CHAPTER 7.0

Stakeholder Engagement

7.0 STAKEHOLDER ENGAGEMENT

7.1 Introduction

This chapter provides information on consultation undertaken with stakeholders and future consultation proposed, including an overview of the Angus Place Colliery's Stakeholder Engagement Strategy. The process was used to determine the perceived issues for consideration for the Project.

This chapter specifically responds to the Director General's Requirements (DGRs), which provide the following in regard to stakeholder engagement:

The Director General's requirements

During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners.

In particular you must consult with the:

- Commonwealth Department of Sustainability, Environment, Water, Population and Communities;
- Office of Environment and Heritage (including the Heritage Branch);
- Environment Protection Authority;
- Division of Resources and Energy within the Department of Trade and Investment, Regional Infrastructure and Services;
- Department of Primary Industries (including the NSW Office of Water, Forestry NSW, NSW Agriculture, Fisheries NSW and Catchments and Lands (Crown Lands Division));
- Transport for NSW (including the Centre for Transport Planning, Roads and Maritime Services);
- NSW Health;
- Hawkesbury- Nepean Catchment Authority;
- Lithgow City Council;
- Delta Electricity; and
- relevant Aboriginal stakeholders.

The EIS must describe the consultation process and the issues raised, and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, justification should be provided.

7.2 Engagement Strategy and Stakeholder Identification

7.2.1 Engagement Strategy

Centennial Coal places utmost importance to stakeholder consultation and engagement. Centennial Coal recognises that effective consultation and engagement is a critical element of its operations and projects and underpins its 'licence to operate' in both social and regulatory spheres.

Effective consultation and engagement is inclusive of all stakeholders and include landholders, residents, local communities, indigenous groups, non-government organisations, local, state and federal government, staff and workforce.

The purpose of the Plan is to provide a consistent management framework to identify and consult with stakeholders with an interest in the Project and to ensure appropriate monitoring and reporting of community initiated enquiries is developed. Desired outcomes of the stakeholder engagement strategy are:

- To maintain and continue to develop trust in Centennial's operations with neighbouring residents, local communities, regional community, Indigenous groups, non-government organisations, government and other stakeholders through comprehensive and well-timed engagement and communication.

- To contribute to good working relationships with neighbouring residents, local communities, regional community, Indigenous groups, non-government organisations, government by proactively anticipating and addressing concerns about the Project.
- To respond to community concerns by incorporating community feedback into periodic internal and external reviews of environmental compliance, community engagement and Stakeholder Engagement Plan.
- To contribute to the development of social capital and capacity by sponsoring and giving to local community organisations

Centennial Coal's Stakeholder Engagement Activities are underpinned by Centennial Environment and Community Management Standards which set out the minimum requirements for community, government and NGO consultation. The Management Standards specify that a Stakeholder Engagement Plan is to be developed for each of Centennials Coal's operations and a supplementary Stakeholder Engagement Plan is required to address consultation and engagement activities associated with each new project or amendment to an existing operation.

7.2.2 Stakeholder Identification

The key stakeholders identified and consulted with as part of the consultation and engagement strategy were the following:

- Local, State or Commonwealth government authorities, including the:
  - Commonwealth Department of the Environment (the former Department of Sustainability, Environment, Water, Population and Communities (SEWPAC));
  - Office of Environment and Heritage (including the Heritage Branch);
  - Environment Protection Authority;
  - Division of Resources and Energy within the Department of Trade and Investment, Regional Infrastructure and Services;
  - Department of Primary Industries (including the NSW Office of Water, Forestry Corporation of NSW, NSW Agriculture, Fisheries NSW, and Catchments and Lands (Crown Lands Division);
  - Transport for NSW (including the Centre for Transport Planning, and Roads and Maritime Services);
  - NSW Health;
  - Hawkesbury- Nepean Catchment Management Authority;
  - Lithgow City Council; and
  - Energy Australia (owner of Wallerawang Power Station, formerly owned by Delta Electricity).
- Specialist interest groups including the Local Aboriginal Land Council and Aboriginal stakeholder groups; and
- The public, including community groups and adjoining and affected landowners.

7.3 Angus Place Colliery Stakeholder Engagement Plan

Stakeholder engagement and consultation will differ according to a range of factors which include but are not limited to:

- Scope of the proposed plan, policy, strategy or development;
- The nature of the proposal;
- Statutory notification/consultation requirements associated with the proposal;
- Other notification/consultation requirements that have been set out;
- Identification of stakeholders who are likely to be directly affected by the Project. Areas of affectation may be by geographic or issue basis;
- Determining who is likely to be interested and whose involvement is likely to be important to this matter; and
- Level of complexity of the overall process or the issues concerned.

The Stakeholder Engagement Plan has been prepared to specifically cover the consultation and engagement activities that are required for the life of the Project between October 2011 and December 2014. The following factors were taken into account at the Project feasibility stage in order to determine the potential areas of affectation and subsequent stakeholder groups:

- The Project is a continuation of existing operations;.
- Coal handling and transport is being managed at the Angus Place Colliery; and;
- Construction of new infrastructure to support the Project will be required.

The Broad Brush Risk Assessment (refer **Section 9.3.1**) was also used to determine stakeholder groups and who and how these groups should be consulted with. It was found that:

- A risk of mine closure if the mine life is not extended.
- Potential costs of GHG abatement.
- Subsidence impacts on groundwater dependant ecosystems.
- Subsidence impacts on surface ecology.
- Management of dirty water at the site for the duration of the Project.
- Aboriginal heritage impacts from subsidence.
- Community support, or lack of, resulting from the Project.
- Potential impacts to surface features including cliffs and rock formations.
- Noise impacts as a result of coal handling operations and haulage activities.
- Traffic impacts to forest tracks and local road networks due to increased personnel.

General comments and potential risks:

- Communities include Lidsdale, and Wallerawang where there is a high percentage of mine related employment;
- The community are generally accepting of the operations of Angus Place Colliery as it is away from residential areas and predominantly under Newnes State Forest;

- The main issues relate to potential environmental impacts arising from subsidence impacts on Newnes State Forest; and
- Stakeholders are government regulators; Colong and BMCS. There may be some other environmental groups, users of the area (bush walkers etc) however these are not identifiable at this stage.

7.4 Outcomes of Community Consultation

7.4.1 Lithgow Regional Forum: 25 February 2011

The NSW Government presented a number of regional forums at the beginning of 2011 to discuss and explore the NSW Coal and Gas Strategy. A summary of relevant and key themes raised by speakers are listed below. It is important to note the outcomes of these consultations as they have informed the current Strategic Regional Land Use Strategy, such as:

- Issues relating to longwall coal mining.
  - Coal mining can affect landowners and environmental issues in the area may have resulted from coal burning.
  - In relation to mining there should generally be better controls around impacts on the environment.
  - There should be buffer zones where mining does not occur that provide clean zones for better lifestyle. We need to protect the ecology and biodiversity of an area.
  - Mining can be very divisive in local and regional communities.
  - We cannot just look at the anti-mining concerns – the Strategy needs to look at a set of balanced outcomes.
  - The benefits of mining cannot be underestimated.
- Social and Community Impacts
  - Given the Sydney Basin is almost exhausted for housing, the western areas (eg including in and around Lithgow) provides an opportunity to house people – mining may compromise that opportunity.
  - There is a need to take into account the needs of future generations in terms of health, housing, ageing population etc., and provide suitable environments for them to live.
  - The issues for balance and certainty for communities is an important issue that needs to be addressed.
  - There is a reluctance of industry to embrace the protection of other values.
  - Serious consideration needs to be given to the assumptions and values that we place on the growth of energy demand and its importance in terms of jobs.
  - In 20 years time we may be talking about shortages of food – The question of what are our long term goals and priorities for the use of our land should be an important consideration in the development of a Coal and Gas Strategy.
  - Tourism – local and regional tourism would be devastated by mining.
  - We need to model costs/benefits/value associated with good lifestyle areas, tourism and ecological aspects.

- People are concerned about the health impacts and want to ensure they have a positive quality of life, health, food water and social connectivity to the community.
- We need to make sure all the values of different land uses, lifestyle opportunities, health benefits, food security etc are recognised.
- Disastrous effects and families on jobs – it was not long ago that there were protests about job losses in Lithgow due to mine closures.
- Legislation needs to change so that property owners know they are likely to be affected before the development consent is issued.
- There needs to be a better contribution towards the needs of communities cost of infrastructure needs to be met and contributed to.
- Need baseline data before we go forward to gauge cumulative impacts.
- Communities have been calling for independent studies for a long time.
- Local communities are being devastated by mining (churches, fire services, schools etc are losing people).
- If there is so much value for the state, will there be consideration to covering the community against the costs of these major developments?
- Social impact assessment should be undertaken to gauge impacts.

7.4.2 Centennial Coal Community Information Sessions

Information gathered during community consultations assists in Project planning and in the development of appropriate management and mitigation strategies to address issues of concern and relevance to the local community.

In early 2012 Centennial Coal undertook consultations and information sessions for a number of projects (Western Coal Services Project, Springvale Mine and Angus Place Colliery projects). Issues raised by the community at this time in relation to wider regional developments included:

- concerns about general visual impacts,
- intensification of mining activities; and
- the consideration of cumulative impacts of other mining operations at Wallerawang and Mount Piper Power Stations.

Letter box drops (notifications) and advertisements in the Lithgow Mercury during late February 2013 were undertaken. Notifications and advertisements were issued, inviting the local community to three community information sessions at the Country Women's Association Hall in Wallerawang, NSW on Wednesday 6 March 2013, 2 pm to 4 pm, Thursday 7 March 2013, 6 pm to 8 pm and Saturday 9 March 2013, 10 am to 2 pm. An article was published in the Lithgow Mercury in March 2013 reporting on the three sessions. These sessions raised the following points:

- the sensitive ecology of the receiving environment;
- the sensitivity of Newnes Plateau to mine subsidence. This includes surface features such as cliff lines, pagodas, swamps, groundwater dependant ecosystems, surface ecology and Aboriginal and European heritage sites;
- adverse impacts to the amenity of the area relating to noise, dust visual impacts that adversely affect visitor's experience; and

- risk of mine closure and subsequent loss of jobs having an impact across the local area and broader region.

These matters have been addressed in the relevant technical assessments. The outcomes from these assessments are reported in the relevant sections of **Chapter 10.0** and were presented back to the community during a structured technical presentation on 12 October 2013 as outlined below.

Following the completion of the technical assessments, additional community information sessions were held at the Country Women's Association Hall in Wallerawang on Thursday 26 September 2013 (6 pm to 7.30 pm) and Saturday 28 September 2013 (1 pm to 2:30 pm). Information provided to the community regarding the Project included:

- presentation of the Project and key components;
- potential impact to the environment from proposed vegetation clearing;
- subsidence predictions, potential subsidence effects and impacts, and the effects of structural geology; and
- potential noise and dust emissions and the proposed mitigation measures.

Information boards with Project plans and illustrations were on display at all times during all sessions. Timelines on Project progress and anticipated submission dates for the EIS were also provided.

A structured technical presentation was held at the Western Mines Rescue Station on Saturday 5 October 2013 (2 pm to 4 pm) as a means of informing the community as to the EIS outcomes following the matters raised during the initial sessions in March 2013 requirements. Overall, information gathered from the community profile and feedback from consultation identified a strong connection to mining in areas such as Lithgow, Wallerawang however this connection is not shared across the entire local government area.

7.4.3 Consultations Relating to Social Impact Assessment

Consultation with users of the Newnes Plateau included adventure visitors (include mountain bike riders, motorbike riders and four wheel drivers) and passive visitors (include bushwalkers, families visiting a particular destination point) have been undertaken at various times throughout 2013 as part of the development of the Social Impact Assessment.

It was found that many visitors who live in the area are aware of coal mining under the Newnes Plateau. It was generally their opinion that mining has not changed their experience when visiting the area and will not change their experience as long as access to the area was permitted. Many of these visits were for adventure type tourism.

Passive visitors, for example, families visiting the area to visit a particular destination point (for example the Glow Worm Tunnel) and bushwalkers generally stated that they did not want their experience changed. The amenity of the area was important to these types of visitors and key words used to describe the area are: quiet, nature, features (pagodas and cliffs) and views from lookouts.

7.4.4 Key Themes Emerging from Consultation

Information gathered from the community profile and feedback from consultation has identified a number of points which are relevant to the social impacts relating to mining. These are summarised below:

- Mining and power generation are a significant feature of the LGA as are agriculture and national parks.
- Mining and power generation is a major contributor to the economy and progress in these sectors is considered essential.
- Mining and power have been a significant source of employment via both direct and indirect employment. Many towns and villages emerged as a result of the local mining industry and local businesses articulate the benefit they receive from 'the mines'.

- There is a strong connection to mining in areas such as Lithgow, Wallerawang and Portland however this connection is not shared across the entire Lithgow LGA. There has been an increasing population in rural areas and the connection that many of these landholders have to the Lithgow LGA are its natural assets.
- Despite the connection to power and mining, residents do not want to be adversely impacted upon by industry when they are not at work. It would therefore be a risk to assume that a strong connection to mining and power generation means that it is acceptable to expand without considering social impacts.
- Amenity is still an important factor to quality of life and noise, dust and visual impacts arising from industry will have adverse effects on residential amenity.

7.5 Consultation with Non-Government Organisations

7.5.1 Blue Mountains Conservation Society and the Colong Foundation for Wilderness

Centennial Angus Place recognizes the Blue Mountains Conservation Society (BMCS) and the Colong Foundation for Wilderness (Colong) as primary Stakeholders as these organisations encompass members of other environmental groups or Non-Government Organisations. Both hold active roles in bringing to the attention of the broader community, actions and activities that are being undertaken by Centennial Coal's mining operations in the Western Coalfield. Accordingly, it is envisaged that communications from Centennial Angus Place to the BMCS and the Colong will be communicated to respective members and therefore through to other environmental groups.

In early 2009, Centennial Coal reflected on its relationship with the Colong and the BMCS. At the time, communication with these two key NGOs was not functional and was not collaborative, with individual mine sites responding to the issues as they arose. One could say, the relationship was led by the NGOs and responses were reactive and inconsistent.

The approach that had evolved at Centennial Angus Place resulted in the following issues:

- Significant resources employed from separate mines responding to issues through letter writing.
- Poor communication through letter writing lead to mis-information.
- Mis-information had bred distrust.
- Letter writing "at ten paces" precluded the opportunity to understand the root cause of the issues raised by BMCS or Colong Foundation.
- Limited (if any) control regarding messages conveyed to the BMCS and the Colong Foundation.

As a result of this reflection, Centennial Angus Place decided that it was time to improve the relationship evolution. This was done through the development of a voluntary Consultation Strategy. The primary objective of the Strategy is to establish a relationship with the key NGOs most active in the Centennial Western Coalfields. The two NGOs identified were the BMCS and the Colong.

It was identified early that the Consultation Strategy must achieve the following:

- Joint ownership.
- Clearly stipulate a Terms of Reference – what are the rules/commitments within the consultation programme and the "how", "when", "who", "what" and "why".
- Provide tangible outcomes.
- Measure performance.

- Clearly identify the issues of the NGOs.

Overall, the strategy clearly acknowledged that all parties are not necessarily going to agree on everything, but the differences can be recognised and acknowledged. To this end, Centennial drafted a Consultation Strategy and this document became the overarching tool stipulating the Terms of Reference for a consultation forum. This provided clear guidance on expectation and outcomes from the overall Strategy.

The Strategy is owned by Centennial Coal, BMCS and the Colong. Ownership of the Strategy has been a key factor to its success. Ownership is implemented through review and update of the Strategy to ensure all comments are incorporated. Most importantly, the Strategy is implemented through action that can be recorded and reviewed. The Strategy is a living document and is always in draft. The purpose and objectives of the Consultation Strategy is to:

- Participate in a series of meetings with the BMCS and the Colong, formalized through structured minute taking and action items in separate forums.
- Develop a relationship with the BMCS and the Colong.
- Discuss issues as they arise with BMCS and the Colong.
- Update the BMCS and the Colong on the activities of the Newnes Plateau underground mining operations.
- Understand the BMCS and Colong issues with a view to achieving workable and practical outcomes where possible, and if not clearly identifying why not.
- Continual improvement in communicating with Centennial's key Stakeholders.
- Reduce the formal letter trail and replace with a process of discussion ,minute taking and actions.
- Provide a forum for informed debate.
- Set some Terms of Reference for meeting conduct and the provision of relevant information.

The Key elements of the Strategy are as follows:

- Documented schedule of meetings.
- Formal minute taking - generation of Actions and Close out of Actions.
- Formalised Agenda – with the opportunity to add Agenda Items.
- The development of Briefing Papers and draft Agendas provided at least one week prior to the meetings to allow for meeting preparation.
- Draft minutes forwarded to participants for review and acceptance.

This solution was chosen as it is a formal way of setting a Terms of Reference with clear expectations, due process and clearly documented outcomes. The ability for all parties to have an input into the process was very important to maintain ownership. The ability to deliver on the documented outcomes aims to develop trust. The face to face meetings were chosen as the primary correspondence forum because it introduces the human element and whilst difficult at first, it has (Centennial believes) strengthened the relationship.

Between 2009 and 2011, Centennial held five meetings with the BMCS and four meetings with the Colong. **Table 7.1** presents the number of actions generated as a result of the meetings and the number of actions closed out over the period. This shows that Centennial, BMCS and the Colong are communicating co-operatively. Having said this, all parties do not agree with all the outcomes but this is to be expected. Since the first draft of the Consultation Strategy in August 2009, the Strategy has been reviewed and updated five times. The revisions have solely been a result of changes suggested by Centennial Coal, BMCS and the Colong. This is a clear example of adaptive management. Updates are based on adaptive management and opportunities to improve communications are constantly reviewed and discussed at meetings. The improvements are documented within the strategy document and approved by the three parties for implementation.

Table 7.1: Meetings with Blue Mountains Conservation Society and Colong

Meeting Date	Actions Generated	Number of Actions Closed Out from Previous Meeting(s)
Meetings with Blue Mountains Conservation Society		
23 April 2009	10	NA
6 August 2009	11	8
24 March 2010	6	12
23 September 2010	6	6
28 January 2011	7	5
Meetings with Colong		
9 April 2009	6	NA
6 August 2009	8	6
26 March 2010	7	8
2 November 2010	5	8

The Strategy has created a central forum to discuss issues and action solutions where possible and where practical.

The meetings commenced in 2009 with a particular focus on dealing with issues identified on the Newnes Plateau. Due to the success of the consultation forum, this has now expanded to include issues identified in the Airly – Genowlan area. At the meeting with the Colong on 02/11/2010, Hadyn Washington (representing the Colong) showed considerable interest and knowledge of the Airly area. This resulted in Washington assisting with mapping of the endangered plant Pultanea in the Airly region.

Centennial Coal now has a more open dialogue with a higher level of trust (in Centennial's view) between the parties. All parties can now openly discuss the functions of each organisation. It is noted however, that a key factor to the success of the programme is the open acknowledgement and recognition that all parties are not necessarily going to agree on everything.

The following outcomes from the meeting with the BMCS in January 2011 are provided below. The note that a dispute resolution is not required, shows the active willingness of Centennial and BMCS to communicate and resolve issues. The note about the usefulness of the meetings again demonstrates the value of the consultation process to all parties. The issue of dispute resolution in the Consultation Strategy was not considered Important. All generally agreed. All agreed that these meetings are very useful and there was a desire for them to continue. (Outcome from meeting held on 28 January 2011).

This Consultation Strategy has been developed by using the parties to the Strategy to decide the terms under which consultation would take place. This has relied on the will of all the parties to work together to improve communication particularly with NGOs of such high profile is leading practice.

Whilst a meeting has not been held since January 2011, it is evident from the raising and close out of issues that the objectives of the consultation were being achieved. Centennial will continue to seek engagement with both the BMCS and Colong. Centennial will continue to consult and engage with these groups to achieve the outcomes of the Consultation Strategy.

There are constant requests by the NGOs to press Government Departments to engage in similar communication strategies. Furthermore, regular comments are made during meetings that other mining companies are not engaging the BMCS or the Colong in the way that Centennial Coal has done. Centennial Coal cannot force anyone to engage, however, it is an indication that the Strategy is working when the groups involved believe it can be adopted by others. This in turn displays that Centennial Coal is leading the way in terms of engaging with high profile NGOs.

7.5.2 Greater Blue Mountains World Heritage Area Advisory Committee

Following submission of the Preliminary Documentation supporting Springvale and Angus Place's EPBC referral applications in 2011, Centennial Coal was approached by the GBMWHA Advisory Committee to provide an overview of the Springvale and Angus Place operations. Two meetings were held with the Committee on 12 October 2011 and 18 November 2011. Ongoing consultation will be undertaken with the Committee during the development of the Project.

7.6 Aboriginal Stakeholders

Consultation with Aboriginal stakeholders was undertaken by Centennial Angus Place and RPS in accordance with the *NSW Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW 2010), which includes a four stage consultation process and identifies specific timeframes for each stage.

The objective of the consultation process is to ensure that an opportunity is given to a broad range of Aboriginal stakeholders to express their cultural heritage values of the Project, including spiritual connections, archaeological sites, and the natural environment and landscape values.

The consultation methodology involved the identification of Aboriginal Land Councils, Elders and other interested parties in accordance with the requirements, followed by consultation with Aboriginal communities and other stakeholders in the area. There were 12 registrations of interest arising from the indigenous stakeholder consultation process, listed below, six groups returned their comments on the methodology and five groups participated in the site surveys.

- Bathurst Local Aboriginal Land Council;
- Dhuuluu Yala Aboriginal Corporation;
- Gundungurra Aboriginal Heritage Association Inc;
- Gundungurra Tribal Council Aboriginal Corporation;
- Hawkesbury-Nepean Catchment Management Authority (Aboriginal Reference Group);
- Mingaan Aboriginal Corporation;
- Mooka Traditional Owners;
- Northeast Wiradhuri Company Ltd;
- Warrabinga Native Title Claimants Aboriginal Corporation;
- Wiradjuri Council of Elders;
- Wiradjuri Traditional Owners Central West Aboriginal Corporation; and
- Wiray-dyuraa Ngambaay-dyil.

A register of interested parties was maintained and specific comments regarding the cultural significance of the Project and report recommendations is outlined in the *Cultural Heritage Impact Assessment* prepared by RPS and is supplied in **Appendix K**.

Copies of the "*Cultural Heritage Impact Assessment: Angus Place Colliery Mine Extension Project, Lithgow Local Government Area*" (RPS, 2013) have been provided to the registered Aboriginal groups for their review and comment.

7.7 Consultation with Energy Australia

Angus Place Colliery has a long standing working relationship with Wallerawang and Mount Piper Power Stations, which are currently owned by Energy Australia (formerly owned by Delta Electricity). Regular meetings are held with Energy Australia to discuss coal supply, property matters and transfers, water supply and other project related matters.

Angus Place Colliery is aware of Energy Australia's concerns regarding the water supply from the SDWTS and is committed to working towards a satisfactory resolution for both parties.

7.8 Government Agency Consultation

DP&I advised that a Planning Focus Meeting for the Project will not be required to formally seek the views of relevant statutory authorities in respect of potential impacts of the Project, or to identify those issues, which would need to be addressed in this EIS. However, a Government Briefing Meeting to discuss collectively four of Centennial Coal's projects from the Western Operations was organised for 17 October 2012 to provide an opportunity for statutory authorities to establish the requirements for the form and content of the EISs for the projects. Site visits were organised for 18 October 2012.

Table 7.2 outlines the Government (Local, State and Commonwealth) consultation undertaken to date.

Table 7.2 Summary of Consultation undertake with Government agencies

Agency	Comment
Local Government – Lithgow City Council (LCC)	On 11 July 2012 Centennial Coal's senior management presented an overview of all projects from the Western Operations, including the Angus Place Colliery Extension Project, to Councillors of Lithgow City Council, the General Manager, the Mayor and the Deputy Mayor. A Government Briefing Meeting was organised on 17 and 18 October 2012 to discuss a number of Projects from Centennial Coal's Western Operations, including the Angus Place Colliery Extension Project. Lithgow City Council staff present at the meeting and took part in a site visit on 18 October 2012, which included a visit to the Newnes Plateau to inspect existing and proposed infrastructure areas, and shrub and hanging swamps. An additional meeting was held on 7 November 2013 to the Angus Place and Springvale mine extension projects, the technical assessments undertaken for the EISs, and an overview of the outcomes of the assessments. Emphasis was placed on discussions on the outcomes of the Economics and the Social Impact Assessments undertaken for the projects. Matters raised related to a Voluntary Planning Agreement. Centennial Angus Place committed to further consultation with LCC on this matter.
Government Agencies-Department of Planning and Infrastructure (DP&I) Office of Environment and Heritage (OEH)Environment Protection Agency (EPA)Division of Resources and Energy (DRE), Department of Trade & Investment, Regional Infrastructure and Services Sydney Catchment Authority (SCA)Transport for NSW NSW Health Forestry Corporation of NSW Lithgow City Council (LCC)DoE (the former SEWPAC)	Representatives of the Government agencies attended the Government Briefing Meeting held on 17 October 2012. These representatives were given the opportunity to provide feedback and/or raise issues of concern on the Project. Further details are provided in **Table 7.3**. Representatives from the DP&I, OEH, DRE, SCA, NSW Health and LCC attended the site visit on 18 October 2012. The site visit included the Newnes Plateau to inspect existing and proposed infrastructure areas, and shrub and hanging swamps.

Agency	Comment
Office of Environment and Heritage (OEH)	Centennial Coal's senior management met with officers of the OEH on 14 February 2013 to discuss Centennial's Western Operations proposal to develop a Regional Biodiversity Offset Strategy to offset the direct potential impacts, including cumulative impacts, of the proposed Extension Projects at Centennial Coal's Western operations. The Angus Place Colliery Extension Project is part of the Regional Biodiversity Offset Strategy (**Section 10.3.7**) being developed and was discussed at the meeting with OEH. A meeting was held with OEH on 25 November 2013 to discuss Centennial Coal's proposed *Regional Biodiversity Offset Strategy*, which include the Angus Place and Springvale mine extension projects. Matters raised in relation to these projects were as follows : • methodology used to determine 'indirect' impacts to swamps; • metric used to determine the proposed offset area for each project. A further meeting with OEH officers was held on 13 March 2014 at Airly Mine to provide information on: • The proposed Regional Biodiversity Offset Strategy relevant to the Project • The metric and methodologies used for direct and indirect offsets proposed in the Regional Biodiversity Offset Strategy.
Commonwealth Department of the Environment (former SEWPAC)	Centennial Coal's senior management met with SEWPAC (now DoE) on 15 June 2013 to discuss the various upcoming Centennial Coal projects, including the Angus Place Colliery Extension Project. SEWPAC (now DoE) were informed that the Angus Place Colliery Extension Project would be referred under the *Environment Protection and Biodiversity Act 1999*. A second meeting between Centennial's senior management and SEWPAC (now DoE) on 3 December 2012 for Centennial Coal to provide additional information on all Centennial projects that will be referred for declaration as controlled actions. The Angus Place Colliery Extension Project was discussed at this meeting.
Department of Planning and Infrastructure	A meeting was held with the Department of the Environment on 12 March 2014 to discuss Centennial Coal's Regional Biodiversity Offset Strategy proposed for Angus Place and Springvale Mine Extension Projects and Neubecks Coal Project, including the metric and methodologies used for direct and indirect offsets proposed in the Strategy.

Agency	Comment
NSW Environment Protection Authority Sydney Catchment Authority Hawkesbury-Nepean Catchment Management Authority	A joint meeting with NSW EPA, SCA and HNCMA was held on 29 October 2013 to provide the agencies with an overview of the Project and the Project Application Area, the existing environment, assessment methodologies undertaken in the noise, air quality, surface water and groundwater assessments. Findings of the .assessments and the proposed mitigation measures were presented. The following matters raised by the agencies: • whether other potential uses of the mine inflows (groundwater) in the projects had been investigated; • progress made with the development of Centennial Coal's *Regional Water Strategy*; • continued transfer of groundwater to Wallerawang Power Station for use in their cooling towers; • likelihood that Wallerawang Power Station will not to accept mine water from Springvale Mine and Angus Place Colliery in the future; • relationship with Energy Australia and the possibility of supplying water to Mount Piper Power Station; • EPA's preferred option for all mine water to be supplied to the power stations as industrial water and not store discharged mine inflows in Lake Wallace and Lake Lyell; • Concerns over discharging all mine inflows into Kangaroo Creek and Coxs River in the absence of water demand from Wallerawang Power Station, in particular impacts on water quality of the Coxs River in relation to salinity; • any proposal to treat water prior to discharge into Coxs River; • Centennial Angus Place's intension not to discharge into Wolgan River • Need for the EISs to discuss water quality impacts of discharging mine inflow into Kangaroo Creek and Coxs River; • impacts to surface water flows as a result of undermining Carne Creek Catchment; • predicted changes to Wolgan River flows. Matters raised have been addressed in the surface and groundwater technical assessments and the outcomes are addressed in **Section 10.2** of this EIS.

Agency	Comment
Division of Resources and Energy	A meeting with DRE was held on 15 October 2013 to present the Angus Place and Springvale mine extension projects, specifically to discuss information regarding the Project Application Area, project attributes (mine design, mining method, mining rate, life of mine) as well as the potential environmental impacts from a subsidence and groundwater perspective. Detailed overviews of the geology, hydrology and hydrogeology were presented. The proposed decommissioning and rehabilitation strategies for the projects were also discussed. Issues raised and discussions held comprised the following: • whether there is proposal to mine under shrubs swamps similar to the East Wolgan Swamp; • whether any consultation with the DoE (the former SEWPAC) had been undertaken to discuss the proposed mining under shrub swamps; • whether precedents exist of longwall mining operations approved with potential far field subsidence effects in National Parks, • no standard criteria for acceptable impacts within National Parks exist and projects are assessed on a case-by-case basis, • the EISs need to provide relevant data on predicted far field subsidence effects with the potential to impact on surface features within the Garden of Stone National Park.

Agency	Comment
Department of Primary Industries	**NSW Office of Water** A joint meeting with the Office of Water and the Department of Planning and Infrastructure was held on 22 October 2013 to describe the Angus Place and Springvale mine extension projects, specifically to: present the hydrogeological model (COSFLOW) developed for the projects by CSIRO; and discuss the water licensing requirements for the projects. The following issues were raised on the groundwater model: • how widely used is CSIRO's COSFLOW model and if it has been bench-marked; • sensitivity of the RAMP function used in the model on hydraulic conductivity and how it was applied in the groundwater assessment; • whether there is a cumulative impact on hydraulic properties in time with continued mining; • whether cumulative impacts of multiple longwall panel subsidence occur; and • whether a third party review of the model had been undertaken. The following issues were raised on water licensing: • whether there was an opportunity of re-injection of mine water into previous underground mining, and whether a potential 'return flow' option might be a way through this question; • time series chart graph to be provided for the take of water from the Sydney Basin Richmond Groundwater Source • mine water quality; • interaction with Delta Electricity (now Energy Australia) as owners of Wallerawang Power Station; • current volume of water supplied to Wallerawang Power Station; • whether a Reverse-Osmosis plant has been considered; • NorBE requirements will need to be met for mine water proposed to be discharged into Coxs River eventually flowing into Lake Burragorang. Consultation with NOW (and DP&I – see above) on water licensing for the two extension projects is ongoing with further meetings planned in the near future. **Office of Agricultural Sustainability & Food Security** The Office of Agricultural Sustainability & Food Security were contacted regarding a face to face consultation to discuss the Agricultural Impact Statements prepared as a due diligence exercise to support the EIS. Given the preparation of the AISs were not required by the DGRs and the fact that the AISs prepared concluded there will be "...negligible impact on agricultural resources, enterprises or related industries" for the Angus Place and Springvale mine extension projects it was agreed that a face-to-face consultation would not be necessary.

Agency	Comment
NSW Health	A meeting with NSW Health was held on 5 November 2013. The overviews of the Angus Place and Springvale mine extension projects were provided. The air quality impact assessment and noise impact assessments for the projects were presented. . The following matters were raised: • require descriptions and locations of sensitive receptors (residential versus recreational) assessed in the impact assessments; • whether the same model was used for Springvale and Angus Place impact assessments; and EISs need to include cumulative impacts for both the extension projects and other industrial operations in the vicinity of Springvale Mine and Angus Place Colliery.
Bathurst Forestry Commission NSW (FCNSW)	The Project Team met with delegates from FCNSW on 6 March 2014 to provide an overview of each Project particularly with regard to activities occurring within the Newnes State Forest. The proposed mine designs were discussed with regard to avoiding significant surface features where possible, or as in the case of Springvale Mine, the significance of proposed longwall geometry to mitigation impacts to shrub swamps. Surface construction footprints regarding dewatering borehole sites and infrastructure corridors were discussed in the context of existing access agreements and rental amounts. Centennial committed to ongoing consultation with FCNSW on the matter of access agreements for the surface infrastructure.

Issues raised at the Government Briefing Meeting on 17 October and site visit on 18 October 2012 are included in **Table 7.3**. The table also provides EIS reference where each issue has been addressed.

Table 7.3 Summary of Issues Raised at the Government Briefing Meetings (17 and 18 October 2012) and Additional Government Agency Consultation Meetings

Stakeholder	Key Issues Raised	EIS Reference
Department of Planning and Infrastructure (DP&I)	1) The cumulative impacts of the Project require consideration. 2) Expectations for regulation of environmental issues such as water discharge have increased since the consent was approved and must be considered. 3) The Project needs to include the long term strategy with regards to the final rehabilitation plan. 4) The Project needs to consider the requirements of the Rural Fire Service, particularly safety of workers in a bushfire. 5) The Project will be assessed by the Planning Assessment Commission (PAC) due to political donations. 6) A mine plan for the proposed longwalls in the southern areas of the Project and an aerial photo showing all surface infrastructure and the proposed mining area is required. 7) The exploration drilling requirements (through Part 4 or Part 5 of the EP&A Act) should be defined within the EIS. 8) Existing consents and all other approvals need to be clarified. 9) The EIS needs to discuss what baseline monitoring has highlighted as the significant surface features. 10) Performance measures for significant surface features need to be set. Use of adaptive management and set outcomes for significant surface features are recommended. 11) The EIS needs to discuss the consequences of impacts, mitigation and strategies to avoid. 12) It is critical to propose standalone criteria and performance measures including economic justification for each significant surface feature and set outcomes for cliffs, steep slopes, other rock formations, swamps etc. 13) Mine planning needs to take into consideration both economic and conservation effort trade-offs, which must be articulated in the EIS. 14) A mine closure plan is required and the end land use discussed. 15) An aquifer interface assessment must be completed and linked to the mine plan. 16) A need for the EIS to discuss water quality impacts of discharging mine inflow into Kangaroo Creek and Coxs River 17) Impacts to surface water flows as a result of undermining Carne Creek Catchment.	1) Chapter 10.0 2) Chapter 10.0 Section 10.2 3) Chapter 10.0 Section 10.11 4) Chapter 10.0 Section 10.14 5) Noted 6) Figure 4.2 7) Section 3.2 8) Section 3.1 9) Chapter 8.0 and Subsidence Predictions and Impact Assessment (Appendix D) 10) Chapter 8.0 and Subsidence Impact Assessment (Appendix D) 11) Chapters 8.0 and 10.0 12) Subsidence Impact Assessment (Appendix D) 13) Chapters 8.0 and 12.0 14) Chapter 8.0 and Section 10.11 15) Section 10.2 and Groundwater Impact Assessment (Appendix E)

Stakeholder	Key Issues Raised	EIS Reference
Sydney Catchment Authority (SCA)	The following principles need to be taken into consideration: 1) There will be no impacts on the quality or the quantity of water flowing into Sydney's drinking water catchment. 2) Any change must have a neutral or beneficial impact on water quality. 3) Discharges need to achieve drinking water quality goals. 4) The Project needs to address the cumulative impacts, not just impacts from mining developments (eg. impacts from Delta's operations need to be included in the western projects). 5) Clarification on hydrological model scope should be included.	Section 10.2 and Surface Water and Groundwater Impact Assessments (Appendix E and F)
Office of Environment and Heritage (OEH)	1) Any alterations to surface water flows that impact on Endangered Ecological Communities must be considered. 2) There is a need to study surface water flow changes due to the Project, and cumulative impacts from all projects. 3) 5-6% of swamps have previously been damaged. Therefore, quantify (percentage) how many swamps will be damaged by the Project and cumulatively. 4) Clarify what the mining impact has been or will be on the Project. 5) The water quality downstream of Carne Creek needs to be understood.	1) Section 10.2 and Section 10.3 2) Section 10.2 and Section 10.3 3) Section 10.2 and Section 10.3 4) Chapter 8.0 and Chapter 10.0 5) Section 10.2
Department of Sustainability, Environment, Water, Populations and Communities (SEWPAC) now DoE	1) Cumulative impacts of the Project must be understood and included in the EIS. 2) Need to reduce the mining related impacts on the swamps as finding 'like for like offset' is unlikely.	1) Throughout the EIS 2) Section 10.2
Forestry NSW	1) Confirmation as to whether Centennial will be installing infrastructure on NSW Forests land for monitoring etc. 2) Security fencing and warning signage around all infrastructure sites will be required to keep recreational users out. 3) Requirement for an occupation permit. 4) Consideration be given to mining the southern longwalls first to provide a guide on how the swamps will react. 5) Need to address noise, dust and water issues at the pit top. 6) Need to eliminate the current issues with LDP001.	1) Chapter 4.0 2) Chapter 3.0 and Chapter 4.0 3) Chapter 3.0 4) Chapter 8.0 5) Chapter 10.0 6) Chapter 4.0 and Section 10.2

Stakeholder	Key Issues Raised	EIS Reference
NSW Health	▪ The impacts on health from cumulative impacts need to be considered. The DP&I however advised that there is no government policy on this topic at this stage and this may be included in the Strategic Regional Land Use Policy, but noted the issue for the Western Coalfields is relatively low priority compared to the Hunter valley coal mines.	Chapter 10.0
Division of Resources and Energy	▪ The EIS needs to provide relevant data on predicted far field subsidence effects with the potential to impact on surface features within the Garden of Stone National Park.	Chapter 8.0

Consultation with stakeholders listed below was undertaken by DP&I during the development of the DGRs. During the application process and submission of the Briefing Paper, government agencies were afforded the opportunity to provide feedback and requirements were considered by the DP&I within the DGRs. A summary of the aspects raised by government agencies and how each of these has been addressed within this EIS is provided in **Table 7.4**.

Table 7.4 Summary of Government Agency Submissions to the DGRs

Stakeholder	Key Issues Raised	EIS Reference
Department of Planning and Infrastructure	1) DGRs for the Project were issued on 06.11.12. 2) The Office of Agricultural Sustainability & Food Security believes that impacts to agriculture will be unlikely from this proposal. Hence an Agricultural Impact Statement is not required.	1) Section 1.6 2) Section 10.10 and Appendix S
Department of Trade & Investment, Regional Infrastructure & Services	1) Requested that the EIS clearly identifies existing coal titles within and adjacent to the Project areas and any new mining titles which will be required in order to undertake the Project. 2) Requested that the proponent complies with the Commonwealth *Native Title Act 1993*. 3) Requested specific information relating to rehabilitation post mining land use and landforms, objectives and mine closure completion criteria. 4) Exploration activities should be clearly defined in the EIS. 5) The proposed mine layouts should be designed and management systems developed, taking into consideration identified subsidence, existing surface structures and stakeholder and community issues. 6) The EIS should provide assessment of subsidence using best available predictive formulae. 7) The EIS should identify if the predicted subsidence will result in fracture connectivity to the surface.	1) Chapter 3.0 and Chapter 4.0 2) Chapter 5.0 3) Section 10.11 4) Chapter 3.0 and Chapter 4.0 5) Chapter 8.0 6) Chapter 8.0 7) Chapter 8.0and Appendix D
Lithgow City Council	Council considers the draft DGRs adequately highlight the relevant Project issues apart from the impacts of any increase in train traffic and visual impact.	N/A

NSW Office of Water	Key issues to be addressed: 1) That adequate and secure water supply is available for all activities for the life of the mine. 2) Compliance with the rules in any relevant Water Sharing Plan and legislation. 3) Baseline monitoring (minimum of fortnightly data sampling for at least 2 years prior to mine operations) of all surface water and groundwater sources and dependent ecosystems within and adjacent to the mining area for calibration of models and development of trigger criteria. 4) Predictive assessments of potential impacts to surface water and groundwater sources, basic landholders rights to water, adjacent licensed water users and dependent ecosystems and monitoring to enable comparison with ongoing monitoring. 5) Mitigation strategies to address impacts on surface water and groundwater sources and dependent ecosystems for the operational and post mining phases of the proposal and final landform.	Section 8.2, Appendix E and Appendix F
Sydney West Area Health Service, NSW Health	Key issues to be addressed: 1) use of local air quality monitoring as far as possible to establish background PM_{10}. 2) assess the incremental impacts on PM_{10} from the Project. 3) include an assessment of potential cumulative impacts on PM_{10} by considering other known new air pollution emissions sources in the area. 4) where schools, nursing homes or health facilities are subject to noise from the Project include the modelled noise impacts.	1) Section 10.7 and Appendix M 2) Section 10.7 and Appendix M 3) Section 10.7 Appendix M 4) Section 10.6 and Appendix L 5) There are no schools or health facilities within the Project Application Area.

Office of Environment and Heritage	1) include full flora and fauna studies and offset proposals; 2) clearly detail the expected quality, temperature and quantity of water being released and any impacts on aquatic biodiversity; 3) consider changes to groundwater levels, as changes in groundwater can lead to impacts such as drying of vegetation communities; 4) include the regional water strategy. 5) ensure that a due diligence assessment to avoid harming Aboriginal objects is conducted prior to ground disturbance; 6) consultation must be in accordance with the Aboriginal Cultural Heritage Consultation Requirements For Proponents 2010 (DECCW 2010); 7) address direct and indirect impacts on public land. The EIS at a minimum should include viewshed analyses from visitors to public land; 8) address the issue of linear infrastructure such as new tracks and power lines linking previously isolated natural features; 9) historic heritage will need to be assessed and heritage management plans prepared; 10) include details of expected greenhouse gas emissions and how these will be minimised. A greenhouse gas management plan should be included within the EIS; 11) clearly identify all natural features and detail how impacts to these will be avoided, mitigated and offset; 12) details of environmental protection zones should be included and how they have been avoided, monitored and or managed; 13) The EIS should identify sensitive features and how sensitivity was defined and delineated; and 14) The EIS will need to provide specific details of intended monitoring programmes and methods.	1) Section 10.3 2) Section 10.2 and Section 10.3 3) Section 10.2 and Section 10.3 4) Section 5.6.2 and Appendix E 5) Section 10.4 6) Section 10.4 7) Section 10.12 8) Chapter 10.0, various sections 9) Section 10.4 10) Section 10.8 11) Chapter 8.0, Section 10.2, 10.3 and 10.4 12) Chapter 8.0 13) Chapter 8.0 14) Chapter 3.0, Chapter 4.0 and Chapter 10.0

Roads and Maritime Services, NSW	A traffic impact study should be prepared in accordance with Section 2 of the RTA's Guide to Traffic Generating Developments, including: 1) hours and days of construction and operation and how proposed operations will interact with existing operations; 2) the road and rail traffic and transport volumes and types. Volumes should also include mine input related traffic generation and impact of mine related traffic generation on public roads. The traffic study should address internal traffic movements and parking facilities; 3) any oversize and over-mass vehicles and loads. 4) the selection of routes having regard to the risk and impact to other motorists ; 5) the impact of traffic and measures employed to ensure efficiency and safety on the adjacent road network, in particular the Castlereagh Highway ; 6) any mitigation measures required to address expected traffic generation; 7) local climate conditions that may affect road safety for vehicles; 8) details of any crossings of public roads, in particular the Castlereagh Highway. All private crossings of Castlereagh Highway will need to be grade separated.	Section 10.5
Forestry Corporation of NSW	1) The requirement of the applicant to enter into an access arrangement with Forestry NSW before entering state forest land 2) All maps showing proposed developments must include tenure information, particularly that of the legal boundary with Forestry Corporation of NSW. 3) All associated developments/infrastructure must be identified. 4) All new indigenous or non-indigenous heritage, flora, fauna or EEC sites identified during the EIA process on State Forest must be communicated to Forestry Corporation NSW and other relevant authorities for recording. 5) Note: Any infrastructure located in the Forest must be secured from the public and made safe at all times.	1) This is an on-going commercial arrangement and an extension of existing agreements that will be addressed post-determination 2) Figure 4.1 and Section 4.1 3) Chapter 4.0 and Figure 4.1 4) Chapter 11.0 5) Chapter 11.0

7.9 Feedback on Stakeholder Engagement

The EIS will be placed on public exhibition for a minimum of 30 days to allow for government agencies, organisations, interest groups, stakeholders and community members to provide written submissions. **Table 7.5** provides information regarding the tools and activities adopted by Centennial Angus Place to encourage the community and stakeholders to provide feedback on the Project or EIS.

Table 7.5 Tools and Activities to encourage feedback

Engagement tool	Details
Contact Mechanisms	(Project telephone number 6354 8700) was established to enable all stakeholders to provide feedback on the Project and ask questions of the Project team. The feedback has been considered during the preparation of the EIS.
Project Website	Information on Angus Place Colliery Extension Project (Briefing Paper and DGRs) has been posted on the Department of Planning and Infrastructure's website and Centennial's website.
Advertisements	Mudgee Guardian and Lithgow Mercury
Aboriginal Consultation	Aboriginal consultation was undertaken in line with *Aboriginal Cultural Heritage Consultation Requirements For Proponents* (DECCW 2010).
Stakeholder Briefings	Face-to-face and written briefings to stakeholders informing them of the public exhibition phase and requests for comment.

Once the EIS exhibition period is complete, Centennial Angus Place will prepare a Submissions Report summarising the issues and concerns raised through the written submissions by the community and stakeholders. Any significant changes to the Project as the result of these written submissions if relevant will be further detailed in a Preferred Project Report and the PAC will then make a determination.

A hard copy of the submissions report will be submitted to the affected landholders and stakeholders and other stakeholders will be notified through the local newspaper or community newsletter.

7.10 Conclusion

As demonstrated in **Table 7.5**, all issues raised by stakeholders have been considered within this EIS and through the completion of specialist assessments.

Centennial Angus Place is having ongoing discussions with NSW Office of Water with regards the issue of necessary licences.

Centennial Angus Place is committed to the timely, orderly, consistent and credible dissemination of appropriate information within the constraints of legal and regulatory requirements to all interested stakeholders. To date, no major complaints have been received from the Angus Place Colliery.

Consultation will continue throughout the life of the Project to ensure the community remains informed of the mine's progress and the outcomes of the EIS.

CHAPTER 8.0

Mine Design and Subsidence

8.0 MINE DESIGN AND SUBSIDENCE

This chapter specifically responds to the Director General's Requirements, which provide the following in regard to subsidence:

The Director General's requirements

Subsidence – including a detailed quantitative and qualitative assessment of the potential conventional and non-conventional subsidence impacts of the development that includes:

- the identification of the natural and built features (both surface and subsurface) within the area that could be affected by subsidence, and an assessment of the respective values of these features;
- accurate predictions of the potential subsidence effects and impacts of the development, including a robust sensitivity analysis of these predictions;
- a detailed assessment of the potential environmental consequences of these effects and impacts on both the natural and built environment, paying particular attention to those features that are considered to have significant economic, social, cultural or environmental values; and
- a detailed description of the measures that would be implemented to avoid, minimise, remediate and/or offset subsidence impacts and environmental consequences (including adaptive management and proposed performance measures).

8.1 Introduction

This chapter describes the proposed mine design and plan, and the resulting subsidence predictions as a result of the Project. It is informed by the technical study of MSEC "Centennial Coal: Angus Place Colliery Extension Project: Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Environmental Impact Statement for the Proposed Longwalls 1001 to 1019 in the Lithgow Seam, May 2013 Rev 04" (Report No. MSEC593) (**Appendix D**).

The proposed mine plan (provided in **Figure 4.2**) and current design philosophy is described, including mining constraints (geology and geotechnical conditions) and any sensitive surface features that were avoided as part of current and future mining operations. It also describes how the potential impacts, not able to be avoided, have been mitigated through optimisation of the mine design.

The area above the proposed longwalls will subside and the potential consequences to, and mitigation measures for, key environmental issues are detailed in their respective sections of **Chapter 10.0**.

The primary objective of mine design is safety, underground and on the surface. By managing safety, the mine manages subsidence impacts on the surface and in turn manages environmental and social consequences. At Angus Place Colliery, the application of risk based planning has driven mine planning, mine design and subsidence management, based on geological and geotechnical constraints, and the sensitive surface features.

8.2 Mine Design Constraints

Angus Place Colliery extracts coal from the Lithgow Seam. The Lithgow seam consists of several coal plies separated by a number of shale and claystone bands all dipping to the northeast. The extracted seam has, to date, been consistent in nature and thickness (Palaris, 2012). Palaris (2012) reports that the seam splits towards the eastern portion of the extension area where seam thickness varies considerably. This thinner working sections may provide certain mining difficulties. **Chapter 2.0** provide details on the local and regional stratigraphy.

Where the seam splits, the resulting effect on the mining operation is a thinner cutting height (1.8 m), poorer coal quality and roof strata that is predominantly coal. A roof that is predominantly coal is subject to greater instability through in-situ stresses.

To mitigate the impact of poor coal quality, it is proposed to reduce cutting height of coal (to 1.8 m) from Longwall 1004 onwards in some parts of the proposed workings or mining area within the Project Application Area (**Figure 4.2**) to allow mining to a stable roof horizon to ensure the safety of mineworkers.

8.2.1 Geotechnical Constraints

The mine has a history of difficult geotechnical conditions. Current mining operations are conducted within an approximately 7 m thick coal seam (which consists of the coalesced Lithgow / Lidsdale seams). The bottom 3.5 m are mined section – leaving approximately 4 m of coal in the roof. The coal roof is interbedded with numerous claystone units. Claystone units reduce the competency of the roof material by providing shear zones which deform over defined periods of time. This roof stratigraphy results in very weak roof conditions

Added to a weak roof, the depth of cover in the current mining area is typically 300 m to 380 m and this will increase to 430 m in parts of the Project Application Area. The deeper the coal that is being mined, the greater the pressure placed on coal pillars left to support the roof and the greater the pressure on the roof. The depth of cover creates both horizontal and vertical stress on these pillars. The combination of a relatively high stress regime and weak, laminated roof has led to numerous roof failures throughout the mine’s 34 year life (an example is shown in **Photograph 8.1**.

The suitability of roof conditions for various mining systems is in part determined by the structural competency of the roof and the stresses in the strata adjacent to the mined coal seam. The roof stress and strength are related to the thickness and rock types present in the overlying strata immediately above the coal being mined, and residual stress and geological structures generated by tectonic movement.

Deep underground mines such as Angus Place Colliery have relatively high inherent vertical stress (which is directly proportional to depth of cover). The principal horizontal stress direction at Angus Place Colliery is aligned in an approximate ENE:WSW direction. This has been determined from extensive underground mapping of existing mine workings and from exploration borehole geophysical testing and analysis in the Project Application Area. Measurements of in-situ vertical and horizontal stress levels have been conducted throughout the life of the mine in the overlying strata immediately above the coal being mined and at coal seam level. Measured horizontal stresses have been found to be approximately double the vertical stress levels. Measured vertical stress in current mining areas is in the range of 8 MPa to 11 MPa and measured horizontal stress is in the range of 14 MPa to 23 MPa. Longwall panels have been mined in various orientations over the life of the mine to date. The current east west orientation (sub-parallel to the principal horizontal stress direction) has resulted in the least challenging geotechnical conditions.

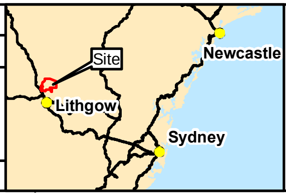
Typically, roof failures occur sometime after roadway drivage (weeks, months or even years later), but in certain geologically structured zones roof failure in the form of guttering, cavities and even major falls has occurred at the development face. In these areas the combination of weak roof, high stress, and geological structure mean that the roof is not self-supporting between the last installed roof support and the development face (a distance of 1 m to 2 m). **Photograph 8.3** shows roof “guttering” at Angus Place, where the roof falls out during the mining process and must be supported immediately to prevent major roof falls.

Due to the extreme strata conditions experienced at Angus Place and Springvale, specialised equipment has been developed at Angus Place Colliery and Springvale Mine to deal with adverse roadway development conditions (**Photograph 8.4**). This equipment includes a “spiling” rig which allows roof support to be installed ahead of the development face and cable bolt installation equipment on the continuous miners to facilitate safe installation of 8 m length cable bolts into the roof within 1 m of the development face. The specialised equipment and processes designed and implemented are considered industry best practice and ensure safe operating conditions for mine workers even in very poor roof conditions. They are however time consuming and expensive to employ and longwall mining is used to mine the main coal body.

Photograph 8.1: Recovered Roof Fall at Angus Place – approximately 7 m high and 10 m wide

Photograph 8.2: Roof Fall on longwall belt at Springvale – approximately 6 m high and 20 m long

DATE	13/03/2014
SEAM	LITHGOW
REFERENCE	127623060-R APC Rev 0
SCALE	NOT TO SCALE



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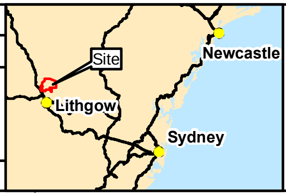
Photograph 8.3: Roof "Guttering" at Angus Place – normal roof horizon is at the level of the pipes

Photograph 8.4: Specialised equipment developed at Angus Place Colliery to deal with adverse roadway development conditions

DATE	13/03/2014
SEAM	LITHGOW
REFERENCE	127623060-R APC Rev 0
SCALE	NOT TO SCALE



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8.2.2 Monitoring Data Used to Understand Effects of Major Geological Structure Zones on Mine Subsidence

Following underground roadway development, the mine roadways can experience high levels of roof movement. Undetected deterioration can result in uncontrolled roof movement leading to roof falls. In some circumstances, where an initial event has been detected, further deterioration can lead to hazardous conditions for personnel installing remedial roof support in roadways in advanced states of deterioration.

To reduce the risk to personnel and develop a database of knowledge on the risks and likelihood of roof falls at Angus Place Colliery, two point wire extensometers (known as telltales) are used for roadway condition monitoring. Statistical analysis of telltale data has allowed an understanding of “typical” roadway behaviour at different stages of the roadway life cycle. Analysis and trending of displacement, displacement rate and acceleration data has enabled both early response to anomalous trends and also detailed strata support design in order to maintain mine safety standards.

Telltales are now installed in the roof of the mine roadways at 25 m centres throughout the current mining area to ensure that anomalous movement trends are detected early and managed through a Trigger Action Response Plan (TARP). Angus Place has a database based on more than 3600 instruments, with monitoring over a 17 year period, commencing in 1996. The “Strata Failure Management System Database” was developed at Angus Place and Springvale in order to manage the large amounts of data generated and to automate the process of notification of trigger exceedances. This system is recognised as industry best practice and has been adopted by a number of other mining non-Centennial operations. **Figure 8.1** shows an example of data trending of roof movement at one of the monitoring sites over the last 12 years.

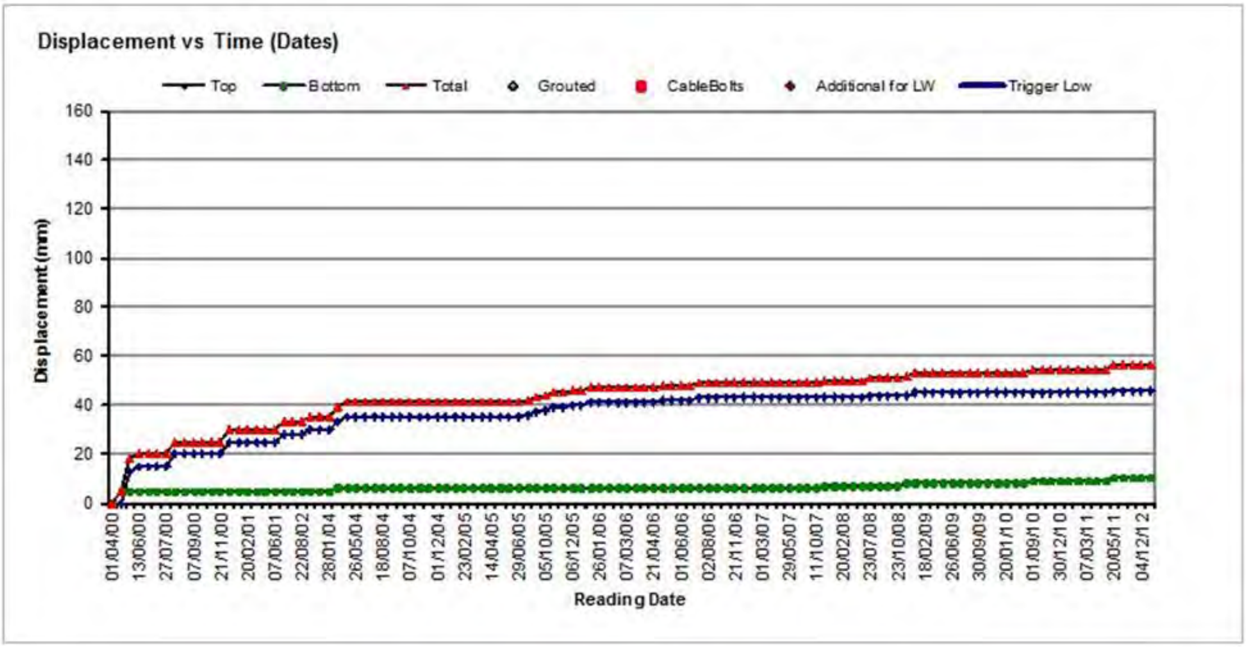


Figure 8.1 Trending of telltale data at a roof movement monitoring site

Based on the very extensive database of measurements from existing workings and from exploration boreholes in the Project Application Area, Angus Place Colliery’s roof is rated weak under the Coal Mine Roof Rating System.

The combination of a weak roof and a high stress environment means that longwall mining in the Lithgow seam at Angus Place Colliery is the only viable and safe mining method. Strata Engineering Pty. Ltd (Australia) in Report No. 03-123-AGP-33 identify that in Australia there is no known precedent for safe and viable partial extraction (i.e. bord and pillar) operation in the geotechnical environment under consideration within the Project Application Area.

It should be noted that historical bord and pillar operations were conducted in shallower depths of cover adjacent to the current Angus Place longwall mining area, but these operations were truncated to the East due to increasing stress levels generated by the increasing depth of cover under the Newnes Plateau.

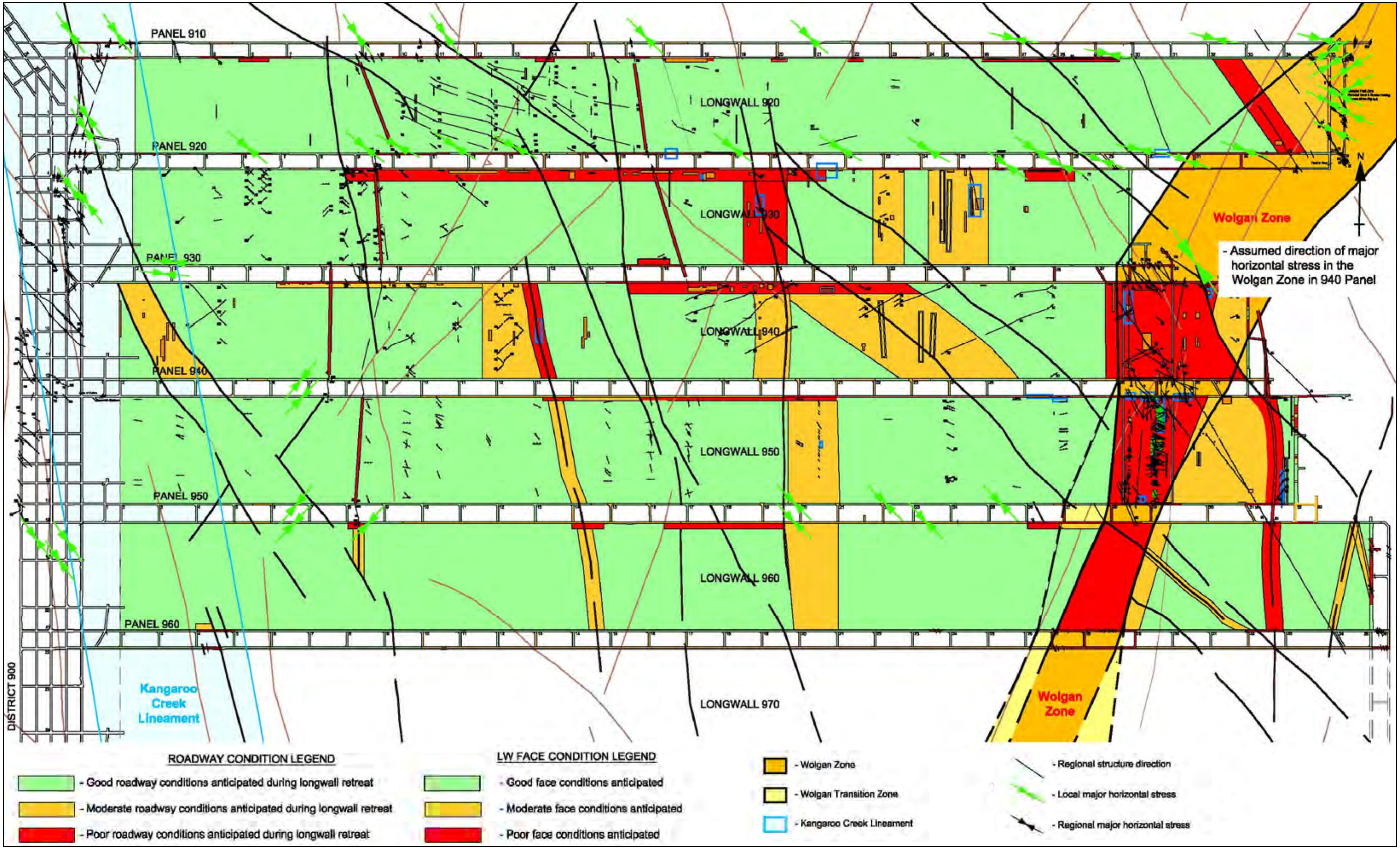
The floor of the Lithgow seam consists of the Marrangaroo Conglomerate. Typically it provides an acceptable floor because of a cap of siltstone that is present above the poorly cemented medium to coarse grained (and coarser) sediments of the Marrangaroo Conglomerate. Wet and very soft floor conditions occur periodically where mining has breached into the underlying coarser sandstone (Palaris 2012). Floor conditions will be similar within the Project Application Area to those experienced in the past and will not cause greater subsidence levels compared to those previously monitored at Angus Place Colliery.

Information gathered from monitoring is used to prepare Geotechnical Hazard Plans, which are then used in all areas of mine planning to allow for safe and efficient operation of the mine. Information used to prepare the plans includes:

- Aeromagnetic Data Interpretation
- Surface Lineament trends
- Geology mapping
- Geotechnical mapping
- Extensometer data trends
- Longwall support hydraulic pressure trends
- Staff and workforce reports

Due to the extensive monitoring conducted, these Geotechnical Hazard Plans at Angus Place are based on an extremely robust dataset. **Figure 8.2** is a representative geotechnical hazard plan from Angus Place 900 Area. Geotechnical hazard plans are also used in the identification of major geological structure zones which could influence subsidence behaviour of the strata overlying the coal seam. The NNE trending zone at the Eastern end of the mine workings (marked in red and orange) directly underlies the Western flank of the surface topographic feature known as the Wolgan Lineament. Refer to **Section 2.6.2** for more detail on the nature and influence of Lineaments.

Subsidence monitoring from Angus Place A and F subsidence monitoring lines across the surface valleys associated with the Wolgan Lineament (which contain Narrow Swamp and East Wolgan Swamp) has identified greater subsidence levels compared to previous predictions. Further analysis of subsidence associated with major geological structures was conducted using LIDAR data (from pre-mining survey in 2005 compared with post-mining data from 2012).



- Mapped in-seam faults
- SRK predicted basement faults
- SRK anticipated structures at seam level
- SRK confirmed structures at seam level

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F081 APC Rev 0
SCALE	NOT TO SCALE

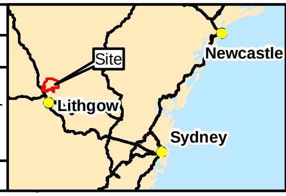


Figure 8.2: Angus Place Geotechnical Hazard Plan

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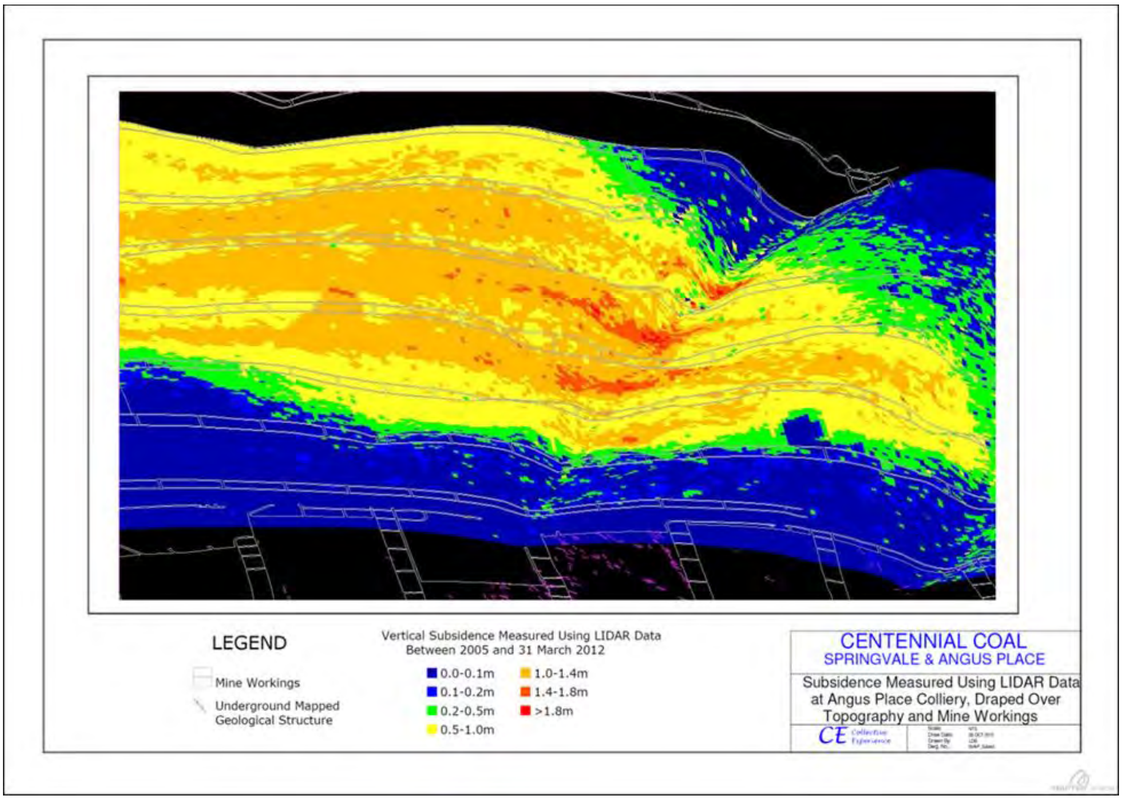


Figure 8.3A LIDAR Subsidence data draped over DTM topography and mine workings

Figure 8.3A shows LIDAR subsidence data draped over topography from the Digital Terrain Model and mine workings. Subsidence levels in excess of previously predicted values (>1.4m) are shown in orange and red and can be clearly seen to be concentrated around the valley which contains Narrow Swamp (and identifies the Western flank of the Wolgan lineament major geological structure zone).

After the relationship between major geological zones and increased subsidence levels was established, a thorough review of subsidence data over history of mining at Springvale and Angus Place was conducted to determine all factors which had caused anomalous subsidence in the history of the mine. The subsidence prediction models for Angus Place and Springvale were revised by DgS (September 2010) and subsequently by MSEC (March 2013).

Analysis indicated that elevated subsidence had not been recorded consistently along the length of known major geological structure zones. It was found that topography was also an important factor in the occurrence of elevated subsidence and mining related impacts. Surface cracking locations were mapped and correlated with measured subsidence and strain anomalies, and it was found that recorded subsidence impacts had occurred only at locations with both major fault zones and incised valleys (with slope gradients > 18^{o}), as shown in **Figure 8.3B**.

Since the subsidence prediction models were revised, the occurrence of anomalous subsidence measurements has been better predicted and reduced, with no recorded occurrences at Springvale and only one recorded occurrence at Angus Place. It must be noted that in this case, where anomalous strain was measured on the EWS Line at East Wolgan Swamp (notification was conducted under SMP reporting protocol on 2nd November 2010), investigation revealed that there was no cracking and that the recorded movements were consistent with a survey mark being "hit" by an external object and were not consistent with mine subsidence movements. This reflects the increased accuracy of the subsidence prediction model, which has been improved through the gathering and analysis of monitoring data at the mines.

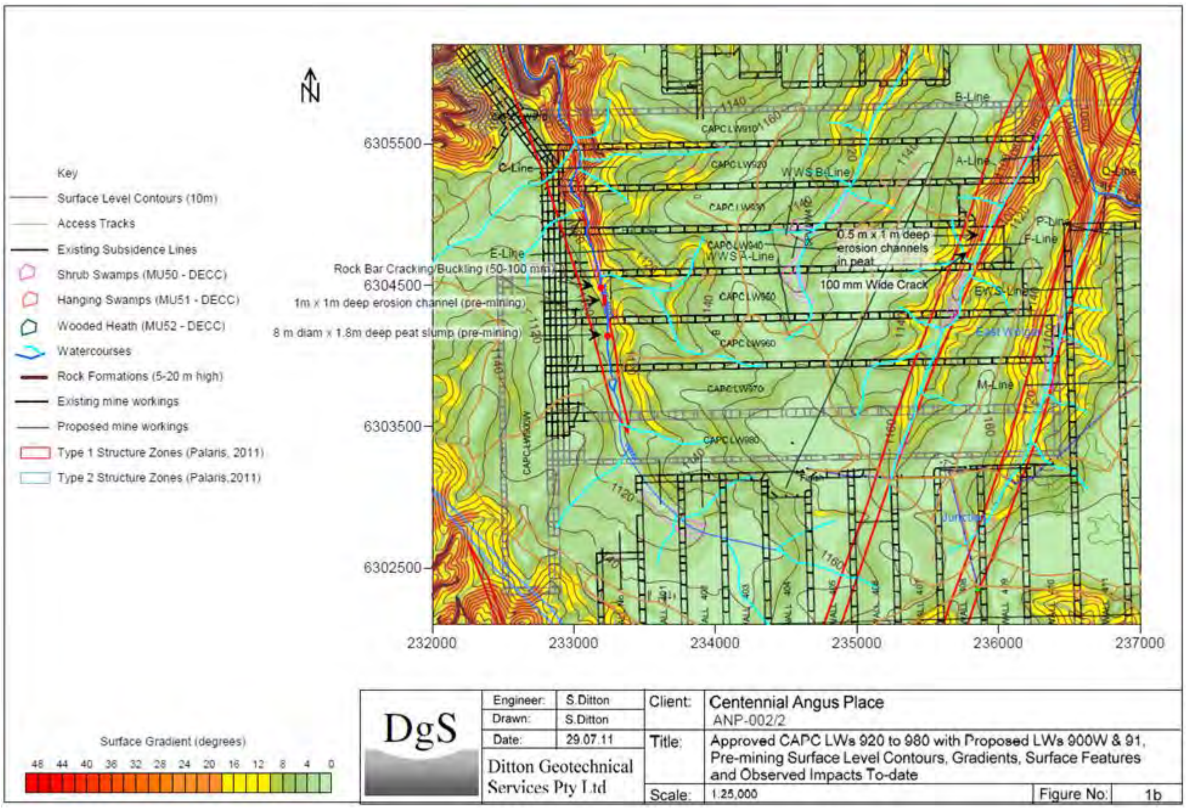


Figure 8.3B Springvale Mine Workings with Topography and Major Geological Structure Zones and the Location of Observed Mining Related Impacts

8.2.3 Narrow Swamp

Narrow Swamp lies in the valley which identifies the western flank of the Wolgan River Lineament.

It should be noted that the elevated levels of subsidence measured at the Angus Place A and F subsidence monitoring lines and using LIDAR (**Figure 8.3A**) across the surface valley associated with the Western flank of the Wolgan River Lineament (Narrow Swamp) did not cause changes to swamp hydrology as shown in **Figure 8.4** and **Figure 8.5**. A discussion on the impacts of mining on swamp hydrology is included in **Section 2.6.2**.

Figure 8.4 is a graph of mine water discharge at Angus Place Colliery's Licensed Discharge Point 5 (upstream of Narrow Swamp) compared to two downstream flow monitoring stations at Narrow Swamp. The similarity of the trend of mine water discharge flows compared to upstream and downstream flow monitoring (similar losses through monitoring period from pre-mining to post-mining period). The monitoring data shows that the three longwall panels that have passed under the Narrow Swamp (i.e. Angus Place Colliery LW920 in 2004, LW940 in 2007 and LW950 in February 2009) have caused no significant loss of flow in the watercourse. Flow monitoring carried out in this swamp prior to the extraction of LW950 has shown that approximately 91% of the discharge from LDP005 reached a weir (NSW1) in the centre of the Narrow Swamp. The deficit in flow volume is apparently taken up in the peat deposits in the swamp (which is normally periodically waterlogged). After undermining by LW950 in February 2009, the monitoring indicated no change in the percentage of the discharge that reached NSW1. In addition, the percentage of discharge from NSW1, which reached a weir at the northern end of the Narrow Swamp (NSW2), was also 91%. Two longwall panels have undermined the Narrow Swamp in the section of the watercourse between NSW1 and NSW2, and so the flow monitoring indicates conclusively that the mining to date has not resulted in any significant cracking in the base of the swamp. This is demonstrated in **Figure 8.4**, which shows the measured discharge at the LDP005 weir as well as the flows at the two weirs further downstream. The increased proportion of flows between NSW1 and NSW2 in the period between October 2008 and January

2008 is due to longer continuous discharge during this period resulting in increased saturation of peat by comparison with earlier emergency mine water discharge period in 2008 which were shorter in duration.

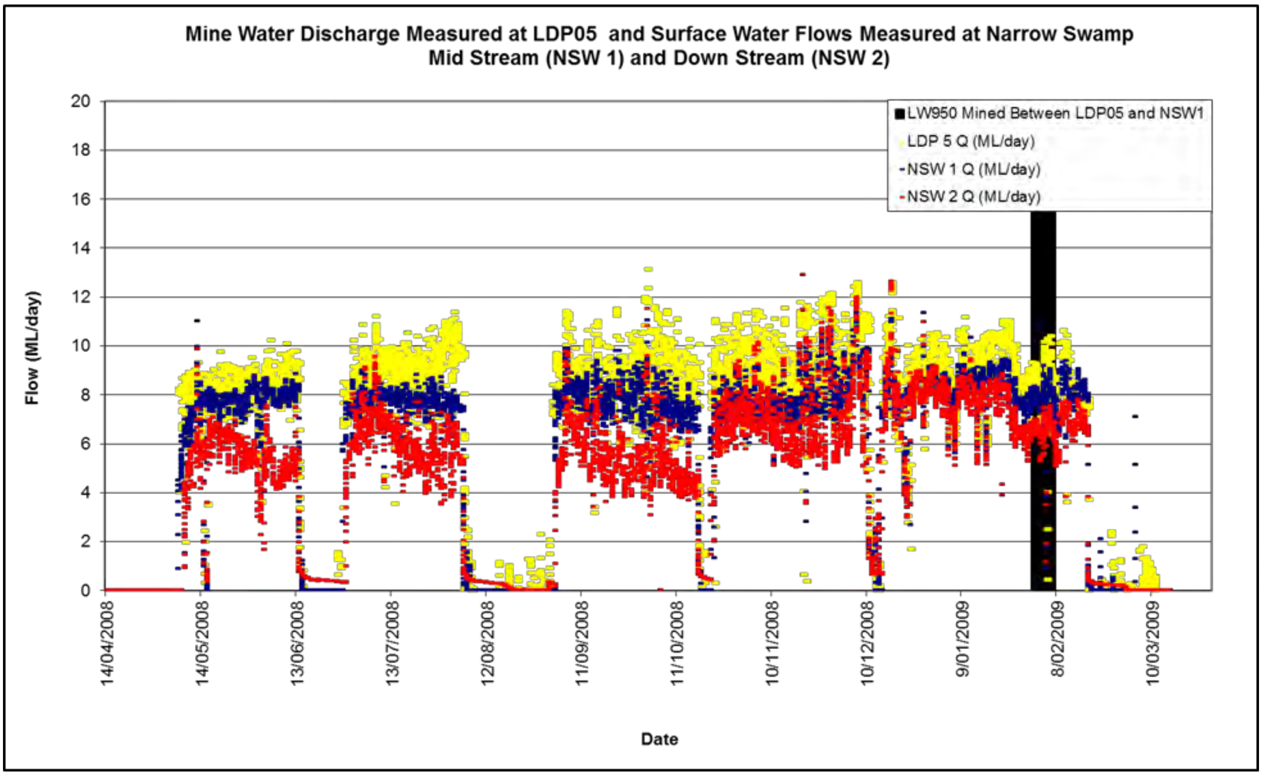


Figure 8.4 Mine water discharge at Licensed Discharge Point 5 compared to two downstream flow monitoring stations at Narrow Swamp

Figure 8.5 is a hydrograph of Narrow Swamp piezometers NS1, NS2, NS3 and NS4 showing the timing of mine water discharge and longwall mining as well as the Cumulative Rainfall Deviation trend. The timing of mining was similar to that of the cessation of mine water discharges at LDP005 in February 2009, but the dominant influencing factor can be seen to be mine water discharges. Following the cessation of mine water discharges, the hydrograph trends can be seen to be strongly influenced by rainfall. The standing water levels rise in response to rainfall events which are in excess of the long term average trends and fall in response to less than average rainfall trends. The responses are typically immediate and of short duration, indicated by the “spikes” in the hydrograph trends. When the data recorded during mine water discharged is removed, the same trend can be seen in the pre-mining baseline data. There is approximately 12 months pre-mining data which is not affected by mine water discharge which clearly shows that the swamp was periodically waterlogged prior to mining. It remains periodically waterlogged following mining.

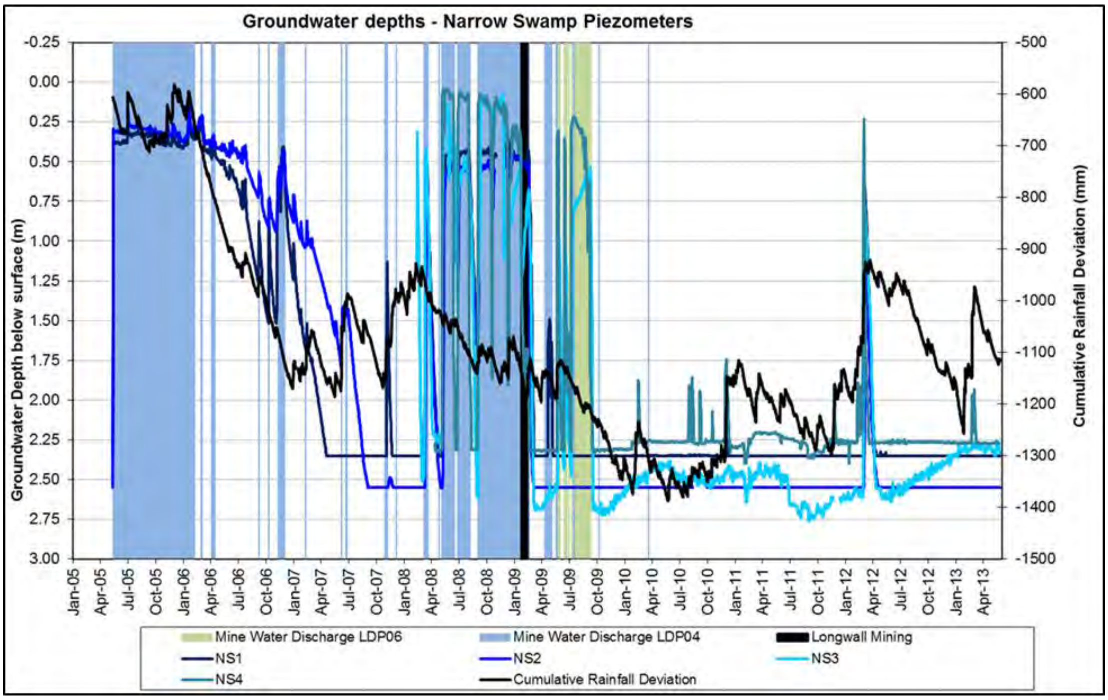


Figure 8.5 Hydrographs of the four piezometers in Narrow Swamp, together with timing of mine water discharges and cumulative rainfall deviation

8.2.4 East Wolgan Swamp

East Wolgan Swamp lies in the valley which identifies the Eastern flank of the Wolgan Lineament.

Subsidence Status Management Reports (SMSR) compiled by Springvale in 2008, indicated that emergency mine water discharge flows (which were released into East Wolgan Swamp from Licensed Discharge Point 4) were not being recorded at the downstream monitoring location. A site inspection was conducted in December 2008, and it was found that mine water discharge was flowing into a cavity at the base of the swamp. Following this incident, Springvale conducted detailed investigations to determine the cause of this phenomenon. A summary of the investigation findings is contained in **Section 2.6.2**.

It was found that the majority of impacts identified at East Wolgan Swamp were triggered by mine water discharge.

It was also found that mine subsidence had caused localised reactivation of geological faulting associated with the major geological structure zone associated with the Wolgan Lineament.

Details of impacts related to mine water discharge are included in **Section 2.6.2**.

The key co-incident factors related to cavity formation at East Wolgan Swamp (into which mine water discharge flowed and caused peat slumping through erosion of sand / peat into the cavity) are listed below:

- Intersection of major geological fault structures
- Orientation of the longwall panel sub-parallel to the major structures
- Steepness and depth of East Wolgan Swamp valley at Northern end
- Prevailing in-situ stress direction and magnitude
- Critical width longwall panel design
- Location of the geological structure close to the permanent barrier pillar (at cavity location)

- Interaction of Angus Place and Springvale mine workings and subsidence effects due to close proximity (at cavity location)

It must be noted that this combination of factors does not occur elsewhere on the Springvale Mine or Angus Place Colliery mine plans. However, this understanding provides a robust basis for mine design in the vicinity of sensitive surface features such as swamps, as outlined below.

8.2.5 Comparison of Mining Related Activities at Narrow Swamp and East Wolgan Swamp

As a result of the differences in observed impacts at Narrow Swamp and East Wolgan Swamp, which are both located in similar geological structure zones within the Wolgan Lineament, a comparison of the mining activities in the vicinity of the swamps was conducted.

The key differences between mining adjacent to East Wolgan Swamp and Narrow Swamp were found to be:

- The orientation of the longwall panels to the watercourse sub-perpendicular which is more favourable than at the East Wolgan watercourse where the sub-parallel orientation produces a large area of increased tensile stress across the valley;
- The chain pillars between longwall panels are designed for elastic deformation, so that there are lower residual strains in evidence over the pillars beneath the Narrow Swamp, than over the barrier pillar between Angus Place and Springvale, adjacent to East Wolgan Swamp.
- Although there are major geological structures which are aligned with the Narrow Swamp watercourse, they cross the longwall panels at a more favourable angle, and are not exposed to a significant tensile stress regime like the structure over longwall 411, which is near-parallel to the panel.
- The valley supporting the Narrow Swamp is not as steep or deep where it has been undermined, as that containing the East Wolgan watercourse beneath the northern end of longwall 411. As a result, the potential for valley closure and uplift is reduced in the Narrow Swamp.

As a result of the investigations into mining related impacts at East Wolgan Swamp, a thorough review of mine subsidence and mine design was conducted. It was recognised that changes had to be made to ensure that impacts from mining related activities were reduced to acceptable levels. **Table 2.6** identifies the causal factors which led to localised anomalous subsidence behaviour which resulted in the formation of a cavity in the base of East Wolgan Swamp and the management responses to prevent recurrence.

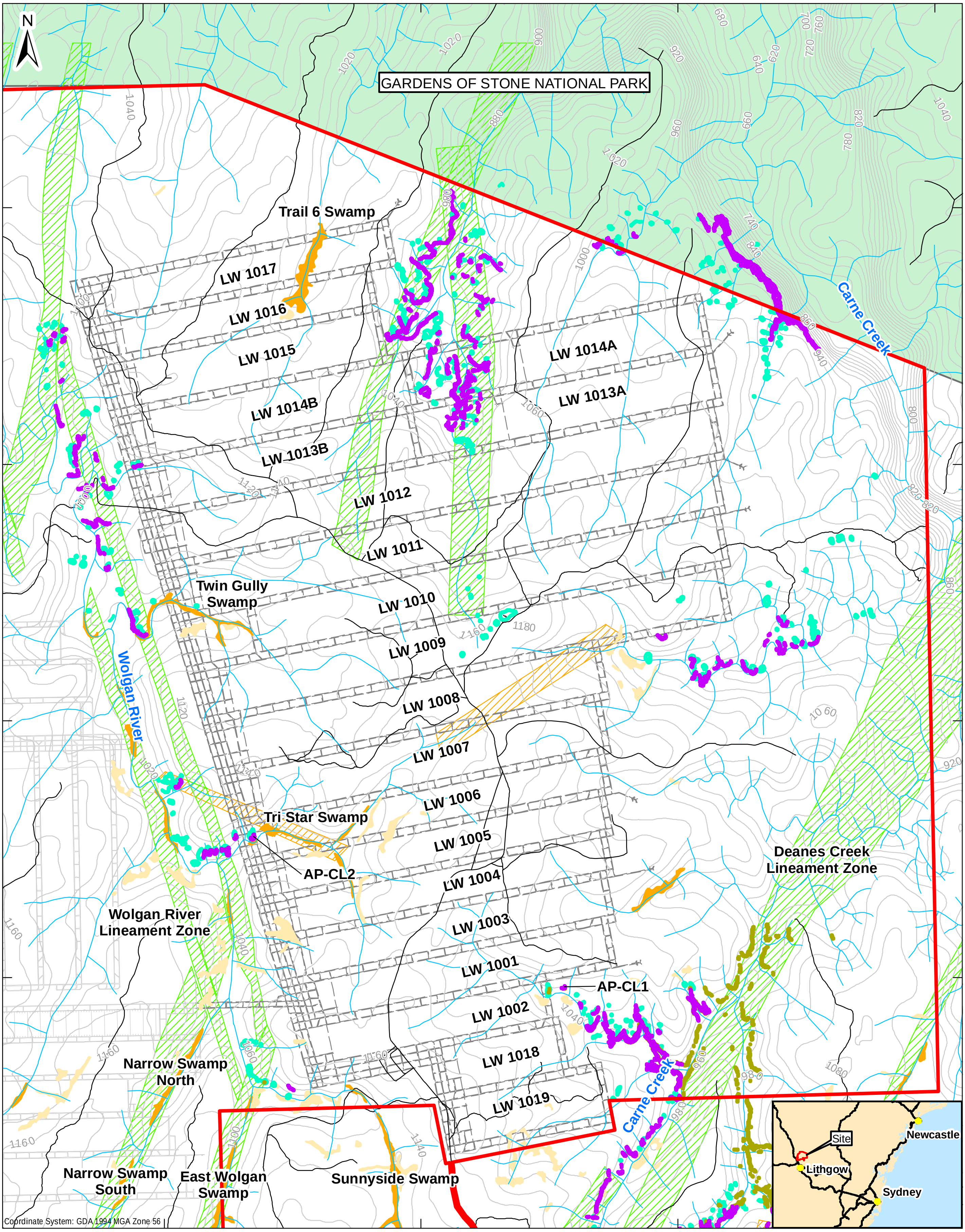
There are a range of minor and major structural features at Angus Place Colliery, the most important being Kangaroo Creek and the Wolgan River lineament. **Figure 2.13** shows these lineaments in the broader context of the Project Application Area. These are faults whose surface expression has guided the direction of some parts of their respective watercourses. There are further short type 2 lineaments above the western end of LW 1006, above the eastern end of LW 1008, and above the middle of LW 1010 to 1012.

These major type 1 and smaller type 2 faults have at times contributed anomalous subsidence over longwalls. Such occurrences are discussed in **Section 8.3.2**. The interactions of mine subsidence with major geological structure zones and resultant groundwater response are outlined in **Section 2.6.2**.

8.2.6 Sensitive Surface Features

Figure 8.6 shows the locations of a range of key surface features in relation to the proposed longwalls. Key natural features with some degree of sensitivity to subsidence are cliffs, pagodas, watercourses, shrub swamps and hanging swamps. Built features of sensitivity in the Project Application Area are tracks and heritage sites.

Centennial Coal has developed a reliable and detailed understanding of the environmental constraints as a result of experience from operating Angus Place Colliery over many years and from the environmental management and monitoring regimes. Using this knowledge, potential environmental constraints have been taken into account during the mine design process to ensure the Project is undertaken safely and in the most environmentally sensitive manner feasible.



Source: MSEC 2013

LEGEND
- Project Application Area Boundary
- Major Cliff
- Minor Cliff
- Pagoda
- Watercourse
- Street / Track
- Shrub Swamp
- Hanging Swamp
- 20m Contour Interval

Major Geological Structure
- Structure Type 1
- Structure Type 2

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Figure 8.6: Key Sensitive Surface Features

0 200 400 600 800 1,000 metres

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8.3 Previous Subsidence and Development of Current Mine Plan and Design

8.3.1 Definitions

Subsidence is the vertical and horizontal displacement of the land as strata immediately above the extracted coal seam collapses into the mined-out void. Mining-induced subsidence can affect land surfaces and sub-surfaces and associated natural and built structures in a variety of ways and to varying extents with the extent of subsidence impact tending to be greater in areas with shallow depth of cover to the coal seam and less in areas with greater depth of cover.

Subsidence occurs over time and as the longwall face moves along the extraction panel and the strata settle, mining-induced effects and new surface profiles change. In the case of single panel mining, subsidence movements will generally cease approximately 12 months after mining is completed, and the final new land surface profile is achieved. In the case of multiple adjacent longwall panels, the mining of subsequent adjacent panels will cause additional subsidence to occur over the previously completed panel, and an additional 2 years is required for final settlement. Subsidence is cumulative across adjacent longwall panels as in the case of Angus Place Colliery. Mining of one longwall will cause a certain level of vertical subsidence and associated strains, and extraction of adjacent longwalls will increase the subsidence above the first longwall.

Subsidence is measured by the vertical change in elevation, which is the result of the removal of the underlying coal seam, and is predominantly downwards. Upwards subsidence (upsidence) is less common and occurs in drainage lines or deeply incised valleys. The extent of subsidence depends on several factors including surface topography, depth of cover and the lithology of the overburden. Other components of subsidence effects are tilt, curvature and resultant strain.

