Centennial Coal

900 Area
Subsidence Management Plan Application

Volume 1

Clarence Colliery

September 2013

Centennial Coal
Environment Matters

Centennial Clarence Pty Limited

CLARENCE COLLIERY

Partial Extraction of 900 Area

Subsidence Management Plan Application

Volume 1 – SMP Written Report

FINAL

September 2013

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EXECUTIVE SUMMARY

Clarence Colliery is an underground partial-pillar extraction coal mine located approximately 15 km east of Lithgow in the Western Coalfields of NSW. Operations at the mine commenced in 1979 and are now undertaken by Clarence Colliery Pty Ltd under a joint venture between Centennial Coal Ltd (85%) and SK Networks Resources Australia Pty Ltd (15%).

This report has been prepared to support an application for Subsidence Management Plan (**SMP**) approval by Clarence Colliery Pty Limited (Clarence Colliery) to undertake partial extraction mining activities within the 900 Area (within Mining Lease (**ML**) 1583, ML 1353 and Consolidated Coal Lease (**CCL**) 705). The NSW Department of Mineral Resources (2003) *Guideline for Applications for Subsidence Management Approvals* (**SMP Guidelines**) has been used to prepare this written report and application for a subsidence management approval within the 900 Area.

Community consultation for the 900 Area commenced early on in the development of this SMP initiated by an advertisement published in The Land and The Lithgow Mercury. The purpose of the advertisement was to inform the public of Clarence Colliery's intention to prepare an SMP and to request participation from those interested stakeholders. The advertisement was followed by an invitation to stakeholders (who have expressed interest in Clarence Colliery's SMP in the past and present) to attend a stakeholder meeting held at Clarence Colliery to discuss the proposal. A brief Fact Sheet was included with the invitation letter. A total of 27 letters were sent out. Issues and concerns raised from the stakeholder meeting were documented. Other consultation carried out during the preparation of this SMP included representatives at Celebrate Lithgow to discuss the SMP, availability of the Fact Sheet at Celebrate Lithgow, updates to the Clarence Community Consultation Committee (**CCC**) and offers to carry out one-on-one meetings/discussions.

A risk assessment (**RA**) was also carried out early on in the development of this SMP. The objectives of the RA were to identify the activities, aspects and potential impacts associated with subsidence caused by the proposed partial pillar mining within the Clarence 900 Area. Issues identified by the wider community were also assessed as part of the risk workshop. These issues included those recorded from the 900 Area SMP Stakeholder meeting as well as relevant issues identified through previous stakeholder meetings carried out for other SMP applications (ie. 700, 700W and 800 Areas). To assist with scoping of the risk assessment, the Guidelines were utilised. The SMP Guidelines were also used to guide the Risk Assessment, in particular section 6.10.2 (of the SMP Guidelines), relating specifically to Risk Assessments for SMP Applications.

Since the initial consultation, the SMP Area has changed (increased by around 40 hectares in the far south west corner of the 900 Area) to include an area that was previously approved under the 700W area (700W extension area) SMP. This area was originally scheduled to accommodate the two Flexible Conveyor Train (**FCT**) panels of 714 and 716 which were both terminated early. The early termination was a result of encountered geological conditions and the difficulties associated with driving through the geological conditions using the FCT equipment. To ensure that Clarence maximises its resource recovery and the expectation that the resource would be more efficiently recovered by a shuttle car panel (as opposed to an FCT panel) oriented east west, this area has been added to the 900 Area. This has been proposed through the extension of two panels, namely 903 and 903a.

The mining system for the proposed SMP Area is the partial-pillar extraction system which has been in place for the last 13 years and carried out within ML 1583, CCL 705 and ML 1353. This system has been designed such that remnant pillars that remain within and between panels are long-term stable. Data from subsidence monitoring have proven that this

method of extraction results in extremely low levels of subsidence. Unlike full extraction mining, partial extraction minimises subsidence through leaving a proportion of the resource in situ. This provides support to the overlying strata, minimising the breakage and falling of the overburden and maintaining the integrity of the aquifers above. Within the proposed SMP Application Area, maximum vertical long-term, post flooding (assuming the area will be flooded following extraction activities) subsidence is predicted to not exceed 100 mm (but may typically range from 60 - 70mm). This level of subsidence is typically considered to be negligible. Verification of the modelling process along with performance monitoring over areas previously extracted (based on many years of data) provides great confidence that proposed mining in the SMP Application Area using the same mining method will have negligible impacts.

The mining of the 900 Area is enabled through a number of existing Development Consents approved in 1976, 1993, 1994 and 2005. Clarence Colliery is seeking SMP approval from the Department of Trade and Investment, Regional Infrastructure and Services – Division of Resources and Energy (**DRE**) for partial extraction mining activities in the 900 Area.

The majority of the surface above the 900 Area is within Crown Land, being the Forests NSW-managed Newnes State Forest. A small area of land (12.8 hectares) is owned by Boral Quarries. The predominant land uses of the surrounding area include native hardwood and pine plantation harvesting and recreational activities such as bush walking, motorcycling and four wheel drive pursuits. Infrastructure over the surface is restricted to Forests NSW tracks. A small area in the far south western portion of the proposed 900 Area accommodates part of a 66kV powerline easement owned and managed by Endeavour Energy.

The potential impacts in the SMP Application Area have been determined through a process of risk assessment, subsidence prediction and specialist investigations. Whilst the SMP Risk Assessment found that the majority of the existing controls in place will adequately address the potential subsidence risks to significant natural and manmade features and infrastructure, Clarence Colliery engaged specialist consultants to investigate the potential risk of impact from subsidence to:

- Flora (including Groundwater Dependant Ecosystems (**GDE**));
- Fauna;
- Archaeology;
- Cliff line and pagodas; and
- Groundwater resources (including perched aquifers supporting swamps, aquifers supporting domestic users and deeper regional groundwater sources).

Assessment was also undertaken to identify and assess any features within the SMP Application Area listed as '*Environmentally Sensitive Areas'* in Appendix B of the SMP Guidelines, 2003 (s6.6.3). Identified natural surface features over the 900 Area include archaeological sites, Cliffs and Pagodas, Newnes Plateau Hanging Swamp (**NPHS**) and Newnes Plateau Shrub Swamp (**NPSS**), threatened flora species, habitat for threatened fauna species and threatened fauna species utilising the area. NPSS is listed as an Endangered Ecological Community (**EEC**) under NSW legislation. NPHS and NPSS together form a component of the federally listed Temperate Highland Peat Swamps on Sandstone (**THPSS**).

Man-made features on the surface within the 900 Area included pine plantations managed by Forests NSW, 4WD tracks, motorbike tracks, a disused quarry owned by Boral Quarries and a 66kV powerline (known as the 811 Feeder) managed by Endeavour Energy.

Given the low levels of subsidence from previous mining at Clarence Colliery and the predicted maximum long term level of subsidence for the SMP Application Area, the risk of damage to natural and man-made surface features is considered to be negligible.

A Trigger Action Response Plan (**TARP**) and a draft subsidence and infrastructure monitoring regime has been proposed to measure the performance of the 900 Area mine layout. This is included in Volume 2. Should this 900 Area SMP be approved, a more detailed Subsidence and Infrastructure Monitoring Program will be developed for approval prior to the commencement of secondary extraction. The TARP establishes trigger levels which are used to measure performance against predictions made within the SMP. The TARP also provides strategic management responses to monitoring results with a focus on response to results that exceed predictions or cause actual or potential impacts and consequences. The predicted subsidence was assessed as not posing a risk to public safety, and therefore in accordance with Section 7.3 of the SMP guidelines a separate Safety Management Plan was not required, however adequate provisions for public safety are included within the TARP. Recommendations from SMP investigations have been considered and included within the SMP TARP, which is included in Volume 2 of this SMP.

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- **Plan 5** 900 SMP **Plan 5** (CL1003)
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1 INTRODUCTION

1.1 PURPOSE

This report has been prepared as part of the application for Subsidence Management Plan (**SMP**) approval by Clarence Colliery Pty Limited (Clarence Colliery) to undertake partial extraction mining activities within the 900 area (within Mining Lease (**ML**) 1583, ML 1353 and Consolidated Coal Lease (**CCL**) 705). **Figure 1** shows the regional setting of Clarence Colliery and extent of the 900 Area.

Three development consents exist over the 900 Area including DA 504.00 approved in 2005, development consent DAM.08.76 in 1976 as modified in 1993 and development consent granted in 1994 (**Appendix A**). In accordance with Condition 2, of Schedule 3, of DA 504.00, Clarence Colliery is required to have an approved SMP in place prior to extraction. Furthermore, each of the MLs and the CCL require the approval of an SMP prior to secondary extraction. The proposed mining within the 900 Area is not the subject of an existing SMP; therefore Clarence Colliery is seeking SMP approval from the Department of Trade and Investment, Regional Infrastructure and Services – Division of Resources and Energy (**DRE**) to undertake partial extraction mining activities in the 900 Area.

1.2 STRUCTURE OF SMP APPLICATION

This report is Volume 1 of the SMP Application, and is referred to as the SMP Written Report.

The SMP Application consists of:

- Letter of Application;
- SMP Written Report (SMP Application Volume 1);
- Supporting Specialist Assessments (contained with Volume 1);
- SMP (SMP Application Volume 2); and
- SMP Approved Plan, SMP Plans (1, 2, 3, 5, 6) and Aerial Photo.

1.3 PROJECT OVERVIEW

Clarence Colliery is an underground partial pillar extraction mine that commenced operations in 1979. Clarence Colliery has existing development approvals in place enabling production of 3 million tonnes per annum (**Mtpa**), but currently produces approximately 2 – 2.5 Mtpa. Coal is extracted from the Katoomba Coal Seam and there are reserves for approximately 20 - 30 years of operations at existing extraction rates. The mine is located approximately 15 kilometres (**km**) east of Lithgow (**Figure 1**) in the Western Coalfields of NSW. The mine entry and primary surface facilities are accessed from the Bells Line of Road. The mine directly employs approximately 230 personnel and is predominantly an export mine railing product coal to Port Kembla for shipping to international customers.

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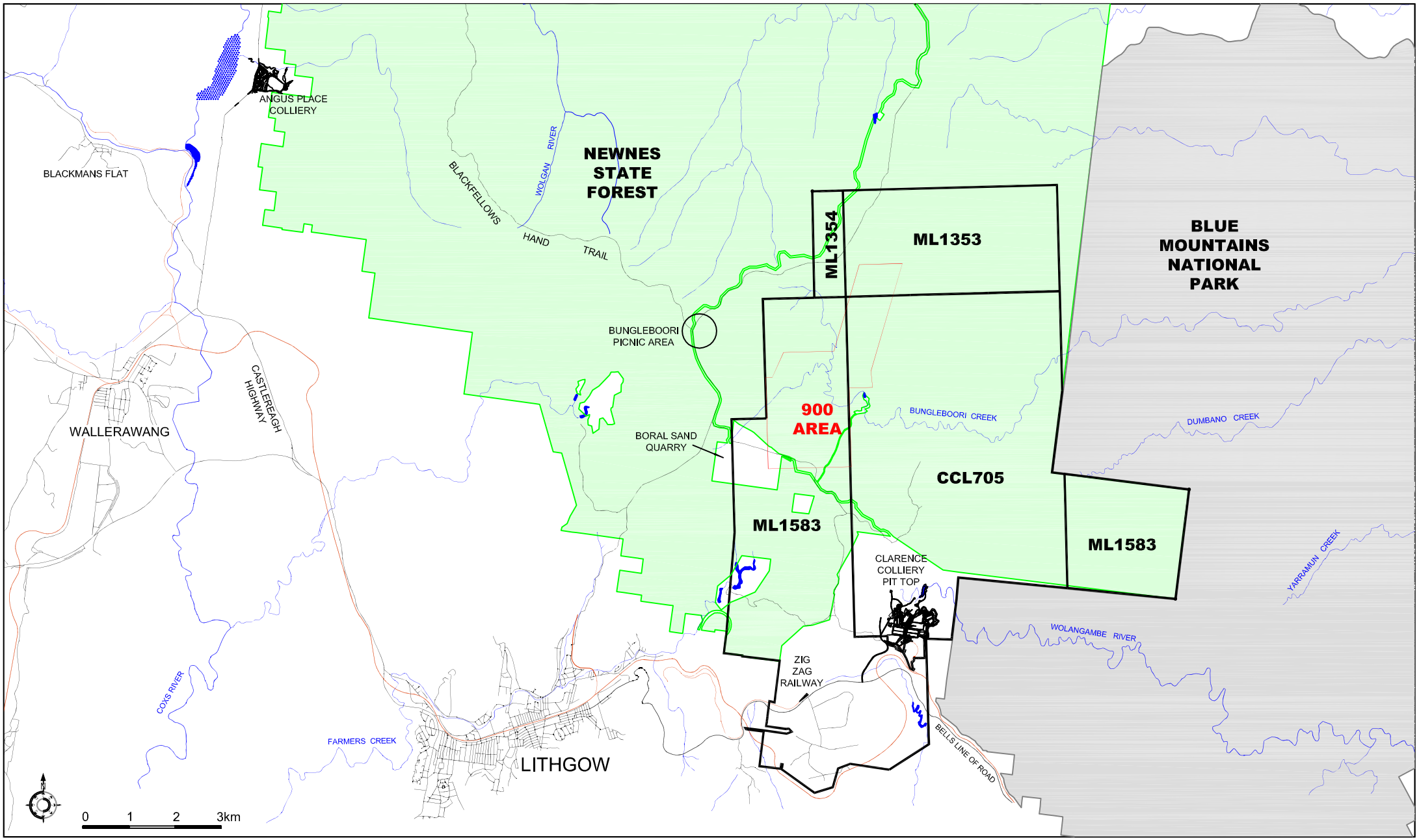

Figure 1. REGIONAL LOCATION PLAN

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The mine entry and primary surface facilities within the existing Mining Leases (approx. 7735 hectares) are located in the Wollangambe River, Bungleboori Creek and Farmers Creek catchments, with a small area in the north west of the lease (approximately 20 hectares) draining in to the Carne Creek catchment.

Clarence Colliery has existing SMP's approved by DRE which are described in **Section 1.6** and shown on **Figure 2**. Clarence Colliery also currently operates under a number of Development Consents and Mining Leases, which are listed in **Table 1** and **Table 2** (respectively), and shown on **Figure 3**. Clarence Colliery also operates under the Environmental Protection License No.726 under the *Protection of the Environment Operations Act 1997*.

Clarence Colliery initially operated as a bord and pillar mine. In 1992, longwall mining was introduced; however this proved unsuccessful due to the unfavourable geological and geotechnical conditions associated with the strata overlying the Katoomba Seam within the Lease area. Centennial Coal Company Ltd purchased the mine in 1998 and introduced partial extraction mining techniques. Partial extraction minimises subsidence through leaving a proportion of the resource in situ. This provides support to the overlying strata, minimising the breakage and falling of the overburden and maintaining the integrity of the aquifers and strata above whilst maximising resource recovery and mine productivity.

It is noted that the development consent associated with ML 1353 approves primarily longwall mining but also allows partial pillar extraction where longwall mining cannot be undertaken. This SMP is solely for partial pillar extraction as at this time, longwall mining cannot be undertaken in the area. This also ensures consistency with other development consents procured by Clarence Colliery.

Since the initial consultation (in late 2012), the 900 SMP Area has changed (increased by around 40 hectares) to include an area that was previously approved under the 700W area (700W extension area) SMP. This area was originally scheduled to accommodate the two Flexible Conveyor Train (**FCT**) panels of 714 and 716 which were both terminated early. The change was a result of encountered geological conditions and the difficulties associated with driving through those geological conditions using the FCT equipment. To ensure that Clarence maximises its resource recovery and the expectation that the resource would be more efficiently recovered by a shuttle car panel (as opposed to an FCT panel), this area has been added to the 900 Area. This has been enacted through the extension of the 903a and 903 Panels.

The partial pillar mining system has traditionally consisted of a seven heading panel layout with 24.5 or 27.5 metre (**m**) solid spine pillars (rib to rib), remnant pillars and a minimum 40 m barrier of solid coal retained on either side of the extraction panel to support the roof. Mining height is set at a maximum of 3 m. Substantial underground and surface monitoring of the performance of the seven heading mining layout over a period of 13 years have given Clarence Colliery great confidence that the models used to predict both pillar stability and surface subsidence are reliable. The data collected to date has shown that subsidence has never exceeded 100 mm (within survey accuracy) of vertical subsidence and tilts and strains have never exceeded 2 mm/m (over a three peg average).

The traditional partial pillar mining technique has been based on a seven heading layout which utilises a continuous miner and shuttle cars to transport the coal to an established conveyor belt which supports the specific panel(s) over its life. Clarence Colliery also employs the FCT, which removes the need for shuttle cars. The FCT is typically used within a 5 Heading Panel Layout. The 5 heading FCT layout comprises a series of parallelepiped pillars (at 70°), the geometry of which is limited by the length of the FCT equipment. The use of the FCT in a five heading layout has been employed over the last two and half years in the 700 and the 700W SMP approval areas. For the 900 Area, Clarence Colliery does not

propose to utilise the FCT rather only the seven heading shuttle car layouts, an eleven heading layout and first workings (mains development) will be undertaken.

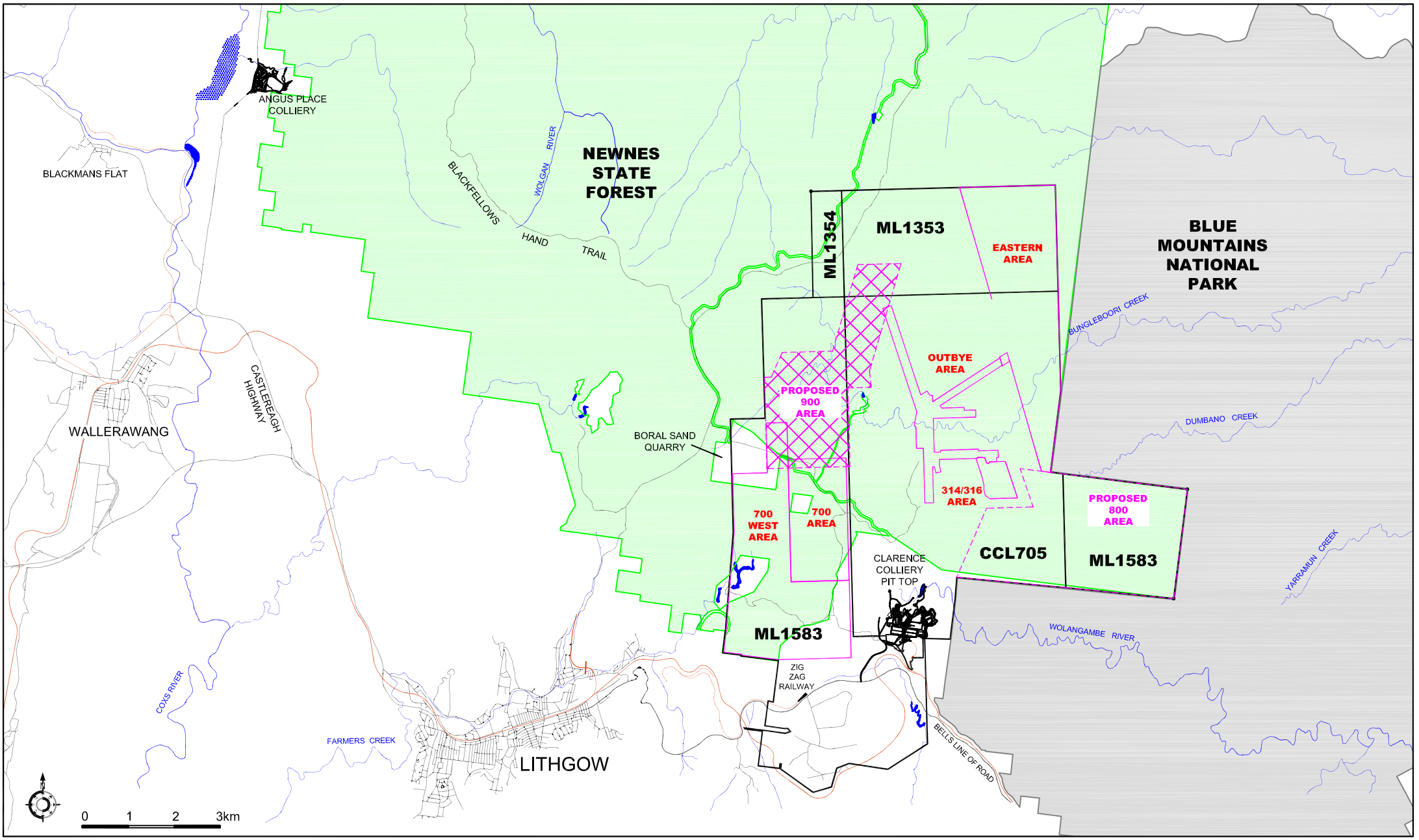

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Figure2. SMP APPROVALS, ML BOUNDARIES AND PROPOSED SMP BOUNDARIES

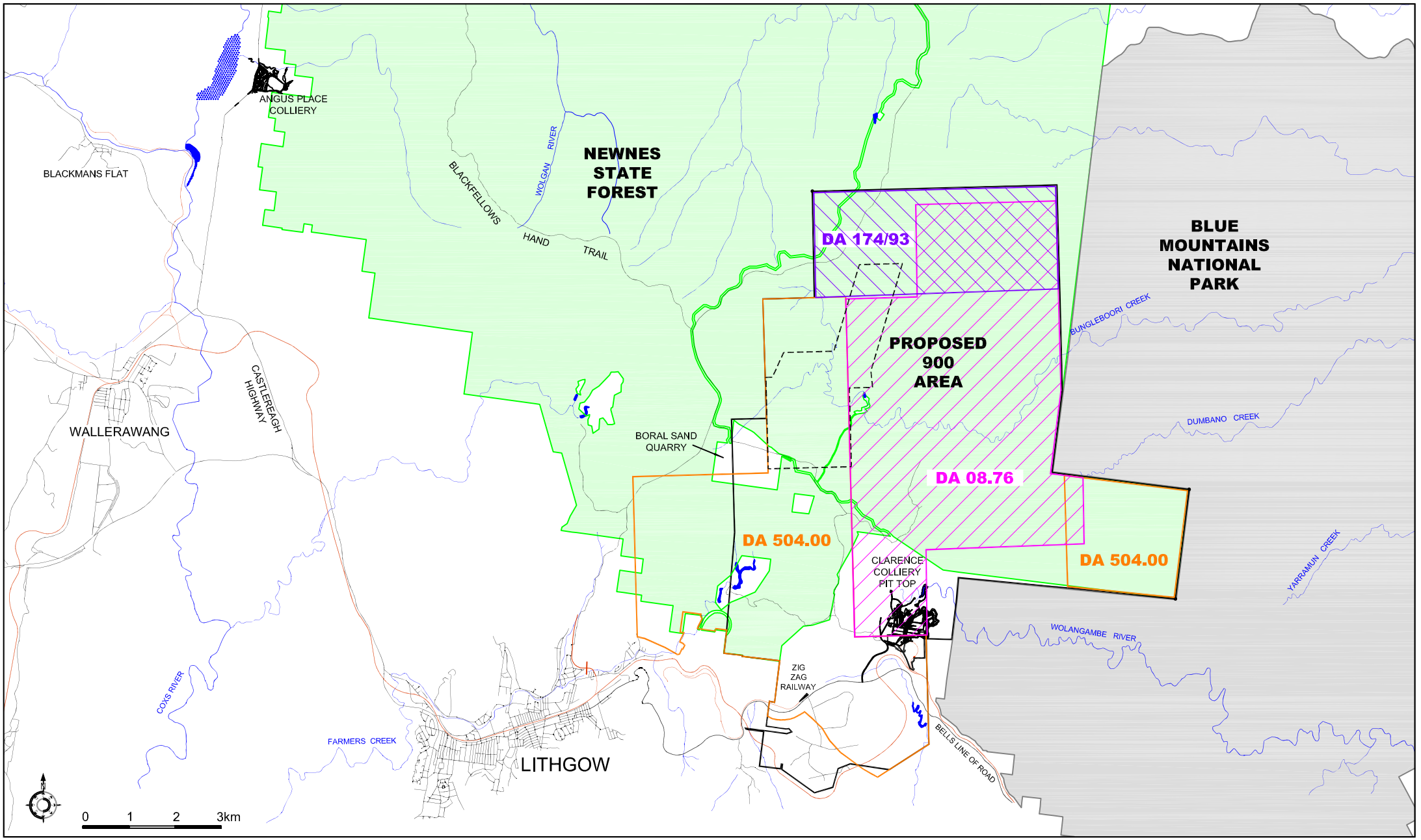

Figure 3. DEVELOPMENT CONSENT BOUNDARIES

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1.4 DEVELOPMENT CONSENT

A summary of Development Consents applicable to Clarence Colliery is presented in **Table 1** and **Figure 3**.

Table 1 Clarence Colliery Development Consents

Approval	Granted	Summary of Consent
Original Development Consent (DAM.08.76) (Blaxland Shire Council)	15/06/1976	Approval of building plans, landscaping, operations in accordance with the EIS, Collection Dam as well as compliance with other State Government Department Conditions.
Amended Development Consent (5161/20000000/0) (Lithgow City Council)	1/07/1993	Amended consent. Underground Coal Mine, Reject Emplacement Areas and Associated Pit Top Facilities.
Development Consent (DA174/93) (Lithgow City Council)	15/02/1994	Development application. Extension of underground mining within ML 1353 and 1354, increase in ground water extraction and subsequent discharges.
Development Consent (DA 504-00) (Department of Planning)	19/12/2005	Partial Extraction in Lease Extension Area ML1583.

The existing consents relevant to this SMP Application are the original development consent (DAM.08.76) (Blaxland Shire Council), as modified in 1993, consent granted by Lithgow City Council in 1994 (DA 174/93) and the development consent granted by the Department of Planning in 2005 (DA 504.00). A copy of the relevant development consents are attached as **Appendix A**. Relevant conditions from these approvals relating to this SMP Application are presented in **Section 10** (Statutory Requirements).

The development consent issued in 2005 stipulates a “first workings zone” beneath the Bungleboori Creek. This zone lies wholly within the proposed 900 Area and is presented in **Figure 4**.

1.5 MINING LEASES

The Clarence Colliery underground mine is accessed through CCL705 into ML1353, ML1354 and ML1583. Partial extraction is currently undertaken in CCL705 and ML1583. A summary of Mining Leases for Clarence Colliery is presented in **Table 2** and **Figure 2**.

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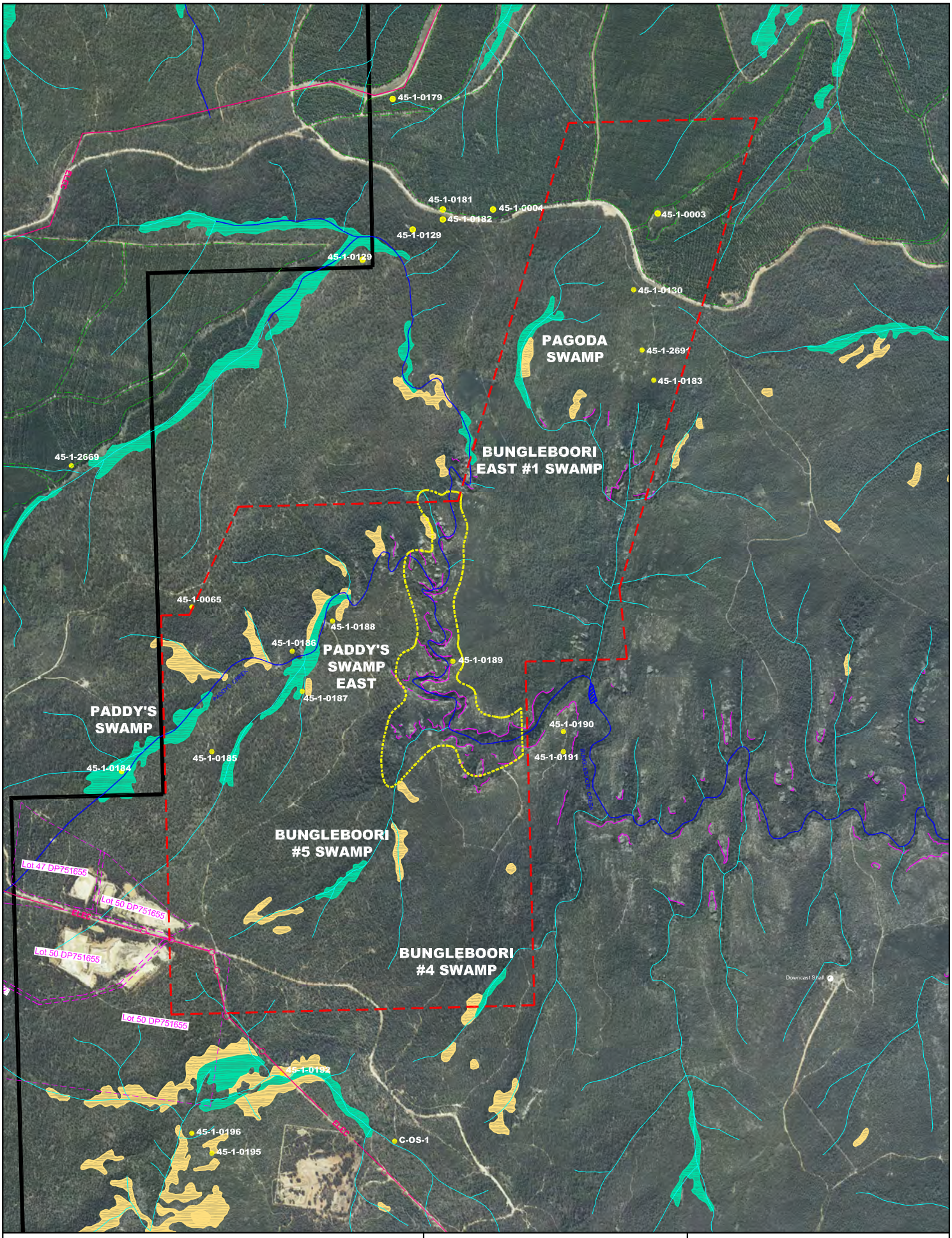

SURFACE FEATURES

NOTE: Aerial photo flown October 2008

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Figure 4.

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Table 2 Clarence Colliery Mining Leases

Primary Facility (underground)	Grant Date	Expiry Date	Area (ha)	Lease Holder
Consolidated Coal Lease 705	20/12/2005	20/12/2026	~3174	Coalex Pty Ltd & Clarence Coal Investments Pty Ltd
Mining Lease 1353	21/07/1994	21/07/2015	1075	Coalex Pty Ltd & Clarence Coal Investments Pty Ltd
Mining Lease 1354	21/07/1994	21/07/2015	155.3	Coalex Pty Ltd & Clarence Coal Investments Pty Ltd
Mining Lease 1583	09/07/2006	09/07/2027	~3331	Coalex Pty Ltd

The leases relevant to this SMP Application are CCL705, ML 1353 and ML1583. A copy of CCL705, ML 1353 and ML1583 are attached as **Appendix A.** Relevant conditions relating to this SMP Application are presented in **Section 10** (Statutory Requirements).

1.6 OTHER SMP's AND EXTRACTION APPROVALS

Clarence Colliery has five SMP's approved by the DRE. The Eastern Area SMP has recently expired (on 1st June 2013). An updated report supporting the 800 Area SMP Application was submitted for approval in late May 2013. Recent variations have also been submitted for the 700 Area and the 700W Area including:

- A reduction in the SMP boundaries to align each boundary so that they are contiguous with the 900 Area; and
- Limited pillar extraction within the mains (700 Panel) of the 700 and the 700W Areas.

As of 9 September 2013, these variations are yet to be approved. This is important to note as the boundaries presented on **Figure 2** show the Approved Plan boundaries which currently overlap the 900 Area in the absence of the above mentioned variation approvals.

Mining activities as per the "Approved Plans" are completed within all SMP Areas with the exception of one panel within the 700 Area (the 706 Panel) which is being utilised as the primary access into the 900 Area and several panels within the 700W Area. Should the 700 and 700W SMP variations be approved, there will be some limited extraction available in the 700 Panel. Details of the approved SMP's (as at 9 September 2013) are shown in **Table 3**.

Table 3 Current SMPs and Extraction Approvals

Approval	Date Approved	Expiry	Panels	Status
Outbye Area	30 January 2009	1 January 2010	602 only	Completed
06/0997 (Outbye Area)	8 May 2009	1 May 2014	302, 305, 306, 307, 400, 403 and 406	Completed
06/0997 (700 Area)	8 May 2009	1 May 2014	700, 702, 704, 706, 708, 710 and 712	706 to be extracted
Panel 314/316	19 February 2010	1 February 2015	314, 316	Completed
700W	18 June 2012	1 June 2017	714, 716, 718, 701, 707, 709, 711, 713, 715, 717, 719, 907, 909	716, 718, 701, 709, 711, 713, 715, 717, 719, 907, 909 to be extracted

1.7 COMMONWEALTH APPROVALS

Clarence Colliery has approval from the Department of Sustainability, Environment, Water, Population and Communities (**SEWPAC**). A referral was submitted to SEWPAC on 3rd July 2012 and determined on 1st August 2012. The referral assessed the potential impacts to Matters of National Environmental Significance (**MNES**) from partial pillar extraction (amongst other things) within ML 1583. The Federal Government determined the mining activities (as well as other matters contained within the referral) to be "not a controlled action if carried out in a certain manner", which means there are a set of conditions associated with the determination. The activities to "be carried out in a certain manner" (or the conditioned activities) do not relate to partial pillar extraction mining, rather they relate to the proposed exploration activities associated with the 800 Area exploration program. To this end, the mine plan proposed under this SMP application complies with the referral approval. The approval is also contained in **Appendix A**.

1.8 SMP GUIDELINES

Clarence Colliery has prepared this SMP Application in accordance with the *Guideline for Applications for Subsidence Management Approvals* (SMP Guidelines) published by the Department of Primary Industries - Mineral Resources (2003) (now DRE). In preparing this SMP Application, Clarence Colliery has been guided by the SMP Guidelines with respect to keeping the SMP Application relevant and "*appropriate to the nature and scale of potential subsidence impacts*".

To better facilitate reference to the SMP Guideline, the report and corresponding guideline references are correlated below in **Table 4**.

