Mitigation measures relating to the Project for the ongoing viability of biodiversity within the Project Boundary are outlined below:

- Limit disturbance of native vegetation to the minimum necessary for each stage of the clearing;
- Implement a two stage clearing protocol for all hollow-bearing tree clearing. Installation of nest boxes to mitigate loss of hollow-bearing trees and maintain an effective fauna monitoring program;
- Prepare a Biodiversity Management Plan as part of the detailed design. This plan will include (but not limited to) information such as protocols for vegetation clearing including inspection of hollows, feral animal and pest control, rehabilitation objectives, and further detailed design measures;
- Undertake ongoing weed management;
- Prepare a detailed rehabilitation / revegetation management plan;
- Implement a flora and fauna monitoring plan for the project;
- Preparation of a sediment and erosion control plan;
- Design and construct waterway crossings in accordance with I&I NSW (previously Department of Primary Industries), *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull & Witheridge, 2003). Maintain fish passage at all times during the construction of the rail bridge across the Namoi River; and
- Plant macrophytes along the stream banks to filter flow and enhance bank stability.

Compensate

In the absence of any amelioration measures the impacts relating to the clearing of native vegetation and fauna habitats would be significant. To compensate for the clearing of native vegetation Boggabri Coal has developed a robust Offsets Strategy package commensurate with the impacts of the Project.

8.5 BIODIVERSITY OFFSET STRATEGY

8.5.1 Background

The Boggabri Coal Biodiversity Offset Strategy has been developed to mitigate and offset the impacts arising from the Project.

The Boggabri Coal Biodiversity Offset Strategy contains large patches of remnant vegetation including Threatened species which are strategically located to provide a corridor for wildlife to move throughout the Project Boundary and access other native habitats in the landscape. It will provide upfront mitigation of the Projects impacts on locally occurring biodiversity.

In recognition of the need for an integrated, robust and comprehensive offset strategy the DoP, in consultation with Boggabri Coal, established a joint working party between SEWPaC, I&I NSW Mineral Resources, Forestry NSW, DECCW, DoP and Boggabri Coal known as the Boggabri Coal Biodiversity Working Group. Through this stakeholder consultation process there has been an emphasis that the strategy considers the following:

- The use of rehabilitation / restoration of existing lands for biodiversity;
- The regional context of the strategy and potential for restoration of wildlife corridors;
- Purchase of high value biodiversity lands;
- The provision for 'broad regional benefits' to biodiversity;
- Compensatory lands for forest production; and
- More generally that the strategy meets the principles of ESD and State and Federal Biodiversity Offset guidelines.

SEWPaC has requested that offsets be provided as part of the Project and that these be assessed against the EPBC draft offsets policy (Department of the Environment & Water Resources, 2007).

Further, Forests NSW are the current management authority for the Leard State Forest, in which the majority of the Projects impacts are associated. In the absence of mining they had proposed the continued sustainable harvesting of millable timber and the harvest of fire wood from the Leard State Forest.

As part of post mine rehabilitation and restoration processes, it is proposed to manage sections of the Leard State Forest that are located within the Project Boundary for timber production. Timber harvesting activities will be restricted to Forestry NSW owned land and the proposed forestry plantation area. It is not proposed that timber harvesting activities be permitted in the Biodiversity offset areas. Any sustainable forestry activities will be conducted in accordance with local and regional sustainable forestry management practices.

The Properties identified in the Boggabri Coal Biodiversity Offset Strategy are considered to have high biodiversity values for the following reasons:

- They contain potential habitat for Threatened flora species;
- The remnant vegetation provides habitat for a range of Threatened woodland birds and bats;
- They contain habitat for other Threatened fauna species;
- They contain habitat for regionally significant species;
- They contain the known presence of hollow-bearing trees;
- They contain remnant Box-Gum Woodland CEEC (as listed under the EPBC Act);
- They also contain Weeping Myall Woodland EEC (as listed under the TSC Act and EPBC Act);
- They contain a portion of local 'High Conservation Priority' lands identified by DECCW;
- They provide valuable vegetation links along the Nandewar Range between large natural vegetated lands associated with Mt Kaputar National Park to the north and the Leard State Forest to the west;
- They contain ecologically significant features such as cliff lines, rocky outcrops and caves. These caves provide roosting habitat for Threatened microchiropteran bats such as the Eastern Cave Bat;
- The Namoi River Offset Area contains soaks on the banks of the Namoi River, these soaks provide suitable habitat for amphibian species including the Threatened Sloane's Toadlet;
- They contain preferred habitat for the Koala; and;
- The Namoi River Offset Area is likely to contain the Threatened ecological community of plains grassland that occurs on the deep alluvial and black alluvial cracking clay-loam (black earths) soils that occur on the Namoi floodplain (listed as CEEC under the EPBC Act).

8.5.2 Biodiversity Offset Strategy Overview

Boggabri Coal's Biodiversity Offset Strategy addresses the Project's impacts with the dedication and enhancement of significant areas of habitat for locally occurring Threatened species and communities. It also provides for targeted restoration and management of Threatened ecological communities, particularly the Box-Gum Woodland.

The offset strategy will form part of a larger vision that aims to create a Regional East-West Wildlife Corridor between the Nandewar Range, Leard State Forest and the Namoi River.

The Regional East-West Wildlife Corridor will restore and conserve important habitat on the Namoi River and Namoi Valley floor areas. Important links between isolated patches of remnant vegetation communities will be created that will increase the area of Threatened vegetation communities and increase the habitat available to Threatened fauna in the region.

Boggabri Coal's Biodiversity Offset Strategy provides the basis for the establishment of a Regional East-West Wildlife Corridor.

The key measures proposed for the Biodiversity Offset Strategy include:

- Restoration and establishment of a network of regional and local wildlife corridors, providing linkages between important large isolated remnants within the region;

- Establishment of long-term biodiversity offset and management areas for conservation of existing vegetation habitats for locally occurring Threatened species and ecological communities, particularly Box-Gum Woodland;
- Rehabilitation of the Leard State Forest mine disturbance area to native vegetation communities including the Box-Gum Woodland;
- Establishing a eucalypt plantation for forestry purposes; and
- A consolidated ecological management program across Biodiversity offset areas and network of wildlife corridors.