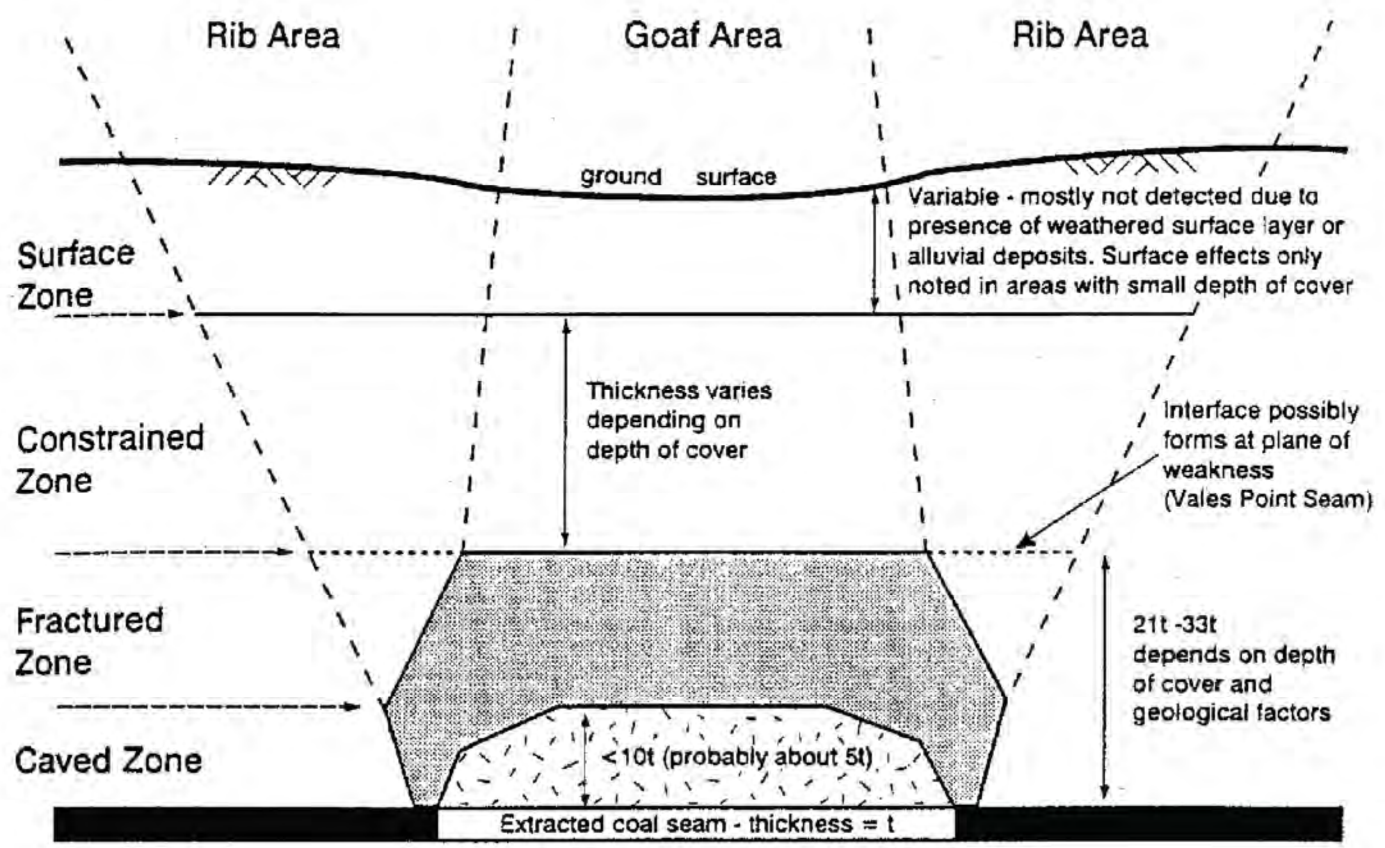
The terms used to describe subsidence, its predictions and impacts are defined in the Glossary of Terms in this EIS. Subsidence movements or effects lead to impacts (such as cracking and slope failure), and these impacts result in environmental or social consequences. Some pertinent terms are defined as follows:

- goaf; the area of fractured rock above the mined out void. **Section 2.6.2** discusses in detail the effects of the height of fracturing on surface subsidence expression;
- chain pillar: a block of coal left unmined between two panels of mined coal. The chain pillar holds up the roof between panels while regular cut throughs allows the passage of air, materials and staff. Generally the wider the chain pillar, the less the subsidence experienced;
- critical width: removal of a panel of coal will form a void, into which the roof will fracture sufficiently to subside the surface. As these voids or longwall panels widen, they reach a critical width, which is when goafing is sufficient to cause maximum possible surface subsidence. A sub-critical width panel is one which does not cause maximum subsidence; Longwall panels that are deeper than they are wide (W/H < 0.9 at Longwall Panels at Angus Place) cause lower magnitudes of subsidence than shallower panels due to natural arching of the overburden across the extracted coal seam.
- depth of cover: the vertical thickness of rock and soil above the mining area (overburden). As the depth of cover increases, the surface expression of subsidence effects is less likely. Observed subsidence is a function of the interaction between void depth to width ratio, such that a narrower, deeper longwall panel will cause less subsidence than a wider, shallower panel;
- panel or void width: the transverse distance across a panel, equal to the longwall face width plus the widths of the roadways on each side;
- angle of draw: the angle measured from the vertical, connecting the edge of the mining void to the surface expression of the lateral limit of subsidence (defined as less than 20 mm/m). At Angus Place Colliery, this angle of draw is 26.5 degrees;

- tilt: the change in ground slope measured by the difference in height of two points divided by their distance apart, measured in mm/m. Positive tilt is towards the direction of measurement;
- curvature: the change in tilt between two adjacent sections of the tilt profile divided by the horizontal length of these sections. Usually expressed as the inverse of the radius of curvature. Curvature can be convex (hogging) or concave (sagging). Hogging causes compression of surface materials while sagging causes tension. The larger the radius or curvature (or the smaller the inverse), the smaller the potential for damage to rigid natural or built structures;
- strain: the changing tension or compression in rocks and soil. Strain is measured by the change in the horizontal distance between two points divided by the original horizontal distance between the points. If this distance increases, it shows tensile strain. If the distance decreases, it shows compressive strain. Strain can be estimated by multiplying predicted curvature by 10;
- conventional movements: the normal ground movements resulting from the extraction of pillars or longwalls are referred to as conventional or systematic subsidence movements. Conventional subsidence profiles are typically smooth in shape and can be explained by the expected caving mechanisms associated with overlying strata spanning the extracted void. Conventional subsidence movements due to longwall extraction are identifiable and predictable where longwalls are regular in shape, the extracted coal seams are relatively uniform in thickness, the geological conditions are consistent and surface topography is relatively flat.
- non-conventional movements are those irregular and to some extent unpredictable ground movements, due to geological conditions and valley related movements. Irregular subsidence movements are occasionally observed at the deeper depths of cover along an otherwise smooth subsidence profile. The cause of these irregular subsidence movements can be associated with:-
  - issues related to the timing and the method of the installation of monitoring lines
  - shallow depths of cover
  - sudden or abrupt changes in geological conditions,
  - steep topography, and valley related mechanisms.

The process of caving and resulting surface deformations is illustrated in **Figure 8.7** (MSEC, 2013 after Foster 1995) and shows the following zones:

- *Caved* or *Collapsed Zone* comprises loose blocks of rock detached from the roof and occupying the cavity formed by mining. This zone can contain large voids.
- *Disturbed* or *Fractured Zone* comprises in-situ material lying immediately above the caved zone which have sagged downwards and consequently suffered significant bending, fracturing, joint opening and bed separation.
- *Constrained* or *Aquiclude Zone* comprises confined rock strata above the disturbed zone which have sagged slightly but, because they are constrained, have absorbed most of the strain energy without suffering significant fracturing or alteration to the original physical properties. Some bed separation or slippage can be present as well as some discontinuous vertical cracks, usually on the underside of thick strong beds, but not of a degree or nature which would result in connective cracking or significant increases in vertical permeability. Some increases in horizontal permeability can be found. Weak or soft beds in this zone may show plastic deformation.
- *Surface Zone* comprises unconfined strata at the ground surface in which mining induced tensile and compressive strains may result in the formation of surface cracking or ground heaving.



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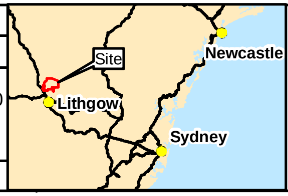

Figure 8.7: Zones in the Overburden (MSEC, 2013)

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8.3.2 Methodology

The approach of Angus Place Colliery to the Mine Extension Project has been to apply a best practice system of environmental management: that is a hierarchy of avoiding, minimising, mitigating and finally, offsetting residual impacts.

In a general chronology, the following steps have been taken to design the Project:

- a detailed geological investigation to delineate the target coal seams and understand associated strata;
- a detailed geotechnical investigation to understand important structures such as faulting that can affect how mineable certain areas of coal are, and the way in which subsidence might occur in these areas;
- a detailed investigation of natural underground features;
- a detailed survey of natural surface features such as cliffs, pagodas, swamps and watercourses;
- a first pass consideration of subsidence effects based on unlimited extraction across the Project area and the subsequent elimination of avoidance areas from further mining consideration;
- the formulation of mine design alternatives based on remnant available areas and potential environmental impacts;
- a detailed cost benefit analysis of the alternate mine designs to select a preferred option;
- detailed subsidence predictions of the preferred mine plan to identify further required avoidance areas or specific mitigation measures required; and
- a consideration of existing approval requirements that may impact upon the Project.

In 2002, Angus Place Colliery commenced intensive monitoring, investigations and research to better understand the surface environment. These investigations have included groundwater, surface water, ecological aspects and the interplay of these aspects on swamps. The data collected and analysed over the past 11 years has been critical to proving that the technologies and engineering methodologies for longwall mining will minimise impacts to sensitive surface features (refer to **Chapter 2.0**).

8.3.3 Evolution of Mine Design and Subsidence

Following the analysis of the East Wolgan Swamp incident, together with observations at Narrow Swamp and Kangaroo Creek Swamp, Angus Place Colliery considered it necessary to review mine design to reduce the potential for subsidence impacts upon sensitive surface features. Sensitive surface features above the resource area are cliffs and pagodas, shrub and hanging swamps and perennial watercourses This mine design review was carried out in consultation with Government departments, and sensitive surface features were avoided where project viability was not at risk.

Significant effort has been invested to evaluate the available coal resource and to avoid or minimise potential impacts that could be associated with the Project. A risk based evaluation including a detailed cost benefit analysis to assess the alternatives, has been completed (**Chapter 6.0** and **Appendix N** and **O**) to apply a best practise system of environmental management: that is a hierarchy of avoid, minimise, mitigate and finally, offset residual impacts.

Using the Wolgan River as the western boundary of the proposed mining area (to avoid direct longwall mining beneath this feature) Centennial Angus Place investigated three mine design options as follows (refer **Figure 8.8**):

- **Option 1** – east west orientation of longwall blocks. Extraction from south to north before the last three blocks in the south;
- **Option 2** - ENE-WSW similar to Option 1 with more favourable stress orientation.; and
- **Option 3 –** NW-SE orientation of longwall blocks. This option was assessed to optimise extraction in areas with thicker seams.

Option 2 is the most viable and preferred option, taking into consideration the varying constraints outlined above of geology (seam split and ash content), geotechnical (roof and floor characteristics), the environment (swamps, cliffs and pagodas), and economics. Option 2 offers the following key advantages:

- optimal geotechnical orientation with longwall panels aligned sub parallel to the regional horizontal stress;
- mains development as the longwall is progressing;
- use of existing longwall equipment for the first 3 longwall blocks (LW1001 – LW1003);
- optimal reserve extraction as available cutting height increases at the western end of the first three longwall blocks; and
- more favourable financial returns than Option 1 and Option 3.

A review of subsidence results for all extracted longwalls at the adjoining Springvale Mine show increases in subsidence above the last six longwalls extracted (LW410 to LW415) as compared to the first ten longwalls (LW1, LW401 to LW409). Increases in measured subsidence are attributed to mining geometry changes. Angus Place Colliery has used width-to-depth ratios to inform future mine design as they are the most important predictors of subsidence behaviour. The ratio is expressed as the longwall void width divided by the depth of cover of strata above the seam. The subsidence effects of these ratios are summarised as follows:

- Subcritical longwall panels are deeper than they are wide ($W/H < 0.9$) and cause lower magnitudes of subsidence than shallower panels due to natural arching of the overburden across the extracted coal seam.
- Critical longwall panels that are almost as deep (H) as they are wide (W) (i.e. $0.9 < W/H < 1.4$) and is the point where yielding of the overburden starts to occur and maximum subsidence is likely to develop if the panel widths are increased.

- Supercritical longwall panels are not as deep (H) as they are wide (W) (i.e. W/H > 1.4) and will cause complete yielding of the overburden and maximum subsidence that is proportional to the mining height (up to 60% of the mined seam thickness).

The measured maximum subsidence above the longwalls LW410 – LW415 with 315 m void widths was higher than the earlier panels (LW1 and LW401 to LW409) where void width ranged from 254 m to 266 m and depths of cover between 300 – 400 m. This placed the wider longwall panels outside the sub-critical range, resulting in surface expression of subsidence effects (as described in **Section 2.6.2** and **Section 8.2.1**).

An analysis of the sensitivity of void widths at the adjacent Springvale Mine identified that:

- marginal subsidence reductions would occur for longwall void widths between 150 m and 260 m and that the greatest reductions can be made from 315 m to 260 m; and
- marginal strain reduction would occur for widths between 150 m and 260 m and that the greatest reduction can be made from 315 m to 260 m.

The relevance of the Springvale Mine experience is that the previously mined narrower sub-critical Springvale longwalls had significantly less subsidence than the wider, critical longwalls that contributed to unpredicted environmental consequences above Springvale Mine. The mine design consequence is that subcritical panel design are proven to minimise impacts on sensitive surface features.

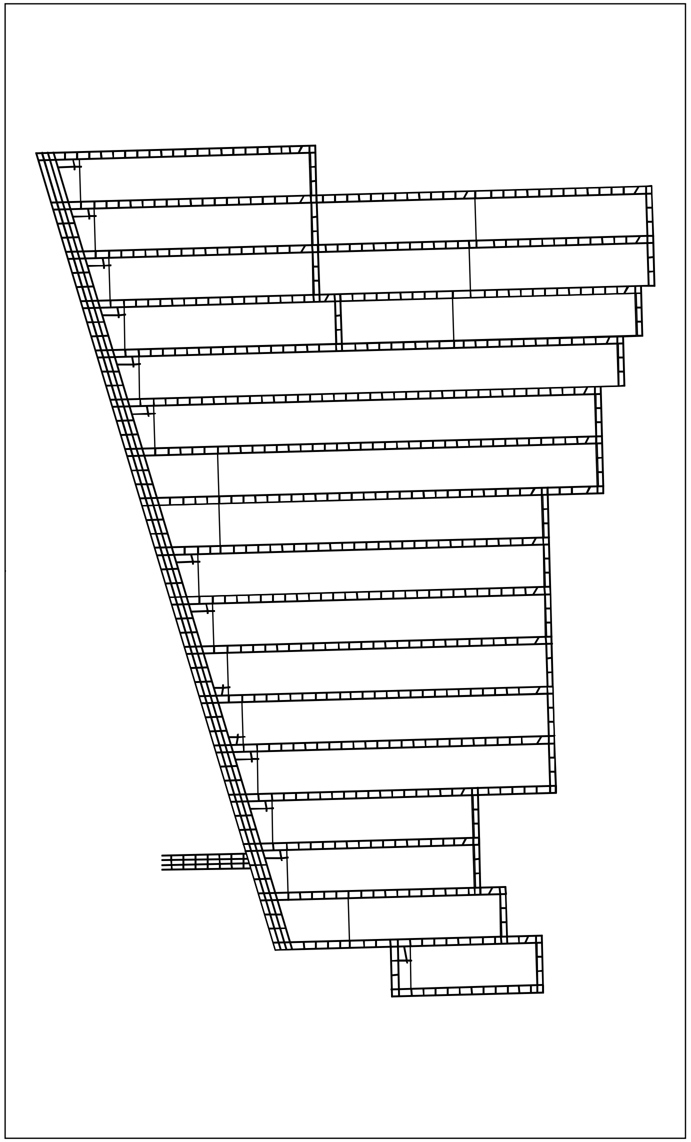
Further to the application of sub-critical void widths, Angus Place Colliery considered modifying the mine plan to avoid sensitive surface features. The final mine plan and design has the following details:

- the mine has been designed with 261 void widths and 58 m chain pillars
- of the three shrub swamps in the mine extension area, the first, Twin Gully Swamp, has been eliminated from the mine plan. The other two, Trail 6 and Tri Star Swamp will be mined under but with narrow, 261 m wide longwall panels;
- no perennial watercourses will be mined under; and
- no cliffs will be mined under.

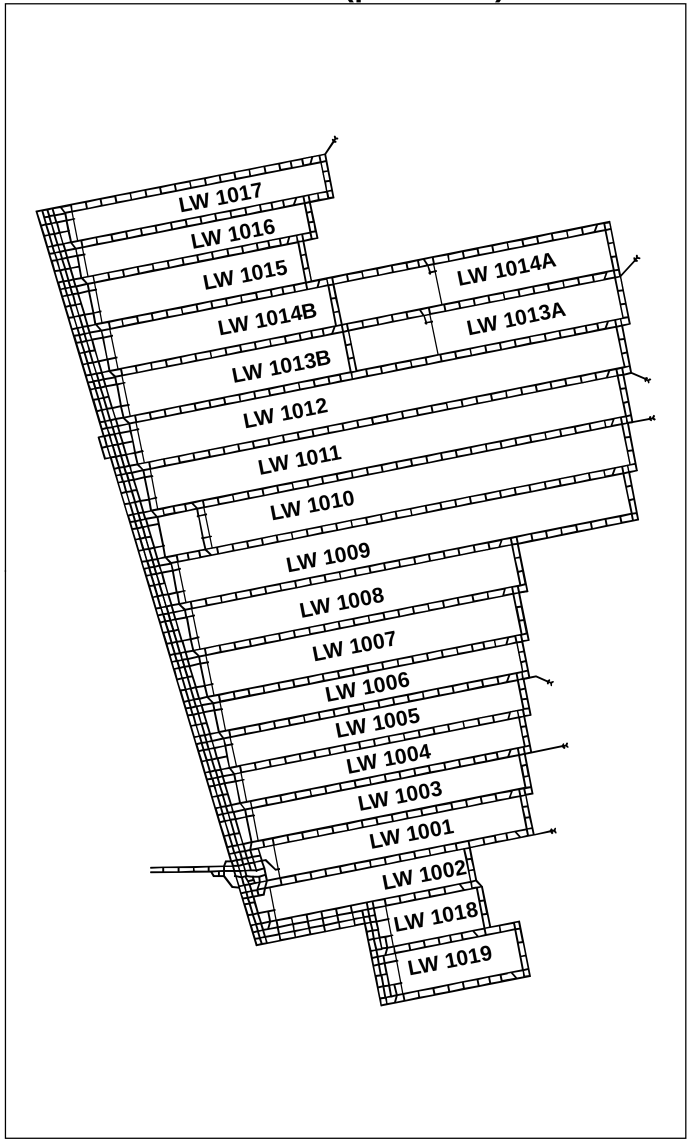
The outcome of detailed mine planning and design as discussed above is that the Angus Place mine plan minimises predicted subsidence and reduces the occurrence of subsidence effects beyond predictions.

Trial mining of the area east of LW910 was approved in PA06_0021 MOD2 in April 2013 and will provide detailed geotechnical and geological information from the new roadways. This trial mining will add to the current database gained from past mining and detailed surface exploration.

OPTION 1



OPTION 2 (preferred)



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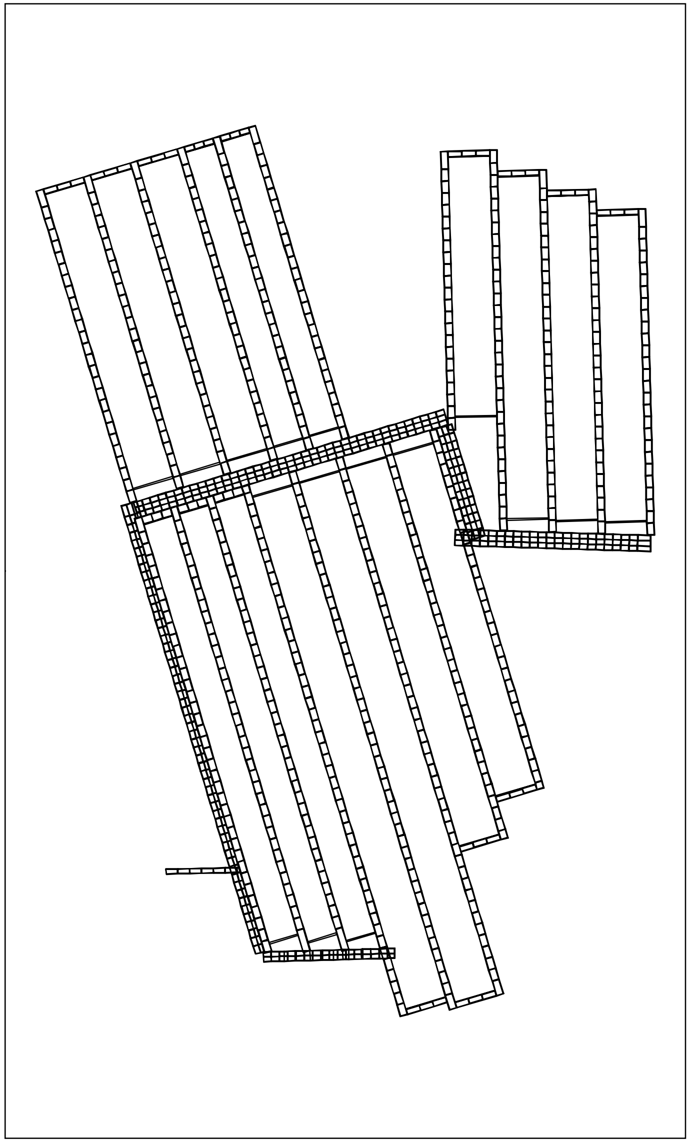

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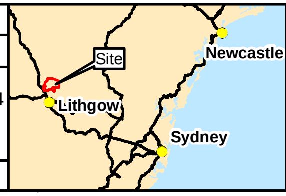

Figure 8.8: Conceptual Plans for Mine Design Options 1 - 3

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8.3.4 Reliability of Subsidence Predictions and Previous Subsidence

The Incremental Profile Method, used by MSEC (2013) for subsidence predictions in this Project, has been developed by MSEC and refined over many years with extensive empirical data from a number of NSW coalfields, including the Western Coalfield in which Angus Place Colliery is located. The observed consistency in the shape of subsidence profiles has allowed the development of standard subsidence prediction curves for the Western Coalfield based on measured data. The prediction of subsidence with the Incremental Profile Method includes the following three stages:

- the calculation of the magnitude of subsidence for each longwall panel based on proposed mine geometry and depth of cover;
- the shape of each panel's subsidence profile; and
- the addition of the incremental profile shapes and magnitude to provide the total subsidence prediction.

The derived incremental profiles allow the derivation of incremental tilts, curvatures and strains, which when added together for each profile can provide both the transient and final values of these effects.

There is a high degree of accuracy between pre-mining modelled subsidence predictions and post-mining measured subsidence, which demonstrates that the subsidence modelling in use is a proven technology, backed up with a rigorous data set that takes into consideration historical mine design, subsidence monitoring, geological modelling, and topography. The reliability of subsidence predictions (MSEC 2013) for the Project is illustrated by comparing the magnitudes of the observed movements with those predicted above the previously extracted longwalls at Springvale Mine and Angus Place Colliery. The comparison between the maximum observed and maximum predicted total subsidence directly above the extracted longwalls is illustrated in **Figure 8.9**.

This figure illustrates the maximum observed total subsidence is less than the maximum predicted total subsidence in all but one case, at LW26N (which is the single point above the 1:1 relationship line), where the anomaly was due to the presence of a major geological structure zone. The maximum observed total subsidence in this location was within 15 % of the maximum predicted total subsidence.

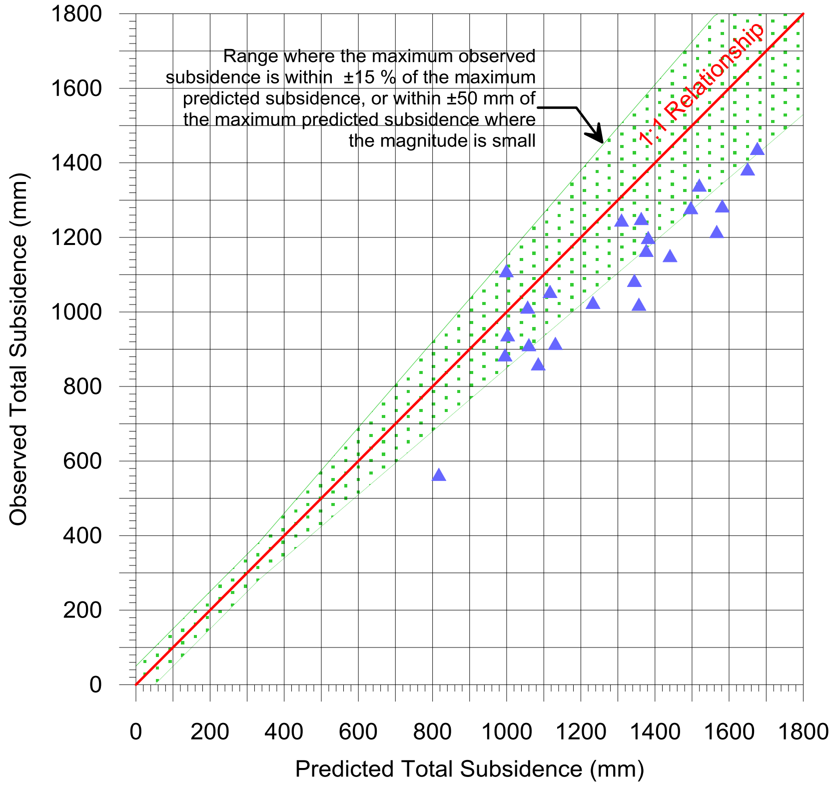


Figure 8.9 Comparisons between maximum observed and maximum predicted total subsidence directly above the previously extracted longwalls at Angus Place and Springvale Collieries (source MSEC, 2013).

The previous anomalous subsidence observed at LW26N is being managed in the Project by:

- the application of various additional methods of refining the location of geological structures (as described in **Section 2.6.2**);
- subsequent consideration of geological structures in the subsidence modelling (geological structures are described in **Section 2.6.2**); and
- changing the mine design to manage sensitive surface features (as documented in **Section 8.3.3**).

Based upon data presented in **Figure 8.9**.

there is a 95% confidence level that maximum observed subsidence will be less than the maximum predicted subsidence in the proposed mining area.

As described in **Section 2.6.2,** geological structure zones influence subsidence behaviour. This has been observed to cause localised anomalous vertical movements at:

- the eastern ends of LW940 at Angus Place Colliery where measured subsidence exceeded predictions by 27% in a small area;
- above the eastern ends of LW950 and LW960 at Angus Place Colliery where measured subsidence exceeded predictions by up to 10% in a small area; and
- the Wolgan River lineament zone between longwalls at Angus Place Colliery and LW411 at Springvale Mine where measured subsidence was up to 800 mm in contrast to the predicted 100 mm.

These elevated subsidence levels are associated with the Wolgan Lineament where it overlies Angus Place Colliery and can be seen in the LiDAR data presented in **Figure 8.3**. As discussed in **Section 8.2.1**, the elevated subsidence levels measured above the western flank of the Wolgan Lineament (and Narrow Swamp) did not cause changes to swamp hydrology. As described in **Section 2.6.2**, Palaris (2013) recently identified major geological structure zones with the potential to influence subsidence behaviour within the proposed mining area (**Figure 2.13**) and MSEC has included the influence of these zones in the subsidence modelling conducted for the Project.

8.3.5 Alternative Mining Layouts

The modifications to the mine design in the Project Application Area were the result of a thorough review of historical subsidence and environmental monitoring data. Subsidence modelling was conducted using industry databases and methodologies. The re-design was intended to ensure that the proposed panel and pillar width combination would ensure sub-critical subsidence behaviour of the overburden. It is important to understand that after the transition from critical panel width to sub-critical panel width, further reductions in panel width cause relatively little incremental reduction in measured subsidence. It is critical to understand that Angus Place Colliery has modified the dimensions of its longwalls to the greatest extent possible without compromising the viability of the business.

It is not possible for Angus Place Colliery to further reduce the longwall block width or increase the chain pillar width due to the prohibitive cost of additional roadway development to achieve the same longwall production rate and significant interruption to mining continuity (ie. the longwall would be forced to "stand down" and wait for development of the next longwall block to be completed due to the increased ratio of roadway development to longwall production.

8.3.6 Current Mine Plan and Design

As mining has progressed at Angus Place Colliery, the alignment and dimensions of longwall panels have been developed and refined over a long period of time for a range of mine designs. There has been significant effort to prioritise avoidance and reduction of potential impacts and constraints of surface features and geological and geotechnical issues, while considering mine safety, feasibility and optimisation.

8.4 Subsidence Predictions for the Proposed Mining Areas

Table 8.1 provides the maximum predicted cumulative subsidence, tilt and curvatures above relevant longwalls. Due to the conservative prediction methodology applied for the Project, it is expected that the actual total subsidence, tilt or curvature generated by the Project will be less than that specified in **Table 8.1**.

The higher numbers in brackets are the maxima for the areas of mining within the zone of influence of the identified surface lineaments. Not all proposed longwalls are listed as the data show the predicted maximum subsidence to be experienced anywhere in the mining area at the completion of extraction of that particular longwall. For example, at the completion of mining LW1007, the maximum subsidence anywhere in the mining area will be 1650 mm (or 1900 mm above any lineaments). This maximum will not increase until after the extraction of LW1019, where the predicted maximum subsidence in the mining area will be 1700 mm (and 1900 mm above lineaments). This is similar to the subsidence predicted and recorded over previous Angus Place mining areas.

The maximum total subsidence, after the completion of all the proposed longwalls is 1700 mm which represents approximately 53% of the 3.2 m maximum extraction height. The predicted total tilt is 20 mm/m (i.e. 2.0 %), which represents a change in grade of 1 in 50. The maximum predicted total curvatures are 0.30 km^{-1} hogging and 0.35 km^{-1} sagging, which represent minimum radii of curvature of 3.3 kilometres and 3 kilometres, respectively. Non-conventional subsidence has been predicted, in brackets, for subsidence above lineaments (**Section 2.6.2** discusses the effects of geological structure on surface expression). Non-conventional subsidence is not likely is any other part of the mine, due to the sub-critical nature of the void width. LW1006 to LW1019 have areas of structural faults that have a higher risk of subsidence increase and predictions of these localities are provided in **Table 8.1**.

Table 8.1 Maximum Predicted Total Conventional Subsidence

Longwall	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km^{-1})	Sagging Curvature (km^{-1})
LW1001	1000	7	0.10	0.20
LW1002	1300	10	0.10	0.20
LW1003	1550	10	0.15	0.25
LW1004	1600	10	0.15	0.25
LW1006	1600 *(1600)*	15	0.25	0.30
LW1007	1650 *(1900)*	20	0.30	0.35
LW1019	1700 *(1900)*	20	0.30	0.35

Figure 8.10 illustrates the predicted total subsidence contours for the proposed mining area and also shows the location of the Prediction Lines A1 and A2 (representative subsidence prediction profile as derived by MSEC).

Figure 8.11 presents the predicted profiles of conventional subsidence, tilt and curvature through representative subsidence prediction lines A1 and A2 resulting from the extraction of LW1009 -1019. These profiles illustrate sections for:

- Surface and Seam Level: a section through the surface topography (black line), showing a representation of the approved and proposed longwalls (in red);
- Subsidence: a section through the existing surface profile (light blue line) above longwalls, the predicted incremental subsidence profile (black dashes) for each longwall, the resultant transient surface topographical profile (thin dark blue lines) and the profile of the total predicted final subsidence (thick dark blue lines) for these longwalls;
- Tilt: a section showing existing grade (pale blue line), predicted incremental tilts (black dashes), transient tilts (thin dark blue) and predicted total tilt (thick dark blue line) for the longwalls; and
- Curvature: a section showing existing, predicted incremental curvature and predicted total curvature. The same colours are used for existing, incremental, and final total and the range of transient curvatures is indicated by grey shading. Shading above the zero line indicates hogging, and shading below the zero line indicates sagging.

LEGEND

- Project Application Area
- Town
- Rail
- Street / Track
- State Forest
- National Park
- Watercourse
- Subsidence Contour
- Proposed Workings
- Existing Workings

CENTENNIAL ANGUS PLACE PTY. LTD.

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F017 APC Rev 0
SCALE	1:35,000

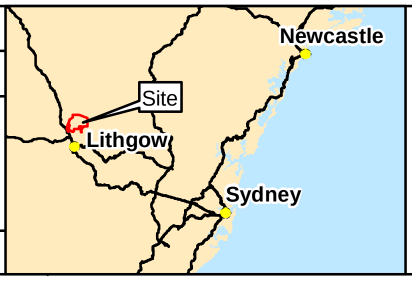


Figure 8.10: Predicted Subsidence Contours

0 1 2 km

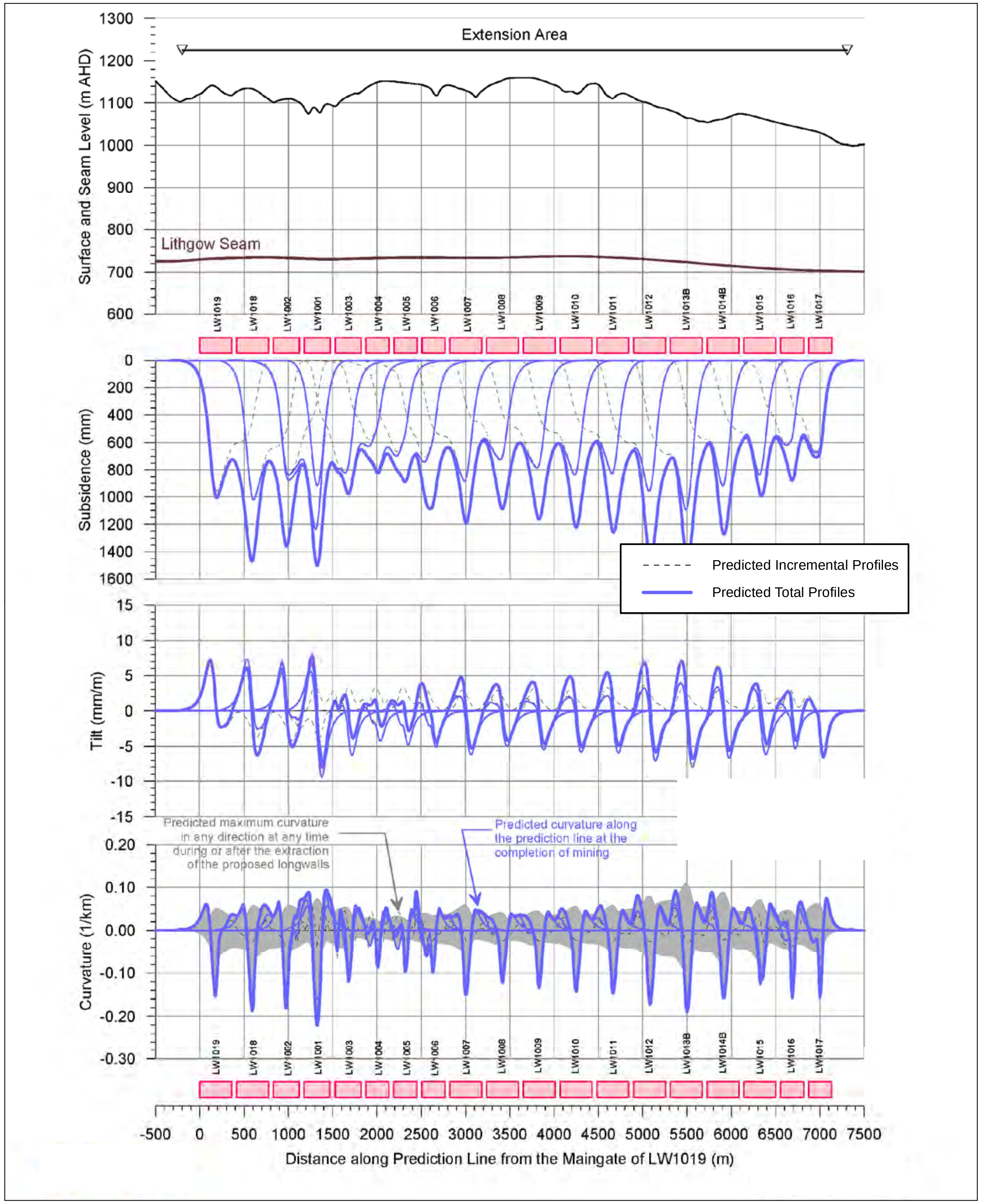
PLOTFILE No.

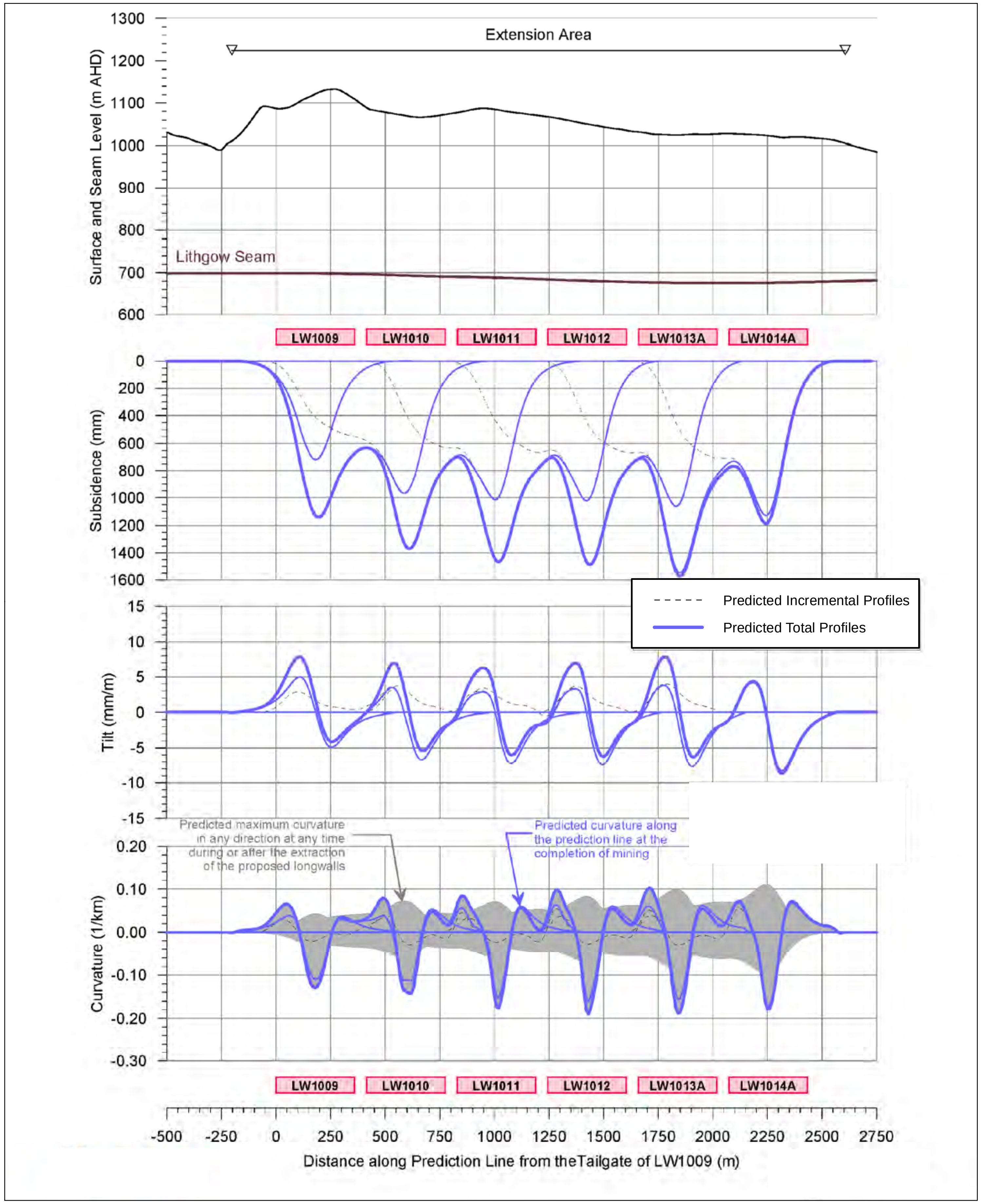
Centennial Coal

Angus Place

DRG No. 17

A3





From MSEC (2013)

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F018 APC Rev 0
SCALE	NOT TO SCALE

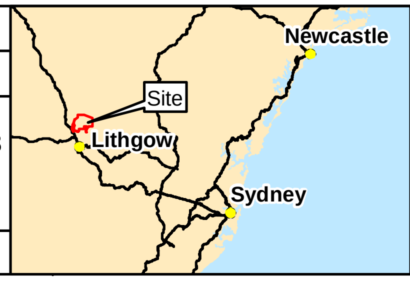


Figure 8.11: Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Prediction Line A1 and A2

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 18

A3

These profiles show that for all predicted and measured subsidence effects, there will be transient changes to surface levels, tilt and curvature as longwalls progress through the Lithgow seam. The transient vertical subsidence changes will add to each other as each longwall is extracted. The final subsidence profile will be achieved approximately 12 months after the longwall has passed a given point. This time will depend on the rate of mining, but essentially, at a given point on the surface, the total final subsidence profile will not be achieved until mining has been completed in subsequent longwalls.

Figure 8.11 shows that during and after mining, a series of parallel subsidence troughs will be formed, the maximum surface reduction being slightly west of the corresponding longwall centreline due to pillar compression and reactivation of the previous longwall goaf. Mining-induced tilts, like subsidence, will vary with time as the longwalls are extracted and the subsidence profile moves across the landscape. In the rugged topography of the Newnes Plateau, these troughs will not be visible, and could only be observed by comparing pre and post mining surveys.

Figure 8.12 provides a series of cross sections through shrub swamps that will be mined undermined showing existing and predicted post-mining ground surface levels and grades. Cross Sections are presented for Tri Star Swamp (a), Tri Star Swamp (b-e), Twin Gully Swamp and Trail 6 Swamp. The cross sections show close correlation between existing and post-mining grades, indicating that the grade changes will be small.

Predicting mine-induced strain is more difficult than that for other subsidence effects due to localised effects of curvature, horizontal movement near surface geology depth of cover and natural rock joints, and errors introduced by survey tolerances. As a result, the measured strains can be irregular even where the measured subsidence, tilt and curvature are relatively smooth. Strains can be either tensile or compressive. Tensile strains occur where hogging or convex curvature is observed, while compressive strains occur where sagging occurs.

Longwall mining redistributes the underground stresses causing horizontal movements in areas away from the mining area, which are commonly referred to as far-field movements. In general, as successive longwalls are mined, the magnitude of far field movements decrease as the first mined longwalls allow the redistribution of in-situ stresses.

The predicted far-field movements at Angus Place resulting from the extraction of the proposed longwalls are very small bodily movements towards the extracted goaf area and are accompanied by very small levels of strain which are less than the order of survey tolerance (i.e. 0.3mm/m). These are not predicted to generate significant impacts on the natural or built features at the site or surrounding area.

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and the locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones. In the Western Coalfield, it has been found that a factor of 10 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional strains.

The maximum predicted conventional strains resulting from the extraction of the proposed longwalls, based on applying a factor of 10 to the maximum predicted conventional curvatures, are tabulated below:

Table 8.2 Predicted Conventional Strains

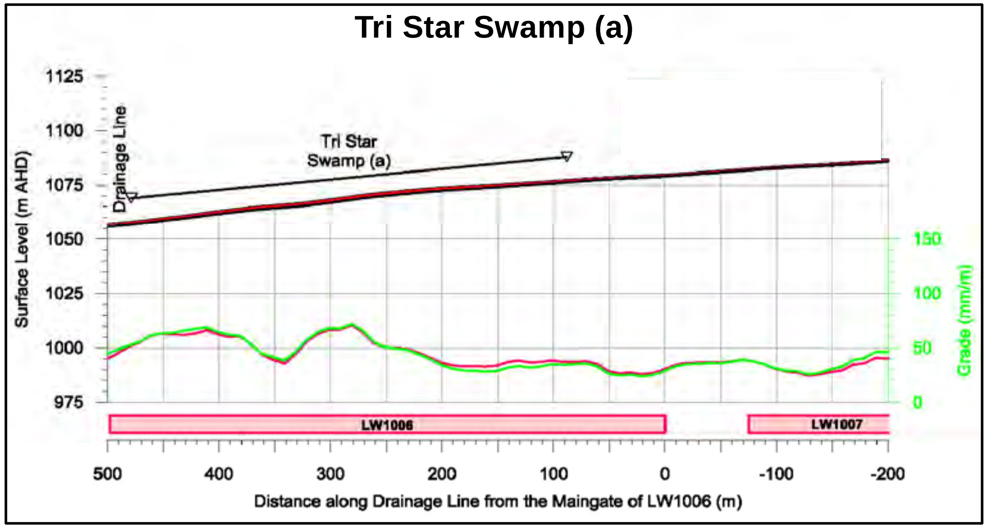
		Tensile Strains (mm/m)	Compressive Strains (mm/m)
Predicted Conventional Strains	LW1001 to 1019	3	3.5

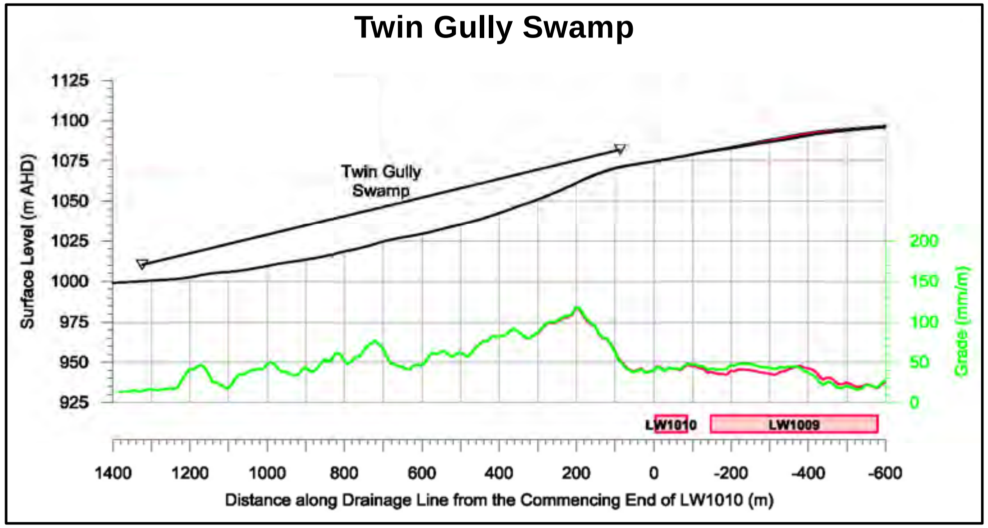
At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. A statistical approach has been used to account for the variability, as in **Table 8.3**:

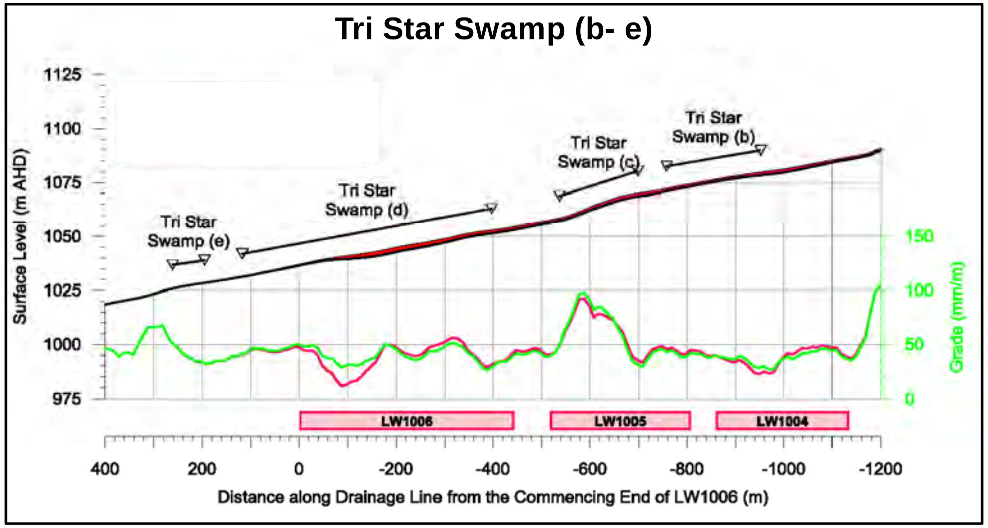
Table 8.3 Predicted Total Strains (Conventional and Non-Conventional)

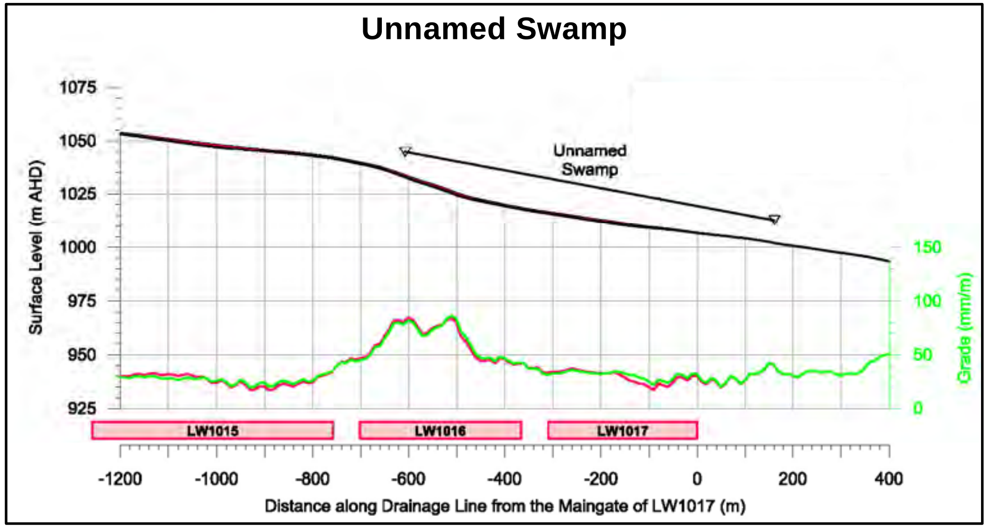
	Tensile Strains		**Compressive Strains**	
Predicted Total Strains (Conventional and Non-Conventional)	95% Confidence Limit	99% Confidence Limit	95% Confidence Limit	99% Confidence Limit
Above Goaf	2.5	5	4	8
Above Solid Coal	1.5	2.5	0.5	1.5
Outside Angle of Draw	0.7	1.3	0.3	0.5
Far Field	<0.3	<0.3	<0.3	<0.3

The statistical analyses did not include the observed strains in the bases of streams, resulting from valley related movements. The compressive strains due to valley closure for the drainage lines which are located directly above the proposed longwalls are between 5 mm/m and 16 mm/m. The compressive strains due to valley closure movements for the drainage lines which are located outside the extents of the proposed longwalls are predicted to be less than 2 mm/m.









LEGEND
From MSEC (2013)
Natural Grade
Predicted Final Grade

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F020 APC Rev 0
SCALE	NOT TO SCALE

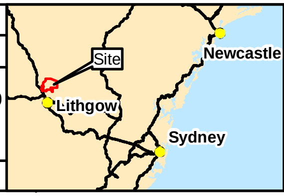


Figure 8.12: Existing and Predicted Post Mining Levels and Grades

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 20 | A4

8.5 Subsidence Impact Assessment

Based on preliminary subsidence predictions and the outcomes of risk assessments, detailed in **Chapter 9.0** of the EIS, a number of specialist investigations were commissioned to assess the consequences of subsidence impacts on key aspects of the natural and built environment.

Chapter 10.0 of the EIS summarises each of these detailed specialist reports and outlines the predicted environmental consequences, mitigation measures and proposed offsets (where applicable) to ensure the potential impacts of subsidence as a result of the Project are not significant.

8.6 Subsidence Management and Mitigation Measures

The primary objective of mine design is safety, underground and on the surface. By managing safety, the mine manages subsidence impacts on the surface and in turn manages environmental and social consequences. At Angus Place Colliery, the application of risk based planning, has driven mine planning, mine design and subsidence management, based on the geological and geotechnical constraints, and the overlying sensitive features.

There are two management strategies for avoiding or minimising the impacts to sensitive surface features as a result of mining. These are:

1. Avoid mining under the sensitive surface feature; or
2. Mine design under the sensitive surface feature has a sub-critical void width.

A summary of the hierarchy of subsidence risk management controls implemented at Angus Place Colliery is provided in **Table 8.4**.

Table 8.4 Hierarchy of Subsidence Management Controls

MANAGEMENT STRATEGY	SENSITIVE SURFACE FEATURE			
	Cliffs and Pagodas	Swamps and other biodiversity	Watercourses	Aboriginal Archaeology
ELIMINATION				
No extraction directly underneath	✓	✓ (Twin Gully Swamp)	✓ (Wolgan River and Carne Creek)	✓
SUBSTITUTION				
Sub-critical void width (261m) with chain pillars at least 55m width	✓ (less than 1% spall of rock faces on cliffs within angle of draw and pagodas above LW1006, 1009, 1010 and 1011)	✓ (Trail 6 and Tri-Star Swamp)	✓ (no valley closure movements at 800m from longwalls)	✓ (sites 45-1-0084)
Sub-critical void width (285m) with chain pillars at least 55m width	✓ (less than 1% spall of rock faces on cliffs within angle of draw and pagodas above LW1006, 1009, 1010 and 1011)	NA	✓ (no valley closure movements at 800m from longwalls)	NA
Void widths 350m with chain pillars at least 55m width	NA	NA	✓ (no valley closure movements at 800m from longwalls)	✓ (sites 45-1-2756/2757)
Offset strategy for residual impacts	NA	✓	NA	NA

MANAGEMENT STRATEGY	SENSITIVE SURFACE FEATURE			
ENGINEERING				
Rehabilitation	NA	✓ (repair erosion using Save our Swamps methodology)	NA	NA
Restoration	NA	NA	NA	✓ (use of pre-mining management techniques for sites 45-1-0084; 45-1-2756/2757, where predictive modelling indicates impacts)
MANAGEMENT AND MONITORING				
Strata management plan and database	✓	✓	✓	✓
Trigger Action Response Plan	✓	✓ (as per engineering controls)	✓	✓
Subsidence monitoring and modelling	✓ (no valley closure impacts to cliffs within angle of draw and pagodas above LW1006,1009, 1010 and 1011)	✓	✓ (flow monitoring upstream and downstream on Wolgan River and Carne Creek; drainage lines within 800m of longwall void to measure far field subsidence effects)	✓

Note 1: *Rehabilitation of Blue Mountains Swamps: Soft-engineering solutions for swamp remediation – a "how-to" guide*, Blue Mountains City Council, August 2008.

The following controls have been applied:

- longwalls adjacent to the Gardens of Stone National Park are to be extracted towards the National Park with potential ground movements progressively monitored and managed as required. This adaptive management approach complements the mine plan design in reducing impacts to the existing environment;
- LW 1004 to LW 1006 will be designed with 261 m voids. The depths of cover directly above these proposed longwalls range from 330 m to 420 m with resulting sub-critical void width to depth ratios of 0.60 to 0.85, which is less than previous longwall development at Angus Place.
- LW1001, LW1002 and LW1003 will be designed with 285 m voids.
- LW1013 and LW1014 have both been split into two sections (A and B) to avoid intervening cliff and pagoda complexes. The longwall sections will be linked underground by twin 5 m wide development headings to provide safe access and ventilation. These first workings will not generate surface subsidence.
- LW1007 to LW1019 will be 350 m wide, with chain pillars 55 m wide. Depths of cover range from 360 m to 420 m. The resulting sub-critical void width to depth ratios are within the range of 0.85 to 1.0, which is similar to those for the previously extracted longwalls at Angus Place.
- LW1010 has been shortened to avoid mining under Twin Gully Swamp.

Specific mitigation measures proposed are detailed in **Chapter 10.0** and summarised in the Statement of Commitments in **Chapter 11.0**.

The current subsidence monitoring programme measures maximum vertical subsidence, tilts and strains induced by previous and current mining, and includes ground surveys along representative subsidence monitoring lines. This programme will be the basis of ongoing subsidence monitoring for the Project. Revisions to the programme will include the required adaptive management procedures as mining approaches the Gardens of Stone National Park, in the later years of mining.

8.7 Conclusion

Angus Place Colliery has applied a risk based approach to the Project to identify, quantify and reduce risks of environmental consequences wherever feasible.

Previous subsidence monitoring has been used to develop and validate a predictive model of subsidence for the proposed mining area. This model has a high level of confidence in its predictions and is built upon a significant dataset comprising geological and geotechnical data.

The mine has been designed to avoid, to the largest extent possible, sensitive surface features. Where a sensitive surface feature has not been avoided, a sub-critical void width has been applied in the mine design (for example LW004 to 006).

The geological and geotechnical constraints to mining, combined with the extensive knowledge of the hydrogeological environment has resulted in a mine design that is reflective of decades of mining experience at the Angus Place Colliery and Springvale Mine.

Chapter 10.0 describes how the application of this mine design results in potential impacts to sensitive surface features.

CHAPTER 9.0

Identification of Key Environmental Issues

9.0 IDENTIFICATION OF KEY ENVIRONMENTAL ISSUES

9.1 Introduction and Objectives

This chapter specifically responds to the Director General's Requirements, which provide the following in regard to risk:

The Director General's requirements

- A risk assessment of the potential environmental impacts of the development, identifying the key issues for further assessment.

This chapter outlines the environmental risk assessment process that has been undertaken to prioritise and address environmental impacts and consequences of the Project.

Angus Place Colliery employs a risk-based approach to identify safety, environmental and business risks at Angus Place Colliery. This practice is guided by the overarching Centennial Environmental Policy, which identifies:

- the vision to conduct business in an efficient and environmentally sustainable manner that is compatible with the expectations of shareholders, government, employees and the community;
- the belief that everyone has a responsibility for minimising impact to the environment and that environmental performance can always be improved; and
- the guiding principles of environmental impacts being recognised and minimised, continual improvement of environmental performance and risk management strategies implemented based on clear science and valid data.

The EIS has been prepared using a risk based assessment approach to identify and evaluate environmental, social and economic aspects relevant to the Project.

The objective of the environmental risk assessment process is to identify the environment and community risks associated with the Project and to identify knowledge gaps or recommend improvements to existing mitigation and management measures already in place to ensure the residual consequences are acceptable. Where there is a knowledge gap in the information available, or where risks are considered unacceptable, a specialist technical assessment has been undertaken.

A Broad Brush Risk Assessment (BBRA) was completed in March 2011 by Centennial Angus Place, providing an initial risk assessment and directing the scope of technical studies to enable adequate assessment and management of key issues. The risk register is presented as part of the Briefing Paper for the Project issued in September 2012 (https://majorprojects.affinitylive.com/public/ad4e5978b607f63895d9aa3536aaccb3/Angus%20Place%20Mining%20Extension%20Project_Briefing%20Paper.pdf).

A subsidence constraints risk assessment was completed in November 2012 to identify and quantify potential risks to the Project due to mining related subsidence. The subsidence constraints risk assessment identifies known mine characteristics and known sensitive features that are potentially at risk of subsidence from the proposed mine plan.

Following completion of the technical assessments and the identification of management and mitigation measures (as appropriate), the residual risks of the Project have been identified to ensure all residual consequences are at an acceptable level. The residual risks and consequences of key environmental issues of the Project are discussed in **Chapter 10.0**.

9.2 Proposed Activities with the Potential to cause Environmental Impacts

The main Project activity is longwall mining. Associated activities are new surface infrastructure required to support mining. This involves the widening of existing access tracks and the construction of new access tracks to required new dewatering facilities and mine services borehole compounds.

Activities associated with the Project, both directly and indirectly, with the potential to cause potential environmental impacts are:

- mining induced subsidence effects upon groundwater, surface water, stream morphology, ecological systems, cliffs, surface rock formations, Aboriginal heritage sites and surface infrastructure;
- vegetation clearing for surface infrastructure establishment;
- surface water and ecological impacts resulting from mine water discharges;
- noise related impacts as a result of coal handling;
- the increase in traffic accessing surface infrastructure on Newnes Plateau;
- increasing greenhouse gas emissions;
- dust generation from the pit top and Newnes Plateau infrastructure sites during operations and construction (Newnes Plateau only), which will impact on air quality; and
- visual impacts from the existing pit top and existing and proposed surface infrastructure on Newnes Plateau.

Each of these activities are on-going in the Project locality and informed the Broad Brush Risk Assessment.

9.3 Risk Assessment

The key Project related environmental issues warranting detailed assessment in the EIS have been identified through:

- the existing environmental context of Angus Place Colliery and the surrounding locality (sensitive receivers, physical environment and existing management practices);
- consultation with stakeholders (government agencies and the community);
- Broad Brush Risk Assessment outcomes;
- subsidence constraints risk assessment;
- technical studies;
- on-going long term environmental monitoring data
- the legislative framework that underpins the Project;
- the DGRs issued for the Project;
- Centennial Western Operations Government Briefing Meeting and site visit held on 17 and 18 October 2012, respectively ; and
- Supplementary (SEWPAC now DoE) to the DGRs .issued on 30 August 2013 by DP&I in relation to EPBC 2013/6881.

The ranking of environmental, consequences is based upon the principles of the *Australian and New Zealand standard AS/NZS 4360:2004 – Risk Management* and Centennial Coal's Risk Management Standard Risk Matrix. Risk allocation considerations are illustrated in **Table 9.1**. The issue prioritisation matrix is provided in **Table 9.2** that apportions priority on the basis of the likelihood of occurrence and the potential consequence if it occurs.

Table 9.1 Risk Allocation Considerations

Likelihood of Risk	**Consequences of Unmanaged Affects**
A Certain	1 Catastrophic
B Probable	2 Major
C Possible	3 Moderate
D Remote	4 Minor
E Improbable	5 Insignificant

Table 9.2 Issues Prioritisation Matrix

Risk Rating	**Risk Category**		**Generic Management Actions**
1 to 4	E	Extreme	Immediate intervention required from senior management to eliminate or reduce this risk.
5 to 9	H	High	Imperative to eliminate or reduce risk to lower level by the introduction of control measures. Management planning required at senior level.
10 to 15	S	Significant	Corrective action, requires senior management attention needed to eliminate or reduce risk.
16 to 19	M	Moderate	Corrective action to be determined, management responsibility must be specified.
20 to 25	L	Low	Monitor and manage by corrective action were practicable.

9.3.1 Broad Brush Risk Assessment

The primary objective of this risk assessment was to identify those issues relating to the Project which pose the greatest environmental risk, and to determine the likelihood and consequence of this issue occurring. The issues and potential impacts assessed in the Broad Brush Risk Assessment for the Project were:

- Subsidence;
- impacts to flora and fauna (including threatened and endangered species/communities and GDEs);
- impacts to surface features including cliffs and rock formations;
- loss of groundwater or depressurisation of groundwater aquifers;
- discharge requirements exceeding current EPL limits for volume;
- cumulative impact;
- rehabilitation;
- traffic impacts;
- noise impact;
- impacts to air quality;
- potential increases greenhouse gas emissions;
- community and social impacts;
- impacts to Aboriginal/cultural heritage sites;
- economic impacts ;
- visual; and
- soils, land use and agriculture.

Potential environmental risks were ranked in the Broad Brush Risk Assessment. Each risk was assessed by determining the probability and consequence of each and in light of the mitigation measures and management strategies already in place.

The identified 'high' and 'significant' environmental issues relate to potential subsidence related impacts to groundwater, flora and fauna as well as potential surface water quality impacts resulting from mine water discharges.

Project risks identified as moderate or above are outlined in **Table 9.3**. Outcomes gained in terms of risk ratings and recommended controls have guided the development of the technical assessments. Where the risks were considered unacceptable, or a knowledge gap identified, technical assessments have been undertaken to determine any potential impacts of the Project on these identified risks. Proposed additional controls discussed in **Table 9.3** are those recommended at the time of the development of the Broad Brush Risk Assessment. Further mitigation measures are discussed in **Chapter 10.0**.

The risk assessment also identified several moderate and low risk environment and community issues relating to the Project. These related to potential subsidence impacts on European heritage sites surface infrastructure and stream morphology. Potential impacts to air quality, noise, waste management and visual amenity were ranked as low risks.

These issues have also been identified in and have been assessed in the technical assessments (**Chapter 10.0**).

Table 9.3 Priority Risk Categories for Management and Proposed Additional Controls - BBRA

Issues and Potential Impacts	Proposed Additional Controls Required to Minimise Risk	Demonstrated implementation of these controls in the EIS
Potentially High Risks (Require additional investigations/controls)		
Socio-Economic Impact from Project refusal	1) Economic assessment to be conducted as part of EIS. 2) Consider assessing cumulative impacts of proposed Angus Place MEP and Springvale MEP.	1) Chapter 6.0 2) Chapter 6.0 and Chapter 12.0
Potentially Significant Risks		
Subsidence	1) Detailed subsidence assessment to be completed on final mine plan 2) Groundwater impact assessment to be completed as part of the EIS 3) Review CSIRO hydrogeological model 4) Exploration programme to investigate near surface stratigraphy and aquifers. 5) Assessment of rock feature and cliffs	1) Chapter 8.0 (Mine Design) and Appendix D (Subsidence Impact Assessment). 2) **Chapter 10.0** (**Section 10.2**) and Appendix E (Groundwater Impact Assessment). 3) CSIRO Model has been peer reviewed by Dr. Noel Merrick 4) Palaris, 2013. 5) Centennial surveyors (surveying along the existing subsidence line is on-going). Chapter 8.0 and Appendix D.
Flora and Fauna (including threatened species, GDEs, EECs)	1) Ecological impact assessment to be completed as part of the EIS. 2) Mine design to consider minimising potential impacts. 3) To minimise impacts to GDEs, groundwater impact assessment to be completed as part of the EIS. 4) Exploration programme to investigate near surface stratigraphy and aquifers. 5) Review CSIRO hydrogeological model	1) Chapter 10.0 (**Section 10.3**) and Appendix H. 2) Chapter 8.0 3) Chapter 10.0 (**Section 10.2**) and Appendix E 4) Palaris, 2013. 5) CSIRO Model has been peer reviewed by Dr. Noel Merrick
Potentially Moderate Risks		

Issues and Potential Impacts	Proposed Additional Controls Required to Minimise Risk	Demonstrated implementation of these controls in the EIS
Greenhouse Gas	1) Greenhouse gas assessment to be completed as part of the EIS. 2) Upgrade the gas monitoring equipment.	1) Chapter 10.0 (**Section 10.10**) 2) Angus Place is a very low gas mine so no equipment upgrade is warranted.
Water Management	1) Site to establish a Water Management Committee to review system adequacy and make recommendations for improvement. 2) Surface water impact assessment to be completed as part of the EIS.	1) This has been implemented. 2) Chapter 10.0 (**Section 10.2**) and Appendix F.
Impacts to surface features including rock formations	1) Detailed subsidence assessment to be completed on final mine layout/design. 2) Mine design to consider minimising potential impacts. 3) Peer review of subsidence assessment. 4) Assessment of rock features and clifflines to be undertaken as part of the EIS.	1) Chapter 8.0 and Appendix D 2) Chapter 8.0 and Appendix D 3) The subsidence prediction assessment (Appendix D) has been reviewed by senior mine staff and Golder. The groundwater assessment, which in part involved a subsidence model was peer reviewed by Dr Noel Merrick. 4) Centennial surveyors (surveying along the existing subsidence line is on-going). Data used in Chapter 8.0 and Appendix D.
Aboriginal Heritage	1) Aboriginal heritage impact assessment to be completed. 2) Consultation with the Aboriginal community in accordance with 2010 DECCW *Aboriginal Cultural Heritage Consultation Requirements for Proponents*. 3) Detailed subsidence assessment to be completed on final mine layout/design. 4) Mine design to consider potential impacts.	1) **Section 10.4** and Appendix K. 2) An information session was held in February 2012. Aboriginal groups undertook field surveys from 6 March to 13 April 2012. 3) Chapter 8.0 and Appendix D. 4) Chapter 8.0 and Appendix D.

Issues and Potential Impacts	Proposed Additional Controls Required to Minimise Risk	Demonstrated implementation of these controls in the EIS
Groundwater users	1) Groundwater impact assessment to be completed as part of the EIS. 2) Mine design to consider minimising potential impacts. 3) Ensure all stakeholders are kept informed of the Project.	1) Chapter 10.0 (**Section 10.2**) and Appendix E. 2) Chapter 8.0 and Appendix D. 3) Chapter 7.0
Community complaints or media coverage.	1) Review and update the Angus Place Colliery Stakeholder Engagement Plan. 2) Prepare a social impact assessment for the Project as part of the EIS. 3) Ensure all stakeholders are kept informed of the Project.	1) Chapter 7.0 2) Chapter 6.0 3) Chapter 7.0
Traffic Impacts	1) Traffic impact assessment to be reviewed for the Project as part of the EIS.	1) Chapter 10.0 (**Section 10.5**)

9.3.2 Subsidence Constraints Risk Assessment

Centennial Management Standard MS 004 Risk Management has the intent of integrating a consistent approach to risk management into all aspects of Centennial's business. In accordance with this standard, a subsidence constraints risk assessment was undertaken for the Project to identify and quantify risks to the natural environment due to subsidence. This analysis followed on from the Broad Brush Risk Assessment and was held on site on the 27 November 2012. Participants included senior mine personnel, the lead environmental consultant for the Project and the specialist consultants providing technical assessments of

In the context of the Project, potential subsidence induced impacts are:

- depressurisation of aquifers – increased groundwater inflow into the underground workings during longwall extraction. The significance of the Mount York Claystone and its role as an aquitard in shielding the upper aquifers from such impacts at depth is taken into account;
- strata deformation – including localized uplift and buckling of strata and the fracturing and displacement of strata at depth; and
- impacts to surface watercourses – subsidence induced surface cracking can result in surface flows being redirected underground until an aquitard or aquiclude results in a lateral subsurface flow. The reduced availability of surface water can impact on regional catchments support ecological systems and surface water users.

  Tilts can result in grade changes which can change the geomorphology of a watercourse;
- ecological impacts - reduced groundwater availability in upper near surface aquifers and perched aquifers can affect groundwater dependent ecosystems and critical fauna habitat. Tilts and strains can increase erosion / sedimentation / ponding potential which may affect an ecosystem. Surface cracking can affect the viability of surface water flows which sustain ecological communities;
- impacts to cliffs and rock features - surface subsidence can cause rock cracking and fracturing as the surface readjusts to a post-mining surface level following underground mining. If not properly managed this can result in rock damage and cliff collapse;
- Aboriginal heritage - subsidence can impact upon Aboriginal heritage items often associated with natural features such as cliffs and rocks;
- infrastructure -surface infrastructure such as roads, powerlines, mining infrastructure are susceptible to subsidence impacts. Adequate consideration needs to be given to both the mine design in addition to the design of infrastructure susceptible to subsidence impacts. Public safety hazards are related to this category;
- far field effects - can impact on features a significant distance from the mining area. Groundwater impacts are of a particular focus given the proximity of the Gardens of Stone National Park and seam dip direction; and
- cumulative impacts - Angus Place Colliery is operating close to Springvale Mine. The proposed mining which forms part of this Project has the potential to have a cumulative impact with regard to mine subsidence.

On this basis, the specific objectives of the subsidence constraints risk assessment were to:

- identify mine characteristics (such as depth of cover, geology, mining method and mine layout), known geotechnical constraints and the mine design criteria to be applied;
- identify sensitive natural and built features that might be at risk, and any characteristics that may be relevant in assessing potential subsidence related impacts and consequences;
- review previous subsidence predictions from nearby operations against actual subsidence results; and

- identify knowledge gaps and requirements to be investigated in the specialist assessments.

As with the Broad Brush Risk Assessment, results of the subsidence constraints risk assessment have been rated on risk. Those identified as moderate or above are provided in **Table 9.4**.

Table 9.4 Priority Risk Categories – Subsidence Constraints Risk Assessment

Issues and potential impacts	**Proposed additional controls required to minimise risk**	**Demonstrated implementation of these controls**
Potentially High Risks		
Regional hydrogeological change	1) Consultation strategy to present CSIRO modelling and results with government stakeholders and interested parties 2) Consideration of Water Management Act implications 3) Quantify groundwater inflows against available licence allocation within the Greater Metropolitan Water Sharing Plan 4) Determine seam 'daylight' boundaries and far field effects 5) Trend monitoring and sensitivity analysis to be carried out on CSIRO model 6) Peer review of CSIRO model 7) Strategy for the beneficial end use of mine water in consultation with stakeholders	1) Meeting with Office of Water and Chapter 7.0 2) Section 10.2 and Appendix E and Appendix F 3) Section 10.2 and Appendix E 4) Section 10.2 and Chapter 8.0. 5) Section 10.2 and Appendix E 6) CSIRO model is included in Appendix E –and has been peer reviewed by Dr. Noel Merrick. 7) Section 10.2.
Impact to groundwater dependent flora and stygofauna	1) Research the extent of dependence on groundwater feed when contrasted to rainfall. 2) Examination of species tolerance 3) Continued targeted species monitoring	1) Section 10.3 and Appendix H 2) Section 10.3 and Appendix G 3) Monitoring will continue.
Impact to aquatic fauna	1) Research the extent of dependence on groundwater feed when contrasted to rainfall 2) Examination of species tolerance 3) Continued targeted species monitoring	1) Section 10.3, Appendix E and Appendix H 2) Section 10.3 and Appendix G 3) Section 10.3 and Appendix G
Impact to terrestrial fauna	1) Examination of species tolerance 2) Continued targeted species monitoring	3) Section10.3 and Appendix H 4) Monitoring has been on-going for several years and will continue.
Potentially Significant Risks		
Mine subsidence – Deep Groundwater	1) As above (for regional hydrogeological change) 2) Consider data from Clarence colliery. Consideration of cumulative impacts. 3) Review of current and proposed monitoring with regard to long term drawdown affects. Based on predicted extent of drawdown. 4) Assessment of model against existing mine inflow data. 5) Ecological surveys to examine 'daylighting' catchment areas to evaluate the extent of ecology dependency 6) Significance of groundwater/surface water interface with regard to regional catchments/rivers/creeks	1) Section 10.2, Appendix E and Appendix F. 2) Section10.2. 3) Section10.2. 4) Section 10.2 and Appendix E. 5) Section 10.2 and Appendix E 6) Section 10.2 and Appendix E.

Issues and potential impacts	Proposed additional controls required to minimise risk	Demonstrated implementation of these controls
Impacts to surface water quality	1) Review example of Kangaroo Creek incident with regard to change in water quality 2) Chemical assessment of regional creeks and rivers 3) Investigate applicability of UNSW research outcomes	1) Goldney et al., 2010, Aurecon 2009 2) Chapter 8.0, Section 10.2 and Appendix E. 3) Section 10.2 and Section 10.3
Fracturing, spalling or dislodgement of rocks	1) Quantify likely impacts in vulnerable areas 2) Additional ground-truthing to consider public safety issues.	1) Chapter 8.0 and Appendix D. 2) Chapter 8.0 and Appendix D
Impact to Aboriginal heritage	1) Mitigation measures to be determined in Cultural Heritage Management Plan 2) Integrate into Aboriginal Consultation Process 3) Consider pedestrian inspections and photographic monitoring	1) Section 10.4 and Appendix K 2) Consultation with Aboriginal group in February and April 2012 and again in May 2013. 3) Section 10.4 and Appendix K.
Impact to Gardens of Stone National Park/Blue Mountains World Heritage Area	1) Consider groundwater monitoring on Project Application Area and Wollemi National Park boundary. 2) Subsidence impact assessment to focus on far field effects 3) Consider integration of trigger action response plans (TARPs) regarding progressive mining	1) Subsidence predictions show that such monitoring is not required. Chapter 8.0 and Appendix D . 2) Chapter 8.0, 10.1.4 and Appendix D . 3) Chapter 8.0 10.1.4 and Appendix D.
Potentially Moderate Risks		
Increased porosity in upper/near surface aquifers resulting in reduced water levels	1) Confirm the integrity of the Mount York Claystone with regard to porosity and behaviour of aquitard. 2) Groundwater monitoring to continue 3) Review of current and proposed monitoring with regard to long term drawdown affects. Based on predicted extent of drawdown.	1) Section 10.2 and Appendix E including CSIRO numerical model. 2) Monitoring will continue. 3) Section 10.2 and Appendix E.
Increased porosity in perched aquifers reducing out flows	1) Review installation standard with regard to environmental monitoring/exploration infrastructure which interact with perched aquifers. 2) Confirm the integrity of the Mount York Claystone with regard to porosity – behaviour of aquitard. 3) Groundwater monitoring to continue 4) Review of current and proposed monitoring with regard to long term drawdown affects. Based on predicted extend of drawdown. 5) Research the extent of dependence on groundwater feed when contrasted to rainfall. 6) Swamp classification to be determined based on groundwater dependence.	1) All monitoring and exploration bores will be installed in accordance with relevant standards 2) Section 10.2 and Appendix E 3) Monitoring will continue 4) Section 10.2 and Appendix E. 5) Section 10.2 and Appendix H. 6) Section 10.2 and Appendix H.
Reduced out flows to regional catchments and water courses.	1) Consultation strategy to address Wolgan Valley residents. 2) Undertake a Water Census for Project Application Area. Identify water users and requirements 3) Review existing monitoring infrastructure with regard to long term adequacy.	1) Chapter 7.0 2) Section 10.2 3) Section 10.2

Issues and potential impacts	**Proposed additional controls required to minimise risk**	**Demonstrated implementation of these controls**
Loss of surface flows.	1) Continued implementation of surface water flow monitoring devices. 2) Consider recommendations from Temperate Highland Shrub Swamp Management Plan in EIS.	1) Monitoring will continue 2) Section 10.2, 10.3 and Appendix H
Change in flow volume or water quality – impact to swamps s; and aquatic ecology	1) Consider recommendations from Temperate Highland Shrub Swamp Management Plan in EIS. 2) Consider pedestrian inspections and photographic monitoring as a monitoring measure. 3) Consider remote sensing techniques as a high resolution monitoring standard.	1) Section 10.2, 10.3 and Appendix H. 2) Photographs are taken by surveyors during subsidence monitoring 3) Centennial has commenced LIDAR surveys and is considering the use of unmanned aerial vehicles for cliff line surveys.
Far field effects	1) Subsidence Predictions and Analysis 2) Ecological surveys to examine 'daylight' catchment areas to evaluate extent of ecology dependency 3) Monitoring of groundwater outside the Project Application Area.	1) Chapter 8.0 and Appendix D. 2) Chapter 10.2 and Appendix E 3) Section 10.2 and Appendix E
Cumulative affects	1) Review monitoring at the Angus Place and Project Application Area boundary 2) Consider integration of TARPS re progressive mining	1) Chapter 10.0 2) Chapter 8.0.
Additional unplanned transfer/treatment infrastructure	1) Consultation strategy to present CSIRO model results to government stakeholders and other interested parties. Integrate into Stakeholder Engagement Plan. 2) Determine the maximum allocation with respect to mine plan. Determine the limits of the Water Sharing Plan to ensure they match the mine plan. 3) Devise strategy for beneficial end use of mine water in consultation with stakeholders. 4) Sensitivity analysis and trend monitoring to be performed on CSIRO model. 5) Water Management Committee to consider alternative options of managing water make beyond transfer. This should align with the Centennial Coal Water Management Strategy.	1) Section 10.2 and Appendix E. 2) Section 10.2 and Appendix E.. 3) Section 10.2 and Appendix E.. 4) Section 10.2 and Appendix E.. 5) Section 10.2.

Further to the environmental risks identified in **Table 9.4**, the environmental issues ranked low on the risk matrix are:

- changes in upper aquifer/perched aquifer groundwater quality (salts and metals);
- realignment of tributary/drainage line geomorphology resulting in increased ponding, scouring, erosion or change in fluvial characteristics;
- realignment of Came Creek and Coxs River and changes in their geomorphology;
- road deformation reducing serviceability (i.e. trafficability, ponding, erosion, etc.);
- impact to public safety from use of deformed roads; and
- powerline deformation and possible failure, or changes in conductor clearances.

9.4 Assessment of Environmental, Social and Economic Consequences

The technical assessments for environmental issues that have the potential to impact on the environment (including Matters of National Environmental Significance in accordance with the EPBC Act), have been denoted with high risk ratings and are discussed in detail in **Chapter 10.0**. Socio-economic impacts to the region as a result of the continuation of mining are discussed in **Chapter 6.0**.

Through comprehensive monitoring programmes for factors including subsidence, hydrology and hydrogeology, water quality, and flora and fauna, Angus Place Colliery have accumulated a wealth of knowledge on sensitive environmental features within the Centennial mining lease areas. On ground monitoring and statistical methods have been used to predict, assess and manage impacts to threatened flora and fauna, hanging and shrub swamps, as well as the site's ecology in general.

The assessment of subsidence (detailed in **Chapter 8.0** and **Appendix D**) provides ground modelling and predicted subsidence effects arising from the extraction of the proposed longwall panels, with conventional and non-conventional mine subsidence movements identified and assessed. The assessment is based on calibrated prediction tools that draw on many years of mine subsidence measurements from Angus Place and mines within the Southern, Newcastle, Hunter and Western Coalfields of NSW.

Subsidence predictions and impact assessments for the natural features within the Project Application Area together with significant natural features located outside the Project Application Area (which may be subjected to valley related or far-field horizontal movements) inform the various specialist assessments as listed below.

Water Management (Section 10.2)

The groundwater and surface water impact assessments have been completed to comply with the Aquifer Interference Policy minimal impact considerations, requirements of the Independent Expert Scientific Committee (IESC) and ANZECC guidelines together with the DGRs.

The numerical model developed by CSIRO (2013) has been an integral component in predicting the potential impacts of mining on groundwater systems and has provided a better understanding of natural recharge processes in the area, and the role of creeks and rivers in constraining the water table. The CSIRO model has been a key input to the groundwater impact assessment. Site specific information has also been considered in the development of the model. Such information includes case study reports on swamp water level responses to longwall progression, hydrograph analysis of swamp and regional groundwater levels, and the extent of drawdown as a result of current operations.

The CSIRO model has successfully enabled reliable predictions to be made for:

- mine water inflow (and dewatering) rates;

- regional changes in groundwater levels during mining and after closure;
- changes in baseflow contributions to surface water courses and swamps; and
- site water balance and regional water balance.

This has also informed the water management strategies for proposed operations. The site specific water balance is complemented by a regional water balance undertaken for all Centennial Coal's Western Operations mines (GHD 2013).

Ecology - Terrestrial Ecology, Aquatic Ecology and Stygofauna (Section 10.3)

The terrestrial ecological impact assessment provides a review of previous ecological investigations undertaken in proximity to the Project Application Area, together with vegetation community and survey mapping within the Project Application Area. An impact assessment of the Project on the terrestrial ecology including threatened species, EECs and habitats due to subsidence impacts and changes in groundwater levels and surface water and groundwater interactions is carried out.

The aquatic ecological impact assessment includes a review of databases and the identification of threatened aquatic species, populations, ecological communities, GDEs and key threatening processes which may impact on these communities. Such processes include water discharges both surface water runoff and mine water make.

Heritage (Section 10.4)

This assessment includes background research, field surveys and an impact assessment of Aboriginal heritage items identified within the Project Application Area with due regard to subsidence assessment results. There has been extensive consultation and involvement with Aboriginal groups.

Traffic and Transport (Section 10.5)

This assessment includes a review of the access and traffic implications of the Project. This is also considered with cumulative traffic increases from the generation of other proposed local projects and annual average increases in traffic flows. Operations at the pit top and Newnes State Forest road networks are examined.

Noise Management (Section 10.6)

This assessment identifies the potential impacts of noise and vibration associated with the Project on the nearest surrounding noise sensitive receivers including consideration of cumulative impacts.

Air Quality Management (Section 10.7)

This assessment quantifies the air quality impacts on surrounding sensitive receivers associated with the Project. Project elements with the potential for air quality impacts are assessed during construction, operation and site rehabilitation.

Greenhouse Gases (Section 10.8)

The assessment considers emissions of greenhouse gases from the Project (both direct and indirect). Data for the assessment is extracted from the Angus Place NGERS report for July 2011 to June 2012 period and utilises NGERS emission factors and other acceptable NGERS emission calculation methodologies.

Soils and Landscape Capability (Section 10.9)

The Soils and Land Capability assessment classifies and determines the soil types in the Project Application Area; identifies pre and post-mining rural land capability and agricultural suitability; identifies potentially unfavourable soil material which may pose high environmental risks if disturbed; and provides relevant management and mitigation measures to minimise potential impacts identified.

Strategic Agricultural Land (Section 10.10)

The Agricultural Impact Assessment assesses the impacts of the Project on the agricultural resources and associated water resources. The potential agricultural production value of the Project Application Area is assessed in this context. Impacts upon soils and land capability are also assessed.

Life of Mine and Rehabilitation (Section 10.11)

This assessment establishes objectives for the decommissioning and rehabilitating of land that will be impacted by the Project. Short, medium and long term objectives are set out which integrate closely with the existing Angus Place MOP.

Visual Amenity (Section 10.12)

This assessment identifies the visual character and existing aesthetic environment of the Project area. Potential visual impacts arising from Project activities are assessed, particularly in relation to construction activities. Proposed mitigation and management measures are outlined.

Waste Management (Section 10.13)

This section provides an overview of existing waste management practices at Angus Place Colliery and predicts proposed waste volumes arising from the Project, particularly construction related aspects associated with the construction of new infrastructure on Newnes Plateau.

Hazards Management (Section 10.14)

This section details the current hazards management plans in place at Angus Place Colliery including the bush fire management plan.

CHAPTER 10.0

Assessment and Management of Key Environmental Issues

10.0 ASSESSMENT AND MANAGEMENT OF KEY ENVIRONMENTAL ISSUES

10.1 Landscape Features

Section 2.3 provides a summary of the overall landscape context of the Project Application Area. The following sections outline the existing environment and detail the potential impacts and consequences of the Project on landscape features. Certain natural features (Wolgan River, Carne Creek, Wolgan valley shrub swamps and Wolgan valley cliff and pagoda complexes) are close to past and proposed Springvale workings and subsidence predictions have taken into account the cumulative effects of both projects.

10.1.1 Cliffs

10.1.1.1 Existing Environment

Cliffs and pagodas predominate around Wolgan River and Carne Creek and their tributaries in the Narrabeen sandstones. To assist in developing a mine plan that minimises impacts, the locations of cliffs have been plotted from 1 m resolution Light Detection and Ranging (LiDAR) survey, aerial photography and detailed site survey.

Figure 8.6 shows the proposed mine plan and distribution of cliffs in the Project Application Area. The mine plan has been modified to avoid cliffs, to the extent that there are three cliffs within the angle of draw and none directly above longwall panels.

10.1.1.2 Potential Impacts

Figure 8.6 indicates that LW1002, LW1018 and LW1019 have been shortened to, amongst other things; avoid significant clusters of cliffs along Carne Creek and its tributaries. This plan also shows the shortening of LW1008 to avoid cliffs to the east. Similarly LW1015 to 1017 have been shortened to, amongst other things; avoid clusters of cliffs to the east. LW 1013 and 1014 will be split into two segments to avoid these same clusters.

The maximum predicted strains for AP-CL1 and CL2 (see Figure 8.6) are 1.5 mm/m tensile and 0.5 mm/m compressive and it is compressive strains that most often result in spalling. Compressive strains of 0.5 mm/m, or less, are unlikely to have any adverse impacts on the cliffs. The cliff adjacent to LW1014B is predicted to suffer potential localised spalling to less than 1% of the rock face.

The cliffs are located away from valley floors and therefore are not predicted to experience significant valley closure related movements. Consequences of Potential Impacts

10.1.1.3 Consequences of Potential Impacts

As identified in Chapter 8, specifically section 8.4, less than 1% of spall of rock faces of cliffs within the 26.5 degree angle of draw is predicted, those being CL1 and CL2. All other cliffs within the Project Application Area have been avoided.

10.1.1.4 Monitoring

Cliffs within the defined 26.5 degree angle of draw boundary over LW1006, 1009, 1010 and 1011 will be visually monitored periodically during and after mining. Several years of mining will be carried out before mining approaches these cliffs, thereby providing additional data on the natural behaviour of cliffs.

10.1.2 Pagodas

10.1.2.1 Existing Environment

Pagodas predominate around Wolgan River and Carne Creek and their tributaries in the Narrabeen sandstones. To assist in developing a mine plan that minimises impacts, the locations of pagodas have been plotted from 1 m grid resolution Light Detection and Ranging (LiDAR) survey, aerial photography and detailed site survey.

Figure 8.6 shows the proposed mine plan and distribution of pagodas in the Project Application Area.

10.1.2.2 Potential Impacts

The mine plan has been modified to avoid pagodas, and **Figure 8.6** shows those pagodas remaining within the angle of draw. There are pagodas above LW1006, LW1009, LW1010 and LW 1011. **Figure 8.6** indicates LW1008 has been shortened to, amongst other things; avoid pagodas to the east. Similarly LW1015 to 1017 have been shortened to, amongst other things; avoid pagodas to the east. LW 1013 and 1014 will be split into two segments to avoid these same pagodas. The isolated pagodas above proposed longwalls are predicted to experience tilts up to 20 mm/m, compressive strains up to 3.5 mm/m and tensile strains up to 3 mm/m.

10.1.2.3 Consequences of Potential Impacts

The pagodas within the angle of draw will experience varying subsidence, up to the maxima detailed in **Table 8.1**. The pagodas are located away from valley floors and therefore are not predicted to experience significant valley closure related movements.

The pagodas located directly above the proposed longwalls are predicted to experience some fracturing and spalling to less than 1 % of their total surface area.

10.1.2.4 Monitoring

Pagodas above proposed LW1006, LW1009, LW1010 and LW 1011 will be visually monitored periodically during and after mining. Several years of mining will be carried out before mining approaches these cliffs, thereby providing additional data on the natural behaviour of pagodas.

10.1.3 Watercourses

10.1.3.1 Existing Environment

The surface water catchments in the Project Application Area are the Coxs River in the west, Wolgan River west in the centre, and Carne Creek (or Wolgan River East) in the east. Coxs River flows generally south past Lithgow skirting the western flanks of the Blue Mountains before entering Lake Burragorang and eventually the Nepean River. Carne Creek and Wolgan River both flow generally northwards before joining and eventually emptying into the Colo River, which joins the Hawkesbury River near Lower Portland. **Section 2.7** details these catchments further. The majority of Angus Place Colliery's historic mining areas have been under the Coxs and Wolgan River west catchments. The proposed longwalls are under the Wolgan River west and east catchments.

The Wolgan River is a fifth order stream that bisects the Project Application Area and flows north via Wolgan Falls into the Wolgan Valley and eventually into the Colo River System, that flows into the Hawkesbury River. In the Project Application Area the Wolgan River is in a deeply incised valley and the river itself is fed by a series of tributaries located in the Newnes Plateau.

Named Watercourses

The main channel of Carne Creek is located immediately east of the Project Application Area and along with the Wolgan River, it is in a deeply incised valley and is fed by a series of tributaries located in the Newnes Plateau. Both Carne Creek and Wolgan River receive groundwater that contributes to their baseflows.

The mine plan shown in **Figure 8.6** shows that the Wolgan River will not be undermined and nor will it be within the angle of draw. The minimum distance from the Wolgan River centreline to the nearest longwall panel LW1002 is 240 m.

The closest that mining will approach Carne Creek is approximately 400 m southeast of LW1019.

Un-named Watercourses

There are various unnamed watercourses above the proposed mining area generally having shallow incisions into the natural surface soils which are derived from the Burralow Formation of the Triassic Narrabeen Group. Some sections of the drainage lines have sandstone outcropping, which form a series of steps or drop downs in the steeper sections.

10.1.3.2 Potential Impacts

Named Watercourses

The maximum predicted subsidence parameters in the Wolgan River channel due to movements from extraction of longwalls in both Angus Place and Springvale Projects are:

- <20 mm subsidence;
- 290 mm upsidence;
- 0.2 mm/m tilt; and
- 360 mm closure.

The Wolgan River is not predicted to experience measurable conventional strains; however valley movements will generate maximum compressive strains of less than 1 mm/m.

Predictions for section of Carne Creek closest to the proposed longwalls are:

- <20 mm subsidence;
- 25 mm upsidence
- 50 mm closure

Unnamed Watercourses

Unnamed drainage lines above the proposed mining area flow into either Wolgan River or Carne Creek and are predicted to experience subsidence movements up to the maxima as identified in **Table 8.1**.

First and second order tributaries are predicted to experience maximum tensile strains of 3 mm/m and compressive strains of up to 3.5 mm/m, with the greatest strains occurring at the centrelines of longwalls.

10.1.3.3 Consequences of Potential Impacts

Named Watercourses

The predicted tilt of 0.2 mm/m for the Wolgan River is very small in comparison to the natural grade of the River, which ranges from 25 mm/m to 200 mm/m and therefore there no significant ponding, flooding, scouring is predicted. Similarly, the predicted cross tilt of 0.2 mm/m represents a change in cross-grade of 1 in 5,000 which is not predicted to effect the stream alignment.

The Wolgan River has previously experienced up to 270 mm subsidence and 310 mm closure due to previous extraction of longwalls at both Angus Place and Springvale, which caused no significant fracturing or related surface water diversions. It is not predicted that any significant fracturing or water diversion will occur due to the Project.

The compressive strains due to the valley closure movements are expected to be less than 0.5 mm/m. The predicted movements at the closest section of Carne Creek to the extraction area are very small and no adverse consequences are predicted.