Table 4 SMP Guideline Requirements

Item	Guideline Reference	Report Reference
Mining system, recovery, statutory requirements, expected subsidence, potential subsidence impacts	Section 6.1	Section 3
Application area description	Section 6.2	Section 2
Mining method, system, seam details, recovery, other seams	Section 6.3	Section 3 & 4
Site conditions, cover, stratigraphy, lithology, geology	Section 6.4	Section 4
Stability of workings, working height, detail of lithology, geotechnical, geology	Section 6.5	Section 4 & 5
Surface structures, natural features, monitoring, identification	Section 6.6	Section 7
Subsidence predictions, individual features subsidence	Section 6.7	Section 6
Community consultation	Section 6.8	Section 9
Legislation, approvals, licences	Section 6.9	Section 1 and 10
Subsidence impacts, impacts of increased subsidence	Section 6.10	Section 6 and 8
Risk assessment and summary	Section 6.10	Section 11
Proposed SMP	Section 6.7	Volume 2 (SMP)
Plans	Section 9	Accompanying
Approved Plan	Section 10	Accompanying

1.9 THE APPLICANT

Clarence Colliery Pty Ltd (**Clarence Colliery**) is a wholly owned subsidiary of Centennial Coal Company Limited (which is a wholly owned subsidiary of Banpu Public Company) and has been appointed as the management entity for the Clarence Joint Venture. Centennial Coal Company Limited has an 85% share in the Clarence Joint Venture, comprised of a number of wholly owned subsidiaries being Coalex Pty Ltd (a 51% share), Clarence Coal Investments Pty Ltd (a 29% share) and Centennial Clarence Pty Ltd (a 5% share). The remaining 15% share in the Clarence Joint Venture is held by SK Networks Resources Australia Pty Ltd.

Clarence Colliery operates the existing underground Clarence coal mine (**Clarence Mine**), near the village of Clarence in NSW, for and on behalf of the joint venture companies who own it. Approval to commence activities at the Clarence Mine was originally granted in 1976. The area within which the partial extraction mining operations are proposed was approved in 2005 by the NSW Department of Planning (**DoP**) and now the Department of Planning and Infrastructure (**DPI**).

Clarence Colliery ("the Applicant") manages the mine.

1.10 COMMUNITY CONSULTATION

Clarence Colliery has applied the *Guidelines for Best Practice Community Consultation in the New South Wales Mining and Extractive Industries* developed by the NSW Minerals Council (2006), throughout the SMP Application process.

Clarence Colliery has undertaken consultation with the land owner, local community, Aboriginal groups, the local and state government authorities and other relevant

stakeholders in preparation of the SMP. A detailed stakeholder consultation log was kept during the preparation of the SMP as a record of the consultation undertaken by Clarence Colliery. A summary of the consultation undertaken is included in **Section 9** (Community Consultation).

The consultation to be undertaken during the mining of the 900 Area is described in the SMP (Volume 2).

1.11 SUBSIDENCE IMPACTS

Appendix B of the SMP Guidelines was used to ensure all potential surface and subsurface features across the SMP Area potentially impacted by subsidence were identified. The surface area within the 900 Area is virtually covered with native vegetation. The only public utilities over the 900 Area are four wheel drive tracks, motorbike tracks, pine plantation (with areas recently cleared), a discussed quarry owned by Boral and a portion of a 66kV powerline which contains four powerpoles. There are no public amenities, farm land or residential establishments. Whilst there are no items of architectural significance, there are items that are of archaeological and/or Aboriginal heritage significance.

The natural features within the 900 Area include creeks, aquifers, springs, cliffs, pagodas, escarpments, swamps, threatened and protected species and natural vegetation. Virtually, the entire area is covered by State Forest.

The potential impacts from the proposed mining within the 900 Area were initially assessed through a formal risk assessment, subsidence predictions and other specialist assessments. Given that there are a number of surface features identified in the area, the risk assessment and the risk assessment process for the 900 Area as well as previous SMP risk assessments highlighted that the following specialist assessments were required to support the SMP Application:

- Flora and fauna;
- Archaeology;
- Cliff line and pagoda;
- Subsidence and pillar stability predictions;
- Collate and review data to confirm subsidence performance;
- Collate and review data to calibrate predictive models; and
- Groundwater resources (including collation and review of historic monitoring data to support the predictions).

The risk assessment concluded that the majority of the existing controls in place will adequately address the potential subsidence risks to significant natural and manmade features and infrastructure. Existing controls include mine design, management plans and monitoring programs developed over the years in accordance with the existing approvals. The most important subsidence control at Clarence Colliery is the pillar and panel design which determines pillar strength, compression and therefore subsidence. Despite the low risk of subsidence impacts, Clarence Colliery engaged suitable specialist consultants to assess the potential impacts from partial extraction as listed above.

As noted above, Golder carried out a detailed review of surface subsidence monitoring and pillar stability (stress cells and gel extensometers) data. This constituted a review of all data

collected over the last 13 years to calibrate the existing models, verify mining performance and confirm confidence in the current models utilised for design purposes. Subsidence predictions and impacts for identified features are addressed in **Section 6 (Subsidence Prediction)**.

2 THE APPLICATION AREA

2.1 LAND USES, LAND OWNDERSHIP AND MINING TITLES

The SMP Application Area for the 900 Area (SMP Application Area) has been defined using the surface area within the CCL705, ML 1353 and ML 1583 boundaries and mining constraints (first workings only) associated with DA 504-00. The 900 Area is approximately 659 hectares. It is noted however, that this area includes a zone of first workings (44 ha) associated with the Bungleboori Creek and its immediate cliff lines.

With the exception of 12.8 hectares, the entire surface of the 900 Area is within Crown Land, being the Forests NSW managed Newnes State Forest. The predominant land uses of the surrounding area include native hardwood harvesting, pine plantations and recreational activities such as bush walking, motorcycling and four wheel drive pursuits. A proportion of the pine plantation overlying the 900 Area has recently been clear felled (see **Plate 1**). The surrounding area is also a declared hunting area.

Plate 1. Cleared Pine Plantation above the 900 Area (photo taken off Waratah Ridge Road – 26 September 2012)

A 66kV powerline (known as the 811 Feeder) traverses the south western area (see **Plates 2 - 3** and **Figure 5**). Endeavour Energy are aware of Clarence's intention to mine underneath the powerline easement. The powerline delivers electricity to industrial customers including the Clarence Quarry, Clarence Colliery and infrastructure associated with the neighbouring Angus Place and Springvale underground coal mines. Reflectors have been installed on the powerpoles to enable powerpole monitoring (both pre and post mining) and a condition assessment on the poles has been undertaken (in 2012) and they were deemed to be in a serviceable and good condition.

Clarence currently forwards its Subsidence Management Status Reports (**SMSRs**) to representatives from Endeavour Energy so that they are aware of Clarence Colliery's mining activities and mining performance.

Plate 2. Powerpole 136 Looking West

Plate 3. Powerline looking to the North Northwest

A small proportion (12.8 hectares) of the SMP Application Area is owned by Boral Quarries (see **Figure 4**). This small portion of land is covered in native vegetation and is not currently used by Boral for quarrying activities as the quarry is currently on care and maintenance. Contact has been previously made with Boral Quarries regarding proposed mining activities underneath their land. Clarence also forwards its SMSRs to a representative from Boral Quarries to ensure that they are informed of Clarence's mining status and performance. Additionally, the area was previously assessed as a part of an SMP variation for 700W (which did not proceed).

The SMP Application Area is located within the Newnes State Forest, Parishes of Clywdd, County of Cook and the Lithgow City local government area.

The majority of the 900 Area drains into the Bungleboori Creek catchment. A very small area in the north western corner of the 900 Area, north of Waratah Ridge Road drains into the Carne Creek catchment.

The SMP Application Area is shown in **Figure 2** and **Figure 3**.

3 MINING SYSTEM AND RESOURCE RECOVERY

3.1 PROPOSED MINING METHOD

Background

At Clarence, the immediate roof to the working horizon is strong sandstone within the Caley Formation which provides a strong roof with excellent spanning capability. This typically means that as pillars are formed and retained (or partially retained), the load is effectively transferred across the roof and redistributed on to the remnant, spine and barrier pillars. The sandstone roof is generally strong with Uniaxial Compressive Strengths (**UCS**) of up to 85 MPa (but modelled at 65MPa). This means that, under normal conditions, the roof provides a strong competent beam over the mine workings. It is also important to note that the Katoomba seam coal is also considered to be strong with UCS ranging between 53-63 MPa. This means that, if pillars are sufficiently dimensioned, they will be adequate to support the redistributed loads from the partial pillar extraction.

The Coal Mine Roof Rating (**CMRR**) is a measure of roof 'quality' or structural competency for bedded roof types typical of underground coal mines. In other words, it rates the ability of the roof to stay up, amongst other things. The system was developed by the United States Bureau of Mines (**USBM**) (now part of NIOSH) in the United States and has been widely applied in Australia since the mid-1990s. CMRR was derived from the South African CSIR's Rock Mass Rating (**RMR**) system, which has been used in the mining and tunnelling industries for over 30 years (**Bieniawski, 1974**). The system was revised in 2003, to incorporate experiences gained since 1994 (**Mark and Molinda, 2003**).

Molinda and Mark (1994) suggests the following categorisation of roof competency:

- CMRR <45 - Weak Roof
- CMRR = 45 to 65 - Moderate Roof
- CMRR >65 - Strong Roof

Review of geotechnical data from the 900 Area reveals CMRRs of around 56 - 81 would be expected. Therefore a moderate to strong roof is anticipated.

Proposed Mining Method

The partial extraction mining system involves the use of continuous miners developing headings or roadways to form up pillars. Partial extraction involves the "part removal" of these pillars from the panel along the heading. In the seven heading layout, the pillar(s) adjacent to the conveyor belt road are not extracted and they are known as "spine pillars". These spine pillars form an important role in providing mid panel support. In between each panel, barrier pillars are retained and form an important role in providing regional support. On balance, approximately 50% of the coal resource is retained in-situ to support the ground above it. This has been the basic partial pillar extraction model used by Clarence since it was re-commissioned by Centennial Coal in 1998. The proposed partial extraction within the 900 Area will employ methods already established and in use at Clarence and uses the same predictive and design models as described below. These models have been in use (and monitored for performance) for thirteen years. Accordingly, Clarence has great confidence in the models used to design and assess the stability of the proposed mining in the 900 Area.

One panel in the proposed 900 Area will consist of an 11 heading layout. Extraction is proposed to be carried out along the rows of cut throughs. In this case, the extraction pattern will consist of partially extracting rows of pillars and then leaving a row of pillars and then partially extracting rows of pillars and then leaving a row of pillars and so on. This pattern of extraction has been successfully carried out at other mines in the Newcastle Coalfield. The row of pillars to be retained intact are referred to as intra-panel spine pillars.

All panels will retain a minimum 40m barrier in between each panel.

The rationale underpinning the panel layout and the associated partial extraction system may be summarised as follows:

i. The 40 m (minimum) barrier pillars have a width to height (**w/h**) ratio of ≥13 and would be commonly regarded as indestructible.

ii. For the seven heading shuttle car panels, the central spine pillars have w/h ratios of ≥8 and the 11 heading layout have intra-panel spine pillars of ≥9. These w/h ratios are considered to be very strong and stiff and are regarded as indestructible.

iii. The remnant pillars associated with the seven heading shuttle car panels are not insignificant in size with a minimum w/h ratio ≥4.5 and the 11 heading layout panel have remnant pillars with a minimum w/h ratio ≥5.5. These pillars provide considerable support, at least to the immediate overburden.

iv. The sandstones dominating the overburden at Clarence have considerable spanning and associated load transfer potential. Therefore, during extraction some of the load carried by the stripped pillars is transferred to the stiffer barrier pillars, spine pillars and intra panel pillars.

v. This spanning ability of the overburden above the seven heading shuttle car panels is enhanced by the maintenance of subcritical span to depth ratios. Sub-panel width to depth ratios are typically much less than 50%, such that subsidence principles indicate natural arching of the overburden, significant load transfer and greatly restricted potential for any surface deformation (i.e. subsidence). This is facilitated by the overlying geology.

vi. As depth reduces, although the spanning capability of the overburden diminishes and width to depth ratio increases, the stability of the in panel pillars and in particular the remnants steadily improves and the reliance on load transfer diminishes. The seven heading shuttle car panel system is therefore effectively self-regulating.

vii. Given that the 11 heading panel is 335.5m wide, no allowance has been made for load transfer from the spines or remnants to the barriers; final barrier pillar loading is super-critical. Load transfer from the stripped remnants to the adjacent rows of intra-panel spines is assumed and calculated using the tributary area theory (a conservative approach). The overall stability of the system is therefore dependent largely on the performance of the spine pillars which have a w/h ratio of ≥9.

The system provides the following major advantages to the mine:

i. The elimination of any appreciable caving, with post-extraction roof collapses limited to the nether roof in the immediate extraction areas (which are only 16.5 m wide). Heights of localized falls are typically <1 m and fall heights of >6 m are unknown (falls tending to be more common in areas of geological structure).

ii. The elimination of caving greatly reduces water ingress from overlying aquifers.

iii. No adverse surface impacts including an absence of evidence of surface cracking or mining related rock-falls.

iv. A simple, productive system of work with restricted extraction spans and a controlled loading environment lends itself to enhanced safety, particularly with respect to the maintenance of consistent roof conditions at the goaf edge. This contrasts with the periodic weighting difficulties and goafing events associated with previous total extraction operations at the mine.

This model has now been in use for around 13 years, having commenced in 605 Panel, without any evidence of large-scale underground instability. This in itself is an important statistic, as the median time to failure for pillar collapses is five years from mining (SEA, 2011).

3.2 MINE LAYOUT

The 900 Area is the northward progression of the Clarence Mine plan situated directly to the north of the existing 700 area, at depths ranging from 200m (the limit of the first workings boundary) up to 320m in the northern portion of the area. Depth of cover reduces to 130m within the first workings zone. The proposed 900 Area is dissected by Bungleboori Creek which is characterised by a steeply incised drainage line. It is noted that this area has been designated a first workings only zone.

The proposed panel layouts are presented in **Figures 5-6 (**also presented in **Appendix B)**. They consist of a 30m centre shuttle car layout, 33m centre shuttle car layout and an eleven heading shuttle car layout. It is noted that “centre” refers to the distance between the two mid points of the roadway either side of the pillar (see also **Figure 5**). The design and implementation of 30m centre seven heading shuttle car panels are assessed on a case by case basis depending on depth of cover and mining height. For the 900 Area, seven heading panels on 30m centres will be developed at a maximum 3.0m mining height and a maximum depth of 240m (Panels 904 and 982). Where mining height reduces to 2.6m, the 30m centre shuttle car layout can be applied at greater depths of cover as pillar strength increases with reduced mining height (ie. squat pillars, see also **Section 3.3**) and width to height ratios increase to ≥9 for spine pillars, ≥5 for remnant pillars and ≥15 for barrier pillars.

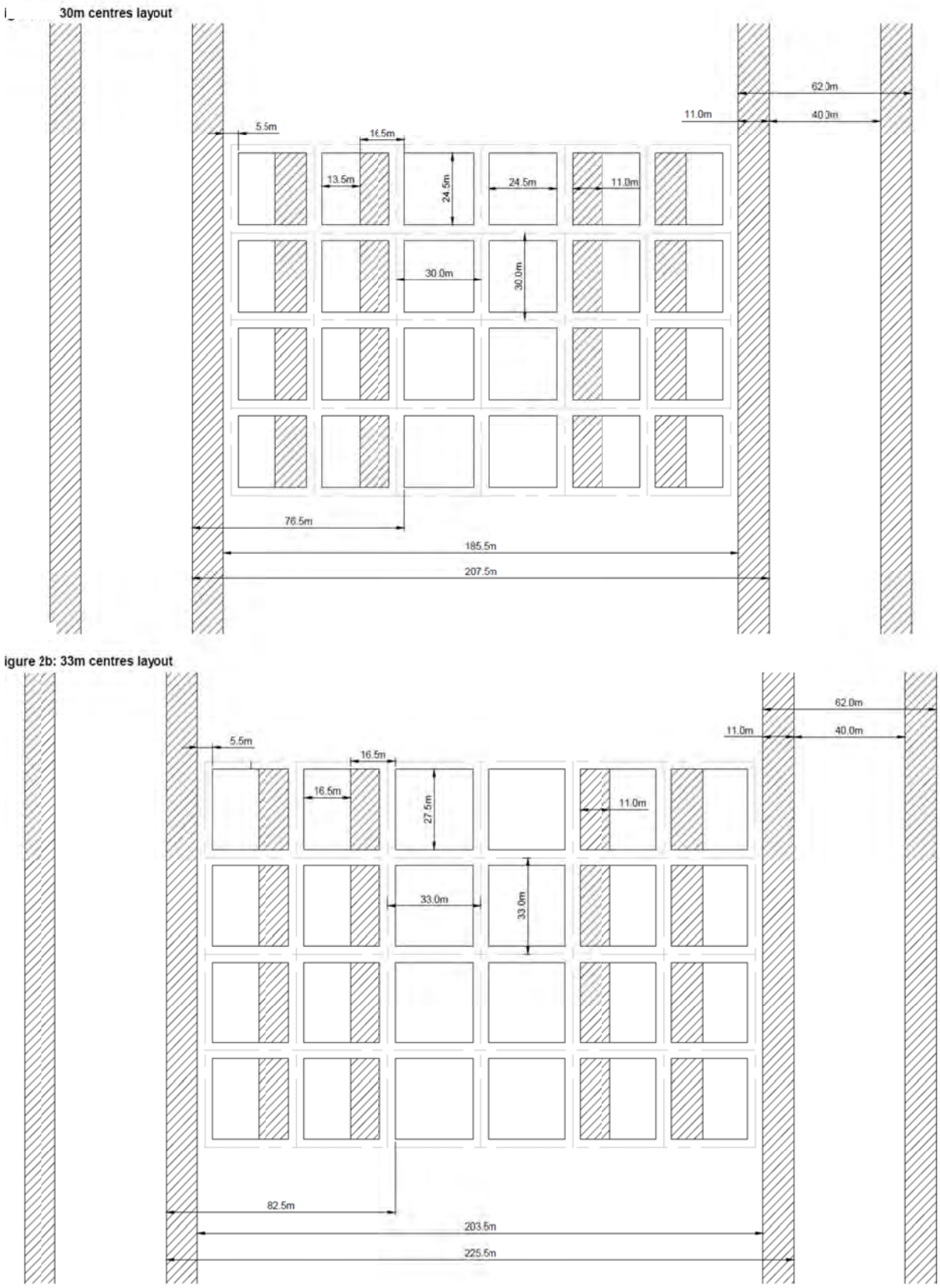

Figure 5 **Typical Layout for Seven Heading Partial Extraction Layouts, 30m and 33m centres (Golder, 2013b)**

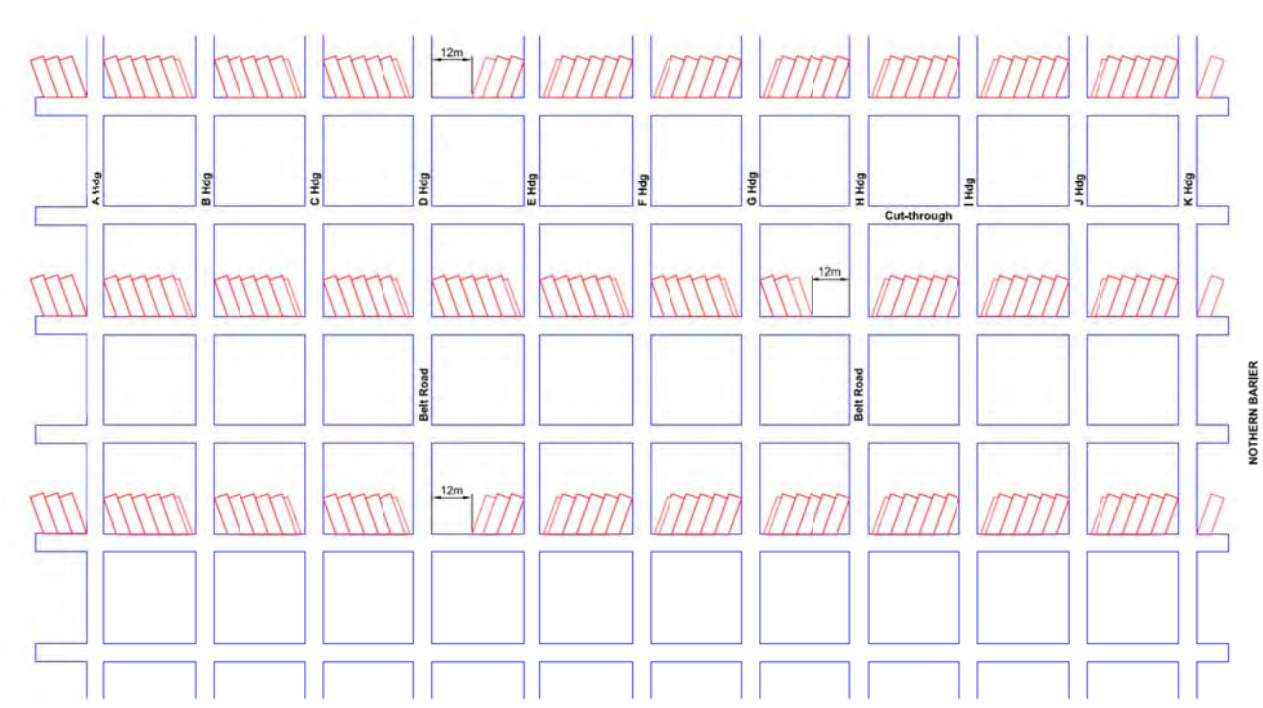

Figure 6 Typical Layout for Eleven Heading Partial Extraction Layout, (Golder, 2013a)

Table 5 and **Figure 7** present the panel numbering for each panel layout for the 900 Area

Table 5 900 Area Panel Numbering and Layout

Panel Number	Panel Layout
903	Eleven Heading Layout
Part 921, Part 919, 903a, 902, 906, 908, 910	Seven Heading (33m centre)
911, 913, 915, 917, 919, 921, 904	Seven Heading (30m centre)
706, 900, 982, 905	First workings / Mains Development

The overall objectives of the mine plan panel layout are:

1. To maximise recovery and productivity;
2. To design the panel such that remnant pillars, intra-panel pillars, barrier pillars and barrier pillars create a system that is considered long term stable;
3. To restrict subsidence to less than 100mm; and
4. To restrict adverse consequences from subsidence on critical surface features above the mining area.

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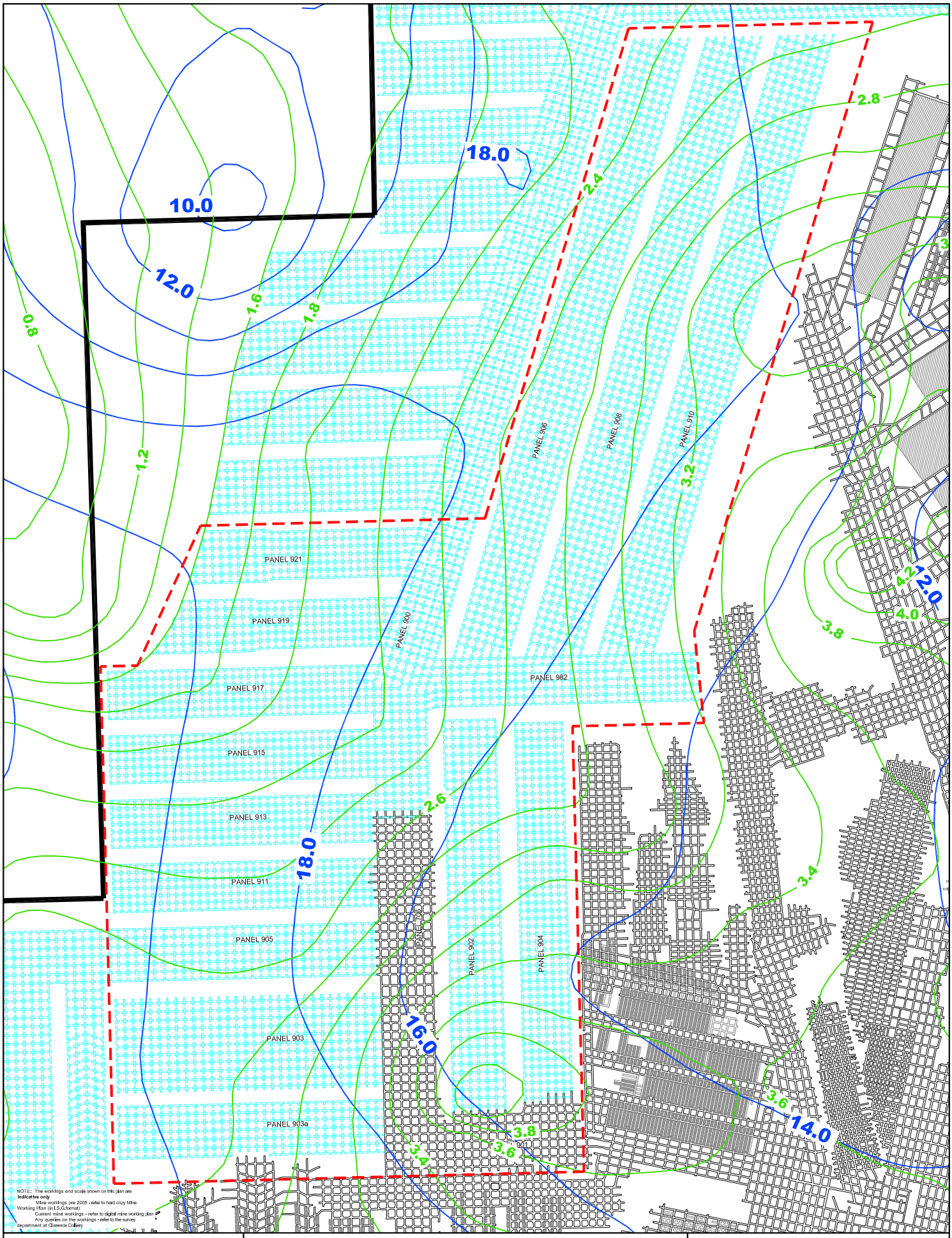

COLLIERY HOLDING BOUNDARY
SEAM HEIGHT (m)
ASH ISOPACHS (%)
WORKINGS
PROPOSED WORKINGS
PROPOSED 900 AREA

SEAM HEIGHT AND ASH ISOPACHS OVER 900 AREA

Centennial Coal
Clarence

Figure 7.

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The strategy for protection of surface features and surface groundwater systems is threefold.

- Firstly the partial extraction mining system minimises subsidence to less than 100 mm by designing pillars of sufficient dimension to support the overburden above and span the excavation.

- Secondly, the integrity of the strata and therefore ground water systems is preserved broadly across the area by avoiding caving (through the use of the partial extraction system). The groundwater data demonstrates this in areas above partially extracted areas and in areas outside of partially extracted areas. To this end, the integrity of groundwater aquifers (above the coal seam) should remain intact both above the mined area and outside of the mined area. This is further discussed in **Section 8** and **Appendix C**)

- Thirdly, the mine design minimises fault plane intercepts by leaving additional coal in faulted pillars where necessary (designed and executed through the manner and sequence plans required under Clause 88 of the Coal Mine Health and Safety Regulation 2006).

It is important to note that the mine plan is based on the geological data available at the time this SMP application was submitted. Whilst considered a reliable indicator of conditions to be expected within the SMP Application Area, it is likely that fault projections will have to be revised to some extent as further characteristics of the geology are confirmed during development through ongoing underground and hazard mapping. The mine layout and approval process will need to be able to readily adapt to such changes. The SMP process allows for changes in mine layout without the need for an SMP Variation where these changes are not major and impacts are unchanged (SMP Guidelines). Clarence Colliery intends to revisit the risk assessment should changes in mine layout be required and consult with the DRE on whether a variation is appropriate.

3.3 SEAM AND EXTRACTION DETAILS

Partial extraction within 900 Area will occur within the Katoomba Seam. Typically, Clarence Colliery has extracted the upper section of coal to a maximum height of 3 m where the seam height exceeds 3m. This is the case for both development and partial extraction. The primary reason for limiting extraction to 3m, is to provide a balance between coal quality, resource recovery and pillar stability. Experience has shown that pillar stability (and subsequent subsidence) is significantly improved as extraction height reduces. Seam height in the 900 Area is variable, ranging from 1.6m in the west of the area to a small (localised) area where the seam height extends to 4m. Ash content across the area is expected to vary between 16-20%. **Figure 7** presents the seam height and ash content across the 900 Area.

There is significant variation in the depth of cover over the proposed 900 Area ranging from 120m (within the first workings zone) up to 320m (presented in **Figure 8)**. The variation in depth of cover is largely attributable to the topographical variation, particularly the incised drainage line associated with Bungleboori creek (**Figure 9**). The panel layout, pillar dimensions and extraction details are largely influenced by the depth of cover and extraction height. **Table 6** presents the upper design rules regarding seam height and depth of cover for each of the panel layouts.

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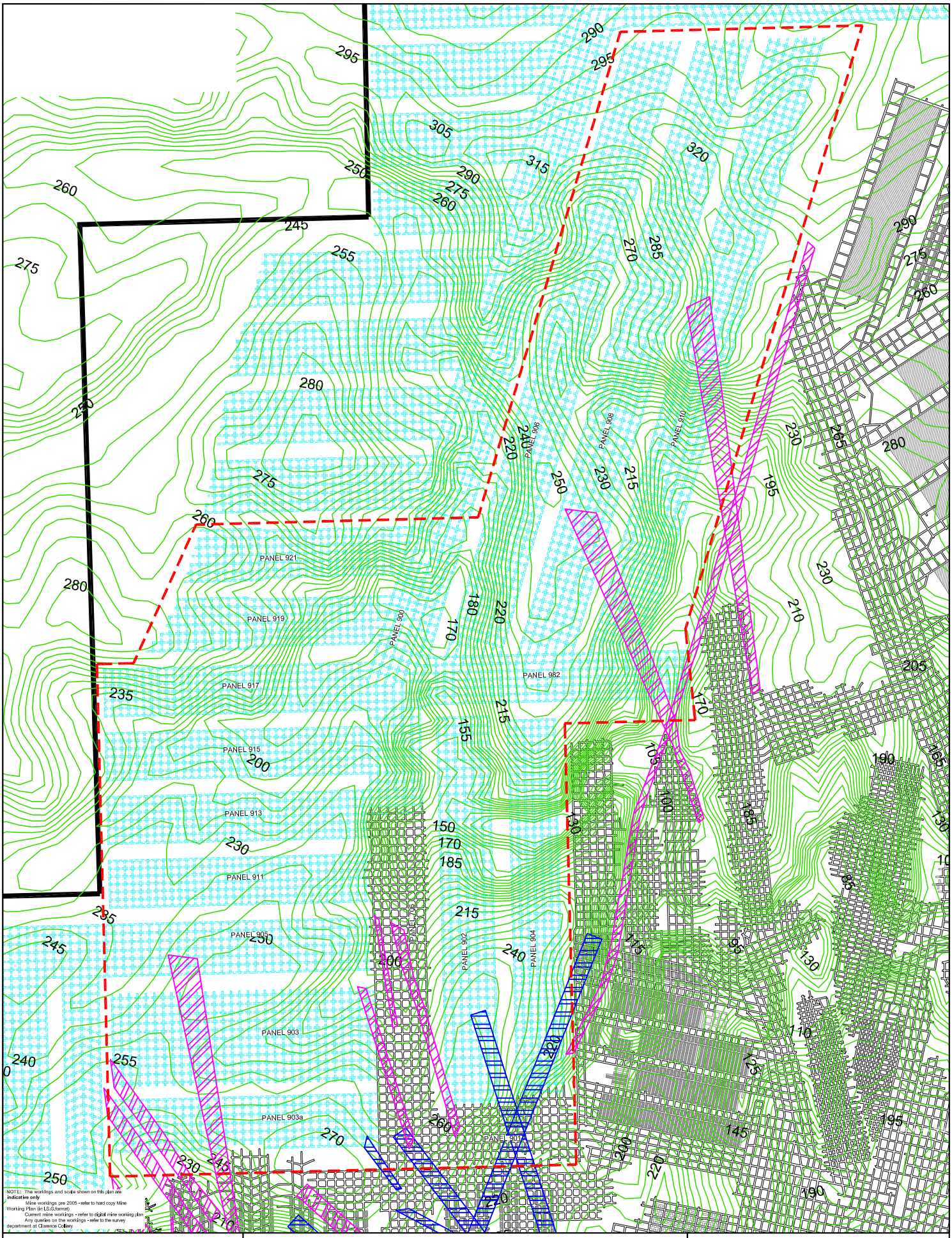


COLLIERY HOLDING BOUNDARY

WORKINGS / PROPOSED WORKINGS

PROPOSED 900 AREA

240 DEPTH OF COVER ISOPACHS

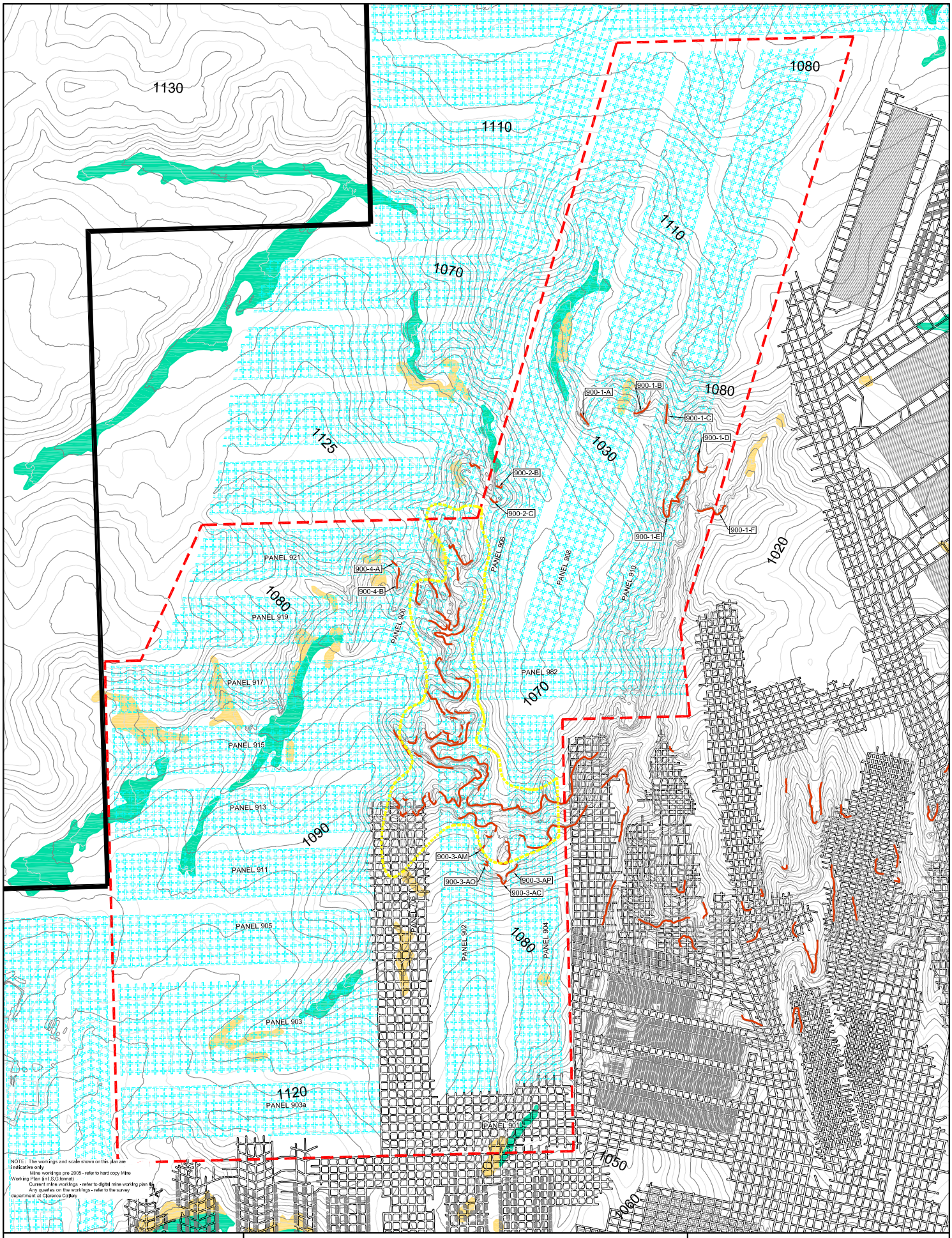
ROOF STRUCTURE ZONE

MODERATE ROOF ZONE

DEPTH OF COVER ISOPACHS OVER 900 AREA

Centennial Coal
Clarence

Figure 8.