This strategy is dynamic and aims to maintain and then improve the ecological values of the landscape over time through the conservation and consolidation of the existing areas of native vegetation and the creation of habitats for Threatened species. The objective of the post mine landform will provide for self sustaining native forest communities that are capable of maintaining pre-mine biodiversity values.

The mining area will be progressively rehabilitated over the life of the Project. A key objective of the rehabilitation plan will be to establish the Threatened Box-Gum Woodland community and other habitat structures characteristic of the pre-mining landscape. The mine rehabilitation area will form part of the offset strategy package.

The Offset Strategy aims to augment the remnant patches of native vegetation to improve and maintain the ecological condition of the landscape within the locality by conserving, improving and creating woodland and forest communities, including habitat for Threatened species, such that the net area of such vegetation communities and the condition of habitats increases over time.

8.5.3 Offsetting Principles

The Boggabri Coal Biodiversity Offset Strategy will generally comply with the biodiversity offsetting principles developed by both the State and Commonwealth governments.

The NSW government has developed a biodiversity banking and offsets scheme (BioBanking) to help address the loss of biodiversity values, including Threatened species.

This Scheme was established under Part 7A of the TSC Act and uses offsets (where appropriate) to assist in addressing the cumulative effects of development in NSW and in particular, to help meet the goal of maintaining or improving biodiversity. The NSW BioBanking Scheme, developed by DECCW (Department of Environment & Conservation 2006) has been used as a guide to developing the biodiversity offset requirements for the Project. This assessment identified a total of 97,909 ecosystem credits and 67 species credits are required to offset the Project impacts.

The Commonwealth requirements for biodiversity offsets are guided by the draft *Environmental Protection Biodiversity Conservation Offsets Policy* (EPBC Offsets) (Department of the Environment & Water Resources, 2007). The objectives of this policy are to ensure the best environmental outcomes are achieved through the consistent, transparent and equitable application of offsets under the EPBC Act. One of the key principles of this draft policy is that environmental offsets, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like' (Department of the Environment & Water Resources, 2007).

The Boggabri Coal Biodiversity Offset Strategy has been developed to comply generally with the above principles in the following ways:

- Provide an increase in the area of 'like for like' habitat woodland, forest and grassland communities within the locality and the region in the long term;
- Provide a ratio of up to 1:1 or greater area of "like for like" Threatened ecological communities such as Box-Gum Woodlands, Plains Grassland and Weeping Myall Woodland that will be impacted by the Project;

- Provide an increase in the area available as habitat for Threatened fauna species such as Threatened woodland birds, Threatened birds of prey (Barking and Masked Owls), microchiropteran bats and the Koala;
- Provide an increase in the habitat available for Threatened flora species such as *Pultenaea setulosa* and *Pomaderris queenslandica*;
- Providing offsets commensurate with the BioBanking criteria for CMA, subregions and vegetation type's;
- Conserve and improve the biodiversity values of all types of woodlands, open forest, grassland that will be impacted upon by the Project;
- Provide a detailed system of corridors to link Leard State Forest, Namoi River floodplain and Nandewar Range;
- Provide for a significant extension of the Leard State Conservation Area; and
- Provide long-term protection of the offset lands.

8.5.4 Regional East-West Wildlife Corridor

The Leard State Forest covers an area of 8,134 ha and forms part of an extensive isolated remnant patch of natural vegetation between the Nandewar Range to the east and the Namoi River to the west. Part of the Leard State Forest was gazetted in 2005 as Leard State Conservation Area and is located 3 km to the north-west of the Project Boundary.

A history of intensive agricultural activities comprising primarily sheep grazing and wheat cropping dominates the landscape in the vicinity of Leard State Forest. These activities have resulted in the isolation of the Leard State Forest from other areas of remnant vegetation within the region (see **Figure 27**).

Historically, the Nandewar Range, Leard State Forest and Namoi River floodplain were once linked by a contiguous corridor of native vegetation. The Boggabri Coal Biodiversity Offset Strategy aims to recreate this important environmental corridor linking existing remnant patches of native vegetation and increasing the overall biodiversity value of the area.

Biodiversity assessments undertaken as part of the Project confirmed that a variety of Threatened communities and fauna would benefit by linking the Nandewar Range, Leard State Forest and Namoi River vegetation communities within the landscape.

Importantly, linkages across this fragmented landscape will specifically benefit the local Threatened koala populations.

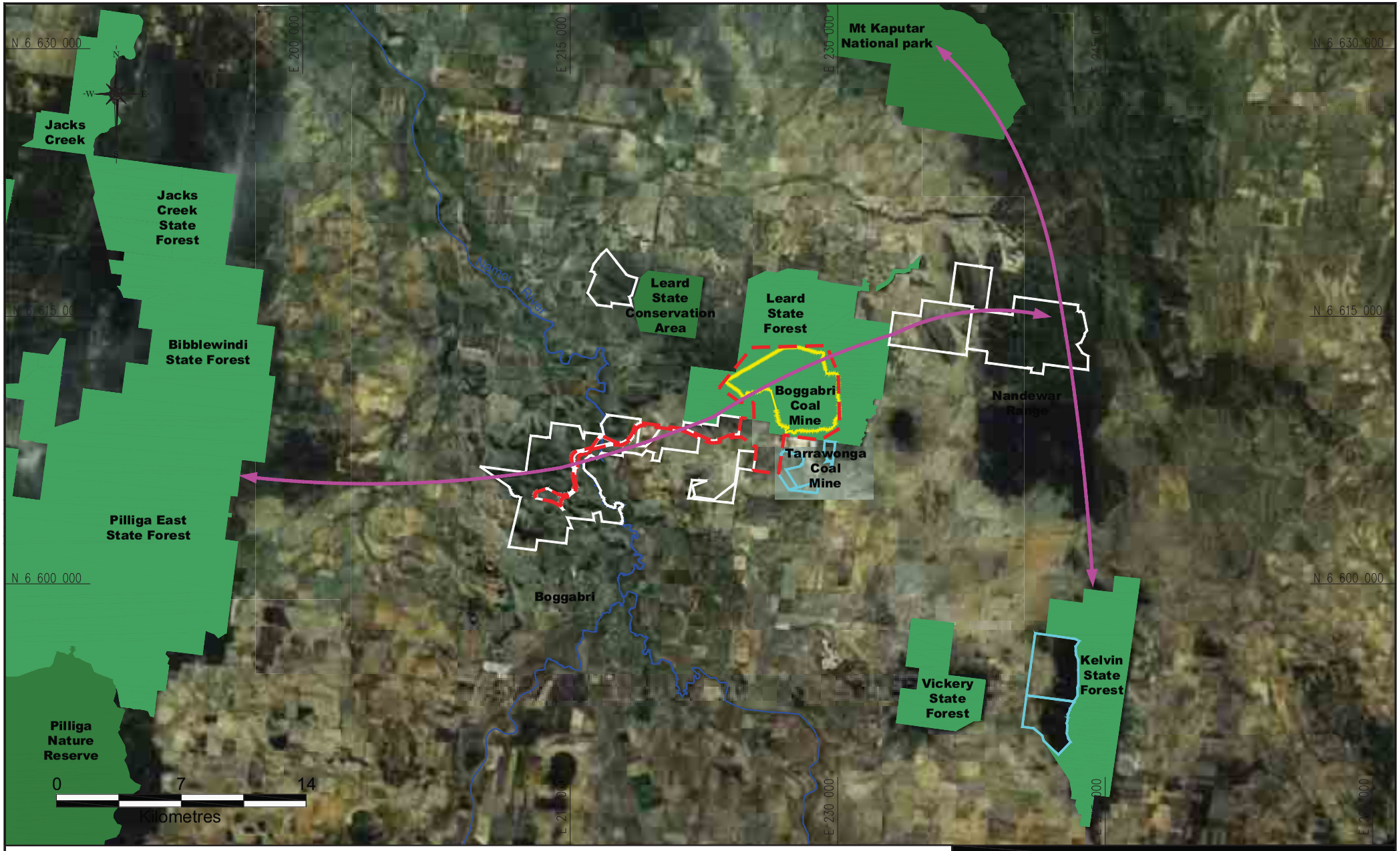
A regional corridor link will provide movement pathways between the preferred habitat on the Namoi River and limited habitat areas in the upper slopes.