Unnamed Watercourses

Cracking of shallow bedrock is possible where tensile strains more than 0.5 mm/m or compressive strains of more than 2 mm/m are caused by subsidence. Given that the predicted strains are higher than this, such cracking is predicted although net loss of water from the catchment is not predicted as any diverted water is expected to re-emerge downstream. Subsidence predictions in this EIS are based on MSEC (2013), a report that is based on the Incremental Profile Method, which is inherently conservative in its predictions. **Section 2.6.2.6** provides details on the closely monitored and researched impacts of mining at Angus Place Colliery and Springvale Mine with regards cracking and hydrology. Springvale Mine and Angus Place Colliery have has previously extracted longwalls from beneath more than 40 kilometres of watercourses and monitoring shows that any impacts to surface water flows are transient at worst.

The maximum predicted tilt within the Project Application Area is 20 mm/m and as the typical channel grades in the Project Application Area vary between 25 mm/m and 300 mm/m, these tilts are unlikely to have any adverse effect.

10.1.3.4 Monitoring

As no significant consequences to watercourses are predicted, monitoring will be confined to flow monitoring upstream and downstream of the Wolgan River and Carne Creek. Flow monitoring on drainage lines within 800m of the longwall voids from LW1008 will be installed to measure far field effects.

10.1.4 World Heritage Areas, National Heritage Places and National Parks

10.1.4.1 Existing Environment

The 15,100 hectare Gardens of Stone National Park adjoins the northern boundary of the Project Application Area, while the 501,700 hectare Wollemi National Park is further north and east. The 248,200 hectare Blue Mountains National Park is located south east of the Project Application Area. Together these and other reserves in the region (Nattai, Kanangra-Boyd and Thirlmere Lakes National Parks and Jenolan Caves Reserve) make up the 1,030,000 hectare Blue Mountains World Heritage Area, which was listed in 2000 for significant biological evolutionary processes and the importance and diversity of habitats. This area is also a National Heritage Place.

10.1.4.2 Potential Impacts

The Gardens of Stone National Park, which is part of the Greater Blue Mountains Area World Heritage Area and National Heritage Place is located adjacent to the northern-eastern edge of the Project approximately 170 m from LW1014A and outside the angle of draw. The area of National Park closest to LW1014A could experience very small vertical movements (less than 20 mm), but it is not expected to experience any measurable conventional tilts, curvatures or strains.

Far field movements are those movements that can be expected to occur at some distance from the mine face. These movements consist of low level strains. Low level strains are likely to affect linear infrastructure (such as pipelines) and may contribute to valley closure movements at some distance from the longwall edge. MSEC (2013) has calculated that the extent of far field movements from the longwalls at Angus Place is 800m from the goaf.

The maximum strains at either Springvale or Angus Place mines in areas outside the angle of draw have been measured at 1.3 mm/m tensile and 0.5 mm/m compressive. These strains did not result in any noticeable soil cracking. Therefore it is not expected that there will be any adverse impacts in the National Park.

Carne Creek within the National Park could experience subsidence related valley closure of less than 20 mm. Even at twice this prediction, the associated compressive strains would be less than 0.5 mm/m. As fracturing of bedrock is not observed at compressive strains of less than 2 mm/m, no stream bed fracturing is expected in the National Park.

There are ephemeral drainage lines closer to the mining area, the closest being at approximately 220 m from LW1014A. Measured closure strains at this distance are typically 2 mm/m, ranging up to 2.8 mm/m, and therefore it is possible that minor and isolated fracturing of bedrock in ephemeral drainage lines will occur in the National Park.

10.1.4.3 Consequences of Potential Impacts

The ephemeral tributaries within the National Park, closest to the LW1014A, could experience very small valley related movements which could cause minor and isolated fracturing, These low level valley related movements are not expected to have adverse consequences to surface water flows or quality

10.1.4.4 Monitoring

Extraction from LW1014A will occur late in the mine schedule, with mining moving towards the National Park, thus allowing for an adaptive management approach. Predicted ground movements due to valley closure in the vicinity of the National Park can be monitored as mining approaches, and any adverse impacts avoided by the implementation of strategies to be prepared in a trigger action response plan. By the time mining approaches the National Park boundary, the flow monitoring data on drainage lines with 800m of the National Park boundary will inform the risk profile for far field effects and the adaptive management strategies to be implemented where monitoring is above the predicted levels.

10.1.5 Newnes Plateau Swamps

10.1.5.1 Existing Environment

Locations of swamps in the Project Application Area are shown in **Figure 2.2** and descriptions and values of these are provided in **Section 10.3**.

10.1.5.2 Potential Impacts

Figure 8.6 shows the locations of swamps in the Project Application Area in relation to the proposed mine plan and the angle of draw and indicates the following with regards swamps:

- Twin Gully Swamp will not be directly undermined by longwalls, owing to a step around in LW1010, but is within the angle of draw;
- Tri Star Swamp is above LW1004-1006, all of which have narrower, sub-critical void widths proposed; and
- Trail 6 swamp is above LW1016 and 1017, both of which have narrower, sub-critical void widths proposed.

10.1.5.3 Consequences of Potential Impacts

Tri Star and Trail 6 swamps, which are located directly above proposed longwalls are predicted to experience maximum conventional tensile strains of 3 mm/m and compressive strains 3.5 mm/m. As shrub swamps are located on the valley floors, they are susceptible to valley related non-conventional movements. Predicted upsidence and closure are greatest for sections of swamps located directly above the proposed longwalls and less for sections of swamps located near the chain pillars. The compressive strains due to valley closure for the shrub swamps located directly above the longwalls are predicted to be up to 15 mm/m.

As a result of longwall mining, fracturing of the uppermost bedrock has been observed in the past where tensile strains have been greater than 0.5 mm/m or where the compressive strains have been greater than 2 mm/m. Swamps that are located outside the extent of the proposed longwalls are predicted to experience tensile strains less than 0.5 mm/m and compressive strains less than 2 mm/m as a result of the Project. As a result, it is unlikely that the bedrock located beneath these swamps would experience any significant fracturing.

The shrub swamps above the proposed longwalls are predicted to experience strains greater than this threshold and therefore fracturing of the topmost bedrock is predicted in these swamps. This cracking is predicted to be isolated and minor due to the high depths of cover and the plasticity of the soils. Crack widths are predicted to be similar to past cracking above previously extracted longwalls, generally between 5 mm and 25 mm, with isolated cracks up to 50 mm wide.

Cracking predictions in this EIS are based on MSEC (2013), a report that is based on the Incremental Profile Method, which is inherently conservative in its predictions. **Section 2.6.2.6** provides details on the closely monitored and researched impacts of mining at Angus Place Colliery and Springvale Mine with regards cracking and hydrology. Subsidence effects to aspects of swamp hydrology have been noted at two swamps (Kangaroo Creek Swamp and East Wolgan Swamp). In both of these cases investigations have revealed that mine design was a primary causative factor. The ratio of longwall mining void width to depth of cover over mine workings was identified to be in the critical subsidence behaviour range. Following this investigation, the mine design was modified for all future proposed mining areas in the vicinity of Newnes Plateau Shrub Swamps to ensure that the ratio of longwall mining void width to depth of cover over mine workings was in the sub-critical subsidence behaviour range. No subsidence effects to swamp hydrology or flora communities have been identified in areas where sub-critical mine design has been used. The Mount York Claystone is 22 m thick and continuous across the Project Application Area and prevents mining-induced fracturing in the strata above the coal seam to the surface. The limited extent of downward cracking from the surface means that fracturing and dilation of bedrock of shrub swamp would not result in losses of infiltrated water and minimal divergence of surface water would occur. With regard to these findings, it is unlikely that the effects of subsidence would have an adverse effect on shrub swamps or hanging swamps such that the ecological functioning of these swamps would be impaired. No previous subsidence effects to swamp hydrology or flora communities have been identified in areas where sub-critical mine design has been used.

Hanging swamps in Tri Star Swamp, Twin Gully Swamp and Carne Creek catchments will be undermined. The maximum predicted conventional curvature strains are 2 mm/m tensile and compressive. Hanging swamps do not occur in valley floors so are not susceptible to effects from closure.

The nature of the soil beneath the swamps determines the likelihood of leakage of water through subsidence induced cracking. Shrub swamps typically have deep layers of peat overlying the natural soils, so most cracks would not be visible. Further, fracturing of shallow bedrock beneath these swamps is likely to be filled with soil during subsequent flow events along the drainage lines. Hanging swamps, which are located on the valley sides contain soft soil or peat layers that overly the bedrock. The potential for fracturing in these locations is less than in the base of the valleys, due to lower compressive strains and higher depths of cover.

Angus Place Colliery and Springvale Mine have previously undermined 13 shrub swamps and 26 hanging swamps with longwall geometries that are likely to have a higher potential impact than what is currently proposed by the Project. This is because the width of a longwall panel in relation to its depth from the surface is a key determinant in conventional and non-conventional movements. The Project proposes smaller width to depth longwall ratios as compared to previously mined longwalls at the adjacent Springvale Mine, which reduces the likelihood and severity of subsidence impacts.

The consequences of predicted subsidence on swamps in the Project area, including the potential to change surface and subsurface hydrology are discussed further **Section 10.2** while ecological consequences are detailed in **Section 10.3**.

10.2 Water Management

This section specifically responds to the DGRs, which provide the following in regard to water aspects:

The Director-General's requirements

Water Resources – including:

- detailed assessment of potential impacts on the quality and quantity of existing surface water and ground water resources in accordance with the NSW Aquifer Interference Policy, including;
  - impacts on affected licensed water users and basic landholder rights;
  - impacts on riparian, ecological, geo-morphological and hydrological values of watercourses, including groundwater dependent ecosystems and environmental flows; and
  - whether the development can operate to achieve a neutral or beneficial effect on water quality in the drinking water catchment, consistent with the provisions of State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011;
- a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply and transfer infrastructure and water storage structures; and
- identification of any licensing requirements, including existing or future Environment Protection Licences (EPLs) or Pollution Reduction Programs (PRPs), and approvals under the Water Act 1912 and/or Water Management Act 2000;
- demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);
- a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;
- a detailed description of the proposed water management system (including sewerage), water monitoring regime, beneficial water re-use program and all other proposed measures to mitigate surface water and groundwater impacts.

10.2.1 Introduction and Background

This section identifies the potential impacts of the Project on the water environment and how these impacts can be appropriately managed to ensure acceptable residual consequences. It is informed by the technical studies, "*Angus Place Mine Groundwater Impact Assessment, RPS November 2013* (RPS, 2013a) provided in **Appendix E** and "*Angus Place Mine Extension Project Surface Water Impact Assessment, RPS November 2013 RevB*" (**Appendix F**).

The surface water and groundwater assessments have been prepared in accordance with the DGRs as noted above and additionally in accordance with the following requirements and guidelines:

- Supplement to the DGRs issued on 30 August 2013 by DP&I in relation to EPBC 2013/6881.
- Independent Expert Scientific Committee's Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources (IESC, 2013) and "Significant Impact Guidelines for Coal Seam Gas and Large Coal Mining developments – Impacts on Water Resources" (Department of Sustainability, the Environment, Water, Populations and Communities, 2013).

Numerous recent and ongoing groundwater studies at Angus Place Colliery have contributed to the definition of a groundwater system that is extensively monitored, using shallow and deep piezometers, within the Project Application Area. Geological investigations have been undertaken through exploration works and geological studies including recently those of Palaris (2013), Palaris (2013b) and McHugh (2013).

RPS (2013a) has developed a conceptual hydrogeological model that identifies the most important geological units and hydrogeological processes within the Project Application Area and the surrounds. Between 2004 and 2013 CSIRO has undertaken a number of studies comprising numerical modelling simulations using COSFLOW to estimate surface subsidence and predict mine inflows from longwall mining. These studies have culminated in a detailed COSFLOW numerical hydrogeological model that has been used in the Project to quantify the groundwater impacts, their magnitude and extent. The numerical groundwater is complemented by the conceptual hydrogeological model prepared by RPS (2013a).

COSFLOW is based on an implicit numerical solution of Richards equation and provides a continuous simulation of both unsaturated and saturated conditions. As such, COSFLOW is capable of simulating the formation of multiple phreatic surfaces (water tables). This is an important attribute in the context of the hydrogeology of Angus Place Colliery.

Studies undertaken at the adjacent Springvale Mine have also investigated the potential impacts of the longwall mining on the THPSS. A study undertaken in November 2012 (RPS, 2012) investigated the long term water levels in selected swamps in association with cumulative rainfall deviation and the progression of the underlying longwalls. A related investigation (RPS, 2013) used both hydrograph rainfall response trends and vegetation mapping to delineate the areas of swamps which are predominantly groundwater dependent (Type C shrub swamp, refer **Section 2.7**), and those that are rainfall dependent (Type A shrub swamp, refer **Section 2.7**).

The numerous investigations have been used to understand the existing hydrogeological environment at the site to allow the assessment of potential impacts of the proposed longwall mining on that environment and the groundwater dependent ecosystems within the Project Application Area.

10.2.2 Existing Environment

The Project comprises underground operations beneath the Newnes Plateau (elevation ~1,150 m AHD), with surface operations (pit top, administration and surface water management infrastructure) on the footslopes of the Newnes Plateau (elevation ~920 m AHD).

Chapter 2.0 describes the topography, hydrology, geology and hydrogeology relevant to the Project in this setting.

10.2.2.1 *Surface Water System*

Spatial details of catchments and associated watercourses are illustrated in **Figure 2.34**. The Project Application Area is located within Wolgan River/Carne Creek and Coxs River catchments which report to the Hawkesbury and Nepean catchments respectively. Angus Place Colliery's surface facilities are located in a local catchment of Kangaroo Creek and licensed discharge occurs to this catchment, which then flows into the Coxs River and then to Lake Wallace further downstream.

The Coxs River Catchment and the Wolgan River Catchment are both under the jurisdiction of the Hawkesbury-Nepean Catchment Management Authority and the Coxs River is also listed within the boundary of the Sydney Drinking Water Catchment under the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*. Whilst water quality and river flow objectives have not been formally set for the Hawkesbury-Nepean catchment, an impact assessment against relevant environmental values is presented. A statement of neutral or beneficial effect is also presented below.

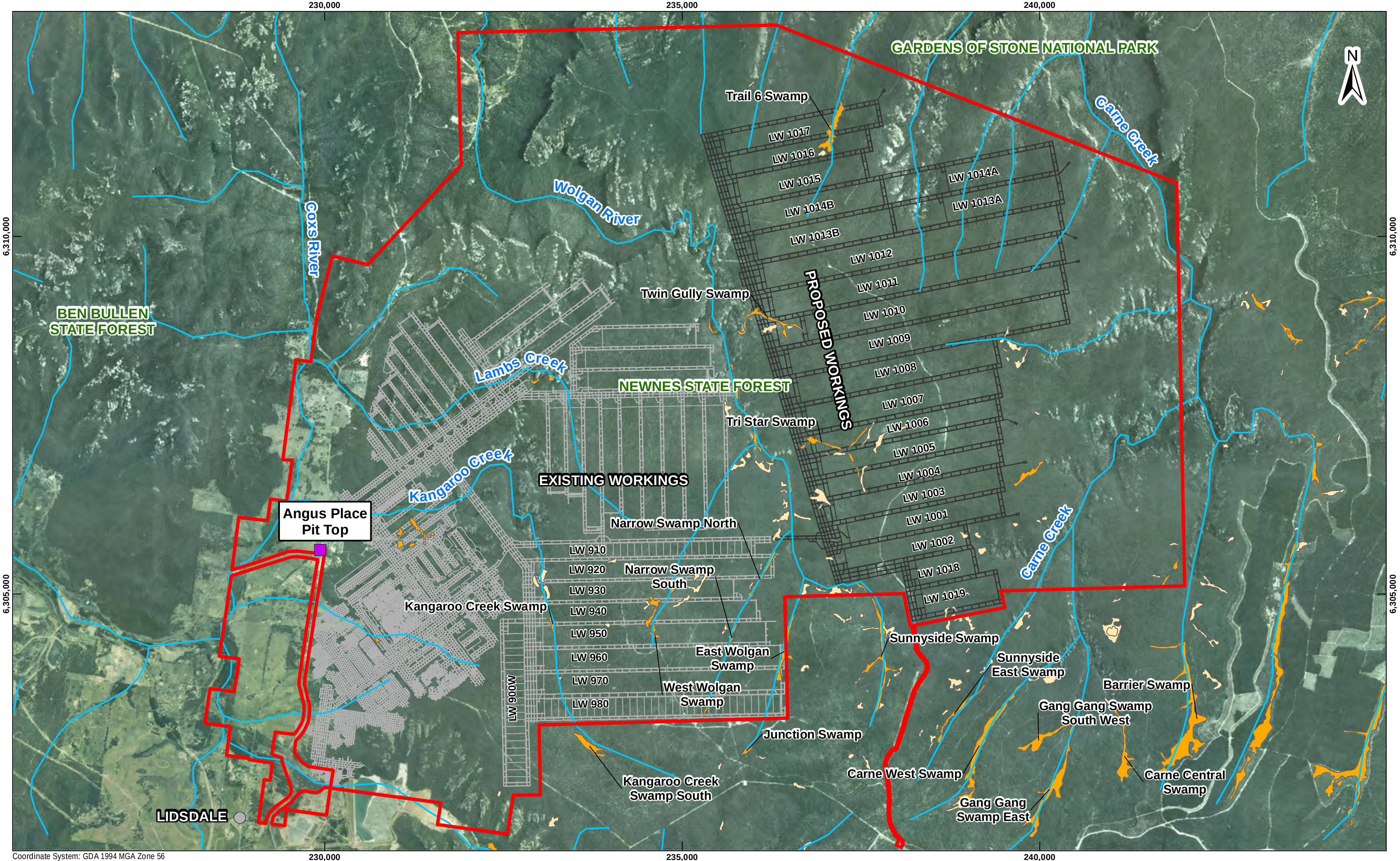
Surface water flow in the Coxs River catchment is in a southerly direction, reflecting surface topographic gradient toward Lake Wallace and further downstream, Lake Lyell, which is the water supply reservoir for Mount Piper Power Station via intermediate transfer to Thompsons Creek Dam. Outflow from Lake Lyell eventually contributes to Lake Burragorang and is the primary drinking water reservoir for the City of Sydney. Surface water flow in the Wolgan River catchment is northerly into the Wolgan Valley.

As outlined in **Section 2.7**, the Project is situated within the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources and the Project Application Area split by the Wywandy Management Zone and Colo River Management Zone of the Upper Nepean and Upstream Warragamba and Hawkesbury and Lower Nepean River Extraction Management Units respectively. Further detail is presented in **Section 2.7**. There is no direct extraction of surface water from either Extraction Management Unit, however, reduction in baseflow contribution to surface water courses from local groundwater systems require licensing, as per the requirements of the NSW Aquifer Interference Policy. Details of licensing requirements are summarised in **Section 10.2.3**.

The main watercourses within the Project Application comprise:

- Rivers: Cox River (5th and 6th order), Wolgan River (4th and 5th order), Carne Creek (5th and 6th order). Stream order has been derived using the Strahler System of Stream Order Classification;
- Hanging swamps and shrub swamps: There are shrub swamps and hanging swamps within the Project Application Area (Tri-Star and Trail Six Swamps, refer **Figure 10.1**). Direct mining under Twin Gully Swamp has been avoided.

Time-series surface water flow in Sunnyside Swamp and Carne West Swamp are presented in **Figure 10.2** These swamps are located within the adjacent Springvale Mine. Mining has occurred on either side of Sunnyside Swamp, whereas Carne West Swamp has not been undermined. From **Figure 10.2**, there is no identifiable change to surface water flow due to subsidence-related impacts of mining.



LEGEND

- Project Application Area
- Village
- Watercourse
- Shrub Swamp
- Hanging Swamp
- Existing Workings
- Proposed Workings

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F060 APC Rev 0
SCALE	1:70,000

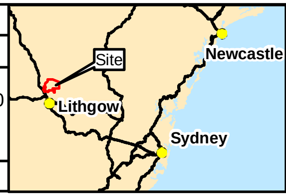


Figure 10.1: Swamp Distribution Relative to Proposed Workings

0 1 2 km

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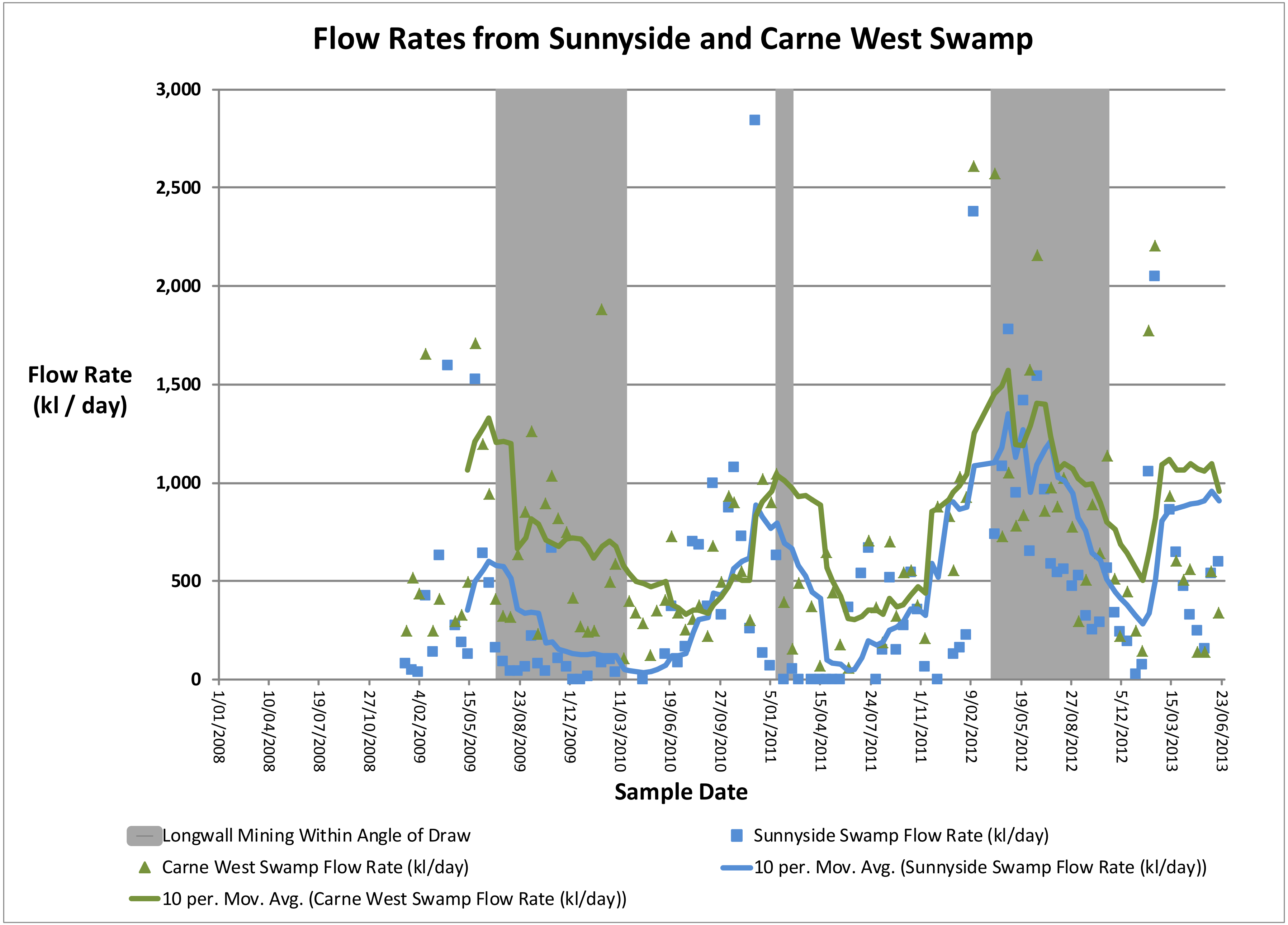

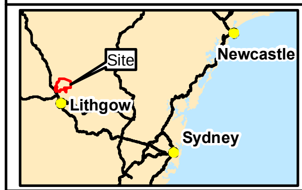

Source:
RPS October 2013

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F083 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.2:
Observed Surface Water Flow Rates (kL/d) – Sunnyside Swamp and Carne West Swamp.

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Centennial Coal
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10.2.2.2 Groundwater System

As noted in **Chapter 2.0**, the underlying strata of Newnes Plateau comprises mostly of sandstones of the Triassic Narrabeen Group with interbedded shale, claystone and siltstone, and the Permian Illawarra Coal Measures. The Narrabeen Group comprises the following sequence of rock formations (as illustrated in **Figure 2.33**):

- the Burralow Formation;
- the Banks Wall Sandstone;
- the Mount York Claystone;
- the Burra-Moko Head Sandstone; and
- the Caley Sandstone.

Angus Place Colliery commissioned a specific exploration programme in 2011 and 2012 to better define the near surface stratigraphy and aquifer systems. This involved a detailed analysis of the lithology (from 501 boreholes) and 3d modelling of stratigraphic units and enabled a correlation to be made between the geology, surface topography and the position of the THPSS. The detailed stratigraphy of the Project Application Area is described in Palaris (2013). The key finding of Palaris (2013) of relevance to the Project is the existence of two correlatable units within the Narrabeen Group characterised by the presence of claystone/shale bands. These units, the Burralow Formation and the Mount York Claystone, occur at the upper and lower boundary of the Banks Wall Sandstone and provide the hydraulic barriers between the perched and shallow groundwater systems (refer **Section 2.6.2**) and the shallow and deep groundwater systems, respectively.

The key elements of the hydrogeological system comprise:

- stacked and segregated groundwater systems recharged by rainfall – locally in the case of shallow and perched systems and regionally in the case of the deeper systems;
- deep regional flow essentially isolated from the shallow and perched groundwater systems;
- perched water systems, supported on low permeability aquitard layers;
- shrub swamps fed partially by groundwater originating from the perched groundwater systems and partially from surface water run-off;
- the Mount York Claystone acting as a significant regional aquitard isolating the shallow and perched groundwater systems from the deep groundwater system;
- the deep interbedded and interbanded aquitard (mudstones) and aquifer (sandstone and coal) units present beneath the Mount York Claystone strongly influence the deep regional groundwater flow pattern at depth;
- groundwater flow is dominated by both porous media flow (dominantly horizontal) and to a much lesser extent, fracture flow associated with the joint, fracture and fault conduits;
- variably enhanced groundwater flow through the lithological pile affected by subsidence induced permeability zones;
- extensive aquifer interference in the deep groundwater system aquifers due to subsidence induced goaf formation, collapse and fracturing affects. These observed aquifer impacts do not extend above the Mount York Claystone;
- shallow formation sagging, induced by subsidence, gives rise to enhanced horizontal permeability in the shallow groundwater system (permeability enhancements decreasing closer to the ground surface); and
- disconnected vertical permeability enhancements are inferred in the shallow surface zones.

Within these sequences a number of key hydrostratigraphic units (refer **Section 2.6.2**) underlie the site. The aquifer units are identified as AQ1 – AQ6 and aquitard units as SP0 – SP4, including YS4 and YS6 within the Burralow Formation. These units were incorporated into the groundwater numerical model at Angus

Place. These units have been incorporated into the boundary conditions for the groundwater model developed for Angus Place.

A brief summary of the identified aquifers and aquitards is provided as follows:

- Weathered section – this is a 10 m thick layer of weathered material which is assumed to cover the top surface of the Project Application Area.
- AQ6 – This aquifer is located in the upper part of the Narrabeen Group sandstone. This is an unconfined aquifer and only appears near the top of the Newnes Plateau.
- SP4 - A thin semi-permeable layer located in the Burralow Formation and comprises claystone (YS4) and sandstone/ siltstone.
- AQ5 – This aquifer is located in the Burralow Formation.
- YS6 – A thin semi-permeable claystone layer separates AQ4 and AQ5.
- AQ4 – This aquifer is located in the Banks Wall Sandstone (Narrabeen Group).
- SP3 - A semi-permeable claystone layer (Mount York Claystone) separates aquifers AQ3 and AQ4.
- AQ3 - Aquifer AQ3 can be identified in the sandstone of the Burra Moko Head Formation and the Caley Formation and located below the Mount York Claystone. It is hydraulically connected with the Katoomba Seam.
- SP2 - A semi-permeable layer with coal, siltstone and mudstone is the boundary between aquifers AQ2 and AQ3. This semi-permeable layer is assumed to occur just below the Katoomba Seam.
- AQ2 – This aquifer contains sandstone with laminated siltstone and Middle River Coal Member.
- SP1 - Aquifer AQ1 is separated from aquifer AQ2 by a semi-permeable layer (SP1) located within the Baal Bone/Denman Formation and comprises mudstone, siltstone and claystone.
- AQ1 – This aquifer is found to include Lidsdale / Lithgow Coal Seam which is hydraulically connected with the laminated siltstone (Berry Siltstone) and sandstone of the Marrangaroo Formation underneath, and the sandstone and siltstone of the Long Swamp Formation and Irondale Coal Seam above.

Recent studies of the upper stratigraphy of Angus Place and Springvale (McHugh, 2013) indicates that there is a lithographic and topographic link between the outcrop of the Burralow Formation claystones and the location of shrub and hanging swamps. The lower permeability horizons in the Burralow Formation (defined by the multiple claystone/shale bands) inhibit vertical groundwater recharge. Rainfall recharge permeates to these horizons and then is transmitted laterally and is discharged to hillsides and cliff-faces, providing a water source upon which these swamp vegetation communities have been established.

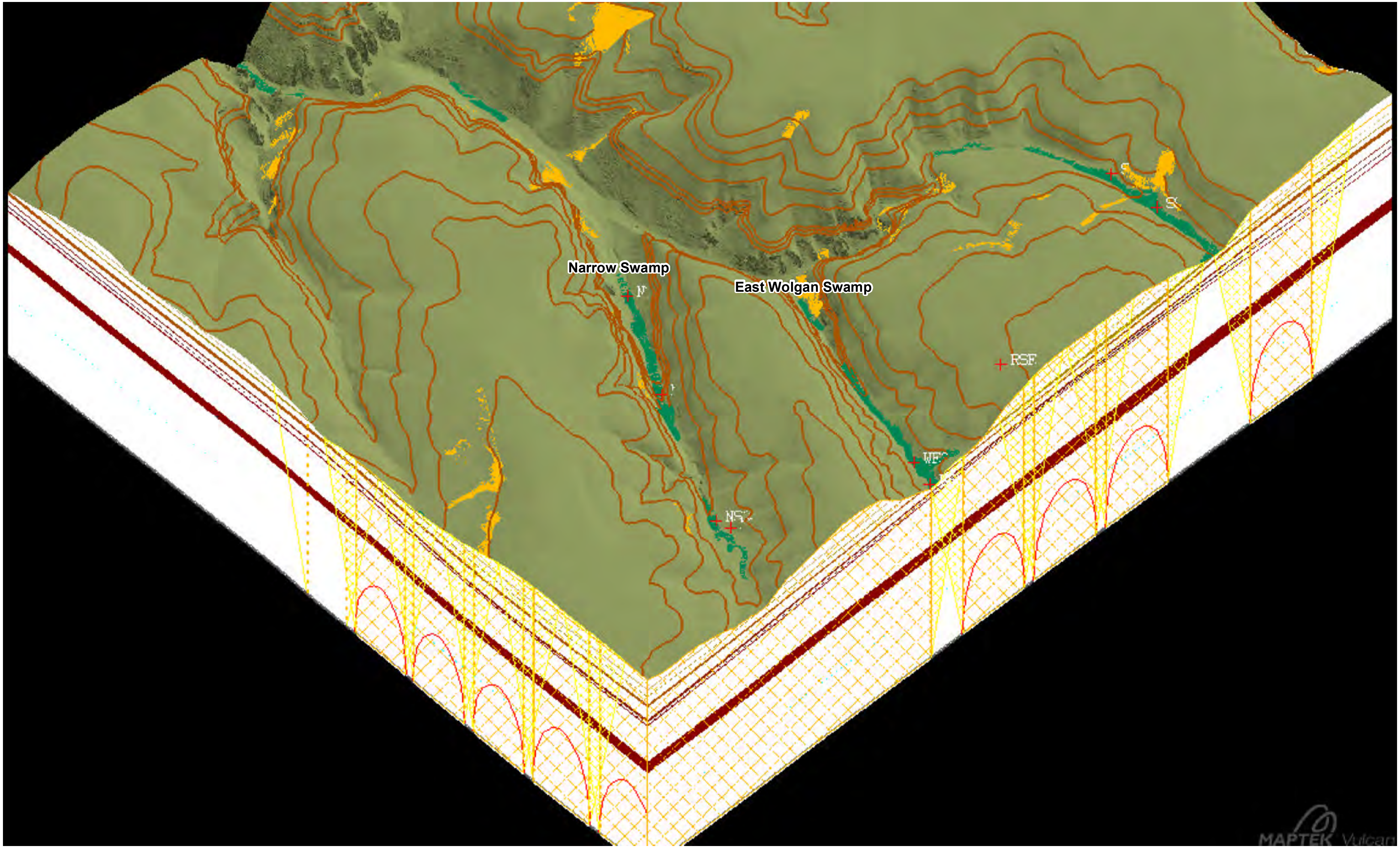
Figure 10.3 presents the 3D representation of the Burralow Formation claystones (YS1 – YS6, brown contours) at Narrow Swamp (NS) and East Wolgan Swamp (WE). **Figure 10.4** presents the equivalent diagram for Sunnyside Swamp (SS), Sunnyside East Swamp (SSE) and Carne West Swamp (CW). It is noted that Sunnyside East and Carne West Swamp reside within the Project Application Area of the adjacent Springvale Mine. The location of the NPSS (green) and NPHS (yellow) are noted in **Figure 10.3** and **Figure 10.4**.

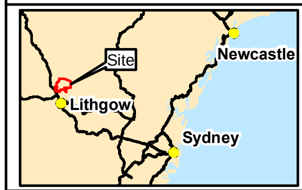
From **Figure 10.3** and **Figure 10.4**, there is a clear association between the occurrence of shrub swamps and the presence of the claystones of the Burralow Formation. This association is also present with respect to Tri-Star, Twin Gully and Trail Six (Japan) Swamp. Topographically, streambed profiles of NPSS are of the order of 2 to 5%. In contrast, the Banks Wall Sandstone is deeply incised, forming the cliff-faces and gorges of the Wolgan Valley.

Conceptually, it is apparent that the NPSS and NPHS are associated with a perched groundwater system and unrelated to the shallow groundwater system of the Banks Wall Sandstone below or the deep groundwater system at depth, within which the coal measures reside and mining occurs.

Existing mining operations comprise longwall mining of the Lithgow Seam at a depth of 300 m to 420 m beneath the Newnes Plateau. A conceptual hydrogeological and hydrological model of the Project Application Area is illustrated in **Figure 10.5** and shows the influence of longwall mining on the overlying geology and the effect this can have on the hydraulic mechanisms that govern groundwater flow. Regional groundwater flow is to the northeast toward the Wolgan Valley, consistent with the regional dip of the target coal seams.

In contrast, the perched aquifer system reflects the local surface topography, eventually discharging to rivers and creeks of the Wolgan River and Coxs River.





LEGEND

- Burralow Isopatch
- Hanging Swamp
- Shrub Swamp
- Burralow Aquitard

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F063 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.3: Correlation between the Occurrence of Shrub Swamp, Hanging Swamps and Burralow Formation Claystones. – Narrow Swamp and East Wolgan Swamp.

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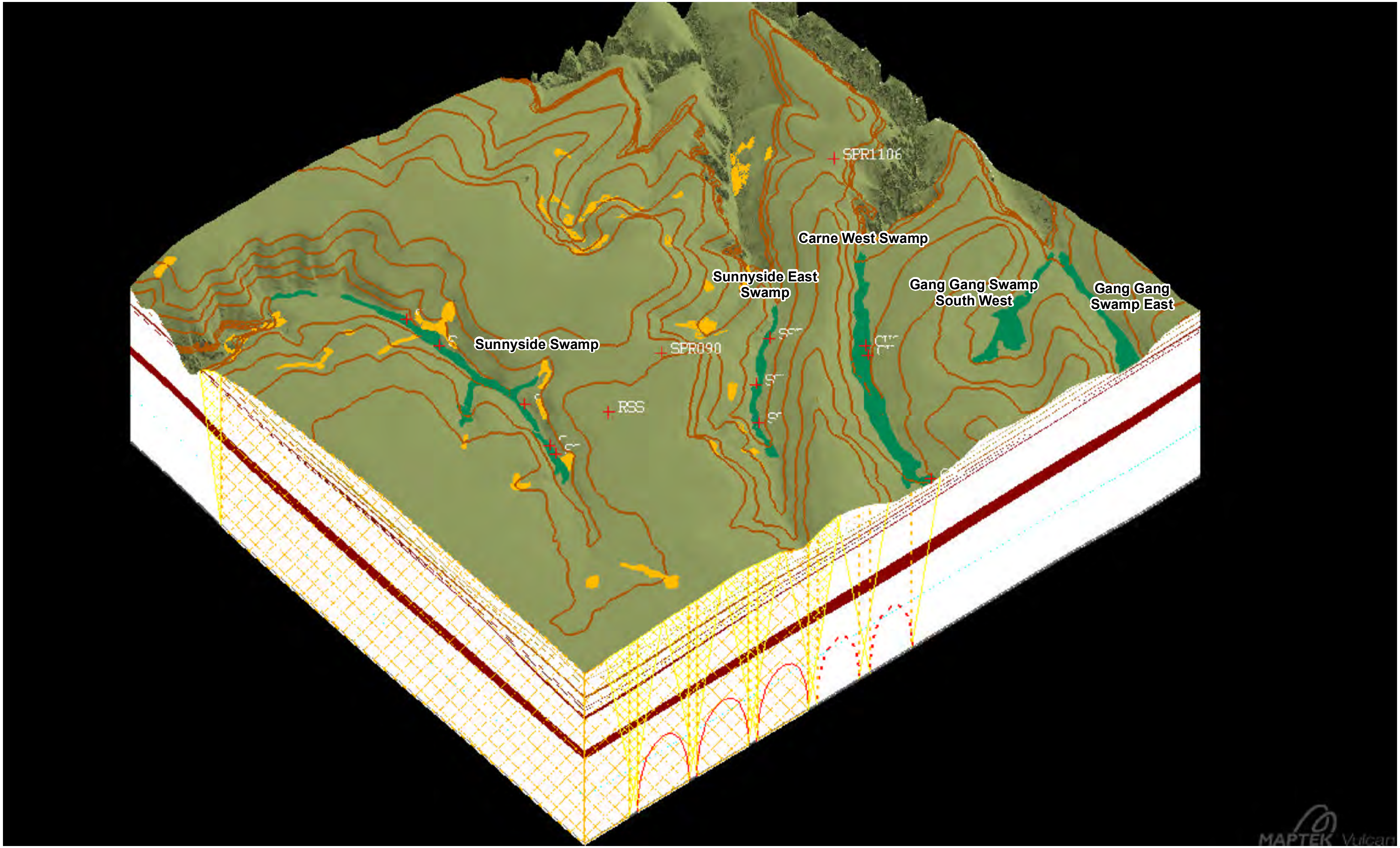
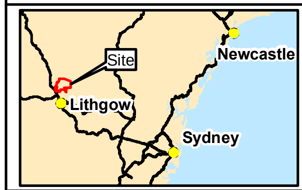




LEGEND

- Burralow Isopatch
- Hanging Swamp
- Shrub Swamp
- Burralow Aquitard

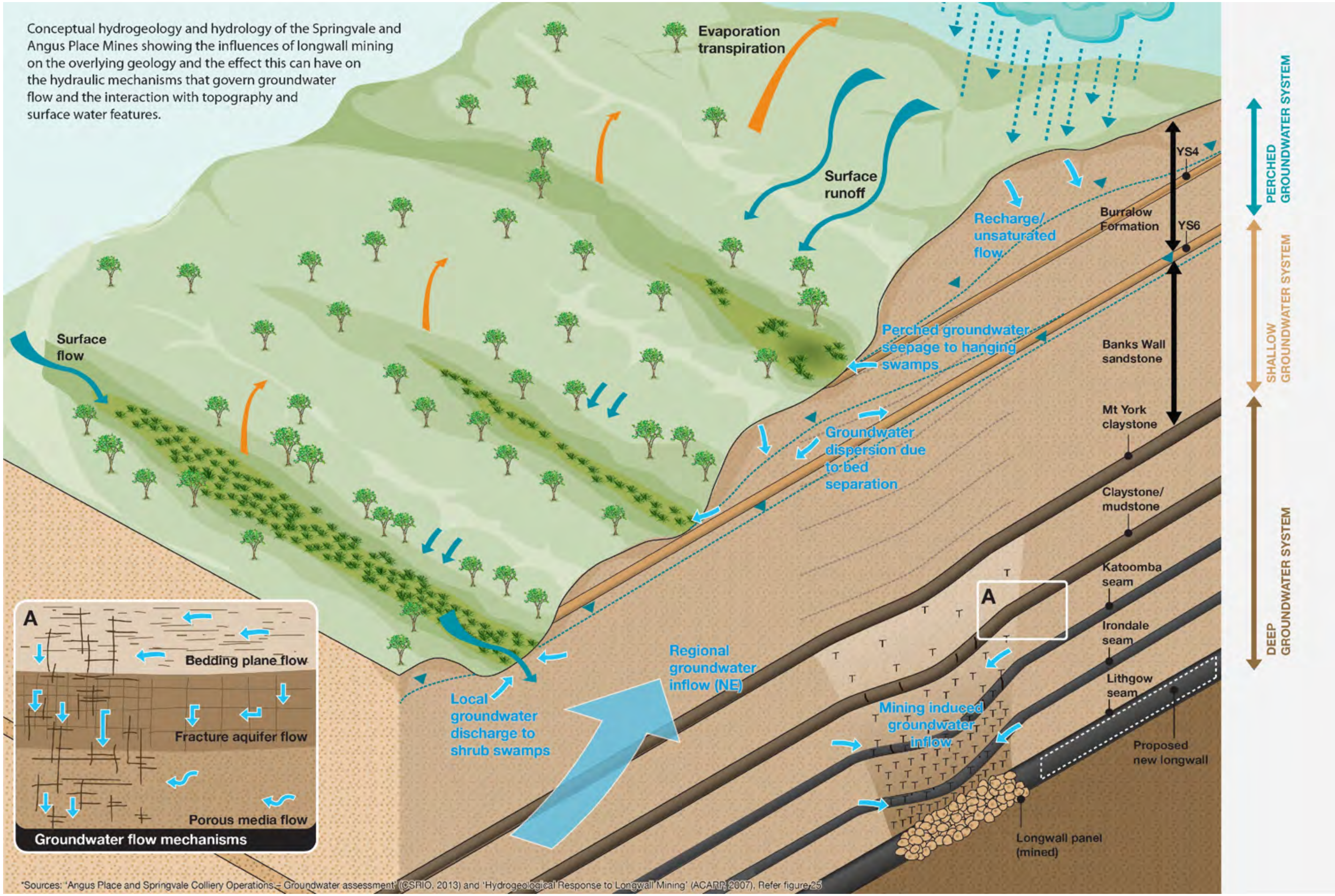
DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F064 APC Rev 0
SCALE	NOT TO SCALE

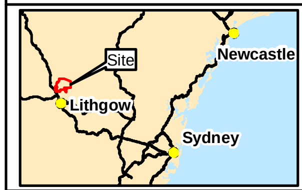
Figure 10.4:
Correlation between the Occurrence of Shrub Swamp, Hanging Swamps and Burralow Formation Claystones.
– Sunnyside Swamp, Sunnyside East Swamp and Carne West Swamp.

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 64 | A4





Source:
RPS October 2013

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F084 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.5:
Conceptual Hydrogeology and Hydrology of the Angus Place Region

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Centennial Coal
Angus Place

DRG No. 84

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10.2.2.3 Water Sharing Plans and Licensing

The Project resides within the Water Sharing Plan of the Greater Metropolitan Region Groundwater Source and the Project Application Area is divided by the Sydney Basin Coxs River and Sydney Basin Richmond management zones. Groundwater modelling (CSIRO 2013) indicates there is groundwater inflow from both the Sydney Basin Coxs River and the Sydney Basin Richmond Management Zones and therefore Water Access Licences (WALs) will be required from both sources. There are limitations in trading between management zones and therefore separate licences for each will be required.

In terms of the NSW Aquifer Interference Policy, the Sydney Basin Coxs River is classified as a Less Productive Groundwater Source and the Sydney Basin Richmond is classified as a Highly Productive Groundwater Source (NSW Office of Water, 2013). The water sources are both Porous Rock Water Sources, due to being predominantly of sedimentary origin (sandstone, siltstone and claystone).

10.2.2.4 Existing Monitoring Network and Overview

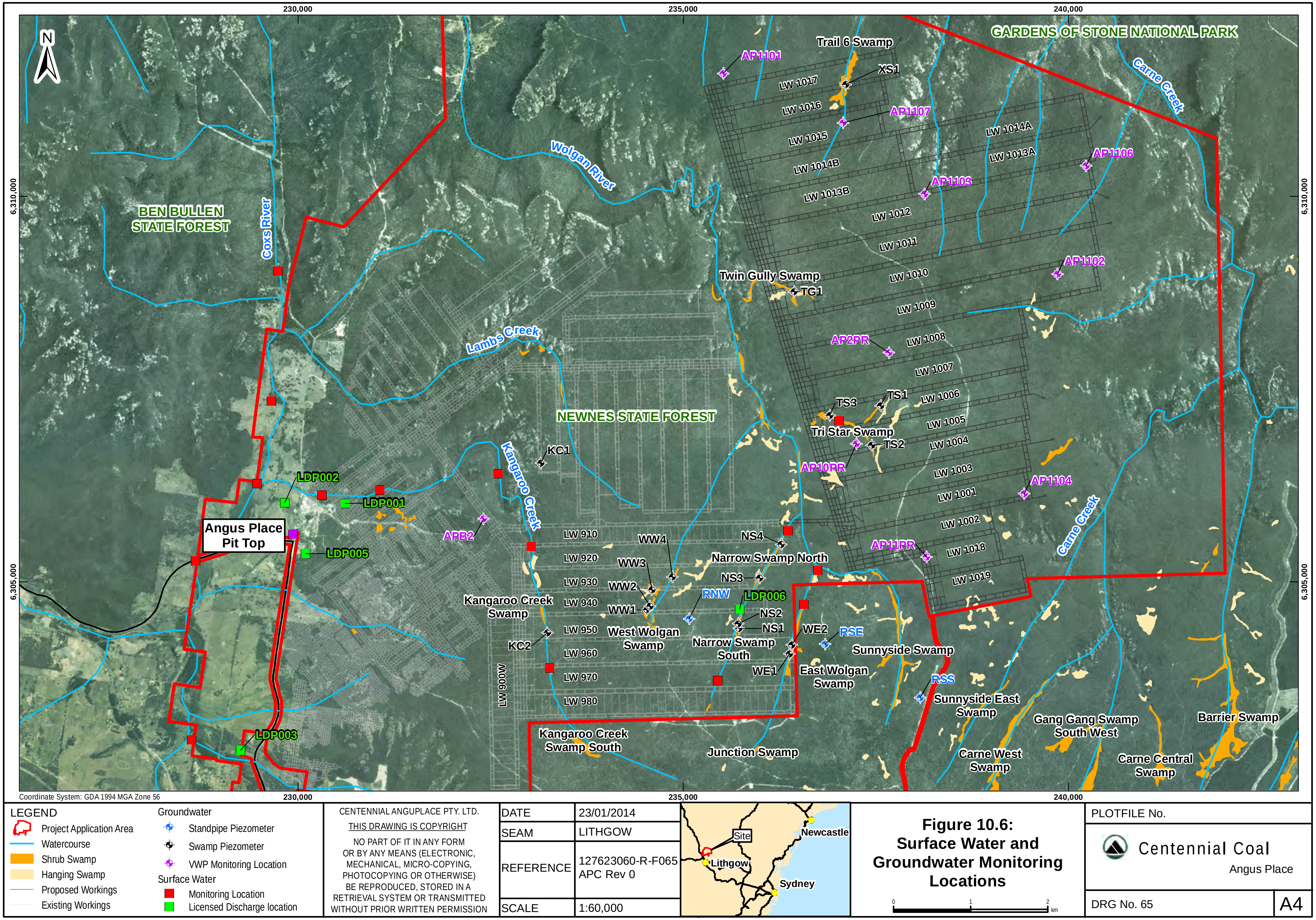
Surface Water

Extensive hydrological modelling has been undertaken across the Project Application Area since operations commenced at Angus Place. Monitoring comprises flow and quality and include licensed discharge points, watercourses (upstream and downstream of points of discharge) and on-going monitoring at swamps on the Newnes Plateau, for the purpose of providing baseline data.

Surface water monitoring at LDPs is undertaken in accordance with the conditions contained within EPL 467 and results of the monitoring are reported on an annual basis to the EPA via the EPA Annual Return. An overview of surface water monitoring is provided in **Table 10.1** and **Figure 10.6**.

Table 10.1 Surface Water Monitoring Programme across the Project Application Area

Watercourse Monitoring Location	Quality	Flow
Rivers		
Coxs River Far U/S	×	
Coxs River U/S	×	×
Coxs River confluence with Kangaroo Creek	×	
Coxs River D/S	×	×
Kangaroo Creek D/S National Park	×	×
Kangaroo Creek U/S	×	×
Kangaroo Creek D/S	×	×
Lambs Creek	×	
Wolgan River		×
Kangaroo Creek Weir 1		×
Swamps		
Narrow Swamp Weir 1 (NSW1)		×
Narrow Swamp Weir 2 (NSW2)		×
Tri-Star Swamp	×	×
Twin Gully	×	×
LDPs		
LDP001	×	×
LDP002	×	×
LDP005		



DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F065 APC Rev 0
SCALE	1:60,000

Figure 10.6: Surface Water and Groundwater Monitoring Locations

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Surface water monitoring indicates that the majority of flow in the Coxs River catchment is derived from discharge from Angus Place as well as other mining operations in the Coxs River catchment. These discharges provide a significant proportion of inflows to Lake Wallace and Lake Lyell further downstream. These water supply reservoirs are required to meet water demand at Wallerawang Power Station and Mount Piper Power Station respectively.

Water quality in the Coxs River is generally fresh. Station No. NSW Office of Water 212054 has a mean salinity of 600µS/cm and mean salinity at Station No. Coxs River U/S is 600µS/cm and pH is 7.7. Water quality is generally consistent with the Australian Drinking Water Guidelines, including salinity.

Current water quality in the Coxs River is also consistent with ANZECC 95% guidelines, with the exception of salinity, Nitrogen and Zinc (Nitrogen and Zinc being marginally higher than the default trigger values). The ANZECC guidance value for salinity is 350µS/cm.

Discharge water quality at Angus PlaceLDP001 has a pH of 7.8, with mean salinity of 1,000µS/cm. This is consistent with the ADWG, with salinity in the range of 600 to 900mg/L (~895 to 1,350µS/cm, assuming a 0.67 conversion factor) being classified as fair drinking water quality in the ADWG. Good quality drinking water is classified as having Total Dissolved Solids of <600mg/L (~895µS/cm). This is relevant given the Coxs River is a sub-catchment of Lake Burragorang, the water supply for the City of Sydney, however, there is limited discharge from Lake Lyell as water is largely extracted to meet demand at Mount Piper Power Station via Thompsons Creek Dam.

Surface water flow in swamps on the Newnes Plateau is highly variable and local water quality is affected by natural drying and wetting cycles of these ecosystems but is generally very good.

Groundwater Levels

Groundwater levels are monitored in the swamps, and in the shallow and deep groundwater systems. Monitoring locations are illustrated in **Figure 10.36** with further details provided in the Groundwater Impact Assessment (RPS, 2013a).

Monitoring consists of both standpipe piezometers and Vibrating Wire Piezometers (VWPs). Groundwater level monitoring indicates there is a vertically downward hydraulic gradient from local aquifers in the Burralow Formation to the Illawarra Coal Measures, with significant difference in hydraulic head across aquitards units.

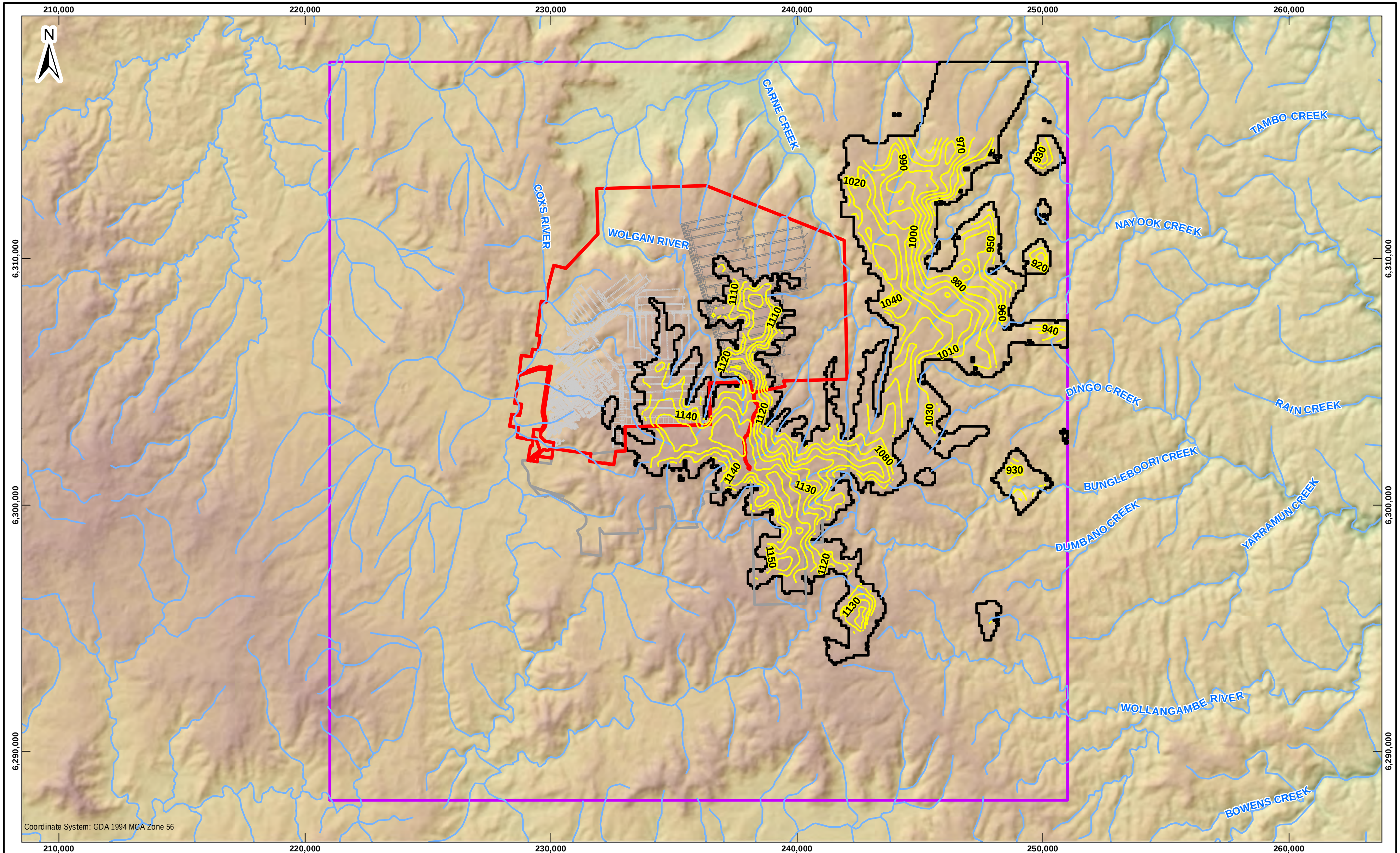
In general, regional hydraulic gradient is to the northeast, discharging to the cliff-faces of the Wolgan Valley.

As presented in **Chapter 8.0**, the key findings of the swamp groundwater level monitoring programme (perched groundwater system) is that similar water level trends are monitored in the swamps that have been undermined by current longwall mining and the swamps that have not yet been undermined. The only subsidence-related influence to water level variations that has been identified in the swamps that have been undermined were at East Wolgan Swamp and Kangaroo Creek Swamp. Details of impacts to Kangaroo Creek Swamp and East Wolgan Swamp are presented in **Section 2.6.2**. Contributing factors to the identified anomalous subsidence at East Wolgan Swamp are presented in **Chapter 8.0**.

Figure 10.7 presents the modelled current water table level within the perched aquifer system. Monitoring in the shallow groundwater system has been ongoing since December 2005 and includes vibrating wire piezometers (VWP) installed since November 2011.

Figure 10.8 presents a north-south cross-section through the Angus Place (LW26N to LW970) and illustrates the modelled existing conditions. It is noted that there is a modelled decline in water table level beneath topographic ridges. Monitoring of ridge piezometers as shown on **Figure 10.10** demonstrates that this does not occur. As will be explained further in **Section 10.2.3.1**, a decline in water table level is due to the assumed RAMP function applied in the model and is a conservative assumption.

Figure 10.10 presents a time-series observation of potentiometric levels along a series of piezometers that are installed on topographic ridges from Narrow Swamp in the west, through East Wolgan Swamp and Sunnyside Swamp to Carne West Swamp in the east. From, there is minimal change in potentiometric level with time and observed fluctuations are correlated with cumulative rainfall deviation.



LEGEND

- Angus Place Project Application Area
- Springvale Project Application Area
- Predicted Groundwater Level (mAHD)
- Watercourse
- Extent of AQ6
- CSIRO Model Boundary
- Proposed Workings
- Existing Workings

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DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F066 APC Rev 0
SCALE	1:200,000

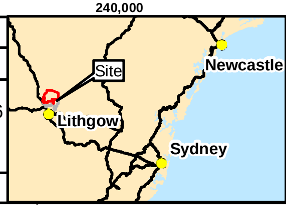


Figure 10.7: Modelled Groundwater Level within the Burralow Formation (Aquifer Unit AQ6)

0 1 2 3 4 5 km

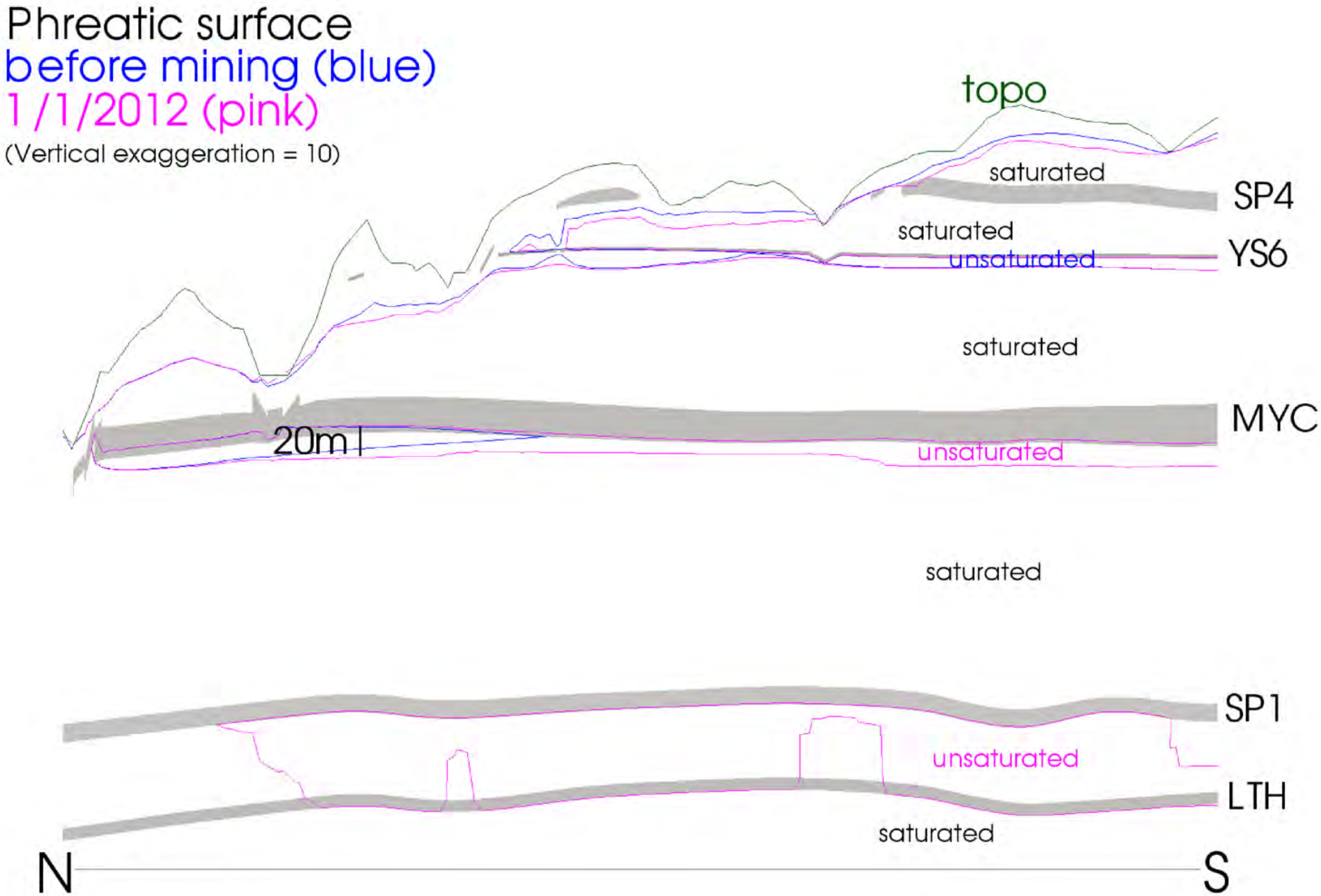
PLOTFILE No.

Centennial Coal

Angus Place

DRG No. 66

A4



Source: RPS October 2013	CENTENNIAL ANGUSPLACE PTY. LTD. THIS DRAWING IS COPYRIGHT NO PART OF IT IN ANY FORM OR BY ANY MEANS (ELECTRONIC, MECHANICAL, MICRO-COPYING, PHOTOCOPYING OR OTHERWISE) BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED WITHOUT PRIOR WRITTEN PERMISSION	DATE	23/01/2014	**Figure 10.8: Predicted Phreatic Surface Cross-Section: LW26N to LW970 - Current Conditions (CSIRO, 2013)**	PLOTFILE No.
		SEAM	LITHGOW		Centennial Coal Angus Place
		REFERENCE	127623060-R-F067 APC Rev 0		
		SCALE	NOT TO SCALE		DRG No. 67 A4

As part of the network of deep monitoring locations across the Project Application Area, a number of fully grouted VWPs have been installed into the horizons underlying the Mount York Claystone. These monitor pore water pressure in the aquifer units overlying the Mount York Claystone and in the deeper aquifer units underlying the Mount York Claystone.

Current and historical mining of the Lithgow Seam (and other coal seams) in the Project Area has resulted in significant dewatering and depressurisation in the coal measures underlying the Mount York Claystone.

Localised changes to groundwater flow direction due to dewatering extraction can be observed within the Project Application Area. **Figure 10.9** presents the modelled current potentiometric level in the Lithgow Seam. It is noted that the Lithgow Seam outcrops to the Wolgan Valley.

Figure 10.10 presents time-varying pressure response in VWPs at Angus Place. From **Figure 10.10**, piezometric pressures measured above the Mount York Claystone fall on or close to a hydrostatic line (45 degree) indicating that the saturated sequence is hydraulically connected and in a state of equilibrium. In **Figure 10.10** below the Mount York Claystone, there are variable potentiometric levels indicating significant depressurisation.

Groundwater Quality

Groundwater quality from the perched groundwater system upon which the TPHSS ecosystems reside can be described as very fresh, with pH from swamp monitoring piezometers ranging between 4.5 – 6.5, reflecting acid conditions associated with natural wetting and drying processes. EC is very low, in general, and ranges between 30 and 100µS/cm.

Groundwater quality of the deep system is described as fresh with pH in the order of 7.2 and EC ranging between 610 and 940µS/cm and is Na-HCO_3 type water.

10.2.3 Water Management Impact Assessment

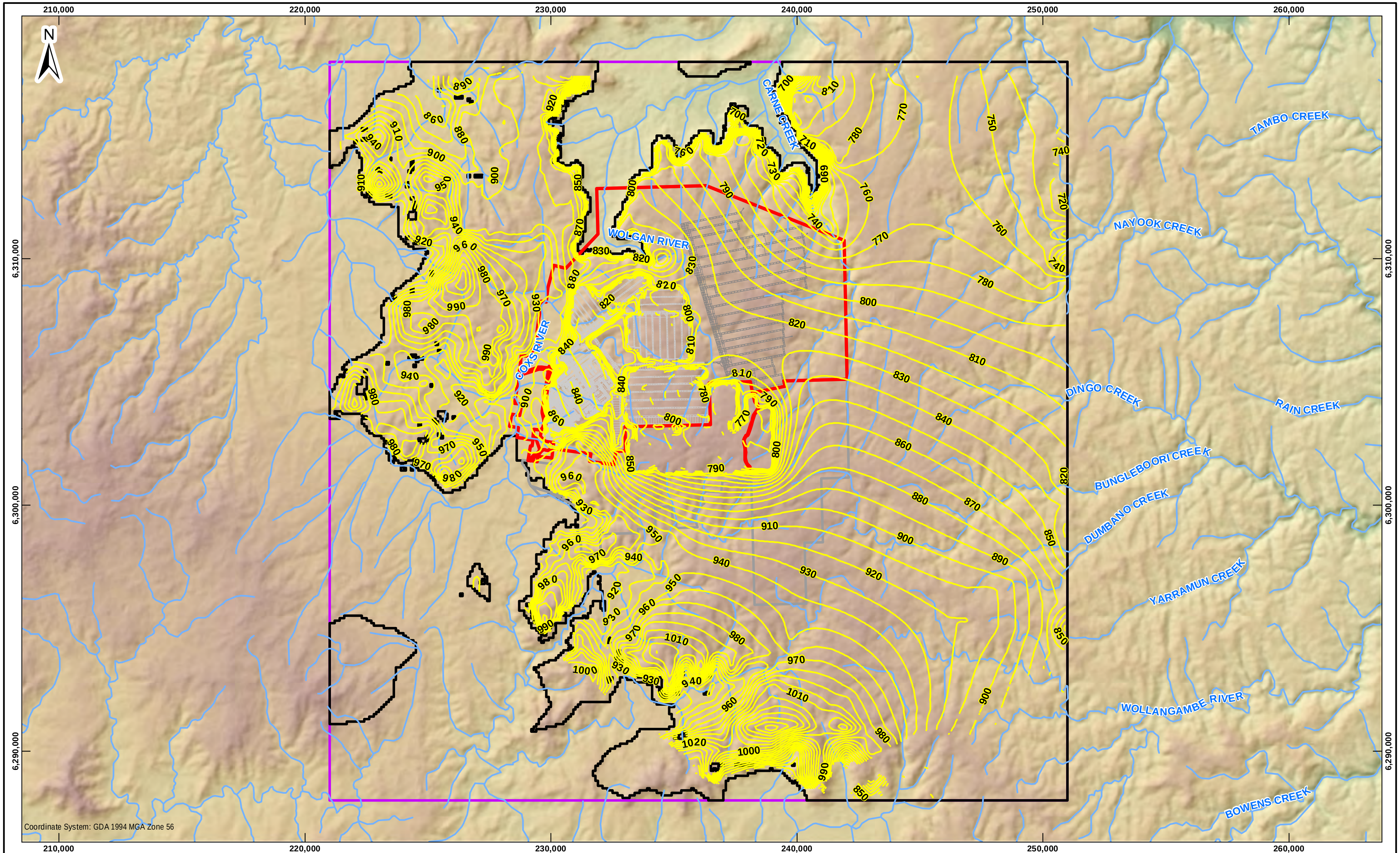
Section 10.2.2 has set out the existing water environment at the site and it is evident that past mining has had an impact on the deep groundwater system at Angus Place and minimal impact on the shallow and perched aquifers, swamps and surface water courses.

As detailed in **Chapter 4.0** the water management strategy of the extension of operations at Angus Place does not include discharge to the Newnes Plateau and therefore the potential impacts are limited to subsidence related effects and potential change in groundwater contribution to local perched aquifers. The mine planning and design process has also eliminated many of the potential adverse impacts on water systems and THPSS in the Project area, as identified early in the risk management process.

The key aspects of the Project which may continue to impact on water systems include;

- Subsurface subsidence impacts due to longwall mining, and associated deformations and permeability changes, however, with limited impact to surface horizons including swamps;
- Depressurisation of coal seam aquifers, dewatering and consequent baseflow contributions to surface water courses and swamps;
- Increased volumes of mine water make from on-going depressurisation below the Mount York Claystone; and
- The construction of infrastructure (dewatering bores, mine services bores and ventilation bores), to support the mining process. This will also involve the construction of access tracks and pipeline burial for conveying water and power.

Each of these impacts can have direct consequences on ecosystem functionality, water supply, downstream flow, visual amenity and aquifer resources. The consequences of each of these principal impacts on the water systems across the site together with subsequent impacts of other environmental components is presented in **Section 10.2.4**.



LEGEND
- Angus Place Project Application Area
- Springvale Project Application Area
- Predicted Groundwater Level (mAHD)
- Watercourse
- Extent of LTH
- CSIRO Model Boundary
- Proposed Workings
- Existing Workings

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F068 APC Rev 0
SCALE	1:200,000

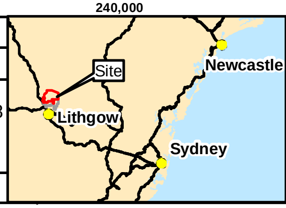


Figure 10.9: Modelled Groundwater Level within the Lithgow Seam (Aquifer Unit LTH)

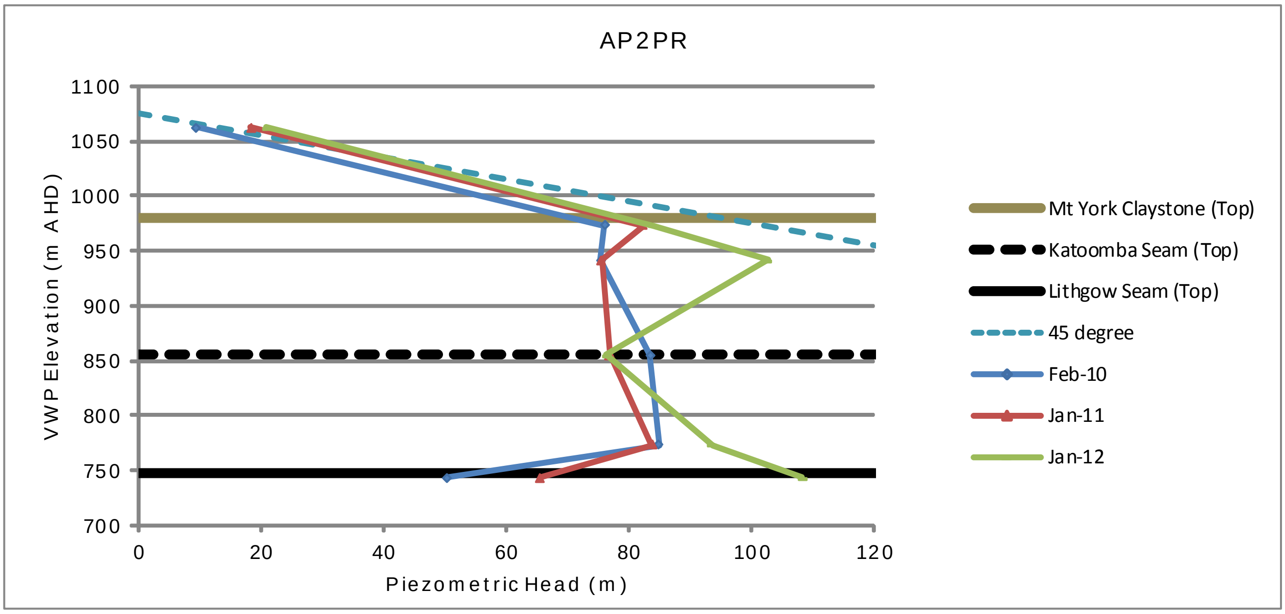
0 1 2 3 4 5 km

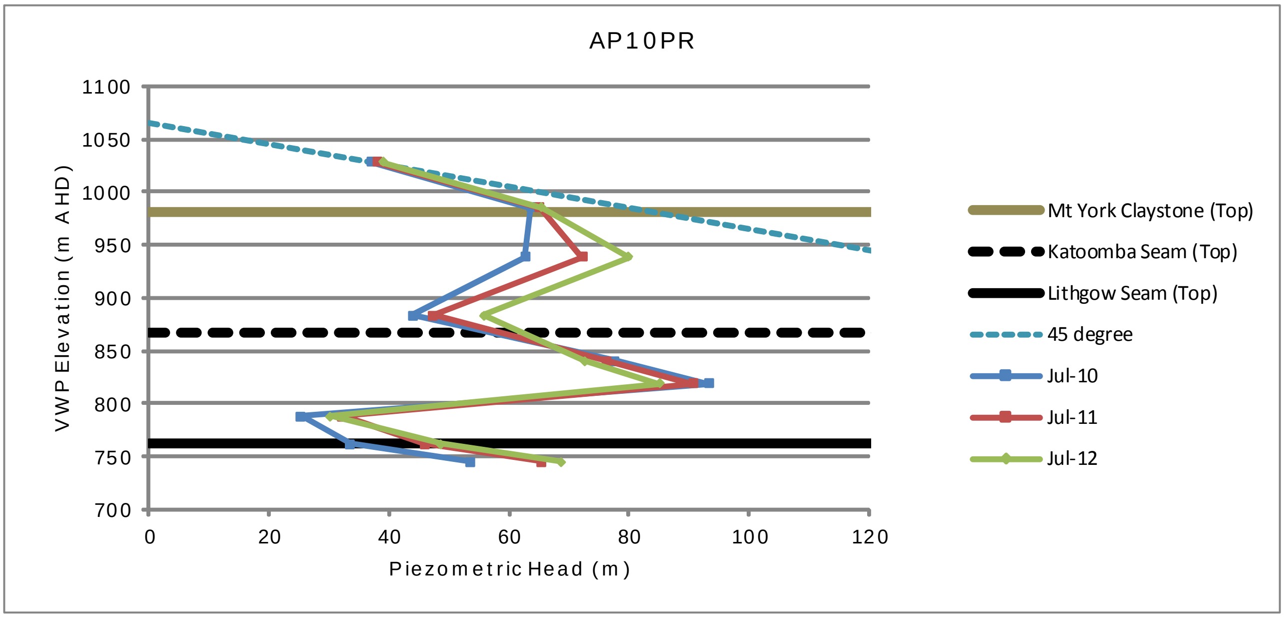
PLOTFILE No.

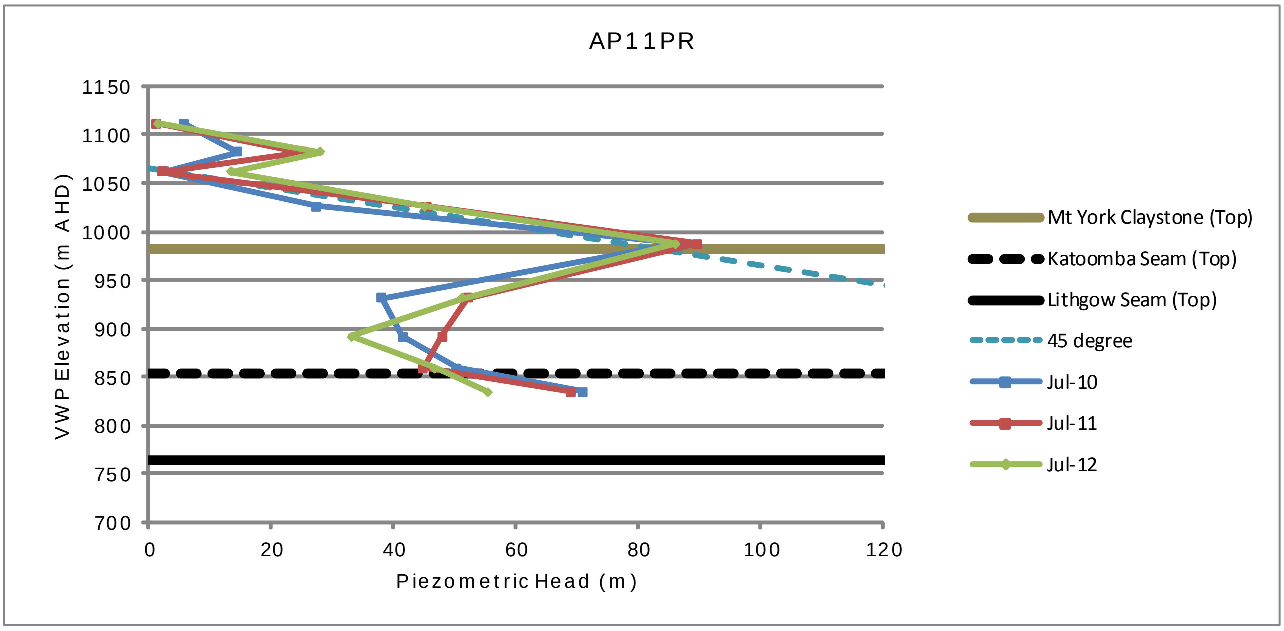
Centennial Coal
Angus Place

DRG No. 68

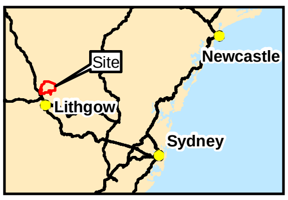
A4







Source: RPS October 2013.



CENTENNIAL ANGUSPLACE PTY. LTD.

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F069 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.10: Time Varying Piezometric Profiles at Angus Place

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 69 | A4

10.2.3.1 Groundwater Assessment

Groundwater Flow and Groundwater Levels

A groundwater model has been prepared of the Newnes Plateau and surrounding hydrogeological environment. This model was first developed by the CSIRO in 2004 using their COSFLOW modelling code between 2004 and 2013. The groundwater model comprises the local geology of the Newnes Plateau and also the surrounding area including the Wolgan Valley. Surface water features such as the Coxs River and primary THPSS are also included. COSFLOW is a finite element solution, implicit, of the groundwater flow equation (Richard's equation) and can simulate both saturated and unsaturated conditions.

The model commenced development in 2004 at the adjacent project at Springvale Mine and has been extended to provide the basis for impact assessment of the extension of mining at Angus Place and the adjacent project at Springvale on groundwater level and flow in the deep, shallow and perched aquifer systems. The COSFLOW model also includes a time-varying RAMP function to account for changes to aquifer characteristics due to mining-induced subsidence. The RAMP function is also height dependent, with decreasing change to aquifer properties with increasing height above the extracted coal seam.

Details as to the calibration of the model and model setup are presented in the Groundwater Assessment (RPS, 2013a). It is noted that all surrounding mine operations have been included in the groundwater model to account for the requirement under the NSW Aquifer Interference Policy of Cumulative Impact Assessment.

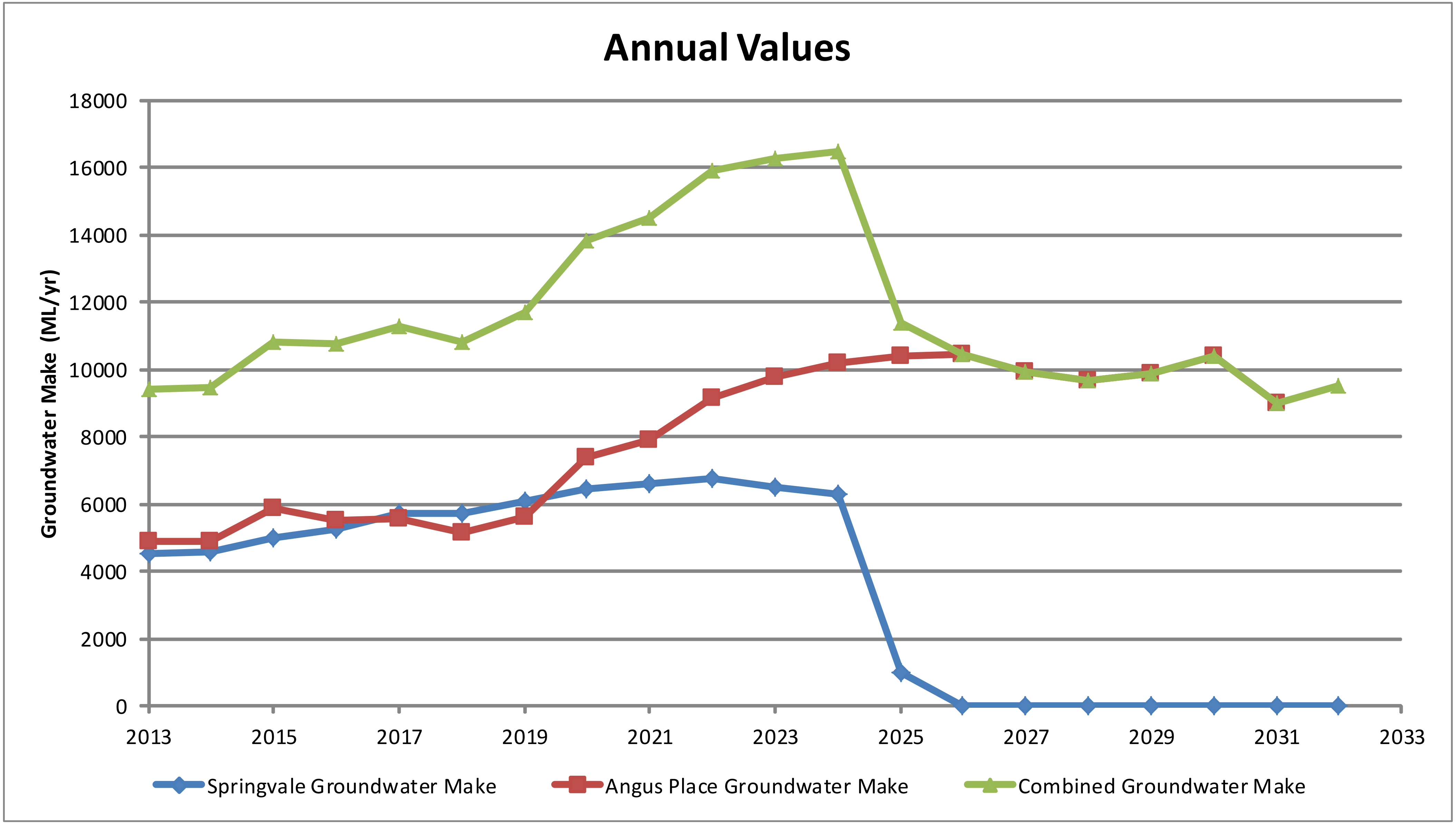
Modelling indicates that extension of the Angus Place Colliery will lead to an increase in dewatering requirements and groundwater inflow to underground workings from ~150L/s (13ML/d or 4,750ML/y) at present (2013) to a peak of ~350L/s (29 ML/d or 10,600 ML/y) in 2026. Following 2032, dewatering at Angus Place Colliery will cease and groundwater level recovery will commence. **Figure 10.11** presents the predicted mine water make at Angus Place Colliery as well as the adjacent project at Springvale Mine.

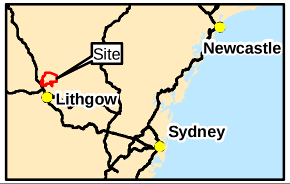
Model results indicate there is significant depressurisation of the Illawarra Coal Measures and aquifers underlying the Mount York Claystone, however, there is limited upward propagation of depressurisation above this layer due to desaturation of the Burra-Moko Head Sandstone (AQ3). Upward propagation of depressurisation above the Mount York Claystone is limited further by the identified low permeability 'plies' within the Burralow Formation.

Figure 10.12 presents the modelled drawdown in the Lithgow Seam at the end of mining in 2032. It is noted that the numerical groundwater model assumed both Angus Place and Springvale would continue dewatering until 2032, whereas Springvale Mine will actually cease dewatering in 2025. This is a conservative assumption.

Figure 10.13 presents the modelled phreatic surface in cross-section through the Angus Place Colliery. This is an equivalent section to that presented in **Figure 10.8**.

Modelled drawdown indicates that there is minimal impact on surrounding groundwater users and groundwater works identified within the Project Application Area that have a cumulative impact of more than 2 m are not used for water supply purposes. This is compliant with Level 1 Minimum Harm Criteria of the NSW Aquifer Interference Policy for Porous Rock Water Sources.





Source:
RPS October 2013

CENTENNIAL ANGUSPLACE PTY. LTD.

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F070 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.11:
Modelled Mine Water Make
in the Site Water Balance

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 70

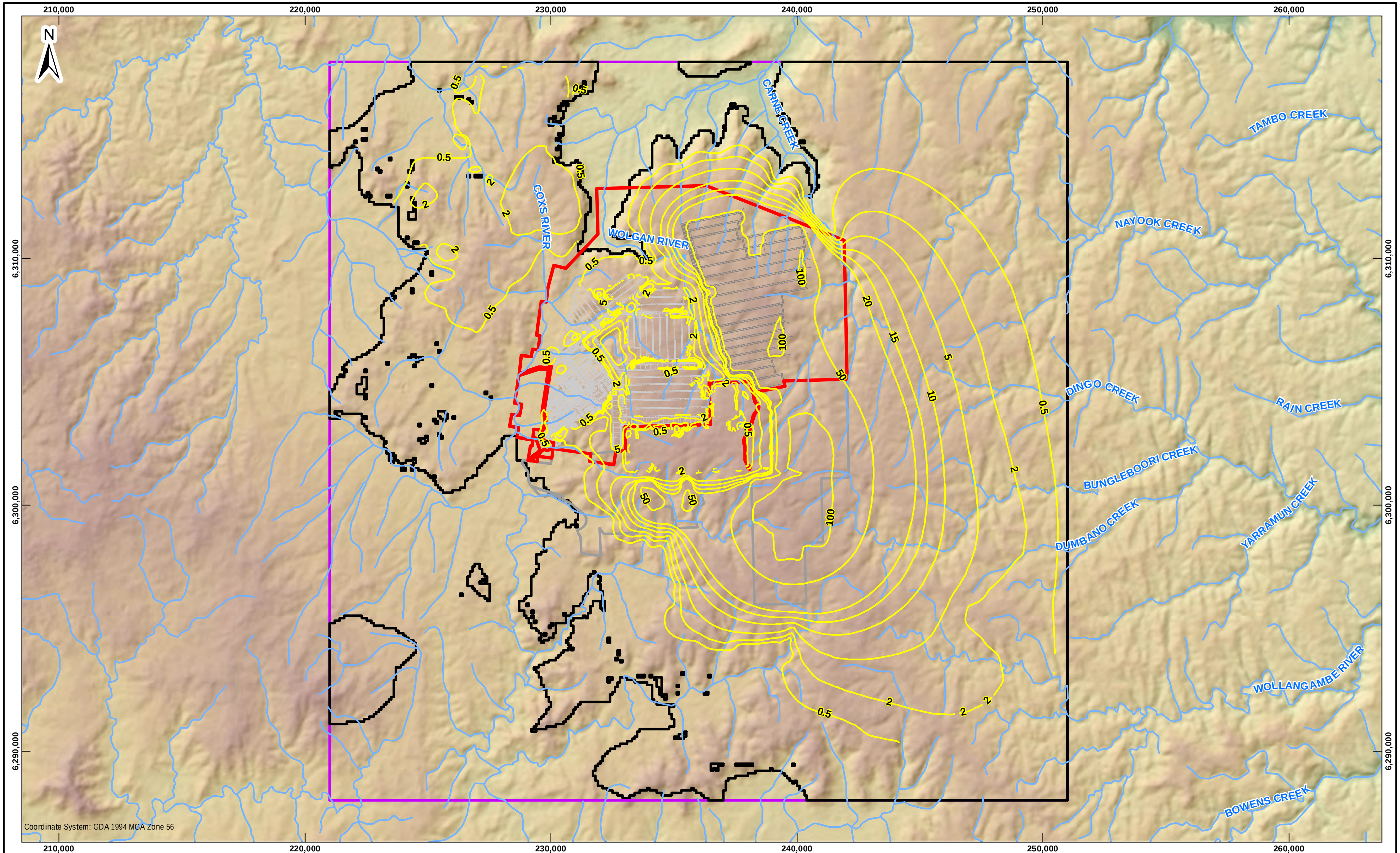
A4

Modelled change in water table level indicates there is not a more than 10% cumulative variation within 40m of high priority groundwater dependent ecosystems (GDEs). For the purpose of this impact assessment, THPSS have been considered to be high priority GDEs, despite not explicitly being listed in the current revision of the Water Sharing Plan. The model adopted was conservative and has assumed that the RAMP function, which accounts for change in hydraulic properties of aquifers and aquitards above the extracted coal seam, leads to subsidence derived dilation of horizontal permeability at surface. This assumption has led to model predictions of increased baseflow to some TPHSS on the Newnes Plateau due to increased horizontal flow from beneath topographic ridges adjacent the local valleys. This is a conservative assumption as it also provides the opportunity for upward propagation of the effect of depressurisation in the deep groundwater system.

Figure 10.14 presents the modelled drawdown in Burralow Formation, AQ6 at the end of mining in 2032. From **Figure 10.14**, there is a drawdown of 5 to 15m below the topographic ridges on either side of the NPSS and NPHS, however, is a conservative prediction. The predicted water table decline beneath shrub swamps themselves is <0.5 m. The greatest water level declines are predicted to occur beneath the upper reaches of the swamps where the swamps are generally above the water table and not reliant on groundwater. Monitoring indicates that this has not occurred.

Modelling indicates that the effect to depressurisation does not reach the perched aquifer system as presented in **Figure 10.13**. Model results are consistent with the conceptual hydrogeological model that the perched and shallow groundwater system, upon which the THPSS reside, are hydraulically independent from groundwater extraction at depth, primarily due to the Burra-Moko Head Sandstone, which is located below the Mount York Claystone, becoming unsaturated.

Table 10.2 presents the calculated change in baseflow contribution to variation Newnes Plateau Swamps. It is noted that there is no predicted impact to the Coxs River. The results presented in **Table 10.2** are the 'Base Case' results. It is also noted that baseflow contributions presented in **Table 10.2** have been rounded to one decimal place since the potential limit of accuracy of what could reasonably be observed is of the order of 0.1 ML/d (0.001 m^3/s).



LEGEND

- Angus Place Project Application Area
- Springvale Project Application Area
- Predicted Drawdown (m)
- Watercourse
- Extent of LTH
- CSIRO Model Boundary
- Proposed Workings
- Existing Workings

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F071 APC Rev 0
SCALE	1:200,000

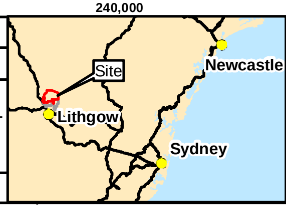


Figure 10.12: Modelled Drawdown within the Lithgow Seam (Aquifer Unit LTH) at end of Mining in 2032

0 1 2 3 4 5 km

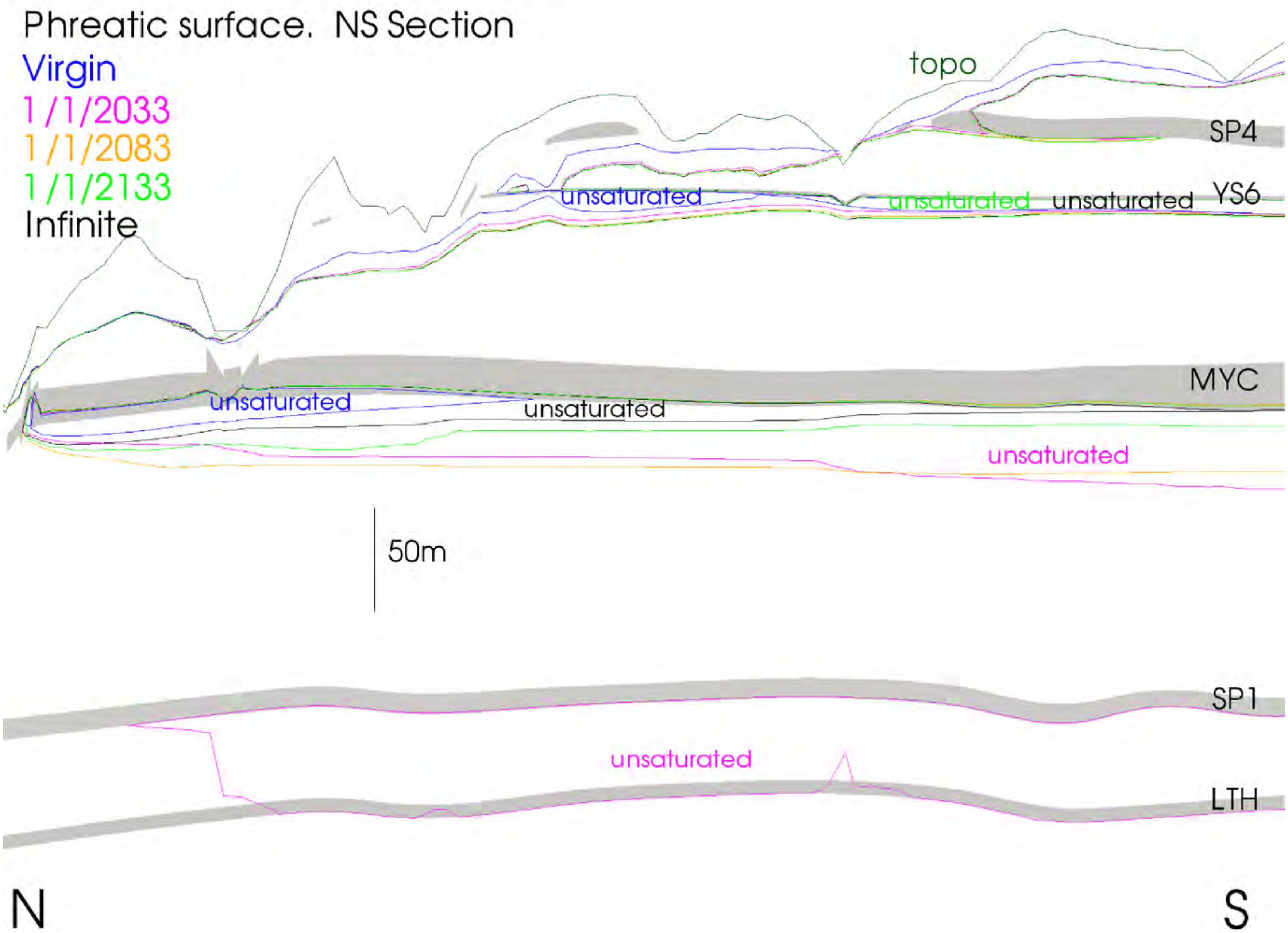
PLOTFILE No.