SURFACE CONTOURS, CLIFFLINES AND SWAMPS OVER 900 AREA

Centennial Coal
Clarence

Figure 9.

Table 6 900 Area Pillar Design Rules

Panel Number	Panel Layout	In Panel Depth of Cover	In Panel Seam Height
903	Eleven Heading Layout	Not restricted over the 900 Area	3.0m
903a, 902, Part 921, Part 919, 906, 908, 910	Seven Heading (33m centre)	Not restricted over the 900 Area	3.0m
911, 913, 915, 917, 919, 921	Seven Heading (30m centre)	Not restricted over the 900 Area	2.6m
904, 982	Seven Heading (30m centre)	Maximum 240m	3.0m
706, 900, 905	First workings / Mains Development	Not restricted over the 900 Area	3.0m

The influence of extraction height on the mechanics of pillar strength (and stability) is widely known. Previous work for Clarence (SCT, 1993) suggests that rib behaviour (and pillar stability) improves markedly at driveage heights of below 3m. Rib stability at Clarence can be correlated to overall pillar stability. Strata Engineering (SEA, 2011) carried out a geotechnical review of rib stability at Clarence noting that pillar deformation can be related to its height by considering the rib to be an end-loaded column subject to Euler buckling. This suggests that the propensity for buckling (and the associated likelihood of instability) is a function of the square of rib height. SEA (2011), further noted that:

i) Stability improves by 15% (from 100 to 115%) as height reduces from 3 to 2.8m, the former being the typical height in recently mined panels, both on driveage and extraction and the latter being the best case height for currently planned panels.

ii) Stability reduces by 27% (from 100 to 73%) as height increases from 3 to 3.5m, which was the typical final height until bottom coaling was stopped

These relative statistics are consistent with practical experience at the mine; rib behaviour is generally improved in areas of reduced height (i.e. <3m). Recent data collected from stress cell monitoring in the 707 panel (where mining height was 2.7m) demonstrated an improvement in pillar stability at lower mining heights (Golder, 2013d). The subsidence data collected over the 707 panel (with reduced mining height) also showed minimal amounts of subsidence (less than 20mm eight months after pillar extraction).

The method of extraction for each of the layouts proposed has been described in **Section 3.3**. Some general points relating to the details of the extraction listed below:

1. Lift depths in all cases shall not exceed 11 m and regardless of roadway size, the total void width opened up in any pillar is not planned to exceed 16.5 m. This is the current practice and has been very successful to date;

2. Local roof support in the extraction workings is to be provided by the primary roof support installed during development. Additional support as required by the pre-extraction review and weekly strata audits will be installed prior to extraction in a pillar and timber support will also be installed (where required) in the form of props as the extraction process proceeds;

3. Stooks will be left at the inbye and outbye end of a pillar being partially extracted to provide localised support to the adjacent intersection and anywhere else in the extraction cycle deemed necessary by management;

4. In regard to the eleven heading layout (for 903 panel) Larger stooks (minimum of 12m) will be left along alternate belt roads to provide local support when lifting off both sides of the belt road (along the cut through); and

5. Prior to the commencement of extraction, a geotechnical audit of the developed panel is undertaken to design and confirm lifts to be taken based on the in panel geological conditions. This is completed through the Clause 88 (Coal Mine Health and Safety Regulations 2006) process. It is usual that some lifts are retained.

3.4 SCHEDULE OF PROPOSED MINING

It is assumed that the mine will continue to operate seven days per week. The production shifts are mainly, but not exclusively, planned on three 8.5 hour shifts during the week.

First workings in the 900 area commenced in November 2012 and extraction will commence during the first quarter of 2014. The 901 Panel has been developed to access the 902 and 904 Panels. The 706 panel is currently being developed to access the northern area of the mining lease within the 900 Area. The 905 Panel will be developed to access the panels in the 700W Area. The 901 panel may be extracted sometime in the future, however this activity will be the subject of an SMP variation prior to extraction.

Extraction within the 900 Area is scheduled to commence during the first quarter of 2014 **Table 7** presents the approximate year that each panel is scheduled to be extracted. This schedule is subject to change depending on equipment availability, conditions in other extraction panels and development rates within panels. Panels currently scheduled for 2021 onwards, may become “spare” panels earlier and it is possible that they could be extracted earlier. This is a reflection of the inherent flexibility of the bord and pillar / partial extraction mining process

Table 7 Approximate Extraction Schedule

Year Extracted	Panel Number
2014	903a, 902,904
2015	903, 903a
2016	903, 910
2017	902,910
2018	908
2019	908
2020	906
2021	906, 911, 982
2022	913, 915, 917
2023	917, 918, 921,

3.5 IMPACT ON RESOURCE RECOVERY OF REMAINING MINING LEASES

The 900 Area mine plan has been designed to take advantage of the existing seam height, equipment availability and the resource available from the early termination of the 714 and

716 panels. With the exception of the north westerly extent of the 900 Area, the adjoining mining lease areas of the 900 Area are held by Clarence Colliery and partial pillar extraction in the 900 Area does not impact on resource recovery in these areas. The westerly extent of the 900 Area forms the boundary between the Clarence Colliery holding and Springvale's Exploration Licence (**EL**) 6974.

3.6 ESTIMATED RECOVERY

Resource recovery in the 900 Area is restricted by a first workings zone of approximately 44 hectares associated with Bungleboori Creek (**Figure 4**). The first workings zone forms part of Clarence's development consent (DA 504-00) as presented in **Appendix 1**.

Resource recovery within the 900 Area SMP Application Area will also be impacted by the extent of retained lifts which will be left depending on geological conditions. For example, if the stability of a pillar is compromised by poor ground conditions or faulting, either a proportion of the pillar or the whole pillar may not be extracted. This is primarily to manage stability on extraction providing local support to extraction crews. The extent of extraction is solely dependent on in panel geotechnical conditions identified following detailed geological mapping and geotechnical assessment after panels have been developed. Total theoretical (or best case) recovery is approximately 50%.

An estimated 10,406,090 tonnes of coal is available for recovery in the proposed 900 area. A summary of the estimated tonnages from each panel is presented in **Table 8**.

Table 8 Estimated Tonnage Recovery

Panel	Heading Layout	Estimated Tonnage (t)	
		Development	Extraction
900 Area			
901	Mains development	143,877	106,205
903	Eleven heading layout	440,641	391,055
904	7 heading shuttle car	448,876	267,524
903a	7 heading shuttle car	275,621	216,525
902	7 heading shuttle car	443,124	233,524
905	7 heading shuttle car	460,195	356,128
911	7 heading shuttle car	247,333	189,600
913	7 heading shuttle car	230,602	176,710
915	7 heading shuttle car	210,126	160,972
917	7 heading shuttle car	190,019	145,390
919	7 heading shuttle car	136,490	95,079
921	7 heading shuttle car	149,479	108,077
982	7 heading shuttle car	266,628	165,271
706	Mains development	548,135	0
900	Mains development	121,410	0
906	7 heading shuttle car	623,381	428,019
908	7 heading shuttle car	672,392	518,110
910	7 heading shuttle car	695,975	543,597

3.7 POSSIBLE EFFECT ON OTHER SEAMS

As the Katoomba Seam is the upper-most seam in the application area, no other seams below will be sterilised by partial extraction within the Katoomba Seam. The only other economically mineable seam in the general vicinity is the Lithgow Seam, which was accessed through the former Blue Mountains Colliery. Blue Mountains Colliery ceased production in December 1999 with all surface infrastructure since removed and rehabilitation works completed in 2000 and 2001. It is anticipated that the Lithgow Seam under the application area is approximately 1 m (or less) thick and not economically recoverable at this time. All other coal seams in the application area are either too thin and/ or too high in ash to be recoverable at this time.

3.8 FURTHER PLANS FOR MINING IN OTHER SEAMS

As discussed above, the only other seam of potential interest in the general vicinity is the Lithgow Seam. This seam is located approximately 110 m below the Katoomba Seam, but is currently understood to be split, of poor quality, and of no economic interest below the SMP Application Area. There are currently no future plans for mining other seams in the application area.

4 SITE CONDITIONS OF THE APPLICATION AREA

4.1 GENERAL SURFACE TOPOGRAPHY

The Newnes Plateau is formed on the Banks Wall Sandstone and is the largest plateau in the Blue Mountains and one of the highest in the Sydney Basin. The surface of the land within (and immediately adjacent to) the SMP Application Area consists of rugged cliff lines (up to 50 m in height), pagodas, gentle plateaus, watercourses and swamps. The area is predominately covered with native vegetation, including communities defined in the *Vegetation of the Western Blue Mountains including the Capertee, Coxs, Jenolan and Gumang Areas* (DEC, 2006) as Blue Mountains Sandstone Plateau Forest, Montane Gully Forest, Newnes Plateau Woodland, Newnes Plateau Shrub Swamp, Newnes Plateau Hanging Swamp, Montane Heath and Pagoda Rock Complex (see **Section 8** for more detail).

Over the 900 Area, the land surface varies greatly from an RL 920mAHD in the Bungleboori Creek drainage line to over RL 1130mAHD along Waratah Ridge Road. RPS (2013a) described the topography of the 900 Area as being characterised by localised steep slopes, rock outcrop and the effects of erosion by water action and shallow soils. Plateau areas are flat topped with the side slopes ranging from gently inclined to moderately inclined. Local rock outcrop commonly occurs as small benches, cliffs and low broken scarps. Swampy drainage depressions are common.

There are a number of cliff lines and pagodas over the 900 area, the majority of which are located in the first workings zone. **Plates 4 – 6** present some of the rock features across the 900 Area with 4 and 6 showing the heavily dissected nature of the area particularly associated with Bungleboori Creek (within the first workings zone). The location of cliff lines is presented in **Figure 9**.

Plate 4 – View of Bungleboori Creek looking north

Plate 5 – View from a pagoda in the northern section of the 900 Area

Plate 6 – Cliff Line over Bungleboori Creek

4.2 GENERAL OVERBURDEN STRATIGRAPHY

The SMP Application Area lies in the Western Coalfield within the Sydney Basin. The overburden stratigraphy is of the late Permian and Triassic periods and largely consists of massive Triassic sandstones (**Table 9**). The strata associated with the coal seams were laid down during the Permian period and comprise the Illawarra Coal Measures.

Table 9 Generalised Stratigraphy of the Western Coalfield

Period	Stratigraphy			Lithology	Height of base above seam roof (m)	Hydro-geology
	Group	Subgroup	Formation			
Tertiary				Basalt		
Triassic	Wiannamatta Group		Ashfield Shale	Shale, Mudstone		
			Hawkesbury Sandstone	Sandstone		
	Narrabeen Group	Grose Subgroup	Burralow Sandstone	Sandstone Shale	~200m	Perched and semi-confined aquifers
			Banks Wall Sandstone	Medium-coarse sandstone	100 - 120m	Unconfirmed and semi-confined aquifers, including Clarence Aquifer
			Mount York Claystone	Claystone, mudstone	80 - 100 m	Major aquiclude
			Burro-Moko Head Sandstone	Sandstone	~30 m	Possible minor aquifer
			Caley Formation	Siltstone. Sandstone, mudstone	0 m	
Permian Late	Illawarra Coal Measures	Wallerawang Subgroup	Katoomba Seam	Coal		Minor confined aquifers
			Farmers Creek Formation	Coal, sandstone, claystone, siliceous claystone		

Aurecon (2013)

In the 900 area, Narrabeen Group rocks near the surface belong to the Grose Sub-group, and include the Banks Wall Sandstone, the uppermost part of which may be deeply weathered and very friable. The sandstone is underlain by the Mt York Claystone, a thin, fine-grained unit that limits vertical infiltration of groundwater from the overlying strata.

4.3 LOCATION OF THE PROPOSED MINE WORKINGS

There are no existing overlying or underlying underground workings within the SMP Application Area that may interact with the proposed partial pillar extraction workings, as defined by Section 6.5 of the SMP guidelines (DPI 2003).

4.4 GENERAL LITHOLOGICAL AND GEOTECHNICAL CHARACTERISTICS OF THE OVERBURDEN

The overburden lithology at Clarence Colliery is characterised by competent interbedded sandstones, shales and fine to medium grained massive sandstones tending to basal conglomerates. The interbedded sandstones are of typical UCS of 60-70 MPa (14-15 Gpa Young's Modulus) while the massive units are generally stiffer (17-18 Gpa) though of lower UCS (around 50 MPa).

Strength testing was undertaken at selected horizons in borehole SPR 26, located within the neighbouring Springvale Mine lease. This is considered to be representative of the regional stratigraphy which includes the Clarence Colliery mining area (see **Table 10**).

Table 10 Regional Geotechnical Properties as shown in SPR 26

Formation	Depth of Sample from Surface (m)	UCS (MPa)	Young's Modulus (Gpa)	Brazil Tensile Strength (MPa)
Banks Wall Sandstone	68.00 – 68.55	16.3	8.5	2.06
Banks Wall Sandstone	100.81 – 101.23	24	9.5*	1.47
Banks Wall Sandstone	132.41 – 132.97	30	11.9*	1.50
Mount York Claystone	152.40 – 152.77	38	8.2*	3.56
Burro-Moko Head Sandstone	166.88 – 167.59	39.4	5	2.66
Burro-Moko Head Sandstone	192.47 – 192.90	48.5	14.9	4.29
Caley Formation	234.05 – 234.37	46*	8.4*	5.31
Caley Formation**	251.16 – 252.71	51.6	8.4	4.77***

* Values calculated from triaxial strength tests
** This formation directly overlies the Katoomba seam
*** Average of finer grained part of sample, coarser part was 22.06 MPa and 10.85 MPa.
Golder Associates (August 2002)

4.5 GENERAL LITHOLOGICAL AND GEOTECHNICAL CHARACTERISTICS OF THE ROOF AND FLOOR

The Katoomba Seam roof and floor material is highly competent and provides excellent support to the pillars at Clarence Colliery (**Table 11**). This summary is representative of the characteristics within the SMP Application Area.

Table 11 Typical Roof and Floor Characteristics, Katoomba Seam, Clarence Colliery

Unit	Lithology	UCS (MPa)	Young's Modulus (Gpa)	Bearing Capacity (MPa)
Katoomba Seam Roof	Bedded sandstone and siltstone	Range 16 - 85 typical and modelled at 64	Range 7.4 - 28.2 typical and modelled at 17.8	182
Katoomba Seam Floor	Laminated, fine grained sandstone and shale	Range 53 - 142 typical and modelled at 53	Range 9.3 – 26.7 typical and modelled at 14.9	151

Golder (2013)

4.6 SPECIFIC GEOLOGICAL CONDITIONS

This assessment is based on Clarence Colliery's geological model which contains mapping data and inferred geological structure (see also **Figure 8**) within the 900 Area. Historical data from geological reports and boreholes was also utilised.

4.6.1 LITHOLOGY

The lithology from the surface consists of the Banks Wall Sandstone of a quartzose Sandstone with minor shales, the distinctive Mount York Claystone of red to brown claystone, the Burro-Moko Head Sandstone of a quartzose Sandstone with minor shales and the variable Caley Formation of interbedded sandstones, and claystones and mudstones. Below the floor of the Katoomba Seam are the sandstones and shales with minor claystone and mudstones of the Farmers Creek Formation.

4.6.2 SEAM THICKNESS

Seam thickness (or seam height) has been previously discussed in **Section 3.3** and presented in **Figure 7**. To reiterate, seam height for the 900 area ranges from 4.0m to 1.6m. The area of seam heights greater than 3.2m is restricted to the 902, 904 and 910 panels. These panels are located on the eastern side of the 900 Area. The seam gradually thins to the west where it is at its shallowest at the far north western corner of the 900 Area.

4.6.3 SEAM QUALITY

Current mining at Clarence Colliery is producing a 15-16% ROM ash product (after processing through the Coal Handling and Preparation Plant). Generally the full seam raw ash in the 900 Area is projected to be 16-20%, deteriorating to the western margins of the 900 Area (see also **Figure 7**).

4.6.4 DEPTH OF COVER

Depth of cover has been previously discussed in **Section 3.3** and presented in **Figure 8**. To reiterate, depth of cover varies widely from around 130m (above Bungleboori Creek) to around 320m in the northern portion of the 900 Area. The first workings zone roughly follows the 200-210m depth of cover contour on the eastern side of the Bungleboori Creek and roughly follows the 170-180m depth of cover contour on the southern and western side of the Bungleboori Creek.

4.6.5 FAULTING

There are two dominant joint directions present at Clarence Colliery, orientated North-northwest and East-northeast.

In the western coalfields surface lineament zones (valleys, steep sided cliffs) can be identified on aerial photos. These surface lineaments, in some cases, can show a strong correlation to seam level faults and basement structures. The lineaments associated with zones of poor roof conditions are generally recognisable because their orientation differs significantly from the regional joint trends.

Inferred structure zones are presented on **Figure 8**. It is important to note that these structure zones have been identified based on the projection of conditions already experienced in the underground workings and are updated regularly ahead of mining.

Localised areas of poor geological conditions are expected on the far inbye ends of the 903 and 903a panels. These are expected to be similar to those conditions encountered in the 714 and 716 Panels responsible for their early termination. However, as compared to an FCT panel (which was the case for the 714 and 716 panels), the shuttle car panel has greater flexibility in navigating around poor structure. Therefore it is expected that these localised areas should not impact upon development and extraction of the 903 and 903a panels significantly and should not affect the resource recovery substantially. However, it is noted that coal will be retained in situ where there is a safety risk from geological structure to underground crews both on development and extraction.

5 STABILITY OF UNDERGROUND WORKINGS

Partial extraction mining at Clarence Colliery removes approximately 50% of the coal seam within partially extracted areas. The remaining coal provides support to the overlying strata, aquifers and surface features. It is worth noting that there are very few cases of collapse where extraction percentage is less than 50%.

Golder carried out assessments on the stability of partial extraction workings planned for the 900 area (**Appendix B**). The scope of the assessment included:

- Evaluation of the pillar stability of the panels under consideration (ie. Factors of safety, width to height ratio, etc);
- Evaluation of the potential loading influence of adjacent panels on these panels; and
- Estimation of the expected long term surface effects.

In relation to the stability of the underground workings within the 900 Area, two separate assessments and reports are provided. Golder (2013a) assesses the stability of the 7 heading layouts and Golder (2013b) assess the stability of the 11 heading layout. The information contained within this section has been summarised from the information provided by Golder which can be found in **Appendix B**.

5.1 PILLAR STABILITY METHODOLOGY

Factor of Safety and Width to Height Ratio

The assessment of pillar stability requires the determination of pillar load, strength and an appropriate Factor of Safety (**FoS**). The FoS is derived using the University of New South Wales (**UNSW**) formulae for pillar strength and the tributary area method that calculates load. The ratio of pillar strength and load (hence the FoS) can be directly related to probability of stability based on an empirical database of failed and intact pillars developed by the UNSW (Hill, 2005). The FoS concept is commonly applied when the potential for pillar collapse or failure is being analysed, as it can generally be related to the probability of failure occurring. A probability of stability of 99.9% is attained at a FoS of 1.63, and further increases in FoS have minimal effect, as the probability of stability curve approaches 100% asymptotically. From a risk management perspective, increasing the FoS beyond 1.63 can only reduce the failure probability by less than 0.1%. It is emphasised that the FoS can relate to the overall panel situation as well as that of individual pillars (SEA 2008b). Having said that, the geotechnical assessments (**Appendix B**) also calculate and present to FoS for spine pillars and remnant pillars.

In terms of the width to height ratio, width refers to the minimum width of a pillar and height refers to the extraction height associated with the mining activity. As the minimum width increases or as the mining height reduces, the width to height ratio increases (see also **Section3.3** regarding extraction height experience at Clarence). The role of increasing width to height ratio (w/h Ratio) in enhancing pillar stability has long been known. Back analysis of case histories from around the world has shown that width to height ratio exerts a major influence on coal pillar strength (Hill, 2005). At low ratios (that being below 3) overloaded pillars tend to fail in a brittle, uncontrolled fashion, whereas at higher ratios (that being greater than 4) the coal pillars demonstrate a more plastic deformation where displacement may take place as spall and roof to floor convergence, but the pillar core remains confined and tends to retain its load carrying capacity (Hill, 2005). Pillar width to height ratio, applied in conjunction with other design criteria, such as FoS, is a useful indicator of design reliability, utilising existing databases of experience. This is illustrated in **Figure 10.**

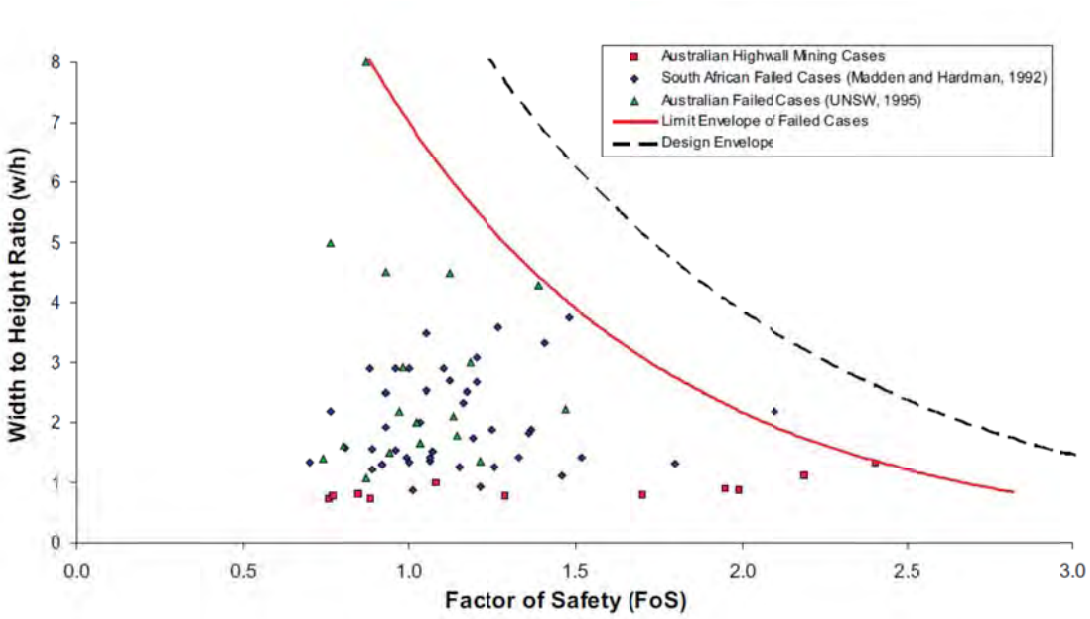


Figure 10 Database of Pillar Collapses – width to height ratio versus FoS (source: Hill, 2005)

Design Criteria Based on FoS and w/h Ratio

Coal pillar design criteria should reflect the specific requirements and nature of the workings (e.g. short-term production panel, as opposed to long-life pillars with surface protection constraints). The general approach adopted by Golder (formerly SEA (2008b)) can be summarised as follows:

1. Short-term production workings, with considerable local knowledge: design may be within the failed pillar database limit envelope, under controlled circumstances.

2. Short-term production workings (general): design on the basis of being beyond the failed pillar database limit envelope.

3. Key underground workings, for example main heading, with medium to long-term serviceability / stability requirements: design on the basis of the limit envelope plus 20% (i.e. the outer database curve).

4. Underground workings beneath critical, highly sensitive surface structures and / or features (e.g. key infrastructure, such as railways / waterways): design on the basis of a minimum w/h ratio of five (i.e. squat pillars) with a minimum nominal FoS of 2.11 (i.e. a probability of failure of $\leq$ 1 in a million).

The partial extraction situation at Clarence Colliery is analogous to “key underground workings” (i.e. Category 3 above); long-term stability is required for surface protection, although in this case the surface features are not in the highest category of “critical infrastructure”.

The above criteria are only guidelines and it remains important that specific attention be given to the geotechnical / mining environment, including historical experience of ground behaviour in the seam under consideration.

Pillar Design Issues for Subsidence Control

To control subsidence above coal pillar workings, SEA (2008b) suggests that long-term pillar design should take into account the following possible issues and subsidence mechanisms:

- Pillar instability (e.g. pillar strength and load);
- Elastic pillar compression;
- Immediate pillar floor and roof compression and the potential for bearing failure;
- Overburden strata spanning capability; and
- Panel dimensions (e.g. panel span, depth, etc.).

The final mining layout is designed to be long-term stable and to control surface subsidence to <100±25 mm.

Methodology Used for Assessment of Stability and Subsidence

1. Determine appropriate factor of safety for the workings proposed;
2. Determine maximum load case – in this case tributary area loading was considered to be the maximum load case;
3. Determine appropriate barrier and pillar sizes for stability at maximum loading;
4. Analytical, empirical and/ or numerical modelling of the systems with varying degrees of pillar softening to determine the effects on barriers and in panel pillars;
5. Analytical, empirical and/ or numerical modelling of the systems to determine likely levels of subsidence. A comparison is also done of the existing system (ie. historical performance) to provide a calibration of the modelling;
6. Compare the results with actual levels of subsidence measured from current partial extraction methods. Performance measurement is used to validate the existing models; and
7. Compare actual pillar, roof and floor performance to assumptions made during the design process to validate and calibrate the existing models.

5.2 RESULTS OF PILLAR STABILITY ANAYLSIS

Based on the methodologies described in **Section 5.1**, **Table 12** summarises the results of the analysis of pillar stability (relating to Panel layout and depth of cover) of the overall system as undertaken by Golder for the 7 heading layout. The loading described is for the maximum case, which was assessed to be tributary area loading. The resistance offered by the pillar system has been calculated from the strength of the individual pillar components. It is noted that **Table 12** refers to Factors of Safety (**FoS**) for the panel system after the pillar has been partially extracted and specifically the 7 heading layout.

Table 12 Overall System Stability (Post Extraction) of each Layout

Layout	Depth (m)	Extraction Height (m)	Total Pillar Load Carrying Capacity	Total Overburden Load	System (Panel) Factor of Safety (FoS)
			(MN per 30m)	(MN per 30m)	
7 Heading Shuttle Car Panel (30 m)	180	2.6	151,742	32,778	4.6
	220	2.6		40,062	3.8
	240	2.6		43,704	3.5
	265	2.6		48,256	3.1
7 Heading Shuttle Car Panel (30 m)	120	3.0	115,077	21,852	5.3
	160	3.0		29,136	3.9
	200	3.0		36,420	3.2
	240	3.0		43,704	2.6
Layout	**Depth (m)**	**Extraction Height (m)**	**(MN per 33m)**	**(MN per 33m)**	**FoS**
7 Heading Shuttle Car Panel (33 m)	160	3.0	144,082	34,380	4.2
	200	3.0		42,975	3.4
	240	3.0		51,570	2.8
	280	3.0		60,165	2.4
	320	3.0		68,760	2.1
7 Heading Shuttle Car Panel (33 m)	180	2.8	164,388	38,678	4.3
	200	2.8		43,975	3.8
	240	2.8		51,570	3.2
	280	2.8		60,165	2.7
	310	2.8		66,611	2.5

For all seven heading layout types, the pillar/panel system FoS ranges from 2.1 to 5.3 following lifting (post extraction). In looking at each pillar function over the varying depths of cover and seam heights, the following is noted:

- 30m centre / 2.6m seam height :
  - ❖ Barrier Pillar : FoS ranges 5.3 – 7.8. Width to Height ratio 15.4
  - ❖ Central Spine Pillar : FoS 1.8 – 2.6. Width to Height ratio 9.4
  - ❖ Remnant Pillar : FoS 1.8-2.6. Width to Height ratio 5.2

- 30m centre / 3.0m seam height :
  - ❖ Barrier Pillar : FoS ranges 4.3 – 8.3. Width to Height ratio 13.3
  - ❖ Central Spine Pillar : FoS 1.5 – 3.1. Width to Height ratio 8.2
  - ❖ Remnant Pillar : FoS 1.7- 3.5. Width to Height ratio 4.5

- 33m centre / 3.0m seam height :
  - ❖ Barrier Pillar : FoS ranges 3.2 – 6.3. Width to Height ratio 13.3

- ❖ Central Spine Pillar : FoS 1.4 – 2.8. Width to Height ratio 9.2
- ❖ Remnant Pillar : FoS 1.6 – 3.3. Width to Height ratio 5.5

- 33m centre / 2.8m seam height :
  - ❖ Barrier Pillar : FoS ranges 3.9 – 6.6. Width to Height ratio 14.3
  - ❖ Central Spine Pillar : FoS 1.6 – 2.8. Width to Height ratio 9.8
  - ❖ Remnant Pillar : FoS 1.8- 3.1. Width to Height ratio 5.9

These results indicate that the likelihood of failure following extraction is considered practically impossible.

Based on the assessment, Golder (2013a) conclude:

> *Having considered the above outcomes for the overall system, as well as the results for the various pillar elements, the likelihood of failure following extraction is considered practically impossible.*

The stability assessment for the 11 heading layout does not consider the panel system, rather assesses each pillar (both remnant and inter panel pillars) based on tributary area loading. This is considered to be a conservative approach as it assumes that all the load is directly transferred to the retained pillars and does not consider any load transfer across the roof to the barrier pillars. As discussed in **Section 3.1**, the roof above the Katoomba seam has excellent spanning capability and so it is likely that load would be transferred across to the barrier pillars. Nevertheless, the result of the stability assessment for the 11 heading layout is presented in **Table 13**.

Table 13 Pillar Stability (Post Extraction) for the 11 heading layout

Pillar Type	Depth (m) [Effective Depth m]	Extraction Height (m)	W/H Ratio	Pillar Strength (MPa)	Stress (MPa)	Factor of Safety (FoS)
Barrier	210	2.9	13.8	64.7	12.5	5.2
	225	2.9			13.4	4.8
	240	2.9			14.3	4.5
	255	2.9			15.2	4.3
Intra-panel Spine	210	2.9	9.5	25.4	13.2	1.9
	225	2.9			14.2	1.8
	240	2.9			15.1	1.7
	255	2.9			16.1	1.6
Remnant Pillar Stability	[61]	2.9	5.7	16.3	3.7	4.4
	[66]	2.9			3.9	4.1
	[70]	2.9			4.2	3.9
	[74]	2.9			4.5	3.6

[Effective Depth] – Post extraction "Effective Depth" based on the abutment angle model (SEA, 2005)

For the 11 heading layout, the pillar system FoS ranges from 1.6 to 5.2 following lifting (post extraction) across the varying depths of cover. Width to height ratios vary between 5.7 – 13.8

Golder (2013b) reported that for the eleven heading layout, the FoS combined with the width to height ratios, it is concluded that the various pillars in the system are considered adequate for the maintenance of long term stability. It was further noted that the FoS plot satisfactorily above the design envelope for long term pillar stability (see **Figure 10**).

The panel designs proposed for the 900 Area are considered to be long-term stable. Furthermore, the designs are regarded as highly conservative, given the range of cover depths involved in these cases.

The stability of all the various pillars in the system is considered adequate for the maintenance of long-term stability. For further details on the system elements refer to the various reports by Golder in **Appendix B**.

5.3 CONFIDENCE IN THE PILLAR STABILITY MODEL

The detailed design of the specific panel geometry has historically been prepared by Strata Engineering (Australia) Pty Ltd (**SEA**) (now Golders) using the same principles and the same calibrated model. To confirm the success of the design and predictive model(s), Golder was again commissioned to undertake a detailed review of all surface (subsidence data) and underground monitoring to verify performance to demonstrate confidence in the modelling and design process (the Golder (2013c) report attached in **Appendix B**). The previous review completed in 2011 (SEA 2011b) supported a previous SMP application, "Partial Extraction of Areas 700 West and 800", and it did not include the results from recent stress cell monitoring (pillar stability / compression) undertaken in the 704 and 707 panels and did not obviously include recent subsidence monitoring data since mid-2011. This recent data demonstrates the conformance of the pillar stability model to conditions experienced in panel (Golder 2013c).

The data from stress cell monitoring is used to measure changes in load within the pillar and therefore, pillar stability. The attached review (**Appendix B**) includes the outcome from the underground monitoring programs (including stress cells) as well as the additional subsidence monitoring (inclusive of that undertaken since 2011).

The purpose of the review is to demonstrate Clarence's confidence in the subsidence and pillar stability modelling process through actual performance. Furthermore the purpose of the review is to also demonstrate Clarence's confidence in using the established model(s) for the proposed designs for the 900 Area. The key notes from the Golder (2013c) review are provided below.

> *The use of complimentary analytical, empirical and numerical methodologies for subsidence estimation is regarded as good engineering practice, enabling a very high degree of confidence with regard to both short and long-term subsidence prediction, across the range of partial extraction geometries applied at Clarence.*
>
> *From the pillar and panel stability perspective, pillar deformation and stress monitoring exercises in both the 600 and 700 Areas have confirmed the long term, post-lifting stability of the pillar systems. In particular, the monitoring has demonstrated that (a) pillar deformation due to lifting is largely confined to the immediate rib, with the pillar core remaining intact (even for the "remnants") and (b) pillar loading and deformation are consistent with a coal strength that is higher than commonly adopted by the applied empirical models, such that actual Factors of Safety are higher than predicted.*
>
> *The key outcomes of this review are summarised as follows:*
> *i) The subsidence information is one element of an overall surface and underground monitoring data set that provides coherent evidence of the satisfactory long-term stability performance of the partial extraction system, with associated favourable surface subsidence outcomes.*
> *ii) Long-term subsidence is of a limited magnitude that would not be associated with any discernible surface damage and indeed none has been observed*

iii) Significant confidence is placed in the mechanics of the panel design methodology and future subsidence outcomes, particularly given the improved understanding of long-term underground flooding effects and the derivation of optimised layouts for the future 800 and 900 workings

Subsidence related impacts are prevented through the careful design of the panel which considers depth of cover, pillar geometry, seam height and pillar strength. The methodology for the pillar and panel design is described in SEA (2005) (**Appendix B**). The primary design criteria for the panel are long term pillar stability and subsidence levels of no more than 100 mm. This is all controlled through pillar design and subsequent stability.