Boggabri Coal is committed to establishing a Regional East-West Wildlife Corridor as part of its Biodiversity Offsets Strategy and will contribute by offering large areas of its landholdings for conservation purposes. The Regional East-West Wildlife Corridor will also compliment existing offsets strategies in the region and provides the foundation stone for future offset areas to build on. The Boggabri Coal Biodiversity Offset Strategy links with the proposed Tarrawonga Mine offset areas by the Leard State Forest and Bollol Creek Corridor.

The Boggabri Coal Biodiversity Offset Strategy provides for the establishment of linkages to the Nandewar Range and potentially in the future to the Whitehaven regional biodiversity offset site adjoining the Kelvin State Forest to the south (see **Figure 27**). This valuable vegetation link along the Nandewar Range will further facilitate wildlife movement between large natural vegetated lands associated with Mt Kaputar National Park to the north and the Leard State Forest to the west

To ensure the Regional East-West Wildlife Corridor remains in place in the Leard State Forest Boggabri Coal will investigate alternative mining methods along the boundary of its Mining Lease to minimise disturbance to existing vegetation communities. This will ensure that a continuous vegetation link within the Leard State Forest remains.

In addition to the restoration of a Regional East-West Wildlife Corridor the Boggabri Coal Biodiversity Offset Strategy provides for the conservation of remnant vegetation adjoining the Leard State Conservation Area.



- Project Boundary
- Mine Disturbance Boundary
- River
- Boggabri Coal Strategic Corridor Properties
- Whitehaven Coal Offset Properties
- Major Wildlife Corridor

Source: Google Maps (2009), Boggabri Coal (2010)

BOGGABRI COAL MINE

Regional East-West Wildlife Corridor

Cad File: 06334F.dwg	Date: 26.08.2010	Drawn: JD	Figure 27

This strategic corridor property will provide for the protection of remnant vegetation and further consolidate conserved habitats for locally occurring Threatened Species in the immediate vicinity of the Leard State Forest. The Boggabri Coal Biodiversity Offset Strategy will provide a solid foundation and direction for future development projects in the region to compliment through the addition of further offset properties.

8.5.5 Strategic Corridor Property Assessment

Strategic corridor properties in the vicinity of the Project Boundary that are suitable for inclusion in the Boggabri Coal Biodiversity Offset Strategy have been identified (see **Figure 28**).

Properties for inclusion in the offset strategy were identified following a methodical property assessment process. The property assessment process included aerial survey via helicopter, ground survey, aerial photographic interpretation, vegetation mapping and discussions with landowners. Following the initial assessment, properties were prioritised and further assessed for potential biodiversity values and their contribution to the Regional East-West Wildlife Corridor. Boggabri Coal owns 50% of a large parcel of land in a joint venture with Aston Resources and is proposing to commit its portion of ownership in this land as part of the offset strategy.

Private land identified within the zone of affectation will form part of the offset strategy as these lands are acquired by Boggabri Coal. Boggabri Coal has consulted with all landowners whose properties have been identified within the ZOA. Additional strategic corridor properties have been identified as containing Threatened Box-Gum Woodland that will add value to the creation of a Regional East-West Wildlife Corridor.

Boggabri Coal has purchased or secured these properties under contract or some such other legal arrangement. Forests NSW are responsible for all lands within the Leard State Forest. Discussions have occurred with Forests NSW over the future rehabilitation and management of these areas that will ensure the area maintains its important ecological values. There are 12 blocks of Crown land adjoining the strategic corridor properties forming the Boggabri Coal Biodiversity Offset Strategy.

Boggabri Coal has assessed the Crown land in terms of its biodiversity values for the consideration of potential inclusion in the establishment of the Regional East-West Wildlife Corridor. Boggabri Coal has consulted with the Land and Property Management Authority to explore opportunities to include the Crown land as part of the Regional East-West Wildlife Corridor and have committed to them that if this can be achieved Boggabri Coal will manage these currently disperate parcels of land at their cost to enhance their ecological value and thus their contribution to the Regional East-West Wildlife Corridor.

A summary table of the proposed cumulative offset area commitments and ratios to disturbance for each land tenure is provided below in **Table 34**.

The Boggabri Coal Biodiversity Offset Strategy will result in the initial reservation of up to 6,526 ha (4.7:1 ratio) of offset lands to compensate for the estimated accumulated impacts on 1,385 ha of remnant vegetation over the 21 year life of the Project.