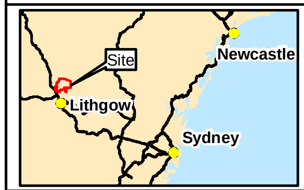
Centennial Coal

Angus Place

DRG No. 71

A4





Source:
RPS October 2013

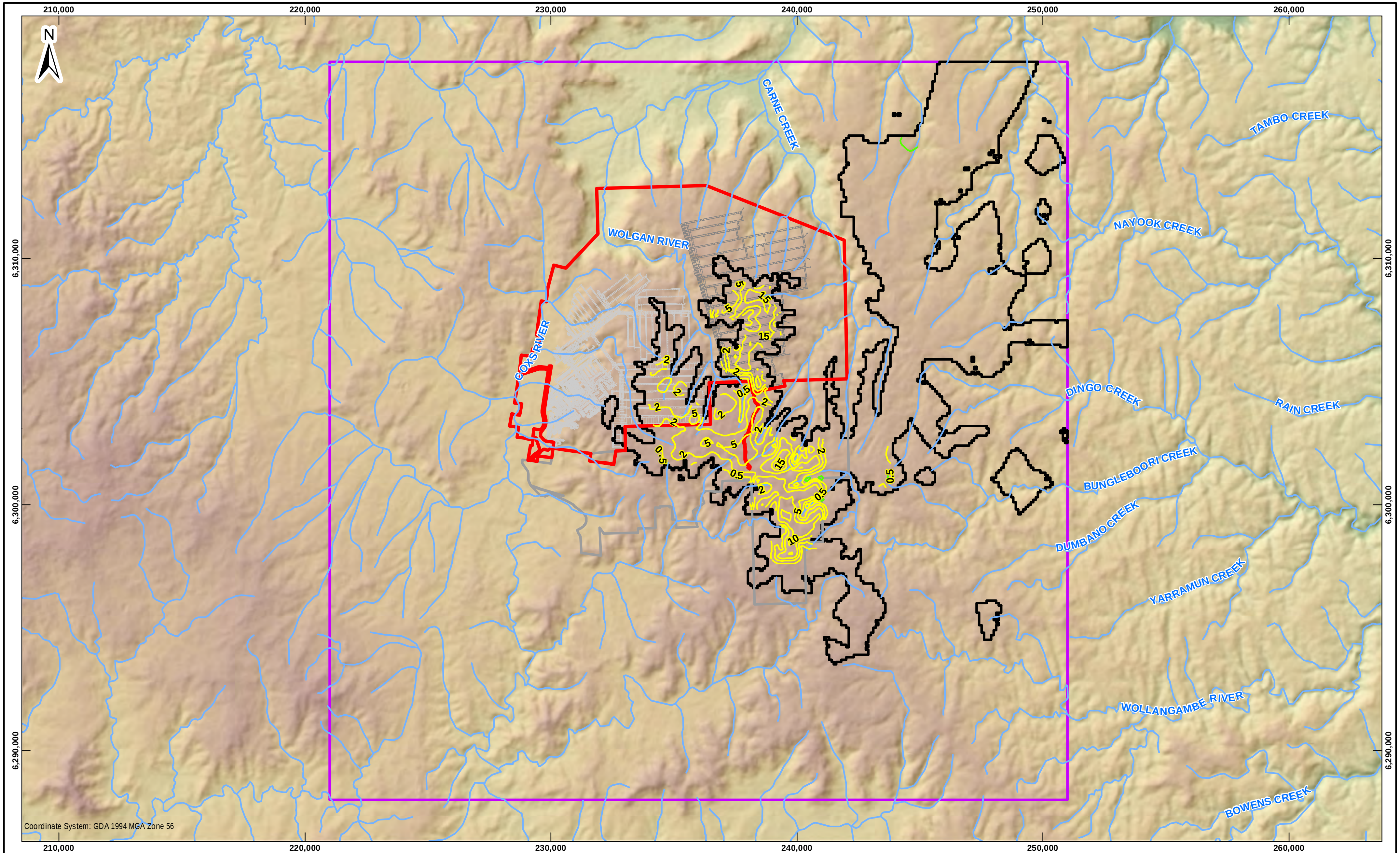
DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F072 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.13: Predicted Phreatic Surface Cross-Section: LW26N to LW970 - Proposed Conditions (CSIRO, 2013)

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 72 | A4



LEGEND
- Angus Place Project Application Area
- Springvale Project Application Area
- Predicted Drawdown (m)
- Predicted Recovery (m)
- Watercourse
- Extent of AQ6
- CSIRO Model Boundary
- Proposed Workings
- Existing Workings

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F073 APC Rev 0
SCALE	1:200,000

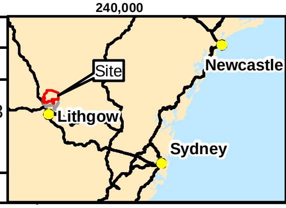


Figure 10.14: Modelled Drawdown within the Burralow Formation (Aquifer Unit AQ6) at end of Mining in 2032

0 1 2 3 4 5 km

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 73

A4

Table 10.2 Predicted Change to Baseflow Contribution (Base Case Simulation)

Surface Water Feature	Baseline (ML/d)	Difference at End of Mining (ML/d) – Angus Place Only	Difference at End of Mining (ML/d) – Cumulative	Residual Difference at 100 yr Post-Mining (ML/d) - Cumulative
Carne Creek Reach CA1	4.6	-0.1	-0.1	+0.4
Carne Creek Reach CA2 (incorporates the lower reach of Carne Central Swamp)	1.2	-0.3	-0.3	-0.2
Carne Creek Reach CA5 (incorporates Sunnyside central Swamp)	0.2	-0.1	-0.2	-0.2
Carne Creek Total	6.1	-0.5	-0.6	-0.1
Sunnyside Swamp	0.1	-0.0	-0.0	-0.0
Tri-Star Swamp	0.0	+0.1	+0.1	-0.0
Twin Gully Swamp	0.1	+0.0	+0.0	-0.0
Wolgan River	1.1	-0.2	-0.2	-0.3
Kangaroo Swamp	0.0	+0.0	+0.0	-0.0
Kangaroo Creek Reach KC1	0.1	-0.2	-0.2	-0.2
Kangaroo Creek Reach KC2	0.1	-0.0	-0.0	-0.0

From **Table 10.2**, there are several modelled swamps where groundwater contribution is insignificant and predicted change is of the same order of magnitude as current groundwater contribution.

These swamps are not groundwater dependent and therefore the impact of the change is not significant, despite being a large change when considered on a percent basis.

As indicated in the Groundwater Impact Assessment and in the Executive Summary of the Technical Appendix prepared by the CSIRO, the ‘Base Case’ predictions have adopted a quite conservative assumption in regard to mining-induced changes to permeability of strata overlying the proposed longwalls. As presented in the Groundwater Impact Assessment, the ‘Truncated Ramp 2’ results, which adopt the same assumed change in permeability as ‘Base Case’ to 230m above the longwalls and above 230 m above the longwalls only assume an increase in vertical permeability and not horizontal, are more consistent with the outcomes of the Subsidence Impact Assessment.

Table 10.2b presents the predicted average drop in standing water level in swamps and streams from the commencement of mining from the ‘Truncated Ramp 2’ simulation (extracted from **Table 7.3** of the Groundwater Impact Assessment, which was derived from Table 40 of the CSIRO Technical Appendix).

In **Table 10.2b**, predicted impacts range from 0.001 m to 0.102 m at Carne Central Swamp, with impact of less than 0.05 m considered not to be significant. Predicted head at Carne Central Swamp at start of simulation is 0.436 m above ground surface, therefore predicted decrease to 0.334m (decline of 0.102 m) is still above ground surface.

Table 10.2b Predicted Average Change in Standing Groundwater Levels in Swamps/Streams before, during and after mining (Truncated Ramp 2 Simulation)

Swamps and streams simulated in this study	Predicted average head above the ground surface (m)	Predicted average head drop since 2012 (m)		
		2022	2032	2064
CA2 (includes Carne Central Swamp)	0.436	0.061	0.101	0.102
Carne West Swamp	0.025	-0.001	-0.001	-0.001
Carne Creek Total	0.512	0.017	0.034	0.009
Gang Gang Swamp South East	-0.119	0.046	0.050	0.050
Gang Gang Swamp South	-0.075	0.036	0.042	0.042
Kangaroo Swamp	0.102	0.000	0.000	0.013
Kangaroo Creek (KC1)	-0.073	0.026	0.047	0.015
Kangaroo Creek (KC2)	0.060	-0.004	-0.003	-0.003
Lamb Creek	0.071	0.009	0.020	-0.001
Long Swamp	-0.118	-0.017	-0.017	-0.017
Marrangaroo Creek	0.115	0.004	0.015	0.018
Nine Mile Swamp	0.026	-0.009	-0.009	-0.009
Paddy's Creek	0.115	0.001	0.001	0.001
Pine Swamp	0.083	-0.003	-0.003	-0.003
Tri-Star Swamp	0.087	0.002	0.028	0.049
Twin Gully Swamp	0.124	-0.001	0.003	0.018
Sunnyside Swamp	0.174	-0.007	-0.007	-0.006
Wolgan River Total	0.165	-0.009	0.013	0.030

Details of groundwater licensing requirements are presented in the Groundwater Assessment (RPS, 2013a) and are summarised in **Table 10.3** below. The results presented in **Table 10.3** are the maximum inflow from any year during mining, including post-mining, as applicable.

Table 10.3 Predicted Groundwater Licensing Requirements

	Sydney Basin Coxs River (ML/y)	Sydney Basin Richmond River (ML/y)
Resource:		
LTAAEL	17,108	21,103
Total Licensed Entitlement	6,926	15,923
Basic Landholder Rights	454	1,623
Unassigned Water	9,728	3,557
Predicted Licence Requirement:		
Modelled Maximum Take	1,813 in 2013	9690 in 2033
Current Licences:		
Bore 940 (10BL601854)*	-	2,523
Collector System (10BL601838)*	2,701	-
Total Licences:	2,701	2,523

* Issued under *Water Act 1912* and in the process of being converted under *Water Management Act 2000*.

From **Table 10.3**, the modelled maximum groundwater extraction exceeds the current licence holding at Angus Place with respect to the Sydney Basin Richmond River water source. Modelling indicates that additional groundwater licences will therefore need to be obtained.

Table 10.4 presents the predicted surface water licensing requirement due to localised reduction in baseflow contribution to surface water bodies. The results presented in **Table 10.4** are the maximum in any year and in this case occurs post-mining.

Table 10.4 Predicted Surface Water Licensing Requirements Due to Baseflow Reduction

	Wywandy Management Zone (ML/y)	Colo River Management Zone (ML/y)
Resource:		
Total Licensed Entitlement	273.3	2887.3
Predicted Licence Requirement:		
Modelled Maximum Take	73.8	321.8
Current Licences:		
NIL	-	-
Total Licences:	0	0

From **Table 10.4**, there are no surface water licences currently held by Angus Place. Modelling indicates that additional surface water licences will therefore need to be obtained, based on the conservative groundwater modelling predictions. It is noted that model predictions are an upper bound for licensing requirement due to the conservative assumption in regard to the RAMP function.

Groundwater Quality

Groundwater quality within the deep groundwater system is fresh, with pH of 7.8 and EC of up to 1,100 µS/cm. The beneficial use category of groundwater, in accordance with the NSW Groundwater Quality Policy, is the highest beneficial use of the water source. The highest beneficial use is drinking water supply and accordingly the Project will not lead to a decrease from this beneficial use category.

Groundwater is extracted from the Illawarra Coal Measures and transmitted to the SDWTS and / or used on-site for industrial purposes such as dust suppression, operations of mining machinery and provision of fire suppression reserves or is discharged to the Coxs River via Angus Place LDP001.

Water quality monitoring indicates that there is no significant difference in groundwater quality between that extracted for the purposes of dewatering and that transmitted to the SDWTS and / or discharged to the Coxs River and as such, the Project is consistent with the NSW Aquifer Interference Policy and NSW Groundwater Quality Policy in this regard.

10.2.3.2 Surface Water Assessment

A water balance model has been constructed and calibrated to existing conditions at Angus Place Colliery. The model was developed to represent existing water management infrastructure and includes surface water runoff from both disturbed and undisturbed catchments and also accounts for groundwater inflows to underground workings obtained from the groundwater model described above. Surface runoff was calculated based on the Australian Water Balance Model (AWBM). A regional water balance has also been prepared and includes all mining activities in the Coxs River catchment.

A stochastic modelling approach was adopted using the Monte Carlo module within GoldSIM. Different potential realisations were generated by sampling the 112 year historical rainfall record at different starting times. In this way, the natural climatic variability at the Project site was encapsulated in model predictions. It is noted, however, that dewatering in advance of mining and inflow to underground workings is the dominant component in the water balance by a considerable margin.

Model simulations of existing conditions at Angus Place comprise mean annual discharges:

- 17ML (0.05 ML/d) through Angus Place LDP001 (now 2 ML/d);
- 106ML (0.3 ML/d) through Angus Place LDP002; and
- 3,070ML (8.4 ML/d) transmitted to Springvale’s SDWTS.

It is highlighted that the water balance model was calibrated to discharge in July 2013, which included a period where mine water make was being temporarily held underground (March 2013 – July 2013). Discharge at LDP001 has now resumed at a rate of 2 ML/d.

Under future conditions, groundwater inflows will increase and mean annual discharges at Angus Place in 2022 (the year of maximum contribution from Springvale to SDWTS), will be:

- 2,300 ML (6.3 ML/d) through Angus Place LDP001;
- 106 ML (0.3 ML/d) through Angus Place LDP002; and
- 4,750 ML (13.0 ML/d) transmitted to Springvale’s SDWTS;

In 2030 (the year of maximum groundwater inflow to Angus Place), mean annual discharge will be:

- 17 ML (0.05 ML/d) through Angus Place|LDP001;
- 106 ML (0.3ML/d) through Angus Place|LDP002; and

- 10,457 ML (28.6ML/d) transmitted to Springvale's SDWTS;

As described above, at a later Project stage, the capacity of Springvale's SDWTS will be upgraded from its current capacity of 30 ML/d to 50 ML/d, upstream of Springvale LDP009 via duplication of the existing pipeline network, once combined inflow to Springvale and Angus Place Colliery exceed 30 ML/d.

Under this circumstance, the predicted mean annual discharges in 2022 (year of maximum contribution from Springvale to SDWTS) would comprise:

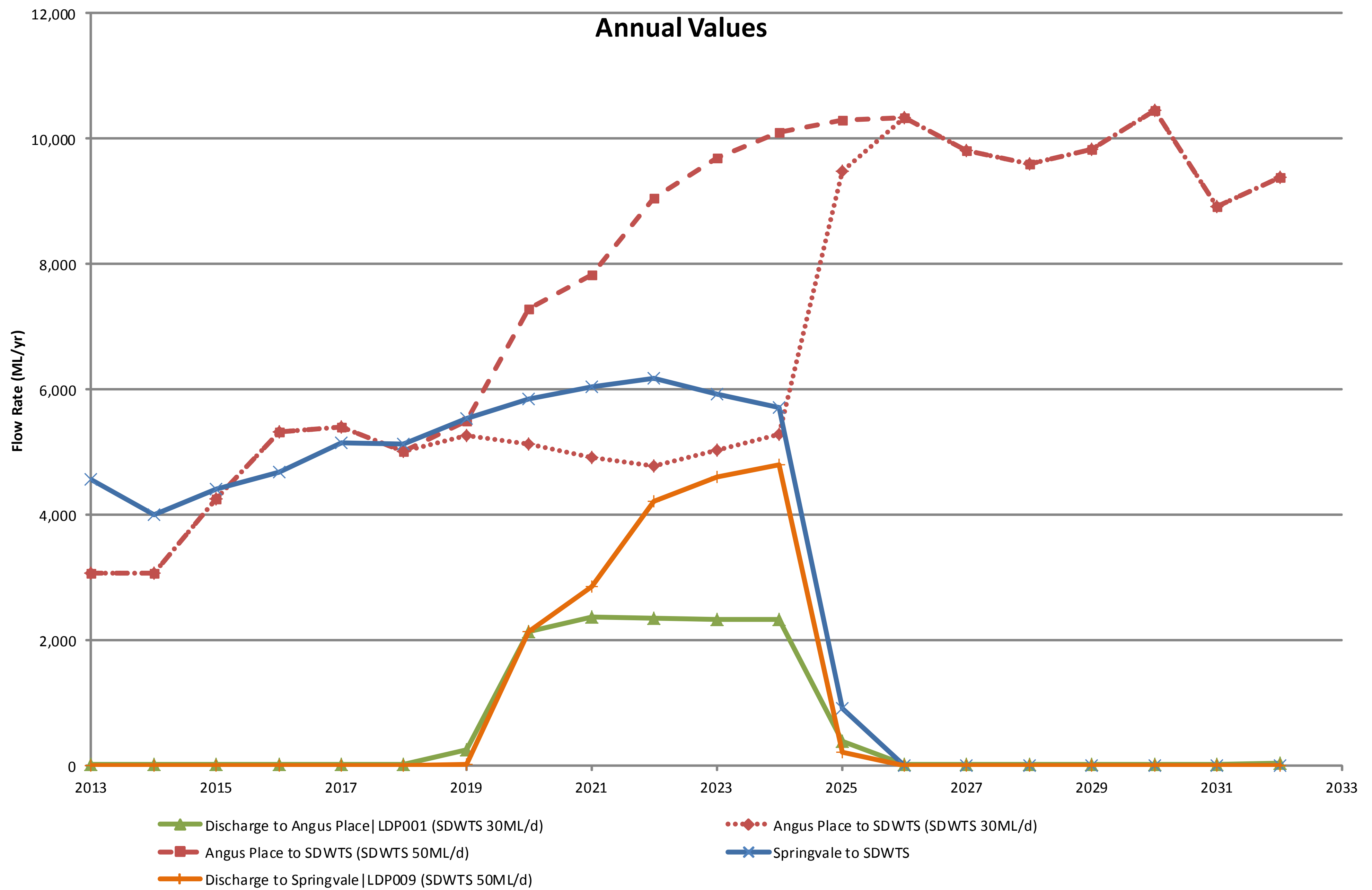
- 17 ML (0.05 ML/d) through Angus Place LDP001
- 106 ML (0.3 ML/d) through Angus Place LDP002
- 9,000 ML (24.6 ML/d) transmitted to Springvale's SDWTS

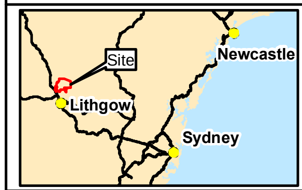
From the above analysis, during the period 2020 to 2025, if the current capacity of the SDWTS is maintained, excess mine water make will be discharged through Angus Place LDP001 (on a continuous basis); however, after this period the current capacity of the SDWTS of 30ML/d is sufficient and minimal discharge to LDP001 will occur.

Development consent is being sought, however, for both discharge at Angus Place LDP001 (on a continuous basis), including at a rate of 30 ML/d in the circumstance that SDWTS is not available, as well as transmission to Springvale Mine's SDWTS.

Figure 10.15 presents the results of water balance modelling. From **Figure 10.15**, Angus Place's transmission to the SDWTS increases from 3,070 ML/y at present to 4,750ML/y in 2022 and then to 10,457 ML/y in 2030. During the period 2020 to 2025, discharge at Angus PlaceLDP001 increases from current rate of 731 ML/y (2 ML/d) to 2,300 ML/y. In the circumstance that the SDWTS is upgraded, then the contribution to Springvale's SDWTS would be 9,000 ML/y in 2022 (year of peak contribution of Springvale Mine to the SDWTS). It is highlighted, however, that transmission to the SDWTS in excess of demand at Wallerawang Power Station of 30 ML/d will be discharged (on a continuous basis) by Springvale Mine to the Coxs River / Lake Wallace reservoir via their LDP009, which is located on Sawyers Swamp Creek adjacent the Ash Dam.

Given the circumstance that the extension of the adjacent project at Springvale does not proceed then either all water make will be discharged (continuous) at Angus Place LDP001 or a commercial arrangement will be entered into with Springvale Mine to maintain access to the pipeline.





Source:
RPS October 2013

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F085 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.15:
Water Balance Predictions – 2013 to 2032

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 85

A4

10.2.3.3 Subsidence Impact Assessment

Detailed discussion of the predicted impact to rivers and creeks and Newnes Plateau swamps is presented in **Chapter 8.0** and includes analysis of total subsidence, change in streambed profile and predicted tensile and compressive strain due to valley-related movements.

Rivers and Creeks

Modelling indicates that there is negligible impact, <20 mm, beyond 50 m from any excavated longwall panel and accordingly, there is no predicted impact on the Coxs River or the Lake Wallace reservoir.

Subsidence analysis indicates that total subsidence along the Wolgan River is <40 mm and accordingly there is negligible impact on streambed gradient. Modelling indicates that additional compressive strain due to valley closure along the Wolgan River is 0.5 mm/m to 1.0 mm/m. MSEC (2013) indicate that compressive strain <2 mm/m is rarely associated with fracturing of uppermost bedrock and therefore the potential impact on the Wolgan River due to fracturing is considered negligible.

Newnes Plateau Swamps

Subsidence analysis indicates that whilst there is a 1,000 mm to 1,400 mm total subsidence, dependent on proximity to either centre of longwall or centre of chain pillar, there is no adverse differential settlement that leads to either reversal of streambed gradient or significant localised change in gradient within any Newnes Plateau Swamp.

Modelling predictions of valley closure above active longwall panels is more than tensile strain of 0.5 mm/m and compressive strain of 2 mm/m and accordingly there is potential for fracturing of uppermost bedrock. The predicted depth of fracturing is less than 10 m to 15 m and where streambed comprises fine-grained surface sediments, such as is the case with NPHS and NPSS, minor surface cracking will be naturally infilled by subsequent surface runoff. The estimated potential for cracking, however, is conservative.

As identified in **Chapter 8.0**, geological structures such as lineaments have been incorporated into subsidence analysis and mine design has been amended to avoid the potential concurrence of risk factors that led to anomalous subsidence in the East Wolgan Swamp.

Figure 8.12 provides a series of cross sections through shrub swamps that will be mined undermined showing existing and predicted post-mining ground surface levels and grades. Cross Sections are presented for Tri Star Swamp (a), Tri Star Swamp (b-e), Twin Gully Swamp and Trail 6 Swamp. The cross sections show close correlation between existing and post-mining grades, indicating that the grade changes will be small.

10.2.4 Consequences of Potential Water Management Impacts

The Project is located at the boundary of the Sydney Basin Coxs River and Sydney Basin Richmond Groundwater Sources. These are Porous Rock Water Sources under the NSW Aquifer Interference Policy and as presented in **Section 2.6**. Level 1 Minimum Harm Criteria are met and consequently there are minimal consequences of the extension of Angus Place Colliery with respect to groundwater flow.

Analysis also indicates that there is negligible to minimal impact on THPSS ecosystems on the Newnes Plateau due to depressurisation of the Illawarra Coal Measures. The impact on groundwater and surface water are addressed in response to the water quality and river flow objectives presented below. There are no specific environmental values set for the Hawkesbury-Nepean catchment within the NSW Water Quality Objective (OEH, 2006), due to the transition at that time from the Healthy Rivers Commission to the Natural Resources Commission. However, catchments in the vicinity have identified water quality and priority river flow objectives that are appropriate for the purpose of presenting the impact of the proposed extension at Springvale Mine and these are presented below. It is noted that the objectives identified in the NSW Water Quality Objectives are consistent with the National Water Quality Objectives presented in ANZECC (2000). The environmental values for relevant waterway ‘type’ are presented below for Uncontrolled Streams (from George’s River; applicable to Angus Place|LDP001).

Water Quality Objectives:

- Aquatic Ecosystems
- Visual Amenity
- Primary and Secondary contact recreation (not relevant)
- Livestock water supply (not relevant)
- Irrigation water supply (not relevant)
- Drinking Water – Groundwater (not listed but relevant to this case)
- Aquatic Foods (cooked) (not relevant)
- Industrial Water Supplies (not listed but relevant to this case)

River Flow Objectives

- Protect natural pools in dry times
- Protect natural low flows
- Maintain wetland and floodplain inundation
- Maintain natural flow variability
- Manage groundwater for ecosystems
- Minimise effects of weirs and other structures (not relevant)

The potential impact of the proposed extension at Angus Place Colliery, including the cumulative impact of the adjacent project at Springvale Mine is presented below with respect to these identified environmental values.

10.2.4.1 Impacts to Flow

The Project will result in increased dewatering requirements and increased inflow to underground workings that will be required to be managed. The increase in mine water make will be managed through discharge at Angus Place LDP001 with transfer to Springvale Mine's SDWTS to the extent of current capacity and at a later project stage, the SDWTS will be upgraded from its current capacity of 30 ML/d to 50 ML/d, when combined mine inflow to both Angus Place and Springvale exceeds 30 ML/d.

River Flow Objective – Protect natural pools in dry times

"Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flow"

Monitoring indicates that the median flow (50th percentile) in the Coxs River, upstream of the confluence with Kangaroo Creek is 2.2 ML/d (Station No. Coxs River U/S). Within Wangcol Creek, a western tributary of the Coxs River, median flow (50th percentile) is only 0.5 ML/d. Accordingly, a significant proportion of flows within the Coxs River are due to discharge at Angus Place LDP001. At present, this discharge contributes to the baseline water supply for the Wallerawang Power Station.

A regional water balance has been prepared (RPS, 2013b) which includes all water users and water sources within the Coxs River catchment. Modelling indicates that current demand at Wallerawang Power Station is 11,000 ML/yr (30 ML/d), of which 7,630 ML/yr (20.9 ML/d) is met by the SDWTS and the remainder obtained from the Fish River Water Supply Scheme or extracted from the Coxs River. In addition, overflow from Lake Wallace is captured by Lake Lyell which is the water supply reservoir for the Mount Piper Power Station via intermediate transfer to Thompsons Creek Dam. The current modelled demand from Mount Piper Power Station is 14,200 ML/yr (38.9 ML/d) and comprises 12,600 ML/yr (34.5 ML/d) from the Coxs River and 1,600 ML/yr (4.4 ML/d) from the Fish River. Regional modelling indicates the proposed Neubeck Coal Project and Pine Dale Mine Stage 2 Extension Project will result in peak discharge to the Coxs River in 2015/16 and therefore well before proposed peak discharge at Angus Place Colliery or the adjacent project at Springvale Mine.

Accordingly, the consequence of cumulative increased discharge to the Coxs River is not significant since there is excess demand for this water resource.

As part of Angus Colliery's development consent, the discharge limit at Angus Place LDP001 is required to be returned to its previous value of 30 ML/d in the new EPL to cover the circumstance that Springvale Mine's SDWTS is unavailable.

Accordingly, the proposed discharge at Angus Place LDP001 will not have negative impact on natural water levels in pools during periods of no flow since discharge will help to meet net excess demand in the Coxs River catchment.

There is no proposed surface water extraction by the extension at Angus Place Colliery from the Coxs River or the Wolgan River catchments on the Newnes Plateau.

The proposed extension at Angus Place Colliery therefore meets this objective.

River Flow Objective – Protect natural low flows

"Protect natural low flows"

As indicated there is no proposed surface water extraction from the Coxs River or from catchments of the Wolgan River on the Newnes Plateau associated with extension to Angus Place Colliery.

The proposed extension at Angus Place Colliery therefore meets this objective.

River Flow Objective – Maintain wetland and floodplain inundation

"Maintain or restore natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems"

The proposed extension at Angus Place Colliery will result in continuous discharge through LDP001 to the Coxs River via Kangaroo Creek of 0.7 ML/d to 6.3 ML/d (0.073 m^3/s) in the period 2019 to 2025 under the circumstance that the SDWTS pipeline is not upgraded. Discharge to Angus Place LDP001 is currently 2 ML/d and has generally ranged between 4 ML/d and 8 ML/d in the period 2010 to 2012. In early 2010, discharge through LDP001 was temporarily 20ML/d. Whilst discharge to Kangaroo Creek / Coxs River will be continuous in the period 2019 to 2025, the magnitude of discharge is small compared to the 1 y ARI peak flood flow and therefore will be maintained in-bank. The Coxs River catchment has been subjected to discharge from mining operations over a considerable period and, as presented in **Section 10.3.3.1** and **Section 10.3.3.2**, the riparian and aquatic ecology is in an adapted state from a natural condition of mostly ephemeral. There are no storage structures proposed within the Coxs River catchment. As such, the proposed discharge will have minimal impact on floodplain ecosystems within Kangaroo Creek/Coxs River.

There is no proposed discharge to the THPSS ecosystems on the Newnes Plateau. Groundwater modelling indicates there is negligible to minimal on groundwater contribution to THPSS due to depressurisation of Illawarra Coal Measures and there is no predicted reduction in groundwater contribution to the Coxs River.

The Proposal is therefore considered to be compliant with this objective.

River Flow Objective – Maintain natural flow variability

"Maintain or mimic natural flow variability in all streams"

The proposed discharge (on a continuous basis) at Angus Place LDP001 of 0.7ML/d to 6.3ML/d (0.073m^3/s) in the period 2019 to 2025 to Kangaroo Creek/Coxs River represents continuation of Angus Place's contribution to flow variability in Kangaroo Creek. At present, discharge to Angus Place LDP001 is 2ML/d (on a continuous basis) and has been between 4 and 8 ML/d in the period 2010 to 2012 and up to 20ML/d in early 2010. Accordingly, whilst continuation of discharge (continuous) to Kangaroo Creek/Coxs River represents a change in hydrologic state compared to natural conditions, there has been discharge from mining operations in the Coxs River for a period of more than 60 years and the catchment is in an adapted state. Following completion of mining at Angus Place, discharge to Kangaroo Creek/Coxs River will cease. For context, the 1 y ARI peak flow in Kangaroo Creek is 10.0 m^3/s. The proposed magnitude of discharge is therefore small compared to whole of catchment runoff. Further detail on the impact to riparian and aquatic ecology is presented in **Section 10.3.4.2**.

There is no discharge to the THPSS on the Newnes Plateau and therefore there is no proposed change to flow variability in those catchments.

The proposed extension of Angus Place Colliery is mostly compliant with this objective in the context of the dominant land use being heavy industry. Following completion of mining operations and power generation, the catchment will revert to its natural state.

10.2.4.2 Impacts to Water Quality

The Project does not lead to a change in the beneficial use of groundwater as drinking water supply, which, in accordance with the NSW Groundwater Quality Policy, is the highest potential use of this water.

Current water quality in the Coxs River upstream of Lake Wallace is generally fresh, with mean EC of 600 µS/cm (range of 400 µS/cm to 1,200 µS/cm, since records commenced in 1992; Station No. NSW Office of Water 212054). Angus PlaceLDP001 is located further upstream of this monitoring station, however, the predicted impact to salinity at that location is equivalent. Detailed modelling of the predicted impact to salinity, locally, is presented in the Surface Water Assessment (RPS, 2013c).

The Coxs River is a disturbed ecosystem. As indicated in the Hawkesbury-Nepean CMA – River Health Strategy, reach Upper Coxs R2 has a management focus of assisted regeneration. The primary use of water in the Coxs River catchment is for industrial purposes in the Wallerawang and Mount Piper Power Stations. The Coxs River, however, lies within the Sydney Drinking Water Catchment and as such current and proposed water quality is also compared to the ADWG so as to address the requirement under the State Environmental Planning Policy (Sydney Drinking Water Catchment) that proposed conditions have a neutral or beneficial impact on water quality.

Further detail of assessment against water quality objectives is presented below.

Water Quality Objective – Aquatic Ecosystems

“Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term”

In accordance with ANZECC (2000) for slightly to moderately disturbed ecosystems (95% protection level), there are three components to protection of aquatic ecosystems:

- Physical and Chemical Stressors
  - Nutrients
  - BOD
  - DO
  - Turbidity/SPM (Suspended Particulate Matter)
  - Temperature
  - Salinity
  - pH
  - changes to flow regime (addressed above with respect to river flow objectives)
- Toxicants
  - Metals and Metalloids
  - Non-Metal Inorganics
  - Organics
  - Pesticides
  - Surfactants
- Sediment Quality (not relevant since there are no ‘works’ that will directly impact sediment quality)

Table 10.4a presents a summary of relevant water quality parameter values of extracted groundwater from Bore 940, discharge at Angus Place LDP001 and LDP002, in the Coxs River immediately upstream of Lake

Wallace and downstream of Lake Wallace, below the spillway. It is noted that median parameter values are presented in **Table 10.4a**, together with minimum and maximum values as well as number of samples.

Nutrients

Concentration of Nitrate at LDP001 is 0.64 mg/L and is 0.02 mg/L at LDP002. The ANZECC guidance value is 0.015mg/L.

The concentration of Nitrate in the Coxs River downstream of the confluence with Kangaroo Creek is 0.07 mg/L and is not monitored at spillway below Lake Wallace further downstream. The concentration of Nitrate is less than ANZECC guidance value at Bore 940.

Analysis indicates that the impact of the higher than guidance value at point of discharge at LDP001 is being dissipated due to mixing within the Coxs River. It is interpreted that guidance value is met below the Coxs River D/S monitoring station.

BOD

There is currently no discharge of BOD material from Springvale Mine. The proposed extension to Angus Place Colliery will also not result in discharge of BOD material. Discharges consist of surface runoff from Pit Top, following treatment, and groundwater extracted from the Permian Coal Measures.

Sewerage system on-site is sufficient to meet expected water-force demand and effluent discharge, following treatment, is via spray irrigation as indicated in Surface Water Assessment (RPS, 2013c).

Dissolved Oxygen

Dissolved oxygen is not currently monitored in the Coxs River, at LDP001 and LDP002. Bore 940 indicates range of 2.0 to 7.5 mg/L at point of sampling. Groundwater extracted on-site for industrial use is aerated prior to pumping back underground. Groundwater extracted as part of dewatering in advanced of mining is transmitted directly to Springvale's SDWTS. Diversion of groundwater in excess of demand will be aerated at point of discharge to Kangaroo Creek, as per current practice.

Turbidity

As presented in the Surface Water Assessment (RPS, 2013c), existing surface water management infrastructure at Pit Top is of sufficient capacity. There is no proposed change to operations at Pit Top and therefore extension of Angus Place Colliery will not lead to increased sediment generation.

Monitored values of turbidity in the Coxs River below confluence with Kangaroo Creek is 9 NTU and is 4 NTU at point of discharge below Lake Wallace further downstream. Turbidity is 4 NTU at LDP001 and is 32 at LDP002. There is minimal discharge from LDP002, therefore minor exceedance of ANZECC guideline value at this location is not particularly significant.

The ANZECC guidance value for turbidity is 2 – 25 NTU. The guideline value is currently met and extension of Angus Place Colliery is also expected to meet this guideline value.

Temperature

There are no industrial processes associated with operation at Springvale that result in impact to temperature of water extracted from Permian Coal Measures or surface runoff capture on-site prior to discharge following settlement and treatment.

Salinity

Analysis indicates that groundwater quality is fresh, being Na-HCO_3 type water, with EC of ~685 µS/cm (597 µS/cm – 972 µS/cm; n = 85) and pH of 7.2 (6.8 – 8.2; n = 85) at Bore 940.

Table 10.4a Summary of Water Quality Parameter Values- Groundwater, LDPs, River and Water Supply Reservoir

Parameter	*Units*	*ANZECC 2000*	*EPL 467 LDP001, LDP002*	*ADWG Health (NHRMC, 2011)*	*ADWG Aesthetic (NHRMC, 2011)*	*Bore 940*	*LDP001*	*LDP002*	*Coxs River D/S (downstream of confluence with Kangaroo Creek)*	*Coxs River D/S (adjacent to NOW Station No. 212054)*	*Wallerawang PS LDP D/S of Lake Wallace (December 2013)*
Physical Parameters											
pH		6.5 – 8.0	6.5 – 9.0	c	6.5 – 8.5	7.2 (6.8-8.2, n=85)	7.93 (7.28-8.88, n=75)	7.83 (6.88-9.12, n=79)	8.0 (6.7-8.5, n=44)	7.8 (6.2-8.9, n=178)	8.1
EC[1]	µS/cm	350	-	-		685 (597-972, n=85)	1,010 (625-1,270, n=33)	314 (171-1,930, n=42)	513 (53-1030, n=44)	652 (215-1570, n=175)	1692
TDS[1]	mg/L	234.5	-	f	Based on taste: < 600 good quality 600 – 900 fair quality	516 (458-916, n=27)	682 (518-2,950, n=26)	292 (14-389, n=24)	348 (62-660, n=30)	470 (154-660, n=36)	N/A
Hardness as $CaCO_3$	mg/L	-	-	f	< 60 soft but possibly corrosive 60 – 200 good quality 200 – 500 increasing scaling problems >500 severe scaling	29 (20-36, n=26)	109 (60-141, n=26)	80 (55-144, n=22)	56 (21-108, n=30)	163 (61-239, n=38)	N/A
TSS	mg/L	-	30	-	-	1.6 (0.2-8.0, n=61)	4 (1-41, n=75)	12 (2-238, n=80)	4 (1-117, n=44)	4 (1-16, n=28)	4
Turbidity	NTU	2 – 25	-	c	5	3 (1-42, n=27)	14 (2-37, n=75)	33 (6-668, n=75)	9 (2-162, n=31)	8 (3-56, n=38)	4
Oil and Grease	mg/L	-	10	-	-	Not Tested	<5	<5	<5 (<5-12, n=42)	<5	N/A
Dissolved Oxygen	mg/L					4.4 (2.0-7.5, n=25)	Not Tested	Not Tested		Not Tested	N/A
Major Ions											

Parameter	*Units*	*ANZECC 2000*	*EPL 467 LDP001, LDP002*	*ADWG Health (NHRMC, 2011)*	*ADWG Aesthetic (NHRMC, 2011)*	*Bore 940*	*LDP001*	*LDP002*	*Coxs River D/S (downstream of confluence with Kangaroo Creek)*	*Coxs River D/S (adjacent to NOW Station No. 212054)*	*Wallerawang PS LDP D/S of Lake Wallace (December 2013)*
Na	mg/L	-	-	f	180	220 (25 July 2012)	213 (24 Jul 2012)	40 (24 Jul 2012)	92 (24 Jul 2012)	68 (11 Sep 2012)	N/A
Ca	mg/L	-	-	-	-	4	24	20	11	25	N/A
Mg	mg/L	-	-	-	-	4	12	5	6	15	N/A
K	mg/L	-	-	-	-	19	27	9	15	11	N/A
Alkalinity[3]	mg/L	-	-	-	-	460	506	122	223	101	N/A
Cl	mg/L	-	-	c	250	25	8	12	8	21	N/A
SO_4	mg/L	-	-	500	250	31	74	32	40	157	587
Trace Ions											
Ag	mg/L	0.00005	-	0.1	-	Not Tested	<0.001	<0.001	Not Tested	Not Tested	N/A
Al	mg/L	0.055 for pH>6.5	-	c	0.2	0.02 (0.01-0.14, n=7)	0.02 (0.001-0.3, n=28)	0.05 (0.001-0.29, n=25)	0.05 (0.02-0.47, n=30)	0.01 (0.01-0.51, n=36)	0.0055
As	mg/L	0.024 as As III	-	0.01	-	0.014 (0.001-0.08, n=30)	0.001 (0.001-0.013, n=29)	0.001 (0.001-0.002, n=25)	<0.001 (n=30)	<0.001 (n=30)	0.008
B	mg/L	0.37	-	4	-	0.06 (0.02-0.08, n=27)	0.07 (0.05-0.10, n=26)	0.05 (0.05-0.05, n=22)	<0.05 (n=37)	0.22 (0.06-1.24, n=39)	0.25
Cd	mg/L	0.0002	-	0.002	-	0.0003(0.0002-0.046, n=7)	0.0001 (0.0001-0.007, n=30)	0.0001 (0.0001-0.0146, n=27)	<0.0001 (n=30)	<0.0001 (n=33)	N/A
Cr	mg/L	0.001 as Cr VI	-	0.05 as Cr VI	-	Not Tested	0.001 (n=1)	0.001 (n=2)	<0.0001 (n=2)	Not Tested	N/A
Cu	mg/L	0.0014	-	2	1	0.003 (0.0003-0.02, n=23)	0.002 (0.001-0.052, n=27)	0.003 (0.001-0.027, n=23)	0.002 (0.001-0.04, n=26)	0.004 (0.002-0.025, n=36)	0.015
F	mg/L	-	-	1.5	-	1 (0.77-1.6, n=30)	1.0 (0.0-1.2, n=28)	0.26 (0.0-1.1, n=28)	0.4 (0.1-0.9, n=29)	0.6 (0.1-0.8, n=39)	1.4

Parameter	*Units*	*ANZECC 2000*	*EPL 467 LDP001, LDP002*	*ADWG Health (NHRMC, 2011)*	*ADWG Aesthetic (NHRMC, 2011)*	*Bore 940*	*LDP001*	*LDP002*	*Coxs River D/S (downstream of confluence with Kangaroo Creek)*	*Coxs River D/S (adjacent to NOW Station No. 212054)*	*Wallerawang PS LDP D/S of Lake Wallace (December 2013)*
Fe	mg/L	ID	-	c	0.3	0.16 (0.06-0.43, n=28)	0.05 (0.05-0.3, n=31)	0.055 (0.05-0.35, n=26)	0.19 (0.006-1.54, n=35)	0.06 (0.05-0.85, n=55)	N/A
Mn	mg/L	1.9	-	0.5	0.1	0.015 (0.012-0.038, n=30)	0.031 (0.004-0.085, n=31)	0.046 (0.006-1.08, n=28)	0.012 (0.004-0.14, n=35)	0.18 (0.016-5.3, n=55)	N/A
Ni	mg/L	0.011	-	0.02	-	0.005 (0.004-0.016, n=31)	0.004 (0.003-0.005, n=30)	0.004 (0.001-0.075, n=27)	0.002 (0.001-0.029, n=29)	0.008 (0.006-0.024, n=37)	0.011
Pb	mg/L	0.034	-	0.01	-	0.002 (0.001-0.004, n=31)	0.001 (n=30)	0.001 (0.001-0.005, n=27)	0.001 (0.001-0.004, n=30)	<0.001 (n=33)	N/A
Se	mg/L	0.011 as Total Se	-	0.01	-	Not Tested	0.001 (n=3)	0.001 (n=3)	Not Tested	Not Tested	0.001
Zn	mg/L	0.008	-	c	3	0.024 (0.013-0.062, n=29)	0.046 (0.016-0.144, n=31)	0.027 (0.008-0.069, n=22)	0.011 (0.005-0.074, n=32)	0.014 (0.005-0.076, n=46)	0.003
Nutrients											
NH_3 as N	mg/L	0.013	-	c	0.4	1.02 (0.02-1.26, n=31)	0.05 (0.01-1.0, n=29)	0.02 (0.01-0.89, n=22)	0.01 (0.01-0.07, n=30)	0.06 (0.01-1.02, n=38)	N/A
NO_3 as N	mg/L	0.015[2]	-	11.3	-	0.04 (0.01-1.29, n=11)	0.64 (0.01-2.7, n=25)	0.02 (0.01-1.29, n=23)	0.07 (0.01-25.5, n=30)	0.04 (0.01-7.86, n=38)	N/A
Total N as N	mg/L	0.25	-	-	-	Not Tested	1.0 (0.2-4.2, n=29)	0.6 (0.1-8.0, n=27)	0.55 (0.1-26, n=30)	0.8 (0.07-11.4, n=39)	N/A
Total P as P	mg/L	0.02	-	-	-	Not Tested	0.01 (0.01-1.2, n=28)	0.02 (0.01-0.6, n=27)	0.02 (0.01-0.4, n=30)	0.08 (0.01-0.44, n=39)	N/A

Notes: 1. The assumed conversation factor is EC (µS/cm) x 0.67 = TDS (mg/L) from Section 4.3.3 of ANZECC (2000). If laboratory determination of TDS has occurred, results are provided; 2. NOx (oxides of N); ID. Insufficient data to derive a reliable trigger value; c. Insufficient data to set guideline value based on health considerations; f. No health-based value considered necessary. 3. Alkalinity is Total Alkalinity of CO_3 2-, HCO_3 - and OH

Salinity at LDP001 is 1,010 µS/cm (625 µS/cm – 1,270 µS/cm; n = 33) and is 314 µS/cm (171 µS/cm – 1,930 µS/cm; n = 42) at LDP002. Salinity in the Coxs River below the confluence with Kangaroo Creek is 513 µS/cm (53 µS/cm – 1,030 µS/cm; n = 44) and is 1,692 µS/cm downstream of Lake Wallace.

Salt mass balance modelling has been undertaken on the basis of water balance modelling, including regional water balance model results. The predicted peak contribution from other proposed mining operations in the Coxs River catchment such as the Neubecks Coal Project and Pine Dale Stage 2 Extension Project occur in 2015/16, well before the expected peak in contribution from Springvale Mine and Angus Place Colliery. **Figure 10.16** presents the predicted average salinity of the Coxs River immediately upstream of Lake Wallace under 'normal' conditions (defined as median (50%) flow at that gauge of 12.2 ML/d) and 'drought' conditions (defined as 5% flow rate at that gauge of 2.9 ML/d).

From **Figure 10.16** the predicted average salinity increases from current value of 580 µS/cm to peak of 815 µS/cm in 2024 and then decreases to 415 µS/cm in 2032 (520 µS/cm if the capacity of the SDWTS is maintained at 30 ML/d). Under drought conditions, salinity is predicted to increase from 790 µS/cm currently to a peak of 965 µS/cm in 2024 and then decrease to 430 µS/cm (740 µS/cm if the capacity of the SDWTS is maintained at 30 ML/d). The results of salt mass balance modelling on the Coxs River downstream of the confluence with Kangaroo Creek is presented in the Surface Water Assessment (RPS, 2013c). Results of that modelling indicate average salinity downstream of the Kangaroo Creek will increase from 515 µS/cm currently to peak of 717 µS/cm in 2021. Under drought conditions, salinity is predicted to increase from 890 µS/cm to peak of 968 µS/cm in 2021.

There is no predicted change to salinity of THPSS due to mining activity at depth.

Salinity in the Coxs River is currently in excess of ANZECC guidelines for protection of aquatic ecosystems and salt balance modelling indicates that salinity will increase due to extension of Angus Place Colliery; however, as presented in **Section 10.3.3.2**, aquatic and riparian ecosystems are adapted to this environment and predicted salinity is within the range experienced historically in the Coxs River catchment.

pH

As presented in **Table 10.4a**, pH of discharge at LDP001 is 7.9 and is 7.8 at LDP002 and pH of groundwater (Bore 940) is 7.2. The pH of Coxs River below confluence with Kangaroo Creek is 8.0 and at bottom of catchment below Lake Wallace is 8.1. Accordingly, there is no change expected to pH due to the proposed extension of Angus Place Colliery.

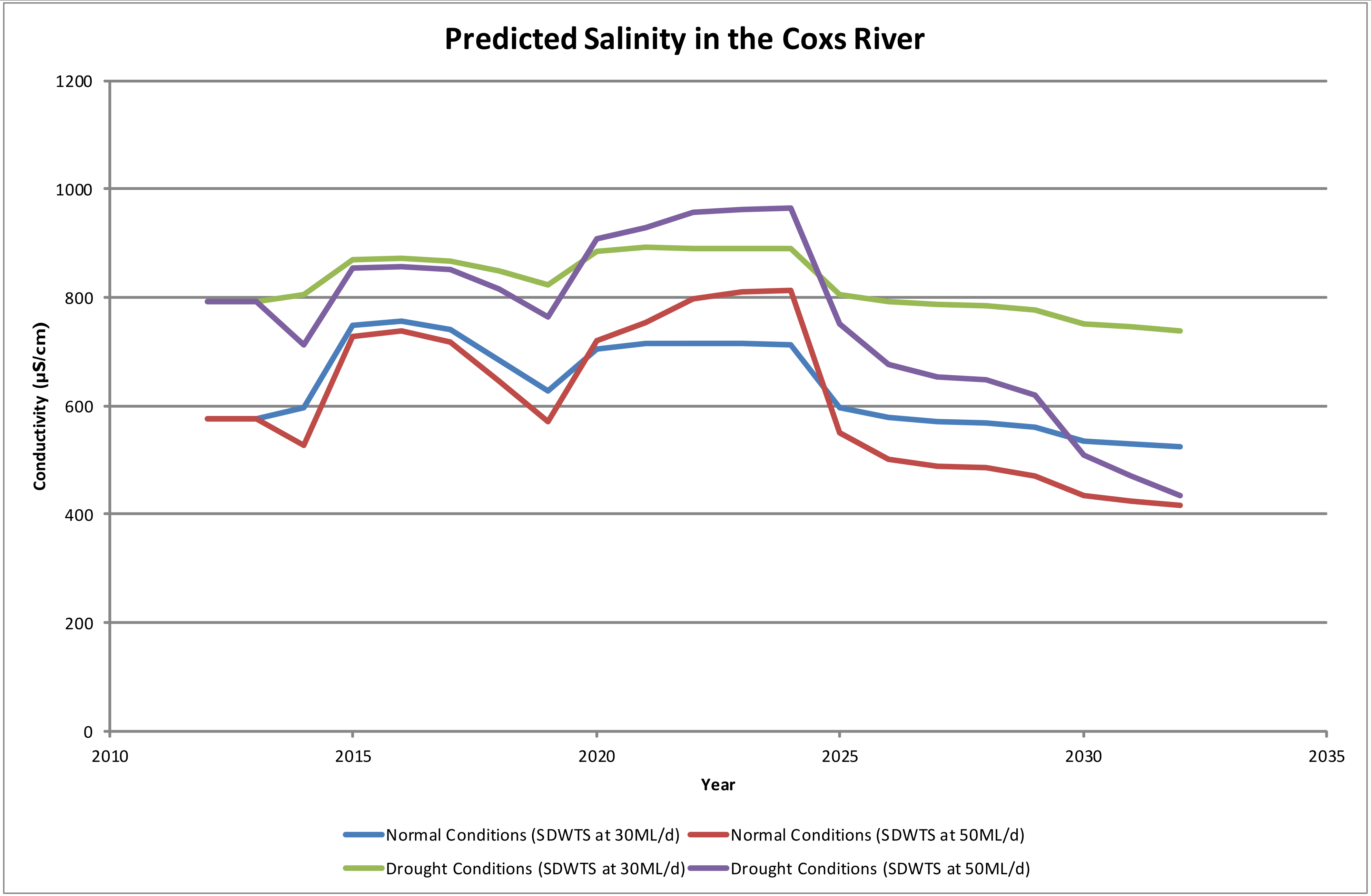
pH of THPSS on the Newnes Plateau are more acidic than surface waters in the Coxs River. Extension of Angus Place Colliery will, however, not result in change to pH of THPSS since there is no discharge to Newnes Plateau considered as part of this extension.

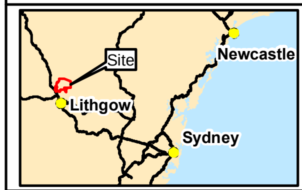
Expected pH in the Coxs River is consistent with ANZECC guideline value.

Toxicants

ANZECC guideline values are provided for metals and metalloids, non-metal inorganics, organics, pesticides and surfactants.

Table 10.4a presents the observed water quality parameter values of dissolved metals and non-metal inorganics. From **Table 10.4a**, the concentration of dissolved metals and non-metal inorganics are low and close to, or are consistent with, 95% protection levels. An exception is Zn and Cu, however, concentrations of these dissolved metals is not significantly above ANZECC default trigger values.





Source:
RPS October 2013

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F086 APC Rev 0
SCALE	NOT TO SCALE

Figure 10.16:
Predicted Average Salinity in the Coxs River above Lake Wallace – 2013 to 2032

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Angus Place

DRG No. 86 | A4

There is not specific testing for pesticides, organics or surfactants as these are not chemicals of concern with respect to site operation and accordingly it is reasonably presumed that operations are compliant with ANZECC guidance.

Sediment Quality

There are no works associated with current operations or proposed extension at Springvale Mine that will impact sediment quality and accordingly it is reasonably presumed that the proposal is compliant with ANZECC guidance.

Water Quality Objective – Visual Aesthetics

"Aesthetic qualities of water"

Key indicators for this water quality objective include:

- visual clarity and colour
- surface films and debris
- nuisance organisms.

The extension of Angus Place Colliery will comprise discharge of groundwater at LDP001 and surface runoff, following settling and treatment, at LDP002 and will be governed under a new EPL. As indicated above, turbidity and TSS of discharge at LDP009 is 14 NTU and 4 mg/L respectively and is 33 NTU and 12 mg/L at LDP002. The ANZECC guidance value for turbidity of 2 – 25 NTU will be met and accordingly the proposed extension of Angus Place Colliery will not trigger adverse impact to visual amenity of the Coxs River.

There is no proposed discharge to THPSS and accordingly there is no adverse impact to visual amenity to catchments on the Newnes Plateau.

Water Quality Objective – Drinking Water – Groundwater

"Refers to quality of drinking water drawn from the raw surface and groundwater sources before any treatment"

Key indicators include:

- Blue-Green Algae
- Turbidity
- Salinity (<1,500 µS/cm, >800 µS/cm causes a deterioration of taste)
- Coliforms
- Dissolved Oxygen
- pH
- Chemical Contaminants.

The ADWG provide health and aesthetic values for evaluation of water quality. It is noted that there are no local users of groundwater with respect to water supply to farmsteads or residences since mains supply is available. The water quality of drinking water – groundwater is relevant in the context that the Coxs River is a tributary of Sydney Drinking Water catchment, although there is a net excess demand for water for industrial use by Wallerawang and Mt Piper Power Stations and accordingly there is minimal discharge from the Lake Wallace reservoir.

Blue-Green Algae

The propensity for formation of algal blooms is not considered to be impacted by the proposed extension at Angus Place Colliery since nutrient concentrations presented in Table 10.6 in groundwater are low.

Turbidity

As presented above, turbidity of site discharges and groundwater extracted from Permian Coal Measures is relatively low. There are no health based level provided for turbidity, however, there is an aesthetic guidance value of 5 NTU. Whilst turbidity at LDP001 is 14 NTU and LDP002 is higher at 33 NTU, permissible ranges for turbidity are controlled by current EPLs. Water quality analysis downstream of Lake Wallace indicates turbidity is 4 NTU and implies discharge from the Coxs River catchment will meet aesthetic guidance value if not extracted for industrial use.

Salinity

Review of groundwater quality against the ADWG indicates it is essentially consistent, with the exception of salinity where the drinking water standard considers a TDS of 600 mg/L (~895 µS/cm) to be good quality drinking water and a TDS of between 600 mg/L and 900 mg/L (~895 µS/cm to 1,345 µS/cm) to be fair quality drinking water. It is noted that the guidance values for salinity in the ADWG is an aesthetic-based value and is not a health-based value.

pH

There is no health-based value for pH; however, there is an aesthetic guideline value of 6.5 – 8.5.

As indicated in Table 10.6, water quality at LDPs, surface water quality downstream of points of discharge and water quality of groundwater are consistent with the aesthetic guideline range.

Coliforms

As indicated with respect to assessment of proposed extension in regard to potential impact to aquatic ecosystems, the current sewerage system is of sufficient capacity to meet expected workforce and there will be no discharge of untreated sewage to the Coxs River. Spray irrigation of treated effluent is administrated under the current EPL and this is expected to be continued.

Dissolved Oxygen

As indicated with respect to assessment of proposed extension at Angus Place against potential impact to aquatic ecosystems, there is no expected negative impact to surface water quality in the Coxs River due to depleted dissolved oxygen. It is not proposed to discharge BOD material to the Coxs River or the Newnes Plateau.

Chemical Contaminants

From Table 10.6, concentrations of dissolved metals at LDPs, and in groundwater, meet ADWG health guideline values.

Water Quality Objective – Industrial Water Supplies

“The high economic value of water taken from river and lakes for use by industry needs recognition in water quality planning and management. It has been identified as an important environmental value through community consultation”

The proposed extension at Angus Place Colliery is compliant with this objective.

Neutral or Beneficial Assessment

SEPP (Sydney Drinking Water Catchment) 2011 requires all new developments in the Sydney Drinking Water Catchment to demonstrate a NorBE on water quality. The SCA has established an assessment guide to assist in addressing relevant issues to determine whether or not a project will have a NorBE on receiving water quality. A number of supporting guidelines and interactive tools have been developed by the SCA to assist approval authorities in undertaking a NorBE Assessment. Of relevance to the Proposal, is the SCA guideline entitled 'Development in Sydney's Drinking Water Catchment Water Quality Information Requirements' as well as the 'Neutral or Beneficial Effect on Water Quality Assessment Guideline'.

Regarding the proposed extension at Angus Place Colliery, the Guidelines require the following information to be included in the assessment:

- Details of the Project including site plans and constraints
- Site contamination report
- Water quality control details
- Surface water modelling
- Pollution control details, including any erosion and sedimentation controls
- Water balance and water cycle management
- Identification of the likely pollutants of concern (both construction and operation)
- Identification of measures to control the identified pollutants
- Description of the expected levels of pollutants before and after the development
- Details of any required offsets.

These matters are discussed below.

Project Plans and Constraints

Details of the Project components are provided in **Chapter 3.0** of the EIS.

The Project consists continuation of longwall mining utilising existing infrastructure including utilisation of Springvale's SDWTS, to the extent available, and at a later project stage, upgrading of the Angus Place's portion of the SDWTS pipeline when the combined mine inflows to Angus Place and Springvale exceed 30ML/d.

Development consent is being sought for both discharge at Angus Place LDP001 (on a continuous basis), including at a rate of 30 ML/d in the circumstance that SDWTS is not available, transmission to Springvale Mine's SDWTS, as well as upgrade of Angus Place's portion of the SDWTS pipeline.

Site Contamination

A phase 1 assessment for the Angus Place Colliery has been carried out. This indicates that the potential contamination at the Site presents a low to moderate risk to human health and the environment. The assessment recommends that a phase 2 assessment be undertaken at target areas, such as fuel and oil storages. Should any remediation be required, it will be conducted following the phase 2 assessment.

Since the desktop assessment does not indicate that contamination, if it exists, is leaving the site, any further reductions in on-site contamination will have a beneficial effect on water quality.

Water Quality Control Details

There is an extensive network of groundwater and surface water monitoring stations at Angus Place Colliery.

Section 3.11 presents the existing water management systems at Angus Place Pit Top. **Section 3.10.4** presents the details of the Angus Place's portion of the SDWTS.

At Angus Place Pit Top, surface runoff captured by Primary Pollution Pond and is transmitted through Secondary Pollution Pond and Filter Pond. Settling Ponds receives overflow from Filter Pond and runoff from stores and workshop areas after it has been treated by the oil-water separator.

Groundwater extracted in advance of longwall mining is transmitted to Springvale's SDWTS in the first instance, with flows in excess of available capacity in the SDWTS discharged to the Coxs River via Kangaroo Creek. Discharge to the Coxs River is ultimately used to meet existing demand at Wallerawang Power Station and Mt Piper Power Station.

There is no proposed discharge to the Newnes Plateau associated with extension at Angus Place Colliery.

Surface Water Modelling

Groundwater modelling indicates there is predicted decrease in groundwater contribution to surface water in the Coxs River.

Modelling also indicates that there is negligible to minimal impact to THPSS on the Newnes Plateau, however, these GDEs lie within the Wolgan River catchment and therefore are outside of the Sydney Drinking Water Catchment.

Detailed site water balance modelling has been undertaken using GoldSIM and there has also been a regional water balance constructed. Details of these models are presented in the Surface Water Assessment (RPS, 2013c).

Pollution control details including any erosion and sedimentation controls

There is no proposed change to surface water management infrastructure at Pit Top as a result of the extension of Angus Place Colliery. As presented in the Surface Water Assessment, analysis indicates that surface water management infrastructure currently in place is of sufficient capacity with respect to required 'Blue Book' capture capacity.

Water Balance and Water Cycle Management

Water balance modelling indicates that there is a significant excess of water compared to site requirements and this water will be discharged to the SDWTS in the first instance.

Regional water balance modelling indicates net demand in the Coxs River catchment is 68.9 ML/d, of which ~20 ML/d is met currently via direct transfer of groundwater to Wallerawang Power Station via the SDWTS.

Median flow (50th percentile) in the Coxs River immediately above Lake Wallace is 12.2 ML/d and accordingly, groundwater meets a significant portion of the everyday requirements of Wallerawang Power Station and consequently Mt Piper Power Station. Overflow from Lake Wallace is transmitted to Lake Lyell, which is the water supply reservoir for Mt Piper Power Station via intermediate transfer to Thompsons Creek Dam.

As an aside, continuation of supply of good quality groundwater to the Coxs River also has the advantage of being a reliable water source to the Power Stations in times of drought.

As presented in Section 4.10.3, when combined mine inflows at Angus Place and Springvale exceed the current capacity of the pipeline of 30 ML/d, the SDWTS will be upgraded to 50 ML/d.

Identification of the likely pollutants of concern (both construction and operation)

Discharge to the Coxs River is subject to a program of regular monitoring in regard to water quality.

The primary pollutants of concern include:

- nutrients
- turbidity
- salinity
- pH
- toxicants

As presented above, water quality criteria are met for the protection of aquatic ecosystems and drinking water – groundwater, with the exception of salinity. Concentrations of nutrients, measurement of turbidity, pH and concentration of toxicants are at or close to ANZECC guidance values and are met for ADWG guideline values.

Salinity

Whilst salinity of discharge exceeds the ANZECC guidance value for the Water Quality Objective - Protection of Aquatic Ecosystems, it is consistent with Water Quality Objective – Drinking Water – Groundwater and Water Quality Objective – Industrial Water Supplies. Review of groundwater quality against the ADWG indicates it is essentially consistent, where the drinking water standard considers a TDS of 600mg/L (~895 µS/cm) to be good quality drinking water and a TDS of between 600 and 900 mg/L (~895 µS/cm to 1,345 µS/cm) to be fair quality drinking water. It is noted that the guidance values for salinity in the ADWG is an aesthetic-based value and is not a health-based value.

Identification of measures to control the identified pollutants

At present, the significant majority of discharge of groundwater is via direct transfer to Springvale's SDWTS for use in the Wallerawang Power Station. Excess groundwater is discharged via LDP001, which is governed by the limitations imposed by the EPL, to the Coxs River catchment.

Surface water runoff from Pit Top areas are subject to settling and treatment before being discharged to the Coxs River via LDP002. The limitations imposed by the current EPL are proposed to be maintained.

There is also a LDP at Angus Place associated with spray irrigation of treated effluent from the on-site sewerage system. The limitations imposed by the current EPL are proposed to be maintained.

Description of the expected levels of pollutants before and after the development

Salt water balance modelling has been undertaken on the basis of water balance modelling including regional water balance modelling results and is presented in **Figure 10.16**.

Modelling indicates that the predicted average salinity immediately upstream of Lake Wallace will increase from current value of 580 µS/cm to peak of 815 µS/cm in 2024 and then decrease to 415 µS/cm in 2032. Under drought conditions, salinity is predicted to increase from 790 µS/cm to a peak of 965 µS/cm in 2024 and then decrease to 430 µS/cm.

Current water quality downstream of Lake Wallace is 1,692 µS/cm, with pH 8.1, and concentration of dissolved metals being low.

There is no predicted change to pH, nutrients, dissolved metal concentrations and dissolved oxygen levels in the Coxs River due to extension of Springvale Mine since pH of groundwater is 7.2 (Bore 940) and concentration of nutrients and dissolved metals is minimal. Groundwater discharge to the Coxs River will be aerated, as per current practice, to minimise its potential to contribute to depleted dissolved oxygen levels.

Following completion of mining at Angus Place, discharges will cease.

During mining, maximum average salinity in the Coxs River of 815 µS/cm under normal conditions or 965 µS/cm under drought conditions has a neutral effect on water quality since the primary beneficial use of that water as potential drinking water and industrial water supply is maintained.

Specifically the Project meets the neutral or beneficial effect test:

"2. The development will not adversely affect water quality off-site because:
a. pollutant loads from the development / activity can be transported to acceptable downstream treatment facility and disposal facilities without adverse off-site water quality impacts; or
c. there are no indirect adverse impacts on water quality caused, or likely to be caused, by changes to factors that currently affect water quality off-site such as treatment, assimilation of pollutants, or the hydrological cycle (such as changes to flow or flow paths, water courses or riparian corridors)."

The downstream treatment and disposal facility being use of groundwater discharged to the Coxs River by heavy industry within Wallerawang Power Station and Mount Piper Power Stations; and consequential to the net excess demand for this water there are no indirect adverse impacts, outside of this local catchment, due to minimal discharge from the Coxs River via Lake Wallace and Lake Lyell.

The current water quality requirement at points of discharge of pH of 6.5 - 9.0, TSS of 30 mg/L and Oil & Grease of 10 mg/L will be maintained, with treatment being required should water quality be outside of these ranges.

Offsets

Proposed offsets associated with upgrade of the SDWTS is presented in **Section 10.3.6.4** and **Appendix H**.

There are no proposed works in watercourses of the Coxs River associated with extension of Angus Place Colliery.

Current erosion and control infrastructure at each LDP will be maintained such that there are no uncontrolled discharges from distributed areas.

10.2.4.3 Impacts to Geomorphology, Flooding and Environmental Flows

The Project will lead to increased discharge to Kangaroo Creek. Current discharge at Angus Place LDP001, from water balance modelling, is 2.0 ML/d (0.023 m^3/s) (on a continuous basis) and this is expected to increase to 6.3 ML/d (0.073 m^3/s) (on a continuous basis). In the circumstance that the SDWTS becomes unavailable in the future, maximum discharge to Kangaroo Creek could be 28.6 ML/d (0.33 m^3/s). The 1 y ARI peak flood flow in Kangaroo Creek is 10.0 m^3/s and therefore the proposed increase in daily flow is well below that experienced during a typical large rainfall event.

To consider the potential impact of discharge through LDP001 on Kangaroo Creek, the channel velocity was estimated using Manning's equation, based on an assumed trapezoidal type section.

Analysis indicated channel velocity would be 0.78 m/s if discharge through LDP001 is 28.6 ML/d and would be 0.47 m/s if discharge through LDP001 is 6.3 ML/d. The calculated velocity during a 1 y ARI design flood event is 2.0 m/s. Comparison of estimated channel velocities under LDP001 discharge conditions in a Hjulstrom Diagram indicates that erosional potential is low. It is noted that the Hjulstrom Diagram does not consider the impact of vegetation. As indicated in the 'Blue Book' (Landcom, 2004) and DECCW (2008), whilst bare soil has critical velocity of only 0.5 m/s, when vegetated the critical velocity increases to 1.8 m/s.

Given that there is not a streambed erosion issue currently in Kangaroo Creek, the potential impact of discharge through LDP001 on geomorphology is considered to be small since the average channel velocity (2.0m/s) experienced in a typical large rainfall event is much higher than proposed channel velocities of 0.78m/s and 0.47m/s respectively.

There are already local scour protection works associated with Angus Place LDP001 and comprise shotcrete lining of the outlet from Angus Place LDP001 to Kangaroo Creek.

There are no hydraulic structures proposed to be installed in any waterway and therefore there is no expected change in hydraulic regime. As such the extension at Angus Place Colliery does not constitute a controlled activity under the *Water Management Act 2000* as there are no works within 40 m of a watercourse. Flow within the Coxs River will be 'normal' depth until it discharges to Lake Wallace.

In the Coxs River, the expected lateral extent of flow associated with increased daily flow will remain in-bank, defined notionally to contain the 2 y ARI flood event. Accordingly, the Proposal will not significantly impact flooding and drainage within the Coxs River catchment.

The extension at Angus Place Colliery does not include any water storage infrastructure, such as weirs or dams, on surface watercourses. As such, there is no impact to environmental flows associated with the extension to Angus Place Colliery since it is not proposed to construct any water storage infrastructure, including on the Newnes Plateau. The impact of proposed discharge to Kangaroo Creek/Coxs River via Angus Place LDP001 is presented in **Section 10.2.4** against the relevant river flow objectives.

10.2.4.4 Impacts of Subsidence

It has been established that whilst total subsidence will be of the order of 1,000 mm to 1,400 mm, there is no predicted adverse differential settlement that would lead to increased ponding or induce increase scour potential.

Potential mining-induced cracking due to valley related movements are expected to be of minor consequence and will infill naturally with soil and sediment over time. Geological structures, such as lineaments, have been included in subsidence analysis and contributed to modification of mine design to minimise potential concurrence of risk factors that could trigger anomalous subsidence.

10.2.5 Water Management and Mitigation Measures

The Project mine design has considered sensitive surface features such as swamps, cliff-lines, significant rock features, watercourses and sites of cultural significance on the Plateau. Through conservative mine planning, Angus Place Colliery avoided or reduced the potential impacts on these sensitive surface features.

Any surface cracking will fill with soil over time, especially during times of heavy rainfall. Where significant localised surface cracks occur, these will be remediated by infilling with soil.

A management plan has been developed by Angus Place Colliery to support an application to the Federal Department of the Environment prior to commencement of mining beneath the THPSS.

Table 8.2 identifies the engineering measures that will be undertaken where impacts to swamps are above defined trigger values.

The following monitoring programmes will be undertaken:

- The monitoring programme of downstream creeks that are within the current mining area will continue for the life of the Project.
- The monitoring of surface and groundwater levels in existing swamps will be reduced to an annual review for a further two (2) years, with a final review within five (5) years of the grant of development consent.
- Monitoring of surface and groundwater levels within swamps proposed to be mined under as part of the Project will be undertaken for a minimum of two (2) years prior to mining to establish a baseline. Once mining has occurred, monitoring of groundwater levels and surface water flows will continue for a period of two (2) years post mining. Where monitoring determines that there is no change in relation to the baseline, monitoring of the swamp will cease. If monitoring determines that there is a change in relation to mining, and this change is attributable to mining related impacts, the management controls identified in **Table 8.2** will be implemented.
- Current monitoring programme at points of discharge (LDPs) is maintained (pH, TSS and Oil & Grease).
- Continuous programme of survey to track subsidence related impacts is maintained, both with respect to swamps and longitudinal profiles along water courses, including high resolution aerial based methods where they can reliably penetrate vegetative cover.
- Additional groundwater monitoring points will be added to Project boundary, in the northern to southeasterly quadrants.
- A Water Management Plan will be development that incorporates the surface and groundwater monitoring outlined above and in **Chapter 10.3** of this EIS as well as the management actions identified in **Table 8.2**.
- As detailed in **Section 4.2**, as the required exploration drill holes are determined, Centennial Angus Place will undertake a series of due diligence assessments to consider surface water and groundwater impacts as relevant. The general approach of the due diligence assessments will be to conduct site investigations to ensure that significant impacts are avoided.

The impacts to shrub swamps will be offset through the Biodiversity Strategy outlined in **Section 10.3.7** and **Appendix H**, therefore monitoring of surface and groundwater impacts to these communities will be limited to gaining an understanding of swamp hydrology and other characteristics as detailed in the Biodiversity Strategy, supported by a Biodiversity Management Plan.

10.2.6 Conclusions

The depressurisation of aquifers in strata overlying the coal seam has been shown to have minimal impact on the swamps on the Newnes Plateau and the surface drainage network of the water supply catchments.

The discharge of groundwater to the Coxs River currently provides a critical base water supply for the power stations in the catchment either via direct transfer to the Wallerawang Power Station via the SDWTS or indirectly through discharge to the Lake Wallace reservoir. Extension of the Project, with associated increase in groundwater inflows, provides an opportunity to substitute water currently sourced from the Fish River Water Source by the power stations and thereby reduce their impact on that Water Source.

Groundwater quality is fresh and meets the current Australian Drinking Water Guidelines, with groundwater salinity consistent with the aesthetic guideline value for fair quality drinking water of 600 mg/L to 900 mg/L. Continuation of mining at Angus Place Colliery is also consistent with the State Environmental Planning Policy (Sydney Drinking Water Catchment) of neutral or beneficial effect on water quality, given that there is excess demand in the Coxs River catchment by heavy industry and that water is captured and consumed by those users.

10.3 Ecology

This section specifically responds to the DGRs, which provide the following in regard to biodiversity aspects:

The Director General's requirements

Biodiversity – including:

- Measures that would be taken to avoid, reduce or mitigate impacts on biodiversity, particularly Temperate Highland Peat Swamps;
- Accurate estimates of direct vegetation impacts, such as clearing and subsidence and indirect impacts such as 'edge effects';
- Detailed assessment of potential impacts of the development on:
  - Temperate Highland Peat Swamps;
  - Other terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and
  - Regionally significant remnant vegetation, or vegetation corridors;
- An offset strategy, which is clearly quantified, to ensure that the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.

Water Resources– including:

- Assessment of impacts on riparian, ecological, geo-morphological and hydrological values of watercourses, including GDEs and environmental flows.

10.3.1 Introduction

This section identifies the potential ecological impacts of the Project. It is informed by the technical assessment of RPS Australia East Pty Ltd (RPS), "Flora and Fauna Impact Assessment, September 2013" (**Appendix H**) and the Cardno "Aquatic Ecology and Stygofauna Assessment, October 2013" (**Appendix G**).

The purpose of this assessment was to examine the likelihood of the Project having a significant effect on any threatened species, populations, or ecological communities listed under the NSW TSC Act and the EPBC Act. The aquatic ecology and stygofauna assessment focuses on the aquatic ecological attributes of streams and swamps in accordance with the NSW *Fisheries Management Act, 1994* (FM Act).

The Project is being assessed as an 'Accredited Assessment' under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). A referral was submitted under the EPBC Act (2013/6889) to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (formerly SEWPAC now DoE) and the Action was determined to be a Controlled Action under the EPBC Act.

This Chapter discusses the existing environment, potential impacts, consequences of potential ecological impacts and mitigation measures for terrestrial flora and fauna, swamps, aquatic and stygofauna.

10.3.2 Methodology

10.3.2.1 Terrestrial Ecology

A review of relevant information was undertaken to provide an understanding of ecological values occurring or potentially occurring within the Project Application Area and locality (i.e. within 10 kilometres of the Project Application Area). The database searches undertaken were:

- Protected Matters Search Tool (EPBC Act) (accessed February 2013); and
- OEH Atlas of NSW Wildlife (TSC Act) (accessed February 2013)

A variety of field survey techniques were employed over the course of fieldwork for this assessment to record a representative sample of flora and fauna guilds across the Project Application Area defined for surveys. The surveys included site inspections to identify initial constraints to inform Project design, vegetation community, and various flora and fauna survey methods.

Surveys were undertaken using methodology for targeting listed threatened species, ecological communities and their respective habitat, including *Survey and Assessment Guidelines* (DECC, 2009) and the *Department of Sustainability, Environment, Water, Populations and Communities* (formerly SEWPAC now DoE) *species- specific survey guidelines for nationally threatened species.*

Fauna survey methods including Elliott trapping, hair traps, hair tubes, bat echolocation, spotlighting, call playback, diurnal bird and herpetological surveys, opportunistic surveys and habitat assessments. Targeted searches for threatened flora and fauna species were also undertaken.

In addition to these ecological surveys other surveys for other projects in the locality were reviewed and used in consideration of adequacy of survey effort and potential for occurrence of threatened species. Apart from Project specific survey, seasonal vegetation monitoring has been undertaken at the site since 2003 and annual fauna monitoring site since 2004 in both shrubs swamps and surrounding woodlands. **Table 10.5** lists the ecological survey efforts undertaken over the years at Angus Place Colliery.

Table 10.5 Ecological Survey Effort

Target Species	Method	RPS Surveys 2010 - 2013	MKES (2004 - 2008) and BMS (20109-2012)	University of Queensland (2003-2012)	Total
Small mammals	Terrestrial A	1800 trap nights	9,960	-	11,760
Medium sized mammals	Terrestrial B	1492 trap nights	336	-	1,828
Large mammals	Cage	264 trap nights	Undertaken, however effort not specified	-	>320
Arboreal mammals	Arboreal B	432 trap nights	1,972	-	2,404
Various sized mammals	Hair Tube Terrestrial	480 trap nights	1,822	-	2,782
	Hair Tube Arboreal			-	
Bats	Harp trap	76 trap nights	-	-	76
	Ultrasonic detection	342 hrs	Undertaken, however effort not specified	-	>342
Various nocturnal mammals and birds	Spotlighting	84 hrs	87	-	171
	Call Playback (mammals)	10 hrs	Undertaken, however effort not specified	-	>10
	Call Playback (birds)	16 hrs	Undertaken, however effort not specified	-	>10
	Bird Census	12 hrs	Undertaken, however effort not specified	-	>12
Reptiles	Habitat Search	4 hrs	Undertaken, however effort not specified	-	>4
	Spotlighting	84 hrs	87	-	171
Amphibians	Habitat Search	14 hours	Undertaken, however effort not specified	-	>14
Plants	Quadrat & Random Meander)	39 sites	-	23	62
	Rapid Data Point	142	-	-	142

Environmental avoidance mapping was undertaken to determine the optimum site for the infrastructure within the Environmental Study Area and involving the least environmental impact. The extent and mapped results of this work along the proposed infrastructure corridors, dewatering sites and ventilation facility are presented in the Flora and Fauna Assessment (**Appendix H**). Environmental avoidance mapping was also carried out along the access tracks for the proposed extension and duplication the SDWTS pipeline. Results of the avoidance mapping are summarised in **Table 12.3**.

Flora survey effort within defined ecology study area (**Section 2.4**) was deliberately focused on the predicted subsidence extents within the angle of draw boundary plus an adequate buffer zone and Environmental Study Areas. The data collected informed any revisions to DEC (2006) mapping and, where applicable, alterations to this vegetation mapping occurred using the collected floristic data and aerial photograph interpretation. The final vegetation map produced utilises the original DEC (2006) mapping in areas of the Project Application Area where no data was collected that may otherwise have informed possible mapping revisions.

The methodology first used aerial photograph interpretation to construct a map template using geographic information system where visible changes in the vegetation and landscape were separately mapped into definable map units.

The vegetation map was systematically updated and refined throughout the course of flora surveys. Additionally, vegetation delineation and threatened flora searches were undertaken while conducting diurnal fauna surveys and while traversing the Project Application Area on foot or within a vehicle.

Due to their specific conservation value, all shrub swamps and most hanging swamps were visited within the predicted subsidence extents and Environmental Study Areas. Where swamps could not be accessed, the extents of these relied on that mapped by DEC (2006).

The Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC 2004) uses a concept of 'stratification units' in order to determine the flora and fauna survey effort to be undertaken over a given area. DEC (2004) recommends that the survey area be initially stratified on biophysical attributes (e.g. landform, geology, elevation, slope, soil type, aspect), followed by vegetation structure (e.g. forest, woodland, shrubland), and then floristics (e.g. species or specific vegetation communities). For the Project, this would require that the site is divided into 21 stratification units of native vegetation and each surveyed at intensity proportionate to the area of that particular unit.

It is appropriate to use broader stratification units that are representative of habitat types of the various target species (e.g. dry woodland, moist forest, heath and swamp). This groups vegetation communities and reduces the survey effort while still providing data representative of the target species. For example at Springvale, a stratification unit of 50 ha or less would require that 24 arboreal trap nights is undertaken. If for instance the heath communities of 45 (36.65 ha) and 46 (6.47 ha) were treated as separate stratification units, each would require 24 trap nights (total 48 trap nights). However, if these were combined as one 'heath' stratification unit it would still be less than 50 ha and therefore would only require 24 trap nights. Both of these communities have Banksia as a dominant species. Therefore, if the target species is Pygmy Possum, which primarily feeds on Banksia, the broader Heath stratification unit is appropriate.

DEC (2004) recommends specific survey effort for each survey method. For the purpose of assessing the deviation from the guidelines, this review will consider arboreal mammal trapping at Springvale as a representative method. To date 1,366 trap nights have been undertaken at Springvale. DEC (2004) recommends that 24 trap nights be undertaken per stratification unit up to 50 ha, plus an additional 24 trap nights for every additional 100 ha. In using the broad stratification units of dry forest/woodland (4,385 ha), moist forest (209 ha), heath (320 ha) and swamp (212 ha), the recommended survey effort would be 1,064 trap nights, 62 trap nights, 89 trap nights and 63 trap nights respectively. This is a total of 1,278 trap nights required and 1366 trap nights performed. Whilst overall survey effort within the Project Application Area has exceeded the guidelines, it is noted that survey effort is biased towards the dry forest/woodland and swamp communities.

Many of the habitats within the Project Application Area are difficult to access, with tracks predominately occurring along the ridge lines. The location and effort of each survey methodology was determined based on achieving a suitable spread across the Project Application Area and included fauna surveys within or close to the ESA. Given that targeted fauna species are highly mobile and contiguous habitat exists across the Newnes Plateau, the likelihood of occurrence of targeted species within potential habitat is considered to be consistent across the entire Study Area, including areas within and surrounding the ESA.

10.3.2.2 Aquatic Ecology

The proposed mining area (**Figure 4.2**) is situated to the east of the headwaters of the Wolgan River, but is traversed by three headwater sub-catchments of Carne Creek. The description of the aquatic habitats, water quality and aquatic flora and fauna of the Wolgan River and site on Carne Creek has been compiled from a series of reports of baseline aquatic ecology monitoring programmes. The aquatic ecology of the Wolgan River sites was monitored biannually between Autumn 2010 and Spring 2012.

The monitoring methodology for the Aquatic Ecology and Stygofauna Assessment was as follows:

- assessment of the condition of the aquatic habitat using a modified version of the River-Creek-Environment developed by Chessman *et al.* (1997) in Cardno (2013);
- measurement of temperature, electrical conductivity, salinity, pH, dissolved oxygen and turbidity just below the surface of the water column and at depth where sufficient water was available;
- a record of the occurrence of aquatic macrophytes;
- sampling, sorting and identification of aquatic macroinvertebrates associated with pool edge habitat in accordance with the Australian Rivers Assessment System (AusRivAS) protocols (Turak *et al.* 2004);
- in the baseline monitoring programme, the SIGNAL2 score (Stream Invertebrate Grade Number Average Level), a biotic index that uses information on the presence or absence of macroinvertebrate families, was used as an indicator of water quality (Chessman 2003);
- AusRivAS predictive modelling software was used to analyse information on the presence/absence of the aquatic macroinvertebrate taxa and physico-chemical environmental characteristics (Coysh *et al.* 2000); and
- sampling of fish and frogs using a combination of overnight and spot bait trapping, dip netting and visual observation.

The aquatic ecology of the Wolgan River was monitored biannually between autumn 2010 and spring 2012, with a site on the Carne Creek incorporated into the monitoring programme in autumn 2012. A total of 4 monitoring sites were surveyed.

10.3.3 Existing Environment

10.3.3.1 Terrestrial Ecology

A comprehensive account of the existing biodiversity of the Project Application Area is set out in the flora and fauna impact assessment report (**Appendix H**).

This section provides a holistic overview of the results of the flora and fauna surveys from both desktop searches and foot surveys, focusing particularly on those species listed under the TSC Act and or the EPBC Act. A full detailed list of species identified is presented in the flora and fauna impact assessment report (**Appendix H**).

A description of the terrestrial ecology (flora and fauna), aquatic ecology and stygofauna in the vicinity of the Project is provided in **Section 10.3.3** and **Section 10.3.4** describes the potential impacts of the Project on terrestrial ecology, aquatic ecology and stygofauna. **Section 10.3.5** outlines the consequences of potential ecological impact, **Section 10.3.7** summarises the proposed offset and compensatory measures and **Section 10.3.8** outlines relevant mitigation measures, management and monitoring.

Flora

Relevant information was reviewed on ecological values in or potentially occurring within the Project Application Area and locality (i.e. within 10 kilometres of the Project Application Area). The results of database searches (OEH Atlas of NSW Wildlife and EPBC Protected Matters Search) and field surveys indicated that 25 threatened flora species have been previously recorded within 10 kilometres of the Project Application Area and/or have potential habitat within the Project Application Area.

Those threatened plant species identified from literature reviews, field surveys and database searches (within 10 kilometres of the Project Application Area) that have been assessed on the likelihood of occurrence of potentially occurring within the defined Project Application Area based on suitability of habitat are listed in **Table 10.6**. The locations of these threatened flora species are shown in **Figure 10.18.** Details of these species can be found in the flora and fauna assessment report (**Appendix H**).

Table 10.6 Likelihood of Occurrence of Threatened Plant Species within the Ecology Study Area

Species / Community	TSC Act	EPBC Act	Likelihood of Occurrence
Acacia bynoeana Bynoe's Wattle	V	V	Could potentially occur.
Boronia deanei subsp. *deanei* Deane's Boronia	V	V	Could potentially occur.
Caesia parviflora var. minor	E		Could potentially occur.
Eucalyptus aggregata	V		Recorded
Eucalpytus cannonii	V		Recorded
Eucalyptus pulverulenta Silver-leafed Gum	V	V	Could potentially occur.
Genoplesium superbum	E		Could potentially occur.
Lastreopsis hispida Bristly Shield Fern	E		Could potentially occur.
Persoonia acerosa Needle Geebung	V	V	Could potentially occur.
Persoonia hindii	E		Recorded
Prasophyllum fuscum Tawny Leek Orchid	CE	V	Could potentially occur.
Prostanthera cryptandroides subsp. cryptandroides (Wollemi Mintbush)	V	V	Could potentially occur.
Thesium australe Austral Toadflax	V	V	Could potentially occur.
Veronica blakelyi syn. Derwentia blakelyi	V		Recorded

V: Vulnerable Species; E: Endangered Species; CE: Critically Endangered

Vegetation communities were mapped within and surrounding the Project Application Area using desktop analysis and vegetation surveys to define and map vegetation communities and to search for threatened flora species.

The report *Vegetation of the Western Blue Mountains- including the Capertee, Coxs, Jenolan and Gurmang Areas* (DEC 2006) has mapped 32 vegetation communities within the Survey Area and the Project Application Area. Ground-truthing of the site identified 16 vegetation communities.

Table 10.17 lists the vegetation communities within the Project Application Area. **Figure 10.17** shows the vegetation communities within the Project Application Area.

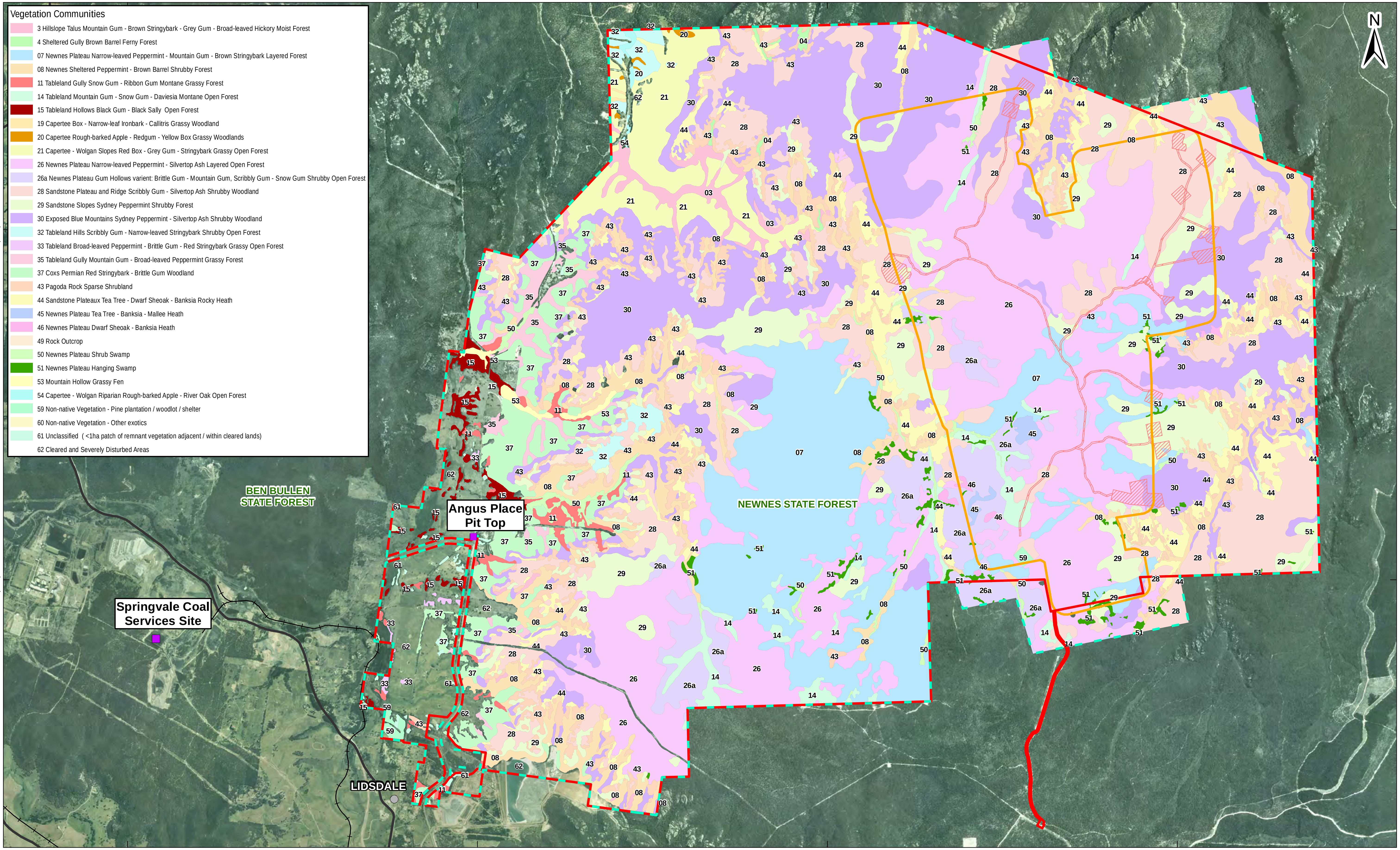
Table 10.7 Vegetation Communities within the Project Application Area

Community	Area (ha)
03 Hillslope Talus Mountain Gum - Brown Stringybark - Grey Gum - Broad-leaved Hickory Moist Forest	91.17
04 Sheltered Gully Brown Barrel Ferny Forest	11.18
7 Newnes Plateau Narrow-leaved Peppermint - Mountain Gum - Brown Stringybark Layered Forest	1124.84
8 Newnes Sheltered Peppermint - Brown Barrel Shrubby Forest	586.95
11 Tableland Gully Snow Gum - Ribbon Gum Montane Grassy Forest	60.46
14 Tableland Mountain Gum - Snow Gum - Daviesia Montane Open Forest	142.43
15 Tableland Hollows Black Gum - Black Sally Open Forest	57.44
19 Capertee Box- Narrow-leaf Ironbark- Callitris Grassy Woodland	1.90
20 Capertee Rough-barked Apple- Redgum- Yellow Box Grassy Open Forest	5.45
21 Capertee- Wolgan Slopes Red Box- Grey Gum- Stringybark Grassy Open Forest	317.20
26 Newnes Plateau Narrow-leaved Peppermint - Silver-top Ash Layered Open Forest	1955.42
26a Newnes Plateau Gum Hollows variant: Brittle Gum - Mountain Gum, Scribbly Gum - Snow Gum Shrubby Open Forest	175.25
28 Sandstone Plateau And Ridge Scribbly Gum - Silver-top Ash Shrubby Woodland	1317.19
29 Sandstone Slopes Sydney Peppermint Shrubby Forest	693.29
30 Exposed Blue Mountains Sydney Peppermint - Silver-top Ash Shrubby Woodland	1662.71
32 Tableland Hills Scribbly Gum- Narrow-leaved Stringybark Shrubby Open Forest	64.30
33 Tableland Broad-leaved Peppermint- Brittle Gum- Red Stringybark Grassy Open Forest	7.87
35 Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest	93.98
37 Coxs Permian Red Stringybark - Brittle Gum Woodland	348.42
43 Pagoda Rock Sparse Shrubland	524.88
44 Sandstone Plateaux Tea Tree - Dwarf Sheoak - Banksia Rocky Heath	392.08
45 Newnes Plateau Tea Tree - Banksia - Mallee Heath	18.03
46 Newnes Plateau Dwarf Sheoak - Banksia Heath	11.31
49 Rock Outcrop	2.92
50 Newnes Plateau Shrub Swamp	39.26
51 Newnes Plateau Hanging Swamp	39.75
53 Mountain Hollow Grassy Fen	42.66
54 Capertee- Wolgan Riparian Rough- barked Apple- River Oak Open Forest	7.01
59 Non-native Vegetation - Pine plantation / woodlot / shelter	13.34
60 Non-native Vegetation - Other exotics (willow etc)	0.24
61 Unclassified (<1ha patch of remnant vegetation adjacent / within cleared lands)	14.82
62 Cleared and Severely Disturbed Lands	647.14
Total	**10470.89**

Ecological assessments were conducted on ESAs larger than the required clearing area. Construction of the proposed surface infrastructure will require the removal of approximately 23.25 ha of woodland within the ESAs all of which will be revegetated during the rehabilitation phase of the Project. **Table 10.8** lists the area of vegetation communities to be cleared within the Project Application Area.