In terms of the 900 Area, long term panel stability and indeed pillar strength will be further enhanced by:

- a **reduction in mining height** (see **Figure 7**); and
- a **reduced depth of cover** (**Figure 8**).

Clarence considers that the 900 Area mine plan incorporates acceptable panel geometries for implementation based on:

- The conservative panel geometry (which has been widely employed at Clarence Colliery over the last 13 years);
- The confidence in the model used to carry out the design;
- Historic performance of the mining system used by Clarence Colliery and verified by many years of data;
- The combination of FoS and width to height ratios in comparison to the database of failed and unfailed cases (**Figure 10**); and
- The width to height ratios of the barrier, spine pillars and intra panel pillars (ranging between 8 - 15), leads to the conclusion that the stability of the various spine pillars, barrier pillars and intra panel pillars in the system are considered adequate for the maintenance of long-term stability.

6 SUBSIDENCE PREDICTION

The partial extraction mining method adopted by Clarence Colliery results in a maximum predicted subsidence of 100 mm with low tilts and strains, virtually immeasurable valley closure, minimal (if any) upsidence and no surface cracking. The primary objective pertaining to surface subsidence is to ensure that subsidence is limited to a value well within that considered to be characteristic of 'elastic' overburden behaviour (i.e. no caving to surface), which is defined as 100±25 mm (SEA, 2005). This subsidence impact threshold has been accepted within previous SMPs for Clarence, and is conditioned within Development Consent DA 504.00 Schedule 3, which states that:

> *'The Applicant shall ensure that surface subsidence generated by the development does not exceed the criteria listed in Table 1 (First Workings – 20mm subsidence, 1.0mm/m tilt, 1.0mm/m horizontal strain. Partial Extraction – 100mm subsidence, 3.0mm/m tilt, 2.0mm/m horizontal strain.'*

Golder carried out an assessment on the stability of partial extraction workings for the 900 area, and the information contained within this section below has been summarised from the information provided in the Golder documents contained in **Appendix B**.

6.1 SUBSIDENCE PREDICTION METHODOLOGY

In relation to surface subsidence, the primary objective is to ensure that subsidence is limited to a value well within that considered to be characteristic of 'elastic' overburden behaviour (i.e. no caving to surface) defined as 100±25 mm (SEA, 2005). As indicated in **Section 5**, the layouts are expected to remain long-term stable. Accordingly, it is considered acceptable to assume that only elastic convergence will take place as a result of partial pillar extraction within the SMP area. Subsidence prediction has been made using two methodologies, namely analytical methods and empirical methods.

The analytical methodology used to estimate the expected surface subsidence is based on the geomechanical properties of the strata and estimates of the average stress change using the elastic theory. The predicted subsidence consists of three components, namely pillar, roof and floor compression. The equations used to determine these three components can be found in Golder (2013a and 2013b) in **Appendix B**. Using the analytical methodology described, both the expected (typical) and worst case (based on the lower bound moduli values) subsidence estimates above the panel after lifting have been determined across the depth range and extraction height.

The empirical methodology back analyses subsidence data from site, focussing on the relationship between subsidence and panel geometry. The main emphasis is on spine pillar or intra-panel pillar design, which is regarded as key to the performance of the overall system. On a panel by panel basis, actual subsidence measured above spine pillars (current performance) has been compared to panel and spine pillar geometry; the relationships identified from the resulting database have aided the subsidence prediction. The key empirical relationships determined from this database are described and presented in Golder (2013a and 2013b) provided in **Appendix B**. The analysis is based on 13 years of data across 11 subsidence monitoring lines.

Clarence considers that the application of two different methods of subsidence estimation is considered to be good engineering practice, noting that the outcomes are similar.

6.2 RESULTS OF SUBSIDENCE PREDICTION

A summary of the results of the estimated expected and "worst case" subsidence above the panels after lifting for the various panel layouts at differing depths of cover is presented in **Table 14** and **Table 15**. Expected subsidence has been determined using the calibrated subsidence model. Following a detailed analysis of the subsidence data collected over the last thirteen years (including data over areas that have been flooded), it is now possible to predict "worst case" subsidence in consideration of the effects of flooding. To this end, estimated subsidence, in the case of "not flooded" or dry panels, post extraction is presented in **Table 14. Table 15** presents worst case subsidence estimates post flooding (assuming the area will be flooded over the long term) in consideration of historic subsidence data post flooding.

Whilst **Tables 14** and **15** present the outcomes of the estimations, the overall subsidence performance criteria for all partial extraction mining undertaken at Clarence is 100mm (vertical subsidence), 3 mm/m tilt and 2 mm/m strain. The TARP is based on these performance criteria.

Golder (2013c) noted that post flooding subsidence results are higher than pre-flooding subsidence reflecting the weakening effect on the strata from saturation. Ongoing monitoring of older areas post flooding are showing the establishment of a normal limit or equilibrium. This agrees with historical research which has shown that saturation can reduce the strength of rocks by 50%. To this end, given the influence of flooding (which could occur over the long term) subsidence estimations include an assessment of the impact of flooding on subsidence magnitudes.

Subsidence estimates from the analytical methodology are presented in the form of calculated compression of the pillar, roof and floor. These calculations take into account geotechnical data from strength testing. Subsidence estimates from the empirical methodology (presented in italics) are derived from a site specific database, and therefore calibrated to historic performance.

Table 14 Analytical Subsidence Estimates for Proposed Heading Layouts

Heading	Maximum Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Average Stress Change (MPa)	Analytical				*Empirical*
					Compression (mm)				
					Pillar	Floor	Roof	Total	*Total*
Shuttle car Panel 7 Heading (30m centre) 2.6m Seam	180	4.5	9.0	4.5	3	7	6	**16**	***26***
	220	5.5	11.0	5.5	3	9	8	**20**	***28***
	240	6.0	12.0	6.0	3	10	8	**21**	***29***
	265	6.6	13.2	6.6	4	11	9	**24**	***29***
Shuttle car Panel 7 Heading (30m centre) 3.0m Seam	120	3.0	6.0	3.0	2	5	4	**11**	***23***
	160	4.0	8.0	4.0	3	7	5	**15**	***25***
	200	5.0	10.0	5.0	3	8	7	**18**	***27***
	240	6.0	12.0	6.0	4	10	8	**22**	***29***
Shuttle car Panel 7 Heading (33m centre) 3.0m Seam	160	4.0	7.5	3.5	2	7	5	**14**	***25***
	200	5.0	9.4	4.4	3	8	7	**18**	***27***
	240	6.0	11.3	5.3	3	10	8	**21**	***28***
	280	7.0	13.2	6.2	4	11	10	**25**	***31***
	320	8.0	15.1	7.1	5	13	11	**29**	***32***
Shuttle car Panel 7 Heading (33m centre) 2.8m Seam	180	4.5	8.5	4.0	2	7	6	**16**	***26***
	200	5.0	9.4	4.4	3	8	7	**18**	***27***
	240	6.0	11.3	5.3	3	10	8	**21**	***28***
	280	7.0	13.2	6.2	4	11	10	**25**	***28***
	310	7.7	14.6	6.9	4	13	11	**27**	***30***
Shuttle car Panel 11 Heading (33m centre)	210	5.2	13.2	8.0	12	15	5	**32**	***25***
	255	6.4	16.1	9.7	15	18	6	**39**	***31***

Subsidence estimates for all 7 heading layout panels in the 900 area subjected to dry (non-flooded conditions) are well within the 100mm performance criteria. The empirical results generally agree with the analytical results particularly at higher depths of cover where subsidence is generally higher due to the increased load on pillars associated with additional overburden to support.

Table 15 also presents the subsidence estimates in the case of the longer term “flooded” or wet panels post extraction. This is considered to be the worst case long term subsidence predictions under the influence of flooding. Again, an analytical and empirical (using site specific data) is used to determine the estimates.

Table 15 Worst Case Subsidence Estimates for Proposed Heading Layouts

Heading	Max. Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Average Stress Change (MPa)	Analytical				*Empirical*
					Compression (mm)				
					Roof	Floor	Pillar	Total	*Total*
Shuttle car Panel 7 Heading (30m centre) 2.6m Seam	180	4.5	9.0	4.5	15	12	2	**29**	***36***
	220	4.5	9.0	4.5	18	14	3	**36**	***44***
	240	5.5	11.0	5.5	20	16	3	**39**	***47***
	266	6.6	13.2	6.6	22	17	4	**43**	***47***
Shuttle car Panel 7 Heading (30m centre) 3.0m Seam	120	3.0	6.0	3.0	10	8	2	**20**	***22***
	160	4.0	8.0	4.0	13	10	3	**26**	***31***
	200	5.0	10.0	5.0	17	13	3	**33**	***46***
	240	6.0	12.0	6.0	20	16	34	**39**	***49***
Shuttle car Panel 7 Heading (33m centre) 3.0m Seam	160	4.0	7.5	3.5	13	11	2	**26**	***30***
	200	5.0	9.4	4.4	16	13	3	**32**	***39***
	240	6.0	11.3	5.3	20	16	3	**39**	***47***
	280	7.0	13.2	6.2	23	18	4	**45**	***55***
	320	8.0	15.1	7.1	26	21	5	**52**	***63***
Shuttle car Panel 7 Heading (33m centre) 2.8m Seam	180	4.5	8.5	4.0	15	12	2	**29**	***34***
	200	5.0	9.4	4.4	16	13	3	**32**	***39***
	240	6.0	11.3	5.3	20	16	3	**39**	***47***
	280	7.0	13.2	6.2	23	18	4	**45**	***51***
	310	7.7	14.6	6.9	26	20	4	**50**	***53***
Shuttle car Panel 11 Heading (33m centre)	210	5.2	13.2	8.0	30	24	5	**58**	***48***
	255	6.4	16.1	9.7	36	29	6	**71**	***60***

Long term post flooding subsidence estimates for all panels in the 900 Area are well within the 100mm predicted performance criteria. The empirical estimates generally agree with the analytical results.

Clarence Colliery's long term, post flooding maximum subsidence is not predicted to exceed 100 mm (as stipulated within other SMP applications and approvals). The results indicate that the expected long-term subsidence from extracting the proposed mine plan in "dry-panels" ranges from 16-39 mm for these panels. As the defined limit of measurable subsidence is 20 mm (DPI, 2003), the expected subsidence due to the partial extraction in these panels using the proposed mining layouts is likely to be almost negligible. The

subsidence estimates related to the maximum depth post flooding (i.e. worst case scenario) range from 29-71 mm, which is still regarded as minor, and below the 100 mm subsidence limit.

No appreciable surface impacts are expected to result from 100mm of subsidence.

6.3 ESTIMATION OF THE RELIABILITY OF SUBSIDENCE PREDICTIONS

The subsidence data from previously mined areas, in combination with the other underground and surface monitoring data sets, constitutes a highly consistent body of information that confirms the favourable and generally highly predictable performance of the partial extraction system, increasing confidence with regard to future stability and related subsidence outcomes.

Strata Engineering Australia undertook a *Review of Subsidence Information from Recent Partial Extraction Areas* (SEA 2011a) in 2011. This study was updated with data collected from surveys carried out during 2011/2012 (presented in **Appendix B)**. The estimated and measured subsidence for the existing partial extraction panels is summarised in **Table 16**. Noting that the ultimate prediction and performance criteria for Clarence Colliery is 100mm.

The review of subsidence was carried out to obtain a thorough understanding of previous mining performance, compare results against the 100 mm performance criteria and complete a thorough calibration of the subsidence model (which has been used to estimate subsidence for this 900 Area SMP). The review also critically reviewed estimated subsidence and measured subsidence from previous assessments and subsequent mining of the approved areas. The other component of the review was the inclusion of underground monitoring in the form of stress cell data. Together, the data provides valuable information regarding pillar performance and compression which significantly influences the magnitude of surface subsidence. Clarence considers that the analysis of the relationship between all data (actual pillar dimensions, surface subsidence data and underground data) is invaluable information and forms a robust data set for the calibration of the models used to estimate subsidence in the future. Of most interest, the review has also looked at the impact of underground flooding on subsidence development.

Table 16 Subsidence Results from Partial Extraction Panels at Clarence Colliery

Panel	No. of Headings	Pillar Width (centres, m)	Representative Depth (m)	Maximum Subsidence at Panel Mid-Span (mm)		
				Analytical and/or Numerical Estimate	Measured	
					Pre-Flooding	Post-Flooding
332	7	30	200	15-20	22	N/A
609D*	7	33	300	25	28	54
609C*	7	33	305	25-30	22	85
609B*	7	33	305	25-30	19	73
609A*	7	33	260	20-25	24	50
609*	7	33	305	25-30	32	91
612*	7	30	240	20-25	78	92
614	6-7	30	170	15-20	37	29
611A	7	30	260	20-25	15	15
611B	7	30	270	20-25	17	30
611C	7	30	220	15-20	40	51
611D	7	30	210	15-20	48	51
611E	7	33	270	20-25	26	29
611	7	33	290	25	20	74
702 Inbye	7	30	220	20-25	35	N/A
702 Outbye	7	33	290	25-30	23	N/A
704 Inbye	5	35.5/30	235	20-25	34	N/A
704 Outbye	5	35.5/30	290	25-30	24	N/A
708 (Inbye)	5	35.5	230	20-25	23	N/A
708 (Outbye)	5	35.5	260	25-30	27	N/A
710 (Inbye)	3	36/25	220	20	15	N/A
710 (Outbye)	3	36/25	270	20-25	39	N/A
712 (Inbye)	5	35.5/34/32.5	215	20-25	26	N/A
712 (Outbye)	5	35.5/34/32.5	270	25-30	44	N/A
714 (Inbye)	5	35.5/34/32.5	200	20-25	21	N/A
714 (Outbye)	5	35.5/34/32.5	230	20-25	53	N/A
707	7	30	210	20	14	N/A
				Average	**31**	**57**
				Standard deviation	**14**	**24**

Golder (2013c)

* - mining practice carried out in these panels are not consistent with current practice with barrier pillars now retained in between extracted panels and extraction height strictly audited and managed at ≤3

Overall, Golder (2013c) confirms that the subsidence results provide significant confidence with regard to current design approaches and likely future subsidence outcomes. Periodic

surface inspections, including photographic surveys, confirm the absence of any discernible subsidence-related damage above partially extracted areas.

The following comments are made regarding these results (Golder 2013c):

- Twenty-seven representative results are available from the mid-span of twenty-one panels (two readings are available for each of the long 700 Area panels).

- Average subsidence prior to flooding is 31mm, very similar to the typical predicted range of 20mm to 30mm, noting that 20mm has historically been regarded as the measurable limit of subsidence. The standard deviation of 14mm suggests that an upper bound result of the order of 50 to 60mm could be expected.

- The post-flooding average of 57mm is 84% higher than the equivalent pre-flooding figure, which reflects the weakening effect on the strata of saturation. The post-flooding standard deviation of 24mm suggests that worst-case subsidence results will remain within the 100±25mm criterion in the long-term.

- Measured subsidence tends to be slightly higher than predicted using the analytical method, which applies measured lower bound strata moduli to arrive at long-term, worst-case compression (subsidence) estimates. Measured impacts tend to be consistent with the new empirical model (i.e. the latter generates subsidence estimates that are typically around 10mm higher).

- Pillar deformation and stress monitoring exercises in both the 600 and 700 Areas have confirmed the long-term, post-lifting stability of the pillar systems. In particular, the monitoring has demonstrated that (a) pillar deformation due to lifting is largely confined to the immediate rib, with the pillar core remaining intact (even for the "remnants") and (b) pillar loading and deformation are consistent with a coal strength that is higher than commonly adopted by the applied empirical models, such that actual Factors of Safety are higher than predicted.

- The numerical model employing the "LaModel" code is considered to be adequately calibrated for the purposes of both panel design and subsidence estimation. In particular, the combined stress measurement, pillar deformation and surface subsidence monitoring exercises conducted for 704 and 707 Panels have generated a set of credible input parameters that can be applied consistently across different layouts.

The combined subsidence estimation methodology, using the analytical, empirical and/or numerical models, is considered robust and good engineering practice.

Overall, the review of subsidence results provide significant confidence with regard to current design approaches and likely future subsidence outcomes. Periodic surface inspections, including photographic surveys, confirm the absence of any discernible subsidence-related damage above partially extracted areas.

Clarence maintains the confidence that subsidence caused by the mining activities associated with the 900 Area will be compliant with the performance criteria of 100mm. This is based on:

- The conservative panel geometry;

- The confidence in the modelling used to predict subsidence (two different methods);

- Performance of the mining system verified by many years of subsidence data; and
- The outcomes from the stability assessment.

6.4 SUMMARY OF SUBSIDENCE PREDICTIONS

The primary objective pertaining to surface subsidence is to ensure that subsidence is limited to a value well within that considered to be characteristic of 'elastic' overburden behaviour (i.e. no caving to surface), which is defined as 100±25 mm (SEA, 2005).

Based on measured experiences to-date and analytical modelling of subsidence, Golder (2013c) concludes that the layouts in current use and planned for future areas are expected to result in subsidence within the 100 mm performance criteria:

> *The limited magnitude of the subsidence associated with partial extraction at Clarence Colliery has not resulted in any discernible surface damage to date, and consequently no significant surface impacts are predicted to occur as a result of the partial extraction proposed in the 900 Areas.*

Experience shows that subsidence measurements above steeply incised gullies tend to be higher than subsidence measured over flatter terrain. This may be a result of a higher tendency for survey error (field survey work is often more difficult in steeper terrain) and/or the complex redistribution of load and stresses over areas with rapid changes in depth of cover (ie. vertical load variations). For the 900 Area, the majority of the area affected by rapid variations in topography (ie. Bungleboori Creek) will only be subject to first workings. Irrespective, through the use of empirical modelling to determine subsidence predictions, higher subsidence measurements over areas with rapid changes in topography have been considered in the modelling through the calibration of the model which uses site specific data. Furthermore, the performance criteria of 100mm is in excess of expected subsidence determined through analytical and empirical methods.

7 IDENTIFICATION OF SURFACE AND SUB SURFACE FEATURES

7.1 MINE SUBSIDENCE DISTRICTS

The SMP Application Area does not lie within a Mines Subsidence District. The nearest district embraces the township of Lithgow approximately 15 km west of the 900 area.

7.2 PROPOSED DEVELOPMENT

The only proposed development within or adjacent to the SMP Application Area is the future installation of temporary subsidence monitoring equipment.

As discussed in **Section 2.3**, the northern portion of the 900 area underlies pine plantations managed by Forests NSW. The majority of this area above the 900 area has recently been clear felled.

Boral has not indicated whether they will recommence operations at their sand quarry during the life of this SMP.

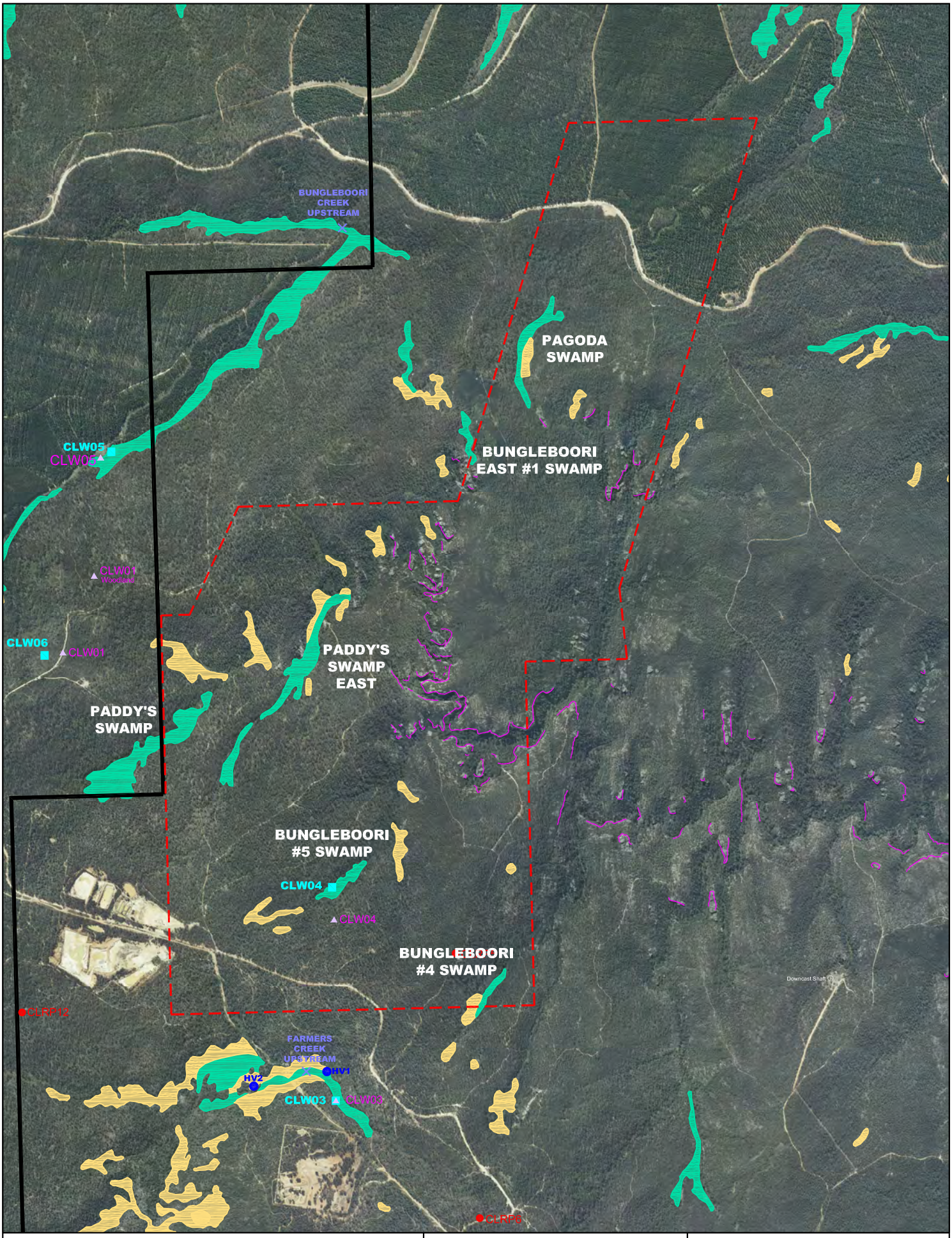
7.3 GENERAL DESCRIPTION

Approximately 2% of the surface of the 900 Area is privately owned (by Boral Quarries). The remainder of the area (approximately 646.2 hectares) is contained within the Newnes State Forest which is predominantly covered with native vegetation, some areas of pine plantations and minimal surface improvements. The only man made surface features over the area include 4WD tracks, a 66kV powerline and a small area of cleared land owned by Boral Quarries.

Reference to the SMP Guideline (DPI 2003) was made to assist in identifying the features that may be affected by mining. Sources used to confirm the features within the SMP Application Area included:

- Aerial photos;
- Digital cadastral information also showing surface features;
- On site surveys by mine surveyors;
- Field surveys and ground truthing by Clarence Colliery staff;
- Community consultation;
- Local knowledge of the area by mine personnel, various consultants and Forests NSW officers;
- Information provided by public utilities;
- Baseline monitoring (**Figure 11**); and
- Information provided by government departments.

The following sections identify and describe all the significant natural features and surface improvements that lie within the SMP Application Area.



BASELINE MONITORING

NOTE: Aerial photo flown October 2008

Centennial Coal
Clarence

Figure 11.

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7.4 IDENTIFICATION OF FEATURES

During the preparation of the SMP, an assessment was undertaken to identify any features in the SMP Application Area from the list in Appendix B of the SMP Guidelines. The results of this assessment are shown in **Table 17** below. The location of the features identified is shown in **Figure 4**.

Table 17 Surface and Subsurface Features

Feature (SMP Guidelines DPI 2003)	Applicable	Detail	Section Ref
Item 1 - Natural Features			
Catchment areas and declared special areas	N	-	-
Rivers and Creeks	Y	Tributaries of the Bungleboori Creek Bungleboori creek	Section 8.1.1. Appendix C
Aquifers, known groundwater resources	Y	Clarence aquifer, which forms part of the Blue Mountains sandstone aquifer. (Provides a potable water supply for the village of Clarence)	Section 8.1.2 Section 8.1.5. Appendix C
Springs	Y	Potentially associated with base flow with Newnes Plateau Hanging Swamp and Newnes Plateau Shrub Swamp.	Section 8.1.2 Section 8.1.5. Appendix C
Sea/Lake	N	-	
Shorelines	N	-	
Natural Dams	N	-	
Cliff/pagodas	Y	There are a number of cliffs and pagodas within the 900 Areas the majority of which are located within a first workings zone	Section 8.1.3. Appendix B
Steep Slopes	Y	There are areas of steep slopes adjoining the cliff lines in the 900 Area	Section 8.1.4.
Escarpments	Y	There are a number of cliffs / escarpments within the 900 Area the majority of which are located within a first workings zone	Section 8.1.3. Appendix B
Land prone to flooding or inundation	N	-	
Swamps, wetlands, water related ecosystems	Y	The flora and fauna assessment has identified areas Newnes Plateau Hanging Swamp and Newnes Plateau Shrub Swamp within the SMP Application Area	Section 8.1.2 Section 8.1.5. Appendix C Appendix D

Feature (SMP Guidelines DPI 2003)	Applicable	Detail	Section Ref
Threatened and protected species	Y	There is the potential for 39 threatened fauna species and 11 threatened flora species and 1 EEC within the SMP Application Area (under NSW Threatened Species Conservation Act 1995) as potential habitat exists within the 900 SMP Area	Section 8.1.6. Appendix D
National Parks	N	-	
State Recreation Areas	N	-	
State Forests particularly areas zoned FMZ 1, 2 and 3	Y	Part of the proposed SMP Application Area is within the Newnes State Forest, FMZ 2	Section 8.1.8. Figure 13
Natural Vegetation	Y	The SMP Area is predominantly covered with native vegetation of various communities	Section 8.1.6. Appendix D
Areas of significant geological interest	Y	Mount York Claystone, which acts as an aquiclude between the mine workings and the Clarence aquifer Pagodas and cliff lines are also considered to be areas of geological diversity	Section 8.1.2. Appendix C Section 8.1.3 Appendix B
Any other feature considered significant	N	-	
Item 2 – Public Utilities			
Railway	N	-	
Roads (all types)	Y	Various NSW Forests roads and trails are present over the 900 Area	Section 8.2.1.
Bridges	N	-	-
Tunnels	N	-	-
Culverts	N	-	-
Water / gas / sewerage pipelines	N	-	-
Liquid fuel pipelines	N	-	-
Electricity transmission lines (overhead / underground) and associated plants	Y	Endeavour Energy 66kV Powerline traverses the south western corner of the 900 Area	Section 8.2.2.
Telecommunication lines (overhead / underground) and associated plants	N	-	-
Water tanks, water and sewerage treatment works	N	-	-
Dams, reservoirs and associated works	N	-	-
Air strips	N	-	-
Any other infrastructure items	N	-	-
Item 3 – Public Amenities	N	-	-

Feature (SMP Guidelines DPI 2003)	Applicable	Detail	Section Ref
Item 4 – Farm Land and Facilities	N	-	-
Item 5 – Industrial, Commercial and Business Premises			
Factories	N	-	-
Workshops	N	-	-
Business or commercial premises	N	-	-
Gas and / or fuel storage and associated plants	N	-	-
Waste storages and associated plants	N	-	-
Buildings, equipment and operations that are sensitive to surface movements	N	-	-
Surface mining (open cut) voids and rehabilitated areas	Y	A very small area of cleared land associated with the Boral Quarry is located above the western extent of the 903 panel. No void area exists within the 900 SMP Area	Section 8.2.3.
Mine infrastructure including tailings dams and emplacement areas	N	-	-
Any other feature considered significant	N	-	-
Item 6 - Areas of archaeological and / or heritage significance (including aboriginal)	Y	The AHIMS database showed 80 sites previously recorded within 10km of the 900 Area. Only eight sites were recorded within the secondary extraction area and one site within a first workings zone. Five of these sites being rock shelters with/without art and or deposit, three sites being artefact scatters and a single grinding groove site.	Section 8.1.7 Appendix E
Item 7 - Items of Architectural significance	N	-	-
Item 8 - Permanent survey control marks	N	-	
Item 9 – Residential Establishments	N	-	-

Section 6.6.3 of the SMP Guidelines (DPI 2003) sets out a list of potentially environmentally sensitive areas to be assessed as part of the application. Each item has been assessed with respect to the SMP Application Area, and the results presented in **Table 18**.

Table 18 Areas of Environmental Sensitivity

Feature (SMP Guidelines DPI 2003)	Applicable	Detail	Section Ref
Land reserved as State conservation area under *National Parks and Wildlife Act 1974* (NPW Act)	N	-	-
Land reserved as an Aboriginal Place under NPW Act	N	-	-
Land identified as wilderness by the Director NPWS under the *Wilderness Act 1987*	N	-	-
Land subject to a conservation agreement under NPW Act	N	-	-
Land acquired by Minister for the Environment under Part 11 NPW Act	N	-	-
Land within State Forests mapped as Forestry Management Zones 1, 2 or 3	Y	The SMP Application Area is within the Newnes State Forest, FMZ 2.	Section 8.1.8 Figure 13
Wetlands mapped under SEPP14 – Coastal Wetlands	N	-	-
Wetlands listed under the Ramsar Wetlands Convention	N	-	-
Lands mapped under SEPP 26 – Coastal Rainforests	N	-	-
Areas listed on the Register of National Estate	N	-	-
Areas listed under the *Heritage Act 1977* for which a plan of management has been prepared	N	-	-
Land declared as critical habitat under the Threatened Species Conservation Act 1995	N	-	-
Land within a restricted area prescribed by a controlling water authority	N	-	-
Land reserved or dedicated under the Crowns Land Act 1989 for the preservation of flora, fauna, geological formations or other environmental protection purposes	N	-	-
Significant surface watercourses and groundwater resources identified through consultation with relevant government agencies	Y	Clarence aquifer, which forms part of the Blue Mountains sandstone aquifer. (Provides a potable water supply for the village of Clarence and potential baseflows to swamps and creeks)	Section 8.1.2. Appendix C

Feature (SMP Guidelines DPI 2003)	Applicable	Detail	Section Ref
Lake foreshores and flood prone areas	N	-	-
Cliffs, escarpments and other significant natural features	Y	There are cliffs and pagodas within the escarpments areas spanning the 900 Area the majority of which are located within a first workings zone	Section 8.1.3. Appendix B
Areas containing significant ecological values	Y	Newnes Plateau Shrub Swamp and Newnes Plateau Hanging Swamp are both listed as endangered ecological communities.	Sections 8.1.2., 8.1.5., 8.1.6. Appendix C Appendix D
Major surface infrastructure	Y	Endeavour Energy powerline and powerpoles (811 Feeder)	Section 8.2.2.
Surface features of community significance (including cultural, heritage or archaeological significance)	Y	Nine Aboriginal sites registered on the Aboriginal Heritage Information Management System within the 900 Area with eight above proposed secondary extraction workings.	Section 8.1.7 Appendix E
Any other land identified by the Department to the titleholder	N	-	-

8 FEATURE CHARACTERISATION AND SUBSIDENCE IMPACT ASSESSMENT

8.1 NATURAL FEATURES

8.1.1 RIVERS AND CREEKS

Characterisation

The 900 Area almost wholly lies beneath the Bungleboori Creek and its tributaries. A very small proportion of the southern extent of the area lies beneath the Farmers Creek catchment passing beneath the upper tributaries that flow into the drainage line. A very small proportion (in the north) of the 900 Area also underlies the upper reaches of the Carne Creek catchment.

Statutory Requirements / Guidelines

The legislation that regulates potential subsidence impacts on creeks and rivers is the *Mining Act 1992* under the SMP Guidelines. This SMP Application has been prepared to gain approval for mining using partial extraction under the creeks and swamps within the application area.

Surface water is regulated under the *Water Management Act 2000*. The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources and the Greater Metropolitan Region Groundwater Sharing Plan both commencing on 1 July 2011 and includes rules for protecting the environment, extractions, managing licence holders' water accounts, and water trading in the area.

Clarence Colliery also has a Water Management Plan in place that was recently reviewed in 2013. The Water Management Plan is a requirement of the development consent DA 504-00 and is managed within the constraints of the consent approval conditions.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F**

During the Stakeholder Presentation for this SMP Application, no issues were raised regarding the potential impact from partial extraction of pillars underneath drainage lines.

Baseline Monitoring

Access to the tributaries within the SMP Application Area is very difficult and measurement of surface water (flow and quality) is not warranted given the negligible impact of mining on the tributaries (demonstrated over the previous 13 years).

Potential impacts on surface water (flow and quality) as a result of mining will be identified through groundwater (piezometric head) monitoring of the near-surface aquifers. Piezometric head monitoring is considered the best indicator of impact as it would occur almost immediately with mining and prior to any surface impacts. It is noted that there is currently limited piezometric monitoring currently within the 900 Area. However, Clarence is scheduled to complete further exploration within the northern portion of the 900 Area throughout 2014. Piezometers will be installed into the exploration holes with sufficient time to collect at least 2 years of baseline data. The proposed piezometer locations will be

presented in the Environmental Monitoring Program to be developed for the 900 Area should this SMP be approved.

Impact Assessment

The partial extraction mining method adopted by Clarence Colliery results in maximum predicted subsidence of 100 mm with low tilts and strains (<2 mm/m), no measured valley closure, no upsidence and no surface cracking. With this low level of movement it is considered that there will be no adverse impacts on the flow, flow characteristics (i.e. ponding, bank stabilisation) or quality of rivers and creeks from mining at Clarence Colliery.

The key issue in relation to the effects of the mining proposal on creeks relate to the loss of water from the upper (near-surface) aquifers that provide base flow to the creeks (and swamps). Studies confirming the predictions in relation to the effects of the proposed partial extraction system on aquifers are outlined in **Section 9** (Community Consultation) and **Appendix F.**

Aurecon (2013) undertook a groundwater assessment for the 900 Area SMP that included an assessment of potential impacts to surface water flows mainly in the context of impacts to surface flows in swamps. This assessment (**Appendix C**) is relevant to drainage lines and surface water flows in general as the biggest risk would be tilting (causing diversion of flows), strains (causing cracking and potential drainage of water) and subsidence troughs (causing pooling or tilting). In their assessment, Aurecon (2013) concluded:

> *Measured strains averaged 0.2 – 0.4 mm/m, with maximum values approximately 1.8 mm/m. A single outlier value of 2.6 mm/m was recorded. Strata Engineering Australia (2011) notes that this value was measured above a fault mapped in the workings, and concludes that "very rarely … increased strain magnitudes can be associated with discrete movements at major structures following [extraction]". Note that previous studies have recommended maximum strains of 2.0 mm/m to protect cliff lines. Such a value is a very conservative maximum to protect swamps from the effects of surface cracking. With the one anomalous exception noted, strain values measured are well below this value.*
>
> *To date, surface inspections have not found any surface cracking above the workings. This includes inspection over the anomalously high strain value recorded at one point. The vertical extent of cracking above the partial pillar extraction areas is likely to be very low, due to the strong roof conditions encountered at Clarence. The roof is in the Caley Formation which typically spans mine openings without significant deflection. Through-going crack systems, which would significantly alter vertical permeability, are highly unlikely to develop with such small ground movements recorded at the surface, and with the observed behaviour of the working seam roof. This is supported by the observations in the multi-level piezometer bores, which show no impact on groundwater except at the level of the working seam. This is also supported by post-mining inspections carried out over the partially extracted areas which show no cracking, detrimental surface movement, or damage.*
>
> *Measured tilts averaged 0.1 mm/m, with maximum values between 0.4 and 1.0 mm/m (Golder Associates, 2013). Note that previous studies have recommended maximum tilts of 2.5 mm/m to protect cliff lines. Such a value is a very conservative maximum to protect swamps from the effects of tilting. The tilt values measured are well below this value.*
>
> *Identifying tilt impacts is difficult. However, shallow groundwater monitoring in the swamps shows no loss of groundwater resulting from tilting diverting flow away*

from the swamps. This is not unexpected as the maximum level of tilt measured is of the order of 4% of the natural groundwater gradient in the swamps, which is less than the natural fluctuation in gradients. Even if the tilts reach a maximum of 2.5 mm/m, this only represents 10% of the natural groundwater gradient.

The continuity of groundwater behaviour indicates that mining has had no discernible impact on water levels in the swamps. This is to be expected, as the mining method used does not have any significant impact on the roof strata of the workings, or on the cover sequence between the workings and the surface, that could have an effect on near-surface groundwater levels. Surface subsidence is very low, and has not resulted in any observed surface cracking. In addition, the levels of mining-induced tilt are very low, and extremely unlikely to affect groundwater flow paths in the swamps.

The only other way that mining could potentially impact on these swamps is if surface cracking and/or tilting were to divert water from the watercourse. However, due to the very low level of subsidence that will be experienced, there will be no cracking or tilting of sufficient magnitude to have any impact on the swamps. Experience to date with subsidence monitoring indicates very low levels of subsidence, strain, and tilt. Maximum predicted long-term subsidence values are ≤70mm. These are higher than measured in the current monitoring program. However, they are still very low absolute values of subsidence, and the likelihood of this amount of subsidence causing negative impacts on aquifers or swamps is extremely low.

Monitoring, Mitigation and Management

Monitoring of rivers and creeks will continue as per the Clarence Colliery Water Management Plan (Clarence Colliery, 2013) submitted for approval (following the recent review) by the Department of Planning and the environmental monitoring programs developed under the Outbye Area (Clarence Colliery, 2009a), Eastern Area (Clarence Colliery, 2005), 700 Area (Clarence Colliery, 2009b) and 700W Area (Clarence Colliery 2012b) approvals. The monitoring points are presented in **Figure 11** and **Figure 12** (which shows monitoring across the whole lease area).

The best form of protection to creeks and drainage lines (particularly that associated with Bungleboori Creek) is to eliminate any risk (no matter how small) and avoid secondary under the area. This is exactly what Clarence Colliery proposes to do through the implementation of a first workings zone designed to protect Bungleboori Creek. On this basis, it is considered that there is negligible (no) risk of impact to Bungleboori Creek through avoidance of secondary extraction.

The best mitigation measure is the mine layout which has been designed with the specific purpose to avoid rock caving, maintain aquifer integrity and to protect surface features. Constant review of subsidence (and underground) data confirms performance. This provides a high level of confidence that performance (no discernible impact on surface features) will continue in the 900 Area.

The residual potential impact of the mining proposal draining the aquifers feeding base flow to rivers and creeks will be addressed through the groundwater monitoring program.

The SMP Application Volume 2 contains further details on the monitoring, mitigation and management of potential impacts. An Environmental Monitoring Program will be developed should this SMP Application be approved.

8.1.2 AQUIFERS – KNOWN GROUNDWATER SOURCES

Characterisation

The nearby Springvale Colliery in conjunction with the CSIRO completed a groundwater assessment titled “Interpretation of Hydrogeological Data at Springvale Colliery” during 2004 (CSIRO, 2004). In addition, Bish (1999) carried out a “Hydrological Assessment for Coxs River Catchment”. Both of these studies looked at defining the extent, reliability and character of groundwater resources within the regional Newnes Plateau area (focusing on the mining areas of Springvale, Angus Place and Clarence Colliery). ERM (2003) carried out a “Groundwater Investigation underneath Clarence” to understand the relationship between shallow aquifers near the Clarence Village and water make within the Clarence Colliery underground operations, and Connell Wagner PPI (2006) completed a “Report on Potential Impacts of Mining on the Local Hydrogeology” at Clarence Colliery. To this end, there has been a significant amount of monitoring, assessment and studies into the groundwater behaviour around Clarence both on a local and regional scale.

In addition to the previous studies, an assessment of the likely impacts on the local groundwater regime was undertaken by Aurecon (2013) specifically for the SMP Application, and is attached as **Appendix C**. The following section includes a summary of the findings of this report.

The aim of the 2013 assessment was to determine the impact of partial extraction mining in the proposed 900 area on the identified aquifers including:

- The identification of aquifers that lie above the mining area; and
- The examination of the potential impact of the proposed mining on the local and regional groundwater regime.

The aquifers identified above the mining area include those that support groundwater dependant ecosystems and those that support a local potable supply of water (ie. the village of Clarence).

To characterise the groundwater behaviour across the Clarence Lease, the Groundwater Impact Assessment completed by Aurecon (2013) conducted a review of the data obtained from the Clarence Colliery groundwater monitoring program. This included the surface to seam piezometer results in six boreholes, groundwater level data from the groundwater observation bores established in the Banks Wall Sandstone (open hole bores), an investigation into the extent of the Clarence Aquifer zone and an interpretation of the current condition of the Clarence Aquifer. This report also reviewed the groundwater level and groundwater behaviour associated with the Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps overlying extracted areas.

In addition to characterising the groundwater behaviour, Aurecon (2013) also undertook an assessment of the groundwater behaviour over areas that have already been partially extracted and in areas away from mining. The rationale in examining the potential for impacts on the aquifers in the vicinity of (but not directly above) the partial extraction mining activities, is to determine the extent of influence caused by partial extraction.

Aurecon (2013) identified three basic groundwater systems that traverse the region including the 900 Area. Aurecon (2013) described these as:

> ***Perched groundwater system*** *– a discontinuous, near-surface system generally independent of the regional groundwater systems, and located within 15 metres of the ground surface. The perched groundwater is derived from excess rainfall*

which is largely prevented from infiltrating deeper down into the regional systems by the presence of near-surface shale or siltstone beds, which are common in the Burralow Formation (McHugh, 2011, Palaris, 2013b). The occurrence of a perched groundwater system may produce lateral seepage (either permanent or periodic), which supports NPHS. This has been confirmed by work carried out at Angus Place/Springvale (McHugh, 2011), where numerous NPHS were shown to be associated with near-surface shale layers, that apparently limit vertical infiltration of rainfall.

***Shallow groundwater system** – this system is a regional groundwater system located in the Narrabeen Group, largely in the Banks Wall Sandstone. This system includes major aquifer zones that are of high importance, since they can support permanently waterlogged groundwater dependent ecosystems such as the NPSS where they intersect the ground surface. Most groundwater flow in the water-bearing sequence is generally in the horizontal direction along bedding planes and/or joints, with some vertical flow occurring from ground surface infiltration. A limited volume of groundwater may also flow vertically from one water-bearing zone to another, depending on the permeability of the intervening strata, and the degree of vertical jointing and faulting in the system. Limited permeability testing carried out previously in the Banks Wall Sandstone indicated a bulk permeability of between 10-6 and 10-7 m/sec (AGC, 1983), although the individual water-bearing zones will have significantly higher permeabilities. The Mount York Claystone forms a low permeability barrier to this vertical infiltration, so that most of the natural groundwater flow in the shallow groundwater system occurs above this horizon in aquifers in the Banks Wall Sandstone. The general flow direction in the aquifers in this system is sub-horizontally towards the north-east, away from the subcrop zone, where recharge to the lower aquifers can occur. This potential recharge zone is located to the west and north-west of the existing workings.*

***Deep groundwater system** – a less important, deeper groundwater system exists in the strata below the Mount York Claystone, including the Burra-Moko Sandstone, which has occasional water-bearing zones, and the Illawarra Coal Measures. The coal measures generally lie at a depth of more than 200 metres (although this depth is reduced in the valley of Bungleboori Creek to a minimum of 130 m). The majority of the coal measure strata have a low permeability; however one or two beds have a slightly higher permeability and could represent water-bearing zones. The few water-bearing zones that do occur at depth in these strata are usually fractured rock aquifers. These include jointed coal seams, including the Katoomba Seam, and localised jointed or fractured zones, often adjacent to faults. Limited permeability testing carried out previously at the Katoomba horizon indicated a bulk permeability of between 10-7 and 10-8 m/sec (AGC, 1980). The general flow direction in the more permeable water-bearing zones in this system is also subhorizontally towards the north-east, away from the subcrop zone, where recharge can occur.*

The two aquifer systems most sensitive to potential impacts from ground subsidence included the Clarence aquifer and those perched aquifers supplying recharge to Hanging Swamps and Shrub Swamp Endangered Ecological Communities. Both systems are sensitive to potential impacts from subsidence, primarily the potential for the aquitards/aquicludes to be disrupted potentially resulting in loss of water. Each of these aquifer systems are explained in more detail by Aurecon (2013) below.

Clarence Aquifer

The available groundwater data show that there is a natural groundwater mound around the Clarence village, which has recharged significantly since the end of the drought in 2008. This is important as it indicates that the major source of recharge to the aquifer in this vicinity is via direct infiltration and percolation of rainwater in the vicinity of the village itself. There appears to be very little potential for recharge of the aquifer from the north, due to the dip of the strata and the presence of Browns Swamp. This demonstrates the importance of groundwater management in the village itself, as the aquifer in this area is effectively isolated.

The aquifer at Clarence drains generally in a northeast direction into Browns Swamp, which would rely on the groundwater from the aquifer as one of its prime water sources. The aquifer in the village also drains west and south into Reedy Creek, and southeast into Dargans Creek.

North of Clarence, the aquifer drains in a northerly direction into Bungleboori Creek, although there is some drainage into the Wollangambe River to the east, and into Farmers Creek to the west. As would be expected, there is a groundwater high beneath the north-south ridgeline.

Where the aquifer zone outcrops, there is the potential for swamp formation as the aquifer would drain into the adjacent valley. In order to check this contention, the main swamps were plotted. The result is convincing, and strongly suggests that the Clarence Aquifer is the source of groundwater for the swamps in the 900 Area south of Bungleboori Creek.

Although the Clarence Aquifer is bounded by Bungleboori Creek on the northern side, there will be an aquifer at the same horizon north of the creek. This aquifer dips to the north east and will not outcrop in this area as it will be much deeper. As a result, it is likely that none of the swamps in the 900 Area north of Bungleboori Creek are supported by the Clarence Aquifer. They most likely owe their existence to an aquifer that is higher up in the stratigraphic sequence.

Newnes Plateau Shrub Swamps and Hanging Swamps

Newnes Plateau swamps can be divided into two basic types, based on the apparent source of groundwater within the swamp. The source of the groundwater in each swamp (and hence the swamp type) has been interpreted solely from the monitoring results to date. The two basic types are:

- *Type A — dependent predominantly on rainfall infiltration with minor groundwater inflow (periodically waterlogged swamps).*
- *Type C — dependent predominantly on an aquifer water source as well as rainfall contribution (permanently waterlogged swamps).*

*The first swamp type (**Type A — periodically waterlogged**) can show large and reasonably rapid variations in groundwater level in response to significant rainfall events. These periodically waterlogged swamps normally do not have a constant flow from their downstream end, and show large variations in groundwater level, particularly after major rainfall events. They may also have small catchment areas, and some are located at high elevations with no significant flanking ridges or obvious drainage lines through the swamp.*

These swamps tend to rely mostly on rainfall but to a lesser extent (based on observations and monitoring data), on local seepage from perched aquifers which recharge and discharge quickly as they are shallow and very limited in extent.

> *The second swamp type (**Type C — permanently waterlogged**) has a relatively stable, near-surface groundwater table that shows no major fluctuations, even after heavy rainfall or during prolonged dry periods. They generally have a constant flow of water from their downstream end, and are located mostly in broad valleys with catchments that are large enough to provide the infiltration required to feed the basal aquifer. Permanently waterlogged swamps can also occur in valleys with very poor drainage or in depressions, so that rainfall/runoff ponds locally and provides a constant water source. Since the percentage of groundwater contribution to the swamp hydrology will vary from swamp to swamp, there may be a range of hydrogeological conditions observed for this swamp type. Typically, permanently waterlogged swamps have an upstream section that can be periodically waterlogged.*

These swamps tend to rely mostly on groundwater seepage from larger aquifers as direct rainfall events (or the lack of rainfall events unless drought conditions prevail) do not appear to significantly impact groundwater levels as demonstrated by many years of monitoring within permanently waterlogged swamps.

> ***Hanging swamps** are generally supported by perched shallow aquifers that mostly provide a **periodically waterlogged** environment, although more permanently waterlogged conditions may prevail at some swamps, depending on the aquifer recharge area.*

The Groundwater Impact Assessment (**Appendix C**) includes a more detailed description (including Figures) of the Clarence aquifer including:

- The extent of aquifer;
- Inferred outcropping of aquifer zone;
- Base of aquifer zone; and
- Groundwater level contours.

Statutory Requirements / Guidelines

The legislation that regulates potential subsidence impacts on aquifers is the *Mining Act 1992* under which the SMP Guidelines (DPI 2003) apply. This SMP Application has been prepared to gain approval for mining under the creek tributaries and swamps within the application area.

Groundwater is regulated under the *Water Management Act 2000*. The Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources commenced on 1 July 2011 and includes rules for protecting the environment, extractions, managing licence holders' water accounts, and water trading in the area. Clarence Colliery currently holds extraction licences to dewater the Clarence Mine Workings.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

Clarence Colliery is aware that any impacts to the Clarence aquifer and associated impacts on swamps would be of concern to the community of Clarence. The impact assessment summarised below (provided in **Appendix C**) addresses the potential impacts to aquifers.

Baseline Monitoring

Monitoring of existing groundwater conditions has been the focus of numerous studies and monitoring programs. Clarence Colliery has an extensive Groundwater Monitoring Program and Response Program (**GW Program**) which is described within the existing Water Management Plan (Clarence Colliery, 2012). The Water Management Plan and GW Program cover the entire Clarence Colliery lease area, developed on accordance with the Development Consent DA504-00. Baseline groundwater data includes 24 groundwater boreholes that exist over the Clarence Colliery holdings (including one within the village of Clarence). An additional two groundwater bores (with collectively six piezometers) have recently been installed (August 2013) in the 800 Area following the completion of an exploration program carried out over July/August 2013.

Groundwater monitoring at Clarence includes shallow and deep bores that are monitored for groundwater level. This program of monitoring commenced in August 2004. The role of each type of monitoring installation is summarised below.

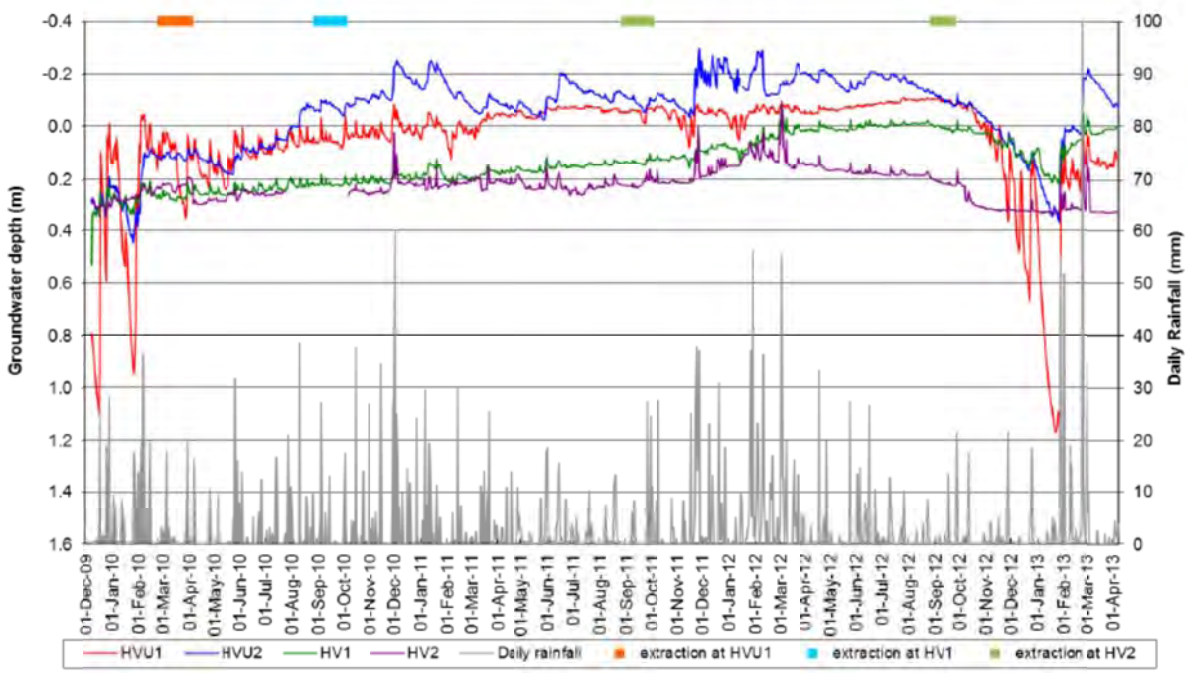
- Shallow groundwater monitoring bores provide data on near-surface groundwater in the swamps.
- Open boreholes with single piezometers monitor groundwater conditions in the Clarence Aquifer
- Deep boreholes with fully grouted strings of vibrating wire piezometers monitoring pore pressures at several levels throughout the cover sequence.

In order to assist in the assessment of the likely impact on the local groundwater system of the proposed mining in the 900 Area panels, Aurecon assessed the groundwater data collected since installation to confirm that the conclusions (predictions) from the previous assessments were valid. This involved:

- A review of the groundwater level and groundwater behaviour before, during and after mining in two swamps overlying extracted areas.
- A review of the surface to seam piezometer results in four boreholes that had either been undermined, or had mining nearby;
- A review of the groundwater level data from the six groundwater observation bores established in the Clarence Aquifer in the Banks Wall Sandstone (one of which has been undermined).

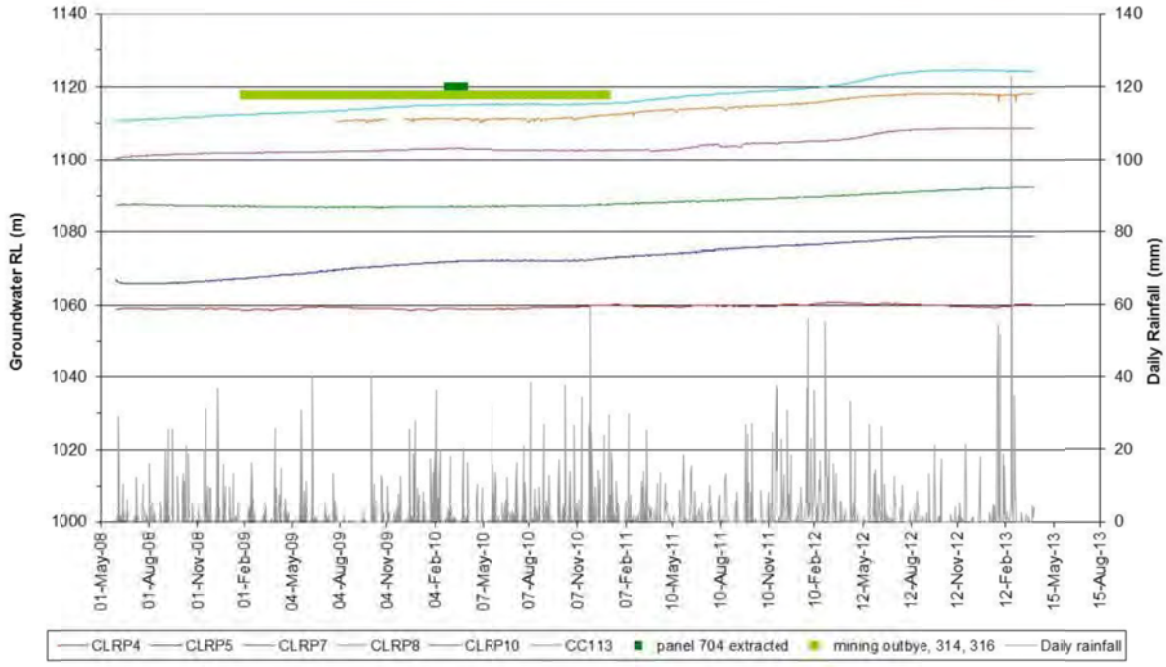
Monitoring carried out within the shallow perched aquifers (supporting NPSS and NPHS), the Clarence aquifer and the deeper groundwater aquifers is summarised herein. Further detail and analyses of the data is provided in **Appendix C**. The reader is encouraged to refer to Appendix for further information.

Graph 1 presents the monitoring carried out within the two swamps (Happy Valley Upper (HVU) – NPHS and Happy Valley Swamp (HV) – NPSS) in the 700 Area. Two piezometers are installed within each swamp with one located downstream of the other. Both Swamps have been extracted beneath over the years. This is presented as coloured bars at the top of the graph. It can be seen that there is no change in the pre and post groundwater behaviour. It can also be seen that the groundwater behaviour is influenced by rainfall patterns. The most sensitive swamp to rainfall patterns is Happy Valley Upper. The upstream portion of the swamp is the most sensitive to rainfall, fluctuating widely during wet and dry times.



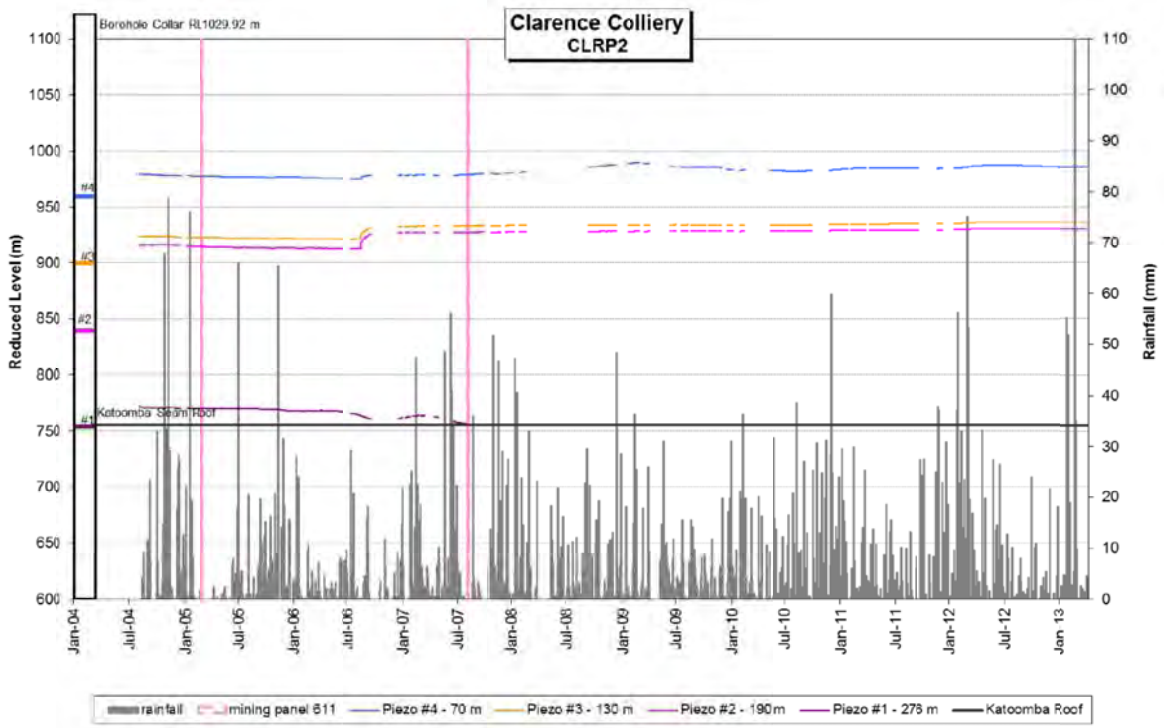
Graph 1. Perched Aquifers - Monitoring within Happy Valley Swamp and Happy Valley Upper Swamps: Pre and Post Extraction

Graph 2 presents the monitoring carried out within the open holes located in the Clarence aquifer. Of the piezometers presented in **Graph 2**, only CLRP 10 has been extracted beneath. The groundwater level shows no changes before, during, and after mining of Panel 704. Mining has had no discernible impact on groundwater level in this bore. All the other piezometers are situated between the mining area and the Clarence Village, within the Clarence Village or in between the mining area and the Lithgow No.2 Dam. All monitoring records show a consistent level with a gradual increase since mid-2011 most likely due to good rainfalls in 2010 and 2011. Conclusively, there has been no impact to the Clarence Aquifer from mining activities.



Graph 2. Shallow Groundwater Aquifers – Open Holes Clarence Aquifer

The data from CLRP2 has been chosen to represent the groundwater monitoring data from long term deeper piezometers located over areas that were extracted in 2007. As shown in **Graph 3**, the groundwater piezometers are showing a consistently flat trend showing no impact to strata above the extracted area.

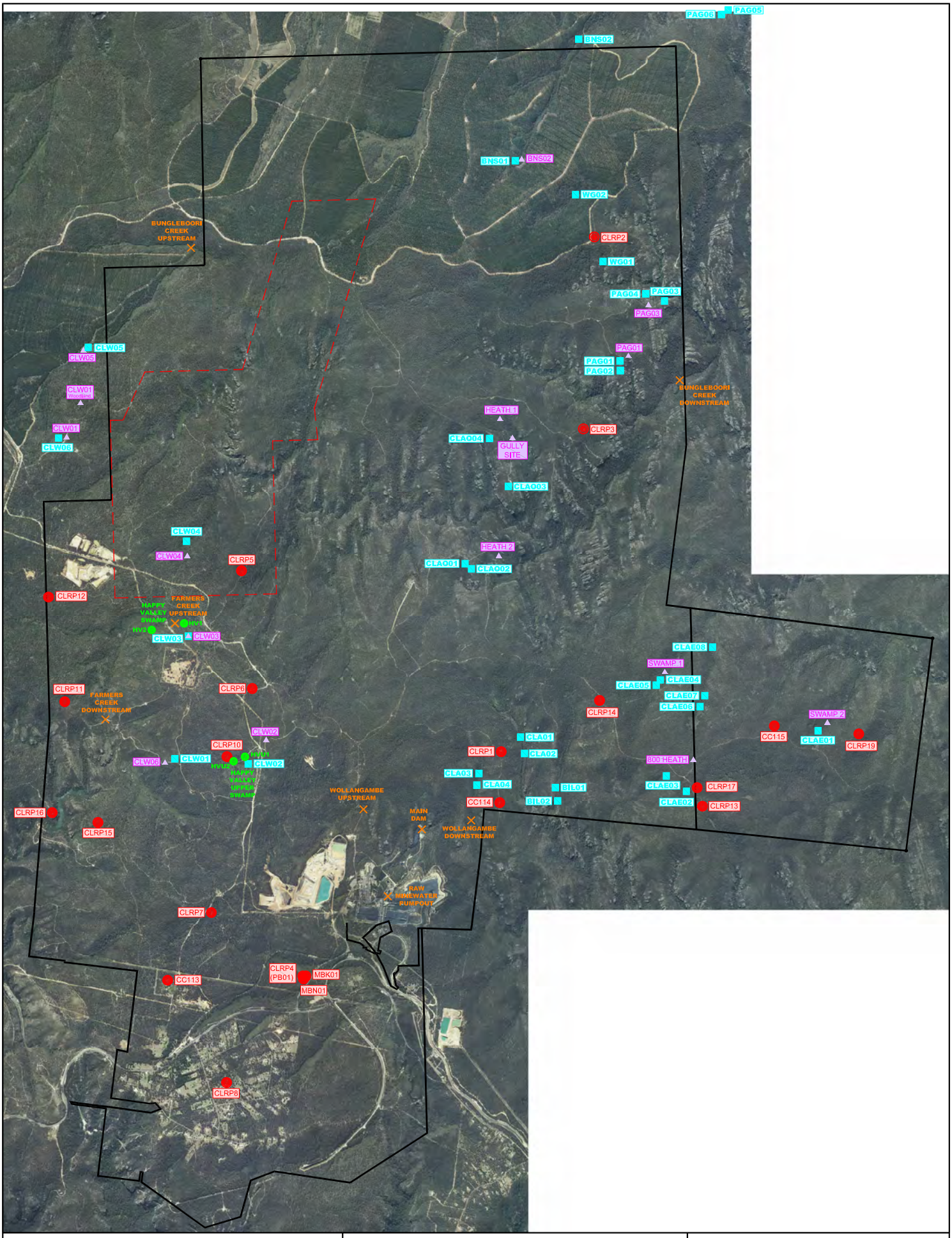


Graph 3. Deeper Groundwater Monitoring from Piezometers in CLRP2 (Panel 611E)

Table 19 presents all the groundwater bores and piezometers across the Clarence Mining Leases. For easy reference, **Figure 12** presents their location. **Appendix C** provides further detail regarding analysis of other monitoring data both above and away from mining areas.

Table 19 Groundwater Monitoring over the Clarence Lease Area

700 West area	Monitoring Commenced	Depth (m)	800 area	Monitoring Commenced	Depth
CLRP11 (P4)	2010	61	C114 (P4)	2009	45
CLRP11 (P3)		74.5	C114 (P3)		75
CLRP11 (P2)		134.5	C114 (P2)		135
CLRP11 (P1)		165	C114 (P1)		165
CLRP4 (MBN01)	2008	71	CC115 (P4)	2010	120
CLRP4 (PB01)		175-181	CC115 (P3)		170
CLRP4 (MBK01)		180	CC115 (P2)		200
CC113	2008	37	CC115 (P1)		270
CLRP7	2008	41	CLRP1 (P4)	2004	60
CLRP10	2010	60	CLRP1 (P3)		100
CLRP12 (P4)	2010	100	CLRP1 (P2)		150
CLRP12 (P3)		120	CLRP1 (P1)		175
CLRP12 (P2)		180	CLRP13 (P5)	2010	80
CLRP12 (P1)		230	CLRP13 (P4)		110
CLRP15 (P4)		60	CLRP13 (P3)		140
CLRP15 (P3)		90	CLRP13 (P2)		210
CLRP15 (P2)		130	CLRP13 (P1)		240
CLRP15 (P1)		160	CLRP14 (P4)	2010	100
CLRP16 (P2)	2010	134.5	CLRP14 (P3)		130
CLRP16 (P1)		165	CLRP14 (P2)		185
CLRP8	2009	28	CLRP14 (P1)		220
CLRP2 (P4)	2004	70	CC113	2008	37
CLRP2 (P3)		130	CC115 (P4)		120
CLRP2 (P2)		190	CC115 (P3)		170
CLRP2 (P1)		276	CC115 (P2)		200
CLRP3 (P3)	2006	85	CC115 (P1)		270
CLRP3 (P2)		138	CLRP6 (P3)	2008	60
CLRP3 (P1)		198	CLRP6 (P2)		100
CLRP5	2008	51	CLRP6 (P1)		160
HV1 (Swamp)	2009	Shallow	HVU (Swamp)	2009	Shallow
HV2 (Swamp)	2009	Shallow	HVU (Swamp)	2009	Shallow
CLRP 19 (P3)	2013	90	CLRP 17 (P3)	2013	70
CLRP 19 (P2)		120	CLRP 17 (P2)		130
CLRP 19 (P1)		170	CLRP 17 (P1)		200



COLLIERY HOLDING BOUNDARY

PROPOSED 900 AREA

CLW06 FLORA MONITORING SITE

CLW04 FAUNA MONITORING SITE

HV2 SHALLOW PIEZOMETERS

FARMERS CREEK UPSTREAM SURFACE WATER MONITORING

CLRP6 PIEZOMETERS

SURFACE MONITORING ACROSS WHOLE LEASE

NOTE: Aerial photo flown October 2008

Centennial Coal
Clarence

Figure 12.

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The baseline groundwater assessment (**Appendix C**) focuses on the results from boreholes CLRP4, 5, 7, 8, 10 and CCL113 to assess Clarence Aquifer and CLRP1, 2, 3 and 6 for general groundwater monitoring across the site. Results indicate that there has been no impact from previous mining on the groundwater levels in the upper strata, including the Clarence Aquifer because the monitoring has shown no change in groundwater behaviour monitored pre-mining and post mining. The base line data provided is invaluable for assessing future mining impacts on groundwater behaviour

Measured Effects of Mining

The available piezometer data has been evaluated and interpreted to determine the likely impact of the mining on the groundwater regime. The Groundwater Impact Assessment (**Appendix C**) contains analysis of data from the above mentioned sites. Summaries from the analysis of the three aquifer systems (perched, shallow and deep) undertaken by Aurecon (2013) are presented below. Further detail can be found in the assessment report provided in **Appendix C**. The reader is also referred to **Graphs 1 – 3** above.

Perched Aquifers – Newnes Plateau Swamps (refer also to Graph 1)

The records for all swamp piezometers show that there are no significant differences in the groundwater record in each hole before, during, and after mining. All observed groundwater behaviour can be attributed to rainfall effects, particularly the surplus / deficit of rainfall from trend, and storm induced effects where rainfall rate was greater that approximately 20 mm/day.

The continuity of groundwater behaviour indicates that mining has had no discernible impact on water levels in the swamps. This is to be expected, as the mining method used does not have any significant impact on the roof strata of the workings, or on the cover sequence between the workings and the surface, that could have an effect on near-surface groundwater levels. Surface subsidence is very low, and has not resulted in any observed surface cracking. In addition, the levels of mining-induced tilt are very low, and extremely unlikely to affect groundwater flow paths in the swamps.

Shallow Groundwater Aquifers – Open Holes Clarence Aquifer (refer also to Graph 2)

Monitoring of the Clarence Aquifer in the six open boreholes shows that the groundwater levels did not vary markedly over the period from June 2008 to the end of 2010. However, since the end of 2010, most bores have shown a significant rise in groundwater level, probably as a result of the recent above average rainfall conditions during that period. The levels in all of the bores are currently higher than when monitoring commenced. While the latter variations observed probably relate, in part to rainfall patterns, this is not consistent, and some bores show a greater variation in level than others, possibly indicating more efficient recharge from the surface. Extraction of the Outbye, 314, and 316 areas occurred in 2009 and 2010, while the 700 series panels were extracted in 2011, 2012 and 2013. Groundwater levels before, during, and after mining are not markedly changed. There is no evidence in these data that mining has had an impact on groundwater in the Clarence Aquifer.

General Groundwater Monitoring – Multi Level Piezometers, Deeper Aquifers (refer also to Graph 3)

> *All the boreholes in mining areas show consistent flat trends in their upper piezometers, similar to those in the unmined area. This indicates that mining did not have any discernible impact on groundwater levels in the upper strata in these boreholes. Piezometers at the mining horizon show groundwater draining as mining occurs. Intermediate strata may show some temporary impacts as mining passes, followed by recovery of pore pressures. These observations are consistent with expectations, given the very low levels of mine subsidence caused by the mining method used, and the observed behaviour of strata above the mining horizon. Available groundwater data indicate that mining has no impact on pore pressures and groundwater levels in the upper strata, including the Clarence Aquifer.*

Available groundwater data indicate that partial pillar extraction has had no impact on groundwater pore pressures and water table levels in the upper strata, including the Clarence Aquifer either above or adjacent to mine workings.

Impact Assessment

The proposed partial pillar extraction within the 900 area is unlikely to have any significant impact on the groundwater system. Nevertheless, it is instructive to examine more closely the potential for impacts on the groundwater systems in the area. The potential for adverse impacts in each area as concluded by Aurecon (2013) are presented below.

Local Impact

> *In can be concluded that, even if the mining resulted in a crack forming from the surface to the seam (an extremely unlikely occurrence), the impact on the Clarence Aquifer would only be local, and similar to the drawdown at Bungleboori Creek. There would be no measurable impact on the aquifer in the vicinity of the Clarence village. The conclusion is therefore drawn that the impact of the proposed mining in the 900 Area on the Clarence Aquifer will be negligible.*
>
> *The 900 Area also underlies the far northern part of the lease where the northern extension of the Clarence aquifer horizon is located at a greater depth. Although the nature of the aquifers in this area is not as well-known as further to the south, it is interpreted that there is at least one important aquifer above the Clarence Aquifer that supplies the swamps in the northern part of the 900 Area as well as the large swamps along the northern edge of the lease. However, it is likely that there will be no impact on this or any other aquifers, since the geology and mining method are the same as the area further south, and any subsidence-related impacts will be identical. The arguments for a lack of impact from mining on the Clarence Aquifer therefore apply equally to any aquifer higher up in the sequence in this northern area. The extra cover thickness between these swamps and the proposed 900 Area extraction, is another mitigating factor and means that there is no likelihood that mining will impact on these features.*

Regional Impact

The previous sections examined the likely impact of the proposed mining on the aquifer systems in the SMP Application Area. It is also important to examine if there will be any adverse unintended regional impacts. It has been demonstrated in the previous sections that the upper sandstone aquifers are unlikely to suffer any significant permanent impacts due to the mining. As a result, the regional impact on these aquifers is also judged to be negligible.

Any regional impacts are likely to be limited to the aquifer associated with the Katoomba seam. The available data suggest that the piezometric head in the seam has already been depleted by the many years of mining in the local area. In addition, the proposed 900 extraction area already has extensive workings on the down-dip side, to which groundwater flow through the seam is currently directed, so that there is unlikely to be significant quantities of groundwater in the seam in these areas. In addition, the coal seam does not outcrop down dip of the colliery, so that there are no creeks or vegetation communities that rely on the groundwater in the seam. Because of this, the conclusion can be drawn that the proposed extraction will not have any incremental effect on the regional hydrogeology. There has been some concern in the past that the presence of a void in the coal seam will over the long term lead to gradual drainage of the upper aquifers. The monitoring to date (particularly in CLRP1) has shown that the pore pressures at all horizons higher than 30 metres above the Katoomba seam have maintained (or increased) their pre-mining pressures, with no evidence of any depletion of groundwater over several years since mining. This is good evidence that there is likely to be no long term drainage of water from the upper aquifers.

Conclusion

Groundwater monitoring over and adjacent to existing mine workings shows no impact on the groundwater regime above the mine, apart from in the immediate mining horizon. Aurecon (2013) has concluded that the proposed mining will have no significant impact on the groundwater regime on both a local and regional scale provided subsidence is maintained at the predicted low levels. Consequently it is highly unlikely that there will be an impact to the shallow groundwater regime in areas adjacent to the proposed mining areas.

Mining within the SMP Application Area will therefore have no adverse impact on the availability of future groundwater supply resources in the area or on aquifers feeding base flow to rivers, creeks or swamps.

Monitoring, Mitigation and Management

Monitoring of groundwater will continue as per the GW Program in the Clarence Colliery Water Management Plan (Clarence Colliery, 2013) recently reviewed in consultation with DP&I, SCA, OEH and NOW and approved by the Department of Planning and Infrastructure, as well as the approved EMP's developed for the Outbye Area (Clarence Colliery, 2009a), 700 Area (Clarence Colliery 2009b), the 700W (Clarence Colliery, 2012b).

The best mitigation measure is the mine layout which has been designed with the specific purpose to avoid rock caving, maintain aquifer integrity and to protect surface features. Constant review of subsidence (and underground) data confirms performance. This provides a high level of confidence that performance (no discernible impact on surface features) will continue in the 900 Area.

Given the likely negligible impact on the groundwater regime from the proposed mining and limited interaction with near-surface aquifers (including the Clarence aquifer), the existing groundwater monitoring program will be sufficient to detect any potential mining related impacts. Some of the existing piezometers are located away from current mining areas (and away from the proposed 900 Areas) and will continue to provide valuable background data on local (and regional) hydrological conditions including the response of aquifers to rainfall.

The SMP (SMP Application Volume 2) contains further details on the monitoring, mitigation and management of potential impacts.

8.1.3 CLIFFS / PAGODAS

Golder (2013c) carried out an assessment on the cliff lines above the proposed 900 Areas (**Appendix B**). The outcomes of this assessment are summarised below.

Characterisation

The SMP Application Area contains a number of cliffs and pagodas. The areas in which cliff lines are found are relatively remote, and are only accessible by foot. Although bushwalkers do periodically enter the area, the area is not frequently accessed, except by mine employees.

The cliff lines forming the subject of the assessment were identified from aerial photographs and a 'Lidar' survey of the Clarence area. The accuracy of the lidar technique (0.15 – 0.2m) was considered acceptable for the purposes of cliff line identification given that the objective of the exercise was to identify cliff lines of 20m (in built 1% error associated with the lidar technique). The relevant sections of the cliff lines in the study area were also inspected, mapped and photographed. The mapping was completed using aerial photographs, surface geology plans, GPS and compass techniques. The cliff locations are shown in **Figure 4** and **Figure 9**.

Plans specifically identifying cliff lines over 20m in height and the proposed panel layouts were provided to Golder Associates by Clarence Colliery prior to the fieldwork, which entailed the inspection of ~50 distinct cliff lines.

The cliff lines inspected in the proposed 900 Area consist mainly of 20m to 40m rounded cliffs with sheer bases. Small (3 to 8m high) pagodas align the crests of approximately 75% of the surveyed cliff lines. The majority of the cliff lines are associated with Bungleboori and Paddy's Creek. Nearly all of the cliff lines associated with the Bungleboori Creek are within a first workings zone and will not be affected by partial extraction mining activities.

Statutory Requirements / Guidelines

The impact of mining operations on cliff lines and pagodas within the SMP Application Area is not regulated by any specific statutory requirements. The legislation that regulates potential subsidence impacts on surface features (including cliffs) is the *Mining Act 1992* under which the SMP Guidelines apply. This SMP Application has been prepared to gain approval for mining under the cliffs and pagodas within the application area.

ACARP Project No. C9067 (2002) '*Subsidence Impacts on River Valleys, Cliffs, Gorges and River Systems'* provides a methodology for assessing subsidence impacts in cliffs. This has been evaluated within the impact assessment.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

During the stakeholder consultation for this SMP Application, concerns relating to impacts on cliffs and pagodas were raised in the context of habitat for endangered bat species. In other words, the concern was that potential impacts to cliff lines and pagodas such as cracking or rock falls may affect the roosting habitats of endangered bat species.

Baseline Monitoring

The relevant sections of the cliff lines in the SMP Application Area were inspected, mapped and photographed by Golder between the 17th and 18th April 2013. The mapping was completed using aerial photographs, surface geology plans, GPS and compass techniques. Scratch testing on accessible rock exposures was also conducted to determine approximate Uniaxial Compressive Strength (**UCS**) values. Point load and laboratory UCS testing was also conducted on representative samples from previous exploration boreholes to define rock strength.

Limitations to the field work included no reasonable access to a number of the gorge areas within Bungleboori Creek (due to the steep terrain and dense vegetation). For these locations, long range photographs in addition to the available aerial photos and topographic maps were used to characterise these cliff lines, noting these areas will be subject to first workings only as most of these of gorge areas lie outside of the area subject to secondary extraction where potential impacts (no matter how small) are substantially reduced through avoidance.

The subsidence monitoring data from previous partial pillar extraction workings indicate that no appreciable mine subsidence damage to cliff lines and pagodas (including slot canyons) has occurred to date in the Clarence Colliery lease above panels extracted using the partial extraction method.

Impact Assessment

The expected impact on the cliffs in the SMP Application Area has been evaluated based on reference to the empirically based impact classification or rating system presented in ACARP (2002).

The ACARP method focuses on overall stability of the cliff lines and the upper bound limit of the proportion of cliff lines that could be impacted by rock falls. The method does not allow a quantitative assessment of the potential for cracking damage. However, a reasonable qualitative assessment is possible by comparing the ratings for previously damaged and undamaged cliff lines. The method essentially allows an overall assessment of the impact of mining on cliff face stability and aesthetic appeal. The contribution of the natural instability of the cliff lines due to on-going weathering processes is also factored into the assessment.

The method requires the following input data:

- The geotechnical/physical characteristics of the cliffs (i.e. height, lithology, geological structure, aesthetic appeal, public accessibility);
- The predicted subsidence deformations and direction of mining in relation to the cliff lines; and
- The active natural weathering processes that cause cliff instability and talus formation (i.e. preferential weathering leading to overhang development, water and wind erosion, groundwater seepage).

The ACARP (2002) methodology classifies a cliff according to three categories of criteria, as follows:

- Category 1: Extent of the mining–induced ground movements.
- Category 2: Aesthetic quality and degree of public exposure.

- Category 3:Natural instability of the cliff formation.

Acceptable Impact Rating for the 900 Area SMP

Previous cliff line impact assessments for partial extraction panels at the mine concluded that a low impact rating or less for both Category 1 (mine subsidence impacts) and the overall Category 1 to 3 rating is ideally required to achieve a low level of impact risk (i.e. no mine induced cracking or obvious increase in rock fall activity). From this study it is expected that the assessment for the 900 SMP Application Area should also fall within these categories.

The maximum subsidence parameters in the proposed mining areas should therefore be limited to the values shown in **Table 20**.

Table 20 Recommended Mine Subsidence Deformation Limits for Cliffs

Mining Induced Cliff Impact Parameter	Acceptable Values
Mine subsidence	<50mm
Differential horizontal movement at crest	<50mm*
Mining induced tilt at cliff	<2.5 mm/m
Mining induced strain at cliff	<2 mm/m

Adapted from ACARP (2002)

*Note: * - The maximum horizontal displacement is estimated by multiplying the tilt values by half the cliff height.*

Impact Assessment

Table 21 presents each cliff line over the area associated with Secondary extraction. The specific panel is also noted along with the expected long term subsidence post flooding.

A summary of the results of the impact ratings for the cliff lines above areas of secondary extraction is provided in **Table 21**. The combined rating for all three impact categories returns a moderate to very low overall impact rating. The locality of these cliff lines can be found in **Figure 9**. Impact ratings for the cliff lines above areas of first workings can be found in Golder (2013) cliff line assessment report located in **Appendix B**. They have not been included in this Section as they will not be subject to secondary extraction.

Table 21 Summary of Impact Assessment Ratings for Cliff Lines in the Secondary Extraction Area

Reference Location	Category			Overall	Panel Number
	Mining Influence	Aesthetic Quality & Public Exposure	Natural Instability		
900-1-A	Very Low	Very Low	Low	Very Low	908
900-1-B	Very Low	Very Low	Low	Very Low	908
900-1-C	Very Low	Insignificant	Low	Very Low	910
900-1-D	Low	Very Low	Very Low	Very Low	Barrier
900-1-E	Low	Very Low	Low	Very Low	910
900-2-B	Very Low	Very Low	Low	Very Low	906
900-2-C	Very Low	Very Low	Low	Very Low	906
900-3-AC	Low	Very Low	Low	Very Low	Barrier
900-3-AM	Low	Very Low	Low	Very Low	First workings
900-3-AP	Low	Very Low	Low	Very Low	904
900-4-A	Low	Very Low	Low	Very Low	First workings
900-4-B	Low	Very Low	Low	Very Low	First workings

All cliff lines to be undermined in the 900 Area are categorised as low to very low in terms of the mining influence and very low in overall assessment. Estimated subsidence associated with each cliff line (based on the panel geometry and depth of cover) is less than 50mm and so it compliant with the recommended deformation limit (**Table 20**). This outcome is indicative of the conservative nature of the mine plan.

The outcome of this rating for the SMP Application Area therefore indicates the following level of impact due to the proposed mining method:

- No acceleration of weathering or increase in rock fall activity;
- No mine induced fracturing or general cliff line instability;
- No changes to natural drainage or erosion patterns.

The predicted outcomes are consistent with actual subsidence experiences associated with the partial extraction system operated at the mine since 1999.

Golder (2013c) concludes that no adverse surface impacts from mining are expected, due to the very limited magnitudes of subsidence associated with the conservative mine plan and the mining method.

Monitoring, Mitigation and Management

Given that the probability of impacts on the cliff lines and pagodas within the mining area is low to very low, it is proposed to photograph and inspect individual cliff lines and pagodas

over each panel in the SMP Application Area prior to and after extraction. Should the impacts to any cliff line or pagoda within the SMP Application Area be greater than the impact predictions various mitigation and public safety procedures will be enacted. These mitigation strategies range from the erection of warning signs in the area notifying of potentially dangerous conditions to the inspection and recommendation of remedial actions and the review of the mine plan and layout by a qualified geotechnical engineer. Clarence Colliery has taken the recommended mine subsidence deformation limits, in respect of cliff lines, into account.

It is again noted that the majority of the cliff lines within the 900 Area will not be extracted beneath virtually eliminating any potential risk or impact.

The SMP (SMP Application Volume 2) contains further details on the monitoring, mitigation and management of potential impacts.

8.1.4 STEEP SLOPES

Characterisation

There are areas of steep slopes adjoining the cliff lines in the 900 area.

Any ground within the SMP Application Area at a grade of 1 in 3 (33.33%) or greater has been considered as a steep slope. Whilst these areas have not been specifically delineated, the steeper areas can be readily identified from the contours on **Plan 2** and **Figure 9**.

Statutory Requirements / Guidelines

The impact of mining operations on steep slopes within the SMP Application Area is not regulated by any specific statutory requirements. The legislation that regulates potential subsidence impacts on surface features (including steep slopes) is the *Mining Act 1992* under which the SMP Guidelines apply. This SMP Application has been prepared to gain approval for mining under the cliffs and pagodas within the application area.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

During the stakeholder consultation for this SMP Application, concerns relating to impact on steep slopes have not been raised by stakeholders.

Baseline Monitoring

The steep slopes in the vicinity of the cliffs and pagodas were visually inspected during the inspection of cliffs and pagodas as part of the Golder (2013c) cliff assessment.

Impact Assessment

Steep slopes have been previously undermined at Clarence Colliery with the full extraction (full pillar extraction and longwall) and partial extraction mining methods. With no impacts in previously mined partial extraction areas, there is a very low potential for any impact on steep slopes as similar mining techniques will be used within the 900 Area. This is supported by the conclusion of Golder (2013) that there is a low probability of any impact on the cliff lines, which are much steeper and intrinsically less stable than the steep slopes.

Monitoring, Mitigation and Management

Given there is a very low probability of impact on steep slopes from the proposed mining operations, minimal monitoring of steep slopes is required.

The steep slopes in the vicinity of the cliffs and pagodas will be visually inspected during the inspection of cliffs and pagodas. This includes ad-hoc inspections of steep slopes prior to and after mining.

The SMP (SMP Application Volume 2) contains further details on the monitoring, mitigation and management of potential impacts.

8.1.5 SPRINGS, SWAMPS, WETLANDS, WATER RELATED ECOSYSTEMS

Characterisation

RPS Australia Pty Ltd (RPS) conducted a Flora and Fauna Assessment (**Appendix D**) to determine the ecological characteristics of the SMP Application Area, and identify any potential impacts from subsidence. The assessment identified the vegetation communities known as the Newnes Plateau Shrub Swamp and Newnes Plateau Hanging Swamp which are dependent on groundwater seepage and rainfall within the SMP Application Area.

The locations of the NPSS and the NPHS are consistent with the findings within 'The Vegetation of the Western Blue Mountains' (DEC, 2006). In this document, Map Unit 50 – *Newnes Plateau Shrub Swamp* (**NPSS**), is listed as an Endangered Ecological Community (**EEC**) under the NSW *Threatened Species Conservation Act 1995* (**TSC Act**). In addition, NPSS and Map Unit 51 – *Newnes Plateau Hanging Swamp (***NPHS**) is also identified in the SMP Application Area both correspond to the *Temperate Highland Peat Swamp on Sandstone EEC* under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (**EPBC Act**). The areas of each of these swamps occurring in the SMP Application Area can be found in **Table 22** and are shown on **Figure 4** and **Figure 11**.

Table 22 Water Related Ecosystem Areas in the SMP Application Area

Vegetation Community	Area within the 900 Area (ha)
Newnes Plateau Shrub Swamp	10.4
Newnes Plateau Hanging Swamp	13.8

Swamps generally occupy gully heads and ridge top sites at points of water seepage where percolating groundwater travelling through the sandstone is forced outwards by impermeable (and most likely) shale layers. Not all swamps are dependent on continuous seepage of groundwater. Some swamps rely more so on rainfall. To this end, the two different types of swamps based on the apparent source of groundwater within the swamp have been classified by Aurecon (2013) as:

- *Type A — dependent predominantly on rainfall infiltration with minor groundwater inflow (periodically waterlogged swamps).*
- *Type C — dependent predominantly on an aquifer water source as well as rainfall contribution (permanently waterlogged swamps).*

The base flow for the swamps is generally fed by near surface aquifers (unless solely dependent on rainfall).

Shallow groundwater monitoring within a NPSS and a NPHS at Clarence has been undertaken within representative swamps. A total of four piezometers have been measuring the groundwater characteristics and behaviour since 2009. This timeframe has allowed for the collection of baseline data (pre-mining) and the collection of data post partial extraction underneath the swamps being monitored. It is noted that this body of knowledge (gathered from the assessment of the monitoring data) forms the basis for the prediction of impacts given that the subsidence impacts are predicted to be the same as that experienced in the past. In summary, the monitoring results showed no change in groundwater behavior when pre-mining and post mining data were compared.

Statutory Requirements / Guidelines

The NPSS within the SMP Application Area is listed as an EEC under the NSW TSC Act. In addition, both the NPSS and the NPHS form a component of the *Temperate Highland Peat Swamps on Sandstone* EEC listed under the EPBC Act.

The Greater Metropolitan Region Groundwater Source Water Sharing Plan states (in Schedule 4) that THPSS are a high priority Groundwater Dependant Ecosystem. Schedule 4 also states that these GDE's will be considered in the assessment of any application for a water supply works approval. This is a separate approval not related to the SMP approval process.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

During the stakeholder consultation for this SMP Application, concerns relating to impact on NPSS or NPHS were raised by stakeholders. Clarence Colliery is aware that any impacts to these swamps would be of concern to the local community and environmental groups, Government Departments and subsequently, the impact assessment below addresses this issue.

Baseline Monitoring

Baseline monitoring of swamps for this SMP Application includes the monitoring of the Clarence aquifer, a swamp within the SMP Application Area and swamps outside the SMP Application Area that are subject to the same mining process as those within the SMP Application Area. Monitoring of other swamps and other vegetation units have been undertaken over the lease area for around 20 years.

Monitoring of the swamps within the Eastern SMP Area commenced in July 2004 for flora and September 2005 for fauna. The objective of these studies was to quantify that the partial extraction mining operation has no impact on either NPSS or NPHS over the Clarence Colliery mining lease area. With extraction completed in these panels, the sites are used to measure any long term impact from mining.

It is believed that the Clarence Aquifer outcrops in the vicinity of the NPSS that lie to the south of the Bungleboori Creek. Another aquifer supports the NPSS that lies to the north of Bungleboori Creek. In their assessment, Aurecon (2013) noted:

> *In addition to the Clarence Aquifer, there are other water-bearing zones higher up in the Banks Wall Sandstone, which averages 100 metres thick in this area. North of the 900 Area, where the stratigraphic sequence thickens due to the north-*

> *easterly dip of the strata, there is good evidence for another high level aquifer (possibly in the Burralow Sandstone). Just north of the lease area there are three large shrub swamps (Carne East Swamp, Bungleboori North #1 Swamp, Bungleboori North #2 Swamp), all of which are most likely fed by a high level aquifer. In this area, the Clarence Aquifer horizon would be of the order of 80 to 100 metres below the level of the swamps, so that it is unlikely it is the groundwater source for these swamps.*

Impact from partial pillar extraction on the Clarence aquifer will be monitored as a part of the groundwater monitoring program. Additional groundwater monitoring installations within the northern portion of the 900 Area during 2014 will be installed following the scheduled exploration program to be conducted. With extraction scheduled for 2016/2017 in this area, at least 2 years of baseline data will be gathered prior to the area being extracted.

The baseline monitoring of the swamps, is presently limited to flora and fauna monitoring within Bungleboori #5 Swamp. This is the first swamp system that will be undermined. It is noted that the outcome from previous monitoring and assessments of the NPSS and NPHS have found that the risk of impact from partial pillar extraction is low and that monitoring effort should be commensurate with the risk of impact. It is further noted that there is sufficient background data and knowledge in respect of the existing groundwater behaviour within swamps on the Newnes Plateau to classify each swamp over the 900 Area following initial inspections undertaken throughout 2012 and 2013.

The four shallow hand augured piezometers within swamps within the NPSS of Happy Valley Swamp (piezometers HV1 and HV2) and the NPHS of Happy valley Upper Swamp (piezometers HVU1 and HVU2) (see also **Graph 1**). Monitoring of HV1, HV2, HVU1 and HVU2 commenced in 2009. HVU1 is located in the upstream section of Happy Valley Upper Swamp and over the life of the monitoring, groundwater levels have fluctuated. These fluctuations have been highly dependent on rainfall with groundwater levels fluctuating from a low of nearly 1.2 m below ground level (**bgl**) to a high of 0.1m above ground level.

HVU2 has shown similar groundwater behaviour to HVU1 albeit with a more muted fluctuations ranging from 0.4 m bgl to just over 0.2 m above ground level. This is because the piezometer is located at the downstream end of the swamp and it receives flows from a larger catchment than that contributing to the upstream portion of the swamp. Both HVU1 and HVU2 have been extracted beneath and their groundwater behaviour has not changed when data from pre and post mining is compared.

HV1 and HV2 are located in a NPSS and have both shown consistent groundwater levels since monitoring commenced in 2009. The water level recorded by both piezometers has generally remained at 0.1 – 0.3 m below ground level even after HV1 was extracted beneath approximately 18 months to two years ago.

In their assessment Aurecon (2013) concluded from the baseline monitoring undertaken to date:

> *Monitoring has confirmed that the swamp groundwater levels show no response to partial extraction mining taking place under or adjacent to the swamps. This is to be expected, due to the very low levels of subsidence and strata disturbance that result from the proposed pillar extraction. Happy Valley Swamp (a Newnes Plateau Shrub Swamp) and Happy Valley Upper Swamp (a Newnes Plateau Hanging Swamp) were both undermined during recent partial extraction mining operations, with shallow groundwater monitoring undertaken before, during, and after mining. Groundwater behaviour in the swamps is consistent with that seen elsewhere, both on the Newnes Plateau, and in other swamps. Groundwater*

> *levels show different amounts of influence from rainfall and groundwater input, and have been recognised as periodically waterlogged (partially rainfall-dependant, Type A) swamps, or permanently waterlogged (groundwater dominated, Type C) swamps. Groundwater levels in the swamps respond to both short-term rain storms, and to longer term rainfall surplus/deficit conditions.*

An additional two flora and fauna sites will be investigated within the Paddys Swamp East. Indicative locations are presented in **Volume 2**. These sites have not been groundtruthed and will only be further investigated should this SMP be approved. Clarence will develop a more detailed monitoring program over the 900 Area as a part of the development of an Environmental Monitoring Program should this SMP be approved.

Impact Assessment

The Groundwater Impact Assessment (Aurecon 2013) found that:

- *The impact of the proposed mining on the Clarence Aquifer will be negligible; and*
- *Since the impact on the aquifer will be negligible, then the likely impact on any groundwater dependent ecosystems that rely on the discharge from the aquifer is also likely to be negligible.*

This finding agrees with monitoring data form piezometers over previously mined areas.

The impact assessment for groundwater concluded that the proposed mining will have no significant impact on the groundwater regime on both a local and regional scale, and that mining will have no significant impact on aquifers feeding base flow to rivers, creeks or swamps.

There are several Newnes Plateau Shrub Swamps in the 900 Area that rely on groundwater and rainfall for their survival, and any depletion in these sources is undesirable. Nevertheless, since the investigations by Aurecon (2013) have indicated that the proposed mining will have no significant impact on the groundwater regime on both a local and regional scale, partial pillar mining will have no significant impact on aquifers feeding base flow to rivers, creeks or swamps.

Aurecon (2013) concluded:

> *The only other way that mining could potentially impact on these swamps is if surface cracking and/or tilting were to divert water from the watercourse. However, due to the very low level of subsidence that will be experienced, there will be no cracking or tilting of sufficient magnitude to have any impact on the swamps. Experience to date with subsidence monitoring indicates very low levels of subsidence, strain, and tilt. Maximum predicted long-term subsidence values are ≤70mm. These are higher than measured in the current monitoring program. However, they are still very low absolute values of subsidence, and the likelihood of this amount of subsidence causing negative impacts on aquifers or swamps is extremely low.*
>
> *Since surface cracking has the potential to impact on the hanging swamps, the likelihood of surface cracking has been evaluated. Due to the mining method used, the occurrence of any surface cracking is highly unlikely. This is supported by evidence from Clarence Colliery where inspections over previously mined areas have shown no cracking, and no other adverse impacts from partial pillar extraction. This has been the case for over 13 years. Groundwater monitoring*

> *data from the Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps that have been undermined previously provides further evidence of no impacts as it shows that there are no changes in groundwater behaviour when comparing pre-mining data to post mining data. Mining could potentially impact these swamps through surface cracking and/or tilting which may divert water from the watercourse. However, due to the very low level of subsidence values (< 100 mm) expected and the very low levels of tilts and strains, the occurrence of surface cracking is highly unlikely, and the likelihood of negative impacts on aquifers or swamps is extremely low.*
>
> *Identifying tilt impacts is difficult. However, shallow groundwater monitoring in the swamps shows no loss of groundwater resulting from tilting diverting flow away from the swamps. This is not unexpected as the maximum level of tilt measured is of the order of 4% of the natural groundwater gradient in the swamps, which is less than the natural fluctuation in gradients. Even if the tilts reach a maximum of 2.5 mm/m, this only represents 10% of the natural groundwater gradient.*

Further to this, the evidence from historical groundwater monitoring data from the Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps shows no changes in groundwater behaviour when comparing pre-mining data to post mining data.

RPS (2013b) concurred with Aurecon's impact assessment:

> *The application of the Seven-part Test concluded that there is not likely to be a significant effect on any identified threatened species, populations or ecological communities, or their habitats arising from the proposed activities*

Monitoring, Mitigation and Management

Mitigation strategies against impacting aquifers by the proposed extraction are not required as the mine design provides substantial mitigation by minimising subsidence and eliminating caving within the overburden. However, the two primary risks to springs and seepage is the cracking of strata and diversion of groundwater flow and the tilting of the ground also resulting in diversion of groundwater flow. This is the same as the primary risk on the aquifers above the Mount York Claystone that feed springs and swamps systems. Subsequently, monitoring of potential impacts on swamps is focused on groundwater monitoring.

Monitoring of groundwater will continue as per the GW Program in the Clarence Colliery Water Management Plan approved by the Department of Planning, as well as the Outbye Area (Clarence Colliery, 2009a), 700 Area (Clarence Colliery, 2009b), and Eastern Area (Clarence Colliery, 2005) and the 700W (Clarence Colliery, 2012) EMP's. Additional piezometers will be installed within the northern section of the 900 Area during 2014 with sufficient time to collect baseline data.

The current assessment has concluded that the proposed mining within the 900 Area using partial pillar extraction methods can be carried out with negligible risk to the local groundwater regime (including the Clarence Aquifer and shallow aquifers and springs supporting the NPSS and NPHS).

The following monitoring, management and mitigation measures are proposed :

1. Continue the existing subsidence monitoring programs.

2. Where mine subsidence exceeds previously observed maxima, undertake a review of reasons for observed results and likely future observations, and implications for groundwater security.

3. Continue existing groundwater monitoring programs.

4. Where groundwater behaviour appears anomalous, undertake a review of reasons for observed results and likely future observations, and implications for groundwater security.

5. Continue existing swamp groundwater and vegetation monitoring programs. The lack of evidence of any impact in the existing data indicates that there is no need to extend these programs to other swamps, given the impact on the swamps that installing and conducting monitoring is likely to have, and the difficulty of access.

6. Develop an inspection regime for the remainder of the swamps in place of groundwater and vegetation monitoring.

7. In cases where continuing monitoring indicates that a potential hazard may be developing, review the mine plan.

8. Review all results at the completion of each mining panel to ensure that mining performance does not exceed predictions.

9. Develop an Environmental Monitoring Program for the 900 Area should the SMP be approved.

10. Install piezometers into exploration holes scheduled for the northern portion of the 900 Area to monitor groundwater behaviour north of Bungleboori Creek.

8.1.6 FLORA AND FAUNA

Characterisation

RPS completed a Flora and Fauna Assessment (**Appendix D**) specific to the SMP Application Area to assess the level of existing ecological information, and determine the likely impacts from the proposed mining activities. To characterise the existing environment and assess the potential impacts from the proposed partial pillar extraction, RPS completed the following as a part of their assessment:

- A desktop assessment of relevant ecological assessments within and adjacent to the SMP Application Area;
- Identification of threatened flora and fauna species, populations and ecological communities known or likely or occur within a 10 km radius of the SMP Application Area;
- Field surveys to ground-truth vegetation mapping and locate threatened flora and fauna species within the SMP Application Area;
- A seven part test under the TSC Act to assess the potential of the project to have a significant impact on any threatened species, populations or ecological communities known or likely to occur in within the SMP Application Area or its immediate vicinity;
- An assessment of likely impacts to Matters of National Environmental Significance listed under the EPBC Act; and
- A State Environmental Planning Policy (**SEPP**) 44 assessment to determine the likely level of impact on the koala.

The SMP Application Area supports a range of native flora and fauna. This assessment has focused on the threatened and protected species which have been characterised in accordance with the TSC Act and the EPBC Act. The initial desktop survey identified a total 24 threatened flora species, 52 threatened fauna species and four Endangered Ecological Communities listed on the TSC Act and the EPBC Act as having a chance of occurring (likelihood of occurrence) on the site.

Flora and Fauna – NSW Threatened Species Conservation Act

In total, 11 threatened flora species, 39 threatened fauna species and one EEC listed under the TSC Act were assessed to be potentially located within the site. The potential for impact upon threatened species and ecological communities as a result of the proposal was limited to seven fauna species, one flora species and the NPSS EEC. Subsequent assessment via a *Seven-part Test* (see **Appendix D**) found that the proposal was unlikely to significantly impact on any of these threatened species or ecological communities.

Flora and Fauna – Commonwealth Environment Protection and Biodiversity Conservation Act

In total, 5 threatened flora species, 12 threatened fauna species and one EEC listed under the EPBC Act were assessed to be potentially located within the site. The potential for impact upon threatened species and ecological communities as a result of the proposal was limited to four fauna species, one flora species and the THPSS EEC. Assessment under the Act (see **Appendix D**) found that the Proposal was unlikely to significantly impact on any of the identified species or communities.

A field survey was undertaken by RPS between the 26th – 30th November 2012 and the 15th – 17th January 2013. The field survey was undertaken to groundtruth existing vegetation mapping (DEC 2006) and to supplement previous surveys in adjoining areas to identify threatened flora and fauna species, populations and ecological communities known or likely to occur within the site or its immediate vicinity. A total of three endangered species and one EEC were located on site during the period of the survey. Two threatened bat species were also identified through the recognition of echolocation recordings.

No Key Threatening Processes (KTPs) as listed under the TSC Act were predicted to be exacerbated as a result of the proposal, and an assessment under SEPP 44 found that no 'Potential Koala Habitat' occurs within the project area and no further assessment under SEPP 44 was required.

Flora

Table 23 presents the threatened flora species, populations and ecological communities potentially occurring within or in the vicinity (within 10km) of the site based on the early literature review. The potential for species to occur within the 900 Area due to available habitat within the 900 Area is indicated by a "**P**". A "*****" indicates that the species was located during the survey.

Table 23 Potential or Known Threatened Flora Species in the 900 Area

SCIENTIFIC NAME	COMMON NAME	TSC Act	EPBC Act
Acacia bynoeana ***(P)***	Bynoe's Wattle	E	
Acacia flocktoniae		V	V
Asterolasia elegans		E	E
Boronia deanei ***(P)***	Deane's Boronia	V	V
Caesia parviflora var. *minor* ***(P)***	Small Pale Grass-lily	E	
Caladenia tessellata		E	V
Cryptostylis hunteriana	Leafless Tounge Orchid	V	V
Veronica blakelyi (formerly Derwentia blakelyi) ***(P)***		V	
Eucalyptus aggregata	Black Gum	V	
Eucalyptus pulverulenta ***(P)***	Silver-leafed Gum	V	V
Haloragodendron lucasii ***(P)***		E	E
Isopogen fletcheri ***(P)***	Fletcher's Drumsticks	V	
Lastreopsis hispida ***(P)***	Bristly Shield Fern	E	
Pelargonium sp. Striatellum (G.W.Carr 10345)	Omeo Storks Bill	E	E
Persoonia acerosa ***(P)***	Needle Geebung	V	V
Persoonia hindii* (P)		E	
Persoonia 100arginate		V	V
Prasophyllum fuscum	Slaty Leek Orchid	CE	V
Prasophyllum sp. Wybong (C. Phelps ORG 5269)	A Leek Orchid		CE

SCIENTIFIC NAME	COMMON NAME	TSC Act	EPBC Act
Pultenaea glabra ***(P)***	Smooth Pea Bush	V	V
Pultenaea setulosa		V	
Streblus pendulinus	Siah's Backbone		E
Thesium australe	Austral Toadflax	V	V
Wollemia nobilis	*Wollemi Pine*	E	*E*
Newnes Plateau Shrub Swamp* (P)		E	
Temperate Highland Peat Swamps on Sandstone* (P)			*E*
Upland Basalt Eucalypt Forest of the Sydney Basin Bioregion			*E*
White Box-Yellow Box Blakelys Red Gum Grassy Woodland and Derived Native Grassland		E	*CE*

V=Vulnerable, E = Endangered, CE – Critically Endangered
* - Located during the field surveys
(P) – Potential to occur within the site

The RPS (2013b) assessment found that there were only 11 flora species with the actual potential to occur within the 900 Area based on the presence of suitable habitat requirements. Two ecological communities have the potential to occur within the 900 Area.

A total of 164 flora species were identified during field investigations, of which only three were exotic. A complete list of the flora species identified on site during the survey is provided in **Appendix D**. One threatened flora species, *Persoonia hindii*, was recorded within several locations in the south-western area of the site during a previous field survey (RPS 2012b). No additional observations of threatened flora species were recorded within the site during the field surveys.

In total, 15 vegetation communities were identified within the SMP Application Area, with ground surveys confirming the location of each. The 900 area is predominately comprised of Newnes Plateau Narrow-leaved Peppermint – Silver-top Ash Layered Open Forest and Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland with both communities covering more than 50% of the 900 area.

The Newnes Plateau Hanging Swamp (NPHS) and Newnes Plateau Shrub Swamp (NPSS) occur in the area. NPSS are listed under the TSC Act as EECs. In addition, the federal EPBC Act lists *Temperate Highland Peat Swamps on Sandstone* as an EEC, which include Newnes Plateau Hanging Swamp and Newnes Plateau Shrub Swamp which both fall into the classification of this vegetation community. This is discussed further in **Section 8.1.5**.

Fauna

The Flora and Fauna Assessment (RPS 2013) identified that there is the potential or likely potential for 39 threatened fauna species to occur in the SMP Application Area, as identified in **Table 24**. Only four of these species were located during the survey. Despite this, habitat to potentially support all species listed in **Table 24** is present in the 900 Area. A "*****" indicates that the species was located during the survey.

Table 24 Potential or Known Threatened Fauna Species in the SMP Application Area

Scientific Name	Common Name	Status TSC Act	Status EPBC Act
Amphibia			
Heleioporus australiacus	Giant Burrowing Frog	V	V
Litoria booroolongensis	Booroolong Frog	E	E
Litoria littlejohni	Little John's Tree Frog	V	V
Mixophyes balbus	Stuttering Frog	E	V
Pseudophyne australis	Red-crowned Toadlet	V	
Reptilia			
Eulamprus leuraensis	Blue Mountains Water Skink	E	E
Hoplocephalus bungaroides	Broad-headed Snake	E	V
Aves			
Hieraaetus morphnoides	Little Eagle	V	
Anthochaera Phrygia	Regent Honeyeater	CE	E
Callocephalon fimbriatum*	**Gang-gang Cockatoo**	V	
Calytorhynchus lathami	Glossy Black Cockatoo	V	
Chthonicola sagittata	Speckled Warbler	V	
Climacteris picumnus	Brown Treecreeper	V	
Daphoenositta chrysoptera	Varied Sittella	V	
Glossopsitta pusilla	Little Lorikeet	V	
Melanodryas cucullata	Hooded Robin	V	
Petroica boodang *	**Scarlet Robin**	V	
Petroica phoenicea	Flame Robin	V	
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V	
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subsp.)	V	
Ninox strenua	Powerful Owl	V	
Ninox connivens	Barking Owl	V	
Tyto tenebricosa	Sooty Owl	V	
Tyto novaehollandiae	Masked Owl	V	
Mammalia			
Cercartetus nanus	Eastern Pygmy-possum	V	
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E
Petaurus australis	Yellow-bellied Glider	V	
Petaurus norfolcensis	Squirrel Glider	V	
Phascolarctos cinereus	Koala	V	
Chalinolobus dwyeri*	**Large-eared Pied Bat**	V	V

Scientific Name	Common Name	Status TSC Act	Status EPBC Act
Chalinolobus picatus	Little Pied Bat	V	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E	E
***Miniopterus schreibersii* subsp. *Oceanensis* ***	**Eastern Bentwing Bat**	V	
Mormopterus norfolkensis	Eastern Freetail Bat	V	
Petrogale penicillata	Brush Tailed Rock Wallaby	E	V
Pseudomys novaehollandiae	New Holland Mouse		V
Saccolaimus flaviventris	Yellow-Bellied Sheathtail Bat	V	
Scoteanax rueppelli	Greater Broad-nosed Bat	V	
Insecta			
Petalura gigantean	Giant Dragonfly	E	

V=Vulnerable, E = Endangered, CE – Critically Endangered
* - Located during the field surveys

Opportunistic observations, anabat recordings positively identified 61 fauna species on site during the surveys. A total of 44 species of birds were opportunistically recorded during the survey. Species identified include common woodland birds including the Eastern Yellow Robin (*Eopsaltria australis*), White-eared Honeyeater (*Lichenostomus leucotis*) and the Grey Fantail (*Rhipidura albiscapa*). Observations of herpetofauna on site were restricted to common species including the Common Eastern Froglet (*Crinia signifera*) and Copper-tailed Skink (*Ctenotus taeniolatus*).

A full list of fauna species identified on site during the recent survey is provided in **Appendix D**.

Four threatened fauna species listed as vulnerable under the TSC Act were recorded including the Gang-gang cockatoo and the scarlet robin whilst the Long Eared Pied Bat and the Eastern Bent Wing Bat were identified through echolocation calls. No threatened invertebrate fauna was recorded during the survey, although habitat was found to be present for the Giant Dragonfly. The food plant of the Bathurst Copper Butterfly larvae, although occurring in the wider locality, was not recorded within the SMP Application Area.

Statutory Requirements / Guidelines

The TSC Act and the EPBC Act aim to list and protect threatened species and habitat types. The Acts protect species by allowing a list of threatened species to be constructed and maintained.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

During the stakeholder consultation for this SMP Application, concerns relating to impact on threatened fauna species were raised by stakeholders. Particular concern was raised in relation to species such as the Giant Dragonfly that are reliant on swamps in the area and therefore are seen (by stakeholders) to be particularly sensitive to subsidence impacts on hydrology. This was considered in the SMP risk assessment, which found that the risk to

threatened fauna species from the proposed partial extraction in the SMP Application Area was low.

During the stakeholder consultation for this SMP Application, concerns relating to impact on NPSS or NPHS were raised by stakeholders. Clarence Colliery is aware that any impacts to these swamps would be of concern to the local community and environmental groups, Government Departments and subsequently, the impact assessment below and in **Section 8.1.5** addresses this issue.

Baseline Monitoring

Since 2004, there have been on-going flora and fauna monitoring surveys within Clarence Colliery holdings, including the 800 area, the 700 Area, Outbye Area, Eastern Areas and the 900 Area. The locations of the baseline flora and fauna monitoring sites are shown in **Figure 11** and in **Figure 12** across the whole lease.

Specifically over the 900 Area, baseline monitoring for flora and fauna has been undertaken in a limited number of swamps and heath land over the 900 Area and the neighbouring 700 Area.

Due to the proximity of the current monitoring locations to the SMP Application Area, it should be possible to monitor any potential effects from mining activities using the partial extraction mining technique by continuing surveys at existing sites. It is acknowledged that it would be impractical to monitor every swamp particularly in light of the risk of impact, and the difficulty / safety hazards regarding access to some of the more remote areas. Furthermore, the data amassed since 2004 regarding known fauna species and the impacts from partial extraction activities is such that the risk of impact from partial extraction is well known to be negligible. In addition to the results from the seven part tests and given the years of performance monitoring, Clarence Colliery is confident that there will be no discernible impact on flora and fauna in the 900 Area.

In 2011, Biological Monitoring Surveys undertook a review of faunal monitoring effort across the Newnes Plateau. Biological Monitoring Surveys (2011) reported:

> *Fauna monitoring across the Newnes Plateau commenced in 2004. The objectives of the monitoring program (which is still ongoing 9 years later) are to provide an ongoing assessment of any potential changes to the native fauna and wildlife habitat that could be caused by mining. With over 29 sites across the Newnes Plateau, surveyed three times per year Centennial (including Clarence) believe that there is now an extensive set of both pre and post mining data. In terms of effort, more than 36,000 trap hours and 16,000 records of fauna have amassed over the years. An important statistic that supports the known fauna is that the number of new species located as leveled off and are reaching an asymptote indicating that by and large, the monitoring program are successful in locating all species on the Newnes Plateau and approaching the total number of species expected on the Newnes Plateau.*

The continued monitoring program (including those sites that have been extracted beneath) have shown no signs of impact when pre-mining data is compared to post mining data. This information supports the impact prediction (or lack thereof) for the 900 Area.

The monitoring sites have been selected to monitor flora and fauna within swamp, woodland and cliff line environments. Previous experience from the extensive flora and fauna monitoring in place over areas that have been extracted (using partial pillar extraction techniques), has shown no impact to flora and fauna following mining. This demonstrates that the risk of impacts from mining on flora and fauna over the SMP application area is

extremely low. Consequently data from the ongoing surveying from these sites can be used to monitor the area associated with the 900 Area, including the swamps. No additional baseline monitoring has been recommended by RPS (2013)

Impact Assessment

RPS (2013a) conducted a seven part test on species that have the potential to be impacted by partial extraction activities. This was essentially limited to those habitats that are most sensitive to subsidence including NPSS and cliff line/pagoda habitat. RPS (2013) concluded:

> *Section 5A of the EP&A Act lists seven factors that must be taken into account in the determination of the significance of potential impacts on 'threatened species, populations or ecological communities (or their habitats)' listed under the TSC Act. The Assessment of Significance (**Seven-part Test**) is used to determine whether there is likely to be a significant impact on threatened species, populations or ecological communities or their habitats, and thus whether a Species Impact Statement (SIS) is required.*

The following species with the potential to occur in the 900 Area that rely on habitat particularly sensitive to subsidence impact are listed below. The habitat types include Cliff lines, pagodas, NPHS and NPSS. The seven part test was carried out on the following species.

Flora Species
Vulnerable Species
- *Boronia deanei*

Fauna Species
Endangered Species
- *Blue Mountains Water Skink*
- *Broad-headed Snake*
- *Giant Dragonfly*
- *Brush-tailed Rock Wallaby*

Vulnerable Species
- *Eastern Bentwing-bat*
- *Large-eared Pied Bat*
- *Little Pied Bat*

Endangered Ecological Communities
- *Newnes Plateau Shrub Swamp (NPSS)*

*An assessment of significance has been completed for the above threatened species and ecological communities (refer to **Appendix D**). The application of the Seven-part Test concluded that there is not likely to be a significant effect on any identified threatened species, populations or ecological communities, or their habitats arising from the proposed activities.*

The Greater Lithgow LGA is listed on Schedule 1 of SEPP 44, and therefore the proposal is subject to SEPP 44 assessment. None of the tree species listed on Schedule 2 were recorded on site. Additionally, none of the vegetation communities recorded on site list any Schedule 2 tree species as a dominant or diagnostic species. Therefore, whilst tree species listed on Schedule 2 may occur within the site, it is unlikely that they would make up 15% or more of the tree species present. The site is therefore unlikely to represent 'potential Koala habitat'. Furthermore, given the low level of impact predicted to occur, it is highly unlikely that any koala habitat, if present, would be affected by the proposal.

The site is not a World Heritage property nor is it a National Heritage place, however, it is closely bordered by the World Heritage declared Greater Blue Mountains Area NSW. The site is located 3.5 kilometres from the western border of the Greater Blue Mountains Area NSW.

The site is not part of any Ramsar Wetland area and is not in close proximity to any Ramsar-declared wetland.

The site is not part of or within close proximity to any Great Barrier Reef Marine Park.

The site is not part of or within close proximity to any Commonwealth Marine Area.

A Protected Matters Search was conducted to determine if any nationally listed threatened species and ecological communities under the EPBC Act 1999 were recorded within a 10km radius of the project area (see also **Table 23** and **24**). A number of threatened species and one community were recorded within a 10 km radius of the project area. An assessment was undertaken in accordance with the EPBC Act and *EPBC Act Policy Statement 1.1 - Significant Impact Guidelines Matters of National Environmental Significance* (DEWHA, 2009). A summary of the results of this assessment carried out by PRS (2013b) are presented below.

No vegetation clearing will occur as a result of this proposal. There is potential for an impact on this EEC if subsidence is significant enough to alter swamp hydrology and/or groundwater levels, although this is highly unlikely from partial pillar extraction activities. A recent review of over 13 years of subsidence monitoring data at Clarence shows that the partial pillar extraction methods utilised by Clarence Colliery has resulted in extremely low levels of subsidence (Golder 2013c), and numerous studies of the long-term predictions for subsidence levels as a result of proposed partial extraction, including areas within the 900 Area SMP Application, do not exceed 'significant' levels of >100mm. Monitoring of groundwater levels is continuously undertaken within a THPSS community at Happy Valley Upper Swamp and Happy Valley Swamp, whilst seasonal photographic monitoring and surface inspections occur within Farmers Swamp and Farmers South Swamp. There was no evidence of mining related impacts to groundwater levels or changes to surface integrity of swamps following bord and pillar mining operations in these areas (Aurecon 2013).

Given that extensive monitoring has not detected any evidence of significant subsidence or modifications to groundwater levels as a result of bord and pillar mining methods, the proposed bord and pillar mining is not considered likely to have a significant impact on areas of THPSS on site.

No threatened species, threatened ecological communities or listed migratory species are expected to be impacted upon as a result of the proposal. No surface impacts are expected as a result of the proposal, and predicted subsidence levels as a result of bord and pillar mining methods utilised on site are projected to be insignificant. This leads to the conclusion that the above-listed thresholds for determining that a significant impact is not likely to have been reached. It is therefore considered unlikely that the threatened species, migratory species and/or ecological community identified above will be affected by the proposal.

The Proposal will not have a significantly adverse effect on any Commonwealth marine area, as there are no such marine areas within the region. Furthermore partial pillar extraction within the 900 Area do not involve nuclear activities.

Based on all of the above and pursuant to the EPBC Act, an assessment of potential impacts arising from the proposal on MNES has concluded that no significant impact is likely to relevant Matters of National Environmental Significance.

Monitoring, Mitigation and Management

Flora and fauna monitoring will continue to be undertaken in accordance with standard practice at Clarence Colliery, at the baseline monitoring locations shown on **Figure 11.** The existing monitoring sites in the 700 Area and Outbye Areas present the majority of the habitat located within the 900 area, therefore it is not deemed necessary to establish additional monitoring. The monitoring is currently undertaken during three seasons of the year (autumn, spring and summer) to ensure natural variability of fauna populations are taken into consideration. Despite this, an Environmental Monitoring Program (**EMP**) will be developed for the 900 Area should this SMP be approved.

The EMP will describe further flora and/or fauna monitoring within the 900 Area. The first swamp to be partially extracted beneath (Bungelboori #5 Swamp) already has monitoring established with more than two years of baseline data. Partial extraction underneath other swamps in the 900 Area will likely occur post 2016 allowing the collection of 2 years baseline data.

Flora monitoring will continue within the following Swamps:

- Bungleboori #5 Swamp;
- Happy Valley Upper; and
- Happy Valley Swamp.

Fauna monitoring will continue at the sites already established within the 900 Area and the 700 Area as well as the sites established for the Outbye Area. An additional two flora and fauna sites will be investigated within the Paddys Swamp East. Indicative locations are presented in **Volume 2**. An additional fauna site will also be investigated in the northern portion of the 900 Area. The objective would be to monitor fauna associated with cliff line and pagoda habitat. These sites have not been groundtruthed and will only be further investigated should this SMP be approved.

The SMP (SMP Application Volume 2) contains further details on the monitoring, mitigation and management of potential impacts.

8.1.7 AREAS OF ARCHAEOLOGICAL AND/OR HERITAGE SIGNIFICANCE

Characterisation

RPS conducted a Cultural Heritage Assessment of the SMP application area to assess the impact of the proposed extraction on known Archaeological sites and Aboriginal artefacts. A copy of the report is attached as **Appendix E**. The assessment (which includes consultation in accordance with the *Aboriginal Cultural Heritage Consultation Requirements (**ACHCRs**) for Proponents* (DECCW 2010)) comprises a detailed background review of previous archaeological assessments for the area, the environmental context, a brief history of Lithgow LGA, results from an Aboriginal Heritage Information Management System (**AHIMS**) database search and searches for non-indigenous heritage within the area.

The Assessment included the development and use of a Predictive Model for the area. A predictive model is created to give an indication of Aboriginal sites likely to occur within the 900 Area. It includes a review of existing information on the regional and local archaeological context and the environmental context. The predictive model is necessary to formulate appropriate field methodologies in addition to providing information for the assessment of archaeological significance.

The following site predictions for the 900 Area have been made on the basis of the environmental context, available historic observations of Aboriginal people in the region, archaeological studies and analysis of the AHIMS data.

On the basis of the AHIMS data, as well as review of the available information, RPS (2013a) considered that rock shelters either with/without deposit and/or art will be the most likely site type to be present in the 900 Area, followed by artefact sites (isolated finds or scatters). Provided certain criteria are met, such as the presence of large fine-grained sandstone sheets either on the plateau areas or drainage corridors adjacent to a reliable water source, grinding groove sites also have the potential to be identified.

RPS found that the majority of artefact scatters and shelters with art and/or deposit located in the 900 Area have been found to lie within 100 metres of a drainage line. It is therefore predicted that investigations near to drainage lines in the 900 Area have an increased potential to identify stone artefact sites and shelters with art or deposit. Shelter sites are also commonly located in elevated areas such as ridges, where rock outcrops are common.

RPS also reviewed previous archaeological investigations to assist with the predictive model. The outcome of the review indicated that artefact sites generally comprise flaked stone artefacts made from chert, quartz, quartzite and mudstone. Shelter sites generally contained deposit, art, or both features simultaneously. RPS therefore predicted that artefact sites within the area will comprise flaked stone tools, cores and flakes and made from chert, quartz, quartzite and mudstone, with shelter sites having potential to contain both deposit and art.

The review of previous archaeological assessments revealed that a number of field surveys had previously been undertaken in the vicinity of the 900 Area, particularly on the Newnes Plateau. A search of the AHIMS database showed that there were 80 sites previously recorded within ten kilometres of the 900 Area. Of these, eight sites were recorded within the secondary extraction area and one site within a first workings zone. Five of these sites being rock shelters with/without art and or deposit, three sites being artefact scatters and a single grinding groove site

An archaeological field survey was conducted by RPS Archaeologist and Aboriginal stakeholders on 4 – 7 February 2013 pursuant to the OEH's Aboriginal Cultural Heritage Consultation Requirements (ACHCRs).Ground trothing of an additional area in the south east portion of the 900 Area was undertaken over 15-16 March 2012 (RSP, 2012a) Registered Aboriginal Groups involved in the field survey included Bathurst Local Aboriginal Land Council, Gundungurra Tribal Council Aboriginal Corporation, Mingaan Aboriginal Corporation, North East Wiradjuri, Warrabinga Native Title Claimants Aboriginal Corporation, and Native Title Claimants Wiray-dyuraa Ngambaay-dyil/Wiray-dyuraa Maying-gu. The survey effort equated to 785 person hours in the field. During the course of the Aboriginal cultural heritage field survey, three of the nine sites previously identified on the AHIMS database were groundtruthed.

The SMP Application Area was surveyed in seven survey units, with each survey unit assessed for exposure and visibility. Further details of the field survey methodology can be found in **Appendix E**. No new Aboriginal objects or places were identified.

The most common sites within the 900 Area are shelters, either with/without art and/or deposit. Rock shelters with art and/or deposit were also the only site type able to be relocated during the field survey. These site types were located on elevated areas such as ridges, and in close proximity to water courses and creek lines, as predicted.

Not all of the artefact sites previously recorded within the 900 Area were able to be relocated. This was largely due to the density of vegetation, changes in the landscape over time, issues of accessibility, the nature of the sites and the time that had elapsed since the site was originally recorded. Of the five previously recorded rock shelter sites that were located within the 900 Area, three were able to be relocated. This was due primarily to issues of accessibility owing to dense vegetation and steep and dangerous terrain. These shelters were largely in good condition, though they were all heavily obscured by vegetation and moss/lichen growth, and the shelter floors have clearly been disturbed.

A description of the registered sites, the predicted subsidence associated with each site within the 900 area and their assessment of significance are presented in **Table 25.** Details regarding the assignment of significance criteria can be found in the RPS assessment contained in **Appendix D.**

Table 25 Summary of Significance of each Archaeological Site and Predicted Subsidence

Site	Site Type	Panel Number	Predicted subsidence (estimated long term subsidence) mm	Local / Regional	Overall Significance
45-1-0003	Mt Horne engraving site	908/910 barrier	100mm (<65mm)	Local	High
				Regional	Moderate
45-1-0130	Shelter with deposit	908	100mm (<65mm)	Local	Low
				Regional	Low
45-1-0183	Shelter with deposit	910	100mm (<65mm)	Local	Moderate
				Regional	Low
45-1-0185	Quartz cores (less than 10)	913	100mm (<50mm)	Local	Low
				Regional	Low
45-1-0186	Pagoda wall with faint red hand stencils – preservation poor	917	100mm (<50mm)	Local	Low
				Regional	Low
45-1-0187	Quartzite core and two flakes, less than 20 quartz flakes and two indurated mudstone flakes in a heavily vegetated area near a swamp margin	915	100mm (<50mm)	Local	Low
				Regional	Low
45-1-0188	Two indurated mudstone flakes and less than ten quartz flakes in an eroded area near to a track and pumping sump	917	100mm (<50mm)	Local	Low
				Regional	Low
45-1-0189	Damp rock wall with two faint red hand stencils on it	902	100mm (<65mm)	Local	Low
				Regional	Low
45-1-2691	Rainwater filled depression with one complete grinding groove and one partial grinding groove located adjacent to it	910	100mm (<65mm)	Local	Low
				Regional	Low

In terms of non-indigenous Heritage Items, RPS (2013a) noted the following in respect of the 900 Area:

- There are no items on the World Heritage list
- There are no items on the National Heritage list
- The are no places/items on the Commonwealth Heritage list
- There are no places on the Register of the National Estate
- There are no items on the State Heritage Inventory
- There are no items listed on the s170 Registers
- There are no items on the Lithgow Local Environment Plan
- There are no other Heritage items

No evidence resembling the early Lithgow settlement record and mining industry, or other items of European cultural significance were identified during the field survey investigation.

Statutory Requirements / Guidelines

The National Parks and Wildlife (**NPW**) Act (1974) (as amended) is the primary state legislation relating to cultural heritage. The legislation is overseen by the OEH.

The NPW Act provides statutory protection for all Aboriginal relics (not being a handicraft made for sale), with penalties levied for breaches of the Act. Part 6 of this Act is the relevant part concerned with Aboriginal objects and places, with the Section 86 and Section 90 being the most pertinent. In 2010, this Act was substantially amended, particularly with respect to Aboriginal cultural heritage requirements.

There are now four major offences:

1. A person must not harm an object that the person knows is an Aboriginal object;

2. A person must not harm an Aboriginal object;

3. For the purposes of s86, "*circumstances of aggravation*" include (a) the offence being committed during the course of a commercial activity; or (b) that the offence was the second or subsequent offence committed by the person; and

4. A person must not harm or desecrate an Aboriginal place.

Penalties for all offences under Part 6 of this Act have also been substantially increased, depending on the nature and severity of the offence.

Historical archaeological relics, buildings, structures, archaeological deposits and features are protected under the Heritage Act 1977 (as amended 1999) and may be identified on the State Heritage Register (**SHR**) or by and active Interim Heritage Order. Certain types of historic Aboriginal sites may be listed on the SHR or subject to an active Interim Heritage Order; in such cases they would be protected under the Heritage Act 1977 and may require approvals or excavation permits from the NSW Heritage Branch.

Stakeholder Consultation

Aboriginal consultation was undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements* (**ACHCR**) *for Proponents* (DECCW 2010). Initially, RPS (in accordance with Stage 1 of the ACHCRs) identified, notified and invited Aboriginal people who hold cultural information to register an expression of interest in the assessment. This identification process drew on reasonable sources of information including: the relevant OEH regional office, the relevant Local Aboriginal Land Council(s), the Register of Aboriginal Owners, the Native Title Tribunal, Native Title Services Corporation Limited, the relevant local council(s) and the relevant Catchment Management Authority. An advertisement was also placed in the Lithgow Mercury on 6 October 2011 (see **Appendix D**) calling for registration of interest for Aboriginal Cultural Knowledge Holders in the Capertee, Blackmans Flat, Lidsdale and Newnes Plateau localities.

Additionally, 15 Aboriginal organisations and/or individuals were notified of the project and were invited to register an expression of interest for Aboriginal consultation. As a result of the invitation for expression of interest letters and the advertisement ten Aboriginal parties registered their interest in the project including:

- Warrabinga Native Title Claimants Aboriginal
- North-East Wiradjuri
- Bathurst Local Aboriginal Land Council
- Gundungurra Tribal Council Aboriginal Corporation

- Mingaan Aboriginal Corporation
- Gundungurra Tribal Council Aboriginal Corporation native title claimants
- Wiray-dyuraa Ngambaay-dyil and Wiray-dyuraa Maying-gu native title claimants
- Mooka Traditional Owners
- Wiradjuri Council of Elders
- Warrabinga/Wiradjuri people native title claimants

Once a list of registered Aboriginal parties has been compiled from the expression of interest process, they need to be consulted in accordance with stage 2, 3 and 4 of the ACHCRs.

Information regarding the proposed heritage assessment methodology and strategy for collecting information on cultural heritage significance was provided in writing to the registered Aboriginal parties on 23 November 2011. Six groups returned their comments on the methodology by the closing date for comments. In addition, the letter of 23 November 2011 invited registered Aboriginal parties to attend an information session at Black Gold Cabins on 7 December 2011. This information session included a formal presentation of the relevant upcoming Centennial projects, as well as a Questions and Answers session in order to allow registered Aboriginal parties to clarify any heritage, methodological or timing issues regarding the projects. An additional letter outlining the specific methodology for the Clarence 900 Area was sent to all registered Aboriginal parties on 21 November 2012. Only four groups responded to the methodology submitted specifically for the 900 Area.

According to the ACHCR process, a site survey should be undertaken with reference to the nature, scale and complexity of the project. With these factors considered, six registered Aboriginal parties were invited to participate in the survey, which was undertaken on 4 – 7 February 2013. This built on the due diligence survey carried out in March 2012. The groups who participated in the field work included:

- Bathurst Local Aboriginal Land Council
- Gundungurra Tribal Council Aboriginal Corporation
- Mingaan Aboriginal Corporation
- North East Wiradjuri
- Warrabinga Native Title Claimants Aboriginal Corporation
- Wiray-dyuraa Ngambaay-dyil and Wiray-dyuraa Maying-gu

A copy of the draft report was provided to the following registered Aboriginal parties on 11 June 2013 for review and comment. No comments were received from any of the Aboriginal Groups.

During the stakeholder consultation for this SMP Application, concerns relating to impact on archaeological sites have not been raised by stakeholders

Baseline Monitoring

Field surveys have verified the locations of the archaeological sites within the SMP Application Area. No additional baseline monitoring is required prior to mining.

Impact Assessment

As the level of subsidence from the proposed mining is predicted to be no more than 100 mm, it is unlikely that artefact scatters or isolated finds will be impacted by the proposed works. **Table 26** provides a summary of potential impacts, risk to heritage and mitigation options. Given the level of impact, mitigation options 1 and 2 under the mine subsidence impact category are the most relevant.

Table 26 Summary of potential impacts, risk and mitigation options for heritage

Impact	Risk to Heritage	Mitigation Option 1	Mitigation Option 2	Mitigation Option 3
Mine Subsidence	Disturbance/damage to cultural heritage sites	Ensure SMP is undertaken in consultation with the registered Aboriginal Groups	Regular monitoring including pre and post mining monitoring programme (based on safe access and egress to the area and risk of impact)	Move artefacts under an Aboriginal Heritage Impact Permit (**AHIP**) to location outside the impact area if subsidence is predicted to cause potential harm
Plant/vehicle movement	Disturbance/damage to identified artefact scatters and isolated finds	Avoid; ensure Centennial Clarence Environmental officer is given site location	Cordon off site area or prevent vehicular access to site	Move artefacts under an AHIP to location outside of impact area
	In wet conditions, heavy plant equipment/vehicles may disturb soil profiles at artefact scatters and isolated finds	Restrict heavy plant/vehicle movement to dry weather conditions	Avoid	Move artefacts under an AHIP to location outside impact area
Vandalism	Disturbance/damage to rock shelters, grinding groove areas and rock art	Avoid; ensure Centennial Clarence environmental officer is given site location	Cordon off site area and block access route to prevent vehicular access to site	Site awareness and sensitivity education program

More specific to the 900 Area, RPS (2013a) undertook an impact assessment based on the extraction of 900 Area resulting in no more than 100mm of movement. A summary of the findings is provided below:

> *There are two main types of activity associated with the proposed development of the 900 Area which have the potential to impact on Aboriginal heritage sites: subsidence associated with underground mining and surface disturbance activities (including construction and land clearance). Of the sites identified within the 900 Area, the site types most likely to be affected by subsidence are rockshelters and grinding grooves. Open sites (artefact sites) are generally made up of scattered artefacts on the ground surface. Due to the technique of mining proposed (partial pillar extraction) artefact sites are not considered to be at risk of harm from subsidence and ground surface disturbance.*
>
> *Of the nine archaeological sites that are located within the 900 Area, six are potentially at risk of harm from predicted subsidence should the mine plan and extraction method change from the partial pillar extraction mining technique. As this report has been prepared to support an SMP application for partial pillar extraction mining, the potential for AHIMS sites #45-1-0003 (shelter with art and deposit), #45-1-0130 (shelter with deposit), #45-1-00183 (shelter with deposit), #45-1-2691 (grinding groove), #45-1-0186 (shelter with art) and #45-1-0189 (shelter with art) to be affected is considered negligible.*
>
> *No archaeological sites are anticipated to be affected by the construction of surface facilities.*

No Aboriginal sites of state significance were identified by RPS (2013a), and as such there are no sites of high significance to NSW that require protection for inter-generational equity purposes. No Aboriginal Places (according the AHIMS register) are located within the 900 Area.

Clarence Colliery has identified no discernible impacts on the surface of previously mined areas using the partial extraction mining methods, and as such it is expected that mining in the 900 Area will also have no impacts on any Aboriginal cultural heritage sites.

As no items of non-Indigenous cultural heritage were identified in the SMP Application Area, no impacts are predicted.

Monitoring, Mitigation and Management

Conservation of Aboriginal sites and areas of archaeological sensitivity is the preferred heritage outcome. The following recommendations have been suggested by Clarence and RPS (2013a), taking into consideration the significance of Aboriginal heritage, potential impacts and relevant legislation.

1. Ensure that disturbance associated with the proposed mining operations is limited to the boundaries of the area identified in this report. If additional works are planned outside of the study area, additional cultural heritage investigation may be required.

2. If impact to any sites containing artefacts is unavoidable then a surface salvage should be undertaken under a Section 90 Permit. A Control and Care Permit should be obtained in consultation with local Aboriginal Community Stakeholders and the artefacts transferred to a designated keeping place. However it is considered highly unlikely that any of the artefact sites within the 900 area will be impacted upon by the proposed bord and pillar partial extraction works.

3. All relevant Clarence Colliery staff should be made aware of their statutory obligations for heritage under NSW NPW Act (1974) and the NSW Heritage Act (1977), which may be implemented as a part of the normal induction process.

4. The location of any Aboriginal cultural heritage sites in the study area should be included in the Clarence Colliery environmental management framework for the study area, so that all relevant staff members are aware that these areas will require management.

5. If further Aboriginal site/s are identified in the study area, then all works in the area should cease, the area cordoned off and contact made with the OEH Environment Line phone no. 131 555, a suitably qualified archaeologist and the relevant Aboriginal stakeholders, so that it can be adequately assessed and managed.

6. In the unlikely event that skeletal remains are identified, work must cease immediately in the vicinity of the remains and the area cordoned off. The proponent will need to contact the NSW Police Coroner to determine if the material is of Aboriginal origin. If determined to be Aboriginal, the proponent must contact the OEH Environment Line 131 555, a suitably qualified archaeologist and representatives of the local Aboriginal Community Stakeholders to determine an action plan for the management of the skeletal remains, formulate management recommendations and to ascertain when work can recommence.

7. If, during the course of development works, significant European cultural heritage material is uncovered, work should cease in that area immediately. The NSW

Heritage Branch should be notified and works only recommence when an appropriate and approved management strategy is instigated.

8. AHIMS #45-1-003 is considered to be highly significant at a local level and moderately significant on a regional level. The Mine design has already taken this into account and is confident in its ability to limit subsidence at this location

9. All relevant Centennial staff and contractors should be made aware of their statutory obligations for heritage under NSW *NPW Act* (1974) and the NSW *Heritage Act* (1977), which may be implemented as a heritage induction

10. Should Centennial Clarence modify or change the above described methodology for extraction, all cultural heritage items assessed in this report will need to undergo a revised impact assessment

8.1.8 STATE FOREST – FORESTRY MANAGEMENT ZONES

Characterisation

Approximately 96.4 hectares of the 900 Area is located within Forestry Management Zone (**FMZ**) 2 (**Figure 13**). Approximately 46% of this FMZ is contained within the first workings zone. FMZ 2 is broadly defined by NSW Forests as:

- **FMZ 2** – Specific management and protection of natural and cultural conservation*:*

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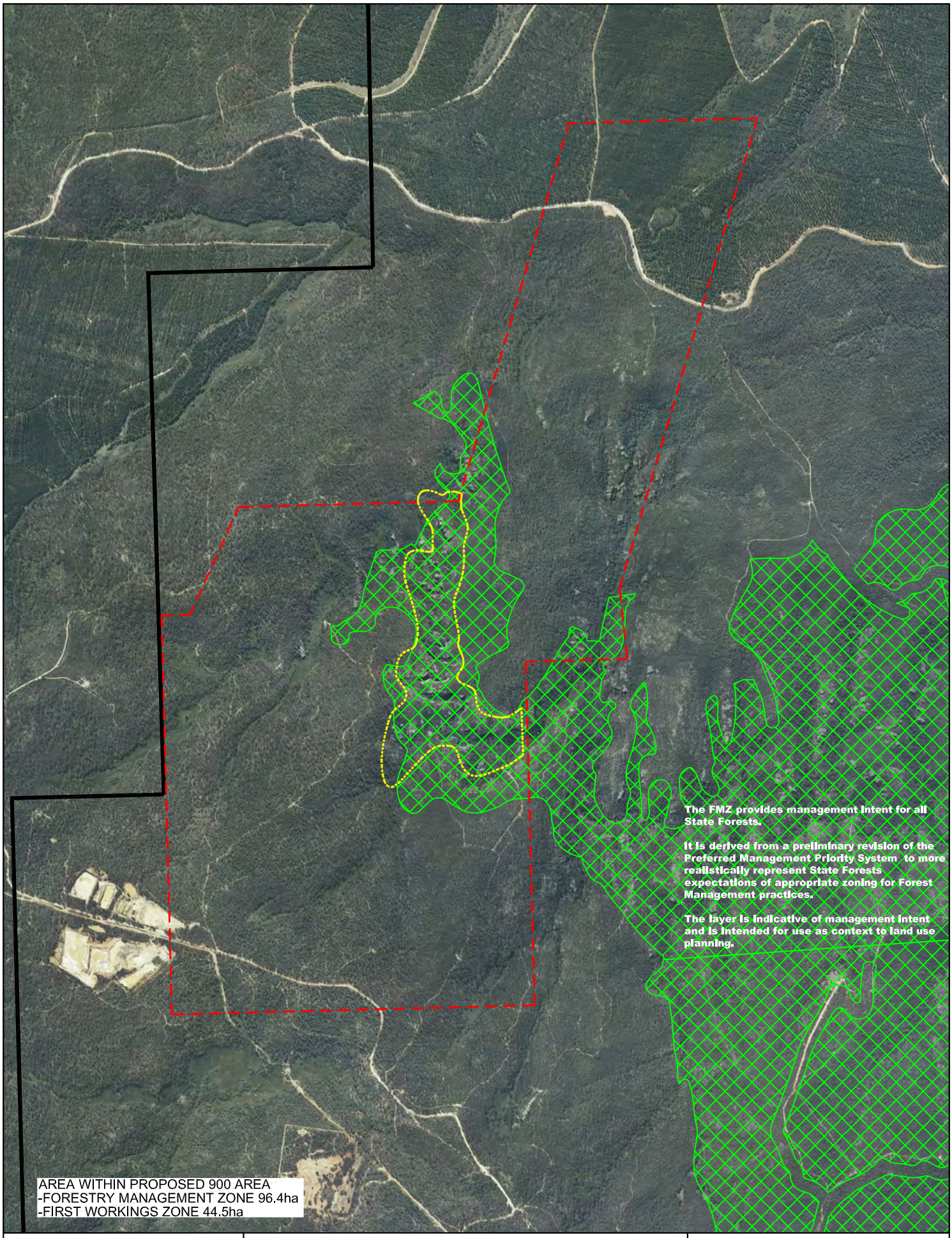

COLLIERY HOLDING BOUNDARY

FORESTRY MANAGEMENT ZONE - 2

PROPOSED 900 AREA

FIRST WORKINGS ZONE

FORESTRY MANAGEMENT ZONE(S)

NOTE: Aerial photo flown October 2008

Centennial Coal
Clarence

Figure 13.

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Statutory Requirements / Guidelines

The SMP Guidelines require that FMZ's 1, 2 and 3 be identified when compiling an SMP Application.

Forestry Management Zones are established under the *Forestry Act 1916* within NSW state forests. The objective of Forestry Management Zones is to delineate areas of high and low conservation value for forestry management purposes. FMZ 2 is reserved for the protection and management of areas of conservation value. Within FMZ 2, mining is permissible. Activities can be permitted provided that it is planned to be fully cognisant of the values that the zone is designed to protect, and would be approved with special conditions focused on environmental management. Timber harvesting is prohibited and new roads and fire trails must only be constructed where no practicable alternative exists. Such roads must be of minimum length, width and disturbance to facilitate safe and economic access.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

Forests NSW has been consulted in relation to this SMP Application and have provided the Forestry Management Zones for presentation in this SMP Application Area. Forests NSW have not indicated any objection to the SMP proposal.

Any surface works required for monitoring i.e. Temporary subsidence monitoring lines, will be undertaken in consultation with Forests NSW.

Baseline Monitoring

No specific baseline monitoring is necessary in relation to Forestry Management Zone 2.

Impact Assessment

The potential impact on the natural and cultural conservation values of the land are addressed in other sections of this document.

It is very unlikely that mining operations will impact upon the natural and cultural conservation values of the land identified as FMZ 2.

Monitoring, Mitigation and Management

Monitoring, mitigation and management in relation to natural and cultural conservation values of the land are addressed in other sections of this document.

The SMP (SMP Application Volume 2) contains further details on the monitoring, mitigation and management of potential impacts.

8.2 PUBLIC UTILITIES

8.2.1 ROADS (ALL TYPES)

Characterisation

There are no gazetted public roads within the SMP Application Area, however there are a number of unpaved Forests NSW access tracks and fire trails throughout the 900 area.

Statutory Requirements / Guidelines

There are no statutory requirements in relation to the undermining of forestry fire trails. Forests NSW does however, construct and maintain the trails to meet its internal standards. Should impacts from subsidence damage the roads, Clarence will repair the roads to an appropriate standard in consultation with Forests NSW.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

During the stakeholder consultation for this SMP Application, concerns relating to impact on roads have not been raised by stakeholders. Forests NSW have been consulted in relation to this SMP Application and have not indicated any objection to the SMP proposal.

Baseline Monitoring

The fire trails and access tracks within the SMP Application Area have been previously driven to ascertain their general condition. Particular attention was paid to cracks in the road and no cracks were noted. Some tracks over the 900 Area are impassable. This has been documented throughout several of the specialist assessment reports whereby access to certain areas was restricted. Furthermore, what appear to be 4WD track on the aerial photograph are actually well worn motorbike tracks, impassable by 4WD vehicles.

Impact Assessment

It is highly unlikely that mining operations will impact on four wheel drive fire trails and tracks in the SMP Application Area This is based on experience, whereby previous inspections of four wheel drive roads and forest trails over partially extracted areas have not suffered impacts due to subsidence. As the 900 Area will be extracted using the same mining technique, it is unlikely that there will be any impacts from subsidence on the tracks/trails.

Monitoring, Mitigation and Management

The monitoring program for roads will include an inspection during undermining and post mining. If surface cracking is present actions from continued observation to repair will be undertaken as appropriate in consultation with Forests NSW.

The SMP Application Volume 2 contains further details on the monitoring, mitigation and management of potential impacts particularly in terms of safety and serviceability.

8.2.2 ELECTRICITY TRANSMISSION LINES

Characterisation

An Endeavour Energy overhead powerline traverses the SMP Application Area. This is a 66kV powerline on wooden poles and provides electricity to Clarence Colliery, Hanson Quarry, infrastructure associated with the Angus Place and Springvale underground mines including Ventilation shafts and dewatering boreholes. The powerline is known as the 811 Feeder.

It is noted that the powerline and powerpoles traversing the 900 area, have been previously assessed as they originally formed a part of the 700W SMP area. The two panels (716 and 714 panels within 700W) that were going to pass underneath the powerline were terminated early due to poor geological conditions underground. Therefore the powerline was never extracted beneath. To ensure Clarence maximises its resource recovery, the 903 and 903a panels were extended to the west to extract the coal that was lost due to the early termination of 714 and 716 panels. This means that extraction activities will take place beneath the powerline as a part of the 900 Area mining.

In August 2012, PowerServe undertook a pre-mining assessment of that part of the powerline and associated powerpoles located above the 714 and 716 panels (now overlying 903a and 903 panels). The assessment included a description of each powerpole, its serviceability and a full photographic log. A full copy of the assessment report was provided to Endeavour Energy for their information. A summary of the assessment by PowerServe is provided below:

> *All structures from pole **132-137** presented in serviceable condition and no major problems were evident, the minor defects that were noted are listed below.*
>
> - *Pole 136 the down earth on the pole is damaged and only half the strands are joined.*
>
> *It was noted during the inspection that the access tracks to these assets were in desperate need of repair and any failure of the overhead network would cause major issues with heavy vehicle access poor or non-existent to most locations.*

Due to the lapse in time associated with the pre-mining condition assessment, another survey will be carried out by PowerServe (or similarly qualified supplier) should this SMP be approved.

Statutory Requirements / Guidelines

Electricity networks are managed under the *Electricity Supply Act 1995*, which provides network service provider to protect electricity assets from damage. The network service provider for the 66kV powerline is Endeavour Energy.

There are no statutory requirements specifically related to subsidence management under powerlines.

Stakeholder Consultation

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

Endeavour Energy have been consulted through the consultation process and concerns relating to impact on the powerline have not been raised by Endeavour Energy or other stakeholders.

Clarence also forwards copies of its Subsidence Management Status Reports to Endeavour Energy to raise awareness of Clarence's activities and performance.

Baseline Monitoring

A condition assessment has been carried out on each powerpole traversing the area as discussed above.

Impact Assessment

Given the low levels of subsidence from previous mining at Clarence Colliery, and the predicted low levels (100 mm) of subsidence for the SMP Application Area, the risk of damage to the powerline and powerpoles is considered low.

A post mining condition assessment was undertaken on powerpoles traversing the 700 Area on 1st August 2012 by PowerServe. The assessment included a description of each powerpole, its serviceability and a full photographic log. A full copy of the assessment report was provided to Endeavour Energy for their information. A summary of the assessment by PowerServe is provided below:

> *All structures from pole **118-131** presented in serviceable condition and no major problems were evident, the minor defects that were noted are listed below.*
>
> - *Pole 120 looked as if it had been struck by lightning which had resulted in damage to the down earth on the pole. There is no connection between the overhead earth and butt earth at this pole.*
> - *Pole 119 There is no connection between the overhead earth and butt earth at this pole.*
> - *Pole 118 There is no connection between the overhead earth and butt earth at this pole.*
>
> *The base of each pole between pole 118-131and surrounding areas was inspected to ascertain if any subsidence was evident and if it had impacted on the powerline and resulted in any load shifts of the overhead network, in our option no detectable differences were evident between this inspection and previous ones that have been completed and no detrimental impact has taken place on the overhead conductors and or structures. If any movement had accrued this is usually displayed with cracking of the ground line around the pole butt, this was not evident with these poles.*

In addition, surveys of the powerpoles have been undertaken over the 700 area. The latest survey was undertaken in January 2013. The results from these surveys records approximately 50mm of subsidence and some movement of the left hand and right hand side cross arms all less than 10cm. Even with the amount of movement recorded, powerpoles remain in a serviceable condition. Similar levels of subsidence are expected over the 903 and 903a panels and it is predicted that this level of subsidence will not impact on the safety or serviceability of the powerline and powerpoles traversing the area.

Monitoring, Mitigation and Management

The regular visual inspection of fire trails for surface cracks will incorporate an inspection of the powerline, and will include an inspection post mining. If there is evidence of ground movement, pole movement or damage, Clarence Colliery would record the observation, consult with the relevant stakeholders and take actions to stabilise the site and/ or remediate the infrastructure.

In addition to inspections, a pre-mining and post mining inspection of the powerpoles will be undertaken by PowerServe (or similarly qualified supplier) to confirm that the powerpoles and powerline are still in a safe and serviceable condition. The 700C line will be extended over the 903 and 903a panels (reflectors have already been installed on each powerpole in readiness for these surveys) with pre and post monitoring undertaken.

The SMP (SMP Application Volume 2) contains further details on the monitoring, mitigation and management of potential impacts.

8.2.3 SURFACE MINING VOIDS AND REHABILITATED AREA

Characterisation

The inactive Boral Sand Quarry marginally encroaches into the 900 area in the far south western portion of the 900 mining area, specifically the far inbye ends of 903 and 903a panels.

Statutory Requirements / Guidelines

The legislation that regulates potential impacts caused by subsidence upon surface mining voids and rehabilitation areas is the *Mining Act 1992 and Coal Mines Health and Safety Act 2002*.

Stakeholder Consultation

Consultation with Boral Quarries has been undertaken during the SMP process, and concerns relating to the impact on the sand quarries were not raised. It is noted that the area of the Boral Quarry traversing the 900 area, have been previously assessed as it previously formed a part of the 700W SMP area. Copies of both the ecological and Archaeological assessment reports were forwarded to Boral for their information. The two panels (716 and 714 panels within 700W) that were going to pass underneath the Boral owned land were terminated early due to poor geological conditions underground. Therefore the area was never extracted beneath. To ensure Clarence maximises its resource recovery, the 903 and 903a panels were extended to the west to extract the coal that was lost due to the early termination of 714 and 716 panels. This means that extraction activities will take place beneath the area as a part of the 900 Area mining.

Clarence forwards copies of its Subsidence Management Status Reports to Boral Quarries to raise awareness of Clarence's activities and performance.

The general consultation process and community consultation undertaken is described in **Section 9** (Community Consultation) and **Appendix F.**

Baseline Monitoring

The area associated with the Boral Quarry has been inspected on several occasions. The area is regularly accessed by 4WD and motorbike riders. Evidence of camping and rubbish dumping is frequently observed.

Impact Assessment

Given the low levels of subsidence from previous mining at Clarence Colliery, and the predicted low levels (maximum of 100 mm) of subsidence for the SMP Application Area, the risk of damage to the sand quarries in the 900 area is considered low.

Monitoring, Mitigation and Management

Due to the low risk of impact, no monitoring is proposed in association with the sand quarries in the 900 area. Consultation with Boral Quarries will continue to be undertaken throughout the mining in SMP Application Area.

8.2.4 AREAS OF ENVIRONMENTAL SENSITIVITY

Areas of environmental sensitivity as described in the SMP Guidelines and applicable to this SMP Application Area are:

- State Forestry Management Zone 2;
- Clarence aquifer;
- Cliffs, pagodas and escarpments;
- Newnes Plateau Hanging Swamp and Newnes Plateau Shrub Swamp; and
- Aboriginal archaeological sites.

All the above items have been addressed above.

8.2.5 IMPACT ASSESSMENT BASED ON INCREASED SUBSIDENCE

For pillar extraction applications, there is a requirement to assess the impacts of subsidence that are five times the predictions. For the SMP Application Area this is a level of subsidence of 500 mm. Subsidence impacts from longwall and full extraction pillar panels have been observed, however the levels of subsidence were not measured. Observed impacts included minor cliff and pagoda cracking and additional groundwater inflow to the workings.

The potential for 500 mm of subsidence in the SMP Application Area is extremely low. Given that the proposed mining method is not designed to cave and the factors of safety for the remaining pillars are intended for long term stability, 500 mm is not considered to be a realistic level of increased subsidence. To date, no subsidence results greater than 100 mm relating to partial pillar extraction have been recorded.

Further monitoring to substantiate pillar loading, long term stability and associated factors of safety, and overburden bridging characteristics are continuing (see Volume 2 of this SMP

Application). Data from this monitoring will be used to substantiate existing subsidence and pillar stability models.

9 COMMUNITY CONSULTATION

Community consultation during the preparation of the SMP was undertaken in accordance with, the requirements of the DPI – Mineral Resources "Guidelines for Applications for Subsidence Management Approvals" dated December 2003 and the "Guidelines for Best Practice Community Consultation in New South Wales Mining and Extractive Industries" (New South Wales Minerals Council, 2006). The definition of "Community" adopted for the purpose of developing the SMP community consultation strategy is anyone with an interest in subsidence issues for the proposed SMP application.

Clarence Colliery have undertaken consultation with the land owner, local community, Aboriginal groups, the Local and State Government authorities and other relevant stakeholders in preparation of the SMP. The extensive consultation previously completed by Clarence Colliery for other projects were used the identify stakeholders, along with an advertisement for registering interest.

A stakeholder consultation strategy has been implemented by Clarence Colliery during the SMP Application process. This process is detailed in **Table 27** below.

Table 27 Stakeholder Consultation Strategy

Key Consultation Actions	Mode of Consultation
Develop and record key consultation actions within consultation log template.	Complete (**Appendix F**)
First round advertising of SMP Application to seek interested stakeholders.	Advertisement in Newspaper (**Appendix F**)
Submit briefing paper to inter-agency panel to advise of SMP Application and seek feedback to address in SMP	Submission of Fact Sheet and various conversations and meetings (**Appendix F**)
Finalise the stakeholder register to include any advertisement respondents, and those stakeholders known from previous consultation	Stakeholder meeting invitations
Send letters to stakeholders (incl. authorities) to advise of SMP Application and seek attendance at stakeholder meeting	Letter
Hold Community Consultative Committee meetings to brief committee members and seek feedback	Meeting
Hold one-on-one consultations with key stakeholders/authorities	Meetings and correspondence
Hold stakeholder meeting at Clarence Colliery to brief attendees on the SMP and seek feedback	Meeting - presentation
Address any feedback received following workshop within the SMP Application	Correspondence received and responded to (**Appendix F**)
Make SMP publicly available following submission (as per DPI guidelines requirement)	Website, CD, hardcopy
Second round advertising - in local & state papers (as per DPI guidelines requirement)	Newspaper advertisement

Key Consultation Actions	Mode of Consultation
Responded to any submissions once the SMP is available for stakeholder comment (as per DPI guidelines requirement)	As required

SMP Advertisements

Clarence Colliery prepared and posted an advertisement in the Lithgow Mercury and The Land newspapers during October 2012. The advertisement was to notify the community of the intention to submit an SMP application for approval and to encourage community members to register an interest in the process so that they can be party to further consultation. The advertisement is attached in **Appendix F**. There were no responses to this advertisement.

Clarence Colliery will also be placing an advertisement in the state and local papers following submission of SMP Application to inform the community of the submission of the SMP and the locations at which the SMP could be viewed and how to provide comment on the submission.

Interagency Panel

Clarence Colliery prepared a factsheet titled “Clarence Colliery – 900 Area – SMP Preparation” which was sent to the Interagency Panel to inform them of the project. The factsheet included background information, locality, details of the panels to be mined, existing environment, SMP preparation and contact details of key people. The factsheet is attached in **Appendix F**.

Community Consultation Committee

Clarence Colliery has a Community Consultation Committee (**CCC**), through which it relates information about the mine to the community by holding regular meetings. Over the last twelve months, there have been three scheduled CCC meetings at which an update on the 900 Area SMP has been provided. Copies of the relevant presentations given at CCC meetings are attached in **Appendix F**.

Letters to Stakeholders

A letter and factsheet titled “Clarence Colliery – 900 Area SMP Preparation” was sent to all persons on the stakeholder register advising of the preparation of an SMP Application and inviting feedback and input into the proposal. Members of the CCC were not invited to the Stakeholder meeting due to the detailed presentations received at CCC meetings. However, all members of the CCC received a copy of the factsheet. The letter also invited the recipients to attend the Stakeholder Meeting where further information would be provided as well as an opportunity to raise issues regarding the project. A consultation log detailing the list of the recipients of this letter is attached in **Appendix F**. Copies of letters sent out are also provided in **Appendix F**.

Stakeholder Meeting

On the 12 December 2012, Clarence Colliery hosted a Stakeholder Meeting on site, to offer all stakeholders the opportunity to be briefed on the SMP Application by Clarence Colliery mining personnel as well as an opportunity to raise concerns and have questions regarding the project answered. The briefing consisted of a PowerPoint presentation covering all facets

of the proposed mining and SMP process. A copy of the presentation is attached in **Appendix F**. A copy of the minutes detailing the questions and feedback received from the attendees is attached in **Appendix F.**

Issues raised during the stakeholder meeting included:

- Depressurisation of aquifers following partial pillar extraction
- Archaeological survey methodology
- Impacts to swamps and groundwater within swamps from partial pillar extraction
- Cliff lines and pagodas and in particular the risk to habitat of endangered cave dwelling bats

Stakeholder Consultation Log

A detailed consultation log was maintained throughout the SMP consultation as a record key consultation actions made by Clarence Colliery and all enquires and submissions made by the stakeholders. The consultation log is attached in **Appendix F**.

10 STATUTORY REQUIREMENTS

Conditions from CCL705, Development Consent DAM.08.76, ML1583, Development Consent DA 504.00, ML 1353 and development consent 174/93 that directly relate to subsidence management are provided in **Table 28**.

Table 28 Relevant Statutory Conditions relating to Subsidence

Condition	How addressed
DAM.08.76	
4.(a) The lease holder shall prepare a Subsidence Management Plan prior to commencing any underground mining operations which will potentially lead to subsidence of the land surface.	This SMP Written Report (Vol 1) and SMP (Vol 2)
4.(c) The lease holder must not commence or undertake underground mining operations that will potentially lead to subsidence other than in accordance with a Subsidence Management Plan approved by the Director-General, an approval under the Coal Mines Regulation Act 1982, or the document *New Subsidence Management Plan Approval Process – Transitional Provisions*.	This SMP Application (Vol 1)
4.(d) Subsidence Management Plans are to be prepared in accordance with the *Guideline for Applications for Subsidence Management Approvals*	SMP (Vol 2) prepared in accordance with SMP Guidelines (DPI 2003)
4.(e) Subsidence Management Plans as approved shall form part of the Mining Operations Plan required under Condition 2 and will be subject to the Annual Environmental Management Report process set out under Condition 3. The SMP is also subject to the requirements for subsidence monitoring and reporting set out in the document *New Approval Process for Management of Coal Mining Subsidence – Policy.*	Noted
12. Operations must be carried out in a manner that ensures the safety of persons or stock in the vicinity of the operations….	SMP (Vol 2), Risk Assessment in **Appendix H**
16. Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution …. For the purpose of this condition, water shall be taken to include any watercourse, waterbody or groundwaters…..	**Section 8.1.1**
17. Operations must not interfere or impair the stability or efficiency of any transmission line, communication line, pipeline or any other utility on the lease area without the prior written approval of the Director-General and subject to any conditions he may stipulate.	**Section 8.2.2.**
19.(a) Operations must not affect any road unless in accordance with an accepted Mining Operations Plan or with the prior written approval of the Director-General and subject to any conditions he may stipulate.	**Section 8.2.1.**
30.(a) The lease holder shall carry out operations in such a way as to conform strictly to all provisions of the Sydney Water Catchment Management Act 1998 and the regulations there under applying to the prevention of pollution of the Warragamba Outer Catchment Area or the preservation of the purity of the water supply provided thereby or derived there from or for the protection of the property of Sydney Catchment Authority.	Clarence Colliery Water Management Plan (2013) recently reviewed and distributed to DTIRIS, SCA, NOW, EPA, OEH and DP&I.
DAM.08.76	

Condition	How addressed
6. That all conditions laid down by the National Parks and Wildlife Service, State Pollution Control Commission, Soil Conservation Department, Planning and Environment Commission of NSW and Department of Mines, must be complied with.	This SMP Application (Vol 1)
ML 1583	
4.(a) The lease holder shall prepare a Subsidence Management Plan prior to commencing any underground mining operations which will potentially lead to subsidence of the land surface.	This SMP Written Report and draft SMP.
4.(c) The lease holder must not commence or undertake underground mining operations that will potentially lead to subsidence other than in accordance with a Subsidence Management Plan approved by the Director-General, an approval under the Coal Mines Regulation Act 1982, or the document *New Subsidence Management Plan Approval Process – Transitional Provisions*.	This SMP Application
4.(d) Subsidence Management Plans are to be prepared in accordance with the *Guideline for Applications for Subsidence Management Approvals*	SMP prepared in accordance with SMP Guidelines (DPI 2003).
4.(e) Subsidence Management Plans as approved shall form part of the Mining Operations Plan required under Condition 2 and will be subject to the Annual Environmental Management Report process set out under Condition 3. The SMP is also subject to the requirements for subsidence monitoring and reporting set out in the document *New Approval Process for Management of Coal Mining Subsidence – Policy.*	Noted.
12. Operations must be carried out in a manner that ensures the safety of persons or stock in the vicinity of the operations….	SMP, Risk Assessment in **Appendix H**
16. Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution …. For the purpose of this condition, water shall be taken to include any watercourse, waterbody or groundwaters…..	**Section 8.1.1., 8.1.2.** Appendix C
17. Operations must not interfere or impair the stability or efficiency of any transmission line, communication line, pipeline or any other utility on the lease area without the prior written approval of the Director-General and subject to any conditions he may stipulate.	**Section 8.2.2.**
19.(a) Operations must not affect any road unless in accordance with an accepted Mining Operations Plan or with the prior written approval of the Director-General and subject to any conditions he may stipulate.	**Section 8.2.1 .**
27.(A) Notwithstanding any Mining Operations Plan, the lease holder must not mine within any part of the lease area which is within the notification area of the **Lithgow No 1 and Lithgow No 2 Dams** without the prior written approval of the Minister and subject to any conditions he may stipulate.	Lithgow No.1 and Lithgow No.2 Dams are noted located within the 900 Area. Condition noted
28.(a) The lease holder shall carry out operations in such a way as to conform strictly to all provisions of the Sydney Water Catchment Management Act 1998 and the regulations there under applying to the prevention of pollution of the **Warragamba Outer Catchment Area** or the preservation of the purity of the water supply provided thereby or derived therefrom or for the protection of the property of Sydney Catchment Authority……	Only a very small area of the 900 Area reports to the Warragamba Catchment associated with Farmers Creek. **Section 8.1.1**
DA 504-00 – Schedule 3	
1. The Applicant shall ensure that surface subsidence generated by the development does not exceed the criteria listed in Table 1 (First Workings – 20mm subsidence, 1.0mm/m tilt, 1.0mm/m horizontal strain. Partial Extraction – 100mm subsidence, 3.0mm/m tilt, 2.0mm/m horizontal strain.	

Condition	How addressed
2. Before carrying out any underground mining operations that will potentially lead to subsidence of the land surface, the Applicant shall prepare a Subsidence Management Plan for those operations in accordance with the following DPI documents (or the most current and updated versions of these documents): (a) *New Approval Process for Management of Coal Mining Subsidence - Policy*; and (b) *Guideline for Applications for Subsidence Management Approvals*, to the satisfaction of the Director-General of DPI. In addition to the above each Subsidence Management Plan shall: (a) describe how the subsidence impact assessment criteria will be monitored over time; (b) provide for the notification of relevant authorities, including DPI, SCA and the Director-General in the event of any exceedance of the impact assessment criteria; and (c) detail measures to reduce, mitigate and remediate any impacts. During the preparation of each Subsidence Management Plan the Applicant shall consult with the Department, Council, SCA, DEC, DNR and the CCC, and have regard for any comments provided by these agencies/committees.	This Written Report and Subsidence Management Plan.
5. The Applicant shall ensure that the development does not result in any: (a) significant inflows to mine workings; (b) reduction in pumping yield in privately-owned groundwater bores; (c) reduction in surface flows and groundwater base flow to upland swamps (Newnes Plateau Shrub Swamps) and wetlands; and (d) reduction in surface flows and groundwater base flow to waterbodies including Marrangaroo Creek, Farmers Creek, Dargans Creek, Wolgan River, Dumbano Creek, Bungleboori Creek, and Wollangambe River (excluding reduction in flows associated with the proposed water transfer scheme), to the satisfaction of the Director-General.	**Section 8.1.1., 8.1.2.** and **8.1.5**. and *Clarence Colliery Water Management Plan (2013)* recently reviewed and distributed to DTIRIS, SCA, NOW, EPA, OEH and DP&I.
6. Within 12 months of the date of this consent, the Applicant shall prepare and subsequently implement a Water Management Plan for the mine in consultation with Council, SCA, DEC, DPI, and to the satisfaction of the Director-General. This plan must be prepared by a qualified hydrogeologist/hydrologist and include: (a) a Water Balance; (b) an Erosion and Sediment Control Plan; (c) a Surface Water Monitoring Program; (d) a Ground Water Monitoring Program; and (e) a Surface and Ground Water Response Plan, to address any potential adverse impacts associated with the development.	*Clarence Colliery Water Management Plan (2012)* recently reviewed and distributed to DTIRIS, SCA, NOW, EPA, OEH and DP&I.
DA 174/93	
2. The south-eastern section of the Northern Extension is to be limited to "first workings" only. Any appropriate protection zones to safeguard surface features shall be determined when the company applies to the Department of Mineral Resources for approval to extract pillars or mine by longwall method in accordance with Section 138 of the Coal Mines Regulation Act, 1982.	*The proposed 900 Area is away from the south eastern section of the Northern Extension Area*
3. The applicant shall prepare, in consultation with the National Parks and Wildlife Service, a monitoring plan for the four Newnes Plateau Shrub Swamps located within the Northern Extension. The plan will measure the impacts, following subsidence, of changes to water levels, plant presence, abundance, structure and animal presence. Monitoring will include amphibians, reptiles, birds and mammals, with special emphasis on the Blue Mountains Water Skink and rare plants. Monitoring will include any appropriate comparisons with swamp areas not subject to longwall mining and shall be undertaken for a period of at least 5 years.	*There are no Newnes Plateau Shrub Swamps located in the in the proposed 900 Area that is within DA 174/93*

Condition	How addressed
4. The applicant shall prepare a contingency plan to re-establish the rare plant *Notochloe microdon, Boronia deanei* and *Celmisia longifolia* prior to longwall mining beneath the Newnes Plateau Shrub Swamps. The plan shall be implemented if existing populations decline. Details of such plan are to be provided to the National Parks and Wildlife Service.	*There are no Newnes Plateau Shrub Swamps located in the proposed 900 Area that is within DA 174/93. Monitoring of Swamps in the 900 Area will be in accordance with an EMP should this SMP be approved. Clarence does not propose to longwall mine in the 900 Area.*
5. The applicant shall inform the National Parks and Wildlife Service of the results of subsidence monitoring prior to commencement of longwall mining under the Mount Horne Aboriginal sites. The likely impacts of longwall mining on these sites, and any appropriate mitigative measures or protection zones, are to be fully assessed when the applicant applies to the Department of Mineral Resources for approval to extract pillars or mine by longwall method in accordance with Section 138 of the Coal Mines Regulation Act, 1982.	Within this SMP application. Clarence does not propose to longwall mine in the 900 Area. Reporting is to be undertaken in accordance with the Subsidence Management Status Report schedule.
14. The applicant shall ensure that all areas subject to mine subsidence which can be accessed by the public are monitored for safety. If an area is deemed to be unsafe by the Department of Mineral Resources the applicant shall take reasonable steps to warn the public and subsequently rectify the situation.	Volume 2 of this SMP Application
ML 1353	
1. The registered holder shall extract as large a percentage of the coal in the subject area as is possible consistent with the provisions of the Coal Mines Regulation Act 1982 and the Regulations thereunder and shall comply with any direction given or which may be given in this regard by the Minister	Within this SMP Application
4a. Operations shall be carried out in such a way as not to cause any pollution of the Hawkesbury River Catchment Area	*Clarence Colliery Water Management Plan (2013)* recently reviewed and distributed to DTIRIS, SCA, NOW, EPA, OEH and DP&I.
4b If the registered holder is using or about to use any process which in the opinion of the Minster is likely to cause contamination of the waters of the said Catchment Area the registered holder shall refrain from using or cease using as the case my require such process within 24 hours of the receipt by the registered holder of a notice in writing under the hand of the Minster requiring the registered holder to do so	*Clarence Colliery Water Management Plan (2013)* recently reviewed and distributed to DTIRIS, SCA, NOW, EPA, OEH and DP&I.
4c. the registered holder shall comply with any regulations now in force or hereafter to be in force for the protection from pollution of the said catchment area	*Clarence Colliery Water Management Plan (2013)* recently reviewed and distributed to DTIRIS, SCA, NOW, EPA, OEH and DP&I.

11 RISK ASSESSMENT

In December 2012, a risk assessment for the 900 Area was undertaken to assess the potential impacts of the SMP Application in accordance with the *Guideline for Applications for Subsidence Management Approvals* (DPI 2003). The risk assessment report is contained in **Appendix G**.

The purpose of the Risk Assessment was to identify the activities, aspects and potential impacts associated with subsidence caused by the proposed partial pillar mining within the Clarence 900 Area. Issues identified by the wider community were also assessed as part of the risk workshop. These issues included those recorded from the 900 Area SMP Stakeholder meeting as well as issues and areas of concern identified through previous stakeholder meetings carried out for other SMP applications (ie. 700, 700W and 800 Areas).

The Risk Assessment was carried out using the Centennial Coal Risk Management Standard (MS-004). A Workplace Risk Assessment and Control (**WRAC**) was used for this Risk Assessment. WRAC is a specific risk assessment method developed for the mining industry and is the most common or preferred method used. It is a participative / pro-active procedure utilizing the expertise and knowledge of the people that are closely associated with the plant or process under review. There are normally three stages of a WRAC method i.e. scoping, assessing and controls implementation.

The key objectives of the risk assessment for the 900 Area SMP were to:

- Establish an appropriate risk assessment team of suitably qualified and experienced Centennial staff and specialist consultants;
- Discuss and review existing information known for the 900 Area SMP and experience in adjacent mining areas;
- Assess the issues and areas of concern brought forward by the broader community at the stakeholder meeting held in December 2012 (held at Clarence Colliery);
- Identify, assess and evaluate potential subsidence impacts to the surface and subsurface features (natural and man-made) for the aspects typically required by government regulators for subsidence impact assessment and management (i.e. the DRE NSW Guideline for Subsidence Management Applications (2003)), and in accordance with the Centennial Risk Management Standard (004) using the Centennial Risk Matrix (probability matrix of consequence and likelihood);
- Establish a Risk Register (WRAC Worksheet) and risk report for the 900 Area SMP for review and comment by the risk team;
- Identify additional controls required (including with respect to updating Centennial management plans) dependant on risk ranking; and
- To produce a Risk Assessment Report (including the Risk Register/WRAC Worksheet) for the 900 Area SMP suitable to accompany the SMP Application addressing requirements stipulated in the SMP Guidelines (DPI 2003) and issues raised during early stakeholder consultation

Table 29 details the invitees and participants of the risk assessment.

Table 29 Risk Assessment Participants

Participants
Edwina White (Centennial Coal)
Jesse Percival (Centennial Coal)
Nigel Campbell (Centennial Coal)
Ziggy Andersons (Ecologist - RPS)
Karyn Virgin (Archaeologist - RPS)
Ian Forster (Hydrogeologist - Aurecon)
Deb Farina (Archaeologist - RPS)
Robert Truman (Geotechnical - Golder)

A risk register has been completed to address only those issues relevant to the 900 Area. This information has been used in the preparation of this SMP Application for the operation.

In terms of impacts to the surface caused by subsidence, the highest risk identified through the risk assessment process as the potential for damage to known or unknown areas of high Environmental, Heritage or Archaeological significance, specifically the Mt Horn engravings site. This risk was identified as medium. As a result, three recommended controls were identified including:

- Complete Archaeological assessment for the 900 Area
- Consider monitoring of the Archaeological sites as a part of the ongoing monitoring program
- Consider cliff line and pagoda assessment for the 900 Area

All these recommended controls have been completed and included within this SMP Application documentation.

All other risks were assessed as being low primarily due to:

- The first workings zone beneath the Bungleboori Creek which encompasses most of the cliff lines in the area
- The method of mining and the data supporting the success of this mining method in relation to limiting subsidence to 100mm or less
- The method of mining and the data supporting the success of this mining method in relation to data collected from monitoring of flora, fauna, groundwater, surface water, cliff lines and pagodas
- The level of assessment and geotechnical design that supports the mine layout and pillar design
- The management of the mining process – auditing and measurement of the mine layout after it has been driven as well as the manner and sequence process to manage that the design is implemented as proposed

Despite this, other recommended controls were identified within the risk assessment and are provided below:

- Develop Public Safety Management Plan;
- Consider using non-obtrusive subsidence monitoring techniques;

- Consider an environmental monitoring program for the 900 surface area;
- Consider water monitoring requirements for the 900 Area;
- Consider completing a cliff line survey for cliffs and pagodas in secondary extraction areas; and
- Develop subsidence monitoring program for the 900 area

All recommended controls were assigned to Clarence personnel with the majority of them completed and the outcomes contained within this SMP application.

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