In the medium to long term the Boggabri Coal Biodiversity Offset Strategy will provide for 7,571 ha (5.5:1 ratio) of offset land. With the inclusion of the post mine rehabilitation the strategy will provide 9,076 ha (6.5:1 ratio). A summary of vegetation communities and the areas of remnant vegetation are shown in **Table 35**.

Of the 1,385 ha to be disturbed within Boggabri Existing and Boggabri Extension, up to 624 ha of the Threatened Box-Gum Woodland as listed under the TSC Act will be impacted.

The Boggabri Coal Biodiversity Offset Strategy will provide for the conservation of up to 1,724.2 ha (2.8:1) Box-Gum Woodland on properties that form part of its Offset Strategy. This will include 789 ha (1.2:1) of 'like for like' good condition and 937.3 ha (1.5:1) of derived native grassland for natural and / or assisted restoration. An additional 1,071 ha of Box-Gum Woodland will be rehabilitated in the mine Disturbance Boundary over the life of the Project. In the long term this will provide a total area of 2,795 ha of Box-Gum Woodland with a ratio of 4.5:1. A summary of the vegetation disturbance, proposed offsets and ratios are included in **Table 35**.

Table 34
Summary of Biodiversity Offset Commitments and Ratio

Land Tenure	Offset Area (ha)	Cumulative Total Offset Area (ha)	Offset Ratio
Boggabri Coal	2,023.0	2,023.0	1.5:1
Boggabri Coal / Aston Mining joint venture	437.0	2,460.5	1.8:1
Strategic corridor properties	4,065.5	6,526.0	4.7:1
Private ownership within ZOA	570.0	7,096.0	5.1:1
Crown Lands	475.0	7,571.0	5.5:1
Forests NSW (Mine Rehabilitation)	1,508.0	9,076.0	6.5:1

Table 35
Vegetation Disturbance, Offsets and Ratios

Vegetation Communities	Project Disturbance (ha)	Offset Area		Rehabilitation		Total Vegetation Offset (ha)	Combined Offset Ratio
		Remnant Vegetation 'like for like' (ha)	Ratio 'like for like'	Offset Area Derived Native Gras. (ha)	Mine Disturbance Boundary (ha)		
Threatened Ecological Communities							
Box-Gum Woodland [1]	623.6	786.9	1.3:1	937.3	1,071.0	2,795	4.5:1 (Improve)
Plains Grassland[1]	0.4	16.1	40:1	0.0	0.0	16.1	40:1 (Improve)
Weeping Myall Woodlands[2]	0.3	3.7	12.3:1	0.0	0.0	3.7	12.3:1 (Improve)
Aquatic Ecological Community[3]	0.6	115.8	193:1	58.4	0.0	174.2	290:1 (Improve)
Sub Total	**624.9**	**922.5**	**1.5:1**	**995.7**	**1,071.0**	**2,989.2**	**4.8 :1 (Improve)**
Other Remnant Vegetation	759.7	4238.6	5.6:1	388.8	437.0	5,064.4	6.7:1 (improve)
Total	**1,384.6**	**5,161.1**	**3.7:1**	**1,384.5**	**1,508.0**	**8,053.6**	**5.8:1 (Improve)**

Notes:
1 – Critically Endangered Ecological Community, listed under EPBC Act, and listed as endangered under TSC Act.
2 – Endangered Ecological Community, Weeping Myall Woodlands under the EPBC Act and the TSC Act.
3 – Endangered Ecological Community, Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River FM Act.

- Project Boundary
- Mine Disturbance Boundary
- Mine Disturbance to Nov 2011
- Railway
- Roads
- River
- Tarrawonga Mining Lease
- Forestry Plantation
- Remnant Vegetation
- Proposed Revegetated Land
- Boggabri Coal Strategic Corridor Properties
- Whitehaven Coal Offset Properties
- Major Wildlife Corridor
- Minor Wildlife Corridor

Source: Google Maps (2009), Boggabri Coal (2010)

BOGGABRI COAL MINE

Strategic Corridor Properties

Cad File: 06382F.dwg	Date: 11.10.2010	Drawn: CP	Figure 28

SEWPaC deemed Boggabri Extension to be a controlled action under the EPBC Act. Boggabri Extension contains 82 ha of Threatened Box-Gum Woodland that will be disturbed by the Project. The Boggabri Coal Biodiversity Offset Strategy will provide for the conservation of 786.9 ha of 'like for like' remnant Box-Gum Woodland. This will provide an offset ratio of up to 9.6:1 for the Box-Gum Woodland community. A summary of the commitments to compensate for the impacts to the Box-Gum Woodland under the EPBC Act are included in **Table 36**.

It is proposed that revegetation work included in the offset strategy would be staged over the 21 year life of the Project as mining progresses. The Project will gradually clear 1,385 ha of Leard State Forest over the 21 year approval period as required by the mining schedule. It should be noted that the 1,385 ha of Leard State Forest will not be cleared in one single event in the early stages of the Project.

Progressive rehabilitation of the mining area with native vegetation communities will follow closely behind the mining activities over the life of the Project (see **Table 36**).

The key principle of providing 'like for like' habitat has been incorporated into the Boggabri Coal Biodiversity Offset Strategy.

This has been shown by the inclusion of large areas of Riverine habitats along the Namoi River and grassland habitats along the floodplain. Areas of woodland and open forest are provided on the west of the Namoi River, while the eastern side contains areas of remnant woodland and potential for the creation of further woodland habitat. The post mine landscape will provide restored areas of grassy woodland / open forest, shrubby woodland / open forest and riverine woodland.

The proposed biodiversity offset areas contain the three Threatened ecological communities that have been recorded within the Project Boundary; these include the Box-Gum Woodland, Weeping Myall Woodland and Plains Grassland.

The conservation and revegetation of woodland habitat will provide additional habitat for Threatened woodland birds and bats. Appropriate management regimes such as exclusion of cattle and restoration of pasture areas will enhance habitat for these species.

A high yield intensive eucalypt plantation is incorporated within the strategy. It should be noted that the plantation will not compensate for the total loss of future timber reserves resulting from the impact of the Project on the Leard State Forest. Future forestry activities will be undertaken in consultation with the land manager.

Table 36
Summary of Offset Commitments Under EPBC Act

Vegetation Community / Threatened Species Habitat	Project Disturbance (ha)	Offsets ('like for like' Remnant Vegetation) (ha)	Ratio
Box-Gum Woodlands	82.0	786.9	9.6:1
Plains Grassland (no offset required)	0.0	16.1	n/a
Weeping Myall Woodlands (no offset required)	0.0	3.7	n/a
Total (ha)	**82.0**	**806.7**	**9.8:1**
Threatened species habitat	**650.2**	**5,161.1**	**7.9:1**

Biodiversity Features

The current offsets comprise approximately 5,161.1 ha of remnant vegetation and 1,384.5 ha of derived native grassland with rehabilitation potential (**Table 35**). The offsets contain large areas of contiguous native vegetation that includes open forest, woodland and grassland communities. The area contains approximately 1,724.2 ha of Box-Gum Woodlands. The offset area contains ecologically significant features such as cliff lines, rocky outcrops and caves that house Threatened microchiropteran bats. The vegetation also contains large areas of woodland habitat for a range of Threatened woodland birds and other Threatened fauna species.

The Offset Area located adjacent the Leard State Conservation Area contains stands of Threatened Box-Gum Woodland and habitat for Threatened woodland birds and other fauna species. These properties contain many significant ecological features including remnant vegetation and rocky outcrops that provide suitable habitat for Threatened species. These properties also provide an important link between the Leard State Conservation Area and the Namoi River floodplain.

Three further Offset properties located to the east of the Leard State Forest contain significant stands of remnant vegetation and habitats within the Nandewar Range, areas of Box-Gum Woodland and large areas of derived native grassland that could readily be revegetated back to Box-Gum Woodland. These properties are strategically located to provide a link between the Nandewar Range and the Leard State Forest. The addition of these properties to the offset strategy will secure the recreation of the Regional East-West Wildlife Corridor.

The addition of the Namoi River floodplain to the Biodiversity Offset Strategy will allow the conservation of the Threatened fauna, flora and communities identified within the Project Boundary. Wildlife movements are facilitated by the inclusion of the Namoi floodplain as part of the offset strategy as it will allow linkages across the floodplain between the Namoi River and the Leard State Forest.

The Namoi River section of the offset area contains mature River Red Gums which are hollow-bearing trees. These tree hollows provide habitat for a range of Threatened fauna, including Threatened birds such as the Masked Owl, Barking Owl and roosting habitat for Threatened hollow-dependent microchiropteran bats. The floodplain also contains soaks on the banks of the Namoi River, these soaks provide suitable habitat for amphibian species including the Threatened Sloane's Toadlet. The Offset Strategy contains approximately 9 km of the Namoi River that will conserve riparian habitats.

The Critically Endangered Plains Grassland community as listed under the EPBC Act and TSC Act is also present on the floodplain and located with the proposed offset area.

The large areas of derived native grassland have potential to be revegetated to grassy woodland habitats particularly after cessation of cattle grazing. This would provide habitat for a suite of Threatened woodland fauna that have been recorded in the Project Boundary.

The Offset Area to the west of the Namoi River has the potential to create important linkages to the Pilliga Nature Reserves, Kerringle State Forest, Pilliga East State Forest and Pilliga National Park. Whilst at present these linkages would be fragmented the conservation of these lands could facilitate future linkages between the Pilliga National Park in the west and the Namoi River.

Proposed Restoration Works

Boggabri Coal is committed to the conservation of Threatened vegetation communities and species habitat in the offset areas. The restoration works will include the removal of stock, fencing and partially rely on natural regeneration. Restoration works will predominantly be undertaken within the native derived grassland areas with potential for natural restoration and soil seed banks in the Offset Areas. Supplementary plantings of tubestock and selective direct seeding will be undertaken to provide linkages between the remnant vegetation patches and in areas where natural regeneration is not successful.

The vegetation will be rehabilitated to resemble the adjoining vegetation communities with particular emphasis on restoration of critically endangered Box-Gum Woodland.

The use of local province seed stock and tubestock will be used in the restoration works to retain local genetic content.

The vegetation communities to be restored include but are not limited to the following four vegetation types:

- White Box – White Cypress Pine grassy woodland (commensurate to Box-Gum Woodland CEEC);
- Pilliga Box – Poplar Box – White Cypress Pine grassy open forest;
- Narrow-leaved Ironbark – White Cypress Pine shrubby open forest; and
- River Red Gum Riparian woodland and forest.

Existing vegetation types within the Offset Areas will be protected and additional supplementary tubestock planting will occur where appropriate for each specific vegetation type (see **Figure 28**).

Post-mining Rehabilitation of Leard State Forest

The primary objective within the post mining open cut disturbance area will be the re-establishment of a self sustaining native vegetation community that contains biodiversity characteristics similar to the pre-mining environment. Progressive rehabilitation will be conducted through the life of the mine as part of the on-going mining operations, thereby minimising the extent of disturbance at any one time on the surrounding environment.

The current mine disturbance area (Boggabri Existing) is proposed to be rehabilitated to Box-Gum Woodlands to assist in mitigation of the impacts of the proposal. The details of the rehabilitation of the post mine landscape are discussed further in **Section 8.16.**

Management and Mitigation

A management plan for the biodiversity offset sites will be developed to guide the long term management of flora and fauna and logging activities within the Offset Areas.

Forestry activities will be limited to Forest NSW owned lands and in the proposed forestry plantation offset area. All forestry activities will be undertaken in accordance with I&I NSW best practice forestry guidelines.

This plan will also include the development and implementation of a scientifically based process for the establishment of Box-Gum Woodland in both the mine rehabilitation areas and the Offset Areas. It is envisaged that the plan will outline management actions for the rehabilitation of all vegetation, weed and feral animal control, grazing regimes and fire management.

In-perpetuity Conservation

Boggabri Coal is committed to establishing an Offset Strategy that will provide ongoing conservation of land beyond the 21 year approval period for the benefit of future generations. It is recognised that offsets must be enduring and must offset the impact of the development for the period that the impact occurs. The security of land tenure and ongoing management of offsets is critical to the long-term viability of offsets and has been carefully considered.

To ensure the conservation of lands in-perpetuity the Biodiversity Offset Strategy will require the dedication of the identified offset areas under a secure conservation arrangement.

The long-term objective of the Boggabri Coal Biodiversity Offset Strategy is to provide conservation of the area in-perpetuity. There are a number of options available to secure land under permanent conservation agreements. Boggabri Coal is committed to exploring and identifying the most suitable conservation arrangement for land in consultation with the relevant stakeholders. Potential options may include:

- Conservation covenants on the land under Section 88 of the *Conveyancing Act 1919*;
- Voluntary conservation agreement with the Minister of the Environment under Section 69 of the NPW Act;

- Acquisition of lands by Boggabri Coal and management through conservation planning commitments;
- Dedication of lands adjoining existing conservation reserve estates to DECCW; and
- Dedication of lands as offset sites under the Biodiversity Banking Scheme.

It should be noted that Boggabri Coal does not own all the land proposed in the Offset Strategy at this time. It should also be recognised that a number of different conservation strategies to provide for the ongoing protection of Offset Areas may be required and a number of different conservation arrangements may be used depending on the land tenure and its location.

Boggabri Coal is committed to establishing suitable conservation agreements for offset areas to meet the objectives of the Offset Strategy and provide a regional approach to biodiversity conservation.

A very carefully designed and robust offsets package is proposed to compensate for identified impacts relating to the Project and improve ecological outcomes for the community.

The Boggabri Coal Biodiversity Offset Strategy identifies large patches of remnant vegetation in the locality of the Project Boundary. Field assessments confirm that these vegetation remnants contain high quality habitat and will create a valuable corridor for Threatened species in the region. Importantly, these areas will provide upfront mitigation of the Project's impacts on locally occurring biodiversity. Further, the Offset Strategy has considered the possibility of additional mining in and adjacent to the Leard State Forest. None of the proposed offset areas are located within a mining Authority and they are not identified as being required for future mining. The Boggabri Coal Biodiversity Offset Strategy will become critical in ensuring the maintenance of future biodiversity in the region.

A critical component of the strategy will be the restoration and establishment of a Regional East-West Wildlife Corridor linking the Leard State Forest with the Namoi River and large vegetation remnants to the west and the Nandewar Range and Mt Kaputar National Park to the east.

The inclusion of these strategic corridor properties as potential Biodiversity Offsets will provide additional conservation areas in the region for Threatened flora and fauna, which has previously been highly fragmented.

8.6 ABORIGINAL ARCHAEOLOGY AND CULTURAL HERITAGE

Insite Heritage Pty Ltd have prepared an Aboriginal Cultural Heritage Impact Assessment Report for the Continuation of Boggabri Coal Mine Project. The report is reproduced in **Appendix K**. The aim of the assessment was to document the Aboriginal landscape within the Project Boundary and assess the potential impacts the Project may have on Aboriginal cultural heritage.

8.6.1 Methodology

The Aboriginal Cultural heritage impact assessment methodology was as follows:

1. To assess the existing archaeological significance of the Project Boundary using desktop study; and
2. To undertake a field survey of all areas not previously surveyed for Aboriginal archaeology and cultural heritage.

Desktop Study

The desktop study included a review of previous archaeological reports relevant to the local area to assess the current status of Aboriginal cultural heritage. Previous studies undertaken over areas that fall within the Project Boundary include:

- Kamminga (1978) – This study was based on interviews of property holders, and brief site inspections – no sites were recorded;
- ARAS (2005 & 2007) conducted a survey and salvage of sites for Boggabri Coal. The 2005 report documented 30 open artefact scatters, 26 isolated finds and four scarred trees. After salvage of sites under Permit No. 2369 & No. 2370 (expired) 24 sites remain extant, 21 of which are within the Project Boundary.

These sites, which include areas of subsurface deposit, remain within the Project Boundary and their management will be included in the Aboriginal Heritage Management Plan;

- Insite Heritage (2008) surveyed an area in the southern extent of the Project Boundary. The survey located a small artefact scatter, an isolated find and a quarry site; and
- A search of the Aboriginal Heritage Information System (AHIMS) data base was conducted to identify sites recorded within the Project Boundary and the surrounding region.

The information above was then used to form a predictive model of site types and locations. This model was then tested by field assessment.

The desktop study found that open sites consisting of stone artefact scatters and isolated stone artefacts are the most common type of Aboriginal archaeology found within the Project Boundary. Five scarred trees were also known to be present within the Project Boundary. A search of the AHIMS database shows that a total of 54 Aboriginal sites are currently registered within the Project Boundary (these include sites subject to an Aboriginal Heritage Impact Permit).

The Aboriginal stakeholder engagement program was conducted in accordance with the relevant guidelines, as discussed in **Section 6.5**.

Field Methodology

The Aboriginal heritage impact assessment aimed to achieve four main functions:

1. To identify and consult with the Aboriginal stakeholders for the Project Boundary, and incorporate their views into the impact assessment;
2. Identify any previously unrecorded sites within the Project Boundary;
3. Assess the significance of the archaeological resource and identify potential impacts by the Project; and
4. Identify Project mitigation and management measures to minimise potential impacts on Aboriginal archaeology and cultural heritage values where practical.

Field survey was undertaken within the Project Boundary on areas that had not been previously surveyed by ARAS (2005) or Insite Heritage (2006). Aboriginal stakeholders were given the opportunity to revisit and familiarise themselves with some of the sites previously identified in earlier studies.

The field assessment was conducted over ten days. The study area was divided into four main landform units - these included the Leard State Forest, Lower Drainage Area, Namoi River floodplain and Baan Baa Range. Survey transects were then carried out within these separate landform units.

The survey of the study area was conducted primarily on foot with some vehicle transects in areas of limited visibility. Where vehicle transects were used, systematic sweeps about 50 m apart were used to find any small areas of exposure, for example cattle tracks, ant nests or localised erosion.

Foot transects were conducted by groups of four to five persons, walking parallel in a relatively straight line spaced 8 to 10 m apart. Each individual in the transect group could deviate temporarily to inspect exposed or disturbed areas more closely as required.

Targeted surveys of older trees were made for evidence of scarring. Exposures of outcropping sandstone, generally in boulder form, were inspected for potential axe-grinding grooves. Sites were recorded by the following features:

- *Location* (Recorded using Garmin GPS 72 hand held GPS, WGS 84 datum);
- *Visible Extent* - as determined by the extent of the artefact scatter or the extent of the visible area of the scatter;
- *Aspect* - where relevant; and
- *Stone Artefacts* - were recorded at a basic level including type, colour, raw material, basic dimensions and obvious diagnostic features. Artefacts were not removed from the sites.

The interpretation of the field results was made in the context of the predictive model. The data was analysed by comparison between landform units taking into account the opportunity to locate artefacts due to the level of surface visibility.

The assessment included the identification of areas of sub-surface potential. The effective survey coverage achieved was sufficient to assess the scale and character of the archaeological resource in the Project Boundary.

8.6.2 Impact Assessment

Archaeological Resource

The general archaeological potential of the landform units within the Project Boundary are variable. The Namoi River floodplain had very low site preservation on the clay soils whilst the lower slopes of the Baan Baa Range and Leard State Forest had greater preservation potential of the archaeological resource.

The archaeological resource within the Project Boundary comprises the sites identified by ARAS 2005 & 2007 and Insite Heritage 2008 that have not been subject to salvage in addition to the sites recorded as part of this study.

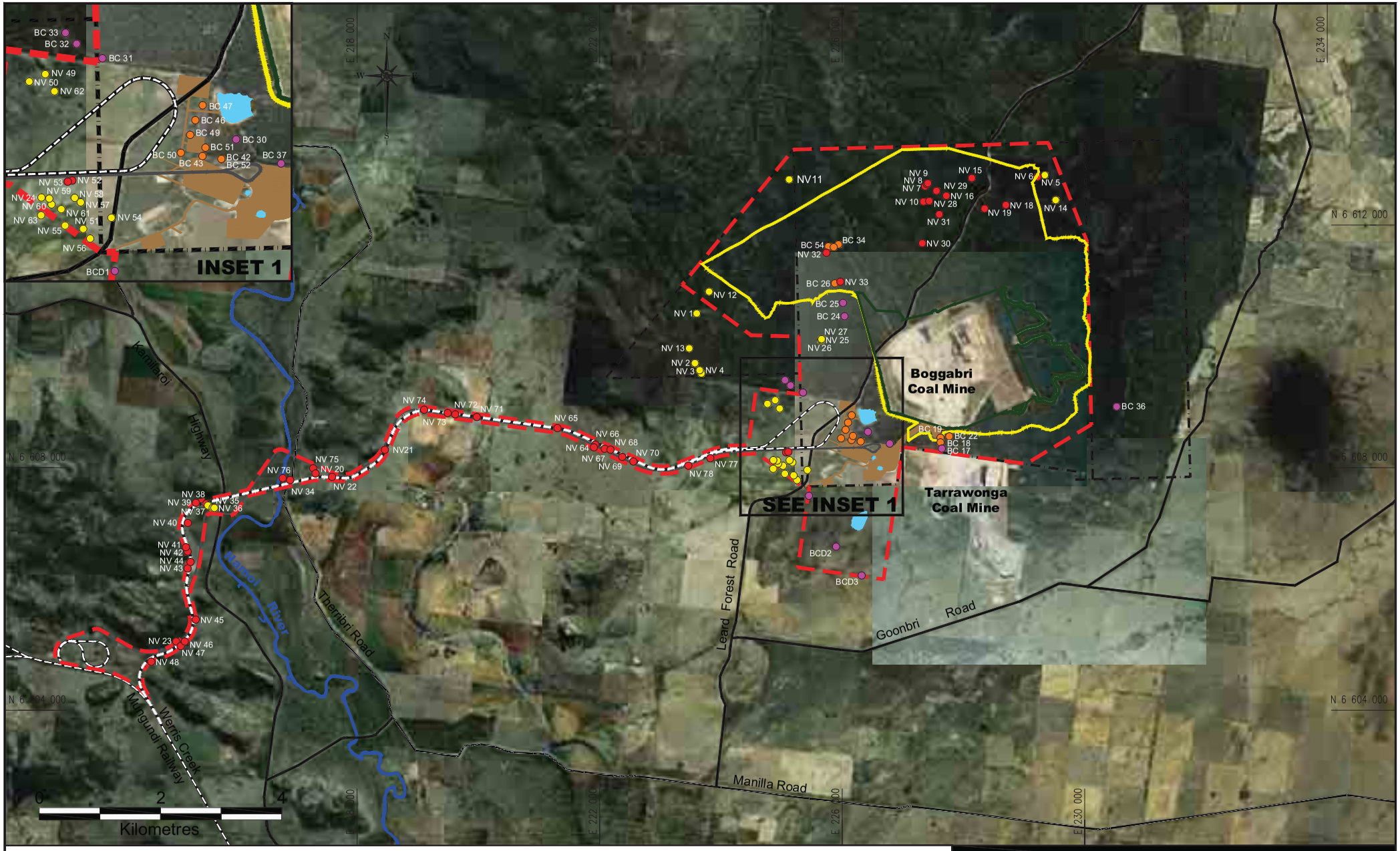
The 2009 survey within the Project Boundary recorded a total of 77 new sites and identified 453 individual artefacts. The 77 new sites included 34 open sites and artefact scatters (including NV56 a quarry), 29 isolated finds and 14 scarred trees. The total of 104 Aboriginal archaeological recordings within and adjacent to the Project Boundary include 77 Insite Heritage (2009) recordings, 24 ARAS (2005) recordings that remain extant after the previous salvage work (2007) and three Insite Heritage (2008) recordings. The known cultural heritage sites are shown on **Figure 29**.

The scarred trees identified within the Project Boundary are of low scientific archaeological significance as once recorded in detail, little further information can be ascertained. The scarred trees are of high cultural significance and they will be managed accordingly in consultation with the Aboriginal stakeholders. A summary of the impact of the Project on Aboriginal archaeological sites is shown in **Table 37**.

Table 37
The Project Impacts on the Aboriginal Archaeological Resource

Site Type	To be Impacted by the Project	Sites Not Impacted by the Project
Artefact Scatter	BC34, BC42, BC43, BC46, BC47, BC54, NV10, NV15, NV20, NV21, NV22, NV23, NV39, NV40, NV43, NV47, NV48, NV65, NV66, NV67, NV68, NV73, NV78	BC31, BC33, BCD2, NV2, NV3, NV4, NV5, NV13, NV24, NV49, NV50, NV54, NV55, NV57, NV58, NV59, NV60, NV62, NV63
Isolated Find	BC18, BC19, BC22, BC26, BC49, NV6, NV7, NV8, NV9, NV16, NV18, NV19, NV38, NV41, NV42, NV44, NV45, NV46, NV52, NV53, NV64, NV69, NV70, NV71, NV72, NV74, NV75, NV77	BC17, BC24, BC25, BC32, BC36, BCD3, NV1, NV11, NV12, NV14, NV51, NV61
Scarred Tree	BC16, BC50, BC51, BC52, NV28, NV29, NV30, NV31, NV32, NV33, NV34, NV76	BC30, NV25, NV26, NV27, NV35, NV36 NV37
Historic Scarred Tree	n/a	BC37
Quarry	n/a	BCD1, NV56

BC (ARAS 2005, 2007), BCD (Insite Heritage 2008). NV (Insite Heritage 2009).



Project Boundary
Boggabri Mining Tenements
Mine Disturbance to Nov 2011
Mine Disturbance Boundary
Railway
Private Haul Road
Roads
River

Proposed Infrastructure Area
Water Management Infrastructure
Previously Identified Sites To Be Impacted
Previously Identified Sites Not To Be Impacted
Newly Identified Sites To Be Impacted
Newly Identified Sites Not to Be Impacted

Source: Google Maps (2009), Boggabri Coal (2009/2010) Insite Heritage (2009), ARAS (2007)

BOGGABRI COAL MINE

Aboriginal Heritage Sites

Cad File: 05453E.dwg	Date: 07.04.2010	Drawn: JD	Figure 29

The characteristics of the sites and the distribution of potential archaeological deposits within the Project Boundary are explained in more detail in the Aboriginal Cultural Heritage Impact Assessment Report included in **Appendix K**.

Statement of Significance

The significance assessment was based on the relevant criteria from the Burra Charter which was adopted by the Australian International Council on Monuments and Sites for the conservation of places of cultural significance in 1979 (ICOMOS 1979). A significance assessment attempts to ascertain a relative value of heritage sites.

The appropriate criteria to determine significance in this study included cultural (importance to Aboriginal people), scientific (archaeological value), representative significance and public (educational value) significance.

The cultural significance determined by the Aboriginal stakeholders is reflected in their responses to the Aboriginal Cultural Heritage Assessment Report (see **Appendix K**). In general the six registered stakeholders expressed satisfaction with the field assessment process.

Four Aboriginal stakeholders (MMAC, RCLALC, BBAC and GGAC) indicated that the landscape including the Leard State Forest and the artefacts and sites found have high cultural value to the Aboriginal community.

The following significance statement addresses the scientific and representative importance (or archaeological significance) of the sites recorded. It is based on the potential for sites to add scientific data to the archaeological record, in terms of age and integrity. The potential to add scientific data or preserve that data is influenced by the representation and rarity of the site, as demonstrated by its contents and context.

The general significance assessment of the archaeological resource has been made on a landform unit basis and assessed against each criterion in accordance with ICOMOS 1979 (see **Appendix K**).

The sites on the Namoi River floodplain adjacent to the existing private coal haul road are considered of low significance in a local context as these sites are likely to occur throughout the region in similar landscapes. These sites have been impacted to a greater extent by the natural movement of the clay soils and the disturbance of this area particularly by ploughing.

The sites within the Baan Baa Ranges are considered to be of moderate significance as they are likely to be replicated elsewhere in the region based on topography and landscape observations, however, there are limited additional studies confirming potential sites in the region. The sites in the area of 'The Rock' property adjacent the existing private coal haul road are relatively undisturbed. The artefact assemblages in this area indicate a variation from the sites found in the Leard State Forest and are likely to contain comparative information that will add value to the archaeological record.

The lower drainage area landform is of moderate significance as relatively high densities of artefacts were recorded in this area. The artefacts have been exposed as a consequence of the construction of contour drains and agricultural activities. There is potential for sub surface artefacts to remain in the lesser disturbed areas adjacent to the Leard State Forest interface.

The Aboriginal archaeological sites found in the Leard State Forest were considered to be well preserved compared to those found in the other land form units. The Leard State Forest has been extensively logged for forestry purposes however, this activity has not impacted on the integrity of the Aboriginal archaeology in the area. Due to the natural features of the Leard State Forest including the vegetation type, species composition, soils and aspect the sites found are considered to be important to the Aboriginal community.

Previous geomorphology assessment (Mitchell in ARAS, 2007) has found that the mid and lower slopes of the Leard State Forest have a colluvial layer which covers the artefact scatters.

The integrity and scientific potential of the sites within the forest makes this area of high significance to the local area.

Intergenerational Equity

The Leard State Forest has been identified as Zone 4 in accordance with the BNC Act and '*dedicated for… forestry, recreational and mineral extraction*' (see **Section 5.6**).

The BNC Agreement provides for the protection and conservation of Aboriginal lands in Zone 1 and Zone 2 and allows for '*appropriate land use by Aboriginal people for cultural purposes*'. The BNC Agreement has set aside significant areas of land for use by Aboriginal people and the protection of Aboriginal archaeology as compensation for areas that will be potentially disturbed in Zone 4 such as the Leard State Forest. The BNC Agreement by its nature provides for intergenerational equity for the protection of Aboriginal culture and archaeology within the BNC Conservation Area.

The Namoi River floodplain and Baan Baa Ranges within the Project Boundary will be subject to minimal impact by the Project. The impacts are considered to be negligible in terms of intergenerational equity.

8.6.3 Mitigation and Management

Specific management actions and commitments in relation to Aboriginal heritage include:

- Preparation of a detailed Aboriginal Heritage Management Plan (AHMP). The AHMP will be guided by specific policies and procedures to manage Aboriginal archaeological sites within the Project Boundary. The AHMP will be developed in conjunction with stakeholders and periodically reviewed by the Aboriginal Stakeholders and DECCW. The AHMP will include as a minimum:
    - Protection of sites prior to salvage and impact;
    - Protection of sites that are not impacted by the Project by means of fencing and management controls;
    - Detail the salvage methodologies, to be carried out prior to impact;
    - Develop protocols for the monitoring of earth works as required; and
    - Identify the location and procedure for the care and control of salvaged artefacts;
- Fund and construct a Keeping Place during the period of this Project. The Keeping Place will store artefacts salvaged as part of the Project. The Keeping Place will be accessible to appropriately trained Aboriginal Community Representatives, or otherwise agreed with Boggabri Coal;
- Offer training for one member of each of the registered Aboriginal stakