply and process water supply for a proposed heap leach SX/EW operation. Water supply of the order of 200 L/s was required. Investigations involved review of groundwater information for much of western Baluchistan, geophysical surveying, identification of groundwater exploration targets, design of a program of exploration drilling, wireline logging, test bore construction, test pumping, numerical modelling, data analysis and reporting. Investigations were also undertaken to assess likely inflows to an open cut pit and design of appropriate dewatering/groundwater control systems. Also responsible for managing surface water investigations by Halcrow Pakistan, involving flood modelling, catchment yield analysis, pipeline design and mine site water management. (Client: Tethyan Copper Company Limited; 2004, 2005)
- Baranj Coal Project, Maharashtra State, India: Assessment of the potential impact of a large-scale open cut mining operation on local groundwater resources. Assessment of the impact on water supplies for a major town and many villages, and the potential for subsidence at an industrial facility. Assessment of methods to mitigate impacts through varying mining scheduling and re-injection of pumped water. (Client: Rio Tinto Technical Services; 2001, 2002)

IAIN HAIR
Principal Hydrogeologist

- Monywa Copper Project, Central Myanmar: Collection and assessment of groundwater, surface water and meteorological monitoring data at operational copper mine. (Client: Ivanhoe Myanmar Holding Ltd; 1996 to 1998)
- Chatree Gold Mine, Central Thailand: The project involved assessing dewatering requirements for a number of open cut pits, and the contribution to water supply that would be possible from dewatering operations. The need for an outside borefield was also assessed using mine water balance modelling for a number of varying climatic scenarios. A numerical groundwater flow model based on data from mineral exploration drilling was utilised to assess groundwater issues for the project. Further stages of work involved refinement of the groundwater model and assessment of monitoring data. (Client: Kingsgate Resources NL/Akara Mining Limited; 1999 to 2002)
- Gibson Island Plant Groundwater Quality Project, Brisbane, Queensland: Assessment of impact of fertiliser manufacturing plant on groundwater quality by establishing a network of 35 monitoring bores, sampling groundwater and conducting chemical analyses for an extensive range of potential pollutants. Development of an ongoing monitoring program conducted by the client company. (Client: Incitec Ltd; 1991)
- Cuu Long Rural Water Supply and Sanitation Project Feasibility Study, Mekong Delta, Viet Nam: The project involved assessing the feasibility of improving water supply and sanitation facilities for village (communes) and small rural towns in five provinces of the Mekong Delta—Long An, Ben Tre, Vinh Long, Bac Lieu and Ken Giang. Mr Hair's role in this project was as groundwater specialist for studies involving three of the five provinces. The work included inspection of provincial level government agencies involved in water resources development and management, an overview of the groundwater resources of the Mekong Delta (including compilation of a conceptual hydrogeological model), data gathering, data analysis, discussion with stakeholders at national, provincial and commune level, design of appropriate groundwater extraction facilities and reporting. (Client: AusAID and Government of Viet Nam; 2000)
- Rapu Rapu Polymetallic Project, The Philippines: Audit review for project financiers of groundwater aspects of the project, including assessment of potential groundwater inflows to an open cut pit, dewatering requirements, groundwater component of mine water supply, and the potential for leakage from tailings storage facilities. Reviewed previous studies and the design level groundwater investigations of another consultant. (Client: RSG Global Mining Consultants; 2004, 2005)
- Pinkenba Site Groundwater Quality Project, Brisbane, Queensland: Assessment of impact of herbicide and pesticide manufacturing plant on groundwater quality by establishing a network of monitoring bores, sampling groundwater and conducting chemical analyses for an extensive range of potential pollutants. Development of an ongoing monitoring program conducted by the client company. (Client: Rhone-Poulenc Rural Australia Pty Ltd; 1992)
- Gladstone Power Station, Gladstone, Queensland: Assessment of the potential for power station ash disposal areas to generate pollutants, and the potential for pollutants to migrate off site with groundwater. The project involved exploratory drilling (hand auger methods), construction of monitoring bores, hydraulic testing of ash and impoundment walls, and sampling and analysis of groundwater, ash slurry water, river/estuary water and biota from the surrounding environment. (Client: Queensland Electricity Corporation; 1994)
- Moreton Island Groundwater Quality Study, Moreton Island, Queensland: The design and construction of 30 monitoring bores in and around the island communities of Kooringal, Cowan and Bulwer, to assess groundwater quality for a range of potential pollutants, including leachates from disposal of domestic wastes, microbiological contaminants and nutrient loadings from septic tanks and sullage trenches, and hydrocarbons from fuel storage facilities and fuel retail outlets. (Client: Brisbane City Council; 1994)
- Crinum Coal Mine, Bowen Basin, Queensland: Evaluation of potential for groundwater inflows to underground workings by numerical modelling. Installation of piezometer network to monitor groundwater levels and quality. Installation of interactive groundwater level logger to alert mining operations centre of rapid groundwater inflows due to longwall collapse. Installation of groundwater level loggers to assess impact of mining on local groundwater resources. (Client: BHP Coal Pty Ltd; 1996, 1997).

Annexure B

Alpha Coal Project - Groundwater Conditions

Alpha Coal Project - Groundwater Conditions

Condition No.	Condition
Coordinator General's Evaluation Report on the Environmental Impact Statement (29.05.2012)	
Condition 2, Part B, Appendix 2	**Condition 2. Regional groundwater monitoring and reporting program** To address the potential cumulative impacts on groundwater quality and availability in the Galilee basin, the Coordinator-General has imposed the following condition for the Alpha project that will be similarly imposed for other projects in the basin. DEHP is designated as the agency responsible for this condition. (a) The proponent must: (i) before commencing mining activities prepare to the satisfaction of the administering authority and implement a groundwater monitoring and reporting program for aquifers impacted by the project off the mining lease (ii) design the program to complement the environmental authority requirements and other groundwater management programs in the Galilee basin. The program should aim to enable a basin groundwater model to be developed to predict, verify and monitor groundwater impacts. (iii) make monitoring results from the program publicly available on the proponent's web site updated at least annually (iv) contribute to any basin wide collaborative project established by the administering authority to develop a basin groundwater model, including pro-rata funding (v) contribute to development of a basin wide groundwater model for determining the capacity of aquifers and acceptable extraction rates, including pro-rata funding Imposed condition 2, Part B, Appendix 2 would be complemented by DEHP/DNRM as the lead agencies for developing a coordinated basin wide monitoring and assessment program, to organise and collate basin wide monitoring programs, data and reports, and to ensure such outcomes influence the ongoing management of groundwater resources.
Recommendation 1, Part B, Appendix 3	**Recommendation 1. Water Security** (a) Before the commencement of mining activities, the proponent must develop to the satisfaction of the administering authority for the Water Act 2000, a plan to address the short and long term implications for groundwater users of dewatering the following: (i) Alluvium aquifers (ii) Colinlea sandstone (iii) Bandanna Formation (iv) Joe Joe Formation; and (b) the plan in (a) must provide for actions to assure the long term security of water for all current groundwater users affected by the project.
Recommendation 2, Part B, Appendix 3	**Recommendation 2. Groundwater Modelling** (a) The proponent must recalibrate the groundwater model referred to in the

Condition No.	Condition
	Groundwater Modelling Report – Alpha Coal Project (Hancock Coal Pty Ltd, 28 March 2012) initially at a minimum of 3-yearly intervals, and subsequently with the approval of the administering authority for the Water Act 2000, at 5-yearly intervals throughout the mining phase of the project; and (b) The proponent must provide a report on each recalibration to the administering authority for the Water Act 2000 within 6 weeks of completion of the recalibration.
Recommendation 3, Part B, Appendix 3	**Recommendation 3. Monitoring** (a) The proponent must: (i) Monitor and record groundwater levels at representative monitoring bores agreed to by the administering authority for the Water Act 2000, at frequencies determined on the basis of the results of baseline monitoring and trigger values (monthly/quarterly/continuous); (ii) Monitor and record groundwater inflows and dewatering volumes pumped (monthly/continuous); (iii) Compare water level changes with model-predicted water level changes, to verify the reliability of model predictions, for input to Condition 25; (iv) Report annually to the administering authority for the Water Act 2000, the results of monitoring and comparison of observed impacts with predicted impacts.
Recommendation 4, Part D, Appendix 3	**Recommendation 4. In-pit tailings disposal assessment** (a) Prior to the in-pit disposal of tailings from the coal handling and preparation plant into the mine pit, the environmental authority holder should undertake a comprehensive assessment of the impacts of this method of disposal, including on groundwater. (b) The assessment referred to in Recommendation 4(a) must be referred to the administering authority for review.
EPBC Approval - 2008/4648 (23.08.2012)	
Condition 11	**Water Quality** **Regional Water Plan** **11** . The person taking the action must submit a Regional Water Plan to the Minister for approval. The plan must address the following requirements: (a) a regional surface water and a regional groundwater water monitoring program with reference to groundwater dependent habitat for listed threatened species and ecological communities, and listed migratory species; (b) the monitoring identified in condition 11 (a) must include identification of linkages between the formations, and likely movement of water into and out of the aquifers; (c) address the potential for impacts to groundwater dependent habitat for listed species and ecological communities, and listed migratory species; (d) Include an ongoing monitoring program to be undertaken to: i. ensure no drawdown impacts result from mining operations on groundwater dependent communities in the Great Artesian Basin;

Condition No.	Condition
	ii. measure the success of management measures 10 inform an adaptive management approach that must be implemented; iii. report on milestones and compliance with this plan; iv. identify measures of success; and v. identify thresholds for intervention, where rehabilitation and vegetation management measures are exceeded. The person taking the action cannot commence construction activities until the Minister approves the Regional Water Plan in writing. The approved Regional Water Plan must be implemented.
Condition 12	**Water Quality Management Plan** 12. To manage potential impacts on the values of the Great Barrier Reef Marine Park World Heritage Area, the person taking the action must submit a Water Quality Management Plan to the Minister for approval. The plan must address the following: (a) management measures for acid rock drainage with particular reference to sulphur content resulting from overburden stockpiles; (b) measures to prevent acid water seepage into catchment systems; (c) include an ongoing monitoring and management program to be undertaken to; i. ensure stormwater and runoff or coal dust impact from the mine, mining operations and the rail is managed 10 minimise sediment into the Burdekin dam and thus into the Great Barrier Reef; ii. ensure that runoff or coal dust impact from the rail corridor and storage areas at Abbot Point is managed to minimise Impact to the Great Barrier Reef; iii. measure the success of management measures to inform an adaptive management approach that must be implemented; iv. report on milestones and compliance with this plan: v. identify measures of success; and vi. identify thresholds for intervention, where rehabilitation and vegetation management measures are exceeded. (d) identify threshold limits and management measures for runoff and coal dust impacts on the Great Barrier Reef World Heritage Area and reporting to the Great Barrier Reef Marine Park Authority six monthly (mid December and mid May). The person taking the action cannot commence construction until the Minister approves the Water Quality Management Plan in writing. The approved Water Quality Management Plan must be implemented.
Draft Environmental Authority (17.12.2012)	
C1	**Release of Contaminants** Contaminants that will or have the potential to cause serious or material environmental harm must not be released directly or indirectly to any waters except

<table>
<tr><th>Condition No.</th><th>Condition</th></tr>
<tr><td></td><td>as permitted under the conditions of this environmental authority.</td></tr>
<tr><td>C50</td><td>Groundwater
A groundwater monitoring program must be developed and submitted to the administering authority for approval before the commencement of mining activities. The monitoring program must :
(a) allow for the compilation of representative groundwater samples from the aquifers identified as potentially affected by mining activities. The geological units monitored include alluvium, Bandanna Formation, Colinlea Sandstone, Clematis Sandstone, Rewan Formation, and Joe Joe Formation;
(b) include at least twelve sampling events, no more than two months apart over a two year period, to determine background groundwater quality;
(c) obtain background groundwater quality in hydraulically isolated background bore(s), and
(d) allow for the identification of natural groundwater level trends, hydrochemical trigger levels, and contaminant limits.</td></tr>
<tr><td>C51</td><td>In addition to Condition C50 groundwater quality and levels must be monitored at the locations and frequencies specified in Table 15: Groundwater monitoring network locations and frequency.
Table 15: Groundwater monitoring network locations and frequency
<table><tr><th>Monitoring Sites</th><th>Parameter</th><th>Frequency</th></tr><tr><td>AMB-01, AMB-02, AMB-03, AMB-04</td><td>Water level</td><td>At least one reading every 12 hours – electronic loggers</td></tr><tr><td></td><td>pH, EC, TDS (lab), cations, anions, selected dissolved metals (Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Hg, Mn, Mo, Ni, Se, Ag, U, Zn), nutrients</td><td>Monthly until sufficient data is compiled</td></tr><tr><td>TSF standpipe bores ATSF-01B ATSF-02, ATSF-03, ATSF-04B, ATSF-07B, ATSF-07C, ATSF-06B, ATSF-08C, ATSF-06B, ATSF-06C, ATSF-05B, ATSF-05C, ATSF-09A, ATSF-09B</td><td>Water level</td><td>At least one reading every 12 hours – electronic loggers</td></tr><tr><td></td><td>pH, EC, TDS (lab), cations, anions, selected dissolved metals (Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Hg, Mn, Mo, Ni, Se, Ag, U, Zn), nutrients</td><td>Monthly until sufficient data is compiled</td></tr><tr><td>Proposed monitoring bores adjacent infrastructure AlphaWest1, AlphaWest2, AlphaWest3, Landfill1, Landfill2, Landfill3, MIA, CHPP1, CHPP2, EWT, TLO1, RWD1, ROMSouth, ROMNorth</td><td>Water level</td><td>At least one reading every 12 hours – electronic loggers</td></tr><tr><td></td><td>pH, EC, TDS (lab), cations, anions, selected dissolved metals (Al, As, B, Cd, Cr, Co, Cu, Fe, Pb, Hg, Mn, Mo, Ni, Se, Ag, U, Zn), nutrients, TPH (selected bores only)</td><td>Every 2 months (for at least two years)</td></tr><tr><td>VWP bores AVP_11, AVP_01, AVP_14, AVP_03, AVP_05, AVP_04, AVP_06, AVP_07, AVP_08, AVP_13, AVP_09, AVP_10</td><td>Water level only</td><td>At least one reading every 12 hours – electronic data readers</td></tr><tr><td>New TSF VWP bores ATSF-01A, ATSF-04A, ATSF-05A, ATSF-06A, ATSF-07A, ATSF-08A</td><td>Water level only</td><td>At least one reading every 12 hours – electronic data readers</td></tr><tr><td>New GAB bores AlphaWest4, AlphaWest5, and AlphaWest6</td><td>Water level only</td><td>At least one reading every 12 hours – electronic data readers</td></tr><tr><td>All monitoring bores</td><td>Al, As, Sb, B, Cd, Cr, Co, Cu, Fe, Pb, Hg, Mn, Mo, Ni, Se, Ag, U, Zn.</td><td>Annually</td></tr></table></td></tr>
<tr><td>C52</td><td>If groundwater monitoring results greater than the trigger levels (or outside the trigger levels range for pH) specified for the relevant aquifer in Table 16 to Table 20 (inclusive) are recorded, then the following must be conducted:</td></tr>
</table>

Condition No.	Condition
	(a) the relevant monitoring point(s) will be re-sampled and the samples analysed for major cations and anions, and selected dissolved metals, including Al, As, Sb, B, Cd, Cr, Co, Cu, Fe, Pb, Hg, Mn, Mo, Ni, Se, Ag, U, Zn; (b) if elevated concentrations (above trigger) are recorded on two consecutive sampling events then an investigation into cause, optimum response, and the potential for environmental harm must be conducted; and (c) if elevated concentrations are recorded on two consecutive sampling events then the administering authority will be notified within 1 month of receiving the analysis results.
C53	If groundwater monitoring results greater than the contaminant limits (or outside the contaminant limits range for pH) specified for the relevant aquifer in Table 16 to Table 20 (inclusive) are recorded, then an investigation into cause, optimum response, and the potential for environmental harm must be conducted.
C54	Groundwater contaminant trigger levels for Table 16 to Table 20 (inclusive) must be finalised based on the Groundwater Monitoring Program approved under Condition C50 and submitted to the administering authority 28 days prior to commencing coal extraction.
C55	Groundwater monitoring bores must be constructed in accordance with methods prescribed in the Minimum Construction Requirements for Water Bores in Australia – 3rd Edition (LWBC), or equivalent.
C56	The monitored data must be reported to the administering authority, and must satisfy the following criteria: (a) Data collected under the monitoring program will be forwarded to the administering authority on a quarterly basis within 30 business days of the end of each quarter and compiled in an annual monitoring report in a format approved by the administering authority; (b) The proponent shall undertake an assessment of the impacts of mining on groundwater after the first 12 months of dewatering commencing and thereafter every subsequent calendar year; (c) The annual monitoring report will be forwarded to the relevant authority by the first of March each calendar year; and (d) The annual monitoring report will include an assessment of impacts, any mitigation strategies as wells as any recommendations for changes to the approved monitoring program. (e) If there is a requirement to submit a similar groundwater report as part of any condition issued under a water licence under the Water Act 2000 then the proponent and the relevant administering authorities may agree for the reports to be combined.

Table 16: Groundwater contaminant limits and trigger levels – Alluvium Aquifers (wet season)

Parameter[2]	Units	Trigger Levels[3]	Contaminant limits
Dissolved metals Aluminium (Al) Antimony (Sb) Arsenic (As) Iron (Fe) Molybdenum (Mo) Selenium (Se) Silver (Ag)	µg/L	80th percentile of background data	99th percentile of background data
Total Dissolved Solids	mg/L		
Electrical Conductivity	µS/cm		
Major anions and cations Sulphate Calcium Magnesium Sodium Potassium Chloride Carbonate Bicarbonate	mg/L		
Total Petroleum Hydrocarbons	ppb		
pH[1]	unit	6.5 – 8.5	Note: ± 1 pH unit from highest / lowest readings
Groundwater level	For interpretational purpose only		

[1]Baseline value ±1.0 for pH, means the corresponding variation allowed is 1.0 pH unit above and below average and maximum / minimum pH values determined for the site.
[2]Parameters and sampling frequency will be revised at the end of background sampling, based on results compiled at each monitoring point and proposed land use.
[3]The administering authority and the holder will agree to suitable trigger levels and contaminant limits (per aquifer and season) once sufficient hydrochemical data has been compiled.

Table 17: Groundwater contaminant limits and trigger levels – Alluvium Aquifers (dry season)

Parameter[2]	Units	Trigger Levels[3]	Contaminant limits
Dissolved metals Aluminium (Al) Antimony (Sb) Arsenic (As) Iron (Fe) Molybdenum (Mo) Selenium (Se) Silver (Ag)	µg/L	80th percentile of background data	99th percentile of background data
Total Dissolved Solids	mg/L		
Electrical Conductivity	µS/cm		
Major anions and cations Sulphate Calcium Magnesium Sodium Potassium Chloride Carbonate Bicarbonate	mg/L		
Total Petroleum Hydrocarbons	ppb		
pH[1]	unit	6.5 – 8.5	Note: ± 1 pH unit from highest / lowest readings
Groundwater level	For interpretational purpose only		

[1]Baseline value ±1.0 for pH, means the corresponding variation allowed is 1.0 pH unit above and below average and maximum / minimum pH values determined for the site.
[2]Parameters and sampling frequency will be revised at the end of background sampling, based on results compiled at each monitoring point and proposed land use.
[3]The administering authority and the holder will agree to suitable trigger levels and contaminant limits (per aquifer and season) once sufficient hydrochemical data has been compiled.

Table 18: Groundwater contaminant limits and trigger levels – Colinlea Sandstone Aquifers

Parameter[2]	Units	Trigger Levels[3]	Contaminant limits
Dissolved metals Aluminium (Al) Antimony (Sb) Arsenic (As) Iron (Fe) Molybdenum (Mo) Selenium (Se) Silver (Ag)	µg/L	80th percentile of background data	99th percentile of background data
Total Dissolved Solids	mg/L		
Electrical Conductivity	µS/cm		
Major anions and cations Sulphate Calcium Magnesium Sodium Potassium Chloride Carbonate Bicarbonate	mg/L		
Total Petroleum Hydrocarbons	ppb		
pH[1]	unit	6.5 – 8.5	Note: ± 1 pH unit from highest / lowest readings
Groundwater level	For interpretational purpose only		

[1]Baseline value ±1.0 for pH, means the corresponding variation allowed is 1.0 pH unit above and below average and maximum / minimum pH values determined for the site.
[2]Parameters and sampling frequency will be revised at the end of background sampling, based on results compiled at each monitoring point and proposed land use.
[3]The administering authority and the holder will agree to suitable trigger levels and contaminant limits (per aquifer and season) once sufficient hydrochemical data has been compiled.

Table 19: Groundwater contaminant limits and trigger levels – Bandanna Formation Aquifers

Parameter[2]	Units	Trigger Levels[3]	Contaminant limits
Dissolved metals Aluminium (Al) Antimony (Sb) Arsenic (As) Iron (Fe) Molybdenum (Mo) Selenium (Se) Silver (Ag)	µg/L	80th percentile of background data	99th percentile of background data
Total Dissolved Solids	mg/L		
Electrical Conductivity	µS/cm		
Major anions and cations Sulphate Calcium Magnesium Sodium Potassium Chloride Carbonate Bicarbonate	mg/L		
Total Petroleum Hydrocarbons	ppb		
pH[1]	unit	6.5 – 8.5	Note: ± 1 pH unit from highest / lowest readings
Groundwater level	For interpretational purpose only		

[1]Baseline value ±1.0 for pH, means the corresponding variation allowed is 1.0 pH unit above and below average and maximum / minimum pH values determined for the site.
[2]Parameters and sampling frequency will be revised at the end of background sampling, based on results compiled at each monitoring point and proposed land use.
[3]The administering authority and the holder will agree to suitable trigger levels and contaminant limits (per aquifer and season) once sufficient hydrochemical data has been compiled.

Table 20: Groundwater contaminant limits and trigger levels – Joe Joe Formation

Parameter[2]	Units	Trigger Levels[3]	Contaminant limits
Dissolved metals Aluminium (Al) Antimony (Sb) Arsenic (As) Iron (Fe) Molybdenum (Mo) Selenium (Se) Silver (Ag)	µg/L	80th percentile of background data	99th percentile of background data
Total Dissolved Solids	mg/L		
Electrical Conductivity	µS/cm		
Major anions and cations Sulphate Calcium Magnesium Sodium Potassium Chloride Carbonate Bicarbonate	mg/L		
Total Petroleum Hydrocarbons	ppb		
pH[1]	unit	6.5 – 8.5	Note: ± 1 pH unit from highest / lowest readings
Groundwater level	For interpretational purpose only		

[1]Baseline value ±1.0 for pH, means the corresponding variation allowed is 1.0 pH unit above and below average and maximum / minimum pH values determined for the site.
[2]Parameters and sampling frequency will be revised at the end of background sampling, based on results compiled at each monitoring point and proposed land use.
[3]The administering authority and the holder will agree to suitable trigger levels and contaminant limits (per aquifer and season) once sufficient hydrochemical data has been compiled.

Annexure C

Glossary of Hydrogeological Terms used in this Report

Glossary of Hydrogeological Terms used in this Report

Aquifer: An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a waterbore or well.

Aquitard: An aquitard is a zone of earth material that may hold water, but will not transmit water at a useful rate or fast enough to be pumped from a waterbore or well. Aquitards often form a confining layer through which little water moves. Clay soils, shale, and igneous or metamorphic rocks with little interconnected porosity or fractures are likely to form aquitards.

Clematis Sandstone: Medium to coarse-grained quartzose sandstone, siltstone, mudstone and conglomerate. Middle to Early Triassic in age. Maximum thickness of ~180 m. An aquifer. See Drawing 1 of this report.

Colinlea Sandstone: Quartz sandstone and pebbly quartz sandstone, with minor conglomerate and siltstone. Late Permian in age. An aquifer. See Drawing 1 of this report.

Conceptual Hydrogeological Model: A description of a groundwater system derived from the collation of geological and hydrogeological data. The CHM describes the hydraulic characteristics, thickness and extent of aquifers and aquitards, groundwater quality, recharge mechanisms, recharge and discharge zones, and groundwater use (including environmental use).

Groundwater Sink: A condition which occurs around a mine void which intersects the groundwater table. In areas where evaporation exceeds rainfall (over most of the Australian continent), the excess of evaporation over rainfall maintains water levels within the mine void below that of the surrounding groundwater system. This results in groundwater always flowing towards the ine void.

Mine Dewatering: The maintenance / reduction of groundwater levels in the vicinity of a mine in order to maintain dry working conditions for mining machinery and to minimise the amount of water produced with coal or ore. Methods of mine dewatering include dewatering bores arranged around a mine or on mine benches or the pit floor, wellpoints and spears, sub-horizontal drains and pit floor sumps.

Numerical Groundwater Flow Model: A numerical representation of a groundwater system, based on a Conceptual Hydrogeological Model.

Rewan Formation: Dominated by green and red mudstone with minor sandstone. Middle to Early Triassic in age, up to 840 m in thickness. An aquitard. See Drawing 1 of this report.

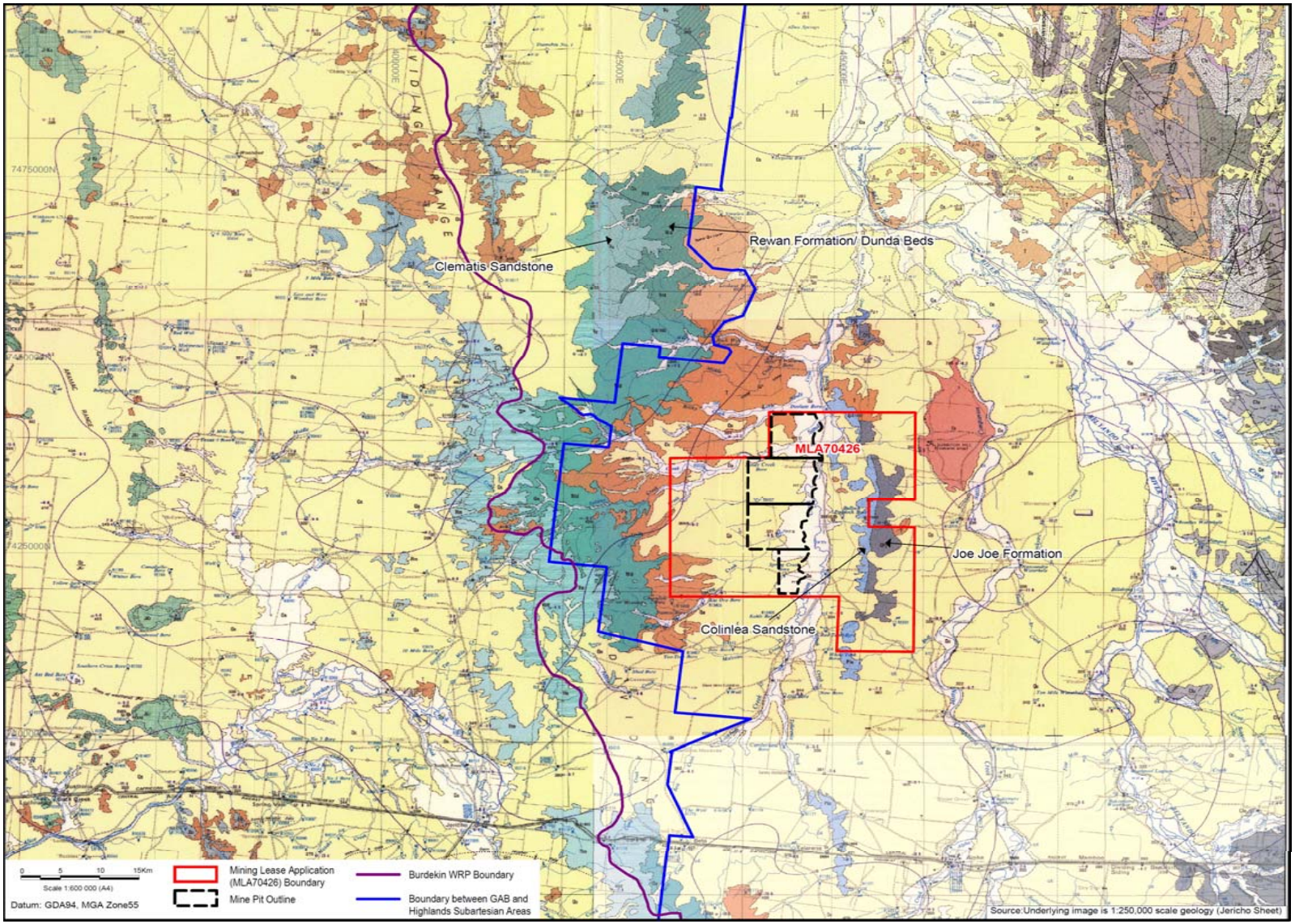
Stratigraphic Relationship: The relationship between stratigraphic units (geological formations) by virtue of their age and environment of deposition / formation. See Drawing 2 of this report).

Vibrating Wire Piezometer (VWP): An instrument used to record groundwater levels (groundwater pressures) continuously over time. VWPs are cemented in a borehole and record the groundwater pressure at the location in which they are set. Several VWPs may be cemented into different layers / aquifer zones in a single borehole. VWPs are connected to a datalogger at the top of the borehole.

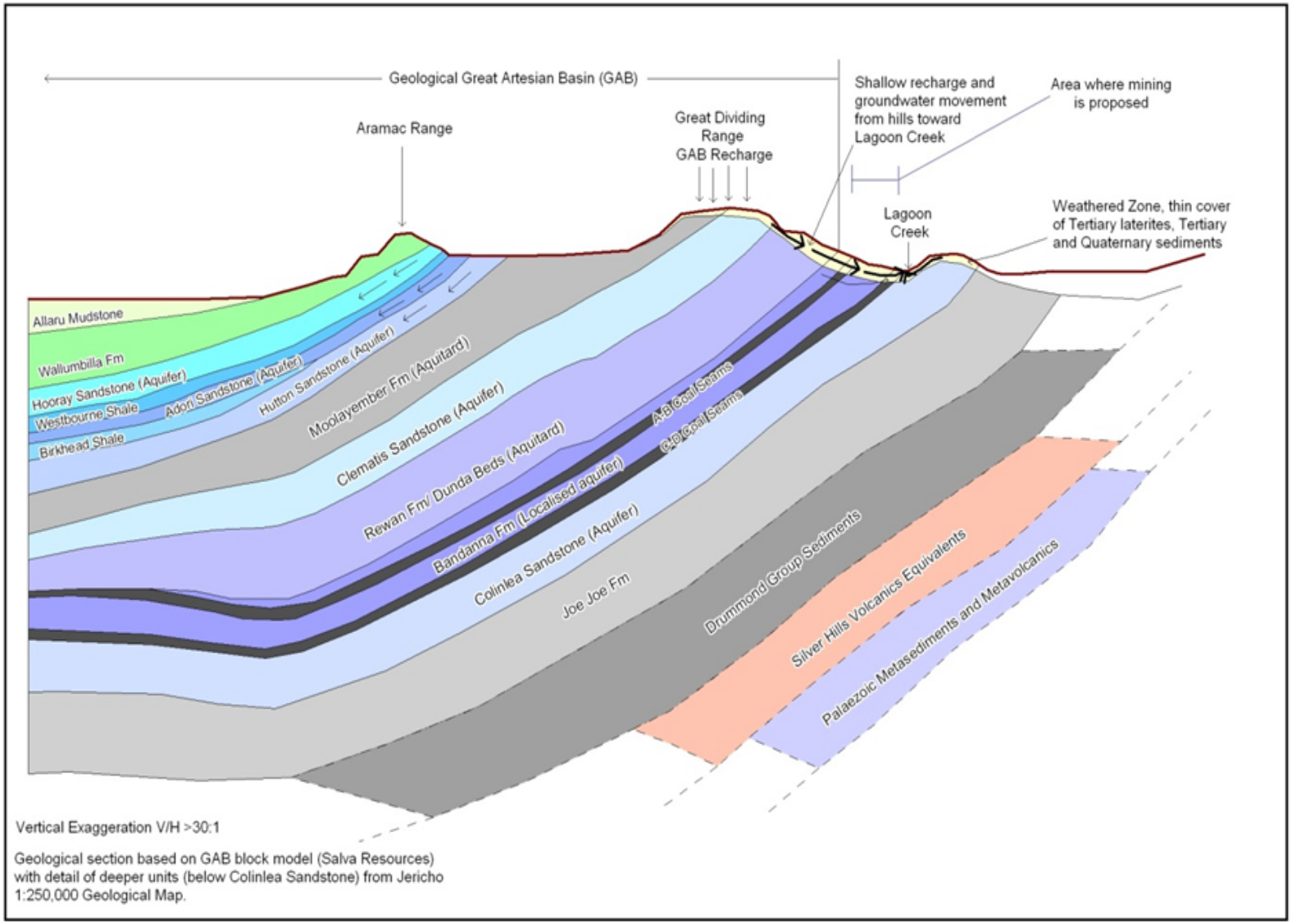
Drawings

Drawing 1: Outcrop Areas of the Great Artesian Basin (GAB) Clematis Sandstone and Rewan Formation in relation to MLA70426

Drawing 2: Schematic Cross Section showing relationship between the Bandana Formation and Colinlea Sandstone (Galilee Basin) and the Clematis Sandstone of the Great Artesian Basin (GAB)



Drawing 1: *Outcrop Areas of the Great Artesian Basin (GAB) Clematis Sandstone and Rewan Formation in relation to MLA70426*



Drawing 2: *Schematic Cross Section showing relationship between the Bandana Formation and Colinlea Sandstone (Galilee Basin) and the Clematis Sandstone of the Great Artesian Basin (GAB)*