Table 10.8 Native Vegetation Communities in ESAs to be cleared

Vegetation Community	Area (ha)	% of Community within the Project Application Area to be Cleared	% of DEC (2004) Mapped Community to be Cleared
7 Newnes Plateau Narrow-leaved Peppermint - Mountain Gum - Brown Stringybark Layered Forest	1.06	0.09	0.04
14 Tableland Mountain Gum- Snow Gum- Daviesia Montane Open Forest	0.16	0.11	0.01
26 Newnes Plateau Narrow-leaved Peppermint - Silver-top Ash Layered Open Forest	8.25	0.42	0.16
26a Newnes Plateau Gum Hollows variant: Brittle Gum - Mountain Gum, Scribbly Gum - Snow Gum Shrubby Open Forest	0.11	0.06	0.01
28 Sandstone Plateau And Ridge Scribbly Gum - Silver-top Ash Shrubby Woodland	5.45	0.41	0.17
29 Sandstone Slopes Sydney Peppermint Shrubby Forest	1.84	0.27	0.06
30 Exposed Blue Mountains Sydney Peppermint- Silvertop Ash Shrubby Woodland	6.38	0.38	0.09
Total	**23.25**		



LEGEND

- Project Application Area
- Village
- Rail
- Main Road
- Environmental Study Area
- 26.5 Degree Angle of Draw
- Terrestrial Ecology Study Area

DATE	12/02/2014
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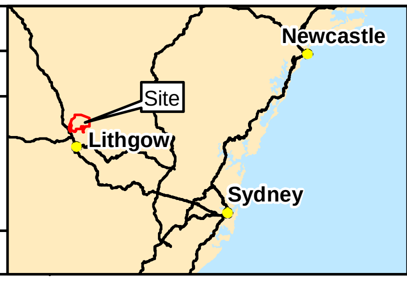

Figure 10.17: Vegetation Communities within Terrestrial Ecology Study Area

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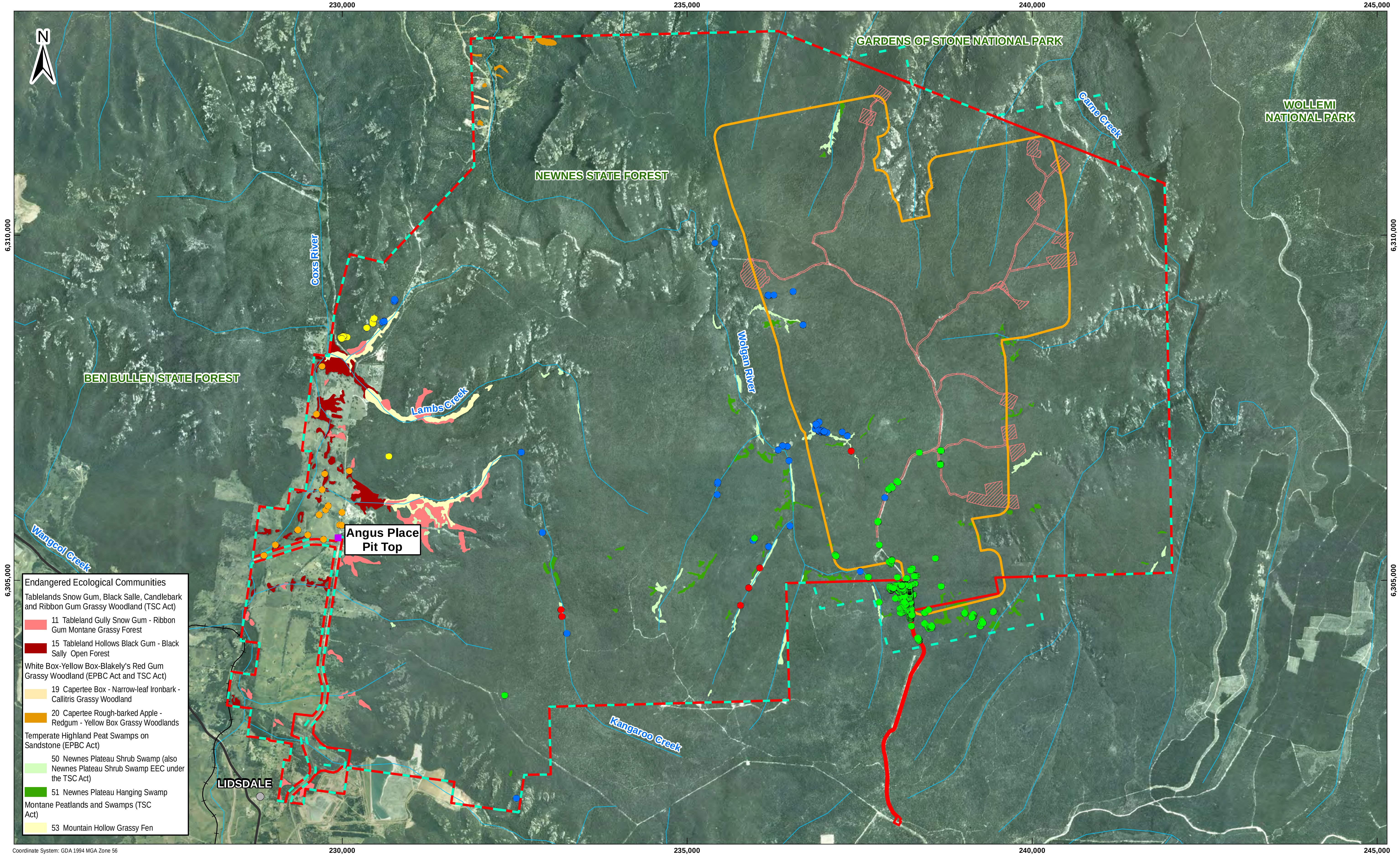

LEGEND

- Project Application Area
- Village
- Rail
- Main Road
- Watercourse
- Environmental Study Area
- 26.5 Degree Angle of Draw
- Terrestrial Ecology Study Area

Threatened Flora (University of Queensland)

- Veronica blakelyi

Threatened Flora (RPS)

- Eucalyptus aggregata
- Eucalyptus cannonii
- Persoonia hindii
- Veronica blakelyi

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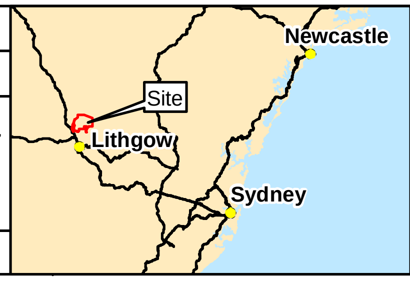

Figure 10.18: Location of Threatened Flora Species and Endangered Ecological Communities within Terrestrial Ecology Study Area

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Angus Place

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Fauna

A review of relevant information on ecological values in the Project Application Area and locality (i.e. within 10 kilometres of the Project Application Area) has assisted in assessing the likelihood of threatened species or ecological communities occurring within the Project Application Area. The results of database searches (NPWS Atlas of NSW Wildlife and EPBC Protected Matters Search) indicated that 57 threatened fauna species have been previously recorded within 10 kilometres of the Project Application Area and/or have potential habitat within the Project Application Area.

Those species identified from literature reviews, database searches (both TSC Act and EPBC Act listed species) and field surveys that are likely to occur within the Project Application Area, based on suitability of habitat, are listed in **Table 10.9**.

Table 10.9 Likelihood of Occurrence of Threatened Fauna within the Ecology Study Area

Species / Community	TSC Act	EPBC Act	Likelihood of Occurrence of Species
Archaeophya adamsi *Adam's Emerald Dragonfly**	-	-	*Could potentially occur.*
Petalura gigantea *Giant Dragonfly*	*E*		*Could potentially occur.*
Heleioporus australiacus *Giant Burrowing Frog*	*V*	*V*	*Could potentially occur.*
Mixophyes balbus *Stuttering Frog*	*E*	*V*	*Could potentially occur.*
Pseudophryne australis Red-crowned Toadlet	V		Could potentially occur.
Litoria littlejohni Littlejohn's Tree Frog	V	V	Could potentially occur.
Eulamprus leuraensis Blue Mountains Water Skink	E	E	Recorded.
Varanus rosenbergi Rosenberg's Goanna	V		Could potentially occur.
Hoplocephalus bungaroides Broad-headed Snake	E	V	Could potentially occur.
Heiraaetus morphnoides Little Eagle	V		Could potentially occur.
Callocephalon fimbriatum Gang-Gang Cockatoo	V		Recorded.
Calyptorhynchus lathami Glossy Black-Cockatoo	V		Recorded.
Chthonicola sagittata Speckled Warbler	V		Could potentially occur.
Climacteris picumnus victoriae Brown Treecreeper (eastern subsp.)	V		Recorded.
Daphoenositta chrysoptera Varied Sittella	V		Recorded .
Anthochaera phrygia Regent Honeyeater	CE	E	Could potentially occur.
Glossopsitta pusilla Little Lorikeet	V		Recorded. .

Species / Community	TSC Act	EPBC Act	Likelihood of Occurrence of Species
Grantiella picta Painted Honeyeater	V		Could potentially occur.
Melanodryas cucullata Hooded Robin	V		Recorded.
Petroica boodang Scarlet Robin	V		Recorded.
Petroica pheonicea Flame Robin	V		Recorded
Pomatostomus temporalis temporalis Grey-crowned Babbler	V		Recorded .
Melithreptus gularis gularis Black-chinned Honeyeater	V		Recorded.
Ninox connivens Barking Owl	V		Likely to occur.
Ninox strenua Powerful Owl	V		Recorded.
Tyto novaehollandiae Masked Owl	V		Recorded
Tyto tenebricosa Sooty owl	V		Recorded
Chalinolobus dwyeri Large-eared Pied Bat	V	V	Recorded.
Chalinolobus picatus *Little Pied Bat*	V		Could potentially occur.
Falsistrellus tasmaniensis Eastern False Pipistrelle	V		Recorded
Miniopterus schreibersii subsp. oceanensis Eastern Bentwing Bat	V		Recorded
Mormopterus norfolkensis Eastern Freetail-bat	V		Likely to occur.
Saccolaimus flaviventris Yellow-bellied Sheathtail Bat	V		Recorded
Scoteanax rueppellii Greater Broad-nosed Bat	V		Recorded
Vespadelus troughtoni Eastern Cave Bat	V		Could potentially occur.
Dasyurus maculatus maculatus Spotted-tailed Quoll	V	E	Could potentially occur.
Cercartetus nanus Eastern Pygmy Possum	V		Recorded
Isoodon obesulus obesulus Southern Brown Bandicoot	E	E	Could potentially occur.
Petaurus australis Yellow-bellied Glider	V		Could potentially occur.

Species / Community	TSC Act	EPBC Act	Likelihood of Occurrence of Species
Petaurus norfolcensis Squirrel Glider	V		Recorded
Petrogale penicillata Brush-tailed Rock-wallaby	E	V	Could potentially occur.
Phascolarctos cinereus Koala	V	V	Likely to occur.
Pseudomys novaehollandiae New Holland Mouse		V	Could potentially occur.

V: Vulnerable Species; E: Endangered Species; CE: Critically Endangered
*threatened invertebrate species under the *FM Act*

Migratory species listed under the EPBC Act have also been considered under this assessment. A Protected Matters Search was undertaken (Accessed February 2013) on the SEWPAC (now DoE) website which lists potential migratory species. **Table 10.10** lists the potentially occurring migratory species within a 10 kilometres radius of the Project Application Area.

Table 10.10 Migratory Species Potentially Occurring within a 10 kilometres radius of the Project Application Area

Scientific Name	Common name
Apus pacificus	Fork-tailed Swift
Ardea ibis	Cattle Egret
Haliaeetus leucogaster	White-bellied Sea-Eagle
Hirundapus caudacutus	White-throated Needletail
Gallinago hardwickii	Latham's Snipe
Lathamus discolour	Swift Parrot
Leipoa ocellata	Malleefowl
Merops ornatus	Rainbow Bee-eater
Monarcha melanopsis	Black-faced Monarch
Myiagra cyanoleuca	Satin Flycatcher
Rhipidura rufifrons	Rufous Fantail
Rostratula benghalensis	Painted Snipe

Threatened species searches were undertaken within suitable habitat in consideration of the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft (DECC 2004).* A relatively diverse range of fauna groups are represented across the Project Application Area and, 111 species were identified including nine threatened fauna species listed under the TSC Act and/or EPBC Act. Threatened fauna species locations are shown in **Figure 10.19**. Those species observed within the Project Application Area are discussed briefly below. A full list of fauna species recorded is provided in the Flora and Fauna Assessment Report **Appendix H**.

Terrestrial Mammals

Open forest communities containing grassy understorey provide suitable habitat for a number of terrestrial mammals. Three species of macropod were encountered frequently within the Project Application Area and the wider locality, namely the Red-necked Wallaby (*Macropus rufogriseus*), Eastern Grey Kangaroo (*M.*

giganteus) and Swamp Wallaby (*Wallabia bicolour*). The Common Wombat (*Vombatus ursinus*) was also recorded regularly during surveys.

Arboreal Mammals

Canopy tree species and understorey shrubs provide foraging resources such as foliage, seeds, pollen, nectar and invertebrates for possums, gliders and bats. Five arboreal mammal species, including the TSC Act listed Eastern Pygmy Possum (*Cercatetus nanus*) were recorded on the Project Application Area. The Greater Glider (*Petauroides volans*), Common Ringtail Possum (*Pseudocheirus peregrinus*), Sugar Glider (*Petaurus breviceps*) and Common Brushtail Possum (*Trichosurus vulpecula*) were recorded during spotlighting surveys. The threatened Eastern Pygmy Possum was detected through the use of arboreal Elliot B traps. Although not observed during surveys, there is suitable habitat within the Project Application Area for the threatened Squirrel Glider (*Petaurus norfolcensis*).

Records for *Petaurus australis* (Yellow-bellied Glider) are sparse on the Newnes Plateau and this highly vocal species was not observed or heard during surveys.

Bats

Ten species of microchiropteran bat were positively identified from echolocation call analysis within the Project Application Area. Of these, three threatened microchiropteran bat species listed under the TSC Act and/or EPBC Act were identified, being the Large-eared Pied Bat, Eastern Bentwing Bat and Yellow-bellied Sheathtail Bat, the location of which are shown in **Figure 10.19**. A full list of bat species recorded within the Project Application Area is provided in Flora and Fauna Assessment Report **Appendix H**.

Avifauna

A moderate diversity of common open forest birds including those characterising elevated habitats were observed across the Project Application Area. Avian species groups encountered were Honeyeaters, Fairy-wrens, Thornbills, Magpies Currawongs, Parrots, Cockatoos, Whistlers and Frogmouths.

Five TSC Act threatened bird species including the Varied Sittella (*Daphoenositta chrysoptera*), Flame Robin (*Petroica phoenicea*), Scarlet Robin (*Petroica boodang*), Powerful Owl (*Ninox strenua*) and Gang-gang Cockatoo (*Callocephalon fimbriatum*) were recorded. These five species are not listed under the EPBC Act.

A number of other State-listed threatened bird species have been recorded within the Newnes Plateau and within the Project Application Area in previous studies, including the Brown Treecreeper – Southeastern subspecies (*Climacteris picumnus* ssp. *victoriae*), Speckled Warbler (*Chthonicola sagittata*), Black-chinned Honeyeater (*Melithreptus gularis* ssp. *gularis*), Hooded Robin – Southeastern subspecies (*Melanodryas cucullata* ssp. *cucullata*) and Glossy Black-Cockatoo (*Calyptorhynchus lathami*).

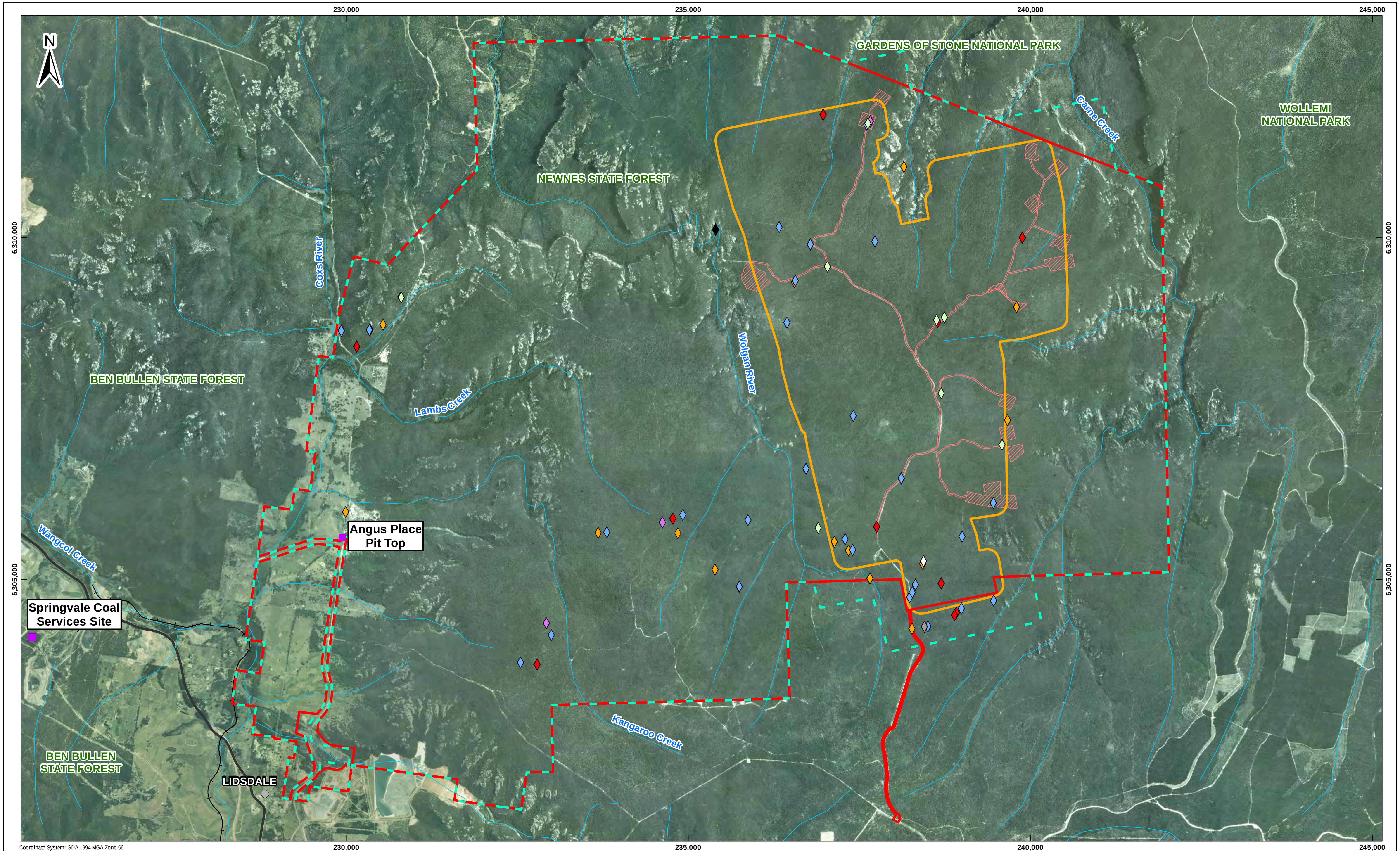
Two native species of Sheoak trees (*Allocasuarina littoralis* and *A. nana*) were found within the Survey Area in patchy distributions. These species of Allocasuarina are potential feed trees for Glossy Black-Cockatoos.

One forest owl, the Powerful Owl, was recorded within the Project Application Area however it is also likely that the Project Application Area is part of the local foraging range of Masked Owls. The Project Application Area contains a variety of terrestrial and arboreal mammals, which make up the diet of these owls.

<u>*Herpetofauna*</u>

A total of 12 reptile species were recorded within the Project Application Area including Cunningham's Skink (*Egernia cunninghami*), Yellow-bellied Water-skink (*Eulamprus heatwolei*), Lesueur's Velvet Gecko (*Oedura lesueurii*). No threatened herpetofauna were detected.

Nine amphibian species were recorded within the Project Application Area including the Blue Mountains Tree Frog (*Litoria citropa*), Tyler's Tree Frog (*Litoria tyleri*) and Spotted Grass Frog (*Limnodynastes tasmaniensis*). *Heleioporus australiacus (*Giant Burrowing Frog) is the only threatened frog recorded in the Survey Area.



LEGEND

- Project Application Area
- Village
- Rail
- Main Road
- Watercourse
- Environmental Study Area
- 26.5 Degree Angle of Draw
- Terrestrial Ecology Study Area

Threatened Fauna

- Eastern Bentwing-bat
- Eastern Pygmy Possum
- Flame Robin
- Gang-Gang Cockatoo
- Large-eared Pied Bat
- Powerful Owl
- Scarlet Robin
- Varied Sittella

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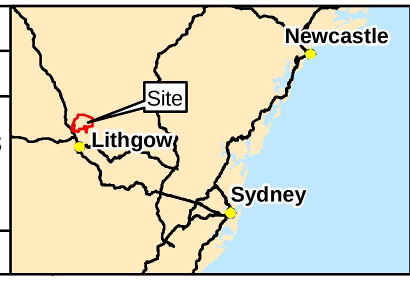

Figure 10.19: Location of Threatened Fauna Species within Terrestrial Ecology Study Area

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Angus Place

DRG No. 58

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Endangered Ecological Communities and Swamps

The document, Vegetation of the Western Blue Mountains- including the Capertee, Coxs, Jenolan and Gurmang Areas (DEC 2006) mapped 32 vegetation communities within the Project Application Area.

Five Endangered Ecological Communities (EECs) were recorded within the Project Application Area. These were:

- Temperate Highland Peat Swamps on Sandstone;
- Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion (Newnes Plateau Shrub Swamp);
- Montane Peatlands and Swamps of the Sydney Basin Bioregion (Montane Peatlands and Swamps);
- Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions (Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland); and
- White Box- Yellow Box- Blakely's Gum Grassy Woodland and Derived Native Grassland.

Temperate Highland Peat Swamps on Sandstone is listed under the EPBC Act. Vegetation communities recorded within the Project Application Area that correspond to this EEC are 50 – Newnes Plateau Shrub Swamp (39.26 ha), 51 – Newnes Plateau Hanging Swamp (39.75 ha) and 52 – Newnes Plateau Rush-Sedge Snow Gum Hollow Wooded Heath as described and mapped within the Vegetation Mapping of the Western Blue Mountains (DEC 2006).

Newnes Plateau Shrub Swamp is listed as an EEC under the TSC Act. One vegetation community recorded within the Project Application Area correspond to this EEC, namely 50 – Newnes Plateau Shrub Swamp.

Montane Peatlands and Swamps is listed as an EEC under the TSC Act. 53 Mountain Hollow Grassy Fen (42.66 ha within the Project Application Area) is regarded by DEC (2006) as forming part of this EEC.

Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland is an EEC listed under the TSC Act. Vegetation communities recorded within the Project Application Area that correspond to this EEC are 11 – Tableland Gully Snow Gum- Ribbon Gum Montane Grassy Forest (60.46 ha) and 15 – Tableland Hollows Black Gum- Black Sally Open Forest (57.44 ha within the Project Application Area).

19 Capertee Box – Narrow-leaf Ironbark- Callitris Grassy Woodland (1.90 ha) and 20 Capertee Rough-barked Apple- Redgum- Yellow Box Grassy Woodlands (5.45 ha) may be commensurate with White Box Yellow Box Blakely's Red Gum Woodland (TSC Act) and White Box- Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act).

The vegetation types within the Project Application Area that clearly fall into the groundwater dependent ecosystem category are:

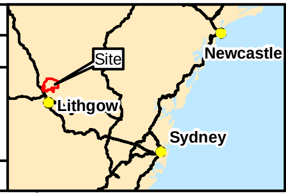
- 50- Newnes Plateau Shrub Swamp;
- 51- Newnes Plateau Hanging Swamp; and
- 53- Mountain Hollow Grassy Fen.

Photograph 10.1 Newnes Plateau Shrub Swamp

Photograph 10.2 Newnes Plateau Hanging Swamp

CENTENNIAL ANGUS PLACE PTY. LTD.

DATE	13/03/2014
SEAM	LITHGOW
REFERENCE	127623060-R APC Rev 0
SCALE	NOT TO SCALE



PLOTFILE No.

Centennial Coal

Angus Place

DRG No. A4

Shrub swamps and hanging swamps can be separated by differences in hydrological regimes, floral assemblages and topographic location. The distribution of these swamp types across the Project Application Area is provided in **Figure 10.1**. A summary of the characteristics of both the shrub swamp and hanging swamp is outlined in **Section 2.8.3** and representative photographs are presented above.

Temperate Highland Peat Swamps on Sandstone (THPSS) form part of the hydrological regime across the Newnes Plateau and are groundwater dependent ecosystems (groundwater dependant ecosystems).

The definition and classification of groundwater dependant ecosystems adopted in this report are those from the Risk Assessment Guidelines For Groundwater Dependant Ecosystems produced by the NSW Office of Water (Serov et al. 2012). Groundwater dependant ecosystems are ecosystems in which the species composition and natural ecological processes are either wholly or partially determined by groundwater. The classification scheme recognises three broad types of groundwater dependant ecosystems associated with underground ecosystems:

- karst and caves;
- subsurface phreatic aquifer ecosystems;
- baseflow stream (hyporheic or subsurface water ecosystems), and four broad types of groundwater dependant ecosystems associated with above ground ecosystems;
- groundwater dependent wetlands;
- baseflow streams (surface water ecosystems);
- estuarine and near shore marine ecosystems, and
- phreatophytes – groundwater dependent terrestrial ecosystems;

The Project could potentially impact on three groundwater dependant ecosystems: baseflow streams, groundwater dependent wetlands and subsurface phreatic aquifer ecosystems.

10.3.3.2 Aquatic Ecology

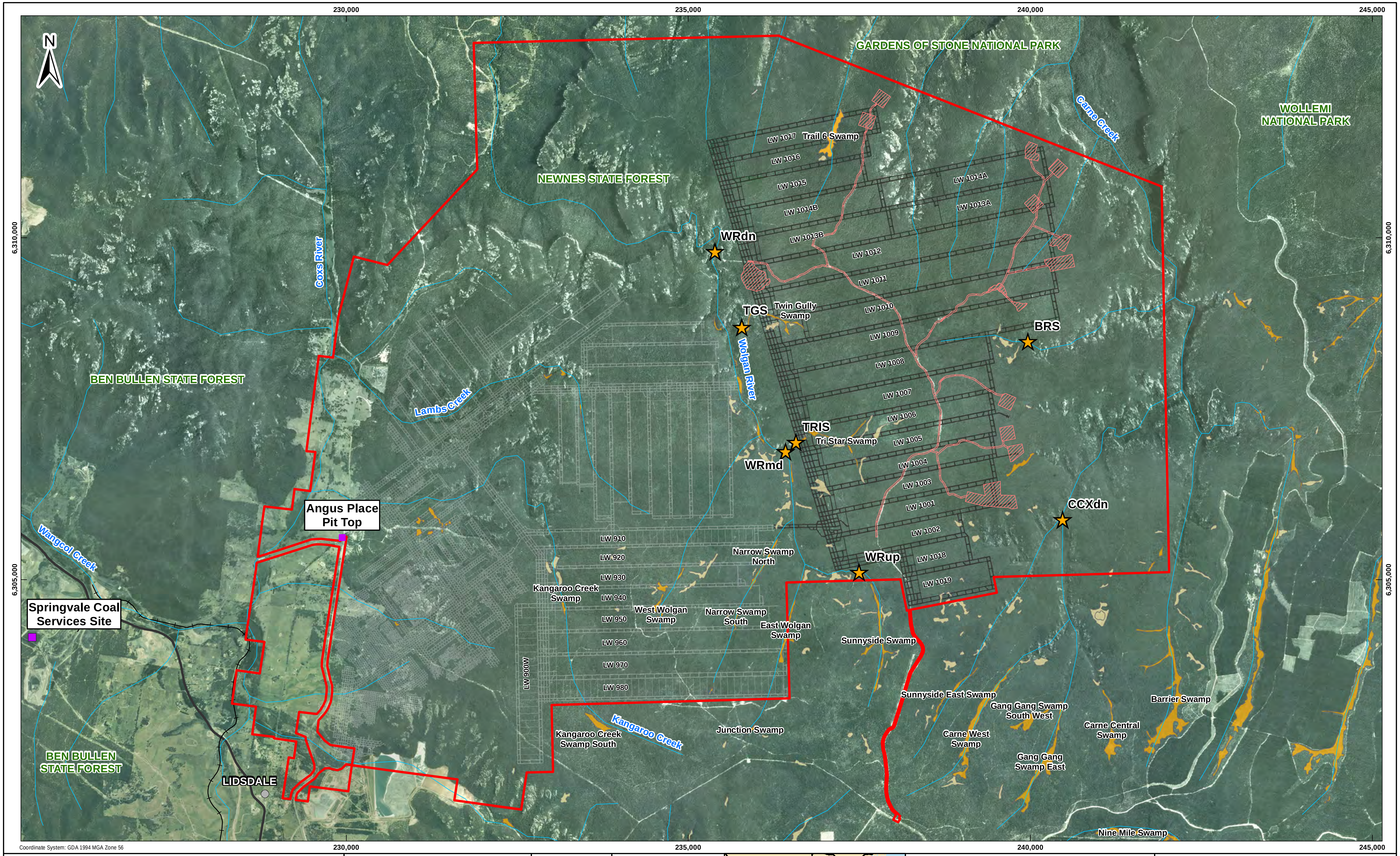
The Protected Matters Search Tool indicated that three threatened fish species listed under the EPBC Act may occur, or suitable habitat for them may occur, within the Lithgow Local Government Area. Two of these species, Murray Cod (*Maccullochella peelii*) and Australian Grayling (*Prototroctes maraena*), are considered to be vulnerable to extinction, whilst the third, Macquarie Perch (*Macquaria australasica*), is endangered.

A search for records of threatened and protected species of fish in the Lithgow Local Government Area and Hawkesbury-Nepean Catchment Management Authority area was undertaken using the online Record Viewer developed by the Threatened Species Unit of I&I NSW. The NSW BioNet managed by OEH's Wildlife Unit, was also used to search for records of flora and fauna held in the Atlas of NSW Wildlife.

According to Record Viewer, the Macquarie Perch is the only threatened fish species listed under the FM Act to have been recorded in the Lithgow Local Government Area, with a record for a specimen caught in the Capertee River in 2006. A search for records of this species over the entire Hawkesbury-Nepean Catchment Management Area revealed it had been also been found in the Colo River in 2007. The wider geographic search indicated that two other threatened fish species (Silver Perch and Trout Cod) listed under the FM Act have been recorded in the Hawkesbury-Nepean Catchment, however, these records are all from coastal rivers and represent stocked fish (NSW DPI 2006b).

The NSW BioNet search recorded one endangered semi-aquatic invertebrate species, the Giant Dragonfly (*Petalura gigantea*), listed under the TSC Act in the Lithgow Local Government Area. This species is typically found in permanent swamps and bogs containing some free water and open vegetation (NSW Scientific Committee, 2004). The Giant Dragonfly has been recorded in a number of swamp or mire types in the Blue Mountains region, including the Newnes Plateau Shrub Swamps (Baird 2012).

Descriptions are provided below of the aquatic environment and biota occurring at monitoring sites on the Wolgan River (WRup, WRmd, and WRdn), Carne Creek (CCXdn) and sites downstream of the two Shrub Swamps (Twin Gully and Tri Star) and one Hanging Swamp (Bird Rock). The locations of the monitoring sites are provided **Figure 10.20**.



LEGEND

- Project Application Area
- Village
- Rail
- Main Road
- Watercourse
- Environmental Study Area
- Shrub Swamp
- Hanging Swamp
- Monitoring Location

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F059 APC Rev 0
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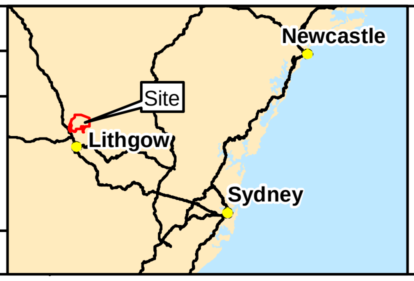

Figure 10.20: Aquatic Ecology and Stygofauna Monitoring Sites

0 1 2 3 km

PLOTFILE No.

Centennial Coal

Angus Place

DRG No. 59

A3

Instream Ecology

The monitoring sites on the Wolgan River (WRup, WRmd, and WRdn) were surrounded by dense, overhanging riparian vegetation. The river channel was narrow, water levels shallow to moderate, with maximum depths varying from 0.2 m- 1.5 m. The river substratum was variable, comprising mostly of bedrock, but with some sandy areas of finer sediments at the upstream site. The midstream site consisted of sandy pools, boulders and cobbles and gravel; sand and boulder fragments at the downstream site. The aquatic habitat in the river had been exposed to small to moderate amounts of disturbance, with the midstream site being in a slightly better condition that the other two sites. Iron flocculation was present at the upstream site only.

The site on Carne Creek (CCXdn) was incised, generally straight, narrow and shallow. Dense vegetation and moss-covered boulders and logs were present along the banks. The channel substratum was variable and comprised sandstone fragments, ranging in size from gravel to cobble, long sand drifts and boulder outcrops. The site had been subject to minimal disturbance.

Table 10.11 outlines the water quality levels for each monitoring site including the electrical conductivity, dissolved oxygen, pH and turbidity levels.

Table 10.11 Water Quality Instream Ecology

Water Quality Levels	WRup	WRmd	WRdn	CCXdn
Electrical conductivity (µS/cm)	42- 51	30-38	33-57	30
Dissolved oxygen (%)	90	90	90	90
pH (units)	6.5- 8.0	6.5-8.0	6.5	6.5
Turbidity (NTU)	2-25	25	2-25	2-25

The electrical conductivity of the water in the Wolgan River at WRup, WRmd and WRdn was low (between 30-57 µS/cm), and within the ANZECC/ARMCANZ (2000) guidelines (30 µS/cm to 350 µS/cm) for slightly disturbed upland rivers in southeast Australia. The single measurement taken on Carne Creek (CCXdn) was below the lower default trigger value of electrical conductivity. The dissolved oxygen and pH levels recorded in the Wolgan River at WRup, WRmd and WRdn were below the lower default trigger value more often than they were within the guidelines. The water at Carne Creek (CCXdn) was more acidic than that at the Wolgan River sites (WRup, WRmd, and WRdn). The turbidity levels at all sites on the creek and river were within the guidelines.

Filamentous green alga was observed at the WRup, WRmd and WRdn on the Wolgan River during most surveys, except that in autumn 2012. No alga was observed at the Carne Creek site (CCXdn). Charophytes were recorded at WRup, WRmd and WRdn on the Wolgan River, except at the WRdn site in Autumn 2010 and 2011, when no charophyte algae was recorded.

Swamp Clubrush was identified at all WRup, WRmd and WRdn. Jointed Rush has also been recorded at WRmd on one occasion. No macrophytes or algae were observed at the CCXdn.

The aquatic macroinvertebrate fauna consisted primarily of insect families plus a few crustacean, worm, bivalve mollusc and mite taxa. The macroinvertebrate fauna in the Wolgan River at sites WRup, WRmd and WRdn supported a diverse range of aquatic macroinvertebrate fauna, with a total of 57 taxa being recorded and total numbers per site ranging from 33-43 taxa. The fauna consisted of 49 insect families, fourth crustacean taxa, two different types of works and one taxon each of bivalves and freshwater mites. Fewer taxa were recorded per survey, with numbers varying from 18-25, 20-25, and 19-24 at WRup, WRmd and WRdn respectively. The proportion of taxa recorded every survey declined from 41.9% at WRup to 36.4% at WRmd site and 28.3% at the WRdn. The macroinvertebrate fauna at Carne Creek (CCXdn site) was less diverse, with a total of 25 taxa recorded and numbers per survey varying from 19 to 23.

Eastern Banjo Frogs (*Lymnodynastes dumerilli grayi*) and Spotted Marsh Frogs (*Lymnodynastes tasmaniensis*) were heard at the WRup site and tadpoles were recorded at WRup and WRdn. The Eel (*Anguilla sp*.) was the only fish species observed at WRmd site. Fish and larvae, most likely Mountain Galaxies, were sighted in Carne Creek (CCXdn).

Table 10.12 lists the in-stream ecology characteristics of Wolgan River and Carne Creek.

Table 10.12 Instream Characteristics of Wolgan River and Carne Creek

	Wolgan River		**Carne Creek**	
	Upstream (n=6)	Mid-stream (n=6)	Downstream (n=6)	Creek (n=2)
Disturbance	Moderate disturbance	Small to moderate disturbance	Small to moderate disturbance	Minimal disturbance
Habitat	Habitat: diverse Riparian: dense with overhang Substrate: sandy	Habitat: diverse Riparian: dense with overhang Substrate: bedrock with boulder/cobbles	Habitat: diverse Riparian: dense with overhang Substrate: sandy with boulder/gravel	Habitat: diverse Riparian: dense with ferns, boulders and logs Substrate: diverse boulder to sand drifts
Algal cover (occurrence and cover)	Filamentous green algae cover: small to moderate Charophytes present	Filamentous green algae cover: small to moderate Charophytes present	Filamentous green algae cover: small Charophytes present	Nil
Macrophytes (occurrence)	At least three species present	At least three species present	At least three species present	Nil
Macroinvertebrates	18-25 taxa	20-25 taxa	19-24 taxa	19-23 taxa
SIGNAL2 (average score range)	3.5 to 4.9 Moderate to severe water quality degradation	5.1 to 5.5 Mild water quality degradation	4.8 to 5.5 Mild to moderate water quality degradation	6.00 to 6.47 Water quality not degraded
AusRivAS	Below reference; significantly impaired	Ranged from significantly impaired to equivalent to reference condition	Ranged from significantly impaired to equivalent to reference condition	N/a
Fish (observations and trapping)	Nil	Eel (*Anguilla* sp.).	Nil	Probable Mountain Galaxias observed
Frogs (observations or heard during aquatic sampling)	Eastern Banjo Frog Spotted Marsh Frog	Nil	Nil (tadpoles observed)	Nil

Aquatic Ecology Downstream of Swamps

The monitoring sites included sites downstream of two Shrub Swamps in the Wolgan River catchment (Twin Gully Swamp and Tri Star Swamp), and a Hanging Swamp (Bird Rock Swamp) in the Carne Creek. The Shrub Swamps are located within the Mine Extension Area, with Twin Gully Swamp being above proposed LW1010 and Tri-Star Swamp above proposed LW1004 to LW1006. Bird Rock Swamp is situated to the east of proposed LW1007 to LW1009.

Water was observed seeping from the cliffs sites downstream of the Shrub Swamps. The drainage channels below the Tri Star, Twin Gully and Bird Rock swamps were overgrown with dense vegetation. The substratum consisted mainly of bedrock, but with some sand and silt accumulations. Boulders were also present downstream of the Twin Gully and Bird Rock swamps. Moss was prevalent along the stream banks downstream of the Shrub Swamps. There was evidence of high flows which had resulted in scouring of habitats, deepening of pools and creation of new flow paths. The riparian habitat and stream channels downstream of the swamps were minimally disturbed.

Table 10.13 outlines the water quality levels for each monitoring site including the electrical conductivity, dissolved oxygen, pH and turbidity levels.

Table 10.13 Water Quality Downstream of Swamps

Water Quality Levels	Twin Gully	Tri Star	Bird Rock
Electrical conductivity (µS/cm)	22-26	18-24	39-48
Dissolved oxygen (%)	90	90	90
pH (units)	6.5	6.5	6.5
Turbidity (NTU)	2-25	2-25	2-25

The electrical conductivity of the water downstream of the Twin Gully and Tri Star swamps was lower than that downstream of Bird Rock Swamp and below ANZECC/ARMCANZ (2000) guidelines. Dissolved oxygen levels at all sites were frequently below the guidelines, especially downstream of Twin Gully Swamp. The pH levels at all three swamp sites were more acidic than the guidelines and below the lower default trigger value, with Tri Star Swamp being less acidic. Turbidity levels downstream of the Twin Gully and Bird Rock swamps were within the guidelines, but those downstream of Tri Star Swamp occasionally exceeded the upper default trigger value.

No aquatic macrophytes were observed downstream of Twin Gully Swamp or Bird Rock Swamp. Three different aquatic macrophytes were recorded downstream of Tri Star Swamp: a plant tentatively identified as a member of the family Cypercaceae (sedge), Bulbous Rush and Swamp Clubrush, with the latter being the most reliable information. Filamentous green algae were generally present downstream of the Shrub Swamps, but found only once downstream of the Hanging Swamp. Charophytes were observed occasionally downstream of Tri Star Swamp.

The macroinvertebrate fauna downstream of the Shrub Swamps was more diverse than that downstream of Bird Rock Swamp. The fauna consisted primarily of insect families, plus crustaceans, worms, bivalves, freshwater mites, leeches and springtails. The site downstream of Tri Star Swamp supported the most diverse fauna, followed by that downstream of Twin Gully Swamp.

No fish or amphibians were observed in the swamps.

Threatened and Protected Species

According to Record Viewer, the Macquarie Perch is the only threatened fish species listed under the FM Act to have been recorded in the Lithgow Local Government Area. This record is for a specimen caught in the Capertee River in 2006. A search for records of this species over the entire Hawkesbury-Nepean Catchment Management Area revealed it had been found in the Colo River in 2007. The wider geographic search indicated that two other threatened fish species (Silver Perch and Trout Cod) listed under the FM Act have been recorded in the Hawkesbury-Nepean catchment, however, these records are all from coastal rivers and represent stocked fish (NSW DPI 2006b). The current distribution ranges of Macquarie Perch indicate they are highly unlikely to occur in the Project Application Area. Australian Grayling, one of the threatened fish species listed under the EPBC Act as potentially occurring in the Lithgow Local Government Area, is listed as a protected species under the FM Act but its current distribution range suggests that this species is highly unlikely to occur in the Project Application Area.

None of the threatened fish species listed under the EPBC Act or FM Act identified as potentially occurring within Lithgow Local Government Area are likely to occur within the Project Application Area. One threatened invertebrate species, the Giant Dragonfly, is known to occur in some of the swamps. There are no records of Adam's Emerald Dragonfly occurring in the vicinity of the Project Application Area, but suitable habitat for this species does exist, so it could potentially be present.

The search of the BioNet website for the Atlas of NSW Wildlife indicated that two semi-aquatic mammals, the platypus (*Ornithorhynchus anatinus*) and water rat (*Hydromys chrysogaster*), that are listed as protected under the NSW *National Parks and Wildlife Act 1974* occur within the Lithgow Local Government Area.

There are, however, no records of either species occurring within the Project Application Area or Newnes State Forest.

The NSW BioNet search also showed that the endangered Giant Dragonfly, listed under the TSC Act has been recorded in the Lithgow LGA. This species has been recorded in several Shrub Swamps within the Project Application Area.

10.3.3.3 Stygofauna

Subterranean aquatic systems often support a diverse group of animals, including crustaceans, worms, snails, insects, other invertebrate groups and fish, referred to collectively as stygofauna.

The aquifers and aquitard that occur below the Project Application Area form three basic groundwater systems- a perched, surficial hydrogeological system, a shallow regional groundwater system, and a deep confined groundwater system.

Stygofauna sampling targeted the groundwater system, individual swamps and the near-surface aquifer in the Banks Wall Sandstone. Samples from the swamp boreholes contained four likely (*Cyclopoid copepoda*, *Harpacticoid copepoda, Copepod nauplii* and *Bathynellid syncarids*) and three possible stygofauna taxa (Rotifera, Tardigrada and Phreatoicid isopods). The boreholes at Sunnyside East Swamp yielded the greatest number of likely and potential stygofauna taxa, but also yielded more water than the other swamp boreholes. One likely (Cyclopoid copepod) and two possible stygofauna taxa (Acarina and Rotifera) were found in the boreholes that targeted the shallow unconfined aquifer.

Hancock and Boulton 2008 surveyed two aquifers in each of Queensland and NSW and noted that most stygofauna were found in water with low electrical conductivity (<1500 µS/cm) and that taxon richness decreased with depth. The most taxon rich bores in each sample site were <10 m deep and associated with alluviums of large river systems.

4T Consultants 2012 noted that the majority of stygofauna in Australia have been recorded in unconsolidated sediments (alluviums) and fractured rock aquifers. No stygofauna have been found in coal seams.

4T Consultants also noted that in alluviums, stygofauna were most likely to be found at shallow depths (<20 m) and that suitable stygofauna conditions exist up to 50 m below ground level in fractured rock aquifers. Similarly Bennison (2012) noted that stygofaunal diversity increases where there is greater likelihood of access to nutrients, organic carbon and oxygen, conditions which would be met at depth less than 20 m below ground surface.

10.3.4 Potential Impacts

10.3.4.1 Terrestrial Ecology

Key potential impacts of the Project on terrestrial fauna and their habitats include habitat removal by clearing for surface infrastructure or habitat modification by subsidence.

Clearing

Terrestrial Ecology

The proposed installation of surface facilities will require the removal of vegetation and habitats potentially suitable for threatened flora and fauna species. Clearing for proposed surface infrastructure covers a total maximum area of 23.25 ha of native vegetation. Two threatened flora species have been recorded within the surface infrastructure ESAs, namely *P. hindii* and *V. blakelyi.* These recorded plants and stems will be avoided by the works and no recorded *P. hindii* and *V. blakelyi stems or plants* will be lost, however 23.25 ha of potential habitat for *P. hindii* and *V. blakelyi* will be removed.

The clearance of 23.35 ha will cause a loss of habitat features including grasses, shrubs and ground debris that may be used by small reptiles, birds and mammals, either directly or indirectly.

Due to their inconspicuous nature and specific habitat associations, two additional species is considered to have potential to occur within ESAs, namely *Caesia parviflora* var. minor and *Genoplesium superbum*.

If any currently unidentified individuals of *Caesia parviflora var. minor* and *Genoplesium superbum* are cleared for proposed surface infrastructure, they are expected to be part of the wider local population across Newnes Plateau. The 7 part test found that given the wide representation of potential habits for this species, it is unlikely to be affected by the Project.

Fauna can use native vegetation for foraging, roosting, movement, shelter and breeding. Apart from minor disturbance associated with monitoring and management in the underground mining areas, the Project would potentially involve the removal of up to 23.25 ha of habitat for construction of surface infrastructure. This habitat is generally characterised by dry shrubby to grassy woodlands and forests which is home to a large number of identified potential threatened fauna.

The Project may therefore constitute a direct loss of potential for threatened fauna including Spotted-tailed Quoll, Southern Brown Bandicoot and New Holland Mouse. This would also remove hunting habitats for species of owl and threatened woodland birds, such as Brown Treecreeper, Hooded Robin, Scarlet Robin and Flame Robin.

The loss of mid-storey and canopy trees would remove nesting and foraging habitat for threatened bird species, as well as foraging habitats for threatened arboreal mammals, micro-bats and hunting habitat for the Broad-headed Snake.

Much of the proposed footprint is also occupied by hollow-bearing trees. Loss of hollows will constitute a loss of habitat to hollow dependent arboreal mammals and hollow dependent species of microbats.

Whilst less abundant, hollow sizes were recorded that would be suitable for supporting forest owls and large species of parrot. The Project will constitute a loss to potential roosting or nesting trees for the Gang-Gang Cockatoo, Glossy Black-Cockatoo and threatened owls.

No potential breeding habitat would be removed for the Giant Burrowing Frog, Stuttering Frog, Red-crowned Toadlet or Littlejohn’s tree Frog. The proposed clearing may however, cause a loss of potential foraging habitat for these species.

All EECs will be avoided.

<u>*Swamps*</u>

Construction activities that take place in the vicinity of swamps could potentially interfere with the shallow perched aquifers that support the swamps and impact on surface waters that flow through the swamps into the drainage lines. The potential impacts on the aquatic ecology of the drainage lines include:

- disturbance of soils and sediments by construction equipment and runoff from access road and areas where vegetation has been cleared and soils have been stockpiled could increase the sediment load in the drainages;
- an increase in sediment load could, in turn, alter the nature of the benthic substratum, smother some aquatic habitats and increase turbidity levels within watercourses, with the latter potentially decreasing the amount of light available for photosynthesis by aquatic plants, clogging the gills and feeding apparatus of aquatic fauna and reducing the visual acuity of some predators;
- runoff from cleared areas and stockpiles of soil could also transfer sequestered nutrients, organic matter and contaminants into the swamps and their downstream drainages;
- the clearing of riparian vegetation could have indirect impacts on abundance, distribution and health of biota associated with the drainages that use the vegetation as a habitat, refuge or source of food; and
- accidental release of lubricating oils, hydraulic fluids and fuel from construction equipment could result in inputs of toxic hydrocarbon and metal contaminants into the drainages and swamps.

The construction of dewatering bores in the vicinity of shrub or hanging swamps could potentially interfere with the shallow perched aquifers that support the swamps and impact on surface waters that flow through the swamps. Potential impacts include:

- discharge of groundwater to the surface which in turn could lead to flooding of swamps and changes in the quality of surface water;
- contamination of swamps either as a result of drilling muds/fluids, drilling additives, oils and lubricants entering surface water within the swamps or seeping into the shallow aquifers that support the swamps; and
- clearing of vegetation around the borehole sites could result in erosion and exposure the swamps to increased sedimentation.

All swamps will be avoided.

Subsidence

Subsidence has the potential to modify habitats through surface cracking, slope changes causing erosion, and changes to hydrological regimes. Most of the Project Application Area is dry woodland, forest or heath. The risks of subsidence related impacts on drier habitats are low as even significant subsidence induced cracking and potholing has minimal effect on dryland plant communities.

Risks of subsidence related impacts are higher in riparian habitats and groundwater dependent ecosystems. This is due to the potential for subsidence to alter the hydrology of surface water or groundwater such that it may interfere with ecosystem function. Specifically subsidence may crack swamp substrates and so cause a loss of water, which in turn reduces the long term viability of the swamp.

Assessment of impacts to GDEs from subsidence has included consideration of the potential for ecosystem functioning of these systems to be impaired. Ecosystem function is defined as 'a functional unit consisting of all the living organisms (plants, animals, and microbes) in a given area, and all the non-living physical and chemical factors of their environment, linked together through nutrient cycling and energy flow' (Serov et al., 2012). Changes in swamp hydrology, which may lead to drying of the peat, has the potential to impair the ecological functioning of this system. This may include increased organic matter decomposition, death of those plant species requiring waterlogged soils and alteration of soil conditions, which may open up these habitats to competition from less specialised species. This section considers the predicted change to base flow and depth of standing water in the monitored swamps, in relation to the requirements of these GDEs to maintain ecosystem function.

Other habitat features that may be susceptible to high levels of subsidence include cliffs, pagodas and caves as subsidence may induce cracking or failure of these features to the extent that they become less suitable for habitation.

Cliffs, Caves and Rocky Habitats

The mine plan has been modified to avoid most of the cliffs, to the extent that there are only three cliffs (AP CL1 & CL2 and one unnamed cliff) are within the angle of draw. The mine plan has been modified to avoid most of the pagodas, and

Figure 8.6 shows the location of those that remain within the angle of draw. Cliffs and pagodas provide potential habitat particularly for the Broad-headed Snake and Brush-tailed Rock-wallaby and cave-dwelling microbats.

The maximum predicted strains for AP-CL1 and CL2 are 1.5 mm/m tensile and 0.5 mm/m compressive and it is compressive strains that most often result in spalling. Compressive strains of 0.5 mm/m, or less, are unlikely to have any adverse impacts on the cliffs. The unnamed cliff adjacent to LW1014B is predicted to suffer potential localised spalling to less than 1% of the rock face. The pagodas located directly above the proposed longwalls are predicted to experience some fracturing and spalling to less than 1 % of their total surface area. Consequently, the Broad-headed Snake, Brush-tailed Rock-wallaby and cave-dwelling microbats are unlikely to be significantly sign impacted by subsidence.

Minor spalling and cracking of rocky habitats is not expected to significantly impact on the habitats of animals that use these landscapes for foraging, shelter or travel routes. The mine plan and design has avoided the potential for total cliff or pagoda failures.

<u>*Riparian Habitats*</u>

The two key potential impacts from longwall mining on riparian habitats are changed channel tilts and cracking of channels.

The maximum predicted tilt within is 20 mm/m or of 1 in 50. As the natural channel grades typically vary between 25 mm/m and 300 mm/m this change is unlikely to have an adverse impact on the surface water flows.

Past observations show that longwall mining can cause channel fracturing up to 15 m deep when the tensile strains are greater than 0.5 mm/m or where compressive strains are greater than 2 mm/m. As these strain limits will be exceeded fracturing of the bedrock channels directly above longwalls is expected. However, the natural steep channel grades combined with the limited expected fracturing depth will mean that flows can be expected to re-join the channels a short distance downstream. In addition, the natural sediment loads of the local watercourses will tend to in-fill any cracks that might occur.

It is expected that fracturing of the bedrock would occur beneath some sections of the drainage lines and where the beds of the drainage lines have exposed bedrock, there may be some diversion of surface water flows into the dilated strata beneath them. It is unlikely that there would be any net loss of water from the catchment, however, as any diverted surface water is likely to re-emerge into the catchment further downstream (MSEC 2013).

Cracking incidences were observed at Kangaroo Creek in 2009 and surface monitoring recorded a drop in water level. The Kangaroo Creek Swamp downstream was recorded as remaining partially full. This cracking observed in 2009, indicates that the Project has the potential to cause minor changes to flows within riparian habitats. These changes have been found to not be of a magnitude that any observable or measurable changes to the riparian vegetation can be noted. In most instances surface cracking would tend to be naturally filled with soil during subsequent flow events and isolated impacts are unlikely to impact upon threatened flora or fauna species that may occur.

Longwall mining can potentially result in increased levels of flooding or scouring of the stream banks, although the small grade changes predicted are not expected to generate more than small isolated ponds in some watercourses and no additional scour. **Figure 8.12** provides a series of cross sections through shrub swamps that will be undermined showing existing and predicted post-mining ground surface levels and grades. Cross Sections are presented for Tri Star Swamp (a), Tri Star Swamp (b-e), Twin Gully Swamp and Trail 6 Swamp. The cross sections show close correlation between existing and post-mining grades, indicating that the grade changes will be small.

Wooded Habitats

Localised tension cracks may cause local destabilisation of the root zone for some plants, however, the number of threatened flora with potential to occur within this area either: respond positively to or readily recover from disturbance, or occur where the soil is naturally unstable. It is highly unlikely that subsidence related ground movements would affect woodland or forest habitats such that they would become in any way unsuitable for any of the threatened fauna that were recorded or could potentially occur.

Therefore, no significant impacts to the dry woodland and forest habitats are predicted as a result of subsidence. Localised changes in soil on steeper slopes may result from isolated tension cracks and compression ridges.

Swamps

Two different vegetation types within the Project Application Area have been identified as groundwater dependant ecosystems within the predicted subsidence extent, these being: 50 – Newnes Plateau Shrub Swamp; and 51 Newnes Plateau Hanging Swamp. These swamps or their immediate surrounds provide known or potential habitat for threatened flora and fauna.

The extraction of coal from the proposed longwalls will result in vertical and horizontal movements of the rock and soil mass above the extracted coal seam, which may, in turn, affect the swamps and their drainages. Changes in water level could in turn result in desiccation and drainage of swamps, loss of standing pools, increased vulnerability to damage during fires, changes in species distribution and composition of vegetation and changes in water quality, including elevated iron and manganese levels and proliferation of iron bacterial mats. These changes could have an impact on the aquatic ecology of swamps and the watercourses downstream thereof. Subsidence may also lead to changes in the slope of swamps which could induce or increase the rate of scouring.

Potential impacts to groundwater dependant ecosystems from longwall mining induced subsidence are the cracking of swamp bases causing consequent loss of water and the tilting and buckling of bedding planes and the ground surface. Cracks may divert some water temporarily from swamps, but will initially fill with water before eventually filling with silt/peat from within the swamp, so that there would be no long-term permanent impact on the groundwater level or flows in the swamp.

The mining layout has been designed so as to reduce the potential impacts on the shrub swamps resulting from mine subsidence movements. LW1010 has been setback so that Twin Gully Swamp will not be directly mined beneath and the widths of the proposed longwalls have also been narrowed beneath Tri Star and Unnamed Swamps.

The shrub swamps are predicted to experience subsidence up to 1900 mm, tilts up to 20 mm/m, and strains up to 3.0 mm/m tensile and 3.5 mm/m compressive. These swamps are located near the bases of valleys and, therefore, are also predicted to experience upsidence up to 750 mm and closure up to 1000 mm. The hanging swamps are predicted to experience subsidence up to 1450 mm, tilts up to 11 mm/m, and strains up to 2 mm/m tensile and compressive.

Fracturing of the uppermost bedrock has been observed in the past, as a result of longwall mining, where the tensile strains have been greater than 0.5 mm/m or where the compressive strains have been greater than 2 mm/m. Shrub Swamps that are not above longwalls are predicted to experience strains less than these limits and so not fracturing is predicted. For those swamps above longwalls, bedrock fracturing typically between 5 and 25 mm is expected; however the existence of shallow overlying soils and peat in these swamps is expected to rapidly infill any cracks.

Fracturing in the valley side hanging swamps is less likely due to the higher depth of cover and lower compressive strains.

The predicted post mining grades within the swamps are similar to the natural grades and, therefore, it is not expected that there would be any adverse changes in ponding or scouring within the swamps. It is also not anticipated that there would be any significant changes in the distribution of the stored surface waters within the swamps as a result of the mining induced tilt or vertical subsidence. **Figure 8.12** provides a series of cross sections through shrub swamps that will be mined undermined showing existing and predicted post-mining ground surface levels and grades. Cross Sections are presented for Tri Star Swamp (a), Tri Star Swamp (b-e), Twin Gully Swamp and Trail 6 Swamp. The cross sections show close correlation between existing and post-mining grades, indicating that the grade changes will be small.

Upsidence could dilate strata beneath drainage lines that feed shrub swamps, which could result in the diversion of some surface water flows. However, that the drainage lines upstream of swamps are generally ephemeral and diverted flows are expected to remerge a short distance downstream, due to both the limited predicted depth of fracturing and the high channel grades in the area.

Proposed longwall mining would not create interconnected fracturing between the aquifer supporting swamps and the longwalls.

Subsidence can alter stream flow via stream-bed cracking, changes to ponding and connective cracking. A key threatening process listed in Schedule 3 of the TSC Act is the '*alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands'.* Localised impacts to vegetation are also possible where subsidence results in destabilisation of exposed rocky escarpments resulting in major rock falls.

Change in flow rates due to the change in gradient caused by extraction may result in ponding in existing waterlogged areas where there is already a low downstream gradient. There may be changes measured in groundwater levels due to the same tilt in the ground surface.

Projected maximum changes to average baseflows and standing water levels for a range of Newnes Plateau Shrub Swamps is presented in **Table 10.2** and **10.2a**, and expanded upon within the CSIRO report (Adhikary and Wilkins 2013). These tables consider shrub swamps that occur directly over proposed longwalls or within close proximity and provides a projection of cumulative change as a result of all current and proposed mining operations at Angus Place and Springvale. Due to a lack of empirical data that would otherwise allow accurate estimates of the magnitude and extent of surface cracking as a result of subsidence, the assessment uses three models (scenarios) that differ in assumptions regarding horizontal and vertical rock permeability at different depths above mining operations. An in-depth analysis of each scenario is provided within the CSIRO report (Adhikary and Wilkins 2013) and **Appendix E**, however can be summarised for our purposes as such:

- 'Base case' scenario – assumes that changes to rock permeability occurs as a result of fracturing after longwall mining occurs throughout all rock strata above the longwalls up to the ground surface;
- 'Truncated-ramp1' scenario – assumes no permeability changes to current values for rock strata higher than 230m above the longwalls but is the same as 'Base case' below 230m; and
- 'Truncated-ramp2' scenario – assumes rock strata higher than 230m above longwalls are only modified in regards to vertical permeability, not horizontal as in the 'Truncated-ramp1' scenario, but maintains same changes to overall permeability below 230m as both previous scenarios.

As indicated in the Groundwater Impact Assessment (RPS 2013a) and the Executive Summary of the CSIRO report (Adhikary and Wilkins 2013), the assumptions within the 'Basecase' scenario regarding mining induced changes to permeability of rock strata are considered quite conservative. The assumptions presented within the 'Truncated ramp1' and 'Truncated ramp2' scenarios are less conservative and, as indicated within **Appendix E**, the assumptions provided in the 'Truncated ramp2' scenario are more consistent with the outcomes of the Subsidence Impact Assessment (MSEC 2013) within which the likely degree of fracturing and associated rock permeability changes for the Project have been concluded. The 'Truncated ramp2' results are therefore the most appropriate for the purpose of this impact assessment with respect to the other technical studies involved. Accordingly, and as per the recommendations presented within **Appendix E**, we have assumed that the results from the 'Truncated ramp2' simulation are the most appropriate for the purpose of evaluating potential impacts to baseflow and standing groundwater levels to the Newnes Plateau Shrub Swamps, and only these results are considered in our assessment. Projected changes to baseflow and average standing groundwater levels for shrub swamps located within the Study Area are provided below (as sourced from Adhikary and Wilkins 2013) and include:

- Kangaroo Creek Swamp;
- Sunnyside Swamp;
- Tri-Star Swamp; and
- Twin Gully Swamp.

Kangaroo Creek Swamp

Kangaroo Creek Swamp is located within the western portion of the Study Area and is not within the subsidence extents of the proposal. One record for the Giant Dragonfly (*Petalura gigantea*) exists within close proximity of this swamp (NSW Wildlife Atlas Data 2014). Baseflow projections for this swamp are for a maximum decrease of a ‘very small volume’ (0.002ML/day) (Adhikary and Wilkins 2013). The associated projected changes to average standing groundwater levels is an approximate drop of 1.2cm from 10.2cm above the ground surface at December 2012 to 9.0cm post mining (Table 40 of Adhikary and Wilkins 2013).

Sunnyside Swamp

Sunnyside Swamp is located in the south of the Study Area between approved Springvale longwall panels LW413 and LW 415, and will not be undermined under current or proposed mining operations. The Giant Dragonfly is known to occur within this swamp (Benson and Baird 2012). Predicted changes to both baseflow and maximum average standing water levels are minimal, with a projected ‘small increase’ in baseflow representing an increase in average standing groundwater levels from 17.4cm above the ground surface in December 2012 to 18.0cm post mining (Table 40 of Adhikary and Wilkins 2013).

Tri-Star Swamp

Tri-Star Swamp is located towards the centre of the Study Area and is located within the subsidence extents for the proposal. No known records exist for threatened fauna or flora species within this swamp. Baseflow projections for this swamp are for a maximum projected decrease of 0.040ML/day, with an associated decrease in average standing groundwater levels of 4.9cm from 8.7cm above the ground surface in December 2012 to 3.8cm post mining (Table 40 of Adhikary and Wilkins 2013).

Twin Gully Swamp

Twin Gully Swamp is located within the central portion of the Study Area, with the eastern half of this swamp located within subsidence extents. No known records exist for threatened fauna or flora species within this swamp. Baseflow projections for this swamp are for a maximum projected decrease of 0.021ML/day, with an associated decrease in average standing groundwater levels of 1.8cm from 12.4cm above the ground surface in December 2012 to 10.6cm post mining (Table 40 of Adhikary and Wilkins 2013).

The most significant reductions to average standing groundwater levels are predicted in Twin Gully Swamp. This swamp has a projected drop in average standing water levels from 12.4cm to 10.6cm above the soil surface. The post mining values predicted at Twin Gully Swamp therefore suggest that soil saturation would persist, maintaining water availability for flora and fauna, as well as soil anoxia, allowing for continued peat formation. All other monitored swamps have smaller projected decreases in average standing water levels and monitored swamps are projected to maintain average standing water levels above the surface. Effects of subsidence are therefore unlikely to result in drying of the peat layer and impair ecosystem functioning of swamps.

The Project is not expected to have a significant impact upon the hydrology of any hanging swamps. The reliance of these areas on perched aquifer systems effectively isolate them from any hydrological changes that may occur to the regional water table as a result of mining operations.

Mine Water Discharge

A significant component of this strategy, with regard to biodiversity, is the preference to not discharge into watercourse containing THPSS. Instead, alternate mine water discharge strategies involve discharging into the Coxs River. The potential impacts from increased mine water discharge include increases in flow and changes to water quality, particularly increases in salinity.

RPS (2013b) indicates that the salinity range from Bore 6 is 700uS/cm to 1200uS/cm. The upper limit of this range may therefore represent the potential maximum salinity within Coxs River if mine water completely dominated. However, for the Coxs River particularity, this is unlikely to be the case much of the time. The salinity levels that may occur within receiving waters are well below salinity tolerance limits of *Eucalyptus* aggregata, as well as *E. stellulata* and *E. viminalis*, which are all common canopy species within the Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland EEC. Therefore, *E. aggregata* or the Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland EEC are unlikely to be affected by changes to salinity as a result in mine water discharge.

Habitats for *Thesium australe* may be found along the low lying areas adjacent to watercourse that may be affected by mine water discharge. However, expected increases in flows are below 1 year ARI flood levels and will remain in bank. Therefore, potential habitats for this species would remain largely unaffected and salinity levels would be particularly low during natural flood events. Predicted salinity changes are therefore unlikely to significantly alter habitats for *E. aggregata*, *T. australe* and Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland.

The current pH levels at the Springvale discharge points are not expected to change as a result of the mine water discharge, remaining between 6.5 and 8.0. Therefore, pH is not expected to affect habitats for *E. aggregata*, *T. australe* and Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland.

10.3.4.2 Aquatic Ecology

In the following sections, the potential direct, indirect and cumulative impacts on aquatic habitats, quality of surface water, aquatic biota in general and threatened aquatic species that may arise during the construction, operation, decommissioning and rehabilitation phases of the Project are described.

Construction

Construction and project surface activities that take place in the vicinity of watercourses could potentially have the following impacts on in stream ecology:

- the disturbance of soils and sediments by construction equipment and runoff from access road and areas where vegetation has been cleared and soils have been stockpiled could temporarily increase the sediment load in the watercourses;
- an increase in sediment load could alter the nature of the benthic substratum, smother some aquatic habitats and increase turbidity levels within watercourses, with the latter potentially decreasing the amount of light available for photosynthesis by aquatic plants, clogging the gills and feeding apparatus of aquatic fauna and reducing the visual acuity of some predators;
- runoff from cleared areas and stockpiles of soil could also transfer sequestered nutrients, organic matter and contaminants into the watercourses;
- the clearing of riparian vegetation could have indirect impacts on abundance, distribution and health of in stream biota that use the vegetation as habitat, refuge or source of food;
- accidental release of lubricating oils, hydraulic fluids and fuel from construction equipment could result in inputs of toxic hydrocarbon and metal contaminants into watercourses; and

The construction of access tracks over watercourses could also lead to changes in the pattern of water flow, disturbance and erosion of stream banks and bed, removal of in stream and riparian vegetation and either impede or prevent fish passage of fish and other aquatic organisms.

The construction of dewatering boreholes in the vicinity of watercourses or drainage could potentially lead to:

- discharge of groundwater to the surface and changes in the quantity and quality of surface water, if drilling intercepts a confined aquifer where groundwater is under pressure; and

- contamination of surface water with drilling muds/fluids, drilling additives, oils and lubricants which may be toxic to aquatic fauna and flora.

Operations

Subsidence

Ground movements may cause fracturing of the stream bed and banks, movements of joint and bedding plains in the stream bed, uplift and buckling of strata in the stream bed (NSW DoP 2008). In turn the ground movement may result in physically changing and adversely impacting the aquatic environment by:

- diverting surface and sub-surface flows, drainage of pools and increases in groundwater inflows;
- tilting of stream beds may result in erosion of the stream bed and banks and increased in stream sediment load, changes in flow rates and migration of stream channels; and
- loss of aquatic habitat, desiccation of fringing vegetation, reductions in longitudinal connectivity, deterioration of water quality and changes in the diversity of riparian and aquatic plants, aquatic macroinvertebrates and fish.

Groundwater Discharge and Recharge

Extraction of the longwall panels would affect groundwater discharge to and recharge from streams, which in turn, will affect their baseflow rates. Groundwater flow to swamps and creeks and the baseflow would be increased by bed separation effects and enhanced horizontal permeability. The predicted impacts on baseflows vary from positive (increased baseflow, or reduced net leakage) to negative (decreased baseflow, or increased leakage) (RPS 2013b).

The impacts of longwall extraction on the shallow groundwater and baseflow are expected to be minor. RPS (2013b) has suggested that the magnitude of the changes are likely to be smaller than that predicted by the hydrogeological modelling, because modelling has not taken into account the infilling of fractures within the creeks by sediments, a factor that would reduce impacts on baseflows. Monitoring of surface water flows at gauging stations has not detected effects of previous longwall extraction on surface flows. The impacts on swamps will be smaller than seasonal variations (Adhikary and Wilkins 2013). It is expected that mining will change the water head in most swamps by a few centimetres on average. Given the above, it is highly unlikely that there would be any measurable effects on the aquatic ecology of streams or the drainages downstream of swamps.

Shallow fracturing of the bedrock overlying the longwalls is expected to enhance shallow permeability and facilitate infiltration of runoff and surface water into the ground and consequently the recharge of shallow aquifers and reduce runoff (RPS 2013b). The increase in permeability is likely to be short lived, because the cracks would be infilled with sediment during subsequent flows. The water that infiltrates is expected to re-emerge as surface flow further downstream and would thus contribute to baseflow within the watercourse. Loss of groundwater to deeper aquifers is not expected to occur as the perched aquifer that supports the swamps is hydraulically independent of the underlying groundwater systems.

Long term monitoring at Angus Place Colliery and Springvale Mine shows that subsidence caused by previous mining has not reduced surface flows in the swamps or reduced shallow groundwater levels. There is consequently unlikely to be any detectable effects on aquatic ecological attributes in the watercourse immediately downstream of the swamps.

Section 2.6.2 outlines specific case studies of groundwater responses to longwall mining.

Mine Water Make Discharges

The expected increase in flow is, however, small compared to the 1 y ARI peak flood flow in Sawyers Swamp Creek of 8.97m^3/s. Accordingly, the potential impact on geomorphology is low compared to the stream bed velocity experienced in a typical large rainfall event.

Rehabilitation and Decommissioning

During the rehabilitation phase, there is a potential for erosion of denuded areas to occur and for soil to be either blown into watercourses or for runoff containing sediments and contaminants such as fertilisers and herbicides to enter watercourses during rainfall events. The potential for such effects would depend on the residence time of the sediment and contaminants within particular areas of the watercourses.

During the decommissioning phase of the Project there is a possibility of impacts on in stream ecology arising if erosion of bare areas results in soil being either blown into watercourses or if sediment- and/or contaminant laden runoff enters watercourses during rainfall events. Aquatic biota could also potentially be impacted when the existing water management structures (e.g. dams and ponds are dismantled, rehabilitated and natural drainage patterns restored.

10.3.4.3 Stygofauna

As the information on likely occurrence of stygofauna in the Mine Extension Area is based on a pilot survey and information on the distribution of stygofauna within NSW aquifers is sparse, the precautionary principle has been adopted. It has been assumed that stygofauna are likely to occur in all the aquifers below the Mine Extension Area.

Past and present mining activities have had an observable impact on the level of water in the deep groundwater system, particularly in the Lithgow Seam, AQ1 and AQ4, but no mining-related impacts are evident at the stratigraphically higher AQ6 due to the intervening aquicludes, the most important of which is the Mount York Claystone, which is approximately 22 m thick and continuous across the Project Application Area.

Model results indicate there will be a significant depressurisation of the Illawarra Coal Measures and aquifers underlying the Mount York Claystone, however, there is limited upward propagation of depressurisation above this layer due to desaturation of the Burra-Moko Head Sandstone (AQ3). Upward propagation of depressurisation above the Mount York Claystone is limited further by the low permeability ‘plies’ within the Burralow Formation. The aquifer below the Mount York Claystone would refill partially on the cessation of mining, but take 350 years to reach a steady state.

Modelling indicates that the effect of depressurisation does not reach the perched aquifer system as presented in **Figure 10.13**. Model results are consistent with the conceptual hydrogeological model that the perched and shallow groundwater system, upon which the THPSS reside, are hydraulically independent from groundwater extraction at depth, primarily due to the Burra-Moko Head Sandstone, which is located below the Mount York Claystone, becoming unsaturated.

Construction and Rehabilitation

Construction and rehabilitation in the vicinity of shrub or hanging swamps could potentially interfere with the shallow perched aquifers that support the swamps. The stygofauna that inhabit the perched groundwater system could be impacted through:

- discharge of groundwater to the surface and associated flooding of swamps and changes in the quality of surface water, including increased sediment load;
- contamination resulting from inadvertent discharges of drilling fluids, drilling additives, oils and lubricants, fertilisers and herbicides into surface water within the swamps or their seepage into the aquifers;
- greater sediment loads in infiltrated water as a result of erosion of areas around the borehole sites and along access roads where vegetation has been cleared.

The construction of dewatering boreholes and underground roadways are the activities most likely to impact on any stygofauna associated with the fractured rock aquifers within the deep groundwater system. The construction of dewatering bores could potentially expose stygofauna to changes in groundwater quality as a result of cross contamination of water within aquifers during or after drilling and contamination of aquifers by drilling muds/fluids or inputs of contaminants from the surface. The potential for cross contamination depends on the permeability of the strata and quantity of groundwater that may enter the borehole during drilling.

The dewatering boreholes on Newnes Plateau will be decommissioned as soon as practicable after they are no longer required. The decommissioning of dewatering boreholes is unlikely to have any impact on stygofauna as they would be permanently sealed by full grouting from the top to the bottom of the bore, in accordance with the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee 2011).

Rehabilitation works such as clearing and grading of land, spreading of topsoil, seeding and/or revegetation, application of fertilisers and control of weeds are unlikely to impact on any stygofauna that may exist in the shallow regional groundwater or deep confined groundwater system, but could affect those associated with the shallow perched aquifer system. During rainfall events, there is a possibility of stygofauna associated with the perched groundwater system being impacted by runoff laden with sediment and contaminants such as fertilisers and herbicides. This is because this groundwater system is situated within metres of the land surface and is derived from excess rainfall that is unable to infiltrate into the deeper groundwater systems due to the presence of less permeable underlying rock layers (RPS 2013b).

Operational Impacts

<u>*Subsidence*</u>

Subsidence fracturing of rock bars, diversions of creek flows, tensile cracking and tensile/shear movement of near-surface strata, bending of strata and horizontal separation of bedding planes, could lead to:

- redirection of sub-surface flows to the surface;
- mixing of aquifers or groundwater with surface water;
- changes in the characteristics of aquifer storages;
- depressurization of strata overlying extracted coal seams.

This could lead to cross-aquifer contamination, mine-water inflows and loss of groundwater resources. The chemical interaction between freshly broken rock faces and percolating groundwater could also lead to changes in groundwater quality, including elevated iron, manganese and aluminium levels.

<u>*Groundwater Discharge and Recharge*</u>

Extraction of the longwall panels would affect groundwater discharge to and recharge from streams, which in turn, will affect their baseflow rates. The impacts will be smaller than those that occur naturally as a result of season variation. This suggests that the impact on stygofauna associated with the perched aquifers is unlikely to be significant.

Shallow fracturing of the bedrock overlying the longwalls is expected to enhance shallow permeability and facilitate infiltration of runoff and surface water to the ground and recharge of shallow aquifers and reduce runoff during rain events. The increase in permeability is likely to be short lived due to cracks filling with sediment during subsequent flow events.

<u>*Dewatering*</u>

Past and present mining activities have had a observable impact on the level of water in the deep groundwater system, particularly in the Lithgow Seam, AQ1 and AQ4, but no mining-related impacts are evident at the stratigraphically higher AQ6 due to the intervening aquicludes, the most important of which is the Mount York Claystone, which is approximately 22 m thick and continuous across the Project Application Area.

Model results indicate there will be a significant depressurisation of the Illawarra Coal Measures and aquifers underlying the Mount York Claystone, however, there is minimal upward propagation of depressurisation above this layer due to desaturation of the Burra-Moko Head Sandstone (AQ3). Upward propagation of depressurisation above the Mount York Claystone is limited further by the low permeability 'plies' within the Burralow Formation. The aquifer below the Mount York Claystone would refill partially on the cessation of mining, but take 350 years to reach a steady state.

Modelling indicates that the effect to depressurisation does not reach the perched aquifer system as presented in F**igure 10.13**. Model results are consistent with the conceptual hydrogeological model that the perched and shallow groundwater system, upon which the THPSS reside, are hydraulically independent from groundwater extraction at depth, primarily due to the Burra-Moko Head Sandstone, which is located below the Mount York Claystone, becoming unsaturated.

The pumping of groundwater from the underground workings to the surface via dewatering boreholes causes a significant and rapid reduction in the level of the water table and thus affects the adjoining aquifer and any stygofauna inhabiting it. However, as detailed in **Section 10.3.3.3**, stygofauna are more likely to occur in shallower aquifers where there is access to oxygen and food. An analysis of available information shows that deeper aquifers such as those below the Mount York Claystone are unlikely to contain stygofauna (4T Consultants).

10.3.5 Consequences of Impacts

10.3.5.1 Terrestrial and Aquatic Ecology

Table 10.6 and **Table 10.9** list those endangered and threatened species and communities, both terrestrial and aquatic that have been recorded or are expected to occur in the Project Application Area. Most of these records or expected occurrences are outside areas to be impacted by proposed surface infrastructure or mining induced subsidence. Those species and communities recorded or expected in these impact areas have been assessed by way of 7 part tests of significance under the TSC Act and/or the assessment of significance under the EPBC Act (**Appendix H**). The results of these tests are summarised in **Table 10.14** and **Table 10.15**.

Table 10.14 Summary of 7 part test of significance

Group and species	(a) Risk of extinction of local population	(b) Risk of extinction of endangered population	(c) adverse impact on the extent of, or modification to EECs or CECs leading to local extinction	(d) habitats of threatened species, EECs or CECs			(e) adverse impact on critical habitat	(f) consistence with recovery or threat abatement plan
				(i) extent of habitat removed modified	(ii) will habitat become isolated	(iii) importance of habitat removed, modified or isolated		
Flora								
Acacia bynoeana	Unlikely	na	na	Not significant	No	Not important	na	na
Boronia deanei	Nil	na	na	Low	No	No impact	na	na
Caesia parviflora var. minor	Nil	na	na	Unlikely	No	Not important	na	na
Eucalyptus pulverulenta	Unlikely	na	na	Unlikely	No	No impact	na	na
Eucalyptus aggregata	Unlikely	na	na	Unlikely	No	No impact	na	na
Genoplesium superbum	Nil	na	na	Unlikely	No	Not important	na	na
Lastreopsis hispida	Unlikely	na	na	Unlikely	No	Not important	na	na
Persoonia acerosa	Nil	na	na	Not significant	No	Not important	na	na
Persoonia hindii	Nil	na	na	Not significant	No	Not important	na	na
Prasophyllum fuscum	Nil	na	na	Low	No	Not important	na	na
Thesium austral (Austral toadflax)	Unlikely	na	na	Not significant	No	Not important	na	na
Veronica blakelyi syn.	Unlikely	na	na	Not significant	No	Not important	na	na

Invertebrates								
Giant Dragonfly	Unlikely	na	na	Unlikely	No	No effect	na	na
Adam's Emerald Dragonfly FM Act	Unlikely	na	na	Unlikely	Unlikely	Not important	na	na
Herpetofauna								
Stuttering Frog	Unlikely	na	na	Unlikely	No	No effect	na	Consistent
Giant Burrowing Frog	Unlikely	na	na	Unlikely	No	No effect	na	na
Littlejohn's Tree Frog	Unlikely	na	na	Unlikely	No	No effect	na	na
Red-crowned Toadlet	Unlikely	na	na	Not significant	No	No effect	na	na
Blue Mountains Water Skink	Nil	na	na	Unlikely	No	No effect	na	Consistent na
Broad-headed Snake	Unlikely	na	na	Unlikely	No	No effect	na	na
Rosenberg's Goanna	Unlikely	na	na	11.4 ha	No	Not important	na	na
Birds								
Regent Honeyeater	Unlikely	na	na	Nil	No	Not important	na	Inconsistent
Gang-gang Cockatoo	Unlikely	na	na	Nil	No	Not important	na	na
Glossy Black-Cockatoo	Unlikely	na	na	Nil	No	Not important	na	na
Speckled Warbler	Unlikely	na	na	Nil	No	Not important	na	na
Brown Treecreeper	Unlikely	na	na	Nil	No	Not important	na	na
Varied Sittella	Unlikely	na	na	Nil	No	Not important	na	na
Little Lorikeet	Unlikely	na	na	Nil	No	Not important	na	na

Painted Honeyeater	Unlikely	na	na	Nil	No	Not important	na	na
Hooded Robin	Unlikely	na	na	Nil	No	Not important	na	na
Scarlet Robin	Unlikely	na	na	Nil	No	Not important	na	na
Flame Robin	Unlikely	na	na	Nil	No	Not important	na	na
Black-chinned Honeyeater	Unlikely	na	na	Nil	No	Not important	na	na
Masked Owl	Unlikely	na	na	Nil	No	Not important	na	Inconsistent
Sooty Owl	Unlikely	na	na	Nil	No	Not important	na	Inconsistent
Barking Owl	Unlikely	na	na	Nil	No	Not important	na	Inconsistent
Powerful Owl	Unlikely	na	na	Nil	No	Not important	na	Inconsistent
Grey-crowned Babbler	Unlikely	na	na	Not significant	No	Not important	na	na
Mammals								
Eastern Bentwing-bat	Unlikely	na	na	Unlikely	No	Not important	na	na
Large-eared Pied Bat	Unlikely	na	na	Unlikely	No	Not important	na	na
Little Pied Bat	Unlikely	na	na	Unlikely	No	Not important	na	na
Eastern Cave Bat	Unlikely	na	na	Unlikely	No	Not important	na	na
Eastern Freetail-bat	Unlikely	na	na	Nil	No	Not important	na	na
Eastern False Pipistrelle	Unlikely	na	na	Nil	No	Not important	na	na
Greater Broad-nosed Bat	Unlikely	na	na	Nil	No	Not important	na	na
Yellow-bellied Sheathtail Bat	Unlikely	na	na	Nil	No	Not important	na	na
Southern Brown Bandicoot	Unlikely	na	na	Nil	No	Not important	na	na
Eastern Pygmy Possum	Unlikely	na	na	Nil	No	Not important	na	na

Koala	Unlikely	na	na	Nil	No	Not important	na	na
Brush-tailed Rock-wallaby	Unlikely	na	na	Nil	No	Not important	na	na
Squirrel Glider	Unlikely	na	na	Nil	No	Not important	na	Inconsistent
Yellow-bellied Glider	Unlikely	na	na	Nil	No	Not important	na	na
Spotted-tailed Quoll	Unlikely	na	na	Nil	No	Not important	na	Inconsistent
EECs and TECs								
Newnes Plateau Shrub Swamp	na	na	Unlikely	Unlikely	No	No effect	na	na
Montane Peatlands and Swamps	na	na	Unlikely	Nil	No	No effect	na	na
Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland	na	na	Unlikely	Unlikely	No	Not important	na	na

Table 10.15 Summary of EPBC Assessment of Significance

Group and Species	(a) Lead to a long-term decrease in the size of an important population	(b) Reduce the area of occupancy of the species	(c) Fragment an existing important population	(d) Adversely affect habitat critical to the survival of a species	(e) Disrupt the breeding cycle of a population	(f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	(g) Result in invasive species becoming established	(h) Introduce disease that may cause the species to decline	(i) Interfere substantially with the recovery of the species
Plants									
Acacia bynoeana	Unlikely	Unlikely	No	No	No	Unlikely	Unlikely	Unlikely	Unlikely
Boronia deanei	No	No	No	No	No	Unlikely	Unlikely	Unlikely	Unlikely
Eucalyptus pulverulenta	Unlikely	No	No	No	No	Unlikely	Unlikely	Unlikely	Unlikely
Prasophyllum fuscum	No	No	No	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Persoonia acerosa	Unlikely	Unlikely	No	No	No	Unlikely	Unlikely	Unlikely	Unlikely
Prostanthera cryptandroides subsp. cryptandroides (Wollemi Mintbush)	Unlikely	Unlikely	No	No	No	Unlikely	Unlikely	Unlikely	Unlikely
Thesium australe	Unlikely	No	No	No	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

Herpetofauna									
Giant Burrowing Frog	Unlikely	No	No	No	No	No	Unlikely	Unlikely	Unlikely
Stuttering Frog	Unlikely	by 0.03 ha	No	No	No	No	Unlikely	Unlikely	Unlikely
Littlejohn's Tree Frog	Unlikely	by 0.33 ha	No	No	No	No	Unlikely	Unlikely	Unlikely
Blue Mountains Water Skink	No	No	No	No	No	No	Unlikely	Unlikely	Unlikely
Broad-headed Snake	No	by 0.63 ha	No	No	No	No	Unlikely	Unlikely	Unlikely
Birds									
Regent Honeyeater	Unlikely	Unlikely	Unlikely	No	No	No	Unlikely	Unlikely	Unlikely
Mammals									
Koala	Unlikely	by 23.08 ha	No	0.16 ha to be removed	Unlikely	No	Unlikely	Unlikely	Unlikely
Spotted-tailed Quoll	Unlikely	by 23.24 ha	No	Unlikely	No	No	Unlikely	Unlikely	Unlikely
Southern Brown Bandicoot	Unlikely	by 23.24 ha	No	No	No	No	Unlikely	Unlikely	Unlikely
New Holland Mouse	No	by 23.24 ha	No	No	No	No	Unlikely	Unlikely	Unlikely
Large-eared Pied	No	No	No	No	No	No	Unlikely	Unlikely	Unlikely

Bat									
Brush-tailed Rock-wallaby	Unlikely	by 0.63 ha	No	No	No	No	Unlikely	Unlikely	Unlikely
EECs and TECs									
Temperate Highland Peat Swamps on Sandstone	Unlikely	No	No	No	No	No	Na	Na	na

With regards to the questions to be addressed in the TSC Act 7 part tests, it can be seen from **Table 10.15** that the Project will cause the following consequences:

- *Is there a risk of the extinction of a local population?* Unlikely or nil in each case;
- *Is there a risk of the extinction of an endangered population?* not applicable in each case as none are listed;
- *Will there be an adverse impact on the extent of, or modification to EECs and CECs leading to local extinction?* Not applicable for all plant and animal species, and unlikely for the single TSC listed EECs;
- *What is the extent to which habitat is likely to be removed or modified as a result of the action proposed?* Nil, unlikely, low, or not significant in all cases;
- *Will an area of habitat is likely to become fragmented or isolated?* No or unlikely in each case;
- *What is the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival in the locality?* Either no impact, no effect, or not important in all cases;
- *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)?* Not applicable in all cases as no critical habitats are present; and
- *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan?* In most cases, this is not applicable as such plans do not exist. For those species with such plans (Regent Honeyeater, Masked Owl, Sooty Owl, Barking Owl, Powerful Owl, Squirrel Glider and Spotted-tailed Quoll, the action is inconsistent with the plans.

With regards to the questions to be addressed in the EPBC Act assessment of significance, **Table 10.16** shows that the Project will cause the following:

- *Lead to a long-term decrease in the size of an important population?* No or unlikely in all cases;
- *Reduce the area of occupancy of the species?* No, unlikely or between 0.03 ha and 23 ha of reduction;
- *Fragment an existing important population?* No or unlikely in all cases;
- *Adversely affect habitat critical to the survival of a species?* No or unlikely in all cases, apart from clearing 0.16 ha of critical Koala habitat ;
- *Disrupt the breeding cycle of a population?* No or unlikely in all cases;
- *Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?* Unlikely or No in all cases;
- *Result in invasive species becoming established?* Unlikely in all cases;
- *Introduce disease that may cause the species to decline?* Unlikely in all cases; and
- *Interfere substantially with the recovery of the species?* Unlikely in all cases.

Key Threatening Processes

An additional part of the 7 part test process under the TSC Act is the consideration of whether any Key Threatening Processes listed under Schedule 3 of the TSC Act will be triggered by the Project. In the case of Angus Place Colliery, the following Key Threatening Processes have the potential to be triggered:

- *alteration of the natural flow regimes of rivers, streams, floodplains and wetlands*: The Project is likely to incrementally change natural flows due to subsidence effects, however these are expected to be minor and localised ;
- *loss of hollow-bearing trees*: 23.25 ha of native woodland will be cleared, in which hollows are located. These hollows maybe used by several threated bat and mammals species, however, the extent of contiguous vegetation with similar hollow density means that significant impacts are not predicted;
- *removal of dead wood and dead trees*; 23.25 ha of native woodland will be cleared, in which is located dead wood and trees, that can serve as habitat for several threatened mammals and birds are located. The free availability of similar habitat elements in adjoining contiguous vegetation means that local extinction of species would not occur;
- *clearing of native vegetation*: clearing of 23.25 ha of native woodland that forms potential habitat for a number of threatened species is not expected to have a significant impact, due to the small area involved and the free availability of adjacent habitat;
- *anthropogenic climate change*: Approval of the Project will allow the continuation of current levels of Scope 1 greenhouse gas emissions, which are 0.01% of Australia's totals;
- *introduction and establishment of exotic rusti fungi or the order Pucciniales pathogenic on plants of the family Myrtaceae*: The Project may aid the introduction and establishment of pathogens due to construction and vehicle movements, although this will be reduced by decontamination procedures for earthmoving plant;
- *alteration of habitat following subsidence due to longwall mining*: The Project will contribute to this Key Threatening Process however the application of proven mine design principles and the proven accuracy of subsidence predictions will minimise the risk associated with the process and to ensure that threatened species and communities are not endangered; and
- *invasion of native plant communities by exotic perennial grasses*: There is a chance that the Project would contribute to this process due to construction, however, this can be minimised and ameliorated by a weed management programme.

Swamps

Monitoring of swamp water levels and surface water gauging has shown that over the life of the current mining operations, no impacts to the swamps or surface water flows have occurred as a result of mining to date at Angus Place (RPS 2013). Regular seasonal monitoring of the flora and fauna since 2005 have also revealed no observable impacts on the flora and fauna recorded within undermined areas, including Shrub Swamps. This observation is supported by a high level of confidence in subsidence predictions, as shown by post-mining subsidence monitoring data. Therefore the Project is unlikely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

10.3.5.2 Stygofauna

Modelling results detailed in **Section 10.2** indicate there will be a significant depressurisation of the Illawarra Coal Measures and aquifers underlying the Mount York Claystone, however, there will be minimal upward propagation of depressurisation above this layer due to desaturation of the Burra-Moko Head Sandstone (AQ3). Upward propagation of depressurisation above the Mount York Claystone is limited further by the low permeability 'plies' within the Burralow Formation. The aquifer below the Mount York Claystone would refill partially on the cessation of mining, but take 350 years to reach a steady state.

Modelling indicates that the effect to depressurisation does not reach the perched aquifer system as presented in **Figure 10.13**. Model results are consistent with the conceptual hydrogeological model that the perched and shallow groundwater system, upon which the THPSS reside, are hydraulically independent from groundwater extraction at depth, primarily due to the Burra-Moko Head Sandstone, which is located below the Mount York Claystone, becoming unsaturated.

The minimal impacts of the Project on upper aquifers above the Mount York Claystone indicates that there would be minimal consequences to any stygofauna that inhabits these aquifers. The reduced likelihood of stygofauna inhabiting the deeper aquifers consequently reduces the likelihood of consequences, however, should stygofauna exist below the Mount York Claystone, dewatering would impact the animals during mine dewatering and for many years after as the groundwater levels re-establish.

10.3.6 Cumulative Impacts

10.3.6.1 Terrestrial Ecology

Two underground mine extensions proposed for the Newnes Plateau are the Angus Place Colliery and Extension Project and the Springvale Mine Extension Project. A third modification to consent at Clarence Colliery relating to a new Reject Emplacement Area is also proposed. These sites are in relatively close proximity to one another and have the potential to result in a cumulative impact. Each mine requires surface infrastructure with resulting surface disturbance footprints in addition to existing surface disturbance footprints. At the Springvale and Angus Place projects, there is potential impacts from subsidence, which to date have been relatively minor. Mining operations in this region have largely operated underground and when considered in a regional context have cleared only relatively minor areas of vegetation and habitat.

The assessment of cumulative impacts has been undertaken throughout the subsidence and groundwater modelling assessments and the results presented are of cumulative impacts between the proposed Springvale project and existing approved projects, and the proposed Springvale projects and existing approved projects plus the proposed extension at Angus Place. Cumulative impacts are observed to some degree, most notably post mining at Springvale when recovery within the Lithgow Seam is delayed until mining at Angus Place is completed. No other significant groundwater related impacts are anticipated.

Flora

In addition to the maximum footprint of 23.25 ha for this Project, the following projects also have proposed or are undertaking vegetation clearing:

- Springvale Mine Extension Project (11.44 ha); and
- The Clarence REA VI Project (4.2 ha).

Neither of these projects proposes to clear any EECs or threatened flora.

Fauna

At Springvale Bore 8 Project a range of threatened fauna species occur within the Project Application Area and its surrounds, including the Gang Gang Cockatoo (*Callocephalon fimbriatum*), Scarlet Robin (*Petroica boodang*), Flame Robin (*Petroica phoenicea*) and Masked Owl (*Tyto novaehollandiae*).

The Clarence REA VI field surveys resulted in the identification of two threatened fauna species, listed as Vulnerable under the TSC Act, namely the Gang-gang Cockatoo (*Callocephalon fimbriatum*) and the Eastern Pygmy Possum (*Cercartetus nanus*).

Within the Clarence REA VI surface facility three threatened fauna species, including the Regent Honeyeater, Spotted-tailed Quoll and Large-eared Pied Bat, were identified with potential to occur or have known habitat within the site or its vicinity

The cumulative impact from these activities is considered to be negligible due to the comparatively low levels of impact expected to occur to their habitats.

Each of these projects occurs within similar forest vegetation of the Newnes Plateau and provides similar fauna habitat opportunities. The proposed surface infrastructure occurs within an area of extensive vegetation providing considerable habitat opportunities and supporting those threatened flora and fauna species considered to have potential to be affected by the Project. Consequently, whilst the cumulative loss of 134.5 ha of vegetation equates to an impact upon potentially occurring threatened flora and fauna, due to the wider habitat availabilities, this is unlikely to be a significant impact.

Swamps

The existing longwalls at Springvale and Angus Place Collieries are overlain by 13 Shrub Swamps and 26 Hanging Swamps and their associated drainages (MSEC 2013). Surface impacts have been detected at four of the swamps (Narrow Swamp North, Narrow Swamp South, East Wolgan Swamp and Junction Swamp). Investigations suggest that the impacts at Narrow Swamp North and South were mostly the result of mine water discharge, but mine subsidence ground movements may have had some lesser impacts (refer **Section 2.6.2** for further details on the impacts of subsidence on swamps). The impacts at the other two swamps were attributed to a combination of mine-induced subsidence, mine water discharge and erosion from nearby roads, although the relative importance of these could not be assessed. Changes in flows were reported along Kangaroo Creek after the extraction of Angus Place LW940, but no loss of surface water flows or adverse impacts on the other drainage lines were reported during previous mining (MSEC 2013). As previous mining of the drainage lines does not appear to have resulted in any loss of surface water flows or adverse impacts, the aquatic ecology of the drainages downstream of swamps is unlikely to be impacted significantly when the proposed longwalls are extracted.

Both watercourses could potentially be impacted by other activities that take place in Newnes State Forest, including tree logging, track construction, undergrowth clearing and burning, and recreational activities such as four-wheel driving and motor biking (Centennial 2012b).

Section 2.6.2 discussed the Newnes Plateau geology related to the swamp formation.

10.3.6.2 Aquatic Ecology

The headwaters of the Wolgan River have been undermined by the Springvale Mine longwalls, but are located to the west of the proposed longwalls within the Mine Extension Area. It is the activities that take place within this mine and within the adjoining Springvale Mine that would have cumulative effects on these watercourses. The proposed longwalls in the Angus Place Colliery Extension area would not undermine the river, but would undermine its drainage lines. The Wolgan River is likely to experience valley related movements during the extraction of the proposed Angus Place longwalls and could be sensitive to these movements. As previous mining of the drainage lines does not appear to have resulted in any loss of surface water flows or adverse impacts, these are unlikely to occur when the proposed longwalls are extracted.

The headwaters of Carne Creek have not been disturbed by past or recent mining activities. However, they are likely to experience valley related movements during the extraction of the proposed Angus Place longwalls and could be sensitive to these movements. Proposed mining is unlikely to have a significant impact on the in stream ecology of Carne Creek.

The Wolgan River also receives mine water discharge from two licensed discharge points (LDPs), which are associated with Springvale Colliery. These discharges were originally continuous, but now occur only when there are operational issues with the SDWTS. The river could also potentially have been impacted by past construction activities at the two mines, be impacted by some construction activities associated with the Mine Extension Projects and could in the future be affected by mine decommissioning and rehabilitation indicates the proposed mining is unlikely to have a significant effect on the in stream ecology of the Wolgan River.

Both watercourses could potentially be impacted by other activities that take place in Newnes State Forest, including tree logging, track construction, undergrowth clearing and burning, and recreational activities such as four-wheel driving and motor biking (Centennial 2012b).

10.3.6.3 Stygofauna

Cumulative impacts to stygofauna will be dependent on the effects of groundwater drawdown and changes due to the Project when considered in addition to other existing or proposed projects that effect groundwater. The two projects that cumulatively effect groundwater at Angus Place Colliery are the Springvale Mine Extension Project and ongoing mining at Clarence Colliery. The effects of both of these mines have been considered in the regional groundwater model and so have been explicitly included in predicted groundwater effects.

The geology of the Newnes Plateau is consistent, as such the extent of the underlying shallow and deep aquifer systems are consistent across the Plateau. Movement of stygofauna within the aquifer are therefore largely unconfined.

10.3.7 Biodiversity Strategy

Offsets are used to compensate for the residual adverse impacts of a Project on the environment. Offsets are used to balance the residual impacts after avoidance and mitigation measures have been implemented. For assessments under the EPBC Act, offsets are only required if these residual impacts are significant. Significance of the residual impact is tested against the Department of the Environment’s Significant Impact Guidelines for Matters of National Environmental Significance and offsets should be related to the conservation priority of the impacted species/community.

Offsets are typically packaged into ‘direct offset’ which provides a measurable conservation gain to compensate for the residual impacts, and ‘indirect or supplementary offset’ which add value to the existing knowledge base of an impacted species/community.

Offsets that deliver social, economic and/or environmental co-benefits are encouraged by both the State and Federal governments. These include offsets that increase land connectivity or offsets that protect and manage privately owned land for conservation purposes.

Centennial Coal has taken these principles into consideration, as detailed in Table 10.16a, when designing this biodiversity strategy.

Table 10.16a Offset Principles

NSW Offset Principles for Major Projects (State Significant Development and Infrastructure)	
Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts	Refer to Chapter 8 where the constraints to the mine design have been identified and included in mine planning considerations.
Offset requirements should be based on a reliable and transparent assessment of losses and gains	Further detail on the assessment method to establish the offset is included in **Appendix I**.
Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities	Further detail on the biodiversity values lost and gained are included in Appendix I.
Offsets must be additional to other legal requirements	There is no current requirement for an offset to be provided by the Project, although the package includes provision to offset previous requirements within the current Springvale Mine and Angus Place Colliery development consent (DA11/92) and project approval (PA06_0021), respectively.
Offsets must be enduring, enforceable and auditable	Centennial intends to enter into covenant arrangements to protect the biodiversity values in perpetuity.

Supplementary measures can be used in lieu of offsets	Supplementary measures, as identified in **Appendix I** of the EIS, have been included to complement the offset package and to reduce the monitoring effort required to establish impacts.
Offsets can be discounted where significant social and economic benefits accrue to NSW as a consequence of the proposal	The offsets required for the Project have been quantified in the context of the biodiversity values, for which the offset land holds high conservation priorities. With the social and economic contributions proposed by the Project (discussed in **Chapter 6.0** of the EIS), the offset package itself provides significant social and economic benefits to the NSW community through: ▪ conservation in perpetuity of high priority biodiversity values ▪ proximity of offset land to existing reservations ▪ provision of ongoing financial support to achieve agreed criteria for conservation ▪ provision of access to conserved land for tourism and recreational purposes ▪ investment in research, recovery and maintenance plans to understand potential threats to conservation outcomes and integrate this understanding with values of adjacent National Parks, World Heritage Areas and National Heritage Places The biodiversity strategy presented in this EIS presents an opportunity cost to Centennial Coal, however, provides a long term benefit to the community.
Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy	
Suitable offsets must deliver an overall conservation outcomes that improves or maintains the viability of the protected matter	As there are no direct impacts to protected matters, and the residual impacts following avoidance and mitigation measures are not significant, direct offsets are not required. Regardless, the offset package proposed includes provision of land to compensate for the potential impacts to THPSS.
Suitable offsets must be built around direct offsets but may include other compensatory measures	As there are no direct impacts to protected matters, and the residual impacts following avoidance and mitigation measures are not significant, direct offsets are not required. Regardless, the offset package proposed includes provision of land to compensate for the potential impacts to THPSS. Further compensatory measures will be implemented, supporting clear conservation objectives and reducing the monitoring related impacts to the Newnes Plateau.
Suitable offsets must be of a size and scale proportionate to the residual impacts of the protected matter	The offset proposed provides for the conservation of 86 ha of critically endangered ecological community and habitat for over 160 fauna species.
Suitable offsets must effectively account for and manage the risks of the offset not succeeding	To ensure success of the strategy, Centennial Coal is providing land already owned by the company with high conservation value. Centennial Coal will also develop completion criteria for the offset land as outlined in this strategy, taking into consideration the *Guide to Managing Box Gum Grassy Woodlands (2010)*. In the unlikely event that the offset does not succeed, Centennial will include provision for offset management in the security held by the Division of Resources and Energy under the *Mining Act 1992*.

Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs	There is no current requirement for an offset to be provided by this Project, although the package includes provision to offset previous requirements within the current Springvale and Angus Place development consent.
Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable	As the land is owned by Centennial Coal, the offset can be secured for the life of the Projects immediately upon grant of consent. The offset land is effective as, outlined in this strategy and **Appendix I**, the land provides connectivity to the Airly State Forest, the Capertee National Park and the Mugii Murum-ban State Conservation Area. Management actions and completion criteria identified in this strategy will result in effective and timely offset security.
Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced	The offset land is land owned by Centennial Coal and as such a baseline condition against which the success of completion criteria can be measured, has been undertaken. This, along with a restrictive covenant arrangement for the land, will ensure the offset can be measured, monitored and audited in accordance with the completion criteria described in this EIS. There are no future development proposals for the land. There are no mineral titles on the land. Centennial Coal holds a coal lease over part of the offset area, however there are no recoverable coal reserves. There is an existing petroleum extraction licence (PEL) over part of the offset land, and a PEL application over the remaining land.

In order to establish the need for an offset, particularly a direct offset, the extent of residual impacts to threatened species/communities and matters of national environmental significance needs to be ascertained. **Section 10.3.4** summarises the likely residual impacts, with details provided in **Appendix H**, concluding that the residual impacts, once avoidance and mitigation measures are implemented, are not significant. The attributes that are likely to be impacted by the proposed project are described in detail in **Appendix I**, and summarised in **Section 10.3.3**.

This conclusion has been formed through the adoption of avoidance measures, including where possible, minimising surface disturbance footprints, placing surface infrastructure outside habitat for threatened species, shortening longwall blocks and narrowing void widths. The Project has specifically reviewed the circumstances that could lead to an impact to sensitive surface features (**Table 2.6)**. This review, combined with a review of the extensometer and piezometer data collected across the existing mining operations, demonstrate a high level of confidence that a managed height of fracturing will result in no significant impact to groundwater and surface water systems or the communities that rely on them.

Despite this, activities undertaken as part of Springvale and Angus Place Mine Extension Projects may indirectly impact the endangered ecological communities that comprise THPSS (Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps).

Angus Place Colliery and Springvale Mine have recognised, through the final land use proposed for the extension Projects, the conservation values that the Newnes Plateau currently holds and will hold in the future following cessation of forestry and mining activities. These conservation values have been identified through consultation with a number of stakeholders and a literature review of stakeholder documentation, including:

- the Greater Blue Mountains World Heritage Area Strategic Plan (2009 to 2019),
- Newnes Plateau Swamp Assessment Project, Save our Swamps (2010)

- Review of Piezometer Monitoring Data in Newnes Plateau Shrub Swamps and their Relationship with Underground Mining in the Western Coalfield, DECCW (2010)
- The Geoheritage and Geomorphology of the Sandstone Pagodas of the North-western Blue Mountains Region (NSW), Washington et al, 2011
- The Gardens of Stone Park Proposal: Stage 2, the Western Escarpment, Airly-Genowlan Mesa, Newnes Plateau and related Crown lands, 2005[1]
- The Impact of Coal Mining on the Gardens of Stone, Colong Foundation for Wilderness, 2010
- Alteration of Habitat Following Subsidence due to Longwall Mining – Key Threatening Process Listing, Office of Environment and Heritage, 2005
- Coalpac Consolidation Project Planning Assessment Commission Report, 2013

This review identified the common theme and desire to protect, conserve, present and rehabilitate the environmental values of the Newnes Plateau for recreation and tourism purposes. This includes consideration of:

- Threats to conservation values that include (but are not limited to) fire, pests and weeds.
- Methods to establish the health status of swamp communities to guide management decisions, as discussed in **Section 10.3**.
- Impacts of mine water discharge on swamp communities, as discussed in **Chapter 2.0** and **Chapter 8.0**.
- Value of pagoda systems that occur within the Banks Wall and Burra Moko Head Sandstones, as discussed in **Chapter 2.0** and **Section 10.1**.
- Impacts of mining related activities to areas with potential conservation value, including construction of access roads and utility corridors, historical cliff collapses, potential changes to hydrology; as discussed in **Chapter 2.0** and **Sections 10.1, 10.2** and **10.3**.
- Support by Centennial Coal Company Ltd for the reservation of Mugii Murum-ban State Conservation Area in a State Conservation Area in 2011.
- A heritage assessment for the Mount Airly Oil Shale Ruins, completed by Centennial Airly Pty Ltd in 2013.
- Discharge of water away from the World Heritage Area and reuse of water for industrial purposes, as discussed in **Section 10.2**.
- Subsidence protection zones whilst maintaining economically viable operations, as discussed in **Chapter 8.0**.
- Collection of real time and relevant data to inform understanding of the biodiversity and geo-diversity values, as discussed in **Chapter 2.0**, **Sections 10.1** and **10.3**.

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[1] Including *The Gardens of Stone Park Proposal Stage Two Illustrated: A proposal to extend the Gardens of Stone and Blue Mountains National Parks and create a Gardens of Stone Conservation Area and a Western Escarpment State Conservation Area*, Blue Mountains Conservation Society and the Colong Foundation for Wilderness, 2005.

Seeing the Gardens…the other Blue Mountains: Nature based tourism and recreation in the Gardens of Stone Stage Two Park Proposal, Blue Mountains Conservation Society and the Colong Foundation for Wilderness, 2009

- Management and monitoring of underground mining operations to achieve predicted height of fracturing, thereby minimising to the greatest extent possible surface related impacts, as discussed in **Chapter 2.0** and **Chapter 8.0**.

By taking into consideration the measures identified above, the conservation values of the Newnes Plateau, and the management strategies to avoid and mitigate impacts, the mining operations at Angus Place and Springvale can be managed to achieve a future conservation outcome. Centennial Coal has developed this biodiversity strategy to meet this broader conservation outcome.

Angus Place and Springvale Proposed Biodiversity Strategy

Centennial has developed a Biodiversity Strategy that considers both the direct impacts of clearing potential habitat and indirect impacts to the Temperate Highland Peat Swamps on Sandstone, incorporating Newnes Plateau Shrub Swamps and Newnes Plateau Hanging Swamps. This package further considers the steps necessary to prepare the Newnes Plateau for its final land use, conservation, through reducing the impacts of intensive monitoring programs and substituting these with robust, less invasive remote sensing methods.

Direct Offset Package:

The Angus Place Mine Extension Project will clear 23.25 ha of native vegetation. The Springvale Mine Extension Project will clear 11.44 ha of native vegetation. The Springvale Mine Extension Project proposed to clear 0.22 ha of Tableland Gully Snow Gum- Ribbon Gum Montaine Grassy Forest, an endangered ecological community under the TSC Act. No habitat for threatened species listed under the EPBC Act will be cleared.

Whilst Angus Place and Springvale have established that the impacts from longwall mining on the natural features of the Newnes Plateau, specifically swamp communities, are negligible (that is, within pre-mining or natural variations), both operations acknowledge that the potential for indirect impacts presents a level of uncertainty that to some stakeholders may be unacceptable.

- The Springvale Mine Extension Project proposes to mine under 76.57 ha of THPSS.
- The Angus Place Mine Extension Project proposed to mine under 20.04 ha of THPSS.
- The total area of THPSS to be mined under is 96.61 ha.

To compensate for both the actual clearing of vegetation and the potential residual impacts to THPSS, it is intended to provide an offset using land owned by Centennial Airly Pty Limited. This land is located adjacent to the Capertee National Park and within proximity of the Mugii Murum-Ban State Conservation Area. This land includes the critically endangered ecological community Capertee Rough-barked Apple-Redgum-Yellow Box Grassy Woodlands and habitat for the threatened Gang Gang Cockatoo, Swift Parrot and Regent Honeyeater.

The land comprises Lot135/DP755757 and totals 86.8 ha in size. **Appendix I** includes:

- Clear quantification of each vegetation community that will be impacted by the Projects
- Maps showing the vegetation communities to be impacted
- Clear quantification of each vegetation community on the offset land
- Map showing the offset land and its vegetation communities
- The metric used to show that the impacts are fully offset

This land will be placed under a restrictive covenant (or similar) to provide for in perpetuity conservation. For the purposes of clarity, in perpetuity is defined as the life of the project, or achievement of completion criteria (whichever comes first). The restrictive covenant will place restrictions on future land use commensurate with conservation outcomes.

The covenant will be supported by a Land Management Plan that will include established completion criteria required to achieve an improved biodiversity outcome on the land such that once criteria are met, Centennial

Coal's conservation obligation will have been realised. The completion criteria have been derived from the priority recovery actions described in *Caring for our Country: A Guide to Managing Box Gum Grassy Woodlands (2010*). Completion criteria will be focussed on achieving a conservation outcome and will include measures to:

- Repair and restore riparian habitat and values
- Timetable and methods for feral animal control and weed management
- Establishment and implementation of fire management practices, including fire breaks
- Exclusion of cattle grazing
- Implementation of erosion control measures

It is anticipated that these measures will result in an initial start-up investment by Angus Place Colliery and Springvale Mine together of $100,000 over three years with ongoing maintenance costs in the order of $15,000 per year until completion criteria are met. Long term management activities will be incorporated into the restrictive covenant for the land ensuring that the conservation values achieved will be maintained in perpetuity.

Centennial Coal will continue to consult with Office of Environment and Heritage and the Federal Department of the Environment to continue to refine this package.

Supplementary Measures to Support Conservation Outcomes

Throughout the development of the Biodiversity Strategy, Centennial Coal has undertaken a review of the Priority Actions for species and communities of concern to the Office of Environment and Heritage and the Department of the Environment. This review has identified a number of threatened species where actions for recovery can be supported by additional investment in research. These species include (but are not limited to):

- *Eucalyptus cannonii*
- *Persoonia hindii*
- *Veronica blakelyi*
- Blue Mountains Water Skink
- Giant Dragonfly
- *Thesium australe*
- *Bursaria spinosa subsp lasiophylla*
- Temperate Highland Peat Swamps on Sandstone (incorporating NPSS and NPHS)

With a focus on those recovery actions towards which Centennial Coal can contribute, the following list has been compiled to provide a suggested research program encompassing these species.

- Contributing research funding towards furthering recovery plans for the threatened species listed above. This research may include mapping the extent of species distribution in a regional context, include trials for the establishment of species habitat, studies of the nature, form and function of species within the landscape, ecology of fire and its impact on species and communities, seed collection and propagation techniques, habitat requirements, methods to communicate research findings, and short and long term goals to measure the effectiveness of the research.
- Working with government and community groups to provide remediation advice and in kind support, for the active rehabilitation of shrub swamp communities impacted by other anthropogenic activities (for example, four wheel drive tracks) on the Newnes Plateau.

The mechanisms for establishing these research programs will be investigated and may include:

- Direct funding of existing research programs to either enhance or redirect research efforts
- Adding funds to the existing agreement between Springvale Coal, Centennial Angus Place and the Australian National University. This agreement was established as the outcome of an enforceable undertaking (described in Chapter 2). The agreement, Temperate Highland Peat Swamps on Sandstone Research Program Agreement, establishes a research program with academic freedom (that is, funding is distributed through a steering committee with expert representation) to pursue research proposals specific to achieving recovery outcomes for the THPSS. This agreement could be amended and extended to include additional research components. To date, the Enforceable Undertaking has invested funding into the following research topics:
  - Mapping, location, distribution and extent of THPSS;
  - Functionality of swamp systems;
  - Ecology and biology of major structural species;
  - Environmental history of swamp communities, including resilience over time to fire;
  - Condition status and trends; and
  - Thresholds for recovery, including fire.

Centennial Coal acknowledges that the existing approval condition requiring both the Angus Place Colliery and Springvale Mine operations to develop and implement a *Persoonia hindii* Research and Management Plan is ongoing; the outcomes of this research and monitoring program will provide information to inform future management decisions regarding potential impacts to *Persoonia hindii*. To mitigate the unlikely event that this research program does not achieve the expected outcomes, the biodiversity package within this EIS includes consideration of *Persoonia hindii* and satisfies the requirement to provide additional offsets. The Management Plan is in the early stages of implementation and to date, the following actions have been undertaken:

- Initial survey and mapping of *Persoonia hindii* across parts of the Newnes Plateau
- Translocation of 62 plants, propagation trials via cuttings and seed collection
- Ongoing monitoring of translocated plants
- Consultation with Office of Environment and Heritage on the progress of the Plan

Centennial Coal will continue consultation with the Office of Environment and Heritage and the Federal Department of the Environment regarding the potential research activities.

Monitoring Program

Centennial Coal has invested considerable research and monitoring effort on the Newnes Plateau over the last 15 years of mining operations. In particular, Centennial's investment has focussed on monitoring the THPSS. Centennial Coal's monitoring effort on the Newnes Plateau is extensive and contributes to an increase in other anthropogenic impacts, such as recreational 4WDs, through the establishment of access tracks for monitoring. Should the current suite of monitoring persist, these incidental (but not insignificant) impacts will continue across the Newnes Plateau, placing greater pressure on areas where conservation values are currently retained.

The biodiversity strategy will enable Centennial Coal to redirect this monitoring investment towards those conservation outcomes described above. The monitoring program will be regionalised with greater effort on remote sensing data collection across a wider distribution of the Newnes Plateau and will focus on supporting research into rapid mapping techniques and defining vegetation community boundaries.

This current monitoring effort is approximately $1.5M per year.

The redefined monitoring program, including the management actions identified above, will be incorporated into an agreed, combined Biodiversity Management Plan for Angus Place and Springvale Mine Extension Projects, thereby reducing the current suite of management plans required for compliance to one. This

Biodiversity Management Plan will be developed in consultation with OEH (including NPWS), Federal DoE and the Forestry Corporation of NSW and will:

- Identify and incorporate the direct offset package identified in this EIS;
- Establish the Land Management Plan for the offset land, including management actions and completion criteria;
- Describe the research and monitoring program that will be implemented to focus on mapping the extent of species distribution in a regional context, include trials for the establishment of species habitat, studies of the nature, form and function of species within the landscape, ecology of fire and its impact on species and communities, seed collection and propagation techniques, habitat requirements; and
- Describe the measures that will be taken to rehabilitate shrub swamp communities impacted by other anthropogenic activities, using the Save Our Swamps Guideline.

The existing and future monitoring programs will focus on establishing these conservation outcomes.

The Cost of the Offset Package

The land proposed for the offset is Centennial Coal's owned land; regardless, there is an opportunity cost to the Company of $140,000 per hectare (as per the Biobanking Calculator) that will be lost once this land is offset for these projects. Ancillary costs, including taxes, conveyancing and current land management expenses are incidental.

It is anticipated that the management actions identified above will result in an initial start-up investment by Angus Place Colliery and Springvale Mine together of $100,000 over three years with ongoing maintenance costs in the order of $15,000 per year until completion criteria are met. Long term management activities will be incorporated into the restrictive covenant for the land ensuring that the conservation values achieved will be maintained in perpetuity.

Centennial Coal's current monitoring investment on the Newnes Plateau will be reduced and redirected following the implementation of the above monitoring program. The ongoing monitoring investment for both Projects will be in the order of $250,000 per year across ecology (terrestrial and aquatic), water (surface and groundwater) and subsidence.

Economic and Social Costs and Benefits of the Biodiversity Strategy

The offsets required for the Project have been quantified in the context of the biodiversity values lost or gained as a result of the predicted impacts of the Angus Place and Springvale Mine Extension Projects. The costs borne by Centennial Coal through avoidance and mitigation measures, including reduced longwall widths and, where economically practical, complete avoidance of sensitive surface features, are significant (**Chapter 6.0**). This significance needs to be considered in the context of the ongoing benefits afforded to the community through the management and research actions taken to date for activities on the Newnes Plateau. These actions have contributed to a greater understanding of this environment, such that the results of these studies can be incorporated into broader recovery and conservation outcomes.

Balanced with this, are the benefits generated through this Biodiversity Strategy that may otherwise not be realised, by providing for:

- conservation in perpetuity of high priority biodiversity values;
- ongoing financial support to achieve agreed criteria for conservation;
- access to conserved land adjacent to the Mugii Murum-Ban State Conservation Area for tourism and recreational purposes; and
- investment in research, recovery and maintenance plans to understand potential threats to conservation outcomes and integrate this understanding with values of adjacent National Parks, World Heritage Areas and National Heritage Places.

Conclusion

Centennial Coal will continue to consult with Office of Environment and Heritage and the Federal Department of the Environment to continue to refine the Biodiversity Strategy. This Strategy, combined with the current measures taken to avoid and minimise impacts, will compensate for the residual impacts, enhance biodiversity outcomes, conserve high conservation communities, and the associated flora and fauna, and will enable focussed effort on improving understanding of the biodiversity values of Box Gum Grassy Woodlands and the Newnes Plateau.

10.3.8 Mitigation and Management Measures

Clearing

The Project includes the construction of surface facilities and track upgrades and widening in specific areas. Removal of vegetation is subsequently required to accommodate the proposed surface infrastructure. These facilities will be constructed within the boundaries of the ESAs. The Project can limit the required clearing to an area of 23.25 ha of native vegetation and avoid removal of any threatened flora. Due to the unavoidable impacts of clearing 23.25 ha of native vegetation, mitigation measures have been developed to minimise the effects of this clearing. **Table 10.16** summarises mitigation measures for both terrestrial and aquatic ecology.

Table 10.16 Mitigation Measures

Impact	Mitigation Measures
Direct Impacts	
Impacts to flora (loss of species and habitat)	For those areas where hard surfaces are required, undertake stockpiling of soil to enable reestablishment of visible habitat following infrastructure decommissioning.
	During clearing, and where it would not interfere with operations, the removal of vegetation will be limited to above ground parts as much as possible. This will enable any vegetation that is able to re-sprout once works are completed to do so.
	The outcomes of the *Persoonia hindii* Research and Monitoring Programme will be used to inform future management decision and monitoring programmes.
Impacts to fauna (loss of species and habitat)	Where possible, clearing activities will be timed to avoid removal of hollow-bearing trees during breeding season of threatened species.
	Employment of best practice methods for felling of hollow-bearing trees.
	Prioritise the retention of hollow-bearing tree with Asset Protection Zones associated with the dewatering bore sites.
	Placement of hollow logs and felled hollow- bearing trees within adjacent uncleared vegetation to provide additional habitat resources for terrestrial fauna.
Impacts to aquatic ecology	Limiting the area of riparian zone and aquatic habitat disturbed.
	Using measures specified in the Erosion and Sediment Control Plan to protect aquatic habitats and biota immediately downstream of the construction area.
	Establishing a bunded area for storage of fuels, oils, refuelling, oils, refuelling and appropriate maintenance of vehicles and mechanical plant.
	Construction works in the vicinity of watercourses will be undertaken in accordance with the NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management.
Impacts to stygofauna	Because the aquifer systems across the Newnes Plateau are consistent, stygofauna will be monitored using standing water levels within one borehole in each aquifer where stygofauna are known to occur (AQ4 to AQ6). Where available, monitoring of the deep aquifer system, AQ 1 to AQ3 will be undertaken to establish presence of stygofauna.

Impact	Mitigation Measures
Indirect Impacts (reduction in quality of habitats)	
Erosion and Sedimentation	Limiting the amount of exposed surfaces that may become eroded by weather and operations.
	Installation of erosion and runoff control measures around cleared and operation areas.
Dust	Implementation of dust control measures to protect adjacent retained vegetation communities.
Weed Incursion	Strict weed management, monitoring and control practices would be implemented to minimise the spread of exotic species into natural areas within the sites.
Exploration drill holes	As detailed in Section 4.2, as the required exploration drill holes are determined, Centennial Angus Place will undertake a series of due diligence assessments to consider ecological impacts as relevant. The general approach of the due diligence assessments will be to conduct site investigations to ensure that significant impacts are avoided.

Subsidence

The mine plan and design has been selected to minimise environmental effects of the Project. Centennial Coal has developed a reliable and detailed understanding of the environmental constraints from operating the Angus Place Colliery which has been in operation for 34 years and the resulting environmental management and monitoring programmes associated with operation of the site. The mine plan for the Project has been proactively designed with a high regard and full consideration of the ecological constraints present within the area.

Ongoing monitoring will use techniques and measuring parameters that are suitably sensitive to detect changes caused by subsidence.

Important parameters which are being monitored are: groundwater levels; surface water levels; groundwater and surface water quality; subsidence levels and related geological and physical impacts from subsidence line surveys and photograph inspections across the landscape; and biodiversity, including a focus on THPSS extent and flora and fauna diversity in general. This monitoring will continue for a further two years post approval and will be used to continue to inform understanding of swamp hydrology and other characteristics as detailed in the Biodiversity Strategy (**Appendix H**), supported by a Biodiversity Management Plan.

As detailed in **Section 10.3.7**, a redefined monitoring program will be developed. This monitoring program will be regionalised with greater effort on remote sensing data collection across a wider distribution of the Newnes Plateau, focussing less on monitoring for impact and more on rapid monitoring techniques and recovery plan objectives for species and communities of concern.

10.3.9 Conclusion

The Project is located mainly in the Newnes State Forest and is surrounded by large areas of contiguous native forest and woodland. The Newnes State Forest and the surrounding areas are known to contain significant areas of habitat for threatened species and communities. A detailed baseline review and extensive surveys, along with avoidance of clearing known locations of threatened plants and formulating a mine design cognisant of ecological values, have all informed an analysis of the residual consequences of the Project.

With regards to the proposed clearing of 23.25 ha of woodland to allow construction of surface infrastructure, a consideration of the TSC Act and the EPBC Act shows that the consequences are low and that the Project is unlikely to have significant direct or indirect impacts on threatened species or communities.

With regards to the area to be subsidised by longwall mining, Centennial Angus Place has undertaken extensive, long term subsidence impact and consequence monitoring above longwall mining areas. Seasonal ecological monitoring undertaken since 2005 has shown no consequences on flora and fauna records in undermined areas, including areas of THPSS. The mine plan has been formulated to avoid most ecologically sensitive areas, and specifically swamps. For example, LW1010 has been foreshortened to step around Twin Gully Swamp. Where avoidance was not possible, the mine design has selected 261 m void widths, which are proven to minimise subsidence induced consequences. LW1004, 1005 and 1006 have been designed with narrower void widths to prevent consequences to Tri-Star Swamp. LW1016 and 1017 have similar narrow void widths to avoid impacting swamps overlying the northern part of the Project Application Area. Longwall mining by the Project is unlikely to have a significant impact on threatened species or EECs.

The information available on in stream ecology and the aquatic ecology of the drainages downstream of the swamps and proposed works indicates the extraction of coal would not have any significant impacts on aquatic habitats, aquatic flora or aquatic fauna, provided that appropriate measures to avoid, minimise and manage impacts associated with the construction, operation, rehabilitation and decommissioning phases are implemented. The discharge of mine water make will result in more rapid and sustained changes in salinity than occur naturally. Although the salinity level in the Coxs River would be below that likely to have direct adverse effects on aquatic biota, the rapidity and sustained nature of the changes may be problematic. The assessment of potential impacts on stygofauna is limited by the lack of information on their occurrence in the aquifers within the Project Area, their response to environmental perturbations and likely conservation significance.

10.4 Heritage

This section specifically responds to the DGRs, which provide the following in regard to heritage aspects:

The Director General's requirements

Heritage – including:

- an Aboriginal cultural heritage assessment (including both cultural and archaeological significance) which must:
    - demonstrate effective consultation with the Aboriginal community in determining and assessing impacts, and developing and selecting mitigation options and measures; and
    - outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures).
- A Historic Heritage assessment (including archaeology) which must:
    - Include a statement of heritage impact (including significance assessment) for any State significant or locally significant historic heritage items; and,
    - Outline any proposed mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures).

10.4.1 Introduction

This section identifies the potential impact of the Project on Aboriginal and historic heritage values and how these will be managed to ensure acceptable residual consequences. It is informed by the technical assessment prepared by RPS, entitled "*Cultural Heritage Impact Assessment: Angus Place Colliery Mine Extension Project, Lithgow Local Government Area*" (RPS, 2013), which is provided in full in **Appendix K**.

The RPS 2013 report considers the potential for Aboriginal archaeological sites to occur, the location of any registered sites within the Project Application Area, and the implications for the Project with regard to any existing or potential archaeological material.

Figure 10.21 identifies various survey units within the Project Application Area. Much of the Project Application Area has been subjected to desktop analysis, and those areas that were ground-truthed cover the proposed mining area and those surveyed as indicated by coloured survey units on **Figure 10.21**.

An historical heritage assessment has been completed including a review of relevant Commonwealth, State and local historic heritage registers. The review of relevant registers included the National Heritage List, Commonwealth Heritage List, State Heritage Register, State Government Agency Heritage and Conservation Register and the Lithgow City Local Environmental Plan. No historic heritage items and/or National Heritage Places have been identified within the Project Application Area or assessed to be impacted upon by the Project. As such, there are no historic heritage impacts associated with the Project.

10.4.2 Consultation

The purpose of Aboriginal community consultation is to provide an opportunity for relevant Aboriginal stakeholders to have input into the heritage management process. Consultation with the Aboriginal community has been ongoing at Angus Place for surveys within the Project area since 1980. Aboriginal community consultation has been in accordance with the "Aboriginal Cultural Heritage Consultation Requirements for Proponents" (DECCW 2010a).

Ten Aboriginal groups registered their interest in participating and all were provided with the proposed heritage assessment methodology and strategy for collecting information on cultural heritage significance. Six groups returned their comments on the proposed heritage assessment methodology by the closing date for comments. These included Aboriginal stakeholders representing Bathurst Local Land Council, Gundungurra Tribal Council Aboriginal Corporation, Mingaan Aboriginal Corporation, Warrabinga Native Title Claimants Aboriginal Corporation and North East Wiradjuri Aboriginal Corporation.

Full details of consultation are provided in the Cultural Heritage Impact Assessment (**Appendix K**).

Registered Aboriginal groups were invited to attend an information session on the Project, of which five attended and were later invited to participate in a field survey from 6 March to 13 April 2012. Copies of the "*Cultural Heritage Impact Assessment: Angus Place Extension Project*" (RPS, 2013) have been provided to the registered Aboriginal groups for their review and comment.

10.4.3 Existing Environment

A search of the Aboriginal Heritage Information Management System (AHIMS) identified 49 sites within the Project Application Area as shown on **Figure 10.21** and as listed in **Table 10.17**.

Table 10.17 AHIMS Site Types

Site type	Number within Project Application Area
Shelter with deposit	29
Shelter with art	9
Isolated find	2
Shelter with deposit; art	2
Artefact(s) unspecified	1
Scarred tree	1
Shelter	1
Potential archaeological deposit (PAD)	1
Shelter with deposit	1
Shelter with art	1
Stone arrangement	1
Total	49

The following archaeological studies in and around the Project Application Area date back to 1980:

- Gaul, post 1980. Prehistoric Archaeology 391-1, Assignment 2: Black-Fellows Hands Shelter and Environs. University of New England;
- Gorecki, 1983, Archaeological Survey Kariwara Colliery Lease;
- Stockton, 1983, Survey for Prehistoric Sites on the proposed Clarence Transfer;
- Rich, 1983, Proposed Prison at Marrangaroo Creek;
- Rich and Gorman, 1988, Archaeological Survey of Proposed Springvale Colliery and Conveyor;
- Rich, 1993, Archaeological Inspection of Aboriginal Sites in the Springvale Coal Project;
- Central West Archaeological and Heritage Services, 2000, Aboriginal Archaeological Study of the Marrangaroo Site;
- OzArk, 2006, Flora/ Fauna and Heritage Assessment: Two Proposed Dewatering Borehole Sites within the Newnes State Forest;
- OzArk, 2007a, Indigenous Heritage Assessment for Subsidence Management Plan for Baal Bone Colliery;
- RPS, 2010, Cultural Heritage Impact Assessment for Angus Place Colliery s75W Modification;
- RPS, 2012, Angus Place Colliery, Ventilation Facility Project: Modification 2 of Project Approval 06_0021;
- RPS, 2013, Cultural Heritage Impact Assessment Springvale Mine Extension Project; and
- RPS, 2012, Aboriginal Cultural Heritage Assessment, Springvale Mine Dewatering Bore 8.

A predictive model was used to provide an indication of areas where Aboriginal sites are likely to occur within the Project Application Area. The predictive model used the analysis of the AHIMS data and a review of the listed reports, the site predictions based on environmental context prior to survey. Environmental context included areas that were considered likely to provide subsistence resources and included the following:

- the most likely site type would be shelters with deposits, followed by shelters with art;
- shelters would generally be found in cliff faces, pagodas and sandstone outcrops or large boulders;
- artefacts would generally comprise stone flakes manufactured from quartz, mudstone, chert and silcrete; and
- the majority of sites would be located within 100 m of watercourses.

Archaeological surveys were designed to cover those areas of potential impact, which comprised areas of predicted subsidence effects and the environmental study areas (ESA) designated for the various surface infrastructure. These ESAs were substantially larger than the actual clearing area needed to build and operate each infrastructure item. The entire potential impact area was divided into a series of survey units, based on topography, access, and ground conditions. 29 survey units were identified for field survey, with an additional area the subject of a desktop assessment. Areas predicted to be impacted by the Project were included in the field survey to be ground-truthed. The desktop assessment did not include any areas predicted to be impacted by the Project. **Figure 10.21** shows these survey units and environmental study areas and a summary provided in **Table 10.18**.

Table 10.18 Summary of Survey Units

Survey Unit	Summary
1	Located in the north east of the Project Application Area. The survey unit included a number of drainage lines and a tributary of Carne Creek, as well as scattered pinnacle rocks and a canyon formation.
2	Located in the east of the Project Application Area. This survey unit comprised an upper slope west of Birds Rock Trail No. 2.
3	Located in the in the east of the Project Application Area. A low order creek line runs through the survey area.
4	This survey unit was located in the Birds Rock Flora Reserve, with Sunnyside Ridge Road in the west and Birds Rock Trail No. 2 in the north. The survey unit includes a number of drainage lines and tributaries of Carne Creek crest and saddle landforms within the survey unit were followed and outcropping sandstone.
5	Located in the southeast corner of the Newnes Plateau and incorporated the west trending tributaries of Carne Creek south of Birds Rock Trail.
6	Located to the north of the Angus Place pit top, in the high ground north of the junction of Wolgan Road and the Bicentennial National Trail. The survey unit included steeply inclined exposed sandstone.
7	Located to the immediate south and east of the Angus Place pit top facility.
8	Located to the north of the Angus Place pit top, in the high ground north of the junction of Wolgan Road and the Bicentennial National Trail. Coxs River was located to the immediate west of the survey unit, with several small tributaries crossing through the survey unit.
9	Located northwest of the Angus Place pit top. This survey unit consisted of low lying open paddocks, spanning both banks of Coxs River.
10	Located to the east of Angus Place Colliery and included a gorge and creek.
11	Located to the east of the Angus Place Colliery. The survey unit was composed of steep escarpments and ridges, with deeply incised creek valleys.
12	Located on the southern boundary of the Project Application Area, to the east of Sunnyside Ridge Road. Tributaries of Carne Creek run through the survey unit, with several drainage lines in the southeast corner.
13	Located to the east of Sunnyside Ridge Road. The area was predominantly characterised by a level to gently sloping plateau, with the exception of a number of steep spurs and sandstone pagodas associated with tributaries of Carne Creek.
14	Located in the eastern portion of the Project Application Area, to the south of a large tributary of Carne Creek. The topography of this area was characterised by undulating hills, moderately steep valley slopes, and spurs and pagodas in the east of the survey unit.

Survey Unit	Summary
15	Located on the southern boundary of the Project Application Area to the west of Sunnyside Ridge Road. The survey unit consisted of moderately steep inclines associated with tributaries of the Wolgan River.
16	Located to the west of Sunnyside Ridge Road and an escarpment followed the western boundary. The remainder of the survey unit was predominantly level to gently undulating slopes, with no rock outcrops or overhangs noted.
17	Located to the west of Sunnyside Ridge Road and to the east of the Wolgan River (western arm). The topography ranged from level to gently undulating in the east of the survey unit to steep in the west of the survey area. Several tributaries of the Wolgan River run through the north, west and south of the survey unit.
18	Located in a small area to the northeast of Sunnyside Ridge Road. The topography of the survey unit was moderate slopes with only a rock outcrop.
19	Located in a narrow strip between a tributary of Carnes Creek and Fire Trail No. 4. The survey unit comprised a moderately steep slope, with a valley and pagodas visible to the east.
20	Located adjacent to the Angus Place pit top and consisted of an open valley.
21	Located on the Newnes Plateau and comprised a ridge and upper slopes. Numerous tributaries of Carne Creek traversed the survey unit.
22	Located on the Newnes Plateau along the western escarpment, adjacent to the Wolgan River.
23	Located in the northeast of the Project Application Area. The survey unit was characterised by steep slopes and escarpments.
24	Located to the northeast of the Project Application Area. This survey unit comprised a central escarpment.
25	Located to the northwest of the Blue Mountain range and the Wolgan River. The topography of this portion of the Project Application Area comprised rolling ridges running north to south.
26	Located to the east of Birds Rock Trail No. 1. The dominant landform was a north trending spur, steep slopes to the east and west leading to drainage channels.
27	Located to the west of Sunnyside Ridge Road and east of the Wolgan River. It comprised a west-trending spur between two large tributaries of the river.
28	This survey unit was bisected by Sunnyside Ridge Road and a Fire Trail No.6 formed the southern border. The dominant landforms in this survey unit were ridges and narrow valley areas, with a steep escarpment.
29	Located to the north of the Angus Place pit top. It was an open valley associated with the Coxs River with Lambs Creek running through the survey unit. in a roughly eastwest direction.

RPS archaeologists and Aboriginal stakeholders (refer **Section 10.4.2**) conducted a survey of the Project Application Area from 6 March 2012 to 13 April 2012. The Project Application Area was surveyed in accordance with the requirements set out in the “Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales” (DECCW, 2010b) and the “Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW” (OEH, 2011).

No new Aboriginal sites were identified during the survey, which was expected given the number of surveys that had already been conducted in the region. Dense vegetation also compromised visibility and hindered access. No recorded sites are within any of the ESAs and there are 14 sites within the survey units in the potential subsidence area indicated by the eastern survey units in **Figure 10.21**. **Table 10.19** lists these sites within the potential impact area along with their significance.

Table 10.19 Archaeological Site Significance

Site	Site type	Significance scale	Rarity	Representativeness	Integrity	Connectedness	Complexity	Research Potential	Total Score	Overall Significance
45-1-0078	Shelter with deposit; grinding groove	Local	3	3	2	3	2	2	15	High
		Regional	3	2	2	3	2	2	14	Moderate
45-1-0084	Shelter with deposit	Local	3	2	2	2	2	2	13	Moderate
		Regional	2	1	1	1	1	1	7	Low
45-1-0137	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0144	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0145	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0146	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0149	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0150	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0151	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0153	Shelter with shelter	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0155	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-0156	Shelter with deposit	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-2689	Stone arrangement	Local	1	2	1	1	1	1	7	Low
		Regional	1	1	1	1	1	1	6	Low
45-1-2756/2757	Shelter with art	Local	3	3	3	3	3	3	18	High
		Regional	3	3	3	3	3	3	18	High

Of the 14 sites, most have low overall archaeological significance. A summary of those sites with moderate to high significance are:

- site 45-1-0078 is a shelter with deposit and grinding groove. It has moderate regional and high local significance;
- site 45-1-0084 is a shelter with deposit and has low regional and moderate local significance; and
- site 45-1-2756/2757 is a shelter with art and has high regional and local significance. This site has duplicate site numbers and consists of two separate shelters underneath one large pagoda. One shelter contains a hand stencil on an internal rock face. While the AHIMS site card lists a grinding groove, RPS' inspection revealed a loose grinding stone and ochre rather than a grinding groove. It is presumed that the site card is in error.

10.4.4 Aboriginal Heritage Impact Assessment

There are no sites located in areas to be disturbed for surface infrastructure. The 14 sites within the potential subsidence impact area are shown on **Figure 10.21.** The angle of draw has been selected for impact assessment purposes as this defines the area expected to show measurable vertical subsidence, which in turn is the key determinant of tilts and strains that might affect certain archaeological sites.

Artefact sites have different sensitivities to mine-induced subsidence. Artefact scatters, isolated finds, stone arrangements and scarred trees are not sensitive to subsidence. Artefacts scatters and isolated finds consist of fragments of worked stone lying on the soil surface, or in some cases remaining unrecorded within in the soil profile. These stone artefacts lie on or in deformable substrates, and because of their very small size, they are not to subject to subsidence induced cracking. The only effect of subsidence is that these sites will be located at a slightly lower elevation that that at which they now exist, the extent of which depends on the site's location in relation to the longwalls. Should any surface soil cracking occur that requires remediation by earthmoving, sites, should they occur, might be physically disturbed.

Stone arrangements are a relatively rare site type and generally have high cultural significance. The largest of these stone arrangements would be site types such as bora rings, which are circular arrangements of similarly sized rocks placed on the soil surface. Like artefacts scatters, the relatively small size of these stones and their lack of direct connection with bedrock mean that subsidence induced cracking of the artefacts would not occur.

Scarred trees are increasingly rare as bushfires and decay take their toll on these significant cultural features. The maximum tilt predicted at Angus Place Colliery, 20 mm/m, would tilt a vertical tree of 15 m tall, by 300 mm from the vertical, which would equate to a 2.5 % or less than 2 degree deviation from the vertical. Given that trees have strong and flexible root systems that have function to retain a tree upright in high winds and contracting and expanding soils, such a small tilt would rarely cause a tree to fall. Research shows that as a tree reaches 15 degrees from the vertical, the risk of toppling rises significantly and that for a tree with a nominal tree root plate radius as a percentage of tree height of 9% would fall due to gravity when the lean reaches 18 degrees from the vertical (Coder 2000).

Sites such as rock shelters and grinding grooves, which are relatively large, rigid, and in direct connection with solid bedrock, are more sensitive to subsidence movements. In the case of isolated but large rock features that are not directly connected to bedrock, the size of the features can provide sufficient leverage for differential ground movement to deform the feature beyond its elastic limit, and so induce cracking. Whilst a small stone feature, isolated from bedrock would not be subjected to strains from mine subsidence, a larger stone feature, directly connected to bedrock, such as a rock shelter, would be subjected to a range of transient compressive and tensile strains as the mined strata adjust. Sefton and Shepherd (2001) analysed the effect of longwall mining on rock shelters above the Metropolitan Mine in the Southern Coalfields. They determined that the shelters most as risk of subsidence damage from subsidence were those that:

- are long and voluminous;
- have seepages in the back wall;

- have distinct bedding planes especially fine sandstone/claystone beds under the overhang.
- have an orientation to the longwall face retreat direction; or
- are located over a chain pillar edge.

Of the sites in the angle of draw, three are at risk of harm form potential subsidence impacts as listed in **Table 10.20**.

Table 10.20 Subsidence Predictions for Sensitive Archaeology Sites

AHIMS Site ID	Location	Description & Scientific Significance	Subsidence (mm)	Tilt (mm/m)
45-1-0084	Within the centre of LW1007	Shelter with deposit. Moderate local and low regional significance.	1800	8
45-1-0137	Above the main headings of LW1006	Shelter with deposit. Low local and regional significance.	20	<0.5
45-1-2756/2757	Within the centre of LW1019	Shelter with art. High local and regional significance.	950	8
All other sites			<20	<0.5

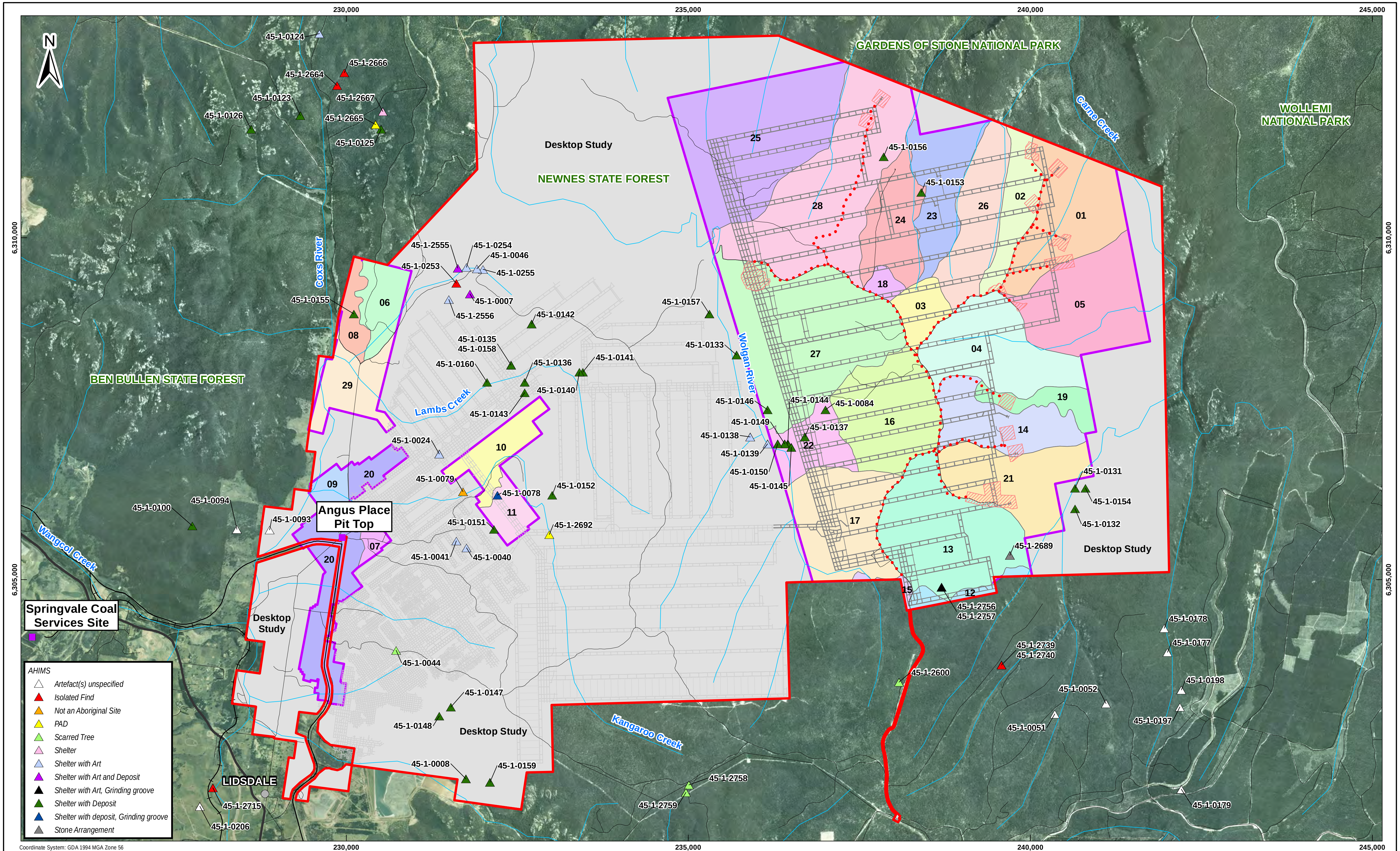
The maximum conventional strains are predicted to be 1 mm/m tensile and 2 mm/m compressive.

10.4.5 Consequences of Potential Aboriginal Heritage Impacts

Table 10.20 shows that the sites with the predicted effects of 20 mm vertical subsidence or more are 45-1-0084, 45-1-0137 and 45-1-2756/2757.

Based on subsidence predictions and prior experience in the Southern Coalfields no significant physical impact is predicted to any of these sites, although there is the possibility of minor spalling occurring on exposed rock faces, and such damage could be coincident with the hand stencil on the wall of 45-1-2756/2757.

The remaining sites are predicted to experience vertical subsidence of 20 mm or less and correspondingly small conventional tilts, curvatures and strains. No consequences are predicted for these sites.



LEGEND

Project Application Area	Watercourse
Village	Proposed Infrastructure Corridor
Rail	Environmental Study Area
Main Road	Proposed Workings
Street / Track	Existing Workings

CENTENNIAL ANGUS PLACE PTY. LTD.

DATE	13/03/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F037 APC Rev 0
SCALE	1:50,000

Newcastle
Site
Lithgow
Sydney

Figure 10.21: Archaeological Sites across the Project Application Area

0 1 2 3 km

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 37

A3

10.4.6 Management and Mitigation Measures

A Cultural Heritage Management Plan will be prepared to detail specifications for:

- baseline recording prior to the commencement of mining under the sites 45-1-0084, 45-1-0137 and 45-1-2756/2757 including detailed archaeological recording, archival quality photographs and installation of at least six survey control points;
- after completion of mining under the relevant site, the condition of the site will be compared with baseline. If the site is found to be damaged, Centennial Angus Place will notify OEH; and
- after approximately 12 months after mining in the vicinity of the site has finished, an inspection will assess whether the ground conditions have stabilised. After a further 12 months, if no changes are observes, no further monitoring will occur.

Centennial Angus Place will consult with relevant Aboriginal groups to develop a Cultural Heritage Management Plan.

In the unlikely event that skeletal remains are found, work will cease immediately in the vicinity of the remains and the area will be cordoned off. The local police will be contacted to make an initial assessment to ascertain whether the remains are part of a crime scene or possible Aboriginal remains. If this is the case, the local police will contact OEH so that they can determine if the remains are Aboriginal.

If, during the course of development works, suspected historic cultural heritage material is uncovered, work should cease in that area immediately. A suitably qualified heritage consultant should be contacted and the NSW Heritage Branch (Enviroline 131 555) notified, works can recommence once an approved management strategy is developed.

As detailed in **Section 4.2**, as the required exploration drill holes are determined, Centennial Angus Place will undertake a series of due diligence assessments to consider heritage impacts as relevant. The general approach of the due diligence assessments will be to conduct site investigations to ensure that significant impacts are avoided.

10.4.7 Conclusion

There have been a number of surveys that have identified 49 Aboriginal heritage sites within the Project Application Area. While 14 of these sites will be subsided to varying degrees, the small predicted subsidence effects and site type means that no consequences are predicted for most.

The four sites above the mining area that will be subsided by 20 mm or more are not predicted to be damaged, although the risk remains. These sites are 45-1-0084, 45-1-0137 and 45-1-2756/2757. Based on subsidence predictions and prior experience in the Southern Coalfields no significant physical impact is predicted to any of these sites, although there is the possibility of minor spalling occurring on exposed rock faces, and such damage could be coincident with the hand stencil on the wall of 45-1-2756/2757.

Accordingly, they will be monitored in accordance with specifications to be formulated in a Cultural Heritage Management Plan.

No Aboriginal sites were found within areas to be cleared for surface infrastructure and therefore this activity is predicted to have no impact on Aboriginal heritage.

No historic heritage items or areas have been identified within the Project Application Area and accordingly no historic heritage consequences are predicted.

10.5 Road Traffic and Transport

10.5.1 Introduction

The Traffic Impact Assessment specifically responds to the Director General's Requirements (DGRs), which provide the following in regard to road traffic and transport:

The Director General's requirements

Traffic & Transport – including:

- an assessment of potential traffic impacts on the capacity, efficiency and safety of the road network; and
- a description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road network in the surrounding area over the life of the development.

A Traffic Impact Assessment for the Project has been undertaken by ARC Traffic + Transport (July 2013) "*Angus Place Mine Extension Project Traffic Impact Assessment*", which is provided in full in **Appendix J**. The scope of this assessment was to review the existing traffic conditions for Angus Place Colliery, assess the likely changes to traffic and the potential impact upon the road network as a result of the Project and identify mitigation measures as required.

The Traffic Impact Assessment has referenced and addressed the following relevant guidelines and assessment criteria as noted within the DGRs:

- RTA Guide to Traffic Generating Developments (RTA Guide) and Road Design Guide (RTA RDG)
- AustRoads Guide to Road Design Part 4A Unsignalised and Signalised Intersections (AustRoads GRD4A); Rural Road Design Guide (AustRoads RRDG); Vehicle Classification System (AustRoads VCS) and Guide to Traffic Engineering Practice Part 2 Roadway Capacity (AustRoads GTEP2);
- Australian Road Research Board Unsealed Roads Manual;
- State Forests of NSW Forest Practices Code: Part 4 Forest Roads and Fire Trails (FPC4); and
- *Forestry Act 2012.*

The Forestry Corporation of NSW and the Roads and Maritime Services were consulted during the preparation of the Traffic Impact Assessment with regard to accident data, general traffic operating conditions and permits within the Newnes State Forest.

Springvale Coal Services Site is assessed as part of the Western Coal Services Project.

The Traffic Impact Assessment has assessed the impact of the Project on the existing road traffic environment associated with the current Angus Place Colliery operations. Light vehicles are defined with reference to AustRoads VCS as Class 1 and Class 2 vehicles. Heavy vehicles are defined with reference to the AustRoads VCS as Class 3 – Class 12 vehicles.

As identified within **Chapter 4.0**, operation of the transport of coal from the Angus Place pit top via the existing private haul roads to Wallerawang Power Station, Mount Piper Power Station will be managed by Western Coal Services.

10.5.2 Existing Road Traffic Environment

10.5.2.1 Angus Place Pit Top

All access to Angus Place pit top is via Wolgan Road north of Lidsdale. Access to Wolgan Road is provided via the intersection of Castlereagh Highway, Wolgan Road and Main Street; or via the intersection of Castlereagh Highway and Ian Holt Drive (**Figure 10.22**). Between the Castlereagh Highway and the pit top, Wolgan Road provides two traffic lanes with wide verges; it has a 50 km/h speed limit north from the Castlereagh Highway and through Lidsdale, then 80 km/h north to and past the pit top.

The Castlereagh Highway generally provides two traffic lanes and well-designed at-grade and grade separated intersections appropriate to the through and turning traffic demands in this part of the regional network.

The Project will result in no operational changes beyond that which exists at Angus Place pit top with no additional traffic generation to the local and sub-regional traffic network. With no information to suggest future variations in traffic flow on Wolgan Road, the key intersections for assessment are those of the Castlereagh Highway and Wolgan Road, and Castlereagh Highway & Main Street. These are the only intersections where potential traffic flows may change due to annual average growth and other sub-regional traffic generating projects during the life of the Project.

The intersections of Castlereagh Highway and Wolgan Road, and Castlereagh Highway and Main Street, effectively operate as a single 4-way priority intersection. Utilising survey data of these intersections and the installation of automatic traffic counter on the Castlereagh Highway south of Wolgan Road in February 2013, the intersection is assessed as operating at a good Level of Service “A” with minimal average delays and significant spare capacity.

Level of Service is a basic performance indicator assigned to an intersection based on average delay. Relevant levels of service which follow the RMS level of service criteria are defined as follows:

- A: delay of less than 15 seconds;
- B: delay of 15 to 28 seconds; and
- C: delay of 29 to 42 seconds.

Data available from the Roads and Maritime Services identify two accidents reported at this intersection; one had alcohol as a contributing factor, while the second resulted from a driver turning into the wrong lane.

Traffic generation at Angus Place pit top comprises trips by mining and office staff, visitors and minor service vehicle demands related to delivery of equipment and maintenance vehicles. The majority of the traffic to Angus Place pit top is private vehicle, with the site operating 24 hours per day, 7 days per week and employing 225 full time equivalent staff.

The vehicle movements occur mainly across three shifts per day (weekday) and these shifts and staff numbers vary between weekdays and weekend as shown in **Table 10.21**.

Table 10.21 Angus Place Staff and Shifts

Angus Place Shifts and Staff Numbers	Weekday Shifts			Weekend Shifts	
	Day	Afternoon	Night	Day	Night
	6:00am – 2:00pm	2:00pm – 10:00pm	10:00pm – 6:00am	6:00am – 6:00pm	6:00pm – 6:00am
Mining	109	80	61	42	42
Office (day 6:30am – 5:00pm	32	0	0	32	0

With reference to the available survey data, the peak vehicle traffic flows on Wolgan Road occur over one to two hour periods prior to and following the three shifts, and generally mirror staff numbers. As shown in **Table 10.22**, arrival and departure flows on Wolgan Road can approach 200 vehicle trips per hour (vtph). This is well below the 300 vtph environmental goal for a 50 km/h collector road (as recommended within the RTA Guide), and as such Wolgan Road provides a good level of service based on low-moderate traffic demands during both morning and afternoon peak periods and has significant spare traffic capacity.

Table 10.22 Angus Place Pit Top Peak Period Trips

Shift Times	Approximate Arrival Trips	Approximate Departure Trips
5:00 – 7:30	140	60
13:00 – 15:00	80	110
21:00 – 23:00	60	80

The pit top generates a further 32 heavy vehicle trips per day (vtpd), the majority of which are smaller (Class 3 – 5 with reference to the AustRoads VCS) heavy vehicles.

Vehicle parking capacity is provided for all staff, visitors and service vehicle demands at Angus Place pit top. There is sufficient capacity for parking that is in excess of the peak demands, which occur during shift changeover periods.

10.5.2.2 Newnes Plateau

Access to existing infrastructure on the Newnes Plateau is available via two routes to cater for separate heavy and light vehicle access; both routes are shown in **Figure 10.22**. The routes used to access existing surface infrastructure and for exploration activities within Newnes State Forest as follows:

- Heavy vehicle access route: Access for heavy vehicles access into the Newnes State Forest is via the intersection of Chifley Road, Old Bells Line of Road and Petra Avenue at Clarence. Access to the Newnes State Forest Project Sites is along a route including Old Bells Line of Road, Glowworm Tunnel Road, Mayinygu Marragu Trail (formerly Blackfellows Hands Road) and Sunnyside Ridge Road.
- Light vehicle access route: The Old Bells Line of Road at Clarence is also used by light vehicles, along with a route via State Mine Gully Road north of Lithgow and then also along Glowworm Tunnel Road Mayinygu Marragu Trail and Sunnyside Ridge Road.

The access routes are also used by other vehicles associated with the adjacent Springvale Mine, logging and forestry management and by recreational vehicles. These access tracks are largely well-formed gravel, all weather roads providing for two-way traffic.

Existing traffic flows for Newnes State Forest have been identified based upon traffic surveys and traffic counters installed over a 7 day period with this data summarised as follows:

- Glowworm Tunnel Road south of Old Bells Line of Road has an average daily traffic flow of 91 vtpd, average weekday traffic 75 vtpd, highest daily flow on Sunday of 144 vtpd;
- Old Bells Line of Road east of Glowworm Tunnel has an average daily traffic flow of 104 vtpd, average weekday traffic 92 vtpd, highest daily flow on Sunday of 154 vtpd; and
- Sunnyside Ridge Road north of Mayinygu Marragu Trail has an average daily traffic flow of 39 vtpd, average weekday traffic 32 vtpd, highest daily flow on Sunday of 57 vtpd.

In accordance with the Australian Road Research Board Unsealed Roads Manual, "…for roads with low traffic volumes <150 vtpd, AustRoads suggests that a single lane two-way operation is adequate". Therefore the primary Newnes State Forest access roads of Glowworm Tunnel Road, Old Bells Line of Road and Sunnyside Ridge Road have suitable spare capacity as they provide well in excess of a single lane.

SIDRA modelling identifies that the primary Newnes State Forest access intersection of Chifley Road, Old Bells Line of Road and Petra Avenue, operates at a Level of Service "B" in the AM peak hour, based on a 15.4 second maximum delay to the right turn movement from Chifley Road to Old Bells Line of Road. All other approaches operate at a level of service "A", and the average delay at this intersection for all movements is less than 5 seconds. While the potential exists for higher peaks to be generated at this intersection associated with peak holiday periods or special events within the Newnes State Forest, the SIDRA analysis indicates that the intersection can accommodate significantly higher flows with little potential for impact. This is reinforced by the zero crash record at the intersection between the 2006 and 2011.

Sixteen accidents were reported to Roads and Maritime Services in the Newnes State Forest during the period 2006 – 2011, including twelve injury crashes and four tow-away crashes (with no fatalities). It was determined by the Roads and Maritime Services that of these incidents, speeding (eight), alcohol (two) or fatigue (three) factored as a cause.

Parking for both light and heavy vehicles on Newnes Plateau is currently provided within secure compounds at each of the existing surface infrastructure compounds.

10.5.3 Road Traffic Impact Assessment

10.5.3.1 Angus Place Pit Top

Access and transport characteristics to Angus Place pit top via Wolgan Road will be unchanged by the Project. The Project will also not alter existing traffic generation at Angus Place pit top, nor change shift structures, employment levels or trip distribution.

The Project will allow the continuation of existing traffic movements to and at the pit top, and analysis indicates that there is significant spare capacity and consistently low average delays. A 10 year forecast shows traffic will remain at level of service “A”.

A SIDRA analysis of the intersections of Castlereagh Highway and Wolgan Road, and Castlereagh Highway and Main Street, identifies performance will continue at a rating of good and level of service “A” through 2024, considering both predicted annual growth and of other projects.

While the Project would not generate additional trips, annual average growth and other sub-regional traffic generating projects would, over the life of the Project, increase flows along the Castlereagh Highway.

All pit top parking demands will continue to be provided within the pit top area, which provides capacity in excess of the peak demands that occur during shift changeover periods.

The low traffic volume generated at the pit top by the Project has a very low impact, which is partly a function of shifts commencing outside of commuter peak periods. Therefore, the Project will have a negligible impact upon traffic at the pit top.

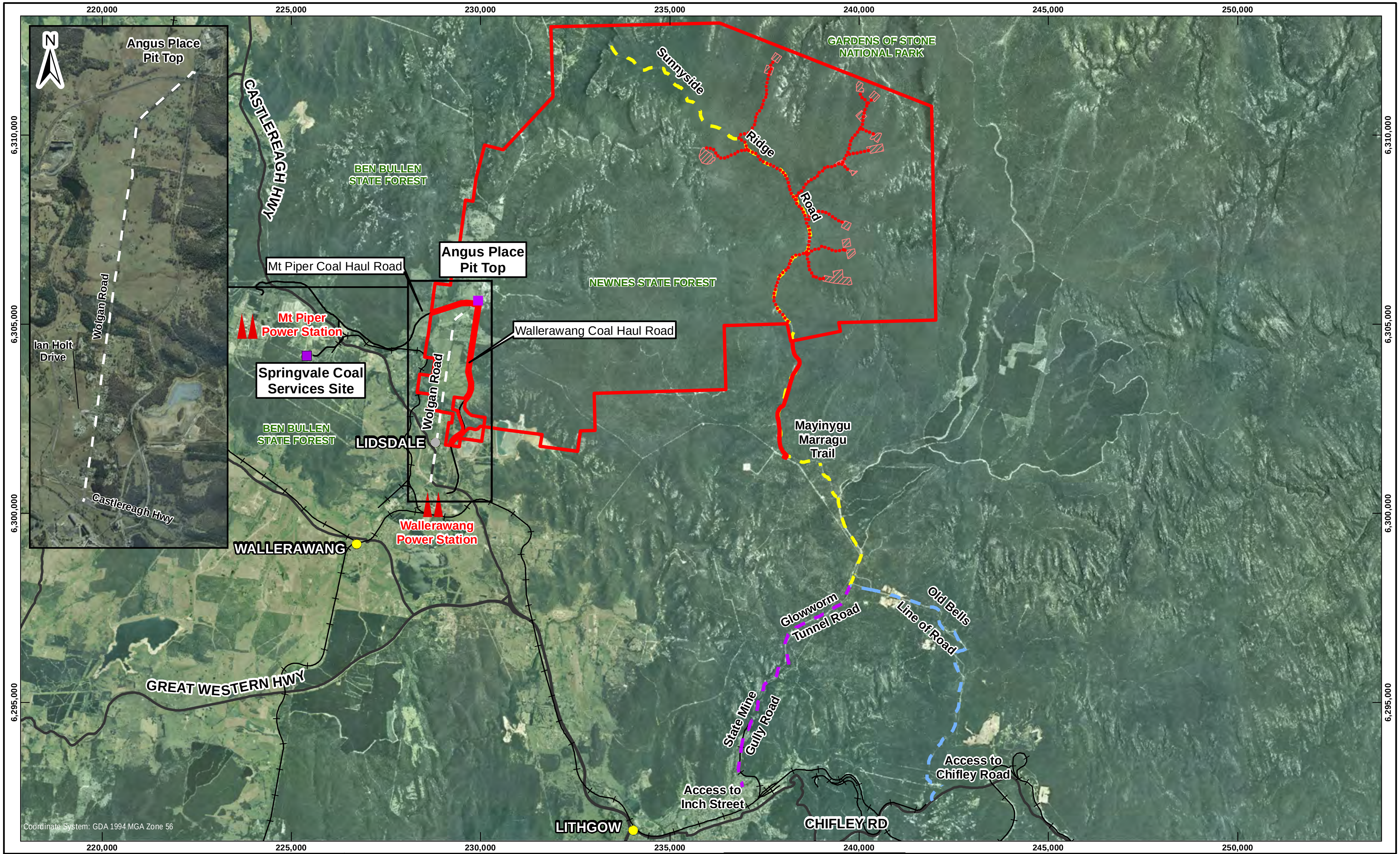
10.5.3.2 Newnes Plateau

Access to existing and proposed Newnes Plateau surface infrastructure (APC-VS3, SDWTS and the borehole sites) will be via existing roads and tracks as shown in **Figure 10.22**. The heavy and light vehicle access routes will link to upgraded and extended access tracks. Specifically an existing access track east of Sunnyside Ridge Road will be upgraded to access APC-VS3, while each of the borehole sites will require an upgrade and extension of existing access tracks off Sunnyside Ridge Road. As agreed with the Forestry Corporation of NSW, these upgraded access tracks will initially provide a width of 10 m to accommodate an access track (5 m) and infrastructure corridor (5 m), before the infrastructure corridor is rehabilitated, retaining the 5 m access track.

Construction

Construction vehicles will travel across two shifts (6.00 am to 6.00 pm and 6.00 pm to 6.00 am), seven days a week. Peak light vehicle movements will occur in relatively short periods around shift changes with construction staff generally travelling in groups to and from construction sites. The construction of components of the borehole site surface infrastructure will be progressive as required.

Construction of each borehole site and associated access track and services corridor is estimated to occur over a 6 month period, while the construction of the APC-VS3 (and associated access track and services corridor) is estimated to occur over approximately 16 months.



LEGEND

- Project Application Area
- Village
- Town
- Rail
- Main Road
- Pit Top Access Route
- All Vehicle Access Route
- Light Vehicle Access Route
- Heavy Vehicle Access Route
- Proposed Infrastructure Corridor
- Environmental Study Area

DATE	13/03/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F044 APC Rev 0
SCALE	1:130,000

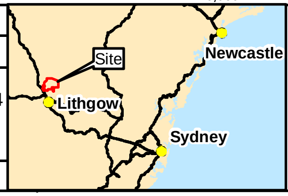


Figure 10.22: Pit Top and Newnes Plateau Access Routes

0 1 2 3 4 5 km

PLOTFILE No.

Centennial Coal

Angus Place

DRG No. 44

A4

Peak construction periods of the surface infrastructure sites will occur for a period of 4 weeks for each site. During these periods maximum construction flows of up to 16 vtpd will be generated. This traffic generation is in and of itself very minor and when combined with the existing traffic flows (refer to **Section 10.5.2**) for the key vehicle access routes of Glowworm Tunnel Road, Old Bells Line of Road and sections of Mayinygu Marragu Trail, there is sufficient existing capacity with average daily flows generally not exceeding 150 vtpd.

Where there is potential for peak flows (Sunday) to exceed 150 vtpd on the Old Bells Line of Road east of Glowworm Tunnel Road, these sections of road are perhaps the widest and best prepared within the Newnes State Forest and provide for two-way traffic, such that these peak flows would represent only a minor percentage of the actual traffic carrying capacity of these sections of the road network.

Estimated vehicle movements (or trips) associated with construction of the surface components are summarised in **Table 10.23**. A return trip consists of two movements. None of the construction periods will overlap.

Table 10.23 Estimated Construction Vehicle Movements

Project Component	Light Vehicles Movements (vpd)	Heavy Vehicles (vpd)	Construction Period (months)
Bore sites and services corridors	8	8	6
APC-VS3 site and service corridor	8	8	16
SDWTS duplication	8	8	16

Operation

During the operational phase of the Project, less than 10 vehicle trips per week (generally comprising up to 6 heavy vtpd and 4 light vtpd) will be required to access the surface infrastructure components of the Project. This traffic generation during operation is considered very low and will have a negligible impact upon traffic flows and intersections within the Newnes State Forest road network and the wider sub-regional network.

Parking

Sufficient parking at surface infrastructure sites within the Newnes State Forest during construction and operation will be provided within compounds at each site during construction and operation.

10.5.3.3 Cumulative Impacts

To account for potential cumulative traffic impacts, all known, proposed or approved projects in the sub-region have been assessed along with annual traffic growth in the sub-regional network. The potential traffic generation of six sub-regional projects considered as part of this assessment and are as follows:

- Springvale Mine Extension Project;
- Western Coal Services Project;
- Neubeck Coal Project; and
- Airly Mine Extension Project.

Based on known traffic generation and construction and operational timeframes for the above projects, the peak cumulative traffic generation in the Newnes Plateau during the Project construction phase will occur for a period of approximately 4 months from December 2014 to March 2015. During this period, the potential exists for the Project (Bore 1 construction) to be generating a peak construction flow of 16 vtpd at the same time as the Angus Place Ventilation Facility Project (Shaft Site construction), which would be generating a peak flow of 12 vtpd, and the Springvale Mine Extension Project (Services Bore construction) generating a flow of 16 vtpd, cumulatively generating a total of 44 vtpd on the Newnes Plateau network.

As a worst case for assessment, 50% of this total generation has been assigned to the surveyed morning peak hour at the intersection of Chifley Road (which is the section of Bells Line of Road between Clarence and Lithgow) and Old Bells Line of Road. This equates to 22 vehicle movements per hour comprising 10 light vehicles and 12 heavy vehicles. The results are virtually unchanged from the existing conditions and will have no significant impact.

10.5.4 Consequence of Potential Road Traffic Impacts

10.5.4.1 Angus Place Pit Top

The existing traffic generated by the Angus Place pit top will remain unchanged as a result of the Project and therefore there are no additional consequences.

Annual growth and short term construction peaks associated with other sub-regional projects would increase traffic flows for a small number of hours per day, but total flows through 2024 would continue to allow the Castlereagh Highway to operate at an acceptable level of service.

10.5.4.2 Newnes Plateau

Considering the maximum of 16 vtpd predicted during construction and less than 10 vehicle trips per week during operation upon the existing Newnes Plateau road network, the consequences of road traffic impacts are low. Notwithstanding this the unsealed Newnes State Forest road network may require additional remediation works and general maintenance in accordance with the *Forestry Act 2012*, so as to appropriately provide for the traffic generated by the Project and other road users.

10.5.5 Road Traffic Management and Mitigation Measures

There are no additional traffic impacts associated with continued operation of Angus Place pit top that require mitigation. Coal is and will continue to be transported along private haul roads (assessed as part of the Western Coal Services Project) and the pit top provides on-site parking capacity to accommodate the unchanged peak staff demand. The sub-regional road network provides significant spare capacity and the Project will not change this.

While traffic associated with the construction and operation of the Project will not have a significant impact on the roads and intersections, Centennial Angus Place will implement the following road traffic management and mitigation measures:

- all heavy vehicle trips within the Newnes State Forest will be undertaken during daylight hours to maximise safety;
- a Construction Traffic Management Plan will be prepared in consultation with the Forestry Corporation of NSW; This will include measures such as warning signs at appropriate locations on the main access roads to the infrastructure sites, advising public road users of when access tracks will be used by increased numbers of heavy vehicles and other construction traffic. Caution will be advised to all road users; and
- consultation with the Forestry Corporation of NSW will continue in relation to potential traffic impacts within the Newnes State Forest. Any road management or maintenance will be undertaken in accordance with any Forestry Corporation of NSW requirements.

10.5.6 Conclusion

The traffic generated as a result of the Project will have no significant impact upon the capacity, efficiency and safety of the local, sub-regional and regional road network over the life of the Project.

The Project will not alter the characteristics of existing pit top traffic flows of the existing level of service “A” of Wolgan Road and the Castlereagh Highway, nor will it alter the Level of Service of the key intersections of Castlereagh Highway and Wolgan Road, and Castlereagh Highway and Main Street to access the pit top.

The impact on the local road network at Newnes Plateau of an additional 16 vtpd generated during construction and 10 vehicle trips per week during operational is low and will not significantly impact the operation of the Newnes State Forest road network. Centennial Angus Place will continue to consult with Forestry Corporation of NSW in relation to potential traffic impacts of the Project.

10.6 Noise

10.6.1 Introduction

This noise assessment specifically responds to the Director General's Requirements (DGRs), which provide the following in regard to noise:

The Director General's requirements

Noise – including:

- a quantitative assessment of the potential:
  - construction, operational and off-site transport noise impacts;
  - reasonable and feasible mitigation measures, including evidence that there are no such other available measures;
  - monitoring and management measures, in particular real-time and attended noise monitoring.

A Noise Impact Assessment (NIA) has been undertaken by SLR Consulting Australia Pty Ltd (July 2013), "*Angus Place Colliery Mine Extension Project Noise Impact Assessment*", which is provided in full in **Appendix L**.

The SLR 2013 report identifies and assesses the potential noise impacts of the Project (including construction, operational, cumulative and off-site transport noise impacts) and provides advice with regard to effective management and mitigation measures to address potential noise impacts.

The NIA has referenced and addressed relevant guidelines and assessment criteria as noted within the DGRs. The NIA has been prepared with reference to Australian Standard AS1055:1997 "Description and Measurement of Environmental Noise" (Parts 1, 2 and 3) and in accordance with:

- EPA (1999) "NSW Industrial Noise Policy" (INP);
- EPA (2009) "Interim Construction Noise Guideline" (ICNG);
- EPA (2011) "NSW Road Noise Policy" (RNP);
- EPA (2006) "Environmental Noise Management – Assessing Vibration: A Technical Guideline; and
- ANZECC (1990) "Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration".

The INP provides noise criteria with the aim of achieving environmental noise objectives; one to account for intrusive noise which involves setting a noise goal objective relative to the existing acoustic environment and the other to protect the amenity of particular land uses.

10.6.2 Existing Environment

Since May 2008, the noise monitoring programme at Angus Place Colliery has provided for quarterly background monitoring, consisting of continuous, unattended noise logging and operator attended noise surveys at the representative residential receivers of W1, L1 and L2 as shown in **Figure 10.23**.

For assessing intrusiveness, the rating background noise level (RBL) is measured during day, evening and night time periods. The RBL is the background noise level median value of the measured assessment background levels. The continuous noise level of the source over any 15 minute period should not be more than 5 decibels above the RBL for the relevant assessment period.

Operator attended noise monitoring has determined that the contribution of the pit top to the nearest Wolgan Road residence (W1) is approximately 33 dBA. Background noise levels have therefore been reduced to account for the contribution of the pit top in order to obtain a representative background noise level in the absence of the Project. Angus Place Colliery noise contribution has estimated to vary between 38 dBA (day), 37 dBA (evening) and less than 30 dBA (night).

At Location L1 noise levels are dominated by road traffic noise from Wolgan Road and residential noise. Noise from Mount Piper Station and Kerosene Vale Ash Dam were occasionally just audible during periods of no traffic, but were not measureable.

Ambient noise levels at Location L2 are dominated by noise from operations at the existing Kerosene Vale Ash Repository. Natural noise sources such as birds, insects and vegetation rustling also contribute.

There is no impact from the pit top in Lidsdale (L1 and L2) and therefore no adjustment to the measurements were undertaken in order to obtain a representative RBL in the absence of the Project. Angus Place Colliery noise contribution has estimated to be less than 35 dBA during day, evening and night at Location L1. Location L2 has estimated to contribute 40 dBA (day) and less than 35 dBA (evening and night).

In addition to the nearest residential receivers identified in **Figure 10.23**, noise sensitive receivers WR3, WR4 and WR5 are located a significant distance from any noise generating developments or major roads. In accordance with the INP, Project specific noise criterion of 35 dBA has been adopted at these to provide a conservative assessment approach.

Noise sensitive receivers NF1 and NF9 have been identified within Newnes State Forest in locations that are used for recreational purposes. An amenity operational criterion of 50 dBA has been adopted in accordance with the INP.

Wind data has been sourced from an analysis of data from Mount Piper Power Station, that identified predominant wind directions ranging from westerly to south south westerly for wind speeds less than 3 m/s.

A synthetic data set was generated using the CALMET meteorological model for 2006 to 2010, centred over the Project Application Area, which showed that prevailing conditions, in accordance with the INP assessment methodology, are not a feature of the area.

Moderate temperature inversions occur on more than 30% of winter nights, and so this weather condition has been included in assessments.

Table 10.24 lists noise monitoring results for the pit top. Quarterly noise monitoring results indicate occasional minor exceedances of the noise impact assessment criteria during the daytime and evening periods when compared to the existing noise impact assessment criteria for operations at Angus Place. There have been no night-time exceedances of the noise impact assessment criteria recorded since January 2009. These previously measured exceedances of the noise impact assessment criteria are identified within the SLR 2013 report as being attributable to the Wallerawang haul road.

Table 10.24 Quarterly Noise Monitoring Summary May 2008 and December 2012

Location	Period	Noise Criteria[a]	Highest Recorded Contributed Noise Level $LA_{eq(15minute)}$ dBA	Month Highest Recorded	Total Number of exceedances between May 2008 and December 2012
Including Wallerawang Haul Road					
R1	Day	42	43	May 2008, July 2012	2
	Evening	38	44	September 2011	7
	Night	36	38	May 2008, September 2008	3
R2	Day	41	—	N/A	0
	Evening	37	43	September 2011	5
	Night	35	37	May 2008	1
R3	Day	44	—	N/A	0
	Evening	40	42	September 2010	1
	Night	35	—	N/A	0
Angus Place Pit Top Only					
R1	Day	42	—	N/A	0
	Evening	38	—	N/A	0
	Night	36	38	May 2008, September 2008	3
R2	Day	41	—	N/A	0
	Evening	37	—	N/A	0
	Night	35	37	May 2008	1
R3	Day	44	—	N/A	0
	Evening	40	—	N/A	0
	Night	35	—	N/A	0

[a] Project Specific Noise Criteria set out in existing approval for Angus Place (PA 06_0021)

10.6.3 Methodology

The data sets used for noise impact assessments differ to that used in air quality assessments. Whilst the starting points for each assessment are similar, the requirements for meteorological data vary, as stated in guidance documentation from the appropriate regulatory authorities.

Worst case noise impacts tend to occur under conditions of low wind speeds when there is little atmospheric turbulence to dissipate the noise emissions. Impacts from dust tend to be greatest under moderate to strong wind speeds, when wind-blown dust is generated and particulate matter can be carried significant distances. Dust impacts are also assessed based on longer term averages (24-hour and annual averages), whereas noise impacts are more likely to be associated with peak events. Furthermore, the weather dataset as a whole is required to contain different meteorological parameters to assess the noise impacts or air quality impacts. For example, for air quality impacts, the mixing heights in the dataset are required to assess the vertical dispersion of pollutants which can have a significant impact on the resultant ground level concentration at the discrete receptors. Mixing heights do not directly influence the noise levels experienced.

For these reasons, the meteorological data used in the noise impact assessment differ from that used in the assessment of air quality impacts from the Project.

The INP provides two methods to assess wind effects; analysis of relevant weather data to determine whether wind is a feature based on the frequency of occurrence and wind speed (*detailed approach*) or to simply assume that wind is a feature of the area (*simple approach*). As stated in the INP Application Notes (http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm): *"The EPA has previously accepted (and will accept) noise predictions based on modelling noise emissions using long term weather data, as it can present a higher level of analysis than that required under the INP".* Furthermore, the Australian Government Department of Resources, Energy and Tourism best practice document (Airborne Contaminants, Noise and Vibration – Leading Practice Sustainable Development Programme for the Mining Industry dated October 2009) states that a noise model requires meteorological data over several years.

Synthetically generated meteorological data was produced for the site using the CALMET meteorological model as part of the Angus Place Air Quality and Greenhouse Gas Assessment (refer SLR Consulting report *670.10168-R1 Angus Place Colliery Ventilation Facility Project Air Quality and Greenhouse Gas Assessment* dated March 2012). The modelling process provided a meteorological dataset for the 2006 to 2008 calendar years, centred over the Project Application Area. Additional meteorological data for the 2009 and 2010 was used to supplement the previously assessed data to provide a comprehensive and up to date assessment of long term prevailing meteorological conditions in accordance with industry best practice for the assessment of noise impacts from mining developments.

Synthetically generated meteorological data was produced for the site using the CALMET meteorological model as part of the Angus Place Air Quality and Greenhouse Gas Assessment (refer SLR Consulting report *670.10168-R1 Angus Place Colliery Ventilation Facility Project Air Quality and Greenhouse Gas Assessment* dated March 2012). The modelling process provided a meteorological data set for the 2006 to 2008 calendar years, centred over the Project Application Area. As part of the Air Quality Assessment for the Project, additional meteorological data has been produced for the 2009 and 2010 calendar years. This data was been used to supplement the previously assessed data to provide a comprehensive and up to date assessment of long term prevailing meteorological conditions in accordance with industry best practice for the assessment of noise impacts from mining developments.

Project specific noise criteria are listed in **Table 10.25**.

Table 10.25 Project Specific Noise Criteria

Location	Period	Adopted RBL	Intrusive Criteria LAeq(15minute) dBA	Amenity Criteria LAeq(period) dBA	Project Specific Noise Criteria LAeq(15minute) (dBA)
WR1	Day	33	38	55	38
	Evening	33	38	45	38
	Night	30	35	40	35
WR1	Day	33	38	55	38
	Evening	33	38	45	38
	Night	30	35	40	35
WR1	Day	33	38	55	38
	Evening	33	38	45	38
	Night	30	35	40	35
WR2	Day	33	38	55	38
	Evening	33	38	45	38
	Night	30	35	40	35
WR3	Day	30	35	50	35
	Evening	30	35	45	35
	Night	30	35	40	35
WR4	Day	30	35	50	35
	Evening	30	35	45	35
	Night	30	35	40	35
WR5	Day	30	35	50	35
	Evening	30	35	45	35
	Night	30	35	40	35
L1	Day	35	40	55	40
	Evening	34	39	45	39
	Night	32	37	40	37
L2	Day	35	40	55	40
	Evening	35	40	45	40
	Night	35	40	40	40

The amenity criterion of 50 dBA for a passive recreational area has been adopted for Newnes State Forest receivers in accordance with the INP.

Based on the adopted RBLs listed in **Table 10.25**, respective sleep disturbance goals are:

- WR1 to WR5 45 LA1 (minute) (dBA);
- L1 47 LA1 (minute) (dBA); and
- L2 50 LA1 (minute) (dBA).

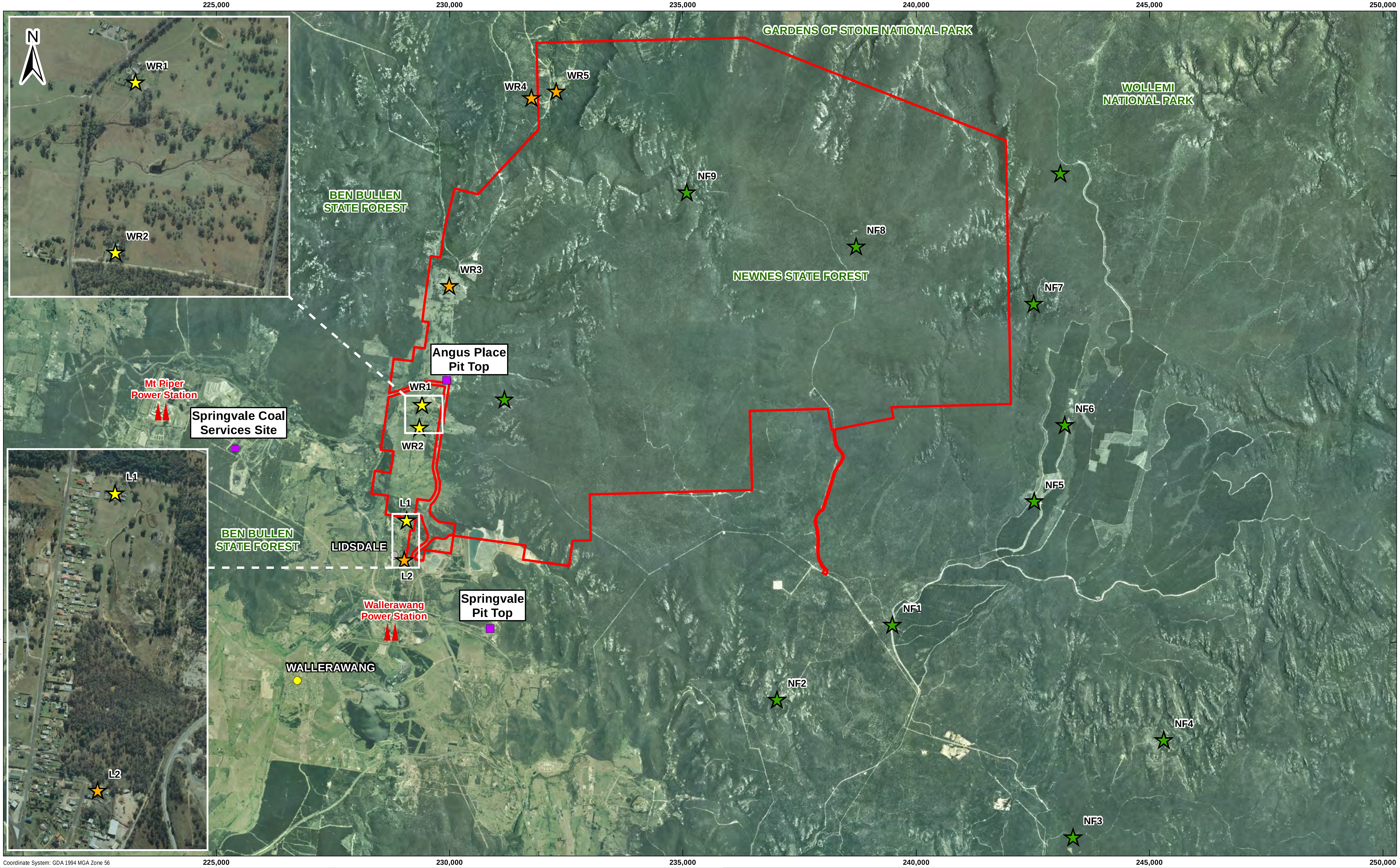
10.6.4 Noise Impact Assessment

10.6.4.1 Construction Noise

Construction will involve site preparation and clearing, drilling of boreholes, compound construction and installation and commissioning of borehole infrastructure. Works will be undertaken 24 hours a day, 7 days a week.

The predicted intrusive $LA_{eq(15minute)}$ noise level from each construction site at the nearest representative receivers are presented in **Table 10.26** along with relevant criteria under calm and prevailing atmospheric conditions.

Construction noise modelling assumed that all plant and equipment operate simultaneously at each proposed borehole location. As such, the model provides a conservative assessment approach; actual noise levels are likely to be lower than predicted for much of the time. As indicated in **Table 10.26** the predicted construction noise levels are significantly below the respective construction noise goals at the nearest receivers and any potential construction noise impacts are negligible.



LEGEND

- Project Application Area
- Village
- Town
- Recreational Receiver
- Residential Receiver
- Logger Location / Residential Receiver

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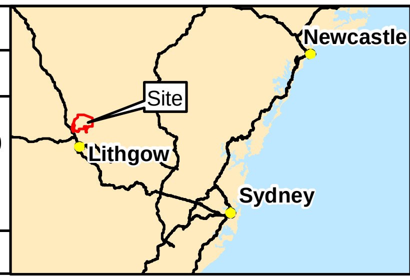

Figure 10.23: Sensitive Noise Receivers and Noise Monitoring Locations

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Table 10.26 Predicted Construction Noise Levels

Location	Period	Predicted Noise Level $LA_{eq(15minute)}$ (dBA)		Project Specific Noise Criteria $LA_{eq(15minute)}$ (dBA)	
		Calm	Temperature Inversion	Noise Affected	Highly Noise Affected
WR1 to WR2	Day	<20	N/A	43	75
	Evening	<20	N/A	38	N/A
	Night	<20	<20	35	N/A
WR3 to WR5	Day	<20	N/A	40	75
	Evening	<20	N/A	35	N/A
	Night	<20	<20	35	N/A
L1	Day	<20	N/A	45	75
	Evening	<20	N/A	39	N/A
	Night	<20	<20	37	N/A
L2	Day	<20	N/A	45	75
	Evening	<20	N/A	40	N/A
	Night	<20	<20	40	N/A
NF1	Day	<20	N/A	60	N/A
	Evening	<20	N/A		
	Night	<20	<20		
NF2	Day	<20	N/A		
	Evening	<20	N/A		
	Night	<20	<20		
NF3	Day	<20	N/A		
	Evening	<20	N/A		
	Night	<20	<20		
NF4	Day	<20	N/A		
	Evening	<20	N/A		
	Night	<20	<20		
NF5	Day	<20	N/A		
	Evening	<20	N/A		
	Night	<20	28		
NF6	Day	21	N/A		
	Evening	21	N/A		
	Night	21	30		
NF7	Day	24	N/A		
	Evening	24	N/A		
	Night	24	32		
NF8	Day	31	N/A		
	Evening	31	N/A		
	Night	31	38		
NF9	Day	40	N/A		
	Evening	40	N/A		
	Night	40	46		

10.6.4.2 Operational Noise

Noise predictions for operations at sensitive receivers are presented in **Table 10.27**, with the relevant Project noise criteria. In providing a worst case scenario modelling scenario, **Table 10.27** provides for predicted noise levels during calm weather and for temperature inversions during the night-time period.

Predicted operational noise contours are provided in **Figure 10.24** and **Figure 10.25**.

Table 10.27 Predicted Operational Noise Levels

Location	Period	Predicted Noise Level $LA_{eq(15minute)}$ (dBA)		Project Specific Noise Criteria $LA_{eq(15minute)}$ (dBA)
		Calm	Temperature Inversion	
WR1	Day	32	N/A	38
	Evening	32	N/A	38
	Night	32	35	35
WR2	Day	30	N/A	38
	Evening	30	N/A	38
	Night	30	34	35
WR3	Day	29	N/A	38
	Evening	29	N/A	38
	Night	29	34	35
WR4	Day	29	N/A	35
	Evening	<20	N/A	35
	Night	<20	<20	35
WR5	Day	<20	N/A	35
	Evening	<20	N/A	35
	Night	<20	<20	35
L1	Day	<20	N/A	40
	Evening	<20	N/A	39
	Night	<20	<20	37
L2	Day	<20	N/A	40
	Evening	<20	N/A	40
	Night	<20	<20	40
NF1 to NF8	Day	<20	N/A	50
	Evening	<20	N/A	
	Night	<20	<20	

Table 10.27 shows that Project operational noise emissions will be within the Project specific noise criteria. With regards sleep disturbance assessment, monthly monitoring at residential receivers has shown that the maximum received noise level from the pit top of 48 dBA at WR1 which is 3 dBA above the relevant criteria and is a minor exceedances. It is however well below the 55 dBA, the level below which awakening reactions are unlikely.

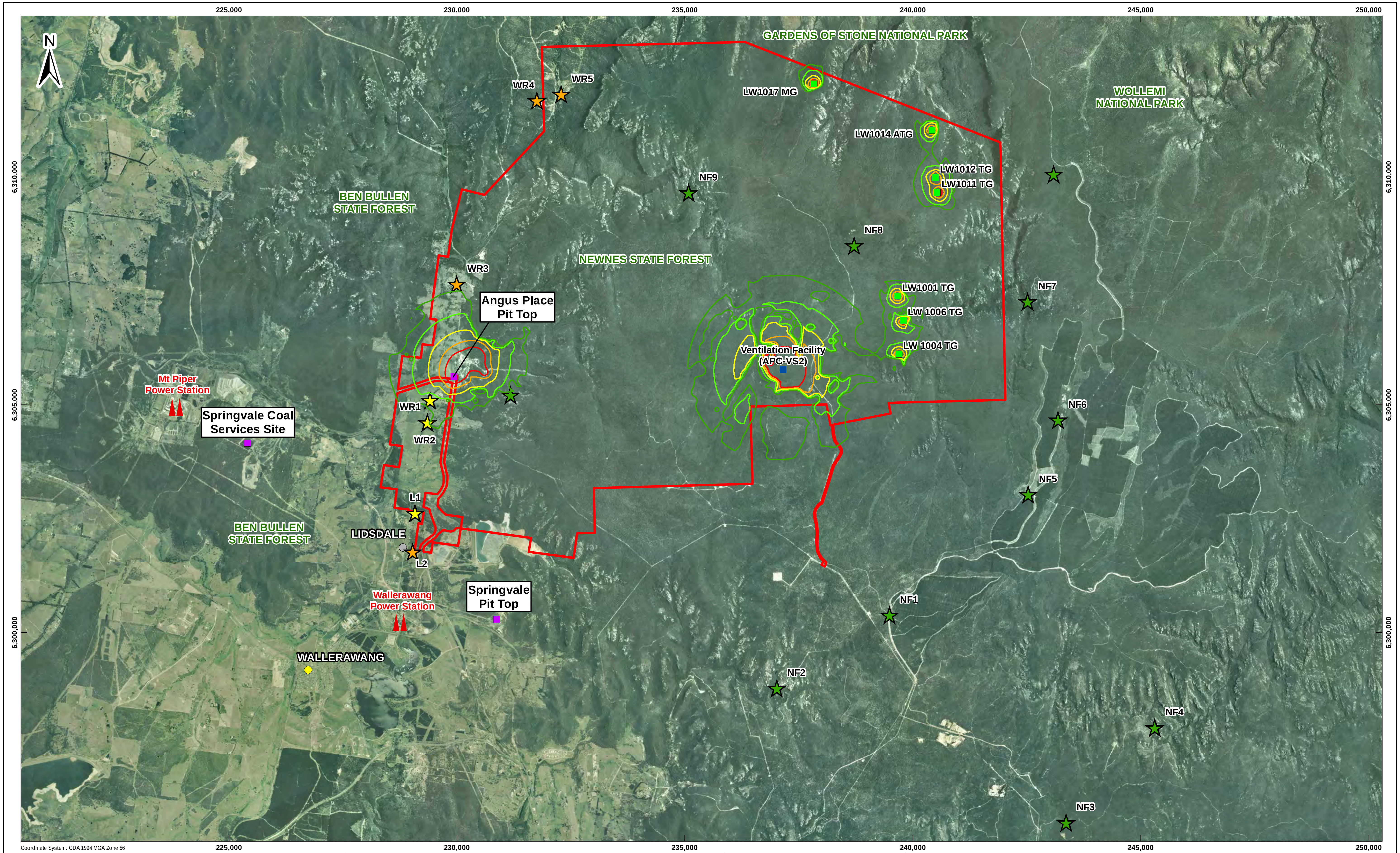

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Figure 10.24: Daytime Operational Noise Contours (Calm Weather)

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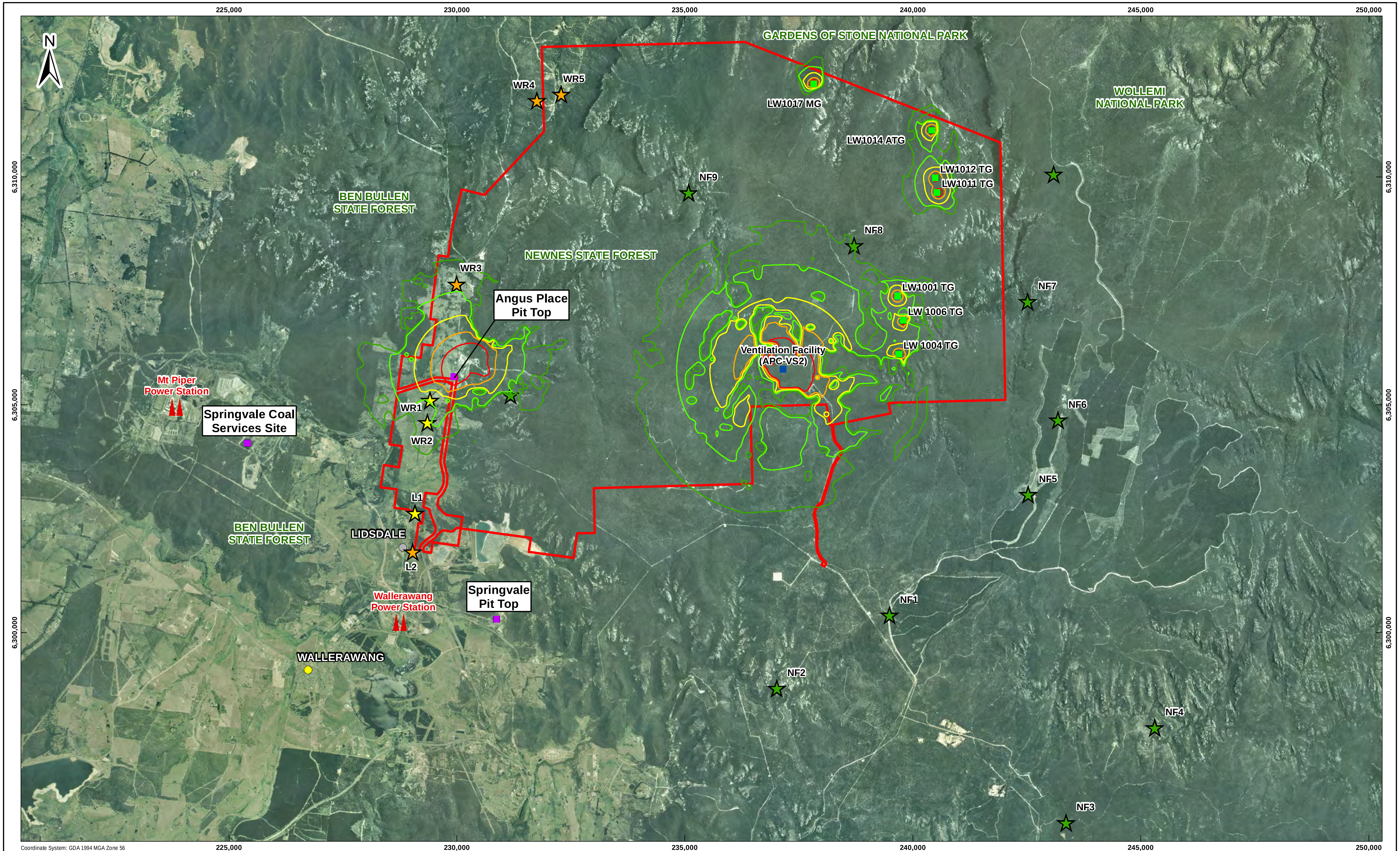

LEGEND

- Project Application Area
- Village
- Town
- Dewatering Borehole Location
- Recreational Receiver
- Residential Receiver
- Logger Location / Residential Receiver

Noise Level

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA

DATE	23/01/2014
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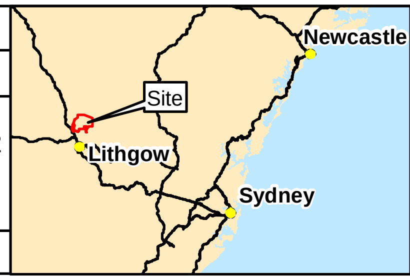

Figure 10.25: Evening and Night Time Operational Noise Contours (Adverse Weather)

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Angus Place

DRG No. 32

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10.6.4.3 Cumulative Noise

The potential cumulative noise impacts from existing and proposed projects have been assessed by the NIA with a view to maintaining acceptable noise amenity levels for residents.

Existing industrial and mining operations in the vicinity of the Angus Place Colliery Extension Plan are:

- Wallerawang and Mount Piper Power Stations;
- Kerosene Vale Ash Repository;
- Lidsdale Siding;
- Western Coal Services; and
- Springvale and Pine Dale Mines.

Cumulative noise impacts from existing and successive developments are considered within the INP procedures by ensuring that the appropriate noise emission criteria are established. Therefore, the cumulative impact of the Project with regard to existing industrial noise sources has been assessed in the determination of the amenity noise criteria for the Project.

There are a number of additional projects proposed in the vicinity of the Project consisting of:

- Pine Dale Coal Mine Stage 2 Extension Project;
- Lidsdale Siding Upgrade Project;
- Western Coal Services Project; and
- Springvale Mine Extension Project.

An analysis of cumulative noise for daytime, evening and night shows that the existing, approved and proposed projects, when combined with the Project are at or below the amenity criteria for all Project receptors

10.6.4.4 Off- Site Transport Noise

Access to the proposed infrastructure sites on Newnes Plateau by heavy vehicles will be via the Old Bells Line of Road at Clarence. Light vehicles will access these sites either by the Old Bells Line of Road from Clarence or via the State Mine Gully Road from Lithgow. Both routes then converge on Glow worm Tunnel Road then Mayinygu Marragu Trail (formerly Blackfellows Hand Road) with final access to the site off Sunnyside Ridge Road on the Newnes State Forest.

The nearest noise sensitive residential receivers to any of the proposed transportation routes are located approximately 100 m from the Old Bells Line of Road at Clarence and approximately 5 m from the State Mine Gully Road in Lithgow. Typical LA_{max} passby noise levels of heavy and light vehicles were used to predict road traffic noise levels from the roadway.

There will be an increase in traffic (along public roads and Forestry Corporation of NSW tracks) and personnel during the construction period. Outside of this period, traffic and personnel movements associated with the dewatering sites are minimal with the occasional light vehicle trip required for maintenance and inspection purposes only.

Up to 8 light vehicle movements and 8 heavy vehicle movements may occur on the Old Bells Line of Road during a “worst case” hourly period during construction. The calculated $LA_{eq(1hour)}$ noise level at the nearest receiver (approximately 100 m from the Old Bells Line of Road) is 42 dBA. This is significantly below the relevant INP criteria of 55 dBA day and 50 dBA (night).

Up to 8 light vehicle movements may occur on the State Mine Gully Road and associated local roads in Lithgow during a “worst case” hourly period during construction. The calculated $LA_{eq(1hour)}$ noise level at the nearest roadside receivers (assumed to be adjacent to the transport route) is 50 dBA. This is below the criteria of 55 dBA (day) and in accordance with 50 dBA (night).

Based upon the road traffic noise criteria for a passive recreation area, the Forestry Corporation NSW tracks could accommodate up to 120 heavy vehicle movements during the 15 hour day time period (7am to 10pm) without exceeding the criteria. This is significantly in excess of the anticipated number of vehicle movements and therefore, road traffic noise level impacts during operation will be significantly below the relevant noise criteria.

During operations, an average of less than 10 vehicles per day would be generated to/from the site compounds. These trips would primarily be light vehicle trips, but a small number of truck trips would likely be generated each week. Due to the small number of anticipated vehicle movements, there will not be any significant road traffic noise impacts associated with the operation of the boreholes and road traffic noise levels will be significantly less than for construction.

10.6.5 Consequences of Potential Noise Impacts

10.6.5.1 Construction Noise

The predicted construction noise levels are significantly below the construction noise goals at the nearest sensitive receiver and therefore the potential construction noise impacts of the Project are negligible.

10.6.5.2 Operational Noise

Project operational noise emissions will be within the Project specific noise criteria for all residential receptors. No noise level increases are predicted at the nearest residential receivers due to proposed additional infrastructure associated with the Project.

The amenity criterion of 50 dBA for a passive recreational area will be met a distances of approximately 550 m and 700 m from the APC-VS2 site under calm and prevailing metrological conditions respectively (**Figure 10.24** and **Figure 10.25**). Noise levels in the vicinity of the proposed dewatering boreholes are predicted to meet the acceptable amenity criterion of 50 dBA for a passive recreational area at distances of less than 100 m from the boreholes.

There is a small area of Sunnyside Ridge Road to the east of the APC-VS2 area which is predicted to experience exceedances of the Project specific noise criteria for a passive recreational area. However, Sunnyside Ridge Road is promoted for use as a 4WD track and noise impacts on potential users are considered insignificant.

10.6.5.3 Cumulative Noise

Predicted noise levels are expected to be minimal due to the Project at the nearest affected receivers. Therefore, any overall increase to noise levels in the vicinity is negligible.

10.6.5.4 Off-Site Transport Noise

Noise from traffic servicing surface infrastructure sites will be significantly below the relevant Industrial Noise Policy criteria and therefore no significant consequences are predicted.

10.6.6 Noise Management and Mitigation Measures

While noise modelling has indicated that there will be negligible noise impacts, the following noise mitigation and management measures will be implemented:

- workers will be regularly trained (i.e. toolbox talks) to use the equipment in ways that minimise noise.
- mobile plant will be operated in a quiet, efficient manner.
- plant and equipment will be well maintained including regular inspection and maintenance.
- for equipment with enclosures (i.e. compressor rooms) it will be ensured that doors and seals are well maintained and kept closed when in use;

- noise monitoring on site and within the community will be continued in accordance with the Angus Place Noise Monitoring Programme (refer Heggies Report 30-1942-R2 *Angus Place Colliery Noise Monitoring Program* dated 15 December 2008);
- onsite noise mitigation measures and plant operating procedures will be refined where practical;
- clear signage will be provided including relevant contact numbers for community enquiries; and
- community issues of concern will be addressed promptly.

As detailed in **Section 4.2**, as the required exploration drill holes are determined, Centennial Angus Place will undertake a series of due diligence assessments to consider noise impacts as relevant. The general approach of the due diligence assessments will be to conduct site investigations to ensure that significant impacts are avoided.

10.6.7 Conclusion

Modelling of the Project components shows that:

- noise from construction of Newnes State Forest surface infrastructure will be within the Project specific noise criteria;
- noise from the operation of Newnes State forest infrastructure will meet Project specific noise criteria apart from a small area of Sunnyside Ridge Road to the east of the APC-VS2; and
- noise from operation of the pit top will be within the Project specific noise criteria.

10.7 Air Quality Management

10.7.1 Introduction

This section specifically responds to the DGRs, which provide the following in regard to air quality aspects:

The Director General's requirements

Air Quality – including a quantitative assessment of potential:

- construction and operational impacts, with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10} emissions and dust generation from coal transport;
- reasonable and feasible mitigation measures to minimise dust emissions, including evidence that there are no such other available measures; and
- monitoring and best practice management measures, in particular real-time air quality monitoring.

An air quality and greenhouse gas assessment for the Project was undertaken by SLR Consulting Australia Pty Ltd (2013) "*Angus Place Mine Extension Project: Air Quality and Greenhouse Gas Assessment*" (Air Quality and GHG Report), which is provided in full in **Appendix M** and has been prepared in accordance with the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (OEH, 2005), (Approved Methods). The Approved Methods specify assessment criteria for TSP and PM_{10}, but not for $PM_{2.5}$. Potential impacts of the Project associated with $PM_{2.5}$ emissions have been assessed against criteria specified in the "National Environment Protection (Ambient Air Quality) Measure" (NEPM).

The scope of the assessment was to quantify the air quality impacts on surrounding sensitive receivers associated with the Project during construction and operation and also estimate greenhouse gas emissions for the Project. Furthermore, an estimation of the likely air quality impacts resulting from the Project rehabilitation was performed within the assessment.

Air quality criteria for the Project as identified within the relevant policy, are presented in **Table 10.28**.

Table 10.28 Air Quality Criteria

Particulate Matter	Averaging Time	Criteria (µg/m^3)	Source
TSP	Annual mean	90	Approved Methods
PM_{10}	24-hour maximum	50	
	Annual mean	30 (NSW EPA)	
	Annual mean	20	World Health Organisation
$PM_{2.5}$	24-hour maximum	25	NEPM
	Annual mean	8	
Dust Deposition	Annual	Maximum incremental (Project only) increase of 2 g/m^2/month Maximum total of 4 g/m^2/month (Project and other sources)	Approved Methods

10.7.2 Existing Environment

The air quality in the region surrounding Angus Place Colliery is influenced by emissions from a range of sources, originating from both within and outside of the local area. Specifically, air quality is influenced by traffic, power stations and associated ash dams, other coal mining operations, pollution transported into the area from more distant sources, and emissions generated by the existing Angus Place Colliery.

10.7.2.1 Suspended Particulate Matter

Since June 2009, on-site ambient TSP and PM_{10} monitoring has been performed by Angus Place Colliery. Two co-located high volume air samplers (refer to **Figure 3.8**) measuring TSP and PM_{10} concentrations on a 1-in-6-day cycle have been used. In 2010, the ratio of mean TSP to PM_{10} concentrations was in the order of 2.5 to 1.

The annual average TSP and PM_{10} concentrations recorded during 2010 were measured at 16.7 µg/m^3 and 6.7 µg/m^3 respectively. In 2011 the annual averages were measured at 11.5 TSP and PM_{10} concentration of 3.5 µg/m^3; and in 2012 were measured at 13.9 TSP and PM_{10} concentration of 4.3 µg/m^3 PM_{10}. The closest long-term tapered element oscillating microbalance (TEOM) monitoring station to the Project that continuously measures PM_{10} concentrations is located in Bathurst, approximately 50 kilometres west of Springvale Mine. A TEOM was recently installed at Blackmans Flat to measure PM_{10} concentration; however, the records for the Bathurst station have been used given longer recording time. The Bathurst station is operated by OEH, and has recorded a mean 24-hour average PM_{10} concentration of 9.5 µg/m^3 in 2010 and 11.0 µg/m^3 in 2011, which are well below the assessment criterion of 50 µg/m^3.

Comparison of the 24-hour average PM_{10} concentrations measured at Bathurst and Angus Place identify that on-site measured data at Angus Place Colliery is consistently lower than that measured at the Bathurst monitoring station. Based upon this comparison, the use of continuous ambient monitoring data from Bathurst is concluded to be a conservative approach for the assessment of existing background PM_{10} concentrations.

No ambient background monitoring data for $PM_{2.5}$ is available in the local area or at the nearest OEH monitoring sites. Therefore a background $PM_{2.5}$ dataset cannot be used within this assessment and comparison of the incremental concentrations to the criteria has been performed.

10.7.2.2 Deposited Dust

Static dust monitoring commenced in January 2011 at eight monitoring locations surrounding the Project (see **Figure 3.8** for locations). All dust deposition results between 2007 and 2011 met the assessment criterion of 4 g/m2/month with the exception of September 2009 (between 10 g/m2/month and 28 g/m2/month) and October 2009 (between 7 g/m2/month and 10 g/m2/month) due to several dust storms.

10.7.2.3 Adopted Background Air Quality Levels

The adopted background air quality levels for the Project are provided in **Table 10.29**.

Table 10.29 Adopted Background Air Quality Levels

Particulate Matter	Averaging Time	Background Concentration	Source
PM_{10}	24-hour	Daily varying background	Monitoring data at Bathurst OEH- station (2010)
	Annual	9.5 µg/m^3	
TSP	Annual	22.8 µg/m^3	TSP/PM_{10} ratio of 2.4 observed at Angus Place Colliery pit top (2010)
Dust Deposition	Annual	1.2 g/m^2/month	Average of dust deposition monitoring data in 2010

10.7.2.4 Sensitive Receptors

As shown in **Figure 10.26** there are seven representative residential receptors. In addition a further nine recreational receptors have been identified within Newnes Plateau for the purposes of assessing air quality impacts of the Project.

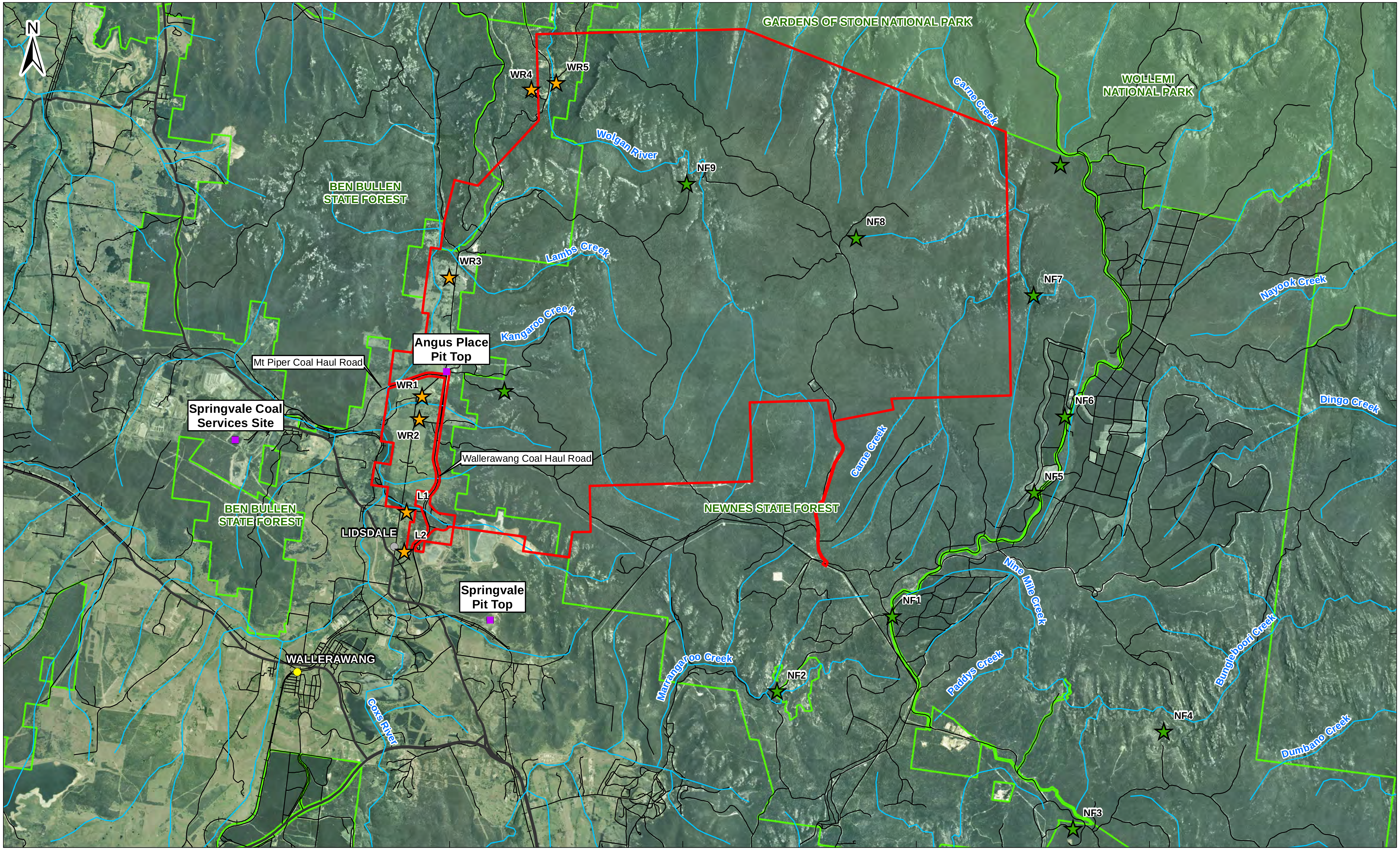
10.7.3 Air Quality Impact Assessment

Construction, operation and rehabilitation activities associated with the existing operations at Angus Place Colliery have the potential to generate particulate matter in the form of:

- deposited dust;
- total suspended particulates (TSP), which refers to all suspended particles in the air and are typically less than 30 µm in diameter;
- PM_{10}, which is a subset of TSP and have a diameter of 10 µm or less; and
- $PM_{2.5}$, which is a subset of PM_{10} and have a diameter of 2.5 µm or less.

Project construction activities likely to generate particulate matter emissions are:

- land clearing (compounds and roadways) resulting in exposed areas;
- construction of a downcast shaft;
- construction of dewatering boreholes;
- construction of associated infrastructure;
- emplacement of the shaft spoil; and
- construction of water management structures.



LEGEND

- Project Application Area
- Village
- Town
- Rail
- Main Road
- Street / Track
- State Forest
- National Park
- Watercourse
- Recreational Receiver
- Residential Receiver

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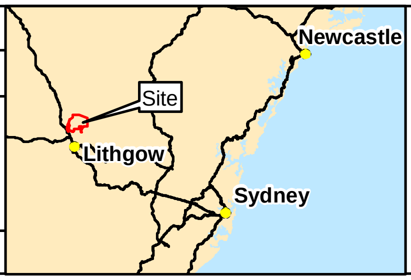

Figure 10.26: Sensitive Air Quality Receptor Locations

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Operational dust sources include coal handling facilities (conveyor transfer points), coal crushing; wheel generated dust from unpaved roads; ventilation shaft emissions; and wind erosion from cleared land.

Rehabilitation activities that will be sources of dust include demolition and removal of roads, buildings and footings, excavation activities, reshaping of landforms and the spreading of topsoil.

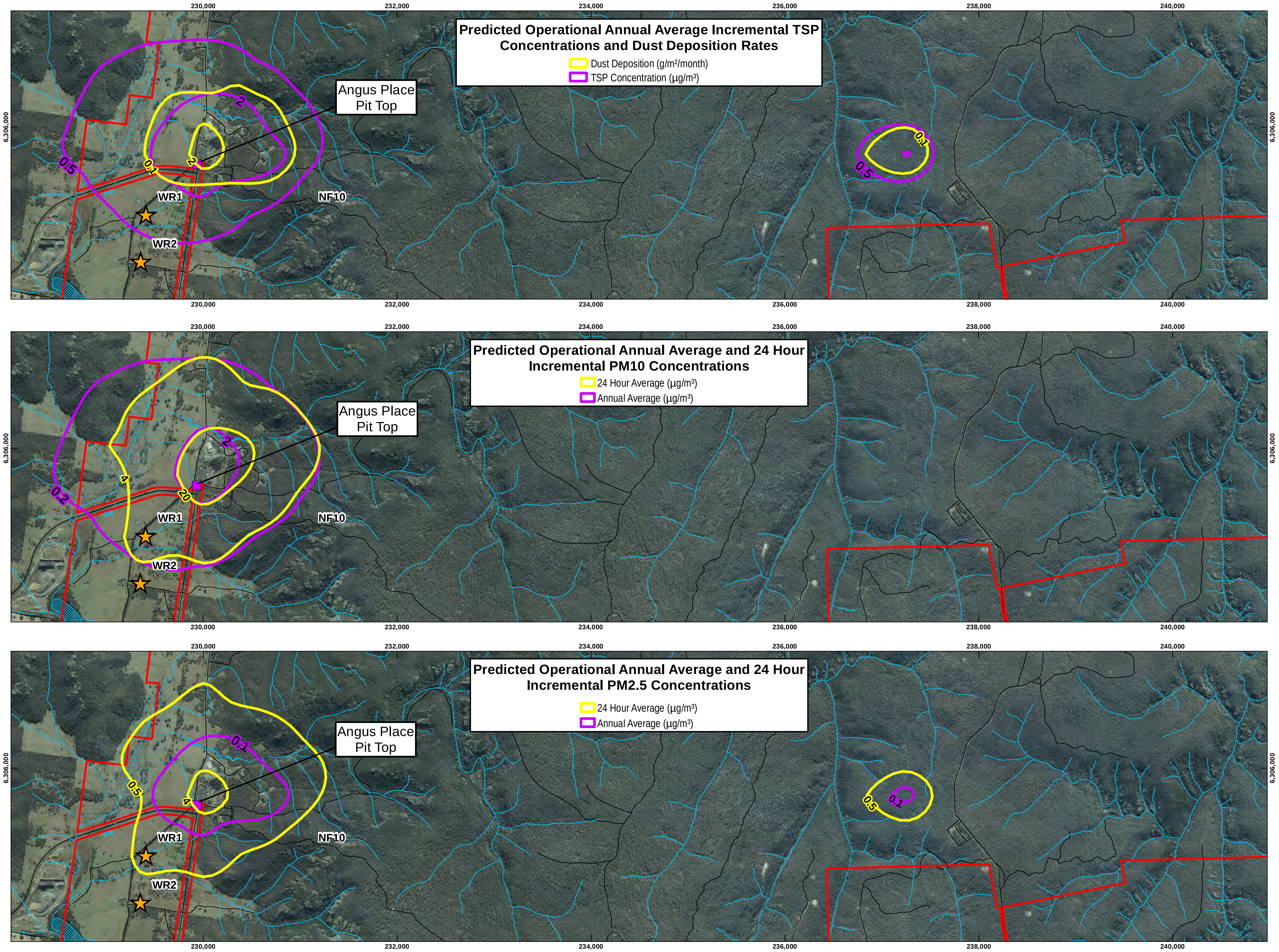
The estimated emissions from Project components were incorporated into an atmospheric dispersion model to predict the impacts upon identified receivers. These results are summarised in **Table 10.30** to **Table 10.36**.

Figure 10.27 provides predicted contour plots of incremental dust deposition, TSP annual average concentration, PM_{10} annual average and 24 hour average concentrations and $PM_{2.5}$ annual average and 24 hour average concentrations.

The predictions in **Table 10.30** show that incremental and total annual average (incremental and background) dust deposition rates at all sensitive receptors are well below the criterion of 2 g/m2/month (incremental increase in dust deposition) and 4 g/m^2/month (cumulative dust deposition). **Figure 10.27** provides predicted contour plots of incremental dust deposition. The incremental increase predicted as a result of the construction, operation and final rehabilitation of the Project are negligible and would not result in a measureable increase above existing levels.

Table 10.30 Predicted Annual Average Dust Deposition Rates (g/m^2/month)

Receptor	**Background**	**Increment**			**Total**		
		Construction	**Operation**	**Rehabilitation**	**Construction**	**Operation**	**Rehabilitation**
WR1	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
WR2	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
WR3	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
WR4	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
WR5	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
L1	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
L2	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
NF1 to NF9	1.4	<0.1	<0.1	<0.1	<1.5	<1.5	<1.5
Criteria		2.0	2.0	2.0	4.0	4.0	4.0



Coordinate System: GDA 1994 MGA Zone 56

LEGEND

- Project Application Area
- Watercourse
- Street / Track
- Residential Receiver

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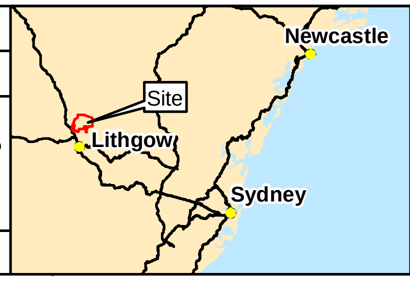

Figure 10.27: Air Quality Impact Assessment

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DRG No. 45

A3

Predicted annual average TSP concentrations as listed in **Table 10.31** are well below the criterion of 90 µg/m3 at all sensitive receptors. **Figure 10.27** provides predicted contour plots of incremental TSP concentrations. The incremental increase predicted as a result of the construction, operation and final rehabilitation of the Project is very low and would not significantly increase existing levels.

Table 10.31 Predicted Annual Average TSP Concentrations (µg/m^3)

Receptor	Background	Increment			Total		
		Construction	Operation	Rehabilitation	Construction	Operation	Rehabilitation
WR1	23.4	0.7	0.7	0.7	24.1	24.1	24.1
WR2	23.4	0.4	0.3	0.3	23.8	23.7	23.7
WR3	23.4	0.2	0.2	0.2	23.6	23.6	23.6
WR4	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
WR5	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
L1	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
L2	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
NF1	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
NF2	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
NF3	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
NF4	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
NF5	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
NF6	23.4	<0.1	<0.1	<0.1	<23.5	<23.5	<23.5
NF7	23.4	0.1	<0.1	<0.1	23.5	<23.5	<23.5
NF8	23.4	0.4	<0.1	<0.1	23.8	<23.5	<23.5
NF9	23.4	0.1	<0.1	<0.1	23.5	<23.5	<23.5
Criterion					90	90	90

Table 10.32 shows that predicted annual average PM_{10} concentrations are well below the criterion of 30 µg/m^3 (NSW EPA criterion) and 20 µg/m^3 (WHO guideline) at all sensitive receptors. **Figure 10.27** provides predicted contour plots of incremental TSP concentrations. The incremental increase predicted as a result of the construction, operation and final rehabilitation of the Project is very low and would not significantly increase existing levels.

Table 10.32 Predicted Annual Average PM10 Concentrations (µg/m^3)

Receptor	Background	Increment			Total		
		Construction	Operation	Rehabilitation	Construction	Operation	Rehabilitation
WR1	9.5	0.3	0.3	0.2	9.8	9.8	9.7
WR2	9.5	0.2	0.2	0.1	9.7	9.7	9.6
WR3	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
WR4	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
WR5	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
L1	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
L2	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF1	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF2	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF3	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF4	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF5	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF6	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF7	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
NF8	9.5	0.2	<0.1	<0.1	9.7	<9.6	<9.6
NF9	9.5	<0.1	<0.1	<0.1	<9.6	<9.6	<9.6
Criterion					30	30	30

Table 10.33 lists predictions for 24 hour PM_{10} due to construction. These show that predicted concentrations are below the criterion of 50 µg/m³.

Table 10.33 Predicted 24 Hour Average PM10 Concentrations During Construction

Receptor	Date	PM_{10} 24-Hour Average (µg/m³)			Date	PM_{10} 24-Hour Average (µg/m³)		
		Highest Background	Increment	Total		Background	Highest Increment	Total
WR1	13-01-2010	43.3	<0.1	<43.4	15-04-2010	17.9	6.0	23.9
WR2		43.3	<0.1	<43.4		17.9	3.3	21.2
WR3		43.3	0.4	43.7	17-11-2010	6.6	1.8	8.4
WR4		43.3	<0.1	<43.4	15-05-2010	8.7	0.2	8.9
WR5		43.3	<0.1	<43.4		8.7	0.2	8.9
L1		44.3	<0.1	<44.4	28-07-2010	10.7	0.3	11.0
L2		43.3	<0.1	<43.4		10.7	0.3	11.0
NF1		43.3	<0.1	<43.4	09-05-2010	3.1	0.7	3.8
NF2		43.3	<0.1	<43.4	28-07-2010	10.7	0.3	11.0
NF3		43.3	<0.1	<43.4	09-05-2010	3.1	0.4	3.5
NF4		43.3	<0.1	<43.4	17-07-2010	5.7	0.2	5.9
NF5		43.3	<0.1	<43.4	24-07-2010	5.6	0.6	6.2
NF6		43.3	<0.1	<43.4		5.6	0.6	6.2
NF7		43.3	0.2	43.5	10-05-2010	8.2	0.3	8.5
NF8		43.3	<0.1	<43.4	28-07-2010	10.7	2.3	13.0
NF9		43.3	<0.1	<43.4	20-09-2010	11.8	0.6	12.4
Criterion				50				50

Table 10.34 lists predictions for 24 hour PM_{10} due to operations and **Figure 10.27** provides contour plots for the same. The results show that the predicted cumulative 24-hour average PM_{10} concentrations are below the criterion of 50 µg/m³.

Table 10.34 Predicted 24 Hour Average PM10 Concentrations During Operation

Receptor	Date	PM_{10} 24-Hour Average (µg/m³)			Date	PM_{10} 24-Hour Average (µg/m³)		
		Highest Background	Increment	Total		Background	Highest Increment	Total
WR1	13/01/2010	43.3	<0.1	<43.3	15-04-2010	17.9	5.9	23.8
WR2		43.3	<0.1	<43.3		17.9	3.2	21.1
WR3		43.3	0.4	43.7	17-11-2010	6.6	1.7	8.3
WR4		43.3	<0.1	<43.3	11-08-2010	0	<0.1	<0.1
WR5		43.3	<0.1	<43.3	08-05-2010	2.4	<0.1	<2.5
L1		43.3	<0.1	<43.3	03-05-2010	15.3	0.3	15.6
L2		43.3	<0.1	<43.3	09-01-2010	19.1	0.3	19.4
NF1		43.3	<0.1	<43.3	24-09-2010	14.3	<0.1	<14.4
NF2		43.3	<0.1	<43.3	17-07-2010	5.7	<0.1	<5.8
NF3		43.3	<0.1	<43.3	24-09-2010	14.3	<0.1	<14.4
NF4		43.3	<0.1	<43.3	09-03-2010	8.9	<0.1	<9
NF5		43.3	<0.1	<43.3	10-05-2010	8.2	<0.1	<8.3
NF6		43.3	<0.1	<43.3	02-05-2010	13.3	<0.1	<13.4
NF7		43.3	<0.1	<43.3	12-07-2010	7.6	<0.1	<7.7
NF8		43.3	<0.1	<43.3	22-08-2010	6.1	<0.1	<6.2
NF9		43.3	<0.1	<43.3	18-11-2010	3.7	0.1	3.8
Criterion				50				50

Table 10.35 lists predictions for 24 hour PM_{10} due to rehabilitation. The results show that the predicted cumulative 24-hour average PM_{10} concentrations are below the criterion of 50 µg/m³.

Table 10.35: Predicted 24 Hour Average PM10 Concentrations During Rehabilitation

Receptor	Date	PM_{10} 24-Hour Average (µg/m³)			Date	PM_{10} 24-Hour Average (µg/m³)		
		Highest Background	Increment	Total		Background	Highest Increment	Total
WR1	13-01-2010	43.3	<0.1	<43.4	15-04-2010	17.9	3.5	21.4
WR2		43.3	<0.1	<43.4		17.9	2.0	19.9
WR3		43.3	0.2	43.5	17-11-2010	6.6	1.0	7.6
WR4		43.3	<0.1	<43.4	11-08-2010	0	<0.1	<0.1
WR5		43.3	<0.1	<43.4	14-09-2010	6.6	<0.1	<6.7
L1		43.3	<0.1	<43.4	03-05-2010	15.3	0.2	15.5
L2		43.3	<0.1	<43.4	09-01-2010	19.1	0.2	19.3
NF1		43.3	<0.1	<43.4	17-02-2010	12	<0.1	<12.1
NF2		43.3	<0.1	<43.4	17-07-2010	5.7	<0.1	<5.8
NF3		43.3	<0.1	<43.4	24-09-2010	14.3	<0.1	<14.4
NF4		43.3	<0.1	<43.4	10-05-2010	8.2	<0.1	<8.3
NF5		43.3	<0.1	<43.4		8.2	<0.1	<8.3
NF6		43.3	<0.1	<43.4	02-05-2010	13.3	<0.1	<13.4
NF7		43.3	<0.1	<43.4	12-07-2010	7.6	<0.1	<7.7
NF8		43.3	<0.1	<43.4	18-11-2010	3.7	<0.1	<3.8
NF9		43.3	<0.1	<43.4		3.7	<0.1	<3.8
Criterion				50				50

Table 10.36 lists the predicted 24-hour average and annual average $PM_{2.5}$ concentrations. As no ambient background monitoring data for $PM_{2.5}$ is available in the local area modelling results have been assessed by comparison of the incremental concentrations against the criteria. All predicted results are well below the advisory reporting standards and the construction, operation and rehabilitation of the Project is not expected to cause and exceedance of the relevant criterion.

Table 10.36: Predicted 24-Hour and Annual Average PM2.5 Concentrations

Receptor	Annual Average $PM_{2.5}$ Increment (µg/m^3)			24-Hour $PM_{2.5}$ Increment (µg/m^3)		
	Construction	Operation	Rehabilitation	Construction	Operation	Rehabilitation
WR1	<0.1	<0.1	0.1	0.7	0.6	2.1
WR2	<0.1	<0.1	<0.1	0.4	0.4	1.2
WR3	<0.1	<0.1	<0.1	0.2	0.2	0.6
WR4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WR5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
L1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
L2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
NF1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
NF2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NF3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NF4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NF5	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
NF6	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
NF7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NF8	<0.1	<0.1	<0.1	0.5	<0.1	<0.1
NF9	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Advisory Reporting Standards	8 (Cumulative)			25 (Cumulative)		

10.7.3.1 Cumulative Impacts

Industrial facilities in the vicinity of Angus Place Colliery that generate particulate emissions are:

- Wallerawang Power Station and associated ash disposal areas;
- Mount Piper Power Station and associated ash disposal areas;
- Haul roads from Angus Place pit top to Mount Piper and Wallerawang Power Stations;
- Springvale Mine;
- Lidsdale Siding and Springvale Coal Services Site operations;
- Clarence Colliery; and
- surrounding forestry activities and recreational activities (e.g. vehicles within the Newnes State Forest).

Background air quality levels adopted to assess the Project's potential impacts were developed based on monitoring data in the region of the Project. Therefore, the identified projects above contribute to the existing background air quality levels and have been considered as part of the Project assessment. However, recently approved (but not operational) projects are not considered as part of the existing environment nor the proposed Springvale Mine Extension Project. Therefore, an assessment of the cumulative impacts of the predicted air quality impacts of the Project and the following recently approved or proposed projects has been assessed:

- Wallerawang Power Station Development Application (024/11DA);
- New Base Load Mount Piper Power Station approved in January 2010 and a new rail coal unloader approved in June 2009;
- application for a new ash placement area at the existing Mount Piper Power Station;
- application for an open cut mining extension to the Pine Dale Coal Mine (located near Blackmans Flat, 17 kilometres northwest of Lithgow);
- Springvale Mine, including an application currently being made for two new dewatering bores and the approved upgrade to vent shaft No. 3;
- Lidsdale Siding Upgrade Project to improve rail loading facilities near Wallerawang; and
- Western Coal Services Project.

The predicted maximum incremental 24-hour PM_{10} concentrations from the above projects at the closest receiver to the Project range between 0.4 µg/m^3 and 1 µg/m^3. Given such low concentrations, no cumulative impact or exceedance of the relevant air quality criteria is predicted on particulate concentrations associated with the Project.

10.7.4 Consequences of Potential Air Quality Impacts

The Project is predicted to comply with all relevant air quality criteria at representative receptors during construction, operation and rehabilitation.

10.7.5 Air Quality Management and Mitigation Measures

The estimated emissions for the Project have been calculated with existing management controls that will continue to be used throughout the life of Angus Place Colliery.

10.7.6 Conclusion

Dust levels (i.e. TSP, PM_{10}, $PM_{2.5}$ and dust deposition) arising from the Project's construction, operation and rehabilitation activities are predicted to be within relevant air quality criteria.

10.8 Greenhouse Gas Management

10.8.1 Introduction

This section specifically responds to the DGRs, which provide the following in regard to greenhouse gas aspects:

The Director General's requirements

Greenhouse Gases – including:

- a quantitative assessment of potential Scope 1, 2 and 3 greenhouse gas emissions;
- a qualitative assessment of the potential impacts of these emissions on the environment; and
- an assessment of reasonable and feasible measures to minimize greenhouse gas emissions and ensure energy efficiency.

An Air Quality and Greenhouse Gas (GHG) Assessment for the Project was undertaken by SLR Consulting Australia Pty Ltd (2013) titled "Angus Place Mine Extension Project Air Quality and Greenhouse Gas Assessment" Report Number 630.10123.01040 (Air Quality and GHG Report) and is provided in full in **Appendix M**.

The GHG assessment has been performed with reference to the Australian Department of Climate Change and Energy Efficiency document "National Greenhouse Accounts Factors" (July, 2011), the NSW Department of Energy, Utilities and Sustainability document "Guidelines for Energy Savings Action Plans" (2005), the *National Greenhouse and Energy Reporting Act 2007* (NGER Act), the Centennial Coal Greenhouse Gas Assessment Guidance Notes (Centennial Coal, 2010) and Climate Change Response Policy (Centennial Coal, 2012b).

The definitions used for Scope 1 and Scope 2 emissions are within the *National Greenhouse and Energy Reporting Regulations 2008*. Scope 3 emissions are not defined within the NGER Act, therefore these estimates have been undertaken in accordance with the National Greenhouse Accounts factors.

Quantification of scope 1, 2 and 3 GHG emissions has been undertaken in relation to both carbon dioxide (CO2) and other greenhouse gases. For comparative purposes, non-CO_2 greenhouse gases are awarded a "CO2-equivalence" (CO2-e) based on their contribution to the enhancement of the greenhouse effect using a global warming potential index.

The gases of relevance to this assessment are:

- methane (CH_4): with a global warming potential of 21;
- nitrous oxide (N_2O): with a global warming potential of 310; and
- sulfur hexafluoride (SF_6): with a global warming potential of 23,900.

10.8.2 Existing Environment

Greenhouse gas data has been sourced from Angus Place NGER reports for the July 2011 to June 2012 period. In this reporting period, Angus Place Colliery was responsible for the generation of 1,049,299 (t CO2-e).

10.8.2.1 Greenhouse Gas Emission Sources

A summary of the potential Project GHG emission sources is provided in **Table 10.37.**

Table 10.37 Summary of Potential GHG Emissions

Project Component	Direct Emissions	Indirect Emissions	
	Scope 1	Scope 2	Scope 3
Fugitive Emissions	Emissions from the release of coal seam methane and carbon dioxide.	N/A	N/A
Diesel	Emissions from the combustion of diesel (both mobile and fixed plant and equipment) by Angus Place Colliery	N/A	Emissions from contractor diesel usage. Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Project site. Contractor or outsourced activities performed as part of the Project activities.
Consumption of sulphur hexafluoride	Consumption of SF_6 for gas insulated switchgear and circuit breaker applications.	N/A	N/A
Oils and Greases	Consumption (non-combustion) of oils and greases.	N/A	Estimated emissions attributable to the extraction, production and transport of oils and greases consumed at the Project site.
Electricity	N/A	Emissions associated with the consumption of generated and purchased electricity at the Project site.	Estimated emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed at the mine and the electricity lost in delivery in the transmission and distribution network.
Solid Waste	N/A	N/A	Emissions associated with the disposal of solid waste to landfill.
Coal Combustion	N/A	N/A	Emissions associated with the combustion of coal from the Project.

Table 10.38 provides a summary of activity emissions data in relation to existing operations and the Project.

Table 10.38 Summary of Emissions Data

Activity	Quantity	
	Existing Operations	**The Project**
Annual ROM Production (million tonnes per annum)	4	4
Annual Electricity Consumption (kWh)	58,356,820	69,573,702
Annual Diesel Consumption (litres) (Centennial)	752,885	752,885
Annual Diesel Consumption (litres) (Contractor)	64,595	64,595
Annual Diesel Consumption (litres) (Construction contractor)	48,384	48,384
Annual Fugitive Emissions from Mine Ventilation (Million m^3)	13,771	13,771
Solid Waste to Landfill (tonnes)	511	511
Sulphur Hexafluoride (SF_6) (kg)	14.826	22.239
Liquid Petroleum Gas (LPG) (kg)	0.0	0.0
Oil/Greases Used (L)	199,153	199,153
Employee Vehicle Movements (number)	82,125	82,125
Vehicle Movements during construction (number)	42 per day (22 light vehicles, 20 heavy vehicles)	42 per day (22 light vehicles, 20 heavy vehicles)
Vehicle Movements during operation (number)	10 light vehicles per week	10 light vehicles per week

10.8.3 Greenhouse Gas Impact Assessment

Calculated scope 1, scope 2 and scope 3 GHG emissions resulting from the emissions sources outlined within **Table 10.38** are presented in **Table 10.39**.

Table 10.39 Scope 1, 2 and 3 GHG Emissions (t CO_2-e)

Activity	Current Operations	Proposed Operations	Increase
Scope 1			
Fugitive Emissions	41,507	41,507	0
Diesel Combustion	7484	748	0
SF_6 Consumption	1.8	2.7	1
Oil and Grease Consumption	214	214	0
Subtotal	**42,471**	**42,473**	**1**
Scope 2			
Electricity Consumption	50,770	60,529	9,759
Scope 3			
Product Coal Combustion	943,920	943,920	0
Diesel Combustion	70	80	10
Oil and Grease Consumption	41	41	0
Electricity Consumption	11,088	13,219	2,131
Waste Disposal	614	614	0
Employee Travel	149	149	0

The Project will result indirect (scope 1) GHG emissions (CO_2-e) increasing by a negligible 2 tonnes per annum from existing operations to 42,473t per annum.

The greatest emission sources associated with the Project are those related to the downstream combustion of the coal (Scope 3), the management of which is not in Centennial Angus Place's control.

10.8.4 Consequences of Potential GHG Impacts

GHG emissions in NSW were reported to be 157.4 Mt in 2010, representing 28% of the Australian total GHG emissions of 560.8 Mt (Department of Climate Change and Energy Efficiency, 2011b). Comparison of the emissions attributable to the Project with NSW and Australian emission totals is presented in **Table 10.40**.

Table 10.40 Comparison of Proposed Project GHG Emissions with State and National Totals

Emission Scope	Estimated Project GHG Emissions (tCO_2-e/annum)	Percentage of NSW GHG Emissions (2010)	Percentage of Australian GHG Emissions (2010)
Scope 1 (direct only)	42,473	0.03	0.01
TOTAL (1,2 and 3)	1,061,024	0.7	0.2

Table 10.40 shows that the Project's contribution to Australian emissions would be relatively small. Estimated annual Scope 1 emissions would represent approximately 0.03% of NSW GHG emissions and 0.01% of Australia's total GHG emissions.

It is widely accepted that increased GHG emissions exert a warming influence on climate. Atmospheric temperature increases can result in: changes in ocean levels (due to melting of glaciers and polar ice caps) and water temperatures; greater humidity; and changes in weather patterns which lead to effects such as more droughts in some areas and more flooding in others.

The Project will directly and indirectly generate GHG emissions, which will contribute to these global environmental effects. However, the increase in GHG emissions resulting from the Project will not measurably increase the total Australian emissions. In addition, due to the uncertainties and complexities of the climate system, quantification of the likely environmental effects associated with greenhouse gases being released in the atmosphere as a result of the Project cannot be made.

10.8.5 Greenhouse Gas Mitigation Measures, Management and Monitoring

To minimise GHG emissions to the greatest extent practicable Angus Place Colliery implements an Energy and Greenhouse Management System that monitors and reports energy usage. Key Performance Indicators including energy demand and GHG emissions per tonne of ROM coal produced are tracked.

Additional management measures that Centennial Angus Place are implementing:

- cost effective measures to improve energy efficiency;
- regular maintenance of plant and equipment to minimise fuel consumption; and
- consideration of energy efficiency in plant and equipment selection.

Traffic management during construction of the Project will minimise fuel use, given the recommended speed restrictions, defined hours of construction and onsite operating practices.

Angus Place Colliery is currently investigating at a corporate level the measures that may be taken to offset scope 1 emissions from their operations. This work is ongoing, but measures may, but not be limited to, alignment with biodiversity offsets, purchasing of greenpower and switching to biodiesel fuel. All measures taken to offset GHG emissions associated with the Project will be in alignment with the highest standards, such as the National Carbon Offset Standard.

10.8.6 Conclusion

The total lifetime direct (scope 1) emissions from the Project are estimated to be approximately 42,473 t CO_2-e per annum, which is relatively small as this represents approximately 0.03% of NSW GHG emissions and 0.01% of Australia's total GHG emissions.

10.9 Soils, Land Capability and Agricultural Suitability

This responds to the DGRs, which require the following issues to be addressed:

The Director General's requirements

Land Resources – including a detailed assessment of impacts to:

soils and land capability (including erosion and land contamination);

landforms and topography, including cliffs, rock formations, steep slopes, etc; and

land use, including agricultural, forestry, conservation and recreational use.

10.9.1 Introduction

A desktop review and field survey was undertaken by SLR to:

- classify and determine the soil types in the Project Application Area;
- identify pre and post-mining rural land capability and agricultural suitability;
- identify any potentially unfavourable soil material which may pose high environmental risks if disturbed; and
- provide any relevant management and mitigation measures to minimise any potential impacts identified.

Field observations were made at 115 locations, of which 28 were detailed soil profile descriptions, 14 were tested in a laboratory, and the remainder were site classification observations.

Soil layers at each profile site were also assessed according to Elliot and Reynolds (2007) to assess the suitability for topdressing based on grading, texture, structure, consistence, mottling and root presence.

10.9.2 Existing Environment

10.9.2.1 Soils

The Project Application Area contains 12 Soil Landscape Units and associated Australian Soil Classification types as listed in **Table 10.41**. The dominant Soil Landscape Unit is Wollangambe, which is an erosional landscape comprised of rounded convex crests and moderately to steeply inclined sideslopes on sandstone. The second dominant unit is Newnes Plateau, which is a residual landscape comprised of level to gently undulating wide crests and ridges on plateau surfaces of sandstone.

Table 10.41 Soil Landscape Units and Soil Types Across the Project Application Area

Soil Landscape Unit	Australian Soil Classification	Project Application Area		Surface Infrastructure Sites	
		ha	%	ha	%
Hassans Walls	Leptic Tenosol	1,418	13.6	-	-
Warragamba	Brown-Orthic Tenosol	1,609	15.4	1	0.7
Cullen Bullen	Mesotrophic Brown Kandosol	305	2.9	-	-
Glen Alice	Eutrophic Brown Kandosol	122	1.2	-	-
Wollangambe	Brown-Orthic Tenosol	2,672	25.5	27	19.2
Lithgow	Eutrophic Brown Kurosol	335	3.2	-	-
Medlow Bath	Red-Orthic Tenosol	1,097	10.5	59	41.8
Newnes Plateau	Brown-Orthic Tenosol	2,028	19.4	52	36.9
Deanes Creek	Mesotrophic Brown Kandosol	131	1.2	1	0.7
Long Swamp	Brown-Orthic Tenosol	236	2.3	-	-
Mount Sinai	Arenic Rudosol	397	3.8	1	0.7
Coco	Rudosol	15	0.1	-	-
Disturbed terrain		95	0.9	-	-
Total		**10,460**	**100**	**141**	**100**

Table 10.41 also details the areas of soil landscape units and soil types for the proposed surface infrastructure sites. Only a fraction of this total area will be cleared (approximately 23.25 ha). The major soil types within the proposed surface infrastructure areas are Brown-Orthic Tenosol covering 80 ha (56.8 %) and Red-Orthic Tenosol covering 59 ha (41.8 %).

Topsoils across the Project Application Area have negligible dispersibility while subsoils are slightly dispersive.

10.9.2.2 Land Capability

In NSW, rural lands are mapped according to two different land classification systems. The first system was developed by OEH and classifies land into eight classes (Classes 1 to 8) known as Land and Soil Capability classes. This system has been recently introduced to replace the former Rural Land Capability System (Emery 1986) that was formerly the benchmark for land capability assessments in NSW. The second system, developed by the former NSW Department of Agriculture, classifies land into five classes (Classes 1 to 5) known as Agricultural Suitability.

Table 10.42 details the areas of the various Land and Soil Capability classes in the Project Application Area. These are also shown on **Figure 10.28**. The assessment of Land and Soil Capability classes included an area larger than the Environmental Study Area and only 28.54 ha (23.25 ha of which is native vegetation) will be disturbed as a result of the Project.

Table 10.42 Land and Soil Capability Classes

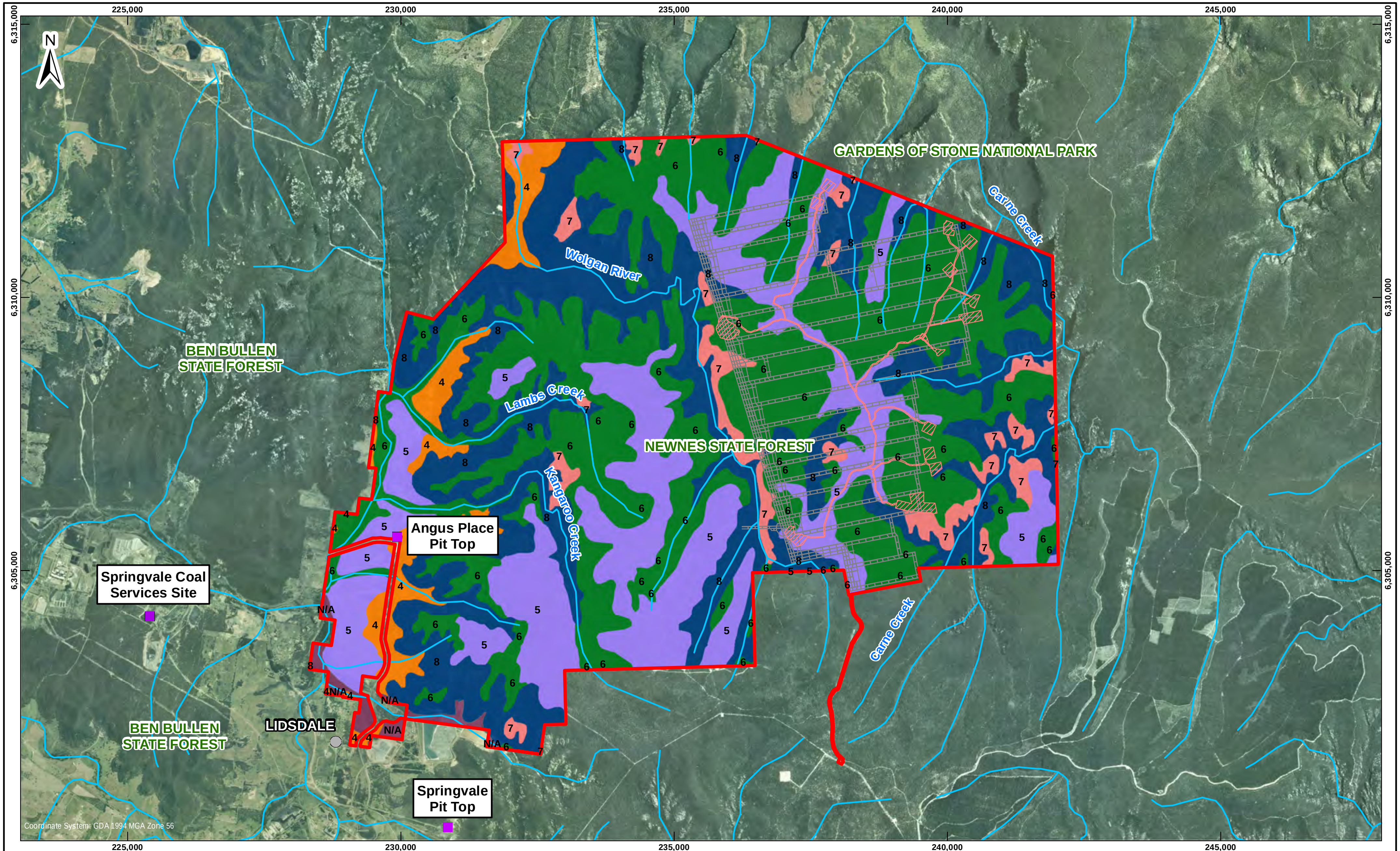
Land and Soil Capability	Project Application Area		Environmental Study Areas	
Class	**ha**	**%**	**ha**	**%**
4	427	4.1	Nil	Nil
5	2,599	24.9	52	36.9
6	3,900	37.2	87	61.7
7	412	3.9	1	0.7
8	3,027	29.0	1	0.7
Disturbed Terrain	95	0.9	Nil	Nil
Total	**10,460**	**100.0**	**141**	**100.0**

Class 6 land, which is the predominant Land and Soil Capability class in the Project Application Area has low agricultural capability and is limited to grazing or forestry.

Class 8 land, which covers 29 % of the Project Application Area has extremely low agricultural capability.

Class 5 land, which covers approximately 25% of the Project Application Area has moderate to low agricultural capability and can be used for a variety of land uses such as grazing, some horticulture, forestry and nature conservation.

The best Land and Soil Capability class present, albeit in small areas, is Class 4 which has moderate agricultural capability and can be used for cropping with restricted cultivation, pasture cropping and grazing.



LEGEND

- Project Application Area
- Village
- Proposed Workings
- Proposed Surface Infrastructure

Land and Soil Capability

- Class 4
- Class 5
- Class 6
- Class 7
- Class 8
- Disturbed Terrain

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Figure 10.28: Land Capability

0 1 2 3 km

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Angus Place

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10.9.2.3 Agricultural Suitability

Agricultural suitability for the Project Application Area was determined by a five class ranking system in accordance with *Agricultural Suitability Maps – uses and limitations* (NSW Agricultural & Fisheries 1990). In this classification system, Class 1 lands have the highest potential agricultural production, with lower classes having progressively lower production potential owing to physical, climatic and geographic constraints. In the Project Application Area, Class 3, 4 and 5 lands were identified, and these are briefly described as follows:

- Class 3: Moderately productive lands suited to improved pasture and to cropping within a pasture rotation;
- Class 4: Marginal lands not suitable for cultivation and with a low to very low productivity for grazing; and
- Class 5: Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.

Table 10.43 lists the agricultural suitability classes by area for the Project Application Area and areas proposed for construction of surface infrastructure.

Table 10.43: Agricultural Suitability

Agricultural Suitability	Project Application Area		Environmental Study Areas	
Class	ha	%	ha	%
3	3,026	29.0	52.0	36.9
4	3,900	37.2	87.0	61.7
5	3,439	32.9	2.0	1.4
Disturbed Terrain	95	0.9	Nil	Nil
Total	10,460	100.0	141	100.0

10.9.2.4 Land Use

The land use of the Project Application Area and surrounds is discussed in **Section 2.5.1.2** and **2.5.1.1** respectively. The Project Application Area covers 10,460 hectares, most of which is State Forest.

10.9.3 Soil and Land Capability Impact Assessment

10.9.3.1 Soils

Subsidence will cause minor cracking of surface soils, which are expected to self-heal. No ponding is predicted that would cause measurable changes to soil resources.

Clearing for surface infrastructure will temporarily remove small areas of soil resources, although staged rehabilitation is expected to recover these resources. Post mine closure and rehabilitation of the pit top will improve the current soil resources that were removed many years ago.

10.9.3.2 Land Capability

Impacts to land capability of the areas above the proposed longwalls and in the areas to be cleared for surface infrastructure are similar to soils impacts. The existing relatively low grade land capability will not change due to the Project.

10.9.3.3 Agricultural Suitability

Impacts to agricultural capability classifications of the areas above the proposed longwalls and in the areas to be cleared for surface infrastructure are similar to soils impacts. The existing low agricultural suitability classifications will not change due to the Project.

10.9.3.4 Land Use

The project will clear 23.5 hectares, which is approximately 0.2% of the Project Application Area, which will have a negligible and temporary impact on Forestry land use. Subsidence under the State Forest is not predicted to impact on forestry activities or productivity.

10.9.4 Consequences of Potential Impacts

The minor changes to land surface predicted from staged clearing, construction and rehabilitation of surface infrastructure on the Newnes Plateau, the proposed longwall mining, will have negligible consequences on soil resources, land capability and agricultural suitability. The Project Application Area covers 10,460 hectares, most of which is State Forest. The project will clear 23.5 hectares which is approximately 0.2% of the Project Application Area, which is not expected to have a measurable consequence on land use.

The life of mine rehabilitation of the pit top will regain soil resources, land capability and agricultural suitability lost during construction and operation of that site.

10.9.5 Management and Mitigation Measures

The key soil and land capability mitigation measures are the identification and selective stripping and replacement of topsoil on areas to be disturbed for surface infrastructure. **Table 10.44** provides the recommended topsoil stripping depths for each soil type at the surface infrastructure sites.

Table 10.44 Recommended Soil Stripping Depths

Soil Type	Stripping depth (m)	Amelioration for Stripped Soil	Associated Surface Infrastructure
Brown-Orthic Tenosol	0 – 0.25	Lime or gypsum application and addition of organics.	- ESA for Dewatering Facility Sites
Brown-Orthic Tenosol	0 – 0.20	None	- ESA for dewatering facility sites - Infrastructure corridor - Ventilation shaft 3
Red-Orthic Tenosol	0 – 0.60	Lime or gypsum application and addition of organics.	- ESA for dewatering facility sites - Infrastructure corridor - Ventilation shaft 3
Brown-Orthic Tenosol	0 – 0.25	Lime or gypsum application and addition of organics.	- ESA for dewatering facility sites - Infrastructure corridor - Ventilation shaft 2
Mesotrophic Brown Kandosol	0 – 0.40	Lime or gypsum application.	- Ventilation shaft 2
Arenic Rudosol	0 – 0.10	Lime or gypsum application and addition of organics.	- ESA for dewatering facility sites

The following topsoil management measures will be applied:

- topsoil will be stripped to depths outlined in **Table 10.44** only when moist and stockpiled a maximum of 3 m high;
- topsoil stripping will immediately precede construction to minimise the time that bare subsoils are exposed;

- ameliorants for each soil type will be applied as per **Table 10.44**; topsoil that is to be stockpiled for longer than three months with be stabilised with an annual cover crop; and
- prior to re-spreading stockpiled topsoil, weeds will be examined and removed or sprayed with herbicide.

10.9.6 Conclusion

The soils in the Project Application Area are predominantly Tenosols, which give rise to land capability classifications ranging from class 4 to 8 and agricultural suitability classification from 3 to 5. The soils are relatively poor and resulting land capability and agricultural suitability classes are relatively low. The existing low agricultural suitability classifications will not change due to the Project. The project will clear 23.5 hectares which is approximately 0.2% of the Project Application Area. Construction and operation of surface infrastructure in this 0.2% of the Project Application Area will have a temporary and negligible effect on landuse.

The life of mine rehabilitation of the pit top will regain soil resources, land capability and agricultural suitability lost during construction and operation of that site.

10.10 Strategic Agricultural Land

10.10.1 Introduction

The DGRs did not require an assessment of Strategic Agricultural Land; however, the Strategic Regional Land Use Policy (SRLUP) (DP&I 2012) requires all state-significant mining development proposals to prepare an Agricultural Impact Assessment at the application stage. A desktop and field investigation was undertaken by GSSE to:

- determine the presence of Biophysical Strategic Agricultural Land (BSAL) with the Project Application Area;
- assess any potential impacts of the Project on agricultural resources and/or industries within the Project Application Area and surrounding area; and
- identify any relevant management and mitigation measures to minimise any potential impacts identified.

The Project Application Area has been assessed under two different BSAL protocols, the first being the Upper Hunter Strategic Regional Land Use Policy (Department of Planning and Infrastructure 2012) and the second being the Interim Protocol for Biophysical Strategic Agricultural Land Verification (Interim Protocol) (Office of Environment & Heritage and Department of Primary Industries - Office of Agricultural Sustainability and Food Security (2013).

10.10.2 Existing Environment

Table 10.45 provides an analysis of the Project Application Area soil types versus the Upper Hunter SRLUP criteria, which shows that there are no soils that are classified as BSAL.

Table 10.45: BSAL Criteria from Upper Hunter SRLUP

Soil Landscape	Australian Soil Classification	LSC Class	Fertility	BSAL
Hassan Walls	Tenosol	**8**	Low	No
Warragamba	Tenosol	**8**	Low	No
Cullen Bullen	Kandosol	**4**	Moderate	No
Glen Alice	Kandosol	**4**	Moderate	No
Wollangambe	Tenosol	**6**	Low	No
Lithgow	Kurosol	**5**	Moderate	No
Medlow Bath	Tenosol	**6**	Low	No
Newnes Plateau	Tenosol	**5**	Low	No
Deanes Creek	Kandosol	**6**	Moderate	No
Long Swamp	Tenosol	**5**	Low	No
Mount Sinai	Rudosol	**7**	Low	No
Coco	Rudosol	**7**	Low	No

The Interim Protocol applies a slightly different set of tests to determine BSAL. No BSAL was determined to be present within the Project Application Area when assessed using the Interim Protocol tests.

10.10.3 Biophysical Strategic Agricultural Land

As there are no areas of potential BSAL within the Project Application Area, the Project will not impact on BSAL.

10.10.4 Consequences of Potential Biophysical Strategic Agricultural Land Impacts

The Project will not disturb any area of BSAL and will not permanently remove land from agricultural use.

10.10.5 Management and Mitigation Measures

No management and mitigation measures are proposed as no BSAL is present within the Project Application Area.

10.10.6 Conclusion

The potential for BSAL was assessed by both the Upper Hunter SRLUP and Interim Protocol which have slightly different assessment protocols. No BSAL was identified by either assessment process. The Project will not impact BSAL.

10.11 Life of Mine and Rehabilitation

This section specifically responds to the DGRs, which provide the following in regard to rehabilitation aspects:

The Director General's requirements
Rehabilitation – including the proposed rehabilitation strategy for the site, having regard to the key principles in Strategic Framework for Mine Closure, including:

- rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;
- nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies;
- a conceptual final landform design, including a detailed figure depicting relevant site features; and
- the potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region.

A Decommissioning and Rehabilitation Strategy for the Project was undertaken by SLR Consulting Australia Pty Ltd (SLR) titled "*Decommissioning and Rehabilitation Strategy:* Angus Place Mine Extension Project". The report is provided in full in **Appendix P** and is the basis of this section. This report was prepared in accordance with the following relevant land use planning and mine rehabilitation guidelines and policies:

- Draft Mining Operations Plan Guidelines (DTIRIS, Resources and Energy, 2012);
- The Strategic Framework for Mine Closure (ANZMEC & MCA, 2000);
- Leading Practice Sustainable Development Programme for the Mining Industry - Mine Rehabilitation (Department of Industry, Tourism and Resources, 2006);
- Leading Practice Sustainable Development Programme for the Mining Industry – Mine Closure and Completion (Department of Industry, Tourism and Resources, 2006);
- The Angus Place MOP (Centennial Coal, 2013);
- The Draft Lithgow City Council Local Environmental Plan 2013 (Lithgow City Council, 2013); and
- The Lithgow Draft Land Use Strategy 2010-2030 (Lithgow City Council, 2011).

10.11.1 General Rehabilitation Principles and Objectives

The key rehabilitation objectives for Angus Place are to:

- provide pre-mining land capacity or better;
- create a self-sustaining and stable final landform;
- proposes to create a woodland final landform commensurate with the proposed RU2 Rural Landscape and RU3 Forestry land zonings in the Draft Lithgow Local Environmental Plan (2013);
- preserve downstream water quality through creation of a final landform that is self-draining;
- develop an effective monitoring programme to assess performance of rehabilitated areas; and
- develop preliminary success criteria for decommissioning and rehabilitation.

10.11.2 Conceptual Post-Mining Land Use

The Project Application Area has been categorised into three primary domains (**Figure 10.29**) and two secondary domains. Primary domains are land management units, usually with a unique operational and functional purpose and therefore similar characteristics.

There are three primary rehabilitation (or operational land use) domains:

- Domain 1: Infrastructure Area, which includes the pit top and surface infrastructure on the Newnes Plateau;
- Domain 2: Other Lands, being the remainder of the Project Application Area, not forming parts of Domain 1 and Domain 3; and
- Domain 3: Water Management area comprising water storage and sediment ponds located at the pit top

Secondary domains are land management units characterised by a similar post mining land use objective and are the outcomes of rehabilitation undertaken on the primary domains.

The secondary or post operational final landform domains (**Figure 10.30**) are:

- Domain A: Woodland: woodland commensurate with adjacent remnant vegetation. Includes all rehabilitation to be undertaken on the Newnes Plateau, Angus Place pit top and covers areas adjacent to the existing undisturbed native vegetation; and
- Domain B: Water Management Areas: water management structures retained in the final landform at the pit top.

Table 10.46 lists the primary rehabilitation objectives of each domain.

Table 10.46 Primary Rehabilitation Objectives

Domain	Rehabilitation Objectives
Domain 1: Infrastructure Area	■ To form a stable landform which will pose no long-term environmental hazard; and to create final landforms for the nominated end land use of woodland.
Domain 2: Other Lands	■ To rehabilitate surface impacts arising from activities other than direct clearing of vegetation, including subsidence effects.
Domain 3: Water Management Area	■ To allow the on-going capture of run-off to provide water for any fauna habiting the pit top and the separation of clean and dirty water.
Domain A: Woodland	■ To form a stable and a self-sustaining landform which will pose no long-term environmental hazard, and to establish native forest ecosystem similar to the immediate surrounds, to ultimately provide opportunities to develop wildlife corridors. ■ To meet current zone objectives and those of the Draft Local Environmental Plan.
Domain B: Water Management Area	■ To provide water resources to the fauna inhabiting the rehabilitated areas at the pit top, to allow separation of clean and dirty water within the rehabilitated areas prior to vegetation establishment within the disturbed areas, and to meet water requirements during the landform establishment, growth medium development, ecosystem establishment and development stages of the rehabilitation programme. ■ To meet current zone objectives and those of the Draft Local Environmental Plan.

Domain A: Woodland comprises the areas to be rehabilitated in the Angus Place pit top (excluding the water management structures), as well as the Newnes State Forest. The Angus Place pit top is zoned 1(c) Rural (small holdings) pursuant to the LEP 1994. The zoning of this land is set to change to RU2 Rural Landscape, under the provision of the Draft LEP 2013., Under both the 1(c) and the RU2 zonings, environmental protection works are permitted with consent. Under the 2013 Draft Lithgow LEP, environmental protection works are defined as means works associated with the rehabilitation of land towards its natural state or any work to protect land from environmental degradation, and includes bush regeneration works, wetland protection works, erosion protection works, dune restoration works and the like, but does not include coastal protection works.

The final land use for this domain will become 'environmental protection works' at the pit top, and forestry on the Newnes Plateau. This final land use is consistent with the surrounding land use of forestry in the Newnes State Forest. These final land uses align with the current *Lithgow LEP 1994*, the *Draft Lithgow LEP 2013* and the *Lithgow Draft Land Use Strategy 2010-2030*. No additional strategic land use planning, or resource management plans or policies apply to the Project Application Area.

Domain B: Water Management Area comprises the pit top water management structures to be retained post-rehabilitation for use as stock water supply. This area is zoned 1(c) Rural (small holdings) pursuant to the LEP 1994. The zoning of this land is set to change to RU2 Rural Landscape, under the provision of Draft LEP 2013. While the pit top area in which this domain is situated, currently does not have an agricultural land use, the existing and current zonings are appropriate for an agricultural final land use.

10.11.3 Conceptual Post-Mining Landform

The landform, during and after mining will be little changed from that which exists now. The majority of the Project Application Area lies within the undulating Newnes Plateau, which comprises of narrow gorges with high ridgelines and steep sided slopes of sandstone cliffs. Topography across the Project Application Area ranges from 680 m AHD to greater than 1,160 m AHD.

Being an underground mine, only very minor landform changes will occur, limited to subsidence (which will not require landform re-shaping), minor cut and fill at Newnes Plateau infrastructure sites, and more substantial cut and fill at the pit top. In limited cases, minor trimming of fill batters will be required, but no bulk earthmoving or significant landform re-shaping is proposed. The majority of the Project Application Area landscape will remain unchanged. **Figure 8.12** shows a series of indicative cross sections through the proposed mining area, and it can be seen that even with the four times vertical exaggeration of these drawings, the change in ground surface levels is almost imperceptible.

10.11.4 Decommissioning and Rehabilitation Implementation

10.11.4.1 Progressive Rehabilitation

Surface infrastructure proposed on the Newnes Plateau will require the disturbance of areas peripheral to operational areas. For example, the proposed pipeline interconnection to the SDWTS and the installation of buried connecting pipelines and power lines to dewatering boreholes will require the clearing of a corridor approximately 10 m wide, but half of this will be rehabilitated on installation of the services.

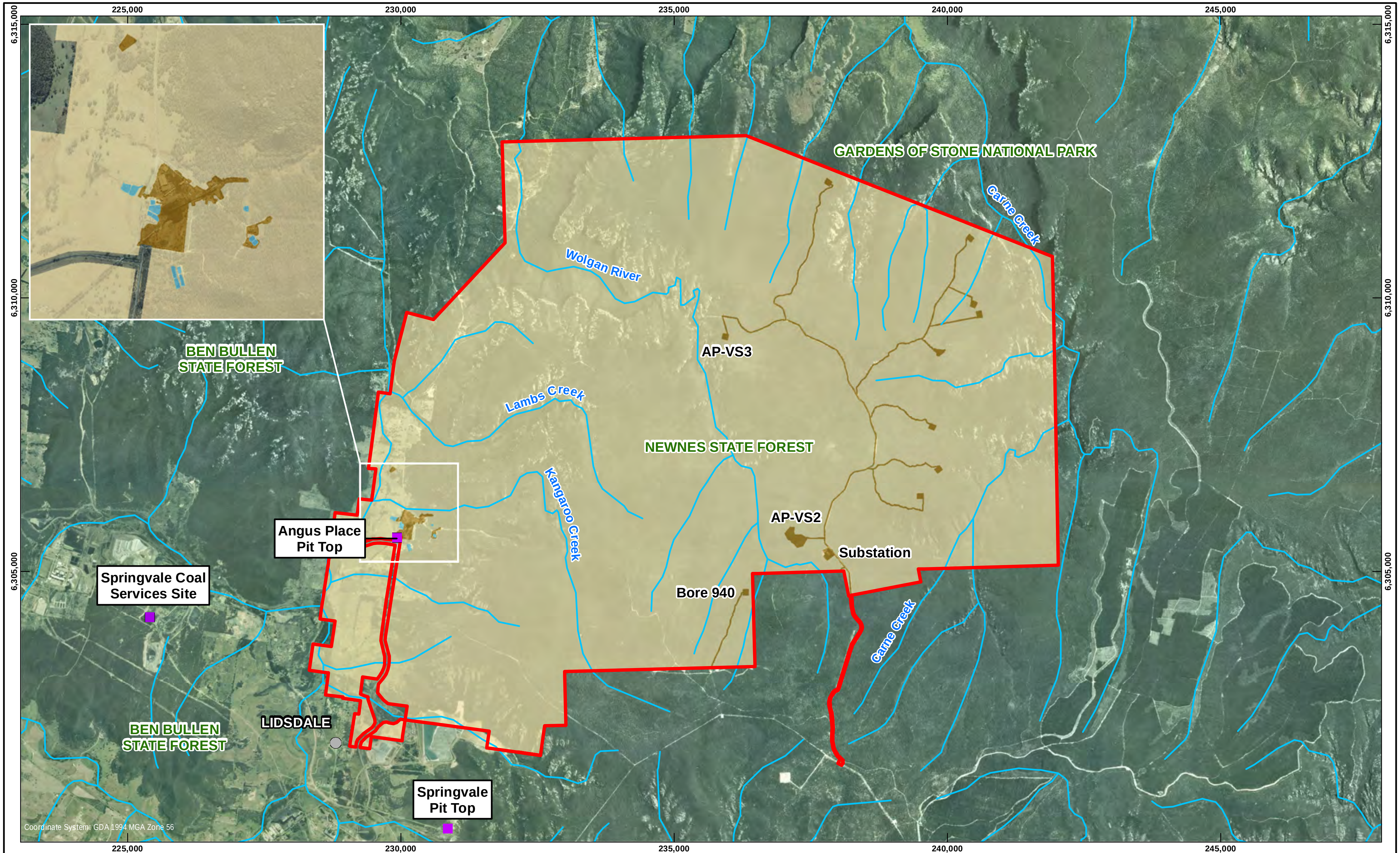
As surface infrastructure becomes surplus to requirements, the facility (dewatering facility) will be decommissioned and the sites progressively rehabilitated. Any exploration drill holes will be rehabilitated on completion.

Progressive rehabilitation is not feasible at the pit top, as the entire area and contained facilities are required until the cessation of mining, at which time a staged rehabilitation process will commence.

10.11.4.2 Life of Mine Rehabilitation

On the completion of mining and associated activities, all disturbed areas will be rehabilitated, through the four stages as follows:

- Decommissioning: demolition of infrastructure;
- Landform Establishment: shaping, bulk earthworks and construction of drainage works;
- Growth Media Development: topsoiling and application of soil ameliorants;
- Ecosystem Establishment: revegetation; and
- Ecosystem Development: monitoring and maintenance.



LEGEND
- Project Application Area
- Village

Primary Domains
- Domain 1 - Infrastructure
- Domain 2 - Other Lands
- Domain 3 - Water Management Area

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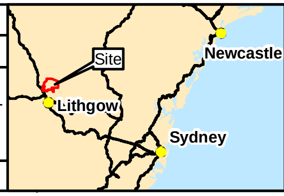

Figure 10.29: Primary Rehabilitation Domains

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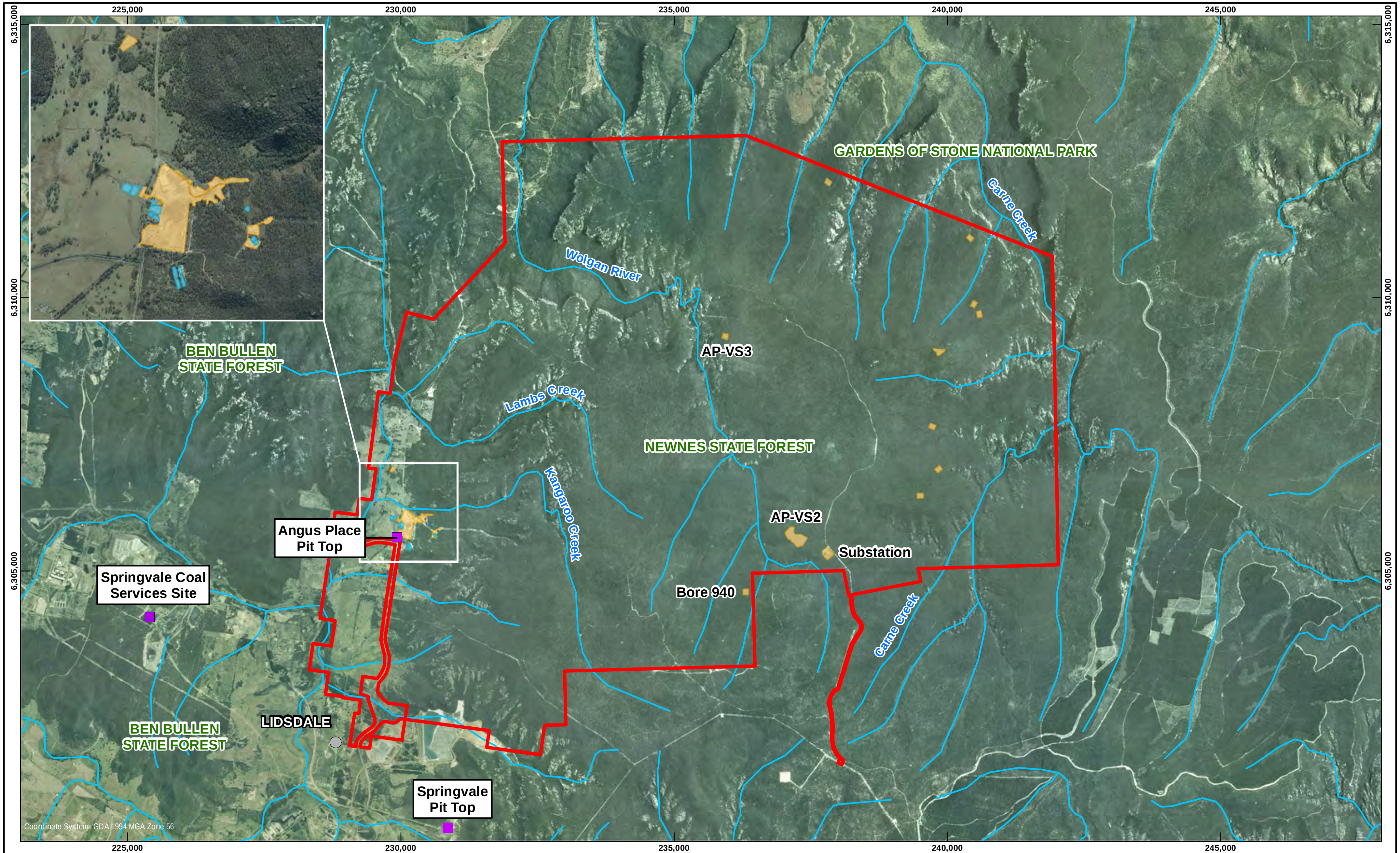

LEGEND
- Project Application Area
- Village

Secondary Domains
- A - Rehabilitation - Woodland
- B - Water Management Area

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REFERENCE	127623060-R-F062 APC Rev 0
SCALE	1:90,000

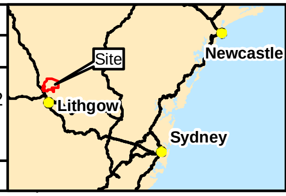

Figure 10.30: Conceptual Final Landform

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Angus Place

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These stages are outlined as follows.

Decommissioning

All pit top buildings, fixed plant, hydrocarbon tanks, fences, substations, pipelines, powerlines, roadways, and dirty water control systems will be demolished.

All Newnes State Forest mine infrastructure will be demolished, although to reduce additional disturbance, underground pipelines and powerlines will be capped and made safe but retained in ground.

Portals, drifts and ventilation shafts will be sealed and made safe in accordance with the relevant guidelines and practice in place at the time of closure.

Groundwater monitoring boreholes will be decommissioned in accordance with the relevant guidelines and practice in place at the time of closure with the objective of preventing gas or water leakage.

In most cases, building materials will be able to be re-used or recycled.

Landform Establishment

Domain 1 Infrastructure Area

Following on from demolition of infrastructure, disturbed areas will be re-profiled to fit in with adjacent areas and to be geotechnically stable, self-draining, and able to be topsoiled and revegetated. Works within the Newnes State Forest would be undertaken in accordance with the conditions of any occupation permit valid at that time. Temporary soil erosion and sediment control measures will be implemented as required.

Domain 2 Other Lands

Should subsidence cause impacts that require remediation, this will be undertaken in accordance with the approved Trigger Action Response Plans and Subsidence Management Plan current at that time. While only minor cracking is predicted, should cracks form that do not self-seal, these will be remediated by infilling with soil or by local re-grading and compaction.

Domain 3 Water Management Area

After demolition of infrastructure, disturbed areas will be re-profiled to fit in with adjacent areas and to be geotechnically stable, self-draining, and able to be topsoiled and revegetated. Temporary soil erosion and sediment control measures will be implemented as required.

Growth Media Development

In accordance with current procedures detailed in the Mine Operations Plan, all new infrastructure sites are stripped of topsoil, which is temporarily stored for reapplication. These procedures will be applied to proposed new disturbance. **Section 10.9.7** details the recommended topsoil stripping depths for the various soil types across the Project Application Area.

Where sufficient topsoil is available, it will be reapplied to disturbed areas at a depth of between 100 to 300 mm. To prepare an adequate seedbed, disturbed areas will be ripped along the contour after topsoiling. The resulting seedbed will be scarified prior to seeding.

Weeds in topsoil stockpiles and the rehabilitation areas themselves can seriously reduce the success of later revegetation and can reduce the biodiversity value of adjacent lands. Accordingly weeds will be managed by regular inspections, followed by herbicides and mechanical removal.

Ecosystem Establishment

Revegetation will be undertaken commensurate with the rehabilitation domain objectives as follows:

Domain A – Woodland

Revegetation will comprise of the following steps:

- appropriate species selection for the rehabilitation domain, consisting solely of local endemic species;
- selection of optimal sowing rates and species proportions;
- seed pre-treatment; and
- soil amelioration and fertiliser application.

Species selection will focus on species which will successfully establish on the available growth medium. The seed mix will comprise a mix of understorey, mid storey and overstorey species, and will utilise where possible species that existed prior to disturbance. Additional species may be required to ensure suitable initial groundcover for site stabilisation and minimal soil erosion.

Domain B – Water Management Area

No revegetation will be undertaken for this domain.

Ecosystem Development

Each domain will have a monitoring programme incorporating indicators and methods that provide completion criteria in accordance with the defined rehabilitation objectives. Monitoring will regularly inspect the following key aspects:

- evidence of erosion or sedimentation;
- success of the initial germination and establishment of plants;
- natural regeneration of native species;
- weed infestation;
- integrity of water management works; and
- general stability of the rehabilitation areas.

Where rehabilitation is not successful, maintenance will be as follows:

- re-seeding and where necessary, re-topsoiling and/or the application of specialised treatments such as compost mulch or bio-solids to areas with poor vegetation establishment;
- installation of tree guards around seedlings or construction of temporary fencing suitable;
- replacement or repair of drainage controls if necessary; and
- weed control.

10.11.4.3 Integration with Surrounding Rehabilitation

The size of the areas of disturbance associated with the Project does not allow for linkages with other rehabilitation and/ or offset strategies in the region. Consequently, the final land uses have been chosen to be consistent with surrounding environment, namely the Newnes State Forest.

Notwithstanding, the Angus Place and Springvale rehabilitation strategies have been prepared simultaneously to ensure they are consistent and the two final landforms for the Projects are integrated. Both of these Projects will be rehabilitated to woodland commensurate with the vegetation communities present across the Newnes State Forest.

10.11.5 Preliminary Rehabilitation Success Criteria

Table 10.47 outlines the preliminary rehabilitation success criteria for the following phases:

- Decommissioning,
- Landform Establishment,
- Growth Media Development;
- Ecosystem Establishment; and
- Ecosystem Development.

Table 10.47 Conceptual Rehabilitation Success Criteria

Rehabilitation Element	Domain	Indicator	Rehabilitation Success Criteria
Decommissioning			
Infrastructure	Domain 1	Land use (open forest/native woodland)	■ All infrastructure within the pit top has been removed, and disposed appropriately, for example, to appropriate waste management facilities. ■ All buildings and equipment, water storage, and other infrastructure removed unless agreed with stakeholders. ■ All boreholes (except those retained for monitoring) shut down, bore casings near the surface are removed and holes plugged or capped. ■ All landforms stable and free draining. ■ Remains as healthy open forest, and the management inputs are no greater than other open forest land.
	Domain 2	Water Management Area	■ Sediment and erosion controls. ■ Water management structures. ■ Water quality of the receiving waters is not affected by surface water runoff from the site and discharge water meets EPL conditions.
			■
	Domain 3	No contamination	■ All sites have been assessed by suitably qualified personnel as not containing contaminants exceeding the relevant criteria for the proposed final land use.
Safety	Domains 1 and 3	Physical	■ Excavations have been rendered safe. ■ All holes/pits and other openings are securely capped, filled or otherwise made safe. ■ Access to members of the public and livestock is restricted as appropriate to site conditions. ■ No rubbish remains at the surface, or at risk of being exposed through erosion.
Landform Establishment			
Landform Stability	Domains 1 and 3	Surface water drainage	■ The landform is stable and contour banks and diversion drains are installed to direct water into stable areas or sediment control basins.
	All Domains	Erosion control	■ Erosion control structures are installed at intervals commensurate with the slope of the landform.
	Domain 2	Stable landform	■ Water storages to be rehabilitated to a stable non-polluting condition.
Growth Media Development			

Top soil	Domain 1 and 3	Physical and chemical parameters	■ Previously stockpiled topsoil has been used in the rehabilitation activities. ■ Suitable and alternative topsoil substitute (for example bio-solids, organics, etc.) have been used at the site to make up any short-fall in the topsoil required for complete rehabilitation.
Ecosystem Establishment			
Vegetation	Domains 1 and 3	Species composition	■ A mixture of native trees, shrubs and grasses representative of regionally occurring woodland is present within Domain A. ■ Established species survive and/or regenerate after disturbance. ■ Weeds do not dominate native species after disturbance or after rain. ■ Pests do not occur in substantial numbers or visibly affect the development of planted species. ■ Minimum of 70% vegetative cover is present (or 50% if rocks, logs or other features of cover are present).
Ecosystem Development			
Vegetation	Domain 1 and 3	Sustainability	■ Species are capable of setting viable seed, flowering or otherwise reproducing. Evidence of second generation of tree/shrub species. ■ Evidence of active use of habitat provided during rehabilitation such as nest boxes, and logs and signs of natural generation of shelter sources including leaf litter.
Fauna	All Domains	Vertebrate Species	■ Presence of representatives of a broad range of functional indicator groups involved in different ecological processes..
	All Domains	Invertebrate species	■ Presence of representatives of a broad range of functional indicator groups involved in different ecological processes.
	All Domains	Habitat structure	■ Typical food and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present.
Land Use	All Domains	Land use	■ The rehabilitated sites can be managed for the designated land uses without any greater management inputs than other land in the area being used for a similar purpose.

10.11.6 Conclusion

A Rehabilitation and Decommissioning Strategy has been prepared for the various landscape domains across the Project Application Area that analyses land use options, considers current and draft legislative controls, and provides an outline of the various stages of rehabilitation, including decommissioning, land-forming, growth media development, revegetation, and monitoring and maintenance.

The Strategy shows that staged and final rehabilitation will ensure that the Project Application Area will be little different during and after mining compared to its current state. Rehabilitation of the pit top area will mitigate the largest area of disturbance caused by Angus Place Colliery. The new component of the Project consist of limited surface infrastructure that will be decommissioned and rehabilitated in stages as these sites are no longer required for mining operations.

10.12 Visual Amenity

This chapter specifically responds to the DGRs, which provide the following in regard to visual aspects:

The Director General's requirements

Visual – including:

- a detailed assessment of the potential visual impacts of the development on private landowners in the surrounding area as well as from key vantage points in the public domain, in particular, those available to recreational users from State forests, State conservation areas and national parks; and
- a detailed description of the measures that would be implemented to minimise the visual impacts of the development.

10.12.1 Introduction

This section identifies the potential impacts of the Project on the visual environment and is informed by the technical report "*Angus Place Extension Project - Visual Impact Assessment; Golder Associates* (*July 2013)"* (**Appendix Q**). The visual character and existing aesthetic environment of the Project Application Area is identified together with the potential visual impact consequences as a result of the Project. Proposed mitigation and management measures are also outlined.

The assessment of visual impact of the Project is based upon the "Guidelines for Landscape and Visual Impact Assessment" published by the Landscape Institute (LI 2002). The potential visual impacts as a result of the Project are assessed in chronological order as follows:

- the identification of representative viewpoints and/or receptors;
- a site visit and photo survey;
- an assessment of visual sensitivity and magnitude of visual change; and
- an assessment of impact significance and formulation of mitigation measures.

10.12.2 Existing Environment

The existing environment is considered in the context of two distinct visual settings; the Angus Place pit top and Newnes Plateau.

10.12.2.1 Angus Place Pit Top

The Angus Place pit top is enclosed on three sides and opens to clear views from the west. There are several houses located to the south west approximately 1000 m to 2000 m from the pit top infrastructure. Lidsdale is located further south (approximately 3000 m from the pit top).

Angus Place pit top comprises a collection of typical mine infrastructure, with the most visible daytime elements being the conveyor, the coal stockpile, and the various workshop and office buildings. At night, floodlights that light work and security areas are visible.

Residences on Wolgan Road most likely to be impacted by the existing infrastructure of the Angus Place pit top are:

- L1: Residential property located approximately 3.4 kilometres south west from the pit top in Lidsdale urban area.
- L2: Residential property located approximately 4.3 kilometres south west from the pit top in Lidsdale urban area.
- WR1: Residential property located approximately 1.1 kilometres south west from the pit top.
- WR2: Residential property located approximately 1.6 kilometres south west from the pit top.
- WR3: Residential property located approximately 1.7 kilometres north from the pit top.

These are the designated residential receptors illustrated on **Figure 10.31** which displays the representative residential viewpoints in proximity to the Angus Place pit top and those located on Newnes Plateau.

10.12.2.2 Newnes Plateau

The majority of the Project Application Area is located within the Newnes State Forest on Newnes Plateau. Newnes State Forest consists of bushland comprising various woodland and forest types and pine plantation, interspersed with swamps and watercourses, although these are less visible as the forest tracks tend to be on ridges.

While Newnes Plateau has no dwellings or fixed receptors within the Project Application Area, it contains forestry tracks and relatively small scale existing mine infrastructure such as overhead power lines, dewatering bore facilities and ventilation facilities. Newnes Plateau is utilised by recreational users with existing recreational facilities of picnic areas and camp grounds within the Project Application Area.

Roads on the Newnes Plateau are used by recreational drivers and have transient viewpoints of mine infrastructure. However, recreational users do not generally have a direct line of sight of mine infrastructure due to the size of the Project Application Area, the general location of recreational sites and areas, the existing topography and vegetation.

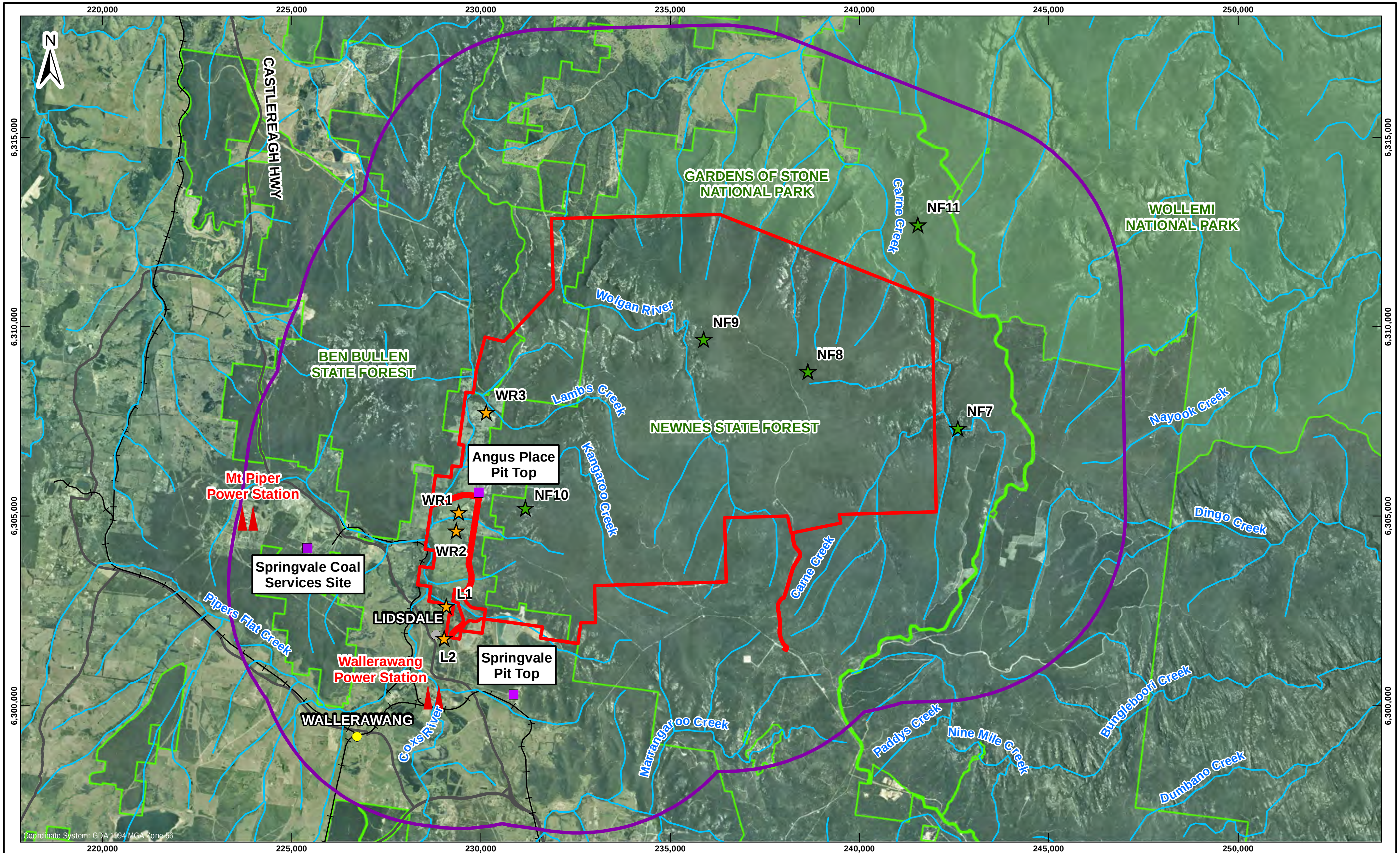
For the purposes of assessing impacts of the Project upon visual amenity, representative receptor viewpoints have been identified. These are the recreational receptors on **Figure 10.31** and have been identified on the basis of:

- consultation with community and recreational users of Newnes Plateau and the regional area;
- review of relevant recreational publications;
- location in relation to proximity to the sites and/or roads, trails and rivers; and
- potential transient viewpoints of existing and Project mine surface infrastructure.

Further information on the selection criteria for representative receptors is detailed in the Visual Impact Assessment (**Appendix Q**).

Representative recreational receptors are:

- NF7: Located approximately 500m east of the Project Application Area at the lookout on the end of Fire Trail No. 5;
- NF8: Located at Birds Rock Trigonometrical Station near Birds Rock Flora Reserve along the proposed infrastructure corridor to several ESAs;
- NF9: Located at proposed Ventilation Shaft 3;
- NF10: located along Angus Place Trail east of the pit top; and
- NF11: Located approximately 2 kilometres north of the Project Application Area at the lookout on the end of Fire Trail No. 7.



LEGEND

- Project Application Area
- Village
- Town
- Rail
- Main Road
- National Park
- State Forest
- Watercourse
- Visual Study Area
- Recreational Receptor
- Residential Receptor

DATE	23/01/2014
SEAM	LITHGOW
REFERENCE	127623060-R-F053 APC Rev 0
SCALE	1:130,000

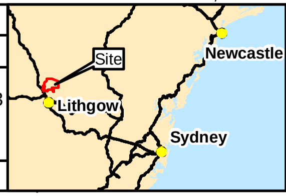


Figure 10.31: Visual Receptor Locations

0 1 2 3 4 km

PLOTFILE No.

Centennial Coal
Angus Place

DRG No. 53 | A4

10.12.3 Visual Impact Assessment

A photographic survey of the existing environment and views of the Project Application Area and receptor locations was undertaken between 29 March 2013 and 1 April 2013, and on the 16 July 2013.

The potential visual impacts of the Project were assessed by evaluating the level of visual modification or magnitude of change as a result of the Project in the context of the visual sensitivity of relevant surrounding land use areas from which the Project may be visible.

The magnitude of change in visual amenity is measured as an expression of the scale of change or the level of visual contrast between the Project and the existing visual environment. The visual sensitivity is a measure of how critically a change to the existing landscape is viewed from various use areas, and is a function of both land use and duration of exposure (i.e. individuals generally view changes to the visual setting of their residencies more critically than changes to transient visual settings during travel).

10.12.3.1 Angus Place Pit Top

The Project will result in no change to the existing operations and infrastructure at Angus Place pit top. With no visual change in magnitude, it is considered there will be no resultant significance of visual effects with no discernible deterioration or improvement of the existing view for Angus Place pit top receptors.

The significance of visual effect resulting from the combination of magnitude of visual change and viewer sensitivity is shown in **Table 10.48**.

Table 10.48 Significance of Visual Effect at Pit Top Receptors

Receptor No.	Magnitude of Visual Change	Visual Sensitivity	Significance of Visual Effects
WR1	No Change	High	None
WR2	No Change	High	None
L1	No Change	High	None
L2	No Change	High	None
WR3	No Change	High	None

10.12.3.2 Newnes Plateau

As discussed in **Chapter 4.0**, proposed surface infrastructure of the Project on Newnes Plateau will consist of:

- dewatering facilities;
- ventilation facilities;
- services; and
- access roads.

Construction of the dewatering facilities will each involve a maximum 1 ha of clearing, borehole drilling machinery and fence installation. The dewatering sites are located at the end of minor terminating tracks and will be decommissioned on completion of mining, with the facilities dismantled and sites rehabilitated to native woodland.

To service the dewatering borehole sites, underground electricity and a pipeline connection will be supplied. This infrastructure will be buried, requiring the clearing of approximately 5 m alongside of existing tracks.

Construction and operation of VS3 will cause minor to moderate visual impacts on recreational road users. This section of road leads to the Wolgan Crossing via the locally named “Spanish Steps”, which are gated and locked and available for use only by registered 4WD clubs under arrangement with the NSW Forestry

Corporation of NSW. This section of track is particularly rough and less commonly used than most other roads on Newnes Plateau. In the long term, the facility will be dismantled and the site revegetated with endemic species to blend with adjacent undisturbed vegetation thereby reducing the long-term visual impact.

Combined with the existing surface infrastructure of Angus Place Colliery located on Newnes Plateau (as discussed in **Chapter 3.0**), the significance of visual effect for Newnes Plateau receptors is provided in **Table 10.49**.

Table 10.49 Significance of Visual Effects at Newnes Plateau Receptors

Receptor No.	Magnitude of Visual Change	Visual Sensitivity	Significance of Visual Effects
NF7	No Change	Moderate	None
NF8	Slight	Low	Minor
NF9 Ventilation Shaft 3	Moderate	Low	Moderate to minor
NF10	No Change	Low	None
NF11	No Change	Moderate	None

10.12.4 Consequences of Potential Visual Impacts

10.12.4.1 Angus Place Pit Top

As the Project will involve no change to Angus Place pit top infrastructure and/or operations, the views from the receptors will remain unchanged. The residential receptors of WR1, WR2, L1, L2, and WR3 will continue to see existing components of Angus Place pit top during the day and night with the Project resulting in no change to the significance of visual effects. When Angus Place Colliery is decommissioned the pit top will be rehabilitated appropriately in accordance with the existing zoning of the site to ensure visual impacts of the final land use are negligible.

10.12.4.2 Newnes Plateau

As shown in **Table 10.49**, the Project is assessed to have significance of visual effects of none to minor at receptor locations with the exception being the Ventilation Shaft 3 due to its proximity to an existing track utilised by recreational users. However, this track, which passes the proposed Ventilation Shaft 3 site is typically gated and locked, minimising the number of recreational users that may be affected.

10.12.5 Mitigation and Management Measures

Visual impact mitigation measures have been incorporated into existing operations at Angus Place Colliery and will continue to be utilised for the Project as relevant. Existing visual mitigation measures consist of:

- elevated conveyers at the pit top are clad in neutral coloured steel sheeting;
- new infrastructure components will use non reflective and neutral toned cladding to reduce the visual impacts;
- lights at the pit top have been designed and installed to Australian Standard 4282-1997 to minimise light spill and direct shining towards receptors;
- the pit top rehabilitation plan provides for revegetation with native woodland and grasslands;
- Newnes Plateau pipelines and powerlines will be buried and the clearing corridor promptly revegetated; and
- Newnes Plateau infrastructure will be progressively dismantled and rehabilitated to an appropriate land use.

10.12.6 Conclusion

The visual character and amenity of the regional and local area of the Project Application Area will not be significantly altered by the Project, as it involves continued operations of Angus Place Colliery, which consists of underground mining with minimal surface disturbance.

Existing infrastructure located at Angus Place pit top will continue to have direct line of sight to residential receptors on Wolgan Road. However, the Project will result in no change in magnitude or significance of visual effects. Once mining is completed and the pit top rehabilitated, the current visual impacts will be ameliorated.

Newnes Plateau has existing surface mining infrastructure, with the Project requiring additional infrastructure. However, the significance of the visual effects of the Project upon Newnes Plateau are predominately none to minor with potential visual impacts on Newnes Plateau being transient and not impacting upon any residential locations. Revegetation will be undertaken appropriately to ensure a suitable end land use that is consistent with the surrounding visual character and zoning of Newnes Plateau.

10.13 Waste Management

This section specifically responds to the DGRs, which provide the following in regard to waste aspects:

The Director General's requirements

Waste – including:

- accurate estimates of the quantity and nature of the potential waste streams of the development; and
- a description of measures that would be implemented to minimise production of other waste, and ensure that that waste is appropriately managed.

10.13.1 Existing Waste Management

Existing waste generated at Angus Place Colliery is classified and managed in accordance with the NSW DECC (2009) "Waste Classification Guidelines" and relevant regulatory requirements of the *Waste Avoidance and Resource Recovery Act 2001 (*WARR Act) and the *Protection of the Environment Operations Act 1997* (POEO Act).

In accordance with the WARR Act, waste management at Angus Place Colliery adopts the principles of the waste hierarchy. This hierarchy provides guidance on the most preferable approach to managing waste as follows:

- avoidance;
- re-use;
- recycling/re-processing/treatment; and
- removal and disposal.

The waste management procedure at Angus Place is operated in accordance with the existing Mining Operations Plan. This has provisions for the management of waste through recovery and recycling, segregation of general waste from cardboard and timber, and recycling of metals and oil. All potentially hazardous material is stored and/or bunded appropriately in accordance with relevant standards. The waste management procedure at Angus Place Colliery aims to minimise the amount of waste sent to landfill and ensure that waste generated on site is managed appropriately in line with relevant legislative requirements.

EPL 467 for the site requires that licensed activities be carried out in a competent manner and this includes the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity. The types and quantities of waste currently generated from activities at Angus Place Colliery, together with the management strategy for this waste are summarised in **Table 10.50**. Quantities have been obtained from the 2012 Annual Environmental Report for Angus Place Colliery. Angus Place does not process coal beyond sizing at the pit top so there is no production waste (fine (tailings) and course reject materials) generated at the pit top. The fine and coarse reject materials generated during the processing of ROM coal at the Springvale Coal Service Site are emplaced at that site's Reject Emplacement Area.

Table 10.50 Existing waste sources and quantities

Waste Stream	Example Waste	Management/Disposal Method	Annual Quantity (2012) (Tonnes)
General Solid Waste			
Mixed Solid Waste	Putrescible wastes and non- putrescible waste such as glass, plastic, rubber, plasterboard, ceramics, bricks, concrete, wood and paper, This also includes waste that meet the classification of *General Solid Waste under DECCW's Waste Classification Guidelines (2009)*	Offsite disposal to landfill	515
Recycled Materials			
Paper and Cardboard	Resource Recovery Centre	Resource Recovery Centre	10
Other recyclables	Oil filters, scrap steel, oily rags, plastic, grease, chemical anchors	Oil recycling facility, steel recycling facility, hazmat facility	350*
Liquid Waste			
Liquid Waste recycling	Oily water, coolant, used oil	Liquid waste recycling facility. Only approved biodegradable drilling fluids will be used.	370
Dirty water	Waste Oils/Grease and Potential hydrocarbon contaminated water, coal sludge	This waste is diverted to the workshop grit trap and oil separator prior to delivery to the two settling ponds west of Wolgan Road, before discharge via LDP002 into Coxs River.	
Waste effluent	Sewage	Sewage and grey water from the bathhouse and administration buildings is treated through a series of oxidation ponds and into a maturation pond prior to spray irrigation over a utilisation area at LDP005.	

**Note: Total includes an amount of 280T for August 2012*

Where possible, all quantities of waste or recyclable material are quantified and recorded for benchmarking and continuous improvement purposes as well as reporting in accordance with the National Greenhouse and Energy Reporting Scheme.

10.13.1.1 Proposed Waste Management

The waste management systems currently employed at Angus Place Colliery will continue to be used for the Project. The Project will not generate any new waste materials or additional waste volumes on an annual basis.

Additional waste volume will be generated on a life of mine basis given the extended operational mine life. However this volume of waste will continue to be managed in accordance with current waste management strategies.

There will be no coarse or fine reject material generated at Angus Place Colliery from coal processing. ROM coal processing and the associated management of production waste will continue to be undertaken at the Springvale Coal Services Site, however, under the consent of the proposed Western Coal Services Project.

Table 10.51 identifies the wastes that are anticipated to be generated by the Project during construction and operation. Where possible, estimated quantities are provided. These wastes will be generated during construction of individual surface facilities.

Table 10.51 Proposed Waste Volumes and Management Measures

Waste Stream	Example Waste	Management/Disposal Method	Estimate of Quantity
General Solid Waste (Construction)			
	General construction waste	There will be skips on site for general waste and recyclable waste.	529 m^3
Liquid Waste (Construction)			
	Excess process and dirty water	A suitably sized sump with appropriate erosion and sediment controls will be constructed to capture all drilling fluid from borehole drilling activities. The drilling fluid will be reused and on completion of drilling activities will be pumped out by a licensed contractor for disposal at an appropriate facility.	21,000 m^3
	Oils and chemicals associated with maintenance and use of construction equipment and plant	There will be preventative measures to ensure controlled use of fluids during construction. All chemicals including oils and drilling muds will be on self bunded storage pallets. Disposal will follow the appropriate guidelines for the disposal of such wastes.	Minor quantities
	Sewage	Chemical toilets will be provided, maintained and removed by licensed contractors	none
General Solid Waste (Operation)			
Mixed Solid Waste	General waste generated at the ventilation and dewatering facilities. Same as current (refer **Table 10.50**)	Offsite disposal to landfill (refer **Table 10.50**)	Minimal to none (refer **Table 10.50**)
Liquid Waste (Operation)			
Liquid Waste recycling	Same as current (refer **Table 10.50**)	(refer **Table 10.50**)	(refer **Table 10.50**)

Waste generation and management will continue to be monitored through the provision of monthly reporting, which show the amounts of each waste type that are disposed of or recycled, and identifies the appropriate contractor or waste facility that receives the waste or recyclables. Waste management will continue to comply with the requirements of the NSW DECC (2009) "Waste Classification Guidelines" and relevant regulatory requirements of the WARR Act and the POEO Act.

The existing waste management system and its associated procedures will be revised to ensure appropriate waste management and recycling processes and will address continual improvement as part of the systems requirements.

As the Project will not result in a significant change or increase to the type or quantity of waste generated at the site, the existing waste management plan is adequate.

10.14 Hazards Management

This section specifically responds to the DGRs, which provide the following in regard to hazards:

The Director General's requirements

Hazards – paying particular attention to public safety, including bushfires.

10.14.1 Hazardous Material Management

The electronic database "CHEMWATCH" is a material safety data sheet database available at the pit top. Hardcopies of material safety data sheets are also kept in a site Chemical Data Register, which is maintained in the first aid room, store and statutory library at Angus Place pit top. Prior to new chemicals being allowed onsite, the Material Safety Data Sheet for the chemical is reviewed in terms of potential health, safety and environment issues.

Above ground self-bunded diesel tanks have been installed for refuelling the coal stockpile dozer. Bunding has also been established at the refuelling station to contain and capture diesel spills. Diesel is transferred to fuel pods for underground use or direct to machinery.

The solcenic store was upgraded in 2008 to improve management and spillage control and now contains two tanks (14,000 litres for new solcenic oil and 7,000 litres for waste solcenic oil and contaminated water) in a bunded and roofed area. The solcenic fill point is concreted and drains to a sump.

In 2012, a Dangerous Goods Audit was conducted by Angus Place Colliery and hazardous materials storage and handling was found to comply with the conditions of AS1940 and AS1596. As such, Angus Place Colliery does not require a Dangerous Goods Licence. There are no explosives on site.

Centennial Angus Place holds a radiation licence RR11830 for the nucleonic gauge in the coal handling plant, issued to protect the community and the environment from exposure to radiation.

10.14.2 Spontaneous Combustion

The Lithgow coal seam has a low propensity for spontaneous combustion. There have been no spontaneous combustion issues in relation to in-situ or extracted Lithgow seam coal, and no incidences of spontaneous combustion in the life of Angus Place Colliery.

Typically, for the Lithgow seam coal, the highest risk of spontaneous combustion is during stockpiling for longer than one year. This is not an issue at Angus Place, as coal is stockpiled for short periods.

10.14.3 Hazardous Goods

Hazardous materials are defined with DoP (2001a) as substances falling within the classification of the Australian Code for the Transportation of Dangerous Goods by Road and Rail (Dangerous Goods Code) (Department of Infrastructure, Transport, Regional Development and Local Government, 2009). Based on this definition, the hazardous materials to be stored within the Project Site, their quantities and storage locations are summarised in **Table 52**. These materials are considered alongside the screening thresholds provided in SEPP 33.

Table 10.52 SEPP 33 Thresholds

Material and class	Storage Quantity	Storage Location	Distance to site boundary	Screening Threshold Limit (Table 3 Applying SEPP 33	Threshold Trigger
Diesel, Class 3 C1	1x 68,000 litre tank. 1 x 31,400 litre tank.	Pit top.	na	na	no
Waste oil, Class 3 C2	5000 litres	Pit top.	na	na	no
Engine oil and transmission fluid, Class 3 C2	2 x 1,000 litre tanks	Pit top.	na	na	no
Hydraulic fluid, Class 3 C2	Nominal 500 20 litre drums	Pit top.	na	na	no
Compressor oil	100 x 20 litre drums	Pit top.	na	na	no
Solcenic Fluid	1 x 8,000 litre tank and nominally 80 20 litre drums.	Pit top.	na	na	no
Grease, Class 3 C2	205l drums	Pit top.	na	na	no
LPG, Class 2.1	2 x 45 kg cylinders	Pit top.		10 t	no
Electric detonators Class 1.1	250 kg	External magazine (at Springvale)	Over 100m	More than 250 kg at less than 100m	no
Assorted drilling fluid additives (Aus-Ben, Aus-Gel, PAC L, CR-650, gypsum, lime, Nalco 625, Ultrion 8588) Non-Dangerous Goods according to NOHSC criteria, and ADG Code.	All small volumes	At drill sites as required	Variable	na	no

Table 52 shows that there are not materials stored that would trigger any further assessment under SEPP 33.

10.14.4 Bushfire

10.14.4.1 Existing Environment

The majority of land within the Project Application Area has been identified as Bushfire Prone Land within the Lithgow LGA. Fire history data from the Forestry Corporation of NSW indicates that the majority of bushfires in the area spread from the north and east of Angus Place Colliery due to the direction of dominant winds throughout the bushfire season. A number of fire trails exist across the Newnes Plateau, namely Sunnyside Ridge Road, Campbells Track and Maiyingu Marragu Trail. These act as containment lines mitigating to a degree the bushfire risk to Angus Place Colliery's infrastructure.

Existing infrastructure at the pit top and on Newnes Plateau surrounded with the relevant bushfire Asset Protection Zones (APZs) as defined by Rural Fire Services (2006a).

The existing (and the proposed) infrastructure locations on Newnes Plateau and pit top are surrounded by woodland and forest type vegetation. For the purposes of determining the bushfire risk within the Project Application Area, the vegetation is classified, after Keith (2004) in PBP (2006b), as dry sclerophyll forest or open forest. The Fire Danger Index for Lithgow LGA is 80 and the slopes within the Project Application Area are predominately upslope with slopes in the range 17 to 25 degrees, which defines the bushfire attack category as Level 3 or extreme (PBS (2006)).

10.14.4.2 Potential Impacts

Proposed surface infrastructure sites on the Newnes Plateau are exposed to strong to gale force winds from the northwest, west and southwest. These winds, combined with the woodland and forest vegetation and steep topography could result in catastrophic bushfire events, if not managed properly.

The construction and operation of the proposed surface infrastructure may present a source of bushfire ignition if not properly managed resulting in a risk to forestry assets, the environment and the broader community. Lightning strikes to poles and aerials can provide a bushfire ignition source during periods of dry weather.

Given the extreme bushfire attack category for the Project Application Area there is a high risk of fire. However, given the frequency of bushfires on Newnes Plateau and the surrounding areas, the local flora and fauna have adapted to fire, and as such adverse environmental impacts from bushfire are low. Notwithstanding, bushfire presents an operational risk to the maintenance of mine related infrastructure, including dewatering bores, ventilation shaft facilities, substations, access tracks to facilities and overland powerlines on the Newnes Plateau and at the pit top.

10.14.4.3 Mitigation Measures

Angus Place Colliery has reduced the operational risk of bushfire through incorporation of mitigation and avoidance measures in the Project design. During the design phase, required APZs for dewatering boreholes and Ventilation Shaft site were incorporated into Project. All new electrical power cables forming part of the infrastructure corridors will be trenched which avoids the potential for overhead lines to trigger bushfires or be destroyed by bushfires.

In accordance with the *Bushfire Management Procedure* and *Management of Bushfire Assets Procedure*, Angus Place has committed to ensuring that there is are adequate APZs around all assets located in BPL.

Angus Place Colliery undertakes a number of bushfire risk management procedures as follows:

- *Entry prohibited to Newnes State Forest during severe fire weather*: Forestry Corporation of NSW can close entry to the Newnes State Forest during periods of severe fire weather. During this period Angus Place Colliery personnel and contractors are prohibited to undertake work in Newnes State Forest unless authorised in writing by Forestry Corporation of NSW.
- *Hot works*. Personnel involved in hot work are professionally trained in emergency response procedures, and effective use of fire prevention methods and fire fighting equipment.
- *Reducing fuel loads and maintaining access*. Angus Place Colliery mitigates the risk of bushfire through maintenance of fire trails and access tracks to the pit top and the infrastructure area on Newnes Plateau, APZs and appropriate fuel loadings within the APZs. Specifically:
  - Fire trails and access tracks are maintained to a suitable standard to allow water tanker access.
  - APZs are maintained around the pit top infrastructure and infrastructure on Newnes Plateau.
- *Fire response*. Fire hydrants and hoses have been installed at a number of locations around the pit top. The fire hydrants are identified by reflective signage and the equipment is regularly inspected and maintained. Mine water can also be easily accessed from the existing pit top Collection System (refer

Section 3.10) for fire fighting purposes at the pit top. Fire extinguishers are available at all infrastructure sites.

An APZ of 20 m will be established for the proposed dewatering facilities. Within the APZ, the vegetation will be managed so as to reduce the fuel load, which will involve trimming and clearing some vegetation on an as needs basis. Before any works are carried out a hazard reduction certificate will be obtained from the Lithgow Rural Fire Service. Access tracks to all infrastructure sites will be maintained.

Given that the Project Application Area is located on Bushfire Prone Land, Angus Place Colliery will commit to the following.

- *Afford occupants of any building adequate protection from exposure to a bushfire* – The buildings within the dewatering bore facilities and other infrastructure on Newnes Plateau will not be occupied on a permanent basis. Personnel will only visit the site intermittently for maintenance and inspection purposes.
- *Provide for defendable space to be located around buildings* – An APZ of 20 m will be established and maintained around the dewatering bore facilities.
- *Provide appropriate separation between a hazard and building which, in combination with other measures, prevent direct flame contact and material ignition* – The fuel load within the vicinity of dewatering sites will be managed to provide appropriate separation between vegetation and the facility or area.
- *Ensure that safe operational access and egress for emergency service personnel and residents is available* – A 5 m wide access track will be constructed and maintained to all infrastructure sites, and will be available for use by emergency personnel.
- *Provide for ongoing management and maintenance of bushfire protection measures, including fuel loads in the APZ* – The APZs associated with the infrastructure and assets will be maintained in accordance with the Angus Place Bushfire Management Procedure.
- *Ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bushfire fighting)* – Fire extinguishers will be available at all proposed infrastructure sites on Newnes Plateau.

10.14.4.4 Conclusion

Given APZs will be established and maintained around all infrastructure, the risk of impact from bushfire on Angus Place infrastructure on Newnes Plateau and the pit top will be minimal. Further, as the proposed electrical powerlines will be trenched this significantly reduces the risk of Angus Place infrastructure acting as a bushfire ignition source.

10.14.5 Public Safety

Public safety is a priority management aspect at Angus Place Colliery, as detailed within the subsidence constraints risk assessment for the Project (**Chapter 8.0** and **Appendix D**). Angus Place Colliery also has an approved Public Safety Management Plan to manage public safety in all surface infrastructure areas. This has been developed during previous Subsidence Management Plan applications and updated where required.

These Plans includes the following controls:

- providing, where practical, fencing and warning signage around the pit top area, and security staff patrols on a regular basis; and
- should subsidence pose a potential public safety risk, warning signs will be erected and subsidence repairs completed as soon as practicable. All actions will be completed as per the Trigger Action Response Plan.

A Road Safety Management Plan has also been developed to reduce the risks associated with road transport at Angus Place Colliery. As outlined in **Section 10.5.5**, a Construction Traffic Management Plan will also be prepared to include measures such as warning signs at appropriate locations on the main access roads to the infrastructure sites. Caution will be advised to all road users for when access tracks will be used by increased numbers of heavy vehicles.

Current controls will remain in place, and minimal risk to public safety is predicted.

10.14.6 Conclusion

Angus Place Colliery has a variety of hazards management plans and systems which have been effective in managing and mitigating any potential associated risk associated with operations. As the proposed Project will not generate any further hazardous materials and existing management plans are adequate. However, a review of these plans will be undertaken on a regular basis.

CHAPTER 11.0

Statement of Commitments

11.0 STATEMENT OF COMMITMENTS

This chapter of details the draft Statement of Commitments to outline all proposed environmental management and monitoring measures to reduce adverse impacts of the Project.

The Director General's requirements

- A statement of commitments, outlining all the proposed environmental management and monitoring measures

Centennial Angus Place is committed to the identification, mitigation and management of potential risks from the continued operations of Angus Place Colliery. Key management plans are already well developed and in place to manage and monitor the performance of these operations including those listed in **Table 11.1**.

Table 11.1 Existing Management Plans for Angus Place Colliery

Management Plan or System	Purpose	Update Required Following Development Consent
Environmental Management Strategy	The Environmental Management Strategy provides an overall structure for environmental management at Angus Place Colliery including the strategic context, statutory requirements and roles and responsibilities of key personnel.	The Environmental Management Strategy will be updated to include the relevant aspects of the Project.
Site Water Management Plan	This plan coordinates the management of all surface water within the Springvale Mine holding boundary in an efficient and sustainable manner.	The existing Site Water Management Plan will be consolidated into a new Water Management Plan for the Project. This Water Management Plan will include the mitigation and monitoring measures identified in **Section 10.2.5**.
Groundwater Management Plan	This plan coordinates the management of all groundwater within the Springvale Mine holding boundary in an efficient and sustainable manner as per relevant bore licences.	The existing Groundwater Management Plan will be consolidated into a new Water Management Plan for the Project. This Water Management Plan will include the mitigation and monitoring measures identified in **Section 10.2.5**.
Flora and Fauna Management Plan	The purpose of this plan is to protect threatened species and communities, minimise impact on native flora and fauna, manage clearing, control weeds, and control access to environmentally sensitive areas.	The Flora and Fauna Management Plan will be superseded by a Biodiversity Management Plan.
Temperate Highland Peat Swamps on Sandstone Management Plan	The purpose of this plan is to satisfy an application to the federal Department of the Environment for mining within the angle of draw of THPSS.	The THPSS MP will be superseded by a Biodiversity Management Plan and Water Management Plan for the Project
Noise Monitoring Programme	This programme sets out procedures for monitoring and assessing noise impacts from Angus Place Colliery.	The noise monitoring programme will be updated to include noise monitoring at sensitive receptors, in accordance with the Project Specific Noise Limits identified in **Table 10.25**.
Public Safety Management Plan	This plan describes the processes to ensure public safety in surface areas that may be affected by subsidence arising from longwall mining.	No
Infrastructure	This plan assists in the management of the	No

Management Plan or System	Purpose	Update Required Following Development Consent
Management Plan	risks to infrastructure as a result of subsidence and mining.	
Land Management Plan	This plan describes management measures for surface cracking, erosion, soil slumping and land degradation caused by subsidence and/or associated activities.	No
Subsidence Management Plan (SMP)	The SMP provides significant detail around the management of subsidence impacts on the natural and built environment. The Subsidence Management Plan is supported by a Subsidence Monitoring and Reporting Programme, Subsidence Community Consultation Process and Newnes Plateau Shrub Swamp Management Plan. A new Subsidence Management Plan will be required as a condition of the Mining Lease, however this Plan will be consistent with the new Extraction Plan required for the Project. The new Extraction Plan for the Project will incorporate requirements for monitoring and mitigating surface water, groundwater, landscape and ecology impacts identified in Sections 10.1, 10.2 and 10.3 of this EIS.	An Subsidence Management Plan will be developed as required by the *Mining Act 1992.* A new Subsidence Management Plan will be required as a condition of the Mining Lease, however this Plan will be consistent with the new Extraction Plan required for the Project, as per ML1424 lease conditions. The new Extraction Plan for the Project will incorporate requirements for monitoring and mitigating surface water, groundwater, landscape and ecology impacts identified in Chapter 10, Sections 10.1, 10.2 and 10.3 of this EIS. Monitoring programs and management plans under existing SMP(s) will be superceded by the monitoring programs and management plans outlined in this EIS and Statement of Commitments.
Environmental Monitoring Programme	The Environmental Monitoring Programme consolidates all monitoring requirements developed in the individual management plans and monitoring programmes. The purpose of environmental monitoring is to gather data on the performance of the operation and determine the need for improvements or additional mitigation measures.	The environmental monitoring programme will be updated in consultation with EPA, SCA, NOW and DOPI.
Air Quality Management Plan	This plan provides for the monitoring and management of air quality at Angus Place Colliery.	No
Erosion and Sediment Control Plan	This plan, covering the pit top and Newnes State Forest, has been prepared in accordance with the Department of Housing's "*Managing Urban Stormwater: Soils and Construction Manual*" (2008) (the 'Blue Book'). It ensures that water discharged off site complies with suspended solids limits as detailed in EPL 3607.	No
Bushfire Management Procedure and Management of Bushfire Assets Procedure	These set out the procedures for reporting fire and for the inspection and maintenance of firebreaks and asset protection zones at the pit top and on the Newnes Plateau.	No
Ventilation Management System	In accordance with Clause 21 of the *Coal Mine Health and Safety Regulation 2006,* Angus Place Colliery has implemented a Ventilation Management System to ensure as far as	No

Management Plan or System	Purpose	Update Required Following Development Consent
	reasonably practicable the safety of all persons present at the coal operation with regard to mine ventilation.	
Strata Failure Management System	In accordance with Clause 28b (ii) of the *Coal Mine Health and Safety Regulation 2006* the objectives of this management system are to ensure as far as reasonably practicable the safety of all persons present at the coal operation with regard to underground strata.	No
Pollution Incident Response Management Plan	The plan details the procedures for notification of pollution incidents resulting in or having the potential to cause material harm to human health or the environment. It is prepared to comply with pollution incident response management obligations as detailed in the *Protection of the Environment Operations Act, 1999.*	No

Notwithstanding the above, the DGRs issued for the Project also require that the EIS includes a summary of all proposed environmental management and monitoring measures, herein referred to as a Statement of Commitments. In addition to the above existing plans of management, **Table 11.2** and **Table 11.3** detail the Statement of Commitments for the Project that Angus Place Colliery is willing to adopt for implementation throughout the Project development phase and through to the end of the Project life, respectively, should approval be granted under *Part 4 of the EP&A Act*. Where practical, monitoring programs and management plans will be developed and implemented regionally across Centennial's western operations. This will include, but not be limited to, monitoring programs and management plans related to water (surface and groundwater), biodiversity, noise, air quality, strata management, bushfire, construction and rehabilitation.

Table 11.2 Project Development Phase- Statement of Commitments

Desired Outcome	Action
Development Phase	
All construction operations are appropriately undertaken to minimise potential impacts to the environment.	Six (6) months prior to construction of surface facilities on the Newnes Plateau, a Construction Environmental Management Plan will be developed in consultation with the Forestry Corporation of NSW. This plan will include noise management in accordance with the Project Specific Noise Criteria detailed in **Section 10.6.3**.

Table 11.3 Project Operation- Statement of Commitments

Desired Outcome	Action
1 General	
All operations are undertaken in a manner that will minimise the environmental impacts associated with the Project.	Operations will be undertaken in accordance with the description provided in this EIS. As detailed in **Section 4.2**, as the required exploration drill holes are determined, Centennial Angus Place will undertake a series of due diligence assessments to consider key impacts as relevant. The general approach of the due diligence assessments will be to conduct site investigations to ensure that significant impacts are avoided.
2. Hours of Operation	
All operations are undertaken within the approved operating hours.	Operations will be undertaken 24 hours a day 7 days a week, 52 weeks per year.
3. Surface Water, Groundwater, Geomorphology and Aquatic	
All surface water groundwater and aquatic impacts are minimised to the greatest extent possible.	Within six (6) months of development consent, a Water Management Plan will be developed that includes the monitoring requirements identified in **Section 10.2.5**. Throughout the life of the Project, stygofauna will be monitored using standing water levels within one borehole in each aquifer where stygofauna are known to occur (AQ4 to AQ6). Where available, monitoring of the deep aquifer system, AQ 1 to AQ3 will be undertaken to establish presence of stygofauna
4. Terrestrial and Aquatic Ecology	
	Within 12 months of development consent, the land to be used for offsetting the impacts of the Project, as identified in Chapter 10.3, will be implemented. Within 12 months of development consent a Research Strategy will be developed in consultation with the DOPI, Forestry Corporation of NSW, Office of Environment and Heritage, National Parks and Wildlife Service and Federal Environment Department. This research strategy will include the research and mitigation themes described in **Section 10.3**. Within two (2) years of development consent, a Biodiversity Management Plan will be developed and implemented. The Plan will be developed in consultation with DOPI, OEH, DoE, Forestry Corporation of NSW, NPWS and will include the outcomes of the Research Strategy.
5. Aboriginal Heritage Management	
Ensure that identified and unidentified Aboriginal Sites are appropriately managed.	Aboriginal Heritage will be monitored and managed in accordance with **Table 8.2** of this EIS. Within 6 months of the date of approval, the Cultural Heritage Management Plan will be updated.
6. Traffic and Transport	
Project-related impacts on the road network are limited.	Six months prior to the commencement of construction activities, a Construction Traffic Management Plan will be developed and implemented. The Plan will be developed in consultation with Lithgow City Council and Forestry Corporation of NSW.

Desired Outcome	Action
7. Noise and Vibration	
All noise impacts are minimised to the greatest extent possible.	The existing Noise Management Plan will be updated to include the noise criteria for the Project and a noise monitoring programme for the sensitive receptors identified in **Figure 10.25** of this EIS. The noise monitoring programme will include continuous, unattended noise monitoring and operator attended quarterly noise monitoring.
8. Air Quality and Greenhouse Gas	
All air quality impacts are minimised to the greatest extent possible.	Within six (6) months of development consent, the Air Quality Management Plan will be updated to include the mitigation measures identified in **Section 10.7**.
9. Soils and Land Capability	
All soil and land impacts are minimised to the greatest extent possible	Soil stripping will be undertaken in accordance with the soil stripping depths in the Soils and Land Capability Report appended to this EIS. The following topsoil management measures will be applied: ■ topsoil will be stripped to depths in **Table 10.44** only when moist and stockpiled a maximum of 3 m high; ■ topsoil stripping will immediately precede construction to minimise the time that bare subsoils are exposed; ■ ameliorants for each soil type will be applied as per the Soils and Land Capability Report; ■ topsoil that is to be stockpiled for longer than 3 months with be stabilised with an annual cover crop; and ■ prior to re-spreading stockpiled topsoil, weeds will be removed.
10. Life of Mine and Rehabilitation	
Rehabilitation of the Springvale Coal Services Site is conducted in accordance with Industry Standards.	Progressive rehabilitation will be undertaken in accordance with the Rehabilitation Strategy appended to this EIS. Within 6 months of approval, the Mining Operations Plan will be updated to include the rehabilitation requirements outlined in the Rehabilitation Strategy of this EIS,
14. Hazards	
Safety of the underground personnel from the underground strata will be maintained.	■ The existing Hazard Plan, being part of the Strata Failure Management System, will be maintained and updated on an ongoing basis as required, in accordance with the Clause 28b (ii) of the *Coal Mine Health and Safety Regulation 2006*.

CHAPTER 12.0

Justification and Conclusion

12.0 JUSTIFICATION AND CONCLUSION

A description of the need and justification for the Project is provided in this chapter having regard to environmental, economic and social considerations. This includes consideration of the principles of Ecologically Sustainable Development (ESD) and the consistency of the Project with the objects of the EP&A Act.

12.1 Need for the Project

Angus Place Colliery commenced operations as a bord and pillar mine in 1949, known then as Newcom Colliery. The first approval for longwall mining was granted in 1979, and the mine currently operates under a consent granted in 2006 (PA 06_0021) in Mining Lease 1434.

Scheduled longwall mining in approved mining areas will end in March 2016 and the Project seeks to provide for the continuation of longwall mining to the east of the current workings for a further 25 years within the existing mining lease boundary. Without Project approval, the mine would close, resulting in the loss of 300 jobs and the loss of access to 25 years of coal production at 4 million tonnes per annum.

If the Project is approved, it will continue the employment opportunities for 300 and provide wages, royalties and flow-on effects with a net economic benefit of approximately $699 million.

12.2 Environmental Impacts

As detailed in **Chapter 9.0**, the potential environmental impacts of the Project have been identified and assessed using a risk based approach, which commenced with the Broad Brush Risk Assessment. The key environmental issues identified in that assessment were the subject of technical studies summarised in **Chapter 10.0** and provided in full in the appendices.

The potential environmental impacts of the Project have been minimised through:

- obtaining a detailed understanding of the key environmental issues. The multi-disciplinary assessment and consultation has been to a level of detail commensurate with the scale of the Project, industry standards and the legislative framework under which the Project is considered;
- a mine design with a successful and proven history in previously mined areas of elimination or minimisation of surface subsidence impacts, and that is safe for the underground workforce and visitors to the surface. Conservative measures in mine design are:
  - consideration of sensitive surface features such as swamps, cliff lines, significant rock features, watercourses and sites of cultural significance that overlie the proposed mining areas;
  - optimisation of mine design such as narrowing longwall widths and increasing chain pillar widths. Narrower void widths are tested and proven to minimise subsidence and occurrence of subsidence effects;
  - the selection of infrastructure sites, although somewhat dictated by the mine plan, but using existing tracks and with the least clearing of native forest, and realigning tracks where avoidance mapping has identified threatened species. Optimal locations for the infrastructure with least environmental impact within the ESAs have been selected; and
  - consideration of alternative mining methods.
- subsidence predictions and impact assessment carried out by MSEC (2013) for the proposed mine design, and used to inform the impact assessments;
- the development of a robust numerical groundwater model (CSIRO 2013) which commenced development in 2004 and has been validated with extensive mine water inflow and groundwater level data, and is capable of predicting mine inflows and potential groundwater impacts with a high level of certainty;

- extensive subsidence, water and ecological monitoring, geological modelling and collaborative research efforts with University of NSW, CSIRO and ACARP spanning over 12 years to understand the existing environment, and its response to longwall mining. The use and interpretation of this data has been critical to proving that the technologies and engineering methodologies for longwall mining will minimise severe impacts to sensitive surface features;
- exploration of the geological, subsidence, ecology, surface and groundwater monitoring date to optimise mine design in conjunction with the existing mine technologies and engineering methodologies of longwall mining to minimise severe impacts to sensitive surface features;
- Centennial Angus Place`s commitment to discontinue mine water discharge into any THPSS, following observations of possible subsidence related and/or surface water impacts at East Wolgan, Kangaroo Creek, Narrow and Junction Swamps, mainly attributable to mine water discharge;
- continued implementation of the existing proactive strategies and up to date management plans employed at Angus Place Colliery to avoid, minimise, mitigate, offset or manage potential impacts;
- Centennial Angus Place`s commitment for the ongoing review and the further development of the existing environmental management plans where required, and the development of new plans as the need arises; and
- implementation of the Statement of Commitments.

Table 12.1 provides an overview of the key environmental assessment issues discussed in this EIS. These are on the basis of the subsidence predictions and impact assessment for the Project.

Centennial Angus Place`s approach to the Project has been to apply a best practice system of environmental management: that is a hierarchy of avoid, minimise, mitigate and finally, offset residual impacts. On this basis, the mine planning and design process had already eliminated and designed out many of the potential environmental consequences identified early in the risk management process. The technical assessments have determined the residual impacts following the implementation of mitigation measures where necessary.

The residual impacts of the Project are not significant and acceptable to meet the objectives of the EP&A Act.

Table 12.1 Summary of Environmental Impacts

Environmental Issue	Overview of Key Findings
Cliffs	▪ Localised spalling is predicted to 1% of one cliff adjacent to LW1014B. No impacts are predicted for the other two cliffs (AP-CL1 and CL2) that occur within the angle of draw. All other cliffs have been avoided by mine plan modifications
Pagodas	▪ Localised spalling to 1% of the surface area of pagodas within the angle of draw is predicted.
Watercourses	▪ No significant fracturing, ponding or scouring is predicted for watercourses.
Conservation Areas	▪ The closest conservation reserve, Gardens of Stone National Park could experience very small vertical and horizontal movements but is not predicted to experience any measurable conventional tilts, curvatures or strains.
Swamps	▪ Longwall mining by the Project is unlikely to have a significant impact on swamps.

Groundwater	▪ The significant depressurisation of aquifers in strata overlying the coal seam has been shown to have minimal impact on the shallow and perched aquifer systems across Newnes Plateau;
	▪ groundwater monitoring data shows that mining induced groundwater level impacts in the deeper aquifer units are limited to areas close to or directly overlying the mined area;
	▪ Mine water inflow rates are predicted to increase as a consequence of the mine extension. This increased mine water make will continue to provide the critical base water supply for the power stations in the catchment.
	▪ Groundwater modelling (CSIRO 2013) has shown that:
	  ▪ there is a separation in response to mining above and below the Mount York Claystone aquitard; and
	  ▪ there is a lack of propagation of mine-induced impacts through the Mount York Claystone aquitard
	▪

Surface Water	▪ The predicted depressurisation of aquifers in strata overlying the coal seam will have minimal impact on the shrub and hanging swamps on Newnes Plateau and the surface drainage network of the water supply catchments; and ▪ Mine water discharges proposed to be piped into the Coxs River for reuse by local power stations will have a neutral effect on water quality since the beneficial use of that water as potential drinking water is maintained.
Ecology	▪ No significant impacts are predicted to threatened species or EECs; and ▪ No significant impacts are predicted on aquatic habitats, aquatic flora or aquatic fauna and or stygofauna.
Aboriginal Heritage	▪ No significant consequences are predicted to the three Aboriginal heritage sites that are sensitive to subsidence and are predicted to experience subsidence of 20 mm or more.
Traffic	▪ There will be no change to pit top traffic; and ▪ There will be no significant impact upon the capacity, efficiency and safety of the local, sub-regional and regional road network as a result of construction traffic to and from the surface infrastructure sites.
Socio-Economic	▪ The Project will enable operations to continue over a period of approximately twenty five years. This will secure ongoing employment opportunities and socio-economic flow on benefits over this time for the local community and up to 225 staff and 75 contractors; and ▪ The total estimate of net economic benefit is approximately $699 million.
Noise	▪ noise from construction of Newnes State Forest surface infrastructure will be within the Project specific noise criteria; ▪ noise from the operation of Newnes State forest infrastructure will meet Project specific noise criteria apart from a small area of Sunnyside Ridge Road to the east of the APC-VS2; and ▪ noise from operation of the pit top will be within the Project specific noise criteria.

Environmental Issue	Overview of Key Findings
Air Quality	▪ Dust levels from the Project are predicted to meet relevant air quality criteria for TSP, PM_{10}, $PM_{2.5}$ or dust deposition.
Greenhouse Gas Emissions	▪ There will be a negligible increase in the annual direct (Scope 1) emissions and the Project represents approximately 0.03% of NSW GHG emissions and 0.01% of Australia's total GHG emissions.
Soils and Land Capability / Agricultural Suitability	▪ Minimal impact to the soils, land and soil capability across the Project Application Area are predicted; and ▪ there is no biophysical strategic agricultural land within the Project Application Area.
Visual	▪ Minimal impacts on the visual character and amenity of the Project Application Area are predicted. Post-mining, the Angus Place pit top (excluding the water management structures), as well as components of infrastructure areas from the Newnes Plataea will be rehabilitated (excluding the access tracks) to Woodland.
Waste Management	▪ No change to the annualised waste materials volumes will occur due to the Project.
Hazards Management	▪ No increased environmental or safety risk from hazardous materials, spontaneous combustion, bushfire or public safety will occur due to the Project.

12.3 Project Benefits

The socio-economic assessment identifies a number of benefits as an outcome of the Project at a local, regional and state level. The Project will involve continuation of current employment and coal production rate of 4.0 million tonnes per annum. Operations will extend the life of mine over a period of approximately 25 years.

Key Project benefits are:

- sustainable mining of coal whilst keeping adverse environmental impacts to a minimum. Proven technologies and engineering methodologies (i.e. narrow longwall panels widths and increased chain pillar widths) have been demonstrated to prevent significant impacts to THPSS;
- improved understanding of the existing groundwater and surface water systems. Using subsidence predictions, the potential impact of the Project on these systems can be well managed, together with the groundwater dependant ecosystems they support;
- predicted increased volumes of mine water make will continue to provide the critical base water supply for the power stations in the catchment. This provides the opportunity to substitute water currently sourced from the Fish River and therefore reduce the reliance and consequent impact on that water source;
- the Project will secure employment and associated flow on effects for the life of the Project.
- continued community participation and support. This helps in strengthening the social fabric of the region;
- improved understanding of heritage significance of the area through field surveying and assessment;
- although determined by mine plan, receptor impact has been kept to a minimum through careful selection of infrastructure sites in remote areas on Newnes Plateau, together with strategies to progressively rehabilitate on decommissioning;
- provision of ROM coal for domestic use and product coal for export;

- Angus Place Colliery is a very low gas emitting mine as the Lithgow seam and overburden is naturally low in gas. Extraction of coal from Angus Place Colliery will generate very modest scope 1 and 2 greenhouse gas emissions; and
- injection of approximately $699 million into the local, regional, state and national economies over the life of the Project. This expenditure is likely to generate additional economic activity and flow on effects, providing further employment opportunities.

Based upon the predicted environmental effects of the Project and the ability to manage these effects to minimise harm to the environment, the Project will present an overall minimal residual consequence with the recommended mitigation measures outlined in the Statement of Commitments implemented for the Project.

12.4 Project Alternatives

Using the extensive knowledge, gained during years of previous mining, potential environmental constraints have been taken into account by Centennial Angus Place during the mine design process to ensure the Project is undertaken safely and in the most environmentally sensitive manner possible.

This has included consideration of alternatives in terms of mining method, mine design and in siting surface infrastructure required to support mining operations.

12.4.1 Mining Method

The longwall mining method has historically been used for the extraction of coal at Angus Place Colliery, (although bord and pillar workings were extracted in its earlier history). The potential use of bord and pillar mining techniques in the future has also been explored (**Chapter 8.0**). However, the appropriate geotechnical conditions do not exist at the mine to allow bord and pillar mining to be undertaken safely and efficiently.

12.4.2 Mine Plan and Design

The evolution of the mine design at Angus Place has been outlined in **Chapter 8.0**. The mine planning and design process considered various alternatives, elimination measures, substitution measures, engineering and administrative controls, all to minimise and manage adverse environmental impacts from the Project. Initial investigations identified some risks associated with mining in the proposed extension area including the risk of dilution (i.e. roof material falling and “diluting” product coal), and the risk that sufficient development rates would not be achieved to allow for the thinner mining section.

A risk based evaluation including a detailed cost benefit analysis to assess the alternatives, has been completed. Following the initial elimination of mining from underneath Wolgan River and most of the significant rock features in the north of the Mining Lease, Centennial Angus Place investigated three mine design options as follows.

- **Option 1** – east west orientation of longwall blocks. Extraction from south to north before the last three blocks in the south;
- **Option 2** - ENE-WSW similar to Option 1 with more favourable stress orientation. This option was previously extended further to the east to maximise coal reserve. However, it was found that the coal quality at the eastern end of the extended blocks is poor (>35% ash) and not economically viable;
- **Option 3 –** NW-SE orientation of longwall blocks. This option was assessed to optimise extraction in areas with thicker seams; and
- **Do Nothing** – Without project approval, the extraction of coal within the Project Application Area cannot continue beyond 2016, sterilising coal resource leading to the premature loss of jobs and early mine closure.

Detailed analysis of each option is carried out in the Angus Place Feasibility Report (Centennial Angus Place; 2012). The findings of this analysis under key performance headings is summarised in **Table 12.2**.

Table 12.2 Comparison of Mine Design Options

Key area	Option 1 EW	Option 2 ENE-WSW	Option 3 NNW-SSE
Feasible to Develop	Yes	Yes	No, impractical to develop
Maximising reserves	Yes, but not as effective as Option 2.	Yes	No (last blocks poor quality)
Geotechnically favourable direction	Less favourable than ENE-WSW	Yes	No, most unfavourable
Coal Quality	Yes	Yes	No, three thick seam blocks, later blocks entire block poor quality
Avoidance of sensitive surface features	Yes	Yes	No

12.4.3 Alternative Surface Infrastructure Locations and Designs

At an early stage in the process of considering surface infrastructure sites for dewatering and ventilation facilities, Centennial Angus Place identified a number of sites and access routes for ancillary infrastructure based on mine design requirements.

Environmental Study Areas (ESAs) were then established around the impact footprint of these locations (**Figure 2.8**). These ESAs represent the only viable locations for the following reasons:

- the ventilation facility needs to be constructed and linked to underground roadways driven from specific longwalls and its location is strongly linked to the mine plan. It cannot be easily be moved to a different location;
- the ventilation facility cannot be subject to mine subsidence as this may impact on the integrity of the ventilation infrastructure. As such, subsidence has been taken into account for the precise location of the shafts and boreholes;
- the surface facilities associated with dewatering bores must be above the targeted dewatering point in the underground workings, which in turn needs to be down dip and at the lowest point of the longwall panel;
- specific design criteria needs to be applied in terms of the relative location of the dewatering and ventilation sites and its associated infrastructure; and
- clearance requirements and recommendations for separation distances to minimise bushfire risk must be satisfied.

Environmental avoidance mapping was undertaken to determine the optimum site for the infrastructure within the ESA and involving the least environmental impact. The extent and mapped results of this work along the proposed infrastructure corridors, dewatering sites and ventilation facility are presented in the Flora and Fauna Assessment (**Appendix H**). During the course of the environmental assessment a hanging swamp was identified within the ESA for the dewatering facility site required in the area of proposed LW 1005, and *Persoonia hindii* was identified at various locations along the access tracks to the infrastructure sites. Centennial Angus Place adopted a precautionary approach and relocated the dewatering facility site within the ESA to be furthest away from the hanging swamp. Similarly where *Persoonia hindii* has been identified along the access tracks, it will be avoided by prioritising track widening on the opposite side. Buffer zones will be established around sensitive areas within which no disturbance of native vegetation will be permitted.

12.4.4 Ancillary Infrastructure and Proposed Infrastructure Corridors

Various power line routes were also considered to service the infrastructure sites. Options such as above-ground lines in new easements, above-ground lines in existing easements, and, below ground lines alongside existing roadways were considered.

It was determined that overhead power lines and their associated asset protection zones may impact considerably upon native vegetation and State-listed threatened species such as *Persoonia hindii*. Overhead power lines also require a clearance envelope to minimise the risk of trees falling on the lines and to minimise any fires which may result from lines arcing. By trenching power cables and pipelines as proposed in this Project, vegetation clearing and the potential bushfire ignition sources is significantly reduced and there is lower visual impact. Below ground infrastructure has by far the highest capital expenditure, but significant environmental and social benefits.

12.5 Ecologically Sustainable Development (ESD)

The concept of sustainable development came to prominence at the World Commission on Environment and Development (1987), in the report titled “Our Common Future”, which defined sustainable development as:

> *Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

The overall objectives of ESD are to use, conserve and enhance natural resources. This ensures that ecological processes are maintained facilitating improved quality of life, now and into the future.

In recognition of the importance of sustainable development, the Commonwealth Government developed a National Strategy for Ecologically Sustainable Development (Commonwealth of Australia, 1992) that defines ESD as:

> *Using, conserving and enhancing the community’s resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.*

To this end, the National Strategy for Ecologically Sustainable Development was developed with the following core objectives:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations;
- to protect biological diversity and maintain essential processes and life support systems; and
- to support development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends

ESD is an objective of the EP&A Act under Section 5(a)(vii) and is a required assessment consideration under Schedule 2, Part 3, clause 7(4) of the *Environmental Planning and Assessment Amendment (Part 3A Repeal) Regulation 2011.*

ESD can be achieved through the implementation of the following principles and programmes:

- The ***precautionary principle***, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- ***Intergenerational equity***, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations;
- ***Conservation of biological diversity and ecological integrity***, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,

- ***Improved valuation, pricing and incentive mechanisms***, namely, those environmental factors should be included in the valuation of assets and services.

In addition to the four ESD principles above, the EPBC Act identifies a fifth principle for consideration in environmental impact:

Decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations.

These five principles are interrelated and need to be considered both individually and collectively as part of determining whether or not a project will be consistent with the principles of ESD.

12.5.1 Application of the Principles of ESD to the Project

Centennial Angus Place is committed to the principles of ESD and understands that social, economic and environmental objectives are interdependent. The principles of ESD have been applied in Project design, planning and assessment through:

- incorporation of risk assessment (**Chapter 9.0**) and analysis at various stages in the Project design and environmental assessment and within decision-making processes;
- thorough consideration of mine design and mining technique in consideration of the geotechnical, hydrogeological and ecological interactions (**Chapter 8.0**);
- implementation of an adaptive management and avoidance approach to minimise the subsidence impacts (**Chapter 8.0**); For example direct mining under Twin Gully Swamp has been avoided;
- numerous design iterations to minimise and where possible avoid impacts to the environment and community (**Chapter 8.0**);
- adoption of high standards for environmental and occupational health and safety performance. There will be no mine water discharge to Newnes Plateau;
- consultation with regulatory and community stakeholders (**Chapter 7.0**);
- assessment of potential greenhouse gas emissions associated with the Project (**Section 10.8**); and
- optimisation of the economic benefits to the community arising from the development of the Project.

12.5.2 The Precautionary Principle

The precautionary principle reinforces the need to take risk and uncertainty into account, particularly in relation to threats of irreversible environmental damage. In the application of the precautionary principle, at Angus Place Colliery, decisions have been guided by careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and by an assessment of the risk-weighted consequences of various options

A rigorous and conservative approach to project planning and design has been employed for the Project as follows:

- as a precursor to initiating the environmental assessment process, a Broad Brush Risk Assessment was completed and issued with the Briefing Paper for the Project. This identified key issues relating to the Project which pose the greatest environmental risk and the likelihood and consequence of occurrence;
- a subsidence constraints risk assessment was conducted in November 2012, to follow on from the Broad Brush Risk Assessment;
- implementation of mine design criteria to avoid, through minimising subsidence effects on sensitive surface features;

- the establishment of ESAs around infrastructure sites and ecological avoidance mapping carried out to site the final location in the area of least environmental impact;
- ongoing extensive environmental monitoring (groundwater, surface water, subsidence, flora, fauna, air quality and noise) and trigger action response development;
- water management measures have been devised to protect potentially significant ecological areas from any potential erosion and sedimentation impacts;
- use of industry-standard and peer-reviewed predictive models for subsidence and groundwater backed up by long term data from the site and other relevant mines;
- a sensitivity analysis of the key predictive models for subsidence and groundwater; and
- a range of mitigation measures will be adopted to minimise the potential for adverse environmental impact. These include physical controls such as subsidence management plans, the development of environmental management and monitoring programmes, contingency measures, compensatory measures and ecological initiatives (**Chapter 10.0**).

12.5.3 Social Equity, Inter-Generational Equity

Social equity is defined by intergenerational equity, which is centred on the concept that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

The primary objective of the Project is to allow continued operations of the existing Angus Place Colliery and maintain continuity of coal production, optimising resource recovery for the life of mine in an environmentally and socially responsible manner.

This EIS has addressed the principles of social equity through:

- assessment of the socio-economic impacts of the Project, including the distribution of impacts between stakeholders, various consultation activities and consideration of the potential socio-economic costs of climate change (**Chapters 6.0** and **7.0**);
- engagement of suitably qualified and experienced technical specialists to ensure that the environmental assessment phases of the Project have been transparent;
- management strategies, mitigation measures and monitoring programmes to minimise adverse impact upon the local environment and nearby communities. Emphasis has been placed on anticipation, avoidance and mitigation of potential impacts, as opposed to undertaking later remedial action; and
- implementation of compensatory measures and ecological initiatives during the life of the Project to compensate for potential localised impacts that have been identified for the development.

These actions and initiatives will assist in ensuring that current and future generations can enjoy equal and equitable access to social, environmental and economic resources through the maintenance of the health, diversity and production of the environment.

The Project will benefit current and future generations through the maintenance and expansion of employment and regional expenditure. The Project will continue to provide stimulus to local and regional economies and provide NSW export earnings and royalties, thus contributing to future generations through social welfare, amenity and infrastructure.

The greenhouse gas assessment has calculated Project emissions and compared with State and National totals. This indicates that the Angus Place Colliery Extension Project Scope 1 emissions represent approximately 0.03% of NSW emissions and 0.01% of Australian GHG emissions.

Centennial Angus Place is committed to addressing the effects of operations and is undertaking research and development into reducing emissions generated by mine operations. Centennial Angus Place is currently investigating at a corporate level the measures which may be taken to offset Scope 1 emissions from their operations. This work is ongoing, but measures may include alignment with biodiversity offsets, and switching to biodiesel fuel if feasible. These measures are being investigated and all measures taken to offset GHG emissions associated with the Project will be in alignment with industry standards.

The most likely method of directly reducing Scope 2 GHG emissions from the site will be through the ongoing implementation of the site's Environmental Management Plan, which will continue to identify where potential savings in electricity could be made, together with the subsequent implementation of energy efficiency strategies where practical.

12.5.4 Conservation of Biological Diversity and Ecological Integrity

The principle of conservation of biological diversity and ecological integrity holds that it should be a fundamental consideration for development proposals.

For the purposes of this EIS, ecological integrity has been considered in terms of ecological health and ecological values. The potential environmental impacts of the Project, including upon ecological communities and habitat values, and measures to ameliorate these potential impacts have been assessed. The Project has sought to avoid, minimise and mitigate potential impacts on ecological values within the Project Application Area through a risk based approach that minimises surface impacts on the surrounding ecology. A great emphasis has been placed on avoidance to minimise adverse impacts in the first instance as opposed to remedial action at a later date.

The avoidance mapping for areas that will be disturbed by surface clearance for proposed infrastructure is an example of how this approach has been implemented.

A specialist ecological investigation was undertaken for the Project (including identification and assessment of any EECs (**Section 10.3**). The Project is located mainly in the Newnes State Forest and is surrounded by large areas of contiguous native forest and woodland. The Newnes State Forest and the surrounding areas are known to contain significant areas of habitat for threatened species and communities. A detailed baseline review and extensive surveys, along with avoidance of clearing known locations of threatened plants and formulating a mine design cognisant of ecological values, have all informed an analysis of the residual consequences of the Project.

In accordance with ESD principles, the Project addresses the conservation of biodiversity and ecological integrity by proposing an environmental management framework designed to conserve ecological values where practicable after consideration of potential Project impacts.

12.5.4.1 Greenhouse Gas Emissions

Natural ecosystems are vulnerable to climate change and projected changes in climate will have ecological implications. Habitat for some species may expand, contract and/or shift with the changing climate, resulting in habitat losses or gains, which could prove challenging, particularly for threatened species.

Valuation of potential impacts of greenhouse gas emissions has been incorporated in the Air Quality Assessment (**Appendix M**) for the Project.

12.5.4.2 Measures to Maintain or Improve the Biodiversity Values of the Surrounding Region

A range of impact avoidance, mitigation, offset and compensatory measures will be implemented for the Project to maintain or improve the biodiversity values of the surrounding region in the medium to long-term.

Pit top facilities (excluding the water management structures), as well as components of infrastructure areas from the Newnes Plateau (excluding access tracks) will be rehabilitated and revegetated to woodland once the facilities are no longer required. There will be progressive rehabilitation of infrastructure sites on decommissioning. The progressive rehabilitation and life of mine rehabilitation will ensure minimal disturbance areas at any time.

Section 10.3.7 summarise a number of Project biodiversity offset and compensatory measures that would assist in maintaining the biodiversity of the region. The Project biodiversity offset and compensatory measures will comprise a combination of securing the long-term viability of existing woodland, revegetation of pit top facilities and ancillary surface disturbance areas, research programmes and financial contributions to rehabilitation, revegetation and other management works in Newnes State Forest.

12.5.5 Improved Valuation and Pricing of Environmental Resource

The principle of improved valuation, pricing and incentive mechanisms deems that environmental factors should be included in the valuation of assets and services, and that those who generate the pollution and waste should bear the cost of containment, avoidance or abatement. The cost associated with using or impacting upon an environmental resource, together with remediation costs is seen as a cost incurred to protect that resource.

While historically, environmental costs have been considered to be external to Project development costs, improved valuation and pricing methods attempt to internalise environmental costs and include them within Project costing. Economic analysis (**Appendix O**) estimates the value of environmental costs at approximately $26.9 million.

To this end, Centennial Angus Place acknowledges and accepts the financial costs associated with all the measures required for the mine to avoid, minimise, mitigate and manage potential environmental and social impacts for the Project.

The Socio-Economic Assessment analyses the Project and incorporates environmental values via direct valuation where practicable (e.g. greenhouse gas emissions of the Project and impacts of ROM coal transport by rail for export). Wherever possible, direct environmental effects of the Project are internalised through the adoption and funding of mitigation measures by Centennial Angus Place to mitigate potential environmental impacts (e.g. SMPs, biodiversity offset and compensatory measures).

The cost benefit analysis in **Appendix O** indicates a benefit-cost ratio of 29.7.

12.6 Conclusions

Angus Place Colliery is a well-established underground coal mine, which has been operating for 35 years, with well-defined surface and mining environments. Due to knowledge gained from historical operations, Angus Place Colliery has an excellent understanding of mine design principles and requirements for the protection of surface features, and management of potential environmental impacts. This is provided for by a range of management plans and a conservative, proven mine design which has been successfully implemented in adjacent mining areas with minimal adverse impacts.

The Project requires approval under Part 4 Division 4.1 of the EP&A Act. As such, an assessment of the short, medium and long term impacts of the Project, taking into account the principles of ESD has been described in this chapter. The existing Angus Place Colliery Environmental Management System, and the Statement of Commitments, provided in **Chapter 11.0**, forms the environmental mitigation, management and monitoring requirements for the Project. Angus Place Colliery is committed to achieving sustainable development. The assessments and predictions made in this EIS will be subject to extensive environmental monitoring to ensure that they are verified and corrective actions implemented if necessary.

The technical studies have concluded that no significant alteration to the supporting physical or hydrological environments is likely to occur as a result of the Project. The Project will not prejudice future use of land in the area or affect the land use of adjacent areas.

A key Project benefit is the sustainable mining of coal with no significant environmental impact. The Project will also continue to supply water to local power stations, thus reducing their reliance on local river catchments.

The socio-economic output of the Project will continue to provide direct and indirect employment and flow on benefits to the Lithgow Government Area and the surrounding region. There will be an injection of approximately $699 million into the local, regional, state and national economies over the life of the Project. As such this is a state significant resource.

Based upon the predicted environmental impacts of the Project and the ability to manage these impacts to minimise harm to the environment, the Project will present an overall minimal residual consequence.

The Project meets environmental performance and socio-economic benefit requirements to be considered for approval.

The Project can be appropriately managed and result in residual consequences that do not have significant impacts on the receiving environment.

REFERENCES

Angus Place (2006) “Mining Operations Plan for Angus Place Colliery”

Angus Place (2012) “Annual Environmental Management Report”

ANZECC, 1990.” *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration“* Australia and New Zealand Environment and Conservation Council

ARC Traffic and Transport, July 2013. “*Angus Place Mine Extension Project Traffic Impact Assessment*”

ArcGIS and Spatial Analyst Version 10.0 Desktop. 2011. ESRI. 380 New York Street. Redlands, CA 92373 USA.

Aurecon, September 2009. “*Newnes Plateau Shrub Swamp Management Plan: Investigation of Irregular Surface Movement in East Wolgan Swamp*”

Australian and New Zealand standard AS/NZS 4360:2004 – Risk Management

Australian Road Research Board (2009) “Unsealed Roads Manual”

AustRoads, 1988 “Guide to Traffic Engineering Practice Part 2 Roadway Capacity”, Austroads Incorporated, Sydney

AustRoads, 2003 “Rural Road Design Guide (AustRoads”, Austroads Incorporated, Sydney

AustRoads, 2006 “Vehicle Classification System” Austroads Incorporated, Sydney

Austroads, 2009. ‘*Guide to Road Design Part 4A: Unsignalised and Signalised Intersections. Austroads Incorporated’,* Sydney.

Blue Mountains Conservation Society and the Colong Foundation for Wilderness, 2009*. ‘Short Walks on the Newnes Plateau’.*

Cardno (NSW/ACT) Pty Ltd, July 2013,’ *Aquatic Ecology and Stygofauna Assessment: Angus Place Mine Extension Project’*, NA49913131, Prepared for Centennial Angus Place

Centennial Coal (2010) Greenhouse Gas Assessment Guidance Notes (Centennial Coal, 2010)

Centennial Coal (2012) Climate Change Response Policy

Centennial Coal (April 2012) Environment and Community Policy.

Centennial Coal Briefing Paper Angus Place Mine Extension Project, Angus Place Colliery, September 2012

Centennial Coal Risk Management Standard Risk Matrix

Centennial Coal, 2010. ‘*Greenhouse Gas Assessment Guidance Notes*’

Centennial Coal, 2012. ‘*Climate Change Response Policy’*

Centennial Coal, April 2012. ‘*Environment and Community Policy*’

Centennial Coal, November 2012. ‘*Angus Place Mine Extension Project – Subsidence Constraints Risk Assessment*’

Centennial Coal, September 2012. ‘*Briefing Paper Springvale Mine Extension Project’*, Springvale Colliery

Central West Archaeological and Heritage Services, 2000,’ *Aboriginal Archaeological Study of the Marangaroo’,* Department of Defence Site, Lithgow, NSW, Dames and Moore Pty Ltd

Coder, 2000. Tree Biomechanics Series Estimating Leaning Tree Failures Dr. Kim D. Coder Professor The University of Georgia September 2000

Commonwealth Department of Climate Change and Energy Efficiency 2011b, National Greenhouse Gas Inventory – Kyoto Protocol Accounting Framework, Australian Greenhouse Emissions Information System, 2011.

Commonwealth Department of Climate Change and Energy Efficiency 2011a, *National Greenhouse Accounts Factors July 2011,* Commonwealth of Australia, 2011.

Commonwealth of Australia 2013, 'Carbon Pricing Mechanism', Clean Energy Regulator, accessed 25/04/13, http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/About-the-Mechanism/Pages/default.aspx

Commonwealth of Australia, 2010a. '*Australia's Emissions Reduction Targets', Commonwealth Department of Climate Change and Energy Efficiency"*, accessed 25/04/13, http://www.climatechange.gov.au/government/reduce/national-targets/factsheet.aspx

Commonwealth of Australia, 2010b. '*Australia's Emissions Projections 2012',* Commonwealth Department of Climate Change and Energy Efficiency, accessed 25/04/13, http://www.climatechange.gov.au/government/emissions-projections.aspx

Commonwealth of Australia, 2013. '*Carbon Pricing Mechanism',* Clean Energy Regulator, accessed 25/04/13, http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/About-the-Mechanism/Pages/default.aspx

CSIRO, 2013. '*Angus Place and Springvale Colliery Operations. Groundwater Assessment*'

DCCEE July 2011a. '*National Greenhouse Accounts Factors',* Commonwealth of Australia.

DCCEE, 2011b.' *National Greenhouse Gas Inventory – Kyoto Protocol Accounting Framework, Australian Greenhouse Emissions Information System, 2011*'

DEC, 2006, '*Assessing Vibration a Technical Guideline*', NSW Department of Environment and Conservation, Sydney.

DEC, 2006, Assessing Vibration a Technical Guideline, SNW Department of Environment and Conservation, Sydney.

DEC, 2006. '*The Vegetation of the Western Blue Mountains. Unpublished report funded by the Hawkesbury-Nepean Catchment Management Authority*' Department of Environment and Conservation, Hurstville

DECC, 2009. '*Waste Classification Guidelines*'

DECCW (2010a). Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 Part 6 National Parks and Wildlife Act. Sydney, Department of Environment, Climate Change and Water DECCW (2010a).'*Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 Part 6 National Parks and Wildlife Act'*. Sydney, Department of Environment, Climate Change and Water

DECCW (2010b). '*Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales. Part 6 National Parks and Wildlife Act 1974'*. Department of Environment, Climate Change and Water.

DECCW, 2011, '*NSW Road Noise Policy*', NSW Department of Environment, Climate Change and Water, Sydney.

Department of Climate Change and Energy Efficiency 2011a, *National Greenhouse Accounts Factors July 2011,* Commonwealth of Australia.

Department of Energy, Utilities and Sustainability (2005) "Guidelines for Energy Savings Action Plans"

Department of Environment and Climate Change NSW 2008. '*Managing Urban Stormwater: Soils and Construction Manual*'

DEUS, 2005. '*Guidelines for Energy Savings Action Plans*'

DP&I, November 2012. '*Director General Requirements SSD_5602'*

DSEWPC 2012, *The National Pollutant Inventory Emission Estimation Technique Manual for Mining v3.1*, published by Department of Sustainability, Environment, Water, Population and Communities, January 2012.

DSEWPC, January 2012. '*The National Pollutant Inventory Emission Estimation Technique Manual for Mining v3.1*', published by Department of Sustainability, Environment, Water, Population and Communities.

EPA, 2000. '*Industrial Noise Policy*' NSW Environmental Protection Authority, Sydney

EPA, 2009, '*Interim Construction Noise Guideline*' NSW Environmental Protection Authority, Sydney

EPA, 2011, '*NSW Road Noise Policy*' , NSW Environmental Protection Authority, Sydney

EPA,2006, '*Environmental Noise Management – Assessing Vibration: A Technical Guideline*', NSW Environmental Protection Authority

EPA,2009, "Interim Construction Noise Guideline" NSW Environmental Protection Authority, Sydney

Gaul, post 1980. Prehistoric Archaeology 391-1, Assignment 2: Black-Fellows Hands Shelter and Environs. University of New England;

GHD Pty Ltd, June 2013, '*Angus Place Mine Extension Project: Water Balance Assessment',* Report ref: 22/16599, Prepared for Centennial Angus Place Pty Ltd.

Golder Associates, July 2013, '*Angus Place Mine Extension Project – Visual Impact Assessment*' Report Number: 127623060_123_Rev2

Goldney. D, Mactaggart. B. & Merrick. N., January 2010. '*Determining whether or not a significant impact has occurred on Temperate Highland Peat Swamps on Sandstone within the Angus Place Colliery Lease on the Newnes Plateau*'. Prepared for Department of the Environment, Water, Heritage and the Arts

Gorecki, 1983, Archaeological Survey Kariwara Colliery Lease;
Gorecki, P.P, 1983, '*Archaeological Survey Kariwara Colliery Lease',* Lithgow, NSW, Longworth and McKenzie Pty Limited.

GSS Environmental, June 2013,' *Agricultural Impact Statement, Angus Place Mine: Angus Place Mine Extension Project, Centennial Springvale Pty Ltd'*, GSSE Ref: CCC07-012, Prepared on behalf of Centennial Angus Place Pty Limited.

GSS Environmental, June 2013. '*Draft Decommissioning and Rehabilitation Strategy: Springvale Mine Extension Project'* Document no. CCC15-011, Prepared on behalf of Centennial Angus Place Pty Ltd.

James Marshall & Co, May 2013, '*Centennial Coal Social Impact Assessment: Angus Place Mine Extension Project*'

Katestone Environmental Pty Ltd, January 2011. '*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining'* Keystone Environmental Pty Ltd.

King, D. P.,1993. '*Soil Landscapes of the Wallerawang 1:100000 Sheet*', Department of Conservation and Land Management, Sydney

Landscape Institute and the Institute of Environmental Management & Assessment, 2002. '*Guidelines for Landscape and Visual Impact Assessment'* Second Edition, SPON Press.

MSEC, May 2013, '*Centennial Coal: Angus Place Colliery Mine Extension Project: Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Environmental Impact Statement for the Proposed Longwalls 1001 to 1019 in the Lithgow Seam*', Report No. MSEC593, Rev 04

National Greenhouse and Energy Reporting Act 2007

National Greenhouse and Energy Reporting Regulations 2008

NSW DECC (2009) "Waste Classification Guidelines"

NSW Rural Fire Service (2006), *Planning for Bush Fire Protection*,

NSW Rural Fire Service, (2006), Standards for Asset Protection Zones

OEH 2005, Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Office of Environment and Heritage, 2005.

OEH, 2011.'Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW', State of NSW and the Office of Environment and Heritage, Department of Environment, Climate Change and Water, Department of Premier and Cabinet

Office of Environment and Heritage (2011). Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW, State of NSW and the Office of Environment and Heritage, Department of Environment, Climate Change and Water

OzArk, 2006, 'Flora/ Fauna and Heritage Assessment: Two Proposed Dewatering Borehole Sites within the Newnes State Forest, Lithgow, NSW'. Centennial Angus Place.

OzArk, 2006, Flora/ Fauna and Heritage Assessment: Two Proposed Dewatering Borehole Sites within the Newnes State Forest;

OzArk, 2007, 'Indigenous Heritage Assessment for Subsidence Management Plan over Three Proposed Longwalls (29-31), Baal Bone Colliery', Xstrata Coal Pty Ltd.

OzArk, 2007a, Indigenous Heritage Assessment for Subsidence Management Plan for Baal Bone Colliery;

Palaris, 2013. 'Stratigraphic Setting Angus Place and Springvale Mine Collieries', Prepared for Centennial Coal

Rich and Gorman, 1988, Archaeological Survey of Proposed Springvale Colliery and Conveyor;

Rich, 1983, Proposed Prison at Marrangaroo Creek;

Rich, 1993, Archaeological Inspection of Aboriginal Sites in the Springvale Coal Project;
Rich, E. 1983*, 'Proposed Prison at Marrangaroo Creek, near Lithgow, NSW',* Centennial Angus Place

Rich, E. 1993, '*Springvale Coal Project, Wallerawang, NSW: Archaeological Inspection of Aboriginal Sites Affected by Construction Works',* Howie Herring and Forsyth Pty Ltd.

Rich, E. and Gorman, A.C., 1992, '*Proposed Springvale Colliery and Conveyor, Wallerawang, Archaeological Survey of Proposed Springvale Colliery and Conveyor',* Sinclair Knight

RPS (2013) *Cultural Heritage Impact Assessment: Angus Place Mine Extension Project, Lithgow Local Government Area*
RPS Australia East Pty Ltd, July 2013, '*Cultural Heritage Impact Assessment: Angus Place Extension Project, Lithgow Local Government Area*' Project Number: PR111285, Prepared for Centennial Coal Pty Ltd

RPS Australia East Pty Ltd. June 2013,' *Angus Place Mine Extension Project: Flora and Fauna Assessment Report*', Project Number: PR 110328

RPS, 2010, Cultural Heritage Impact Assessment for Angus Place Colliery s75W Modification.
RPS, June 2013, *'Angus Place Colliery – Surface Water Impact Assessment'*, Report ref: S187C/R001a, Prepared for Centennial Coal Company

RTA, 1988, "Road Design Guide", Roads and Traffic Authority, NSW, Australia.

RTA, 2002 "Guide to Traffic Generating Developments", Roads and Traffic Authority, NSW, Australia.

RTA, 2008. '*Mount Victoria to Lithgow Great Western Highway upgrade: strategic review of a Newnes Plateau corridor*' Roads and Traffic Authority, NSW, Australia

RTA, 2010. '*Traffic Control at Work Sites'*, Version 4.0, Roads and Traffic Authority, NSW, Australia

Sefton and Shepherd, 2001. Subsidence Impact On Sandstone Cliff Rock Shelters In The Southern Coalfield, New South Wales

Sinclair Knight Consulting Engineers, February 1992. '*Springvale Coal Project Environmental Impact Statement*'

SLR (2012), "Air Quality Impact Assessment and Greenhouse Gas Assessment, Angus Place Ventilation Facility Project".

SLR (2013) "Angus Place Mine Extension Project Air Quality and Greenhouse Gas Assessment" Report Number 630.10123.01040

SLR Consulting Australia Pty Ltd (2013) Angus Place Mine Extension Project: Air Quality and Greenhouse Gas Assessment, Report Number 630.10123.01040-R1

SLR Consulting Australia Pty Ltd, July 2013, 'Angus Place Colliery Mine Extension Project: Noise Impact Assessment' Report Number 630.10123.01010-R1, Rev 3, Prepared for Centennial Coal

SLR Consulting Australia Pty Ltd, July 2013. 'Angus Place Mine Extension Project: Air Quality and Greenhouse Gas Assessment', Report Number 630.10123.01040-R1 Rev0, Prepared for Centennial Angus Place Pty Ltd

Springvale Coal Environmental Policy and EMS Framework

Springvale Coal, 2009. '*Mining Operations Plan for Springvale Colliery*'

Springvale Coal, 2012. '*Springvale Colliery: Annual Environmental Management Report*'

State Forest of NSW, February 1999. '*Forest Practices Code Part 4: Forest Roads and Fire Trails'*, State Forests of NSW, Pennant Hills, NSW

Stockton, J. 1983, '*A Survey for Prehistoric Sites on the Proposed Clarence Transfer for the Lithgow Water Supply, NSW'*, Public Works Department of the N.S.W. Government

Strata Engineering (Australia) Pty. Ltd., 2010. '*Report No. 03-123-AGP-33*'

(The Blue Mountains World Heritage Institute accessed 29/10/2013 http://www.bmwhi.org.au/worldheritage.html).

US EPA 1997, AP42 Compilation of Air Pollutant Emission Factors, Fifth Edition, published by the United States Environmental Protection Agency, 1997.

Washington, H. G. and Wray, R.A.L. (2011) The Geoheritage and Geomorphology of the Sandstone Pagodas of the North-western Blue Mountains Region (NSW) accepted for publication in Proc. Linn. Soc, 132: 131-141

Commonwealth Legislation

Clean Energy Act 2011

Energy Efficiency Opportunities Act 2006

Environmental Protection and Biodiversity Conservation Act 1999

Native Title Act 1993

National Greenhouse and Energy Reporting Act 2007

Minerals Resources Rent Tax Act 2012

State Legislation

Aboriginal Land Rights Act 1983

Coal Mine Health and Safety Act 2002

Coal Mine Health and Safety Regulation 2006

Contaminated Land Management Act 1997

Crown Lands Act 1989

Environmental Planning and Assessment Act 1979

Electricity Supply Act 1995

Explosives Act 2003

Fisheries Management Act 1994

Forestry Act 1916

Heritage Act 1977

National Parks and Wildlife Act 1994

Native Title (New South Wales) Act 1994

Noxious Weeds Act 1993

NSW Environmental Planning and Assessment Regulation 2000

Mine Subsidence Compensation Act 1961

Mining Act 1992

Protection of the Environment Operations Act 1997

Protection of the Environment Legislation Amendment Act 2011

Radiation Control Act 1990

Roads Act 1993

Threatened Species Conservation Act 1995

Waste Avoidance and Resource Recovery Act 2001

Water Act 1912

Water Management Act 2000

Work Health and Safety Act 2011

SEPP State and Regional Development 2011

SEPP (Mining, Petroleum Production and Extractive Industries) 2007

SEPP (Infrastructure) 2007

SEPP No.33 – Hazardous and Offensive Development

SEPP (Sydney Drinking Water Catchment) 2011

SEPP No.55 – Remediation of Land

SEPP No.44 – Koala Habitat Protection

Lithgow City Local Environment Plan 1994

Lithgow City Local Environmental Plan 2013 (draft)

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