APPENDIX D

Surface Water Impact Assessment

0718-01-F [Rev 3]
28 January 2014

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Dorian Walsh
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Dear Dorian,

SUBJECT: SURFACE WATER IMPACT ASSESSMENT, CULLEN VALLEY AND INVINCIBLE COLLIERY MODIFICATIONS

1 INTRODUCTION

Coalpac Pty Ltd (Coalpac) owns and operates the existing operations of Invincible Colliery and Cullen Valley Mine. Invincible Colliery has been owned and operated by Coalpac since 1988 and Cullen Valley Mine was acquired by Coalpac in 2007. Each mine operates as a separate entity with separate planning approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act). Coalpac is seeking to modify both planning approvals under Section 75W of the former Part 3A of the EP&A Act.

WRM recently prepared a Surface Water Impact Assessment report for the Coalpac Consolidation Project (WRM, 2011). The Surface Water Impact Assessment comprised an assessment of available water quality data for the existing operations at Cullen Valley Mine and Invincible Colliery and receiving watercourses, and an assessment of the likely impacts on surface water resources. Daily water balance modelling of the Coalpac Consolidation Project water management system was also undertaken.

While the Coalpac Consolidation Project Application has since been withdrawn, the Modifications proposed at both mines occur within parts of the works proposed in the Consolidation Project. This surface water impact assessment of the Modification works will make reference to the findings of the WRM (2011) report, as relevant to the proposed Modifications.

2 EXISTING CONDITIONS

2.1 Topography and Surface Water Drainage

Figure 1 and Figure 2 show the existing topography, mine infrastructure and disturbance areas and key drainage features at Invincible Colliery and Cullen Valley Mine respectively. Detailed discussion of the surface water management systems at both operations, and analysis of available water quality data is provided in WRM (2011). Key points of note are:

- The Invincible Colliery operations are located entirely within the upper catchment of Cullen Creek;
- The licensed discharge point for Invincible Colliery is the Invincible Main Colliery Dam (LD002);
- Cullen Valley Mine operations are located within the catchments of Jews, Cullen and Red Springs Creeks. Cullen and Red Springs Creeks are tributaries of Dulhunty's Creek;
- Cullen Valley Mine has two licensed discharge points, Dam 1 (LD001) and Dam 4 (LD004);
- Both Invincible Colliery and Cullen Valley Mine are located above an extensive network of abandoned underground workings, which hold large amounts of water (AGE, 2011). Coalpac staff have indicated that runoff collecting in pit sumps, fine reject dams and coal stockpile areas above the abandoned underground workings tends to seep into the abandoned underground workings shortly after a runoff event occurs. More details of the flooded underground workings are provided in the Consolidation Project impact assessments by WRM (2011) and AGE (2011); and
- Significant portions of Invincible Colliery are affected by pre-existing surface cracking from underground Bord and Pillar mining in the abandoned Invincible Colliery and Ivanhoe Colliery underground workings. Coalpac staff have advised that much of the surface water runoff which drains through these previously mined areas does not report to downstream surface water management structures, and instead enters the sinkholes and fractures and reports directly to the abandoned underground workings.

3 DESCRIPTION OF PROPOSED MODIFICATION WORKS

3.1 Invincible Colliery

The Invincible Colliery Modification (INV MOD4) will seek approval for the following activities that are not approved under its current Project Approval (PA 07_0127):

- Extension to PA 07_0127 for four years from December 2016 to December 2020;
- Extension of 87.7 ha to areas approved for open cut mining;
- Extension of 85.7 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance; and
- Installation of a water pipeline which will result in the ability to transfer water between Invincible Colliery and Cullen Valley Mine. The pipeline alignment will largely remain on or adjacent to existing access tracks within the Ben Bullen State Forest; and
- Backfilling of the residual final voids resulting from existing mining operations and the rehabilitation of areas affected by subsidence from historic underground mining operations in the area to create a free-draining final landform.

All other aspects of operations on site, including coal production and processing, coal transport, operational hours and employment would generally remain consistent with that approved under PA 07_0127. Although the extension to PA 07_0127 is sought until December 2020, it is likely that mining operations at Invincible Colliery under the proposed modification would be concluded within four years of approval being granted.

The proposed layout for Modification operations at Invincible Colliery is shown in Figure 3. The following is of note:

- There are three additional open cut disturbance areas, all of which currently consist of both active mining and spoil emplacement areas;
- Coal crushing and handling will continue to take place in the existing established area north of the fine reject disposal area;
- All new disturbance areas are located above abandoned underground workings, and the southernmost disturbance area is located within the pre-existing subsidence zone;
- The open cut pit within Area 3 will intersect the flooded underground workings. Coalpac predict (as a potential maximum worst case scenario) that approximately 1,382ML of water may need to be dewatered from the flooded underground workings (via the open cut pit) to maintain the water level at a level below the open cut pit floor.
- A pump and pipeline will be established to dewater the open cut pit. This water will be used for coal processing and dust suppression at Invincible Colliery. Water can also be transferred to the existing holding tanks at Cullen Valley Mine. Any transferred water could then be used for coal processing, dust suppression, and reticulated into the flooded Old Tyldesley underground workings to assist in the control of existing subsurface heating issues.

3.2 Cullen Valley Mine

The Cullen Valley Mine Modification (CV MOD2) is seeking approval for the following activities that are not approved under its current Development Approval (DA 200-5-2003):

- Extension of 61.9 ha to areas approved for open cut mining;
- Extension of 78.6 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance;
- Ability to benefit from the transfer of water to and from Invincible Colliery;

- Backfilling and rehabilitation of the residual final void resulting from existing mining operations to create a free-draining final landform.

All other aspects of operations, including coal production and processing, coal transport, operational hours and employment would generally remain consistent with that approved under DA 200-5-2003. It is anticipated that mining operations at Cullen Valley under the proposed modification would be concluded within four years of approval.

The proposed layout for modification operations at Cullen Valley Mine is shown in Figure 4. The following is of note:

- One new disturbance area is proposed at the northern tip of the existing operations, consisting of open cut and spoil emplacement;
- Construction of the Cullen Valley Bund to the north of the proposed open cut mining area;
- C crushing and handling area will be relocated closer to mining operations, within the existing disturbance footprint; and
- The new disturbance area and coal crushing and handling areas are located within the catchment area of Jews Creek.

3.3 Final Landform

Figure 5 and Figure 6 shows the proposed final landform configurations at Invincible Colliery and Cullen Valley Mine. The following is of note:

- Under the final landform, disturbance areas at Invincible Colliery will be rehabilitated to drain freely to the tributaries of Cullen Creek downstream of the mine boundary; and
- The final landform at Cullen Valley Mine will result in a depression located on the southern side of the proposed Cullen Valley bund. The final landform will be constructed such that the depression is free draining, with a channel passing around the eastern end of the Cullen Valley bund and into the tributary of Jews Creek.

4 PROPOSED SURFACE WATER MANAGEMENT MEASURES

4.1 Objectives

The objectives of the proposed surface water management measures proposed for the Invincible Colliery and Cullen Valley Mine are as follows:

- Collect and reuse surface water runoff from catchments disturbed by mining or coal crushing and handling; and
- Prevent the discharge of sediment laden or mine affected water from the mine sites without appropriate treatment.
- Ensure any discharges from the existing licensed discharge points comply with the existing EPL conditions.

4.2 Assumptions

The proposed surface water management measures are based on the assumptions which were provided by Coalpac staff and other consultants (AGE, 2011) during the preparation of the WRM (2011) report. Key assumptions include:

- Groundwater seepage into open cut pits at the project site is likely to be negligible (AGE, 2011), with the exception of the Northern Mining Area at Invincible Colliery which will intersect the flooded underground workings;
- With the exception of the Area 3 pit at Invincible Colliery, any runoff collecting in open cut pits located within the abandoned underground workings is not dewatered, but allowed to flow along the floor of the pit into the workings; and
- No runoff reports to the water management system from surface water catchments that are affected by pre-existing surface cracking. Runoff from such catchment drains into surface cracking and depressions before seeping into the abandoned underground workings.

4.3 Invincible Colliery Modification

All runoff draining to the Southern and Eastern Mining Areaswill be collected in sumps located within the active mining areas and allowed to evaporate or infiltrate into the abandoned underground workings, as per existing operations. If necessary, sumps can be pumped out to the Invincible Main Colliery Dam. Runoff from any spoil emplacement areas that do not drain to the sumps are captured and treated by sediment basins designed in accordance with *Managing Urban Stormwater: Soils and Construction, Vol. 1, 4th Edition* (Landcom (2004)). Water collected in sediment basins and sumps will also be reused to supply mine site water demands at both Invincible Colliery and Cullen Valley Mine, wherever possible.

The open cut pit in the Northern Mining Area will intersect underground workings that may be flooded to varying levels, depending upon rainfall levels and underground storage water levels in adjacent underground mines. A pump will be installed at the open cut pit floor to maintain the water level in the underground workings. The pump will transfer water to the Invincible Main Colliery Dam or the existing holding tanks at Cullen Valley Mine for reuse. A significant surface water catchment drains to the Northern Mining Area pit, and the pump and pipeline will also be utilised to collect and transfer any surface water runoff that reports to the pit to the Invincible Main Colliery Dam or the Cullen Valley Mine. The management of the water transferred to Cullen Valley Mine from the Northern Mining Area at Invincible Colliery is discussed in detail in Section 4.5.

Surface water runoff from the coal crushing and handling area will continue to drain to the fine reject disposal area, and then infiltrate to the abandoned underground workings. Runoff draining to the coal

crushing and handling area from the upstream catchment area is substantially reduced due to pre-existing subsidence cracking.

Due to the steep terrain, and extent of existing disturbance from historical underground mining at the mine site, it would not be possible to divert runoff from the upstream undisturbed catchments around the proposed disturbance areas.

4.4 Cullen Valley Mine Modification

All runoff draining to the Modification disturbance areas will be collected in sumps located within the active mining areas, and dewatered to Cullen Valley water reticulation system and reused to supply mine site water demands. Due to the steep terrain, it is not possible to divert runoff from the upstream undisturbed catchments around the proposed disturbance areas. Runoff from the relocated coal crushing and handling area will be directed into the active mining sumps for collection and reuse.

A new sediment basin, referred to as CV Dam 5, will be constructed at the low point along the northern boundary of the Modification disturbance area. This basin will be designed in accordance with Landcom (2004) and will capture and treat runoff from any spoil emplacement areas and haul roads that do not drain to the active mining sumps. Water captured in the sediment basin will be collected and reused to satisfy Cullen Valley Mine water demands wherever possible. No coal-affected water drains to this basin, only runoff from the spoil emplacement and Cullen Valley bund. Runoff from the spoil emplacement and Cullen Valley bund that exceeds the capacity of the sediment basin will drain across the northern boundary of the modification towards Jews Creek.

4.5 Transferal of Water between Cullen Valley Mine and Invincible Colliery Northern Mining Area

Dewatering of the open cut pit at the Invincible Colliery Northern Mining Area will consist of both water from the flooded underground workings and surface water runoff from the undisturbed upstream catchment. Dewatering flows will be used in coal processing and dust suppression at Cullen Valley Mine and reticulated into the Old Tyldesley underground workings. If the amount of water dewatered from the Invincible Colliery Northern Mining Area exceeds these demands it may be reticulated to Cullen Valley Dam 1 and Dam 4 (See Figure 2) for release via the existing licensed discharge points, provided any releases meet the existing EPL conditions for these discharge points. Table 1 lists the existing EPL discharge criteria for the Cullen Valley Mine licensed discharge points.

Table 1 Cullen Valley Mine Discharge Water Quality Criteria, EPL 10341

Pollutant Parameter	Units of Measure	100 Percentile Concentration Limit / Range
Oil & Grease	mg/L	<10
pH	pH	6.5 – 8.5
Total Suspended Solids (TSS)	mg/L	<50

5 SURFACE WATER IMPACT ASSESSMENT

5.1 Invincible Colliery

All coal affected water will be collected in active mining sumps and reused on site, transferred to Cullen Valley Mine for reuse or release, or allowed to evaporate or infiltrate into the abandoned underground workings. Sediment laden runoff that does not drain to the active mining sumps will be collected and treated by sediment basins and reused or released. Therefore coal affected or sediment laden runoff is unable to drain directly across the mine boundary towards Cullen Creek. Water quality data presented in WRM (2011) indicates that runoff collected in the Invincible Main Colliery Dam is typically suitable for release under the current approved EPL for the mine. The proposed Modification will result in little or no change in runoff draining to the Invincible Main Colliery Dam and therefore the potential impacts on downstream water quality due to the proposed modifications is considered to be negligible.

Further, the modification works at Invincible Colliery will not result in the reduction of catchment area draining to Cullen Creek, as the catchments impacted by the proposed modification are already captured by the Invincible Colliery surface water management system. The proposed disturbance areas will be rehabilitated along with the remainder of the Invincible Colliery site in accordance with the final landform described in Section 3.3, returning the catchment of Cullen Creek to generally pre-mining conditions.

Dewatering flows from the Northern Mining Area may be released via the Invincible Main Colliery Dam (LD002) provided the quality of these releases complies with the existing EPL conditions.

5.2 Cullen Valley Mine

The proposed Modification works at Cullen Valley Mine are located wholly within the Jews Creek catchment. The potential for the Modification works to impact on water quality in Jews Creek and its tributaries will be limited by ensuring all coal affected runoff is captured in the active mining sumps and transferred to Cullen Valley Dam 4 for reuse, and that any runoff from spoil emplacements and haul roads draining across the northern Modification Boundary is captured and treated in appropriately designed sediment basins.

Water quality data presented in WRM (2011) indicates that runoff collected in Cullen Valley Dam 1 and Dam 4 is typically suitable for release under the current approved EPL for the mine. The proposed modification will result in little or no change in runoff draining to the Cullen Valley dams, however dewatering flows from Invincible Colliery Northern Mining Area may be released via these dams provided the quality of these releases complies with the existing EPL conditions.

The modification works will result in a very small temporary reduction in catchment area draining to Jews Creek, with approximately 85ha of catchment area captured by the Cullen Valley Mine surface water management system during modification operations. This represents approximately 1.4% of the total Jews Creek catchment area upstream of the Turon River and the impacts of such a temporary reduction in catchment area are likely to be undetectable. Following completion of mining, the disturbance area will be shaped and rehabilitated to generally restore the pre-mining drainage characteristics and catchment of Jews Creek.

6 MITIGATION & CONCLUSIONS

The proposed Modification works at Invincible Colliery and Cullen Valley Mine will have negligible potential for additional impact on water quality and quality in downstream watercourses due to the following mitigating factors:

6.1 Invincible Colliery

- All coal-affected runoff from the Invincible Colliery modification works will be captured and infiltrated or recycled to supply mine site water demand including coal processing and dust suppression. Runoff from spoil emplacements and haul roads that does not drain to the active mining sumps will be captured and treated in sediment basins before being reused or released;
- Pit dewatering from Invincible Colliery Northern Mining Area may be transferred to Cullen Valley Mine for reuse in coal processing, dust suppression and reticulation to the Old Tyldesley underground workings to manage subsurface heating issues. If the dewatering flows exceed these demands, some water may be released via existing licensed discharge points including the Invincible Main Colliery Dam and/or at Dam 1 and Dam 4 at Cullen Valley, provided the quality of these releases complies with the existing EPL discharge conditions; and
- The modification works at Invincible Colliery will not result in the reduction of catchment area draining to Cullen Creek, as the catchments impacted by the proposed modification are already captured by the Invincible Colliery surface water management system.

6.2 Cullen Valley

- All coal-affected runoff from the Cullen Valley Mine modification works will be captured and recycled to supply mine site water demand including coal processing and dust suppression. Runoff from spoil emplacements and haul roads not draining to the active mining sumps will be captured and treated in sediment basins before being reused or released;
- The proposed modification works at Cullen Valley Mine will result in a temporary 1.4% reduction in the catchment of Jews Creek, and the impacts of such a temporary reduction in catchment area are likely to be undetectable;
- The existing licensed discharge points (and associated EPL discharge limits) at Invincible Colliery and Cullen Valley Mine will be maintained under the modification works, and no new licensed discharge points will be required. It is assumed that a licensed discharge point is not required for releases of water from sediment basins' and
- The final landform at Cullen Valley Mine will result in a depression located on the southern side of the proposed Cullen Valley bund. The final landform will be constructed such that the depression is free draining, with a channel passing around the eastern end of the Cullen Valley bund and into the tributary of Jews Creek.

6.3 Mitigation Applicable to Both Sites

- Mining operations under the proposed modifications is likely to be completed within four years of grant of approval, at which point rehabilitation of the disturbance areas will commence, and the potential for any further surface water impacts will be limited; and
- The final landform at Invincible Colliery will be rehabilitated to drain freely to the tributaries of Cullen Creek downstream of the mine boundary.

6.4 Management Plans & Licensing

The existing, approved Water Management Plans for each of Invincible Colliery and Cullen Valley Mine will be updated in consultation with relevant regulators, to the approval of DP&I in consideration of the mitigation measures For Cullen Valley Mine and Invincible Colliery, each will continue to hold relevant licences required under the *Water Act 1912* and *Water Management Act 2000* as required.

I trust the above is of assistance. If you have any comments or queries please contact me.

For and on behalf of
WRM Water & Environment Pty Ltd

Rhys Cullen
Project Engineer

References:

AGE (2011) *Coalpac Consolidation Project Groundwater Impact Assessment*, Australasian Groundwater & Environmental Consultants, November 2011.

Landcom (2004) *Managing Urban Stormwater: Soils and Construction*, Volume 1, 4th Edition, Landcom, 2004.

WRM (2011) *Surface Water Impact Assessment for Coalpac Consolidation Project*, Report prepared by WRM Water & Environment on behalf of Coalpac Pty Ltd, November 2011.

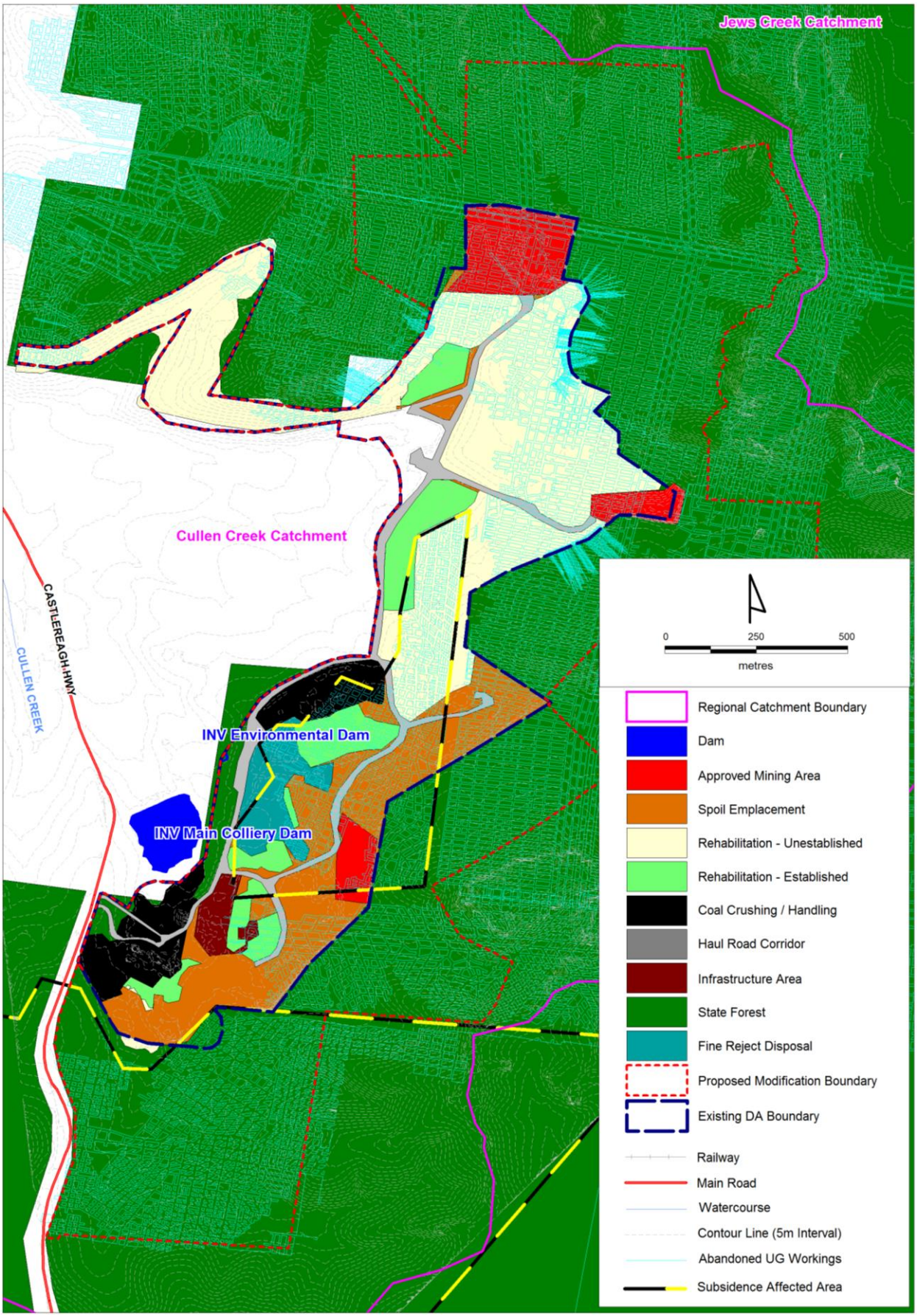


Figure 1 Invincible Colliery Existing Layout and Key Drainage Features

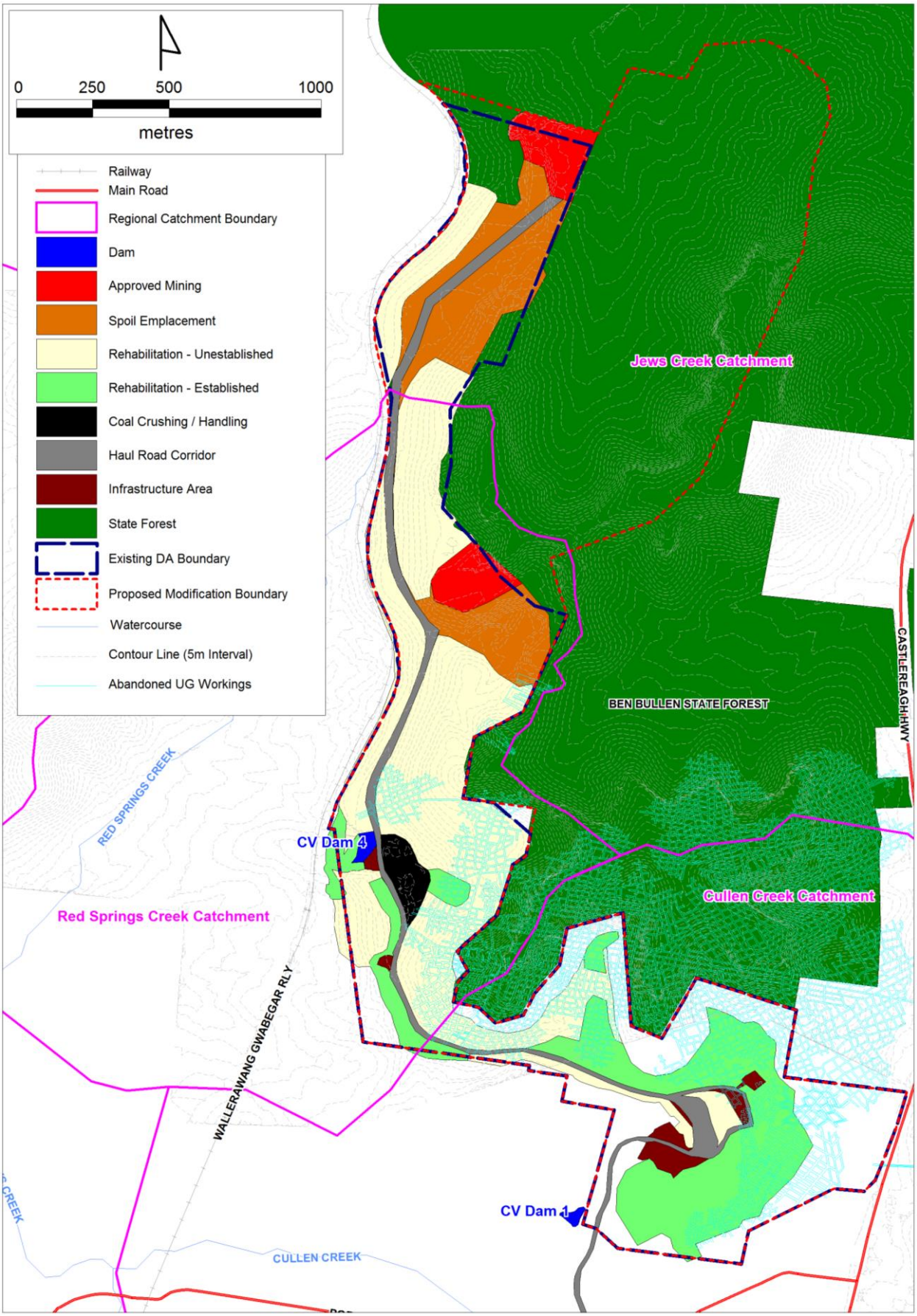


Figure 2 Cullen Valley Mine Existing Layout and Key Drainage Features

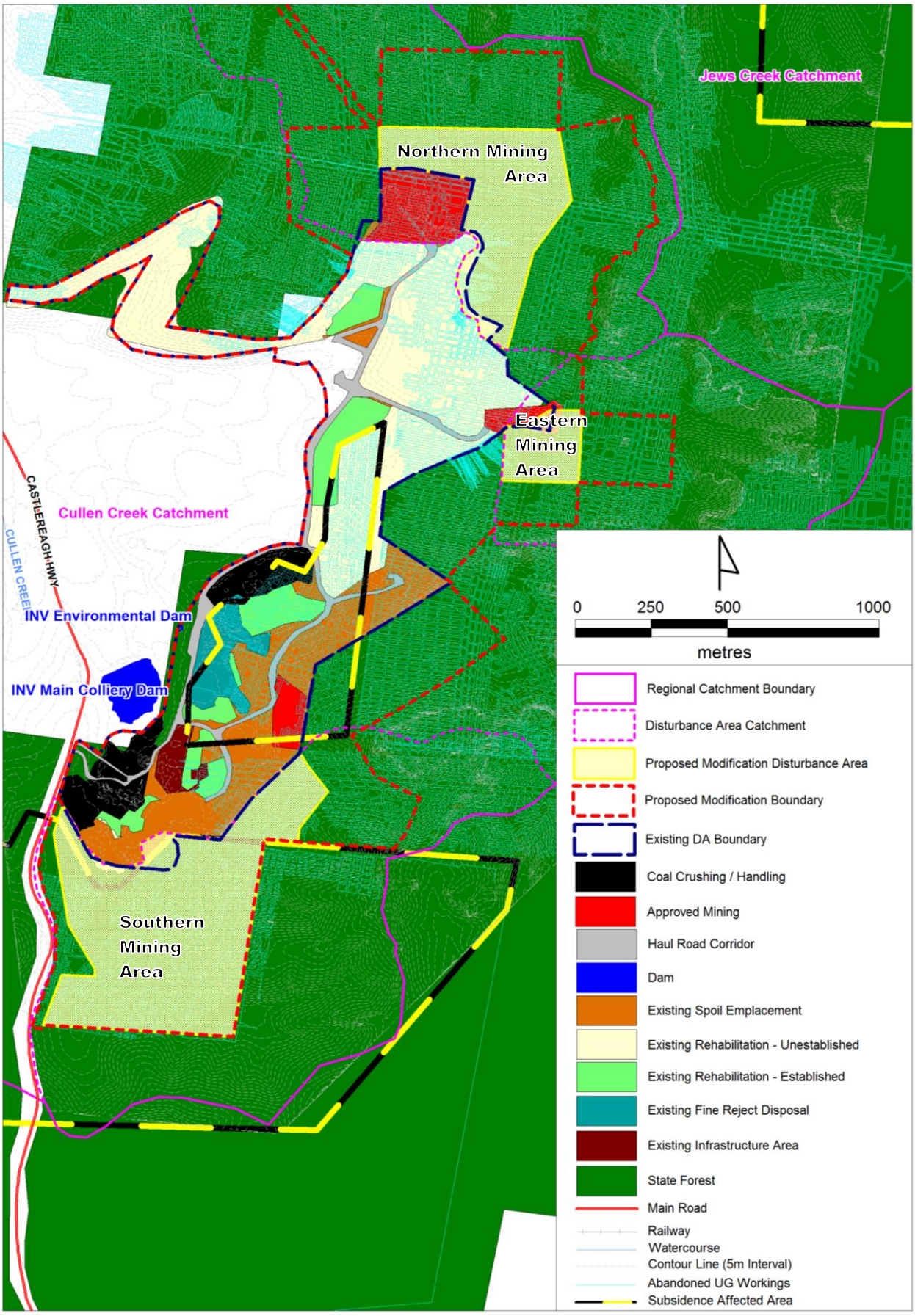


Figure 3 Invincible Colliery Proposed Modification Disturbance Areas

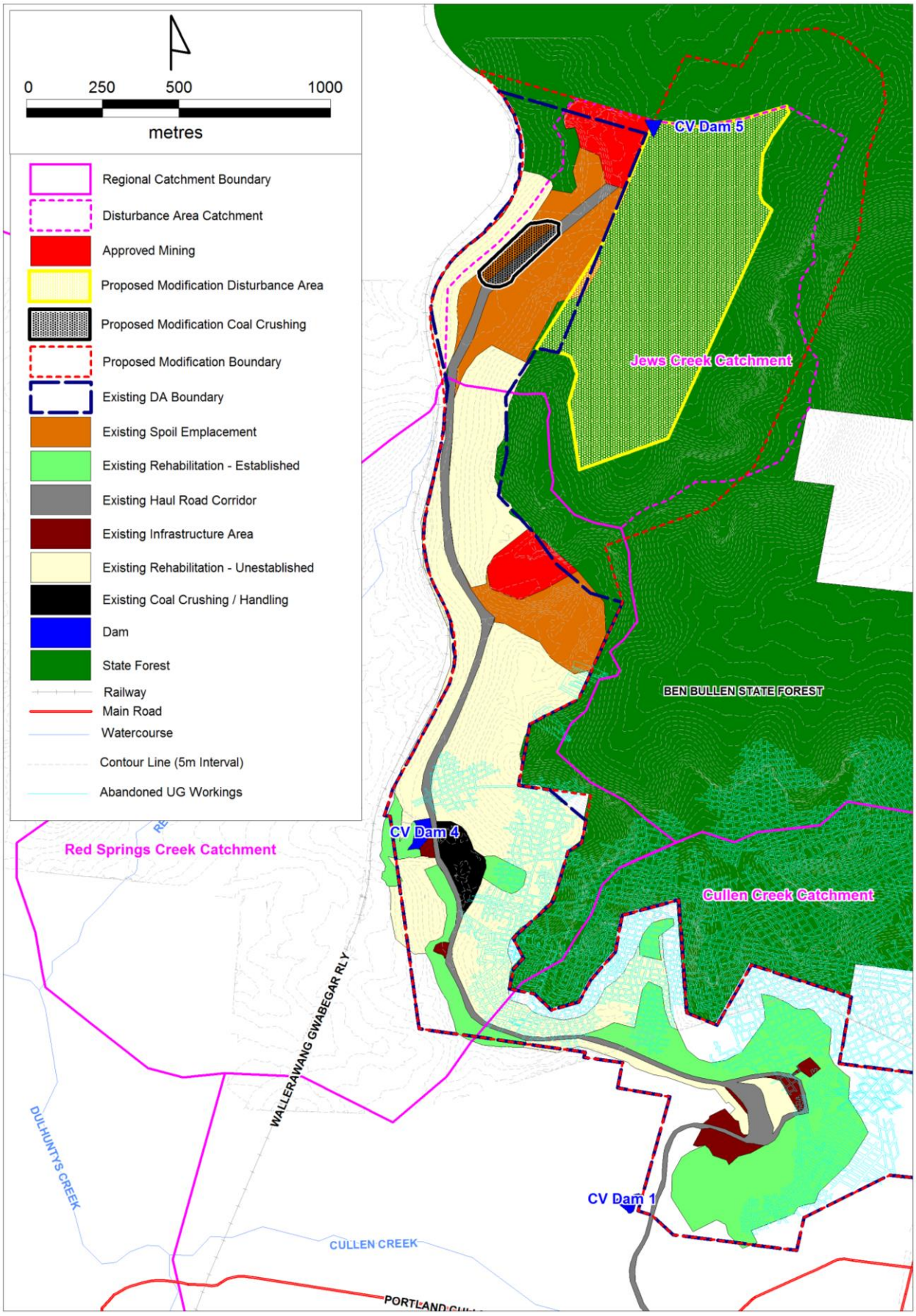


Figure 4 Cullen Valley Mine Proposed Modification Disturbance Areas

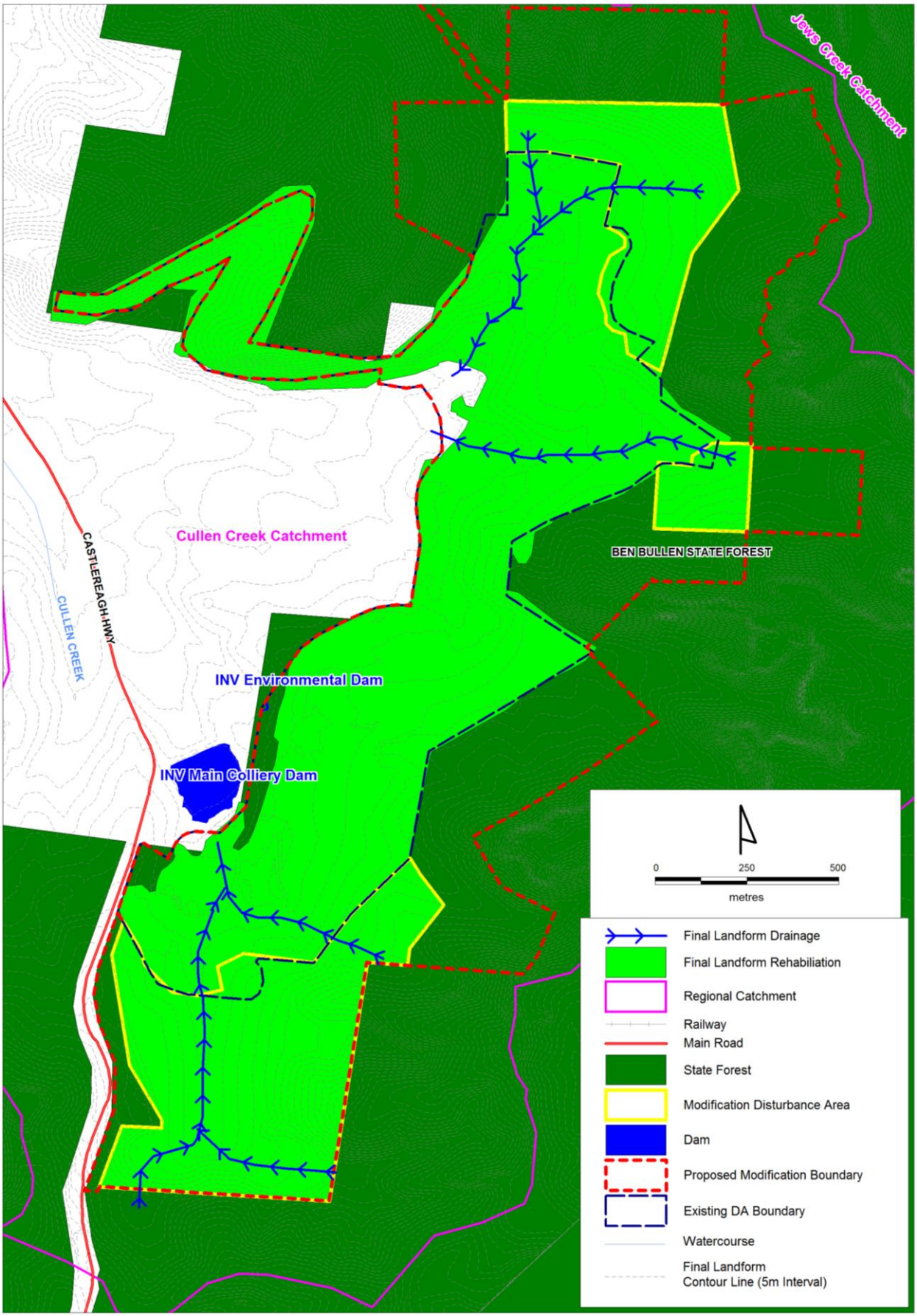


Figure 5 Invincible Colliery Conceptual Final Landform

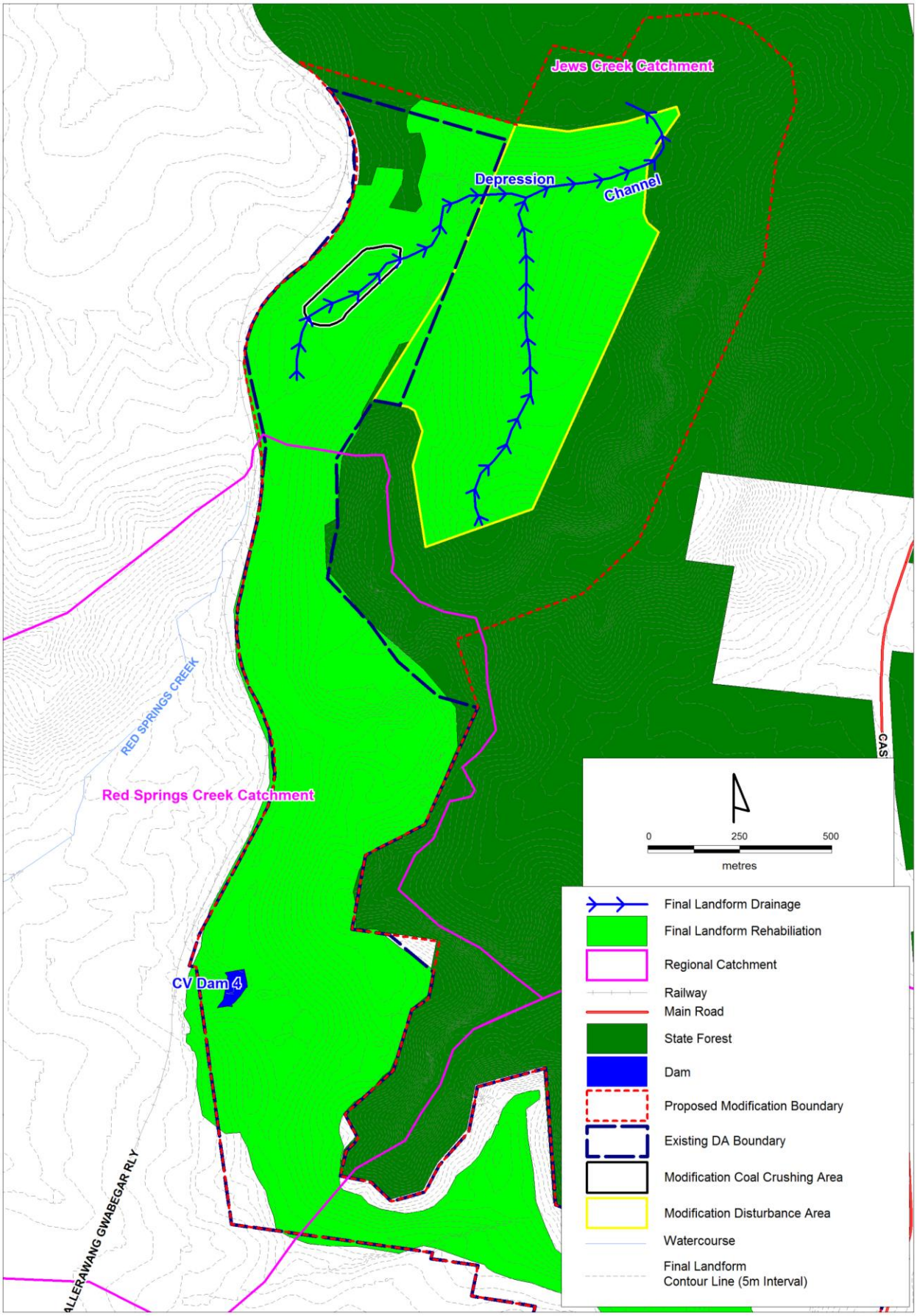
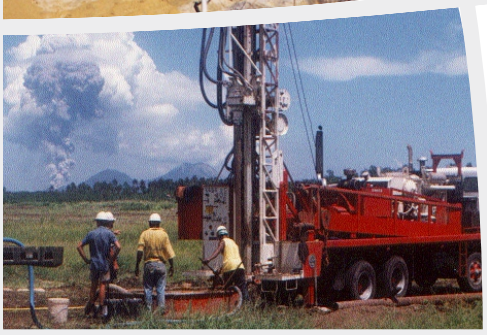


Figure 6 Cullen Valley Mine Conceptual Final Landform

APPENDIX E

Groundwater Impact Assessment



Australasian
Groundwater & Environmental
Consultants Pty Ltd

REPORT on

GROUNDWATER IMPACT STUDY

INVINCIBLE COLLIERY AND CULLEN VALLEY MINE MODIFICATION

prepared for
HANSEN BAILEY PTY LTD

Project No. G1515/A
February 2014

ABN:64 080 238 642

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TJA:tl/ae (Coalpac Modification)
Project No. G1515/A
February 2014

REPORT ON

GROUNDWATER IMPACT STUDY

INVINCIBLE COLLIERY AND CULLEN VALLEY MINE MODIFICATION

1 INTRODUCTION

The Cullen Valley Mine and Invincible Colliery operations are located adjacent to the Castlereagh Highway, approximately 25 km to the northwest of Lithgow, New South Wales (NSW). Coalpac Pty Ltd (Coalpac) owns and operates both mines. The Invincible Colliery has been owned and operated by Coalpac since 1988 and Cullen Valley Mine was acquired by Coalpac in 2007. Each mine operates as a separate entity with separate planning approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Coalpac is seeking to modify both planning approvals under Section 75W of the former Part 3A of the EP&A Act (the Modifications). The Modifications are sought to facilitate the extension to the respective approved mining areas via open cut and highwall mining methods at each site that have been specifically designed to result in the creation of a free draining final landform and thus the orderly rehabilitation of the currently disturbed mining areas.

Hansen Bailey Pty Ltd (Hansen Bailey) has been commissioned to prepare an Environmental Assessment (EA) in support of the Project Applications for the Modifications. This groundwater assessment has been undertaken by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) at the request of Hansen Bailey on behalf of their client Coalpac.

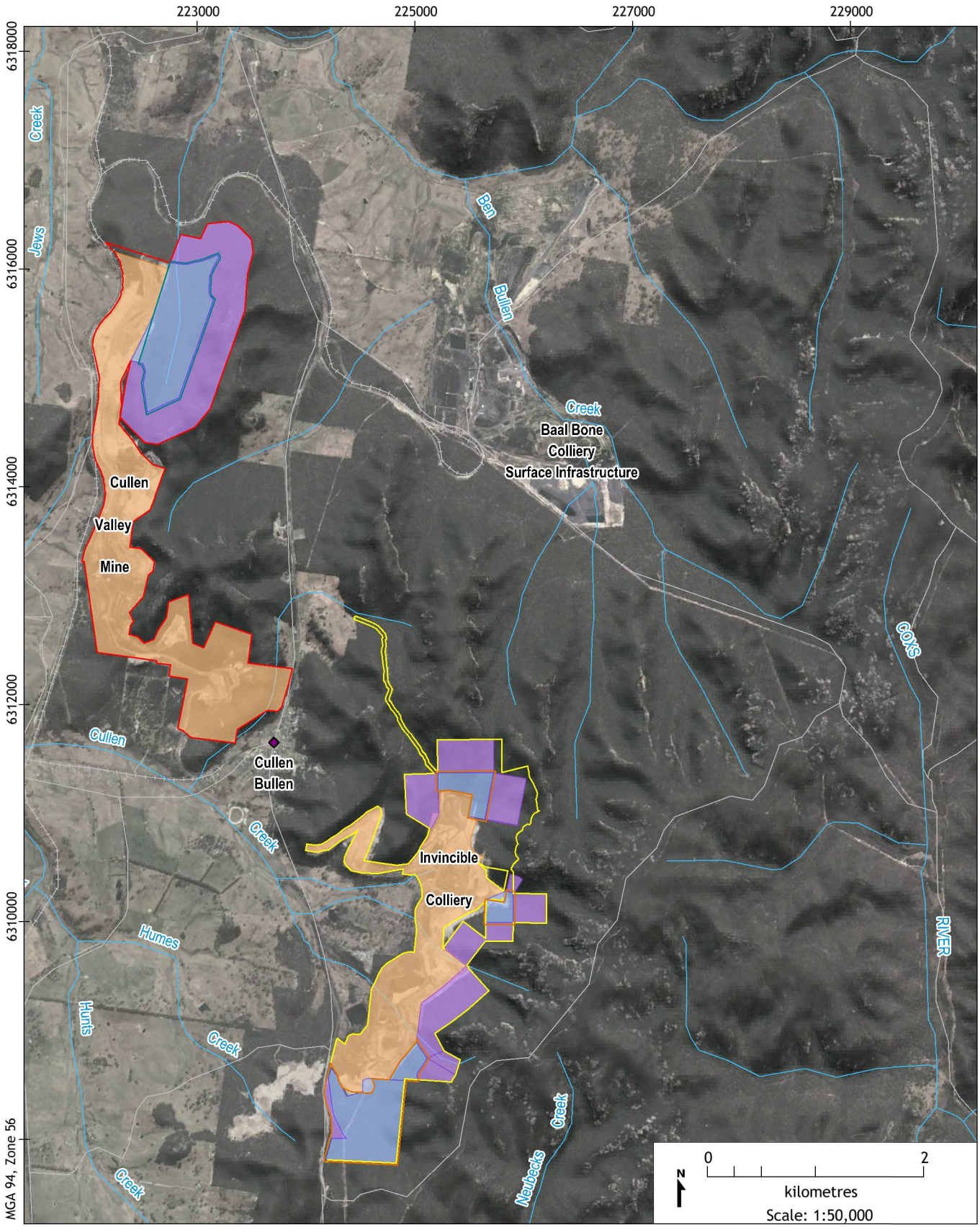
2 MINING AREA MODIFICATIONS

2.1 Invincible Colliery Modification

The Invincible Colliery Modification (INV MOD4) will seek approval for the following modifications to its current Project Approval (PA 07_0127):

- Extension to PA 07_0127 for four years from December 2016 to December 2020;
- Extension of 88 ha to areas approved for open cut mining. The proposed areas of mining modification are shown on Figure 2-1;
- Extension of 86 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance;
- Installation of a water pipeline which will result in the ability to transfer water between Invincible Colliery and Cullen Valley Mine. The pipeline alignment will largely remain on or adjacent to existing access tracks within the Ben Bullen State Forest; and
- Backfilling of the residual final voids resulting from existing mining operations and the rehabilitation of areas affected by subsidence from historic underground mining operations in the area to create a free-draining final landform.

All other aspects of operations on site, including coal production and processing, coal transport, operational hours and employment, would generally remain consistent with that approved under PA 07_0127.



LEGEND:

- Approved Disturbance
- Proposed Open Cut Mining
- Proposed Highwall Mining
- Cullen Valley Mine Modification Boundary
- Invincible Colliery Modification Boundary
- Cullen Valley Mine Modification Disturbance Boundary
- Invincible Colliery Modification Disturbance Boundary
- Town
- Watercourse
- Road / Track
- Railway

Coalpac Modification (G1515A)

Invincible Colliery & Cullen Valley Mine Proposed Modifications

DATE: 8/1/2014

FIGURE No: 2-1

2.2 Cullen Valley Mine Modification

The Cullen Valley Mine Modification (CV MOD2) is seeking approval for the following modification to its current Development Approval (DA 200-5-2003):

- Extension of 62 ha to areas approved for open cut mining;
- Extension of 79 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance;
- Ability to benefit from the transfer of water to and from Invincible Colliery; and

  Backfilling and rehabilitation of the residual final void resulting from existing mining operations to create a free-draining final landform.

All other aspects of operations, including coal production and processing, coal transport, operational hours and employment, would generally remain consistent with that approved under DA 200-5-2003.

3 ASSESSMENT PROCESS

In 2010, Coalpac lodged Project Application 10_0178, under Part 3A of the Environmental Planning & Assessment Act 1979, seeking major Project Approval for the development and operation of the Coalpac Consolidation Project (CCP). The CCP Application sought approval to consolidate and extend the coal mining operations and management of the Cullen Valley Mine and Invincible Colliery under a single planning approval to allow the continuation of mining operations for a further 21 years. A groundwater study was undertaken by AGE (2012) for the CCP. While the application for the CCP was subsequently withdrawn on 16 October 2013, this report has drawn on relevant sections of the CCP report prepared by AGE (2012).

The modification applications for Invincible Colliery and Cullen Valley Mine, for which this report has been produced, seeks separate approvals to extend the open cut and highwall mining at both sites into new areas.

The footprints of the proposed Modifications are substantially smaller than the previous CCP. The proposed timeframe for mining under the Modifications is also substantially reduced.

4 SCOPE OF WORK

The groundwater study for the CCP concluded that the risk to groundwater was low (AGE, 2012). This conclusion was reached because the Cullen Valley Mine and Invincible Colliery are located along an elevated ridge where much of the strata are located above the groundwater table and are unsaturated. The Modifications are also located adjacent to extensive underground workings which have significantly depressurised the coal seam strata.

Hansen Bailey requested AGE compile a groundwater impact assessment to support an application to modify the current mining approvals. This report has addressed the predicted mining related impacts for each modification area independently, and has drawn from relevant sections of the CCP report prepared by AGE (2012). The objective of the current study was to assess the impacts of the Modifications on the groundwater regime and compliance with NSW Government Policies.

5 LEGISLATION

The following legislation and policy regulates groundwater in NSW:

- Water Management Act 2000 and subordinate Water Sharing Plans;
- Groundwater Quality Protection Policy;
- Groundwater Dependent Ecosystems Policy;
- Groundwater Quantity Management Policy; and
- Aquifer Interference Policy.

AGE (2012) outlines the objectives and requirements of the above documents. Of most relevance to the Modifications is the Aquifer interference Policy (AIP). The AIP states that "*all water taken by aquifer interference activities, regardless of quality, needs to be accounted for within the extraction limits defined by the water sharing plans. A water licence is required under the WM Act (unless an exemption applies or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity causes:*

- *the removal of water from a water source; or*
- *the movement of water from one part of an aquifer to another part of an aquifer; or*
- *the movement of water from one water source to another water source, such as:*
    - *from an aquifer to an adjacent aquifer; or*
    - *from an aquifer to a river/lake; or*
    - *from a river/lake to an aquifer."*

The AIP requires that proponents of mining projects assess the likely volume of water taken from a water source(s) due to the aquifer interference activity. These predictions need to occur prior to Development Consent approval. After Development Consent approval and during operations, these volumes need to be measured and reported in the Annual Review. In most circumstances proponents must hold water access licences with a sufficient share component and water allocation to account for the take of water from affected sources.

In addition to the volumetric water licensing considerations, the AIP requires details of potential:

- Water level, quality, or pressure drawdown impacts on nearby water users, connected surface water sources and groundwater dependent ecosystems;
- Increased saline or contaminated water inflows to aquifers and highly connected river systems;
- To cause or enhance hydraulic connection between aquifers; and
- For river bank instability, or high wall instability or failure to occur.

The AIP presents minimal impact considerations for aquifer interference activities based upon whether the water source is highly productive or less productive, and whether the water source is alluvial or porous / fractured rock in nature. In general, the AIP applies a predicted 2 m drawdown maximum limit at existing water supply works.

The NSW Office of Water's (NOW) assessment of impacts and subsequent advice and proposed conditions of approval for a project is based on an "*account for, mitigate, avoid/prevent, and remediate*" approach. NOW's methodology is based on "*a risk management approach to*

assessing the potential impacts of aquifer interference activities, where the level of detail required to be provided by the proponent is proportional to a combination of the likelihood of impacts occurring on water sources, users, and dependent ecosystems, and the potential consequences of these impacts."

Sections 11, 12, 13, and 14 provide a technical discussion and predictions of how the mining modifications have been assessed in accordance with the requirements of the AIP.

6 REGIONAL SETTING

6.1 Location

Cullen Valley Mine and Invincible Colliery are located on the western slopes of the Great Dividing Range adjacent to the township of Cullen Bullen (Figure 2-1), which has a population of approximately 200 people. The closest urban area is the regional centre of Lithgow, situated approximately 25 km to the south-east along the Castlereagh Highway.

The existing mining areas are bounded to the north, east, and south by the Ben Bullen State Forest, and the lower lands of Cullen Valley to the west. Figure 6-1 shows the lease boundaries of Invincible Colliery and Cullen Valley Mine, along with the lease boundaries of adjacent mining operations in the local area.

6.2 Historical Mining Operations

6.2.1 Cullen Valley Mine

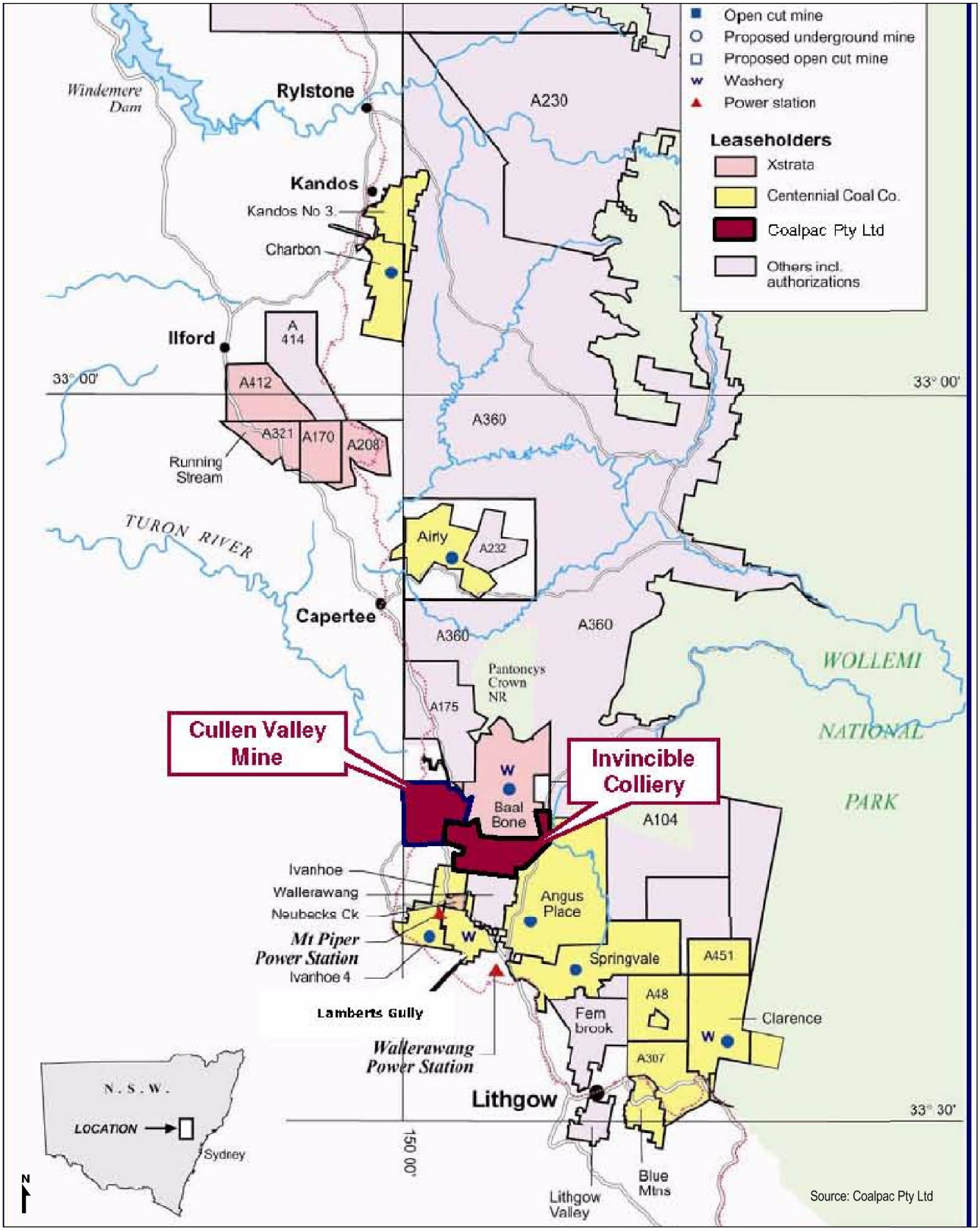
The Cullen Valley Mine site contains the former operational areas of the Old Tyldesley Colliery, where coal mining via underground methods commenced in the late 1800's. A range of open cut and underground mining operations have been undertaken at the site since this time, with activities suspended at various times in the intervening period.

The Minister for Planning approved the Feldmast Coal Project at Cullen Valley Mine in 1997 (IEC, 1997). Open cut mining consistent with the Feldmast EIS commenced in 2000. The Department of Infrastructure, Planning and Natural Resources approved a further modification in 2004, following identification of additional open cut coal reserves on the western side of Tyldesley Hill.

6.2.1 Invincible Colliery

Coal mining at Invincible Colliery commenced in 1901 with the establishment of an underground mining operation located on the eastern side of the township of Cullen Bullen. This operation (referred to in this document as the Old Invincible Colliery) continued into the mid 1950's, when the mine entrance was relocated approximately 4 km to the south to commence another underground operation (Invincible Colliery) which remained active until 1998, when underground operations were suspended.

Limited open cut mining at Invincible Colliery commenced in 1998 and continued until 2001, when the site was placed on Care and Maintenance.



Coalpac Modification (G1515A)

Adjacent Mining Tenements

DATE: 23/12/2013

FIGURE No: **6-1**

In May 2005, Coalpac secured a contract from Delta Electricity to supply coal to the Mount Piper Power Station (MPPS) over a three-year period. An application for Project Approval under the EP&A Act, supported by the *Environmental Assessment for Proposed Extension of Invincible Open Cut Mine and Rehabilitation Activities* (Craven Elliston Hayes, 2006), was submitted to Department of Planning (DoP) for an extension to the open cut operations at Invincible Colliery to allow this contract to be met. Project Approval (PA 05_0065) was granted on 7th September 2006 for the mine extension and Invincible Colliery was taken off Care and Maintenance.

Following the recommencement of open cut mining at the Invincible Colliery being approved, two further successful applications were made for the modification of PA 05_0065. These modifications gained approval to introduce highwall mining within the open cut mine area.

Current mining operations at Invincible Colliery are approved under PA 07_0127 (as modified), which was initially granted on 4th December 2008 for the extension of open cut and highwall mining operations as described in the *Environmental Assessment of the Proposed Extension to the Invincible Colliery Open Cut Mine and Production Increase* (R.W. Corkery, 2008).

6.3 Topography and Drainage

The Cullen Valley Mine and Invincible Colliery are located on the western slopes of the Great Dividing Range at elevations between 900 and 1,100 mAHD, as shown on Figure 6-2. The land to the east of the mining areas rises steeply, with remnant sandstone escarpments to the immediate east of the Invincible Colliery. This area is covered by the Ben Bullen State Forest.

The gentle slopes of the Cullen Valley fall toward an elevation of approximately 840 mAHD to the west of the Cullen Valley Mine and Invincible Colliery.

The region is located in the upper Turon River catchment, a tributary of the Macquarie River. The upper Turon River flows in a north-west direction joining the Macquarie River north of Bathurst. There are a number of minor drainage lines in the vicinity of both mining areas, with local catchments consisting of ephemeral creeks and watercourses.

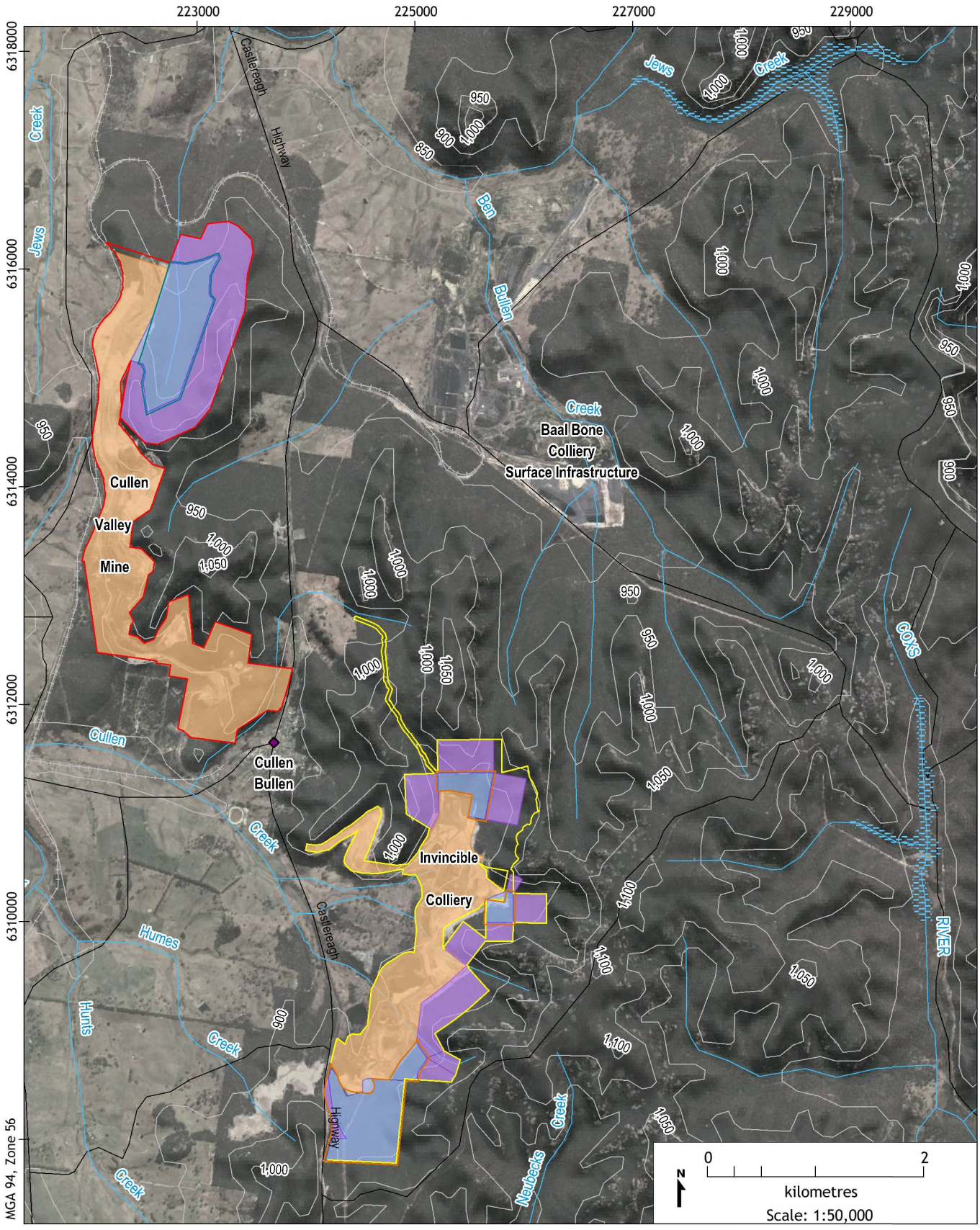
No wetland areas or groundwater dependent ecosystems have been identified within the immediate vicinity of the Cullen Valley Mine or Invincible Colliery. The closest wetland areas are located at the Coxs River Swamp and the Jews Creek Swamp.

Coxs River Swamp is located approximately 3.5 km to the east of the Invincible Colliery Modification Boundary. Jews Creek Swamp is located approximately 5 km east of the Cullen Valley Mine Modification Boundary. The locations of creeks and swamp areas are shown on Figure 6-2.

6.4 Climate

The climate of the region is defined by its latitude, inland location, and the steep ridge and valley escarpments typical of the western slopes of the Great Dividing Range. Generally, the climate is cool-temperate, characterised by relatively mild summers and cold winters. Rainfall patterns are summer dominant. Fog and frost are common in cooler months, although a range of factors including the ridge and valley topography, altitude, aspect, and exposure result in some localised temperature variations. Temperature inversions are common in winter months, tending to occur on frosty mornings and on days when fogs are present.

The average annual rainfall at Lidsdale is 766 mm with January typically being the wettest month (BOM Station No. 063132). Evaporation of about 1,350 mm/year exceeds rainfall throughout most of the year except for the winter months of June, July, and August (BOM Station No. 063005).



LEGEND:

- Approved Disturbance
- Proposed Open Cut Mining
- Proposed Highwall Mining
- Cullen Valley Mine Modification Boundary
- Invincible Colliery Modification Boundary
- Cullen Valley Mine Modification Disturbance Boundary
- Invincible Colliery Modification Disturbance Boundary
- Elevation Contour (50m Interval)
- Town
- Watercourse
- Swamp Area
- Road / Track
- Railway

Coalpac Modification (G1515A)

Site Topography and Drainage

DATE: 8/1/2014

FIGURE No: 6-2

7 GEOLOGY

Both Modifications are located within the Western Coalfields of NSW, which is geologically located on the western edge of the Sydney Basin. The Sydney Basin consists of a series of gently dipping sedimentary beds of shale, coal, and sandstone of Permian age that were overlain and capped by massive sandstones of Triassic age (Yoo, et al. 2001).

The Western Coalfields extend in an easterly direction, dipping gently at an angle of 1° to 3° to the north-east towards the coast, and continue out to sea. The Western Coalfields are characterised by prominent cliffs and eroding plateaus of the Triassic age sandstone and shale of the Narrabeen Group. This group overlies the shale, sandstone, conglomerate, and coal of the Permian aged Illawarra Coal Measures, which form the eroded slopes that fall away from the sandstone and shale cliffs of the Narrabeen Group.

The existing operations of Cullen Valley Mine and Invincible Colliery and their proposed Modifications extract coal seams of the Illawarra Coal Measures. There are seven identified coal seams in the Illawarra Coal Measures, which in descending stratigraphical order are as follows:

- Katoomba Seam;
- Middle River Seam;
- Moolarben Seam;
- Upper Irondale Seam;
- Irondale Seam (1.5 m to 2.3 m thick);
- Lidsdale Seam; (0.7 to 1.5 m thick); and
- Lithgow Seam (0.1 to 3.6 m thick).

The coal seams located above the Irondale Seam (i.e. Katoomba, Middle River, and Moolarben Seams) are not always present having been largely removed by weathering and are commonly truncated by topography, especially near the Cullen Valley Mine. The Lithgow Coal Seam has been worked extensively in the vicinity of Invincible Colliery by historic underground and open cut workings in addition to current operations. However, commercial scale mining of the Irondale Coal Seam has only occurred relatively recently.

The Coxs River Lineament Fault Zone follows the valley of the Coxs River and has been identified by seismic surveys at Baal Bone Colliery. The fault zone is a north-south trending graben structure, about 250 m wide. The displacement on the eastern structure is about 4 m to 5 m, up to the east. The western fault shows a lesser displacement in the seismic survey in the order of 2 m. Between these two faults, the seismic data indicates other smaller faults exist, in conjunction with brecciation of the strata (Connell Wagner, 2006).

The Marrangaroo Formation is located beneath the Lithgow Coal Seam (typically separated by carbonaceous mudstone) and crops out persistently throughout the Western Coalfield, ranging in thickness from 2 m to 16 m.

8 PROPOSED MINING METHODS

The approach to mining differs from a typical open cut coal mine, due to the high relief and steep slopes. The mine targets strips of outcropping coal with open cut methods, and highwall mining. The proposed mining operations will recommence with open cut methods followed by highwall

mining once the strip ratio becomes too high. Highwall mining is anticipated to advance into the coal face by 300 m.

Open cut and highwall mining will not proceed through the flooded Old Tyldesley Colliery and Old Invincible Colliery underground workings. No open voids will remain at the conclusion of mining operations at either the Cullen Valley Mine Modification or Invincible Colliery Modification.

9 GROUNDWATER MONITORING PROGRAM

The standing water level within the flooded workings of the Old Tyldesley Colliery (Cullen Valley Mine area) has been recorded within the Tyldesley Colliery Drainage Bore (GW804393) since 2000. Similarly, the standing water level within the flooded workings of the Invincible Colliery has been recorded within LD001 since 2010.

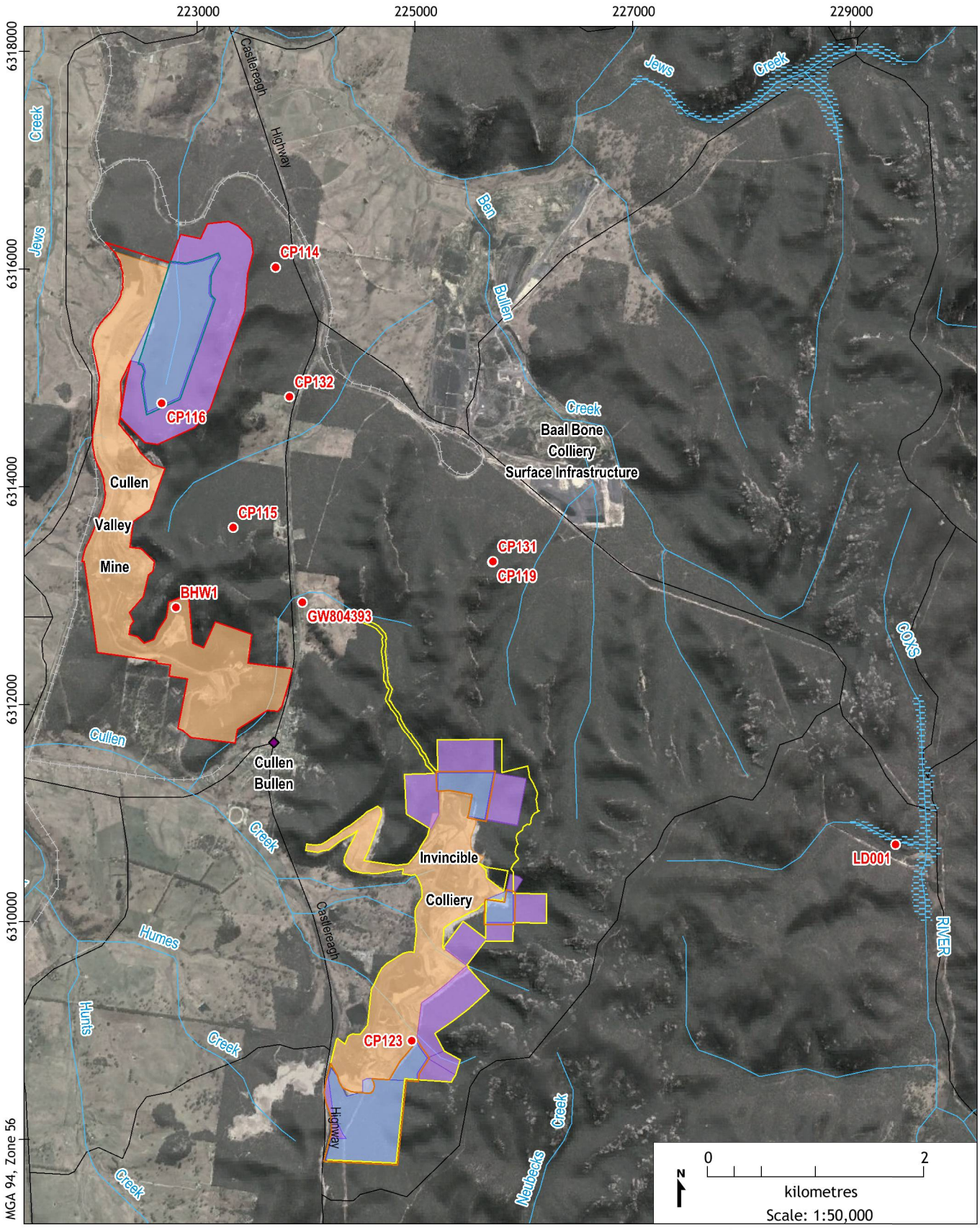
An expanded groundwater monitoring bore network was installed in early 2011 to augment the existing bores at each mining area. Five monitoring bores (CP114, CP115, CP116, CP119, and CP123) were constructed in exploration drill holes. The sites were selected to provide sufficient spatial coverage over the area proposed to be mined for the CCP. Two more monitoring bores (CP131 and CP132) were installed in 2012 and one bore (BHW1) was installed in 2013. Figure 9-1 shows the locations of the monitoring bores, with bore construction details summarised in Table 1.

In total, the current groundwater monitoring network for the Cullen Valley Mine comprises seven bores, and the Invincible Colliery monitoring network comprises one bore.

Table 1: GROUNDWATER MONITORING NETWORK DETAILS

Drill Hole ID	Hole Depth (mbgl)	Screen (mbgl)	Screen Zone Geology
Cullen Valley Mine			
CP114	41.9	36.9 – 41.9	Marrangaroo Formation (sandstone/conglomerate)
CP115	71.2	68.2 – 71.2	Lithgow Coal Seam
CP116	56.8	53.8 – 56.8	Lithgow Coal Seam
CP119*	79.5	68.9 – 72.9	Lithgow Coal Seam
CP131	74.59	70.58 – 73.58	Lithgow Coal Seam
CP132	41.38	32.7 – 35.7	Marrangaroo Formation (sandstone/conglomerate)
BHW1	50.78	48.92 – 50.78	Lithgow Coal Seam (Tyldesley Colliery flooded workings)
GW804393	24.03	22.09 – 24.03	Lithgow Coal Seam (Tyldesley Colliery flooded workings)
Invincible Colliery			
CP123*	36.5	33.5 – 36.5	Marrangaroo Formation (sandstone/conglomerate)
LD001	104	100 – 104	Lithgow Coal Seam (Invincible Colliery flooded workings)

Note: mbgl = metres below ground level
* decommissioned bore



LEGEND:

- Monitoring Bore
- Approved Disturbance
- Proposed Open Cut Mining
- Proposed Highwall Mining
- Cullen Valley Mine Modification Boundary
- Invincible Colliery Modification Boundary
- Cullen Valley Mine Modification Disturbance Boundary
- Invincible Colliery Modification Disturbance Boundary
- Town
- Watercourse
- Swamp Area
- Road / Track
- Railway

Coalpac Modification (G1515A)

Groundwater Monitoring Bore Locations

DATE: 8/1/2014

FIGURE No: 9-1

The groundwater level within each monitoring bore is recorded by automatic water level loggers on a continuous, four-hour basis. Groundwater quality was measured from each monitoring bore soon after its installation. The groundwater samples were analysed for:

- General parameters: pH, Electrical Conductivity (EC), and Total Dissolved Solids (TDS);
- Major cations: sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg);
- Major anions: chloride (Cl), sulphate (SO_4), bicarbonate (HCO_3), carbonate (CO_3), and fluoride (F);
- Selected metals : aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), thallium (Ti), thorium (Th), tin (Sn), uranium (U), vanadium (V), zinc (Zn), and bromine;
- Nutrients: nitrate (NO_3), nitrite (NO_2), and phosphate (PO_4).

10 GROUNDWATER REGIME

The groundwater regime surrounding the Cullen Valley Mine and the Invincible Colliery comprise the following units:

- Overburden sediments of the Triassic Narrabeen Group;
- Coal seams within the Permian Illawarra Coal Measures separated by Permian overburden / interburden sediments; and
- The Marrangaroo (sandstone/conglomerate) Formation.

10.1 Aquifers and Aquitards

The groundwater systems within the Narrabeen Group of sediments are complex with perched water tables and semi-confined leaky aquifers separated by relatively impermeable claystone layers (Bish, 1999). The water bearing units of the Narrabeen Group have low flow inter-granular primary porosity and greater secondary porosity provided by fractures, bedding partings, and fissures within the strata. The water-bearing zones within the Narrabeen Group are heavily influenced by topography.

The Permian strata can be categorised into the following hydrogeological units:

- Hydrogeologically “tight” and hence very low yielding to essentially dry sandstone, siltstone and mudstone that comprise the majority of the Illawarra Coal Measures; and
- Low permeability coal seams which are the prime water bearing strata within the Illawarra Coal Measures.

The upper seams in the Illawarra Coal Measures outcrop at the Wolgan Valley escarpment and are frequently truncated by the ridge and valley topography that is particularly dominant near the Cullen Valley Mine. Therefore, the upper coal seams are typically limited in extent, predominantly unsaturated and have limited groundwater resource potential on a regional scale.

Historical underground mining at the Old Tyldesley Colliery, Old Invincible Colliery, the Invincible Colliery, and Baal Bone Colliery have all targeted the Lithgow Coal Seam, this being the deepest and most continuous coal seam.

The Marrangaroo Formation of sandstone and conglomerate crops out persistently throughout the Western Coalfield. The permeability of the formation is regionally variable and in some locations will be high enough to form a productive aquifer.

10.2 Hydraulic Properties

The Permian Coal Measures throughout the region have variable permeability. Permeability is generally higher in the coal seams and occasionally in the overburden / interburden sediments due to localised fracturing. The coal seams are classified as aquifers due to their higher permeability compared to the overburden / interburden sediments. The overburden / interburden sandstones, siltstones, and mudstones typically have significantly lower permeability than the coal seams (by one or more orders of magnitude) and they generally act as aquitards.

The hydraulic conductivity of the Lithgow Seam ranges between 0.03 m/day to 0.07 m/day, which is typical for coal seam aquifers (AGE, 2012). Investigations at the Springvale Colliery have shown that the strata overlying the Lithgow Seam have lower hydraulic conductivity with a range from 0.001 m/day to 0.01 m/day (Aurecon, 2010). The hydraulic conductivity for the Marangaroo Formation is expected to range between 0.05 m/day up to about 0.5 m/day (AGE, 2012).

10.3 Water Quality

The Permian aquifers host fresh to slightly brackish water with an average EC value of about 500 µS/cm (AGE, 2012). Water stored within the underground workings is very fresh with an EC value of about 150 µS/cm (AGE, 2012).

The lower salinity of the water stored within the Invincible Colliery void is most likely the result of higher recharge rates into underground workings from surface water flows. The higher recharge rate occurs through vertical fractures extending above subsided underground extraction panels and rainfall infiltration that directly enters the mine workings.

The water stored within the underground workings is slightly acidic with a pH value of 5.9. Groundwater in the Lithgow Seam is typically near neutral, but ranges from slightly alkaline to slightly acidic with pH values between 6.6 and 7.2.

Groundwater in the Marrangaroo Formation is typically fresh and has a near neutral pH ranging between 6.3 and 7.3.

10.4 Sub-surface Water Levels

Due to the presence of extensive underground workings and their proximity to the outcrop of the Lithgow Seam, any water contained within the Lithgow Seam horizon may be a combination of some groundwater and the majority being meteoric run-off, and has therefore been termed ‘sub-surface water’. Figure 10-1 shows sub-surface water levels recorded by automatic water level loggers since 2011. Sub-surface water levels within the Lithgow Coal Seam and the Marrangaroo Formation generally have little temporal variability. This limited fluctuation suggests recharge to the sub-surface water system may be limited and slow. However, the sub-surface water level response to rainfall appears to be increased near existing mine workings where there is a greater opportunity for direct recharge.

Sub-surface water levels are not anticipated to have large fluctuations owing to the relatively short distance between the bores and the outcrop area, the shallow gradient of the aquifers (in areas where underground workings are not present), and the relatively short distance to discharge areas at valley escarpments.

The sub-surface water level is approximately 892 mAHD near the Lithgow Coal Seam outcrop in the west. A hydraulic gradient exists towards the east-northeast, in the direction of the Wolgan Valley escarpment and the Baal Bone Colliery.

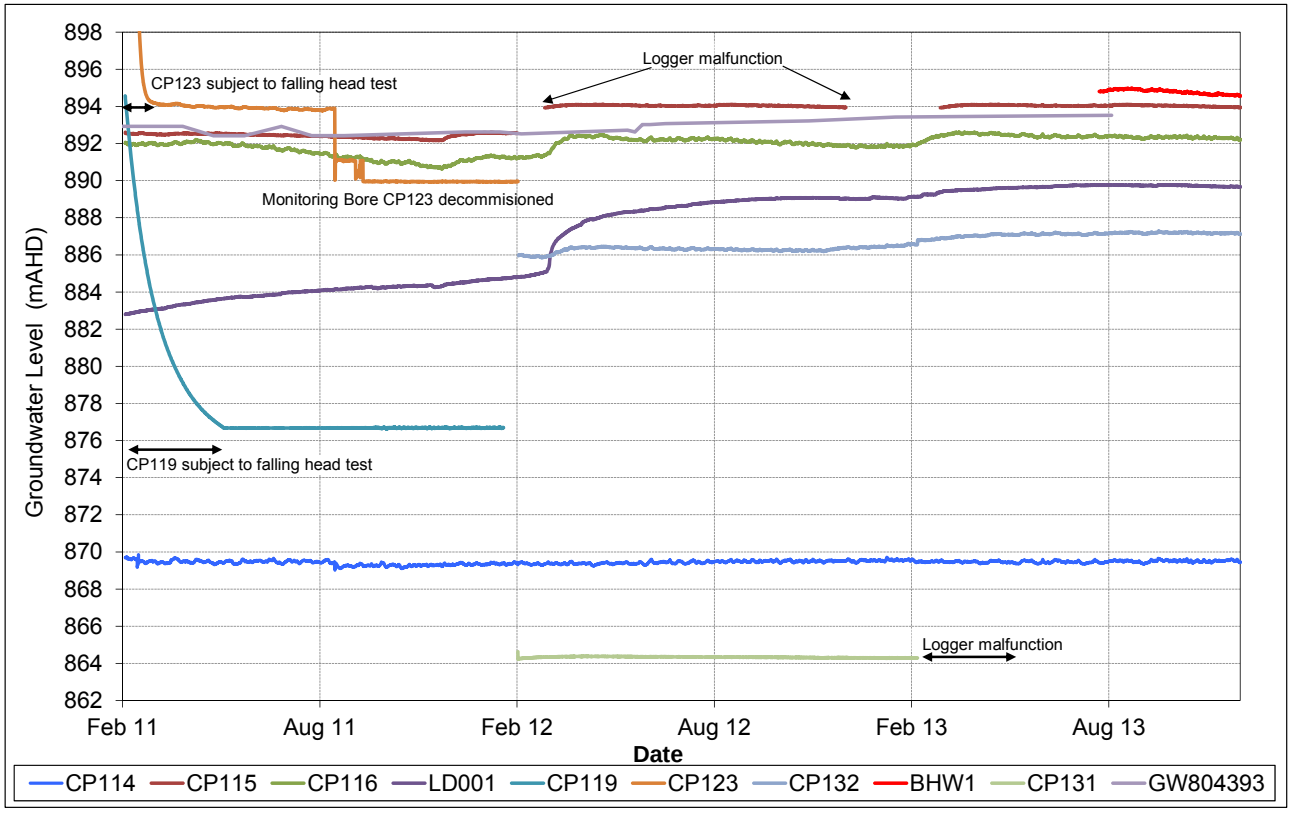
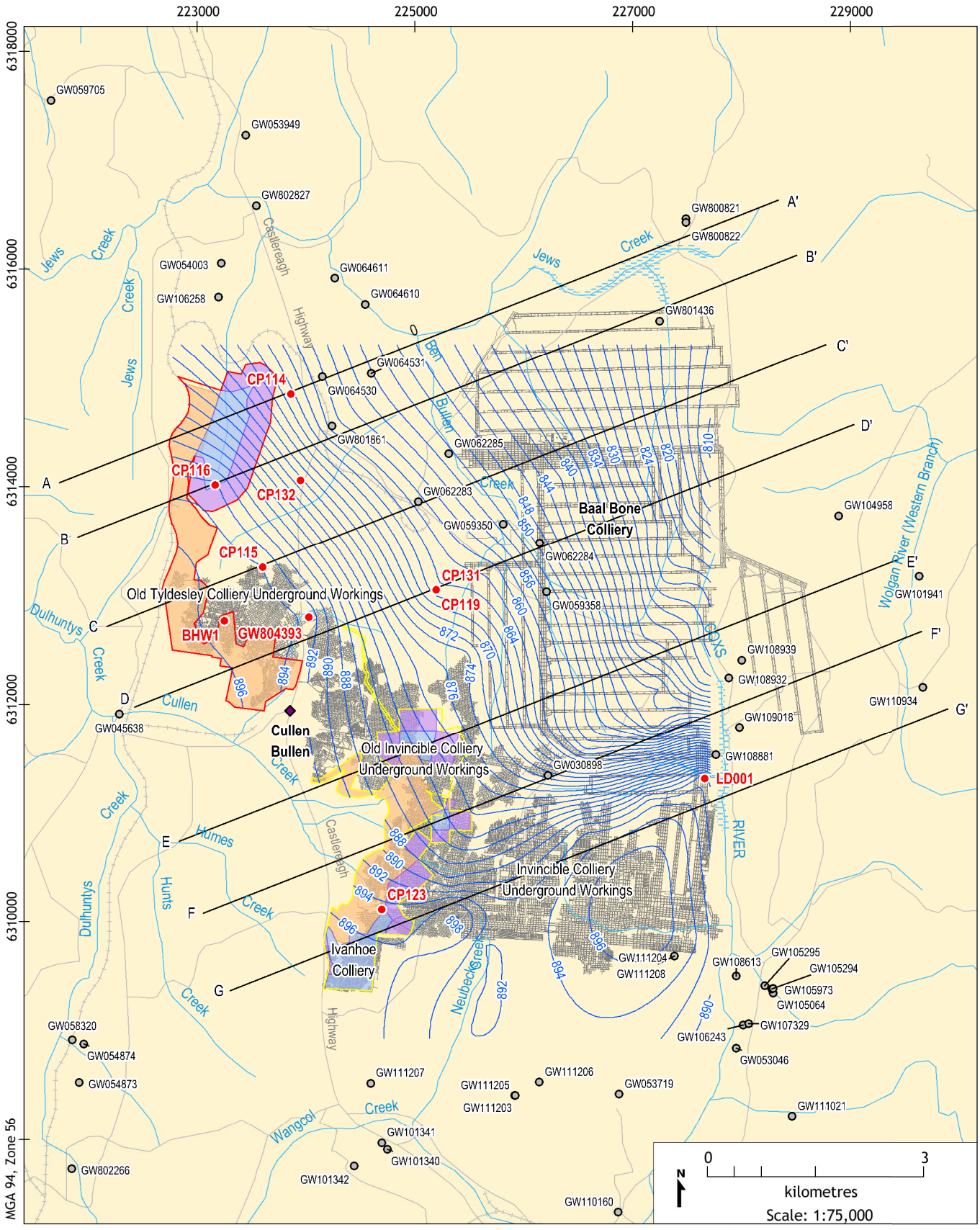


Figure 10-1: Hydrograph of Sub-surface Potentiometric Head

The Lithgow Coal Seam has been mined extensively in the region and is largely drained of groundwater (excluding water held within flooded mine workings). Continuous pumping from the Baal Bone Colliery since 1982 has been undertaken to keep the underground mine workings dry (Connell Wagner, 2006). This extraction has lowered the groundwater and sub-surface water level surrounding the Baal Bone Colliery. The floor elevation of the Baal Bone Colliery southern workings ranges from ~871 mAHD on the western longwall panel to ~812 mAHD on the eastern side near the escarpment of the Wolgan Valley.

A sub-surface water level (potentiometric) surface contour plan is shown on Figure 10-2. The potentiometric surface across the Cullen Valley Modification area was observed to range from ~892 mAHD down to ~870 mAHD. Only the Lithgow Seam is likely to be saturated, and only in the southern half of the Cullen Valley Mine Modification Boundary, where the Old Tyldesley Colliery underground workings exist. All of the coal seams located in the northern extent of the Cullen Valley modification are likely to be unsaturated, as shown on Figure 10-3. The maximum head of sub-surface water above the base of the Lithgow Seam in the far south of the Cullen Valley Mine open cut area will be about 6 m, and it will be a maximum of about 9 m within the highwall mining area.

A significant portion of the southern extent of the Invincible Colliery Modification Boundary is also likely to be unsaturated, as shown on Figure 10-3. The potentiometric surface across the Invincible Colliery Modification was observed to range from ~892 mAHD down to ~878 mAHD. The flooded extent of the old mine workings (sub-surface water) are located to the east (i.e. down-dip) of the proposed open cut pits. The majority of the Invincible Colliery Modification area is not likely to intercept saturated coal seams.



LEGEND:

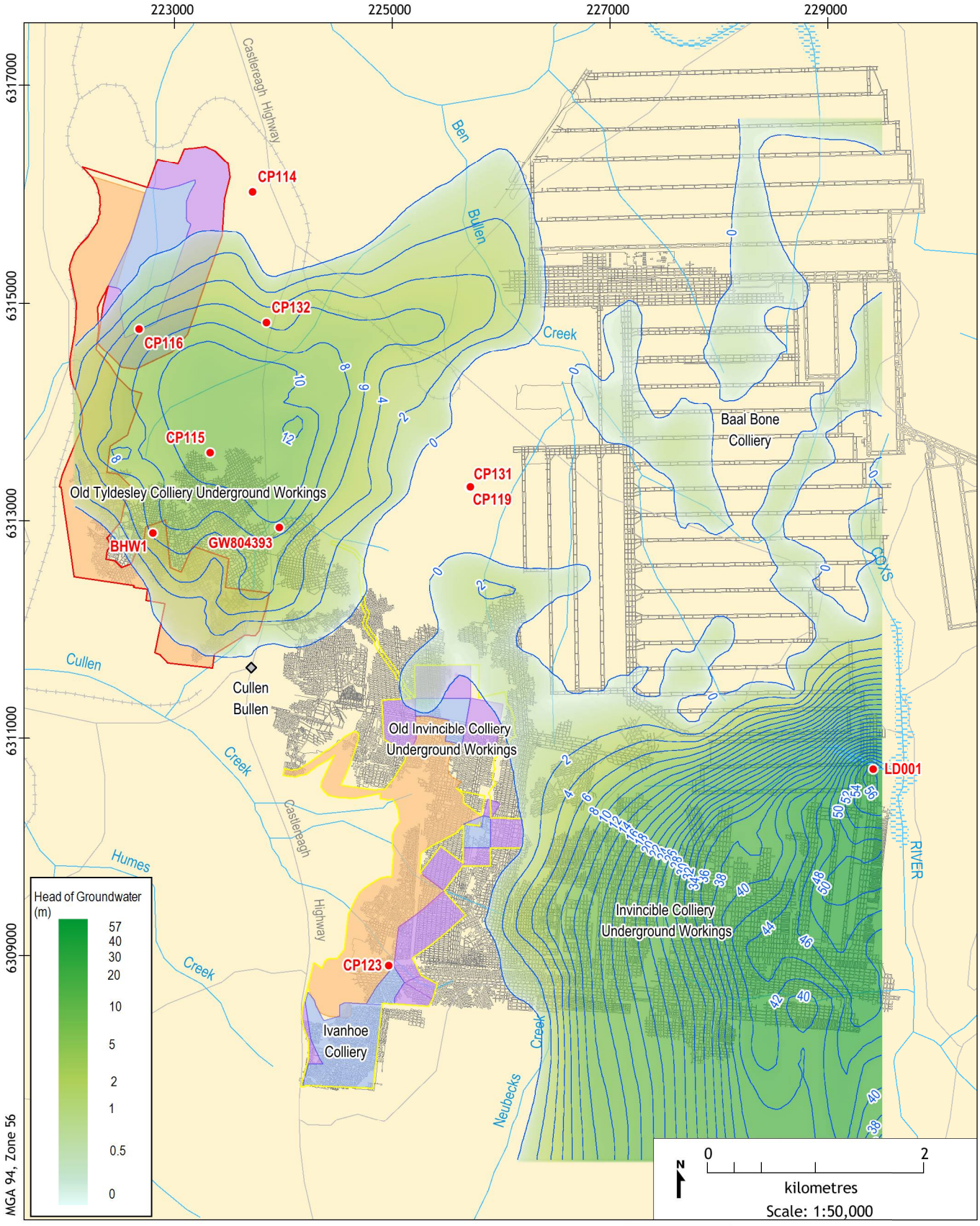
- Groundwater Potentiometric Surface Contour (2m Interval)
- Cross Section Line
- Underground Mine Working
- Approved Disturbance
- Proposed Open Cut Mining
- Proposed Highwall Mining
- Cullen Valley Mine Modification Boundary
- Invincible Colliery Modification Boundary
- Monitoring Bore
- NOW Registered Bore
- Town
- Watercourse
- Swamp Area
- Road / Track
- Railway

Coalpac Modification (G1515A)

Sub-surface Water Potentiometric Surface

DATE: 16/1/2014

FIGURE No: 10-2



LEGEND:

- Head of Groundwater above Lithgow Coal Seam (2m Intervall)
- Underground Mine Working
- Approved Disturbance
- Proposed Open Cut Mining
- Proposed Highwall Mining
- Cullen Valley Mine Modification Boundary
- Invincible Colliery Modification Boundary
- Monitoring Bore
- Town
- Watercourse
- Swamp Area
- Road / Track
- Railway

Coalpac Modification (G1515A)

Head of Sub-surface Water above Lithgow Coal Seam

DATE: 16/1/2014

FIGURE No: 10-3

11 IMPACT ASSESSMENT METHOD

The following groundwater assessments were based on a conceptual analytical hydrogeological model which used Darcy's Law to quantify groundwater flow and the potential impacts on the groundwater regime. The use of a conceptual hydrogeological model to assess the potential impacts on the groundwater regime is considered an appropriate method in the absence of significant interaction of the proposed mine modifications and the surrounding groundwater systems.

Therefore, a numerical groundwater model was not developed to assess the potential impacts resulting from the mine modifications. The predictions made by a numerical model would be unlikely to be significantly more accurate than the predictions made by the analytical assessment, nor reduce the already low uncertainty in the predicted impacts.

12 IMPACT ASSESSMENT – INVINCIBLE COLLIERY MODIFICATION

12.1 Groundwater Seepage to Open Pits

The Invincible Colliery Modification Boundary contains three proposed open cut pit areas known as the Northern, Eastern, and Southern mining areas. All three open cut areas are planned to extend through each of the existing exposed coal seams, including the Lithgow Seam which has been partially removed by the historical underground workings of the Old Invincible Colliery, Invincible Colliery, and Ivanhoe Colliery.

The cross-sections of E-E`, F-F`, and G-G` (shown on Figure 12-1, Figure 12-2, and Figure 12-3 respectively) confirm the very limited occurrence of the Narrabeen Group within the Invincible Colliery Modification Boundary. The Narrabeen Group will therefore be unsaturated and unlikely to yield any groundwater.

Similarly, the vast majority of the coal seams within the Illawarra Coal Measures (i.e. the Katoomba Seam down to the Lithgow Seam) are located above the potentiometric surface throughout the Invincible Colliery Modification Boundary (Figure 12-1, Figure 12-2, and Figure 12-3).

The flooded extent (i.e. 'tide mark') of the Old invincible Colliery and Invincible Colliery is, for the most part, located to the east (i.e. down-dip) of the proposed open cut pits (Figure 10-3). The sub-surface water stored within the flooded underground workings is wholly sourced from meteoric run-off. Therefore, the sub-surface water stored within the underground workings of the Old Invincible Colliery and Invincible Colliery is not considered to be groundwater because it is not sourced or held in a groundwater aquifer.

The Eastern and Southern mining areas are not anticipated to intercept flooded workings and are also not anticipated to intercept saturated aquifers (Figure 10-3). Therefore, groundwater seepage from the coal seams and sub-surface water from the flooded underground workings will not occur during open cut mining within the Eastern and Southern mining areas.

A small area in the proposed Northern open cut pit area may encounter partial saturation of the Old Invincible Colliery underground workings (Figure 10-3). A structural dip in the elevation of the coal seams in this northern area promotes the accumulation of sub-surface water within the underground workings. The head of water above the floor of the Lithgow Seam is anticipated to be <1 m throughout the underground workings, within the vicinity of the Northern open cut pit (Figure 10-3).

The sub-surface water stored within the Old Invincible Colliery, within the vicinity of the Northern open cut pit, will be removed to promote dry and safe working conditions. The removal of sub-surface water from the workings in the Northern open cut pit will not promote measurable seepage of groundwater into the Northern open cut pit because historical mining within the Old Invincible Colliery has effectively removed aquifer (i.e. the Lithgow Seam) continuity within this area.

12.2 Groundwater Seepage to Highwall Mining Drives

Highwall mining is planned to occur in all available coal seams, except within the Lithgow Seam due to the presence of old underground workings. As previously stated, all of the coal seams located above the Lithgow Seam within the Invincible Colliery Modification Boundary are unsaturated. Therefore, groundwater seepage will not occur from these coal seams into the highwall mining drives.

12.3 Aquifer Depressurisation

Groundwater is not predicted to seep into the open cut and highwall mining areas of the Invincible Colliery Modification Boundary. Therefore, no aquifer depressurisation is anticipated to occur.

12.4 Impact on Groundwater Users

No registered bores are predicted to be impacted by the open cut and highwall mining areas of the Invincible Colliery Modification Boundary.

12.5 Impact on Flooded Workings (Sub-surface Water)

The volume of sub-surface water removed from the workings in the Northern open cut pit will be small compared to the overall sub-surface water storage volume. An estimate of 125 ML of sub-surface water will be removed from the Old Invincible Colliery, which is approximately 2% of the total volume of water stored within the workings of the Old Invincible Colliery and Invincible Colliery. Dewatering the Old Invincible Colliery within the vicinity of the Northern Open cut pit will therefore not likely have a measurable impact on the water levels within the remainder of the flooded workings.

The Eastern, and Southern mining areas proposed for the Invincible Colliery Modification are located up-gradient of the flooded underground workings. Therefore, no sub-surface water seepage is predicted to occur from the flooded underground workings into the open cut pits, assuming that current climatic and mining conditions persist during the modification period.

However, there is a low likelihood that extraordinary rainfall events could produce significant runoff into the Invincible Colliery Modification open cut pits and the flooded underground workings of the Old Invincible Colliery. If this occurs, water from the Old Invincible Colliery underground workings may rise further into the northern open cut pit in the Invincible Colliery Modification Boundary. The rainfall runoff water that directly enters the Invincible Colliery Modification open cut pits and indirectly enters the pits via the flooded underground workings (i.e. mine affected sub-surface water) will be removed from the pits to maintain dry working conditions, and will be managed within the mine water circuit.

In addition, the water level within the flooded underground workings of the Old Invincible Colliery may rise if the Baal Bone Colliery ceases to dewater their underground workings. The long-term dewatering strategy of the Baal Bone Colliery is currently unavailable to assist with a detailed assessment of timing and impact magnitude. However, the recovery of water levels within the Baal Bone Colliery may be on a timescale of decades. Therefore, the potential scale of any potential impact on the flooded workings of the Old Invincible Colliery is considered minor and therefore manageable.

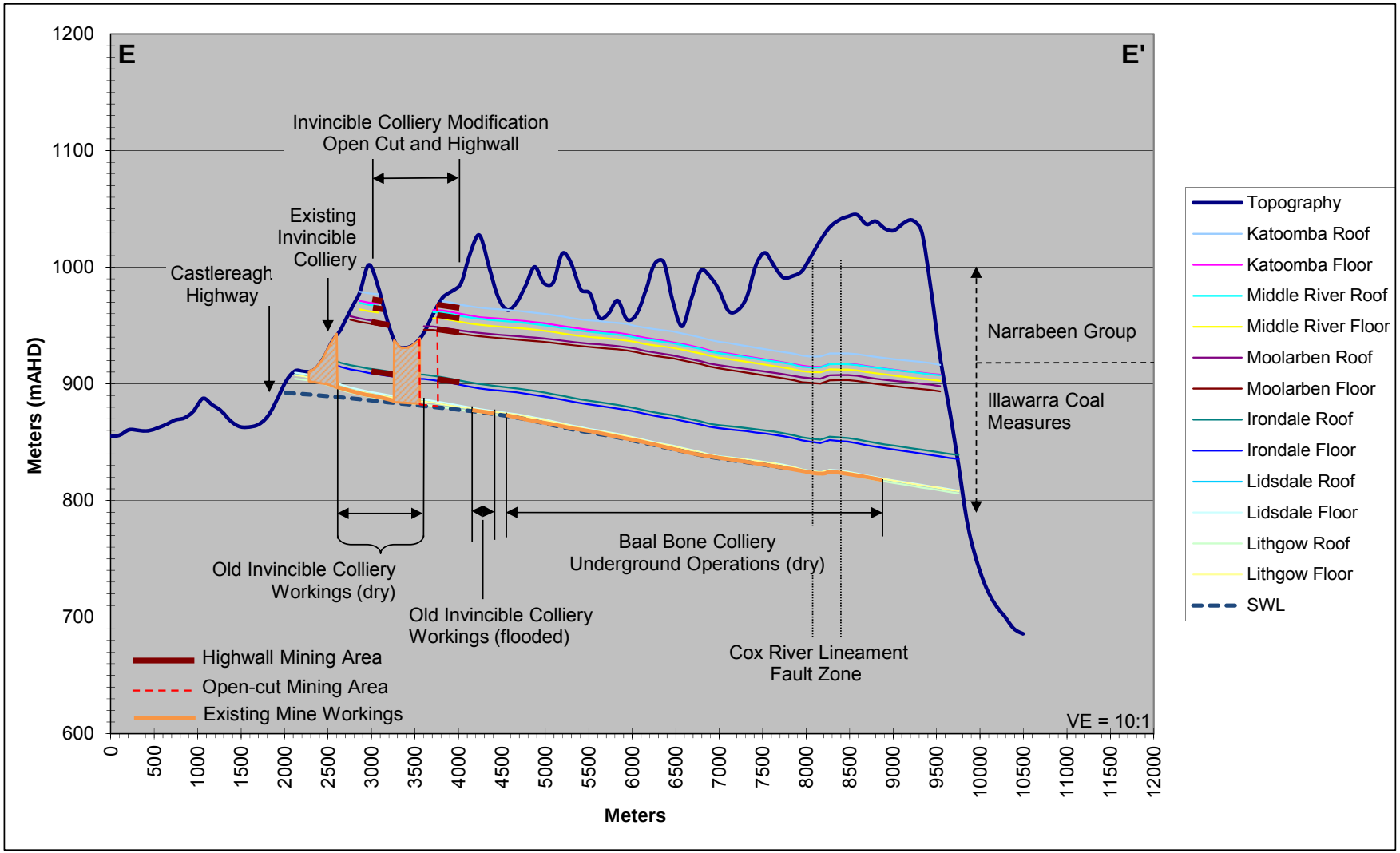


Figure 12-1: Cross-Section E-E`

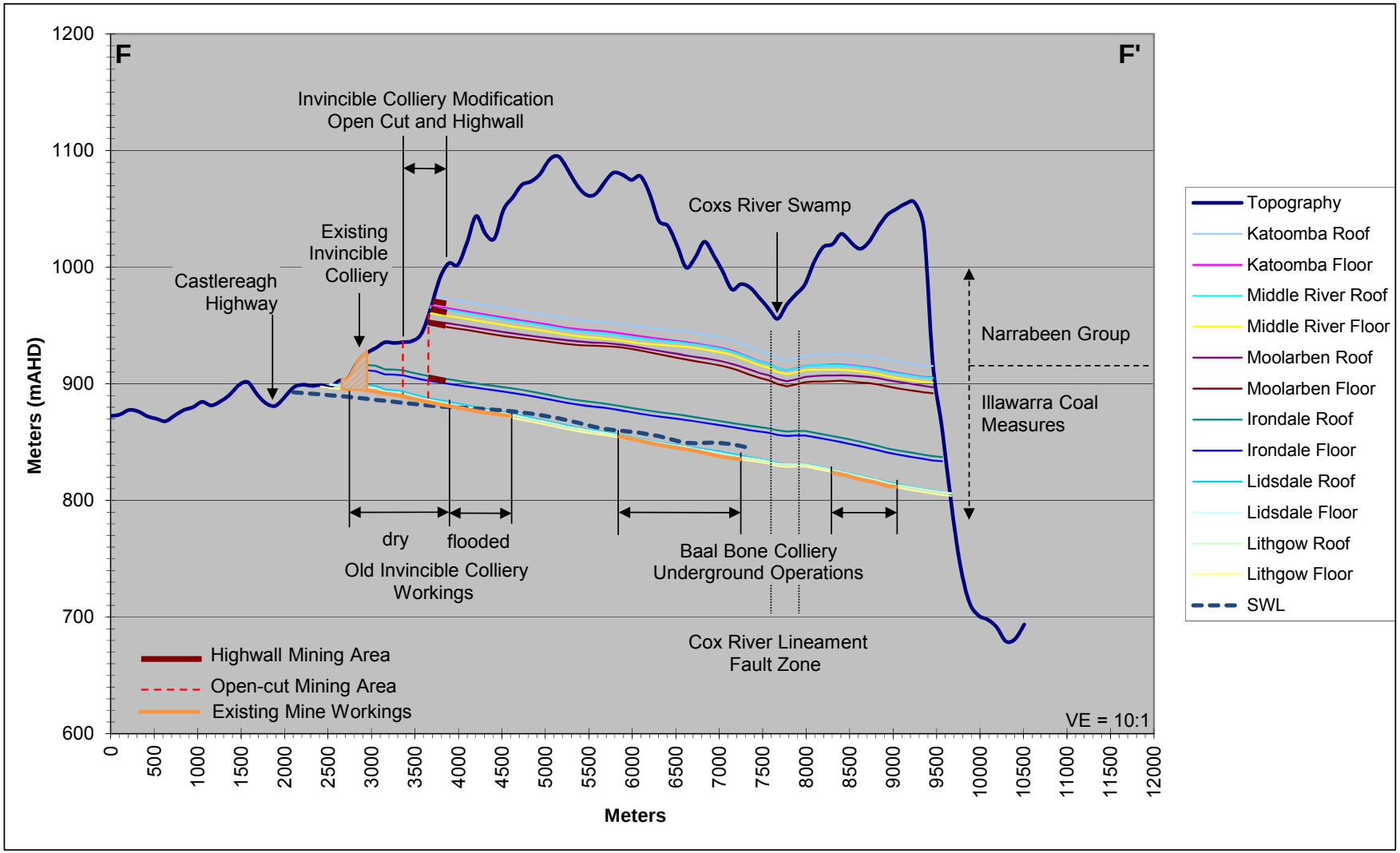


Figure 12-2: Cross-Section F-F`

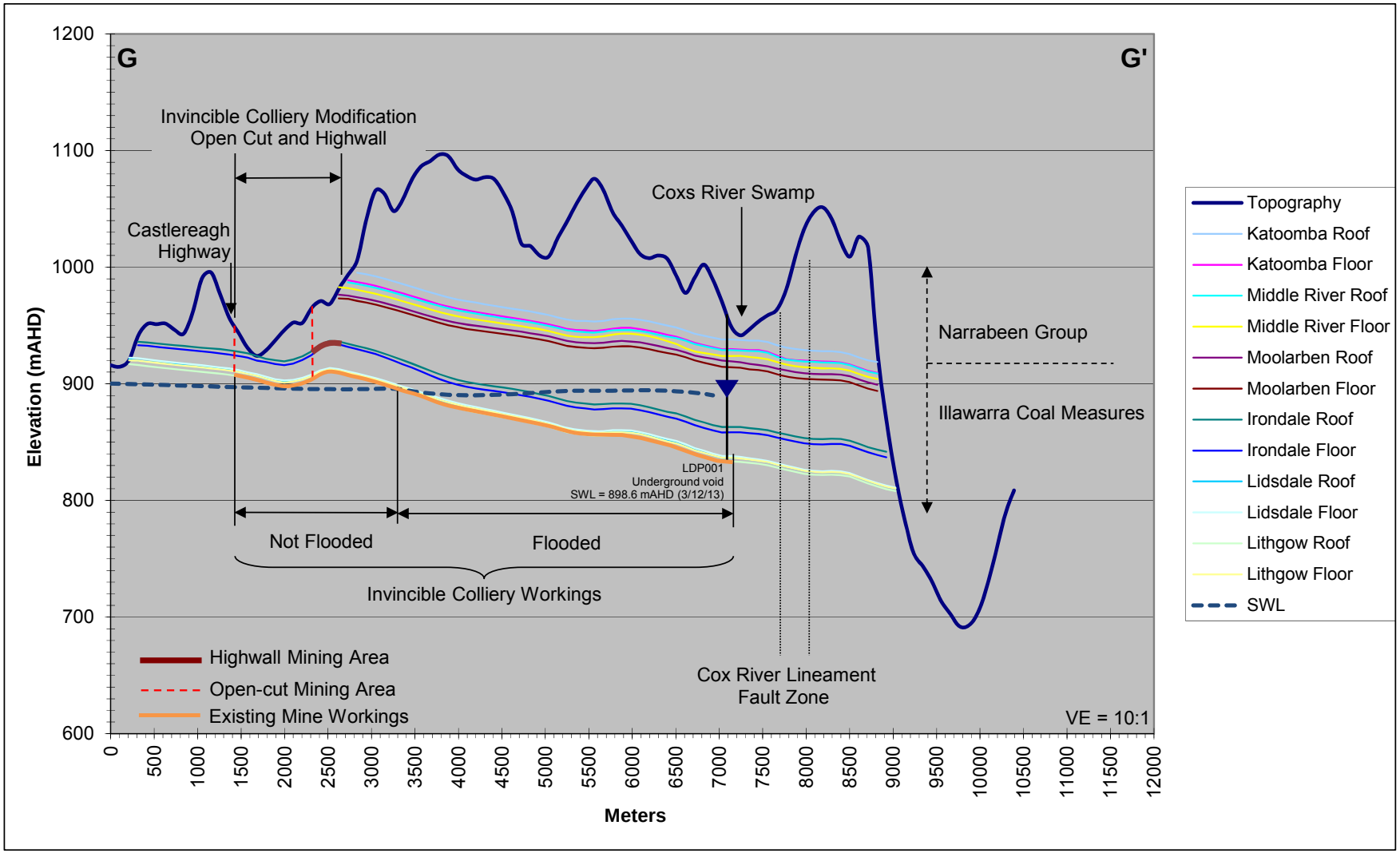


Figure 12-3: Cross-Section G-G`

12.6 Impact on Groundwater Dependent Ecosystems

No GDEs are located within the footprint of the Invincible Colliery Modification Boundary. The absence of any groundwater seepage and aquifer depressurisation will ensure that no GDEs will be impacted.

12.7 Impact on Groundwater Quality

RGS Environmental (2011) undertook a geochemical assessment to assess the potential for the overburden and reject material to contaminate groundwater and surface water. The geochemical assessment concluded that:

Overburden

- Overburden materials at the mine sites are likely to be non-acid forming (NAF) and have a high factor of safety with respect to potential acid generation. Most overburden samples have negligible total sulphur content and a low to moderate acid neutralising capacity;
- Most overburden materials will generate pH neutral, low-salinity run-off and seepage following surface exposure. The major ion chemistry of initial surface run-off and seepage from overburden materials is likely to be dominated by sodium and sulphate with lesser amounts of bicarbonate and chloride; and
- The concentration of dissolved trace metals in initial and ongoing run-off and seepage from overburden materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the project.

Coal Rejects

- Most coal reject materials are likely to be NAF and have an elevated factor of safety with respect to potential acid generation;
- Some coal reject materials have uncertain geochemical characteristic or are potential acid forming (PAF). The few PAF coal reject materials appear to be associated with the Lithgow Seam and particularly coarse reject materials. In contrast, tailings materials generated from processing the Lithgow Seam appear to be NAF;
- The concentration of total metals in potential coal reject solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues;
- Most NAF potential coal reject materials will generate pH neutral and relatively low-salinity run-off and seepage following surface exposure. However, PAF coarse reject materials from the Lithgow Seam may generate acidic and more saline run-off and seepage if exposed to oxidising conditions;
- The major ion chemistry of initial surface run-off and seepage from NAF coal reject materials is likely to be dominated by sodium and sulphate with lesser amounts of bicarbonate and chloride;
- For PAF coarse reject materials, the initial concentration of soluble sulphate in surface run-off and seepage is expected to be relatively low, although further exposure to oxidising conditions may lead to increased sulphate concentrations; and
- The concentration of dissolved metals in initial run-off and seepage from NAF coal reject materials is unlikely to present any significant environmental issues associated with surface water and groundwater quality as a result of the project. For PAF coarse reject materials, there is some potential for the concentration of dissolved metals in surface run-off and seepage to increase over time, if not managed appropriately.

In summary, leachate generated from the overburden is unlikely to promote an adverse impact to groundwater quality (RGS Environmental, 2011). However, there is a potential for some acid drainage from the Lithgow Seam coarse rejects. Seepage leachate from coal reject emplacement areas should therefore continue to be monitored to ensure there are no adverse impacts to surrounding sub-surface water systems.

In addition to the above, as the mine plan extension has been specifically designed to infill the existing mining void to create a free draining final landform, there will be no opportunity for the build-up of a low quality water body within the mining footprint which could potentially form a sub-surface water contamination source.

13 IMPACT ASSESSMENT – CULLEN VALLEY MINE MODIFICATION

13.1 Groundwater Seepage to Open Pits

The occurrence of the Triassic Narrabeen Group is very limited within the Cullen Valley Mine Modification Disturbance Boundary, as these units have been largely removed from the stratigraphic profile by erosion. Where the Narrabeen Group occurs, it is limited to the tops of ridges as shown by cross-sections A-A`, B-B`, C-C`, and D-D` (Figure 13-1, Figure 13-2, Figure 13-3, and Figure 13-4 respectively). The Narrabeen Group will therefore be unsaturated and is unlikely to yield any groundwater.

Similarly, the Illawarra Coal Measures located above the combined Lidsdale/Lithgow Seam are not saturated as the coal seams typically crop out to the east, north, and west. Therefore, groundwater seepage from these coal seams will not occur during open cut mining and highwall mining.

The combined Lidsdale/Lithgow Seam horizon may be saturated in the southern half of the proposed open cut mine Modification Disturbance Boundary, as shown on Figure 10-3. The maximum head of water above the base of the combined Lidsdale/Lithgow Seam horizon is estimated to be about 6 m in the far south of the proposed open cut area.

The rate that groundwater will seep from the face of the combined Lidsdale/Lithgow Seam horizon is governed by the permeability of the coal (hydraulic conductivity) and the hydraulic gradient. The rate of steady-state seepage from the Lithgow Seam to the open cut mining areas was predicted using the Darcy Law equation:

$$Q = Ki\,A$$

Where:

	Q	=	seepage from the coal seam face (m^3/day)
	K	=	hydraulic conductivity of the coal seam (m/day)
	I	=	steady state hydraulic gradient (dimensionless)
	A	=	cross section area of coal seam aquifer (m^2)

A range of hydraulic conductivity values were used to assess the sensitivity of the predicted rate of steady-state groundwater seepage into the open cut mine area. The hydraulic conductivity values ranged from an upper limit of 0.2 m/day and a lower limit of 0.07 m/day, which are representative of regional coal seam permeability.

The radius of drawdown surrounding the open cut mine area is likely to be limited by the extent of the saturated Lidsdale/Lithgow Seam, which is about 500 m down-gradient of the Cullen Valley Modification Disturbance Boundary (Figure 13-2). The radius of potential impact may therefore produce a hydraulic gradient towards the open cut pit of about 0.012.

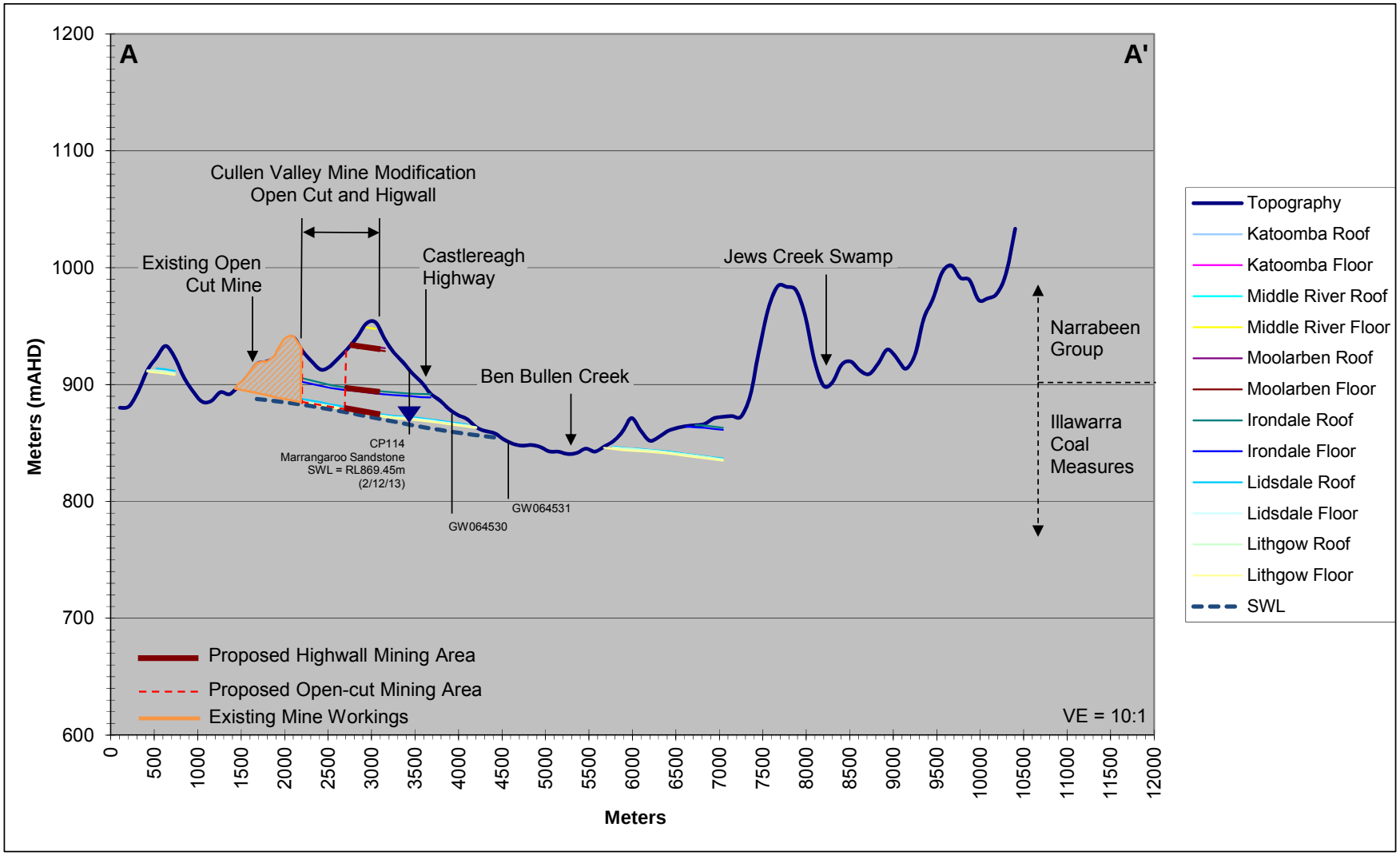


Figure 13-1: Cross-Section A-A`

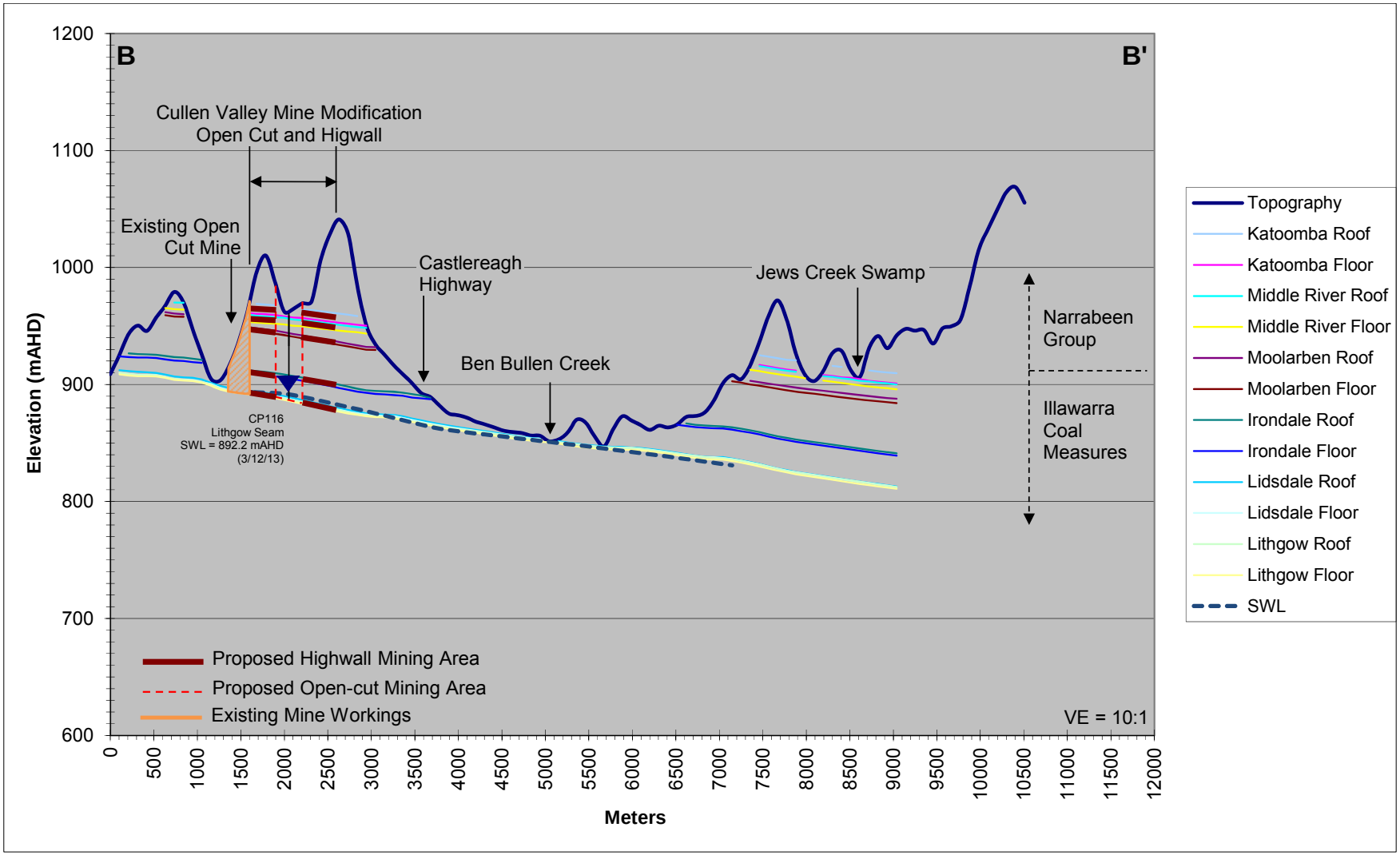


Figure 13-2: Cross-Section B-B`

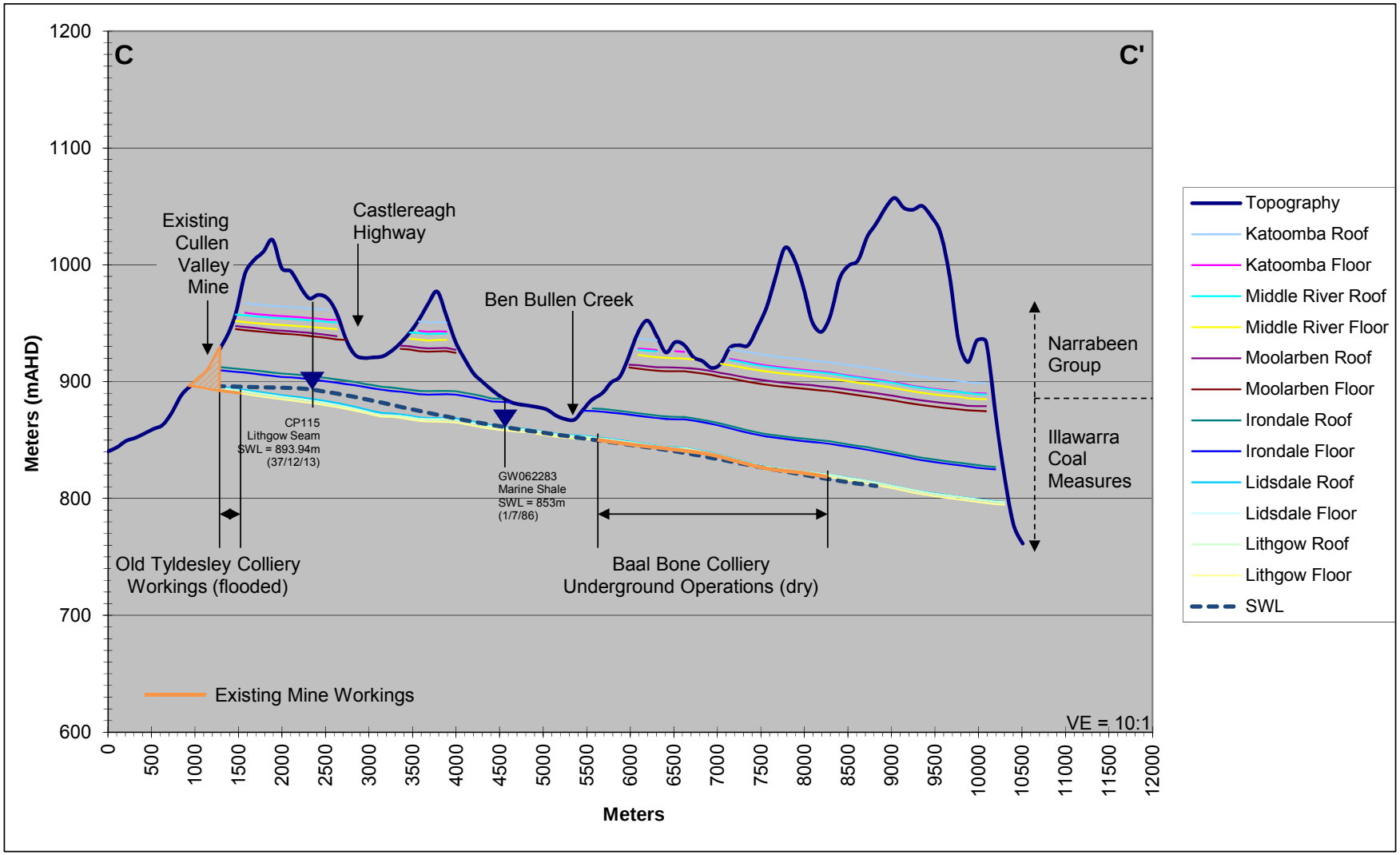


Figure 13-3: Cross-Section C-C`

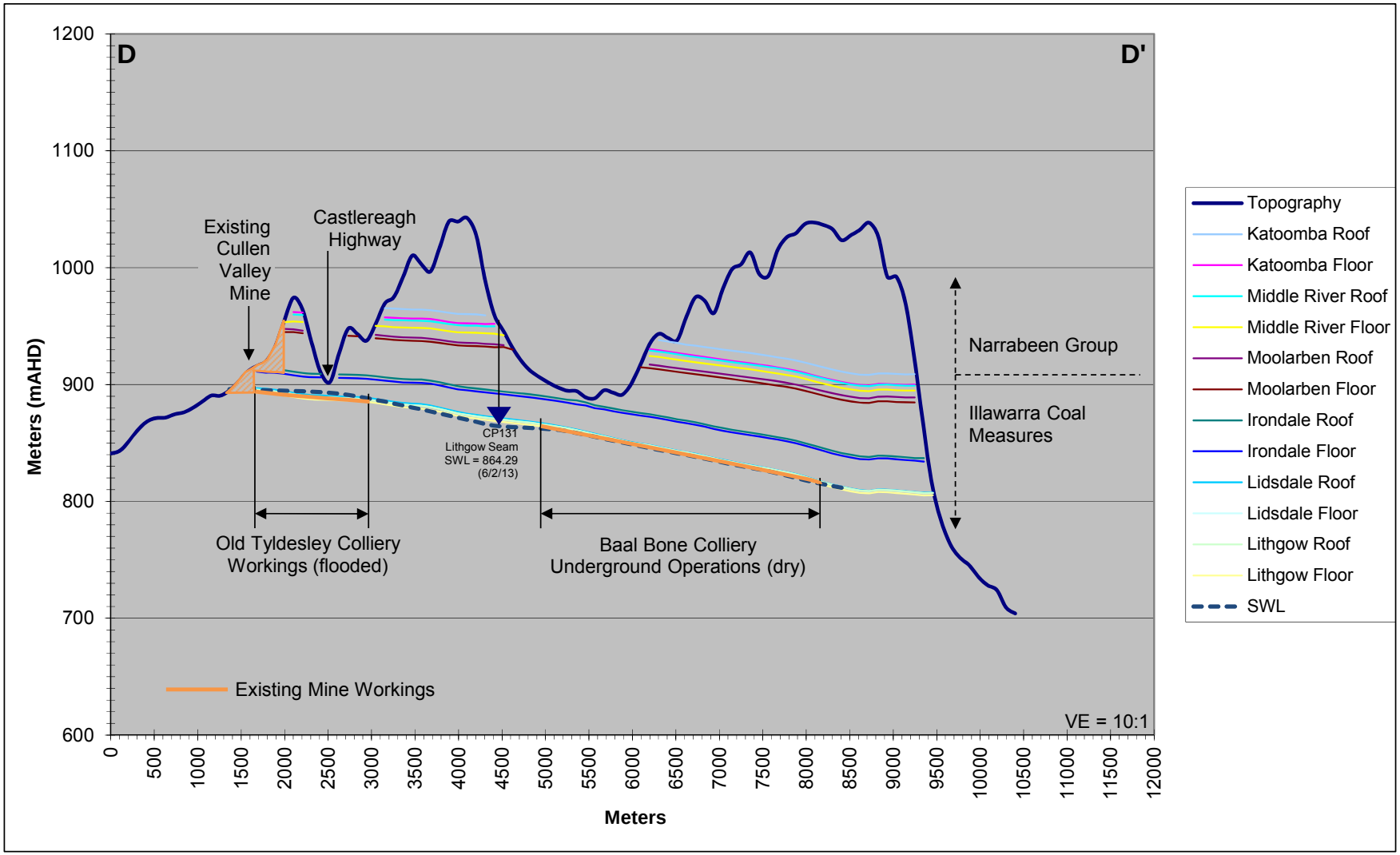


Figure 13-4: Cross-Section D-D`

The maximum length of the proposed open cut pit within the Cullen Valley Mine Modification Disturbance Boundary is about 1.5 km. However, only the southern half of the mine open pit may intercept saturated coal. Therefore, the maximum exposed length of saturated coal will be restricted to about 750 m. The combined Lidsdale Seam and Lithgow Seam horizon in the vicinity has an average thickness of about 2.5 m.

The predicted steady-state groundwater seepage rate across the total pit length ranged from 0.4 ML/year up to 1.2 ML/year, as shown on Figure 13-5. These seepage rates are considered to be extremely low, particularly when compared to the volume of groundwater water extracted from the neighbouring Baal Bone Colliery each year (~1,300 ML/year).

Figure 13-5: Predicted Seepage to Open Cut Pit – Cullen Valley Mine Modification

The range of predicted groundwater seepage rates into the open cut pit were corrected for the effect of evaporation from the seepage face. A rate of 70% pan evaporation was applied to the seepage face to account for partial shadow effects created by the predominantly north-south orientation of the pit wall. Evaporation from the seepage face is predicted to account for 100% of groundwater seepage as shown on Figure 13-5. Therefore, evaporation from the seepage face is likely to produce a dry open cut pit.

13.2 Groundwater Seepage to Highwall Mining Drives

Highwall mining is planned to occur in all coal seams within the Cullen Valley Mine Modification Boundary. Each highwall mining drive will have a height of up to 2.5 m, a width of 3 m, and a length of 300 m. Each highwall mining drive will be separated from the next drive by a pillar of coal up to 3 m wide. The open end of the drive will be backfilled with overburden soon after completion.

As previously discussed, the coal seams within the Cullen Valley Mine Modification Boundary that are located above the Lidsdale/Lithgow Seam are unsaturated. Therefore, groundwater seepage will not occur from these coal seams into the highwall mining drives.

The combined Lidsdale and Lithgow Seam horizons may be saturated in the southern half of the proposed highwall mining area of the Modification Boundary, as shown on Figure 10-3. However, the Lithgow Seam is too thin to highwall mine in this area. The Lidsdale Seam immediately above the Lithgow Seam may be a highwall mining target and the cutting height of the drive in this case will be about 1.2 m.

The maximum head of water above the base of the coal seams is estimated to be about 9 m in the highwall mining area. The rate at which groundwater seeps into highwall mining drives is governed by the permeability of the coal and the hydraulic gradient.

The rate of steady-state seepage from the Lidsdale/Lithgow Seam horizon to the highwall mining drives was predicted using the Darcy Equation (described in Section 12.1). The analytical assessment assumed that all highwall mining drives were installed simultaneously, which is appropriate considering the short length of time taken to install them (i.e. <4 years), compared with the length of time taken to fill them by groundwater seepage (>100 years).

The saturated extent of the combined Lidsdale/Lithgow Seam horizon (i.e. ~750 m) is proposed to be mined by about 125 highwall drives. Each drive will have a storage volume of about 1.08 ML. Therefore, the total void area removed from the saturated coal seam will be about 135 ML. The predicted steady-state groundwater seepage rate into the highwall mining drives ranged from 0.36 ML/year up to 1 ML/year, as shown on Figure 13-6.

The predicted time taken to fill the voids with seepage water is inversely proportional to the seepage rate. The predicted time taken to fill the highwall drives within the Lidsdale Seam ranged between 132 years up to 376 years (Figure 13-6).

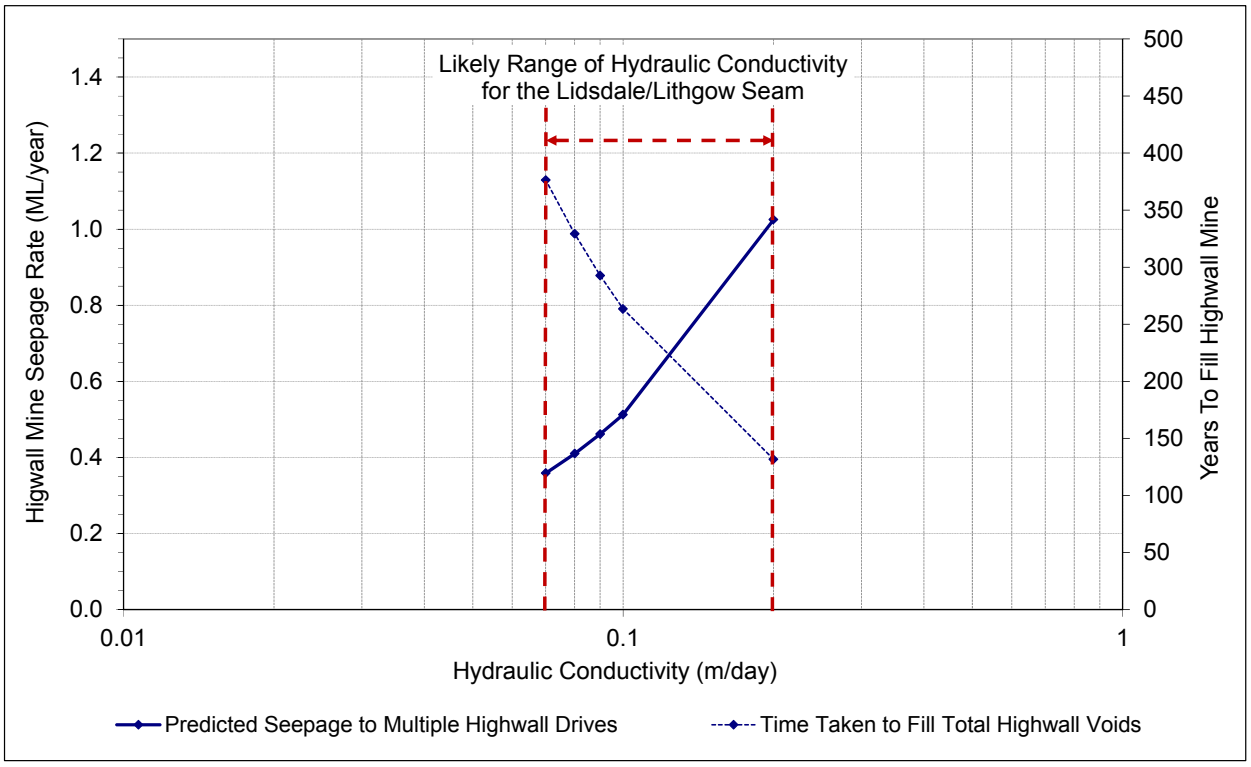


Figure 13-6: Predicted Seepage Inflow to Highwall Mining Drives – Cullen Valley Mine Modification

13.3 Aquifer Depressurisation

The extent of aquifer depressurisation is likely to be restricted to the immediate vicinity of the Cullen Valley Mine Modification Boundary, and only within the combined Lidsdale/Lithgow Seam horizon. The extent will be limited by the small potentiometric head above the combined Lidsdale/Lithgow Seam horizon, the shallow hydraulic gradient, the moderately low permeability of the coal seam, and the truncation of the coal seam within the adjacent valley floor and ridge escarpments. The radius of drawdown surrounding the open cut mine area is likely to be limited by the extent of the saturated combined Lidsdale/Lithgow Seam horizon, which is about 500 m down-gradient of the Cullen Valley Modification Boundary (Figure 13-2).

13.4 Impact on Groundwater Users

No privately registered bores are located within the predicted zone of aquifer depressurisation surrounding the Cullen Valley Mine Modification Boundary. The two closest registered bores (GW64530) and (GW801861) are located about 650 m and 850 m (respectively) away from the proposed highwall mining area.

The depth of GW64530 is 85.4 mbgl and the depth of GW801861 is 72 mbgl. The depth of the Lithgow Seam within these bores is estimated to be about 15 mbgl. The depth of these bores suggests they access groundwater from Permian rock units that are significantly deeper than the Lithgow Coal Seam. Therefore, groundwater water levels within the registered bores are predicted to not be impacted by the open cut or highwall mining areas proposed for the Cullen Valley Mine Modification.

13.5 Impact on Flooded Workings

The Cullen Valley Mine Modification will not intercept the flooded underground workings of the Old Tyldesley Colliery. The flooded workings are located about 1 km to the south of the proposed open cut and highwall mining area. The small level of predicted aquifer depressurisation created by the Cullen Valley Mine modification is unlikely to extend to the Old Tyldesley Colliery. Therefore, aquifer depressurisation will not induce any change to the head elevation of water stored within the flooded underground workings.

13.6 Impact on Groundwater Dependent Ecosystems

There are no known groundwater dependent ecosystems (GDEs) within the Cullen Valley Mine Modification Boundary, or within the predicted zone of aquifer depressurisation. Therefore, no GDEs will be impacted by the proposed mine plan.

The closest groundwater dependent ecosystem to the Cullen Valley Mine Modification Boundary is Jews Creek Swamp, which is located about 5 km towards the north-east. This system is fed by perched Triassic aquifers that are unlikely to be connected to the Permian Coal Measures. The existing Baal Bone Colliery monitoring bores and surface water stations currently monitor the health of the swamps.

13.7 Impact on Groundwater Quality

Leachate generated from the overburden at Cullen Valley Mine is unlikely to promote an adverse impact to groundwater quality. No coal washing will occur at the Cullen Valley Mine which will result in no coarse reject material being disposed at this site.

Consistent with the Invincible Colliery Modification, as mine plan extensions have been specifically designed to infill the mining void to create a free draining final landform, there will be no opportunity for the build-up of a low quality water body within the mining footprint which could potentially form a groundwater contamination source.

14 IMPACT COMPLIANCE – NSW AIP POLICY – INVINCIBLE COLLIERY

The tables below (Table 2, Table 3, and Table 4) compare the predicted groundwater impact for the Invincible Colliery Modification against the compliance requirements of the NSW AIP (DP&I, 2012).

Table 2: ACCOUNTING FOR OR PREVENTING THE TAKE OF WATER

	AIP requirement	Proponent response
1	Described the water source (s) the activity will take water from?	Based on the AIP, the groundwater system surrounding the Invincible Colliery Modification Boundary is described as: • porous and/or fractured consolidated sedimentary rock of the Permian coal measures. • the Permian coal measures are considered a less productive aquifer according to the AIP because yields >5 L/sec are considered unlikely.
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	Predicted take of groundwater for the Invincible Colliery Modification Boundary is 0 ML/year.
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	Predicted take after mining is no greater than that predicted during mining operations.
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (page 27)	Predictions are based on analytical calculations of groundwater flow, which are appropriate considering that the mine Modification Boundary will have very limited interaction with saturated rock. A 3D numerical modelling was not warranted for the assessment.
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	Predicted groundwater take based on the analytical assessment: • Permian coal measures – 0 ML/year at peak.
6	Described how any licence exemptions might apply?	Not necessary.
7	Described the characteristics of the water requirements?	Predicted take of groundwater: • Invincible Colliery Modification Boundary: o Open cut mine – 0 ML/year; and o Highwall mining area – 0 ML/year.
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	An aquifer access licence will not be required for the Invincible Colliery Modification. A water allocation is not required. Despite this finding, Coalpac holds water licences with a combined allocation of 106 ML.
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Not necessary.

Table 2: ACCOUNTING FOR OR PREVENTING THE TAKE OF WATER		
AIP requirement		**Proponent response**
10	Determined how it will obtain the required water?	Water supply will be met by stored surface water and from water in abandoned underground workings.
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	The Invincible Colliery Modification Boundary is unlikely to intercept saturated aquifers.
12	Considered actions required both during and post-closure to minimise the risk of inflows to a mine void as a result of flooding?	The local topography and the style of open cut mining minimise the chance of flooding of mine pits. Further, the open cut mining voids are proposed to be backfilled post the completion of mining activities.
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Not necessary.
	Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised water users? *Items 14-16 must be addressed if so.*	No, the likelihood of intercepting saturated aquifers is very low.
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	Not necessary.
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	Not necessary.
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Not necessary.

Table 3: DETERMINING WATER PREDICTIONS		
AIP requirement		**Proponent response**
1	Addressed the minimum requirements found on page 27 of the AIP for the estimation of water quantities both during and following cessation of the proposed activity?	A 3D numerical modelling was not warranted for the assessment because the Invincible Colliery Modification is unlikely to intersect saturated aquifers.

Table 4: OTHER REQUIREMENTS		
AIP requirement		**Proponent response**
1	Establishment of baseline groundwater conditions?	Refer Section 10.
2	A strategy for complying with any water access rules?	No – aquifer access licences will not be required because the Invincible Colliery Modification will not intersect saturated aquifers.
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	No – the Invincible Colliery Modification will not intersect saturated aquifers.

Table 4: OTHER REQUIREMENTS		
AIP requirement		**Proponent response**
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	No – there are no connected groundwater and surface water systems.
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	No – no GDEs will be impacted.
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	No – a specific intent of these modifications is that all existing mine voids will be backfilled and no new voids created such that there will no longer be a potential source of saline water. Overburden backfill will generate pH neutral, low-salinity run-off and seepage following surface exposure. Lithgow Seam reject material will be managed appropriately to limit potential acid formation.
7	Potential to cause or enhance hydraulic connection between aquifers?	No – highwall mining drives will be designed to prevent land subsidence and fracturing of overlying strata. No surface disturbance will occur beyond the footprint of the proposed open cut mine areas.
8	Potential for river bank instability, or high wall instability or failure to occur?	No – river banks are not located near the Invincible Colliery Modification Boundary. Highwall faces will be designed to maintain stability.
9	Details of the method for disposing of extracted activities (for CSG activities)?	N/A

There are two levels of minimal impact considerations specified in the AIP. If the predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable. Where the predicted impacts are greater than the Level 1 minimal impact considerations, then the AIP requires additional studies to fully assess these predicted impacts. If assessments show that the predicted impacts do not prevent the long-term viability of the relevant water-dependent asset, then the impacts will be considered to be acceptable.

The absence of any interaction with groundwater by the Invincible Colliery Modification will result in no impact to the regional groundwater system. Therefore the predicted impacts by the modifications do not exceed the Level 1 minimal impact considerations.

15 IMPACT COMPLIANCE – NSW AIP POLICY – CULLEN VALLEY MINE

The tables below (Table 5, Table 6, and Table 7) compare the predicted groundwater impact for the Cullen Valley Mine Modification against the compliance requirements of the NSW AIP (DP&I, 2012).

Table 5: ACCOUNTING FOR OR PREVENTING THE TAKE OF WATER		
AIP requirement		**Proponent response**
1	Described the water source (s) the activity will take water from?	Based on the AIP, the groundwater system surrounding the Cullen Valley Modification Boundary is described as: • porous and/or fractured consolidated sedimentary rock of the Permian coal measures. • the Permian coal measures are considered a less productive aquifer according to the AIP because yields >5 L/sec are considered unlikely.

Table 5: ACCOUNTING FOR OR PREVENTING THE TAKE OF WATER		
AIP requirement		**Proponent response**
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	Predicted take of groundwater for the Cullen Valley Mine Modification Boundary is 2.2 ML/year at peak.
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	Predicted take after mining is no greater than that predicted during mining operations.
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (page 27)	Predictions are based on analytical calculations of groundwater flow, which are appropriate considering that the Cullen Valley Mine Modification Boundary will have very limited interaction with saturated rock. A 3D numerical modelling was not warranted for the assessment.
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	Predicted groundwater take based on the analytical assessment: • Permian coal measures – 2.2 ML/year at peak.
6	Described how any licence exemptions might apply?	Not necessary.
7	Described the characteristics of the water requirements?	Predicted take of groundwater: • Cullen Valley Mine Modification Boundary: o Open cut mine – 1.2 ML/year at peak; and o Highwall mining area – 1.0 ML/year at peak.
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	The Modification Boundary of both Cullen Valley Mine and Invincible Mine area wholly contained within the Water Sharing Plan (WSP) for the Murray-Darling Porous Rock Groundwater Sources area. The current predictions suggest that dry mining conditions will still prevail for the Cullen Valley Mine Modification due to evaporative losses. The small volume of seepage that is predicted to occur within the Cullen Valley Mine Modification Boundary will be sufficiently covered by the current allocation of 106 ML/year from the Murray-Darling Porous Rock Groundwater Sources. The upper limit of predicted seepage into the Cullen Valley Mine Modification was 1.2 ML/year from the open cut mine pit, and 1.0 ML/year from the highwall mine.
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	The modifications will adhere to all rules specified for the Sydney Basin MDB Groundwater Source under the water sharing plan of the Murray-Darling Basin Porous Rock Groundwater Sources.
10	Determined how it will obtain the required water?	Groundwater will be taken via seepage to the mine face and movement of water into the highwall mining drives, only within the Cullen Valley Mine Modification Boundary. However, 100% of the seepage to the mine face is predicted to be removed via evaporation and will not enter the mine water circuit. Water supply will be met by stored surface water and from water in abandoned underground workings.
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	Current groundwater entitlement for the Sydney Basin MDB Groundwater Source is 60,443 ML/year. Predicted impacts for the Cullen Valley Mine Modification Boundary are considered negligible against existing entitlements.
12	Considered actions required both during and post-closure to minimise the risk of inflows to a mine void as a result of flooding?	The local topography and the style of open cut mining minimise the chance of flooding of mine pits. Further, the open cut mining voids are proposed to be backfilled post the completion of mining activities.

Table 5: ACCOUNTING FOR OR PREVENTING THE TAKE OF WATER		
AIP requirement		**Proponent response**
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Coalpac holds sufficient water allocation to cover water take during and after the completion of the Modification. Any additional future water entitlements are not anticipated; however, these will be secured as necessary.
	Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised water users? *Items 14-16 must be addressed if so.*	No, the range of predicted seepage rate is very low because of very low hydraulic gradients, low to moderate aquifer permeability, and limited aquifer saturation. These attributes combine to restrict the amount of uncertainty within the inflow predictions. Coalpac holds sufficient groundwater entitlements that cover the upper limit of predicted inflows which conservatively overestimates the amount of seepage into the mine workings. No adjacent registered bores are likely to be affected because these bores access groundwater from aquifers that are located beneath the Lithgow Seam.
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	Not necessary.
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	Not necessary.
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Not necessary.

Table 6: DETERMINING WATER PREDICTIONS		
AIP requirement		**Proponent response**
1	Addressed the minimum requirements found on page 27 of the AIP for the estimation of water quantities both during and following cessation of the proposed activity?	Predictions are based on analytical calculations of groundwater flow, which are appropriate considering the very limited interaction that both Modification Boundaries will have with saturated rock. A 3D numerical modelling was not warranted for the assessment.

Table 7: OTHER REQUIREMENTS		
AIP requirement		**Proponent response**
1	Establishment of baseline groundwater conditions?	Refer Section 10.
2	A strategy for complying with any water access rules?	Sufficient aquifer access licences have been secured by the proponent for the Modifications.
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	No – adjacent registered bores source groundwater from deeper aquifers than those proposed to be mined and potentially depressurised.
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	No – there are no connected groundwater and surface water systems.

Table 7: OTHER REQUIREMENTS		
AIP requirement		**Proponent response**
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	No – there are no GDEs located within the area predicted to be impacted.
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	No – a specific intent of these Modifications is that all existing mine voids will be backfilled and no new voids created such that there will no longer be a potential source of saline water. Overburden backfill will generate pH neutral, low-salinity run-off and seepage following surface exposure.
7	Potential to cause or enhance hydraulic connection between aquifers?	No – highwall mining drives will be designed to prevent land subsidence and fracturing of overlying strata. No surface disturbance will occur beyond the footprint of the proposed open cut mine areas.
8	Potential for river bank instability, or high wall instability or failure to occur?	No – river banks are not located near the Modification Boundaries. Highwall faces will be designed to maintain stability.
9	Details of the method for disposing of extracted activities (for CSG activities)?	N/A

The absence of significant interaction with groundwater by the Cullen Valley Mine Modification will result in very limited impact to the regional groundwater system. Therefore the predicted impacts by the modifications do not exceed the Level 1 minimal impact considerations.

16 WATER LICENCE

Coalpac currently holds three groundwater licences, the details of the water licences are listed in Table 8. The currently held licences entitle Coalpac to take 106 ML/year from the NSW Murray-Darling Porous Rock Groundwater Sources, and 120 ML/year from the Greater Metropolitan Region Groundwater Sources.

Table 8: WATER LICENCE DETAILS				
Water Management Act 2000 Licence Number	**Water Act 2012 Licence Number**	**Share Component (ML)**	**Water Source**	**Water Sharing Plan**
TWAL27898	-	80	Sydney Basin MDB Groundwater Source	NSW Murray-Darling Porous Rock Groundwater Sources
10AL118580 & 10WA118581	10BL602584	26		
-	10BL602586	120	Sydney Basin Coxs River Groundwater Source	Greater Metropolitan Region Groundwater Sources

The current predictions suggest that dry mining conditions will still prevail for the Cullen Valley Mine Modification due to evaporative losses, and for the Eastern and Southern mining areas of the Invincible Colliery Modification because of the low likelihood of intercepting saturated aquifers and flooded underground workings.

The Northern mining area of the Invincible Colliery Modification is anticipated to intercept the partially flooded workings of the Old Invincible Colliery. An estimated volume of 125 ML of sub-surface water stored within the workings is predicted to be removed to allow mining to re-commence within the Lithgow Seam. The Invincible Colliery Modification as proposed will not intercept any existing natural groundwater aquifers, and as such, there is no need for further licence entitlements.

The upper limit of predicted seepage into the Cullen Valley Mine Modification was estimated to be 1.2 ML/year from the open cut mine pit, and 1.0 ML/year from the highwall mine. The small volume of seepage that is predicted to occur within the Cullen Valley Mine Modification Boundary will be sufficiently covered by the current allocation of 106 ML/year from the Murray-Darling Porous Rock Groundwater Sources.

The WSP for the Murray-Darling Porous Rock Groundwater Sources reports the long-term average annual extraction limit of 60,443 ML/year for access licences, not including supplementary water and water taken pursuant to basic landholder rights. Predicted impacts for the Cullen Valley Mine Modification Boundary are considered negligible (<0.004%) against existing entitlements.

17 GROUNDWATER MONITORING PLAN

17.1 Monitoring Bore Network

The existing monitoring bore network established by Coalpac will be adequate to monitor the predicted impact on the groundwater regime. The main purpose of the monitoring bore network will be to monitor for aquifer depressurisation, principally in the Lithgow Seam and the Marrangaroo Formation on an on-going basis.

Monitoring of groundwater levels within CP114 and CP132 will be particularly important, as these bores are located between the Cullen Valley Mine Modification Boundary and the closest adjacent registered bores (GW64530 and GW801861). Although no adjacent registered bores are predicted to be impacted by the mine modifications, monitoring bores CP114 and CP132 would observe aquifer depressurisation (although highly unlikely to occur) prior to the impact affecting the neighbouring bores.

17.2 Water Level Monitoring Plan

Each monitoring bore is currently equipped with an automatic water level logger. The water level loggers record data on a four-hour basis. The water level records will be downloaded from the loggers on a monthly basis and the data will be transferred to the site environmental database.

17.3 Water Quality Monitoring Plan

Water samples will be collected from the monitoring bores on a yearly basis (or as otherwise agreed with NOW) and the samples analysed for:

- General parameters: pH, EC, and TDS;
- Major cations: Na, K, Ca, and Mg;
- Major anions: Cl, SO_4, HCO_3, CO_3, and F;
- Selected metals : Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Ag, Ti, Th, Sn, U, V, Zn, and bromine; and
- Nutrients: NO_3, NO_2, and PO_4.

The existing water quality monitoring program will continue for the life of the both Modifications. Water quality trigger values will be derived for each monitoring bore in the water management plan for each Modification. However, in the absence of long-term historical groundwater quality data, the use of ANZECC guideline trigger values for stock watering should be utilised until site specific trigger values are available.

17.4 Mine Water Monitoring

The Cullen Valley Mine and Invincible Colliery have historically operated with dry mine site conditions. The current predictions suggest that dry mining conditions will still prevail for the Cullen Valley Mine Modification due to evaporative losses, and for the Eastern and Southern Invincible Colliery Modification mining areas because of the low likelihood of intercepting saturated aquifers. The existing approved surface water and groundwater monitoring networks will be continued to ensure any potential adverse impacts are identified and appropriate management and mitigation measures implemented.

17.5 Data Management and Reporting

Data management and reporting will include:

1. Annual assessment of departures from identified monitoring data trends. If consecutive monitoring data over a period of 6 months exhibit an increasing divergence in an adverse impact sense from anticipated trends, then such departures should initiate further actions. These may include a need to conduct more intensive monitoring or to invoke impact re-assessment and/or mitigative measures.
2. If more intensive monitoring is initiated (under Point 1 above) then normal review of depressurisation of coal measures should be undertaken by a suitably qualified hydrogeologist. The reporting will include consideration of all relevant water level and water quality data.

18 SUMMARY AND CONCLUSIONS

The proposed Modifications pose a low risk to the groundwater regime because:

- Only half of the proposed Cullen Valley Mine Modification Disturbance Boundary is likely to intercept a saturated coal seam, this being the Lidsdale/Lithgow Seam. All other coal seams are unsaturated;
- The Cullen Valley Mine Modification is predicted to generate a localised zone of depressurisation in the coal seams, but this is not expected to impact on adjacent landholders' bores or other aquifers adjacent to the Modification Boundary;
- Predicted take of groundwater for the Cullen Valley Mine Modification Boundary is 2.2 ML/year at peak;
- The current predictions suggest that dry mining conditions will still prevail for the Cullen Valley Mine Modification due to evaporative losses;
- The Northern mining area proposed for the Invincible Colliery Modification will intercept sub-surface water in the Old Invincible Colliery underground workings. Mine dewatering of up to 125 ML are predicted in this area. The Eastern and Southern mining areas proposed for the Invincible Colliery Modification are unlikely to intercept saturated aquifers and flooded underground workings;

- The removal of up to 125 ML sub-surface water from the Northern mining area from within the flooded workings of the Old Invincible Colliery is negligible, representing approximately 2% of the estimated water stored in that system. The flooded underground workings will therefore remain largely unaffected by the proposed Modifications;
- The backfilling of all of the existing mining void areas across both mine sites and the creation of a free draining final landform at both Cullen Valley and Invincible Colliery as proposed by these modifications will reduce the risk of poor quality water build up on either mine site and the potential for any surface water or groundwater contamination;
- No groundwater dependent ecosystems (GDEs) have been identified within the Modification Boundaries, and there are no known springs within the that are fed by groundwater around which GDEs may have developed; and
- The Coxs River Swamp and Jews Creek Swamp are considered to be the closest GDEs to the Modification Boundaries, but they are located approximately 3.5 km and 5 km away from the respective mining activities proposed for Invincible Colliery and Cullen Valley Mine, which is beyond the zone of predicted impacts.

The current hydrogeological regime supports these conclusions because:

- Many of the coal seams are topographically elevated and located within the unsaturated zone (i.e. above the potentiometric surface), where much of the mining will be undertaken;
- The upper coal seams crop out at the ground surface in a number of locations, meaning they do not form continuous aquifers;
- The hydraulic gradients and hydraulic conductivities of the coal seam and sandstone aquifers are both low;
- The coal seam aquifers crop out to the east and west of the Modification Boundaries; and
- Groundwater levels have already been significantly drawn down to the east (down-gradient) of the Modification Boundaries by the Baal Bone Colliery.

Groundwater management has not been a major operational issue at the Cullen Valley Mine and the Invincible Colliery during their long history for the reasons outlined above. Hence, limited monitoring of groundwater levels and quality has been undertaken until recently. In the absence of abundant long-term groundwater data, a dedicated groundwater monitoring network was installed adjacent to Invincible Colliery and Cullen Valley Mine to enhance the collection of groundwater data, specifically to provide baseline groundwater data and for long-term data collection, assessment, and reporting.

19 REFERENCES

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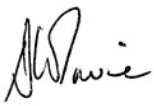

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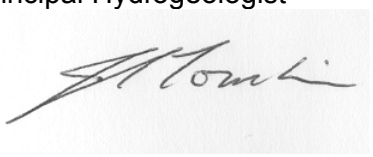

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LIMITATIONS OF REPORT

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) has prepared this report for the use of Hansen Bailey Pty Ltd in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 15 November 2013.

The methodology adopted and sources of information used by AGE are outlined in this report. AGE has made no independent verification of this information beyond the agreed scope of works and AGE assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to AGE was false.

This study was undertaken between 12 December 2013 to 10 February 2014 and is based on the conditions encountered and the information available at the time of preparation of the report. AGE disclaims responsibility for any changes that may occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. It may not contain sufficient information for the purposes of other parties or other users. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing and other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. Where borehole logs are provided they indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of the site, as constrained by the project budget limitations. The behaviour of groundwater is complex. Our conclusions are based upon the analytical data presented in this report and our experience.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, AGE must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge, information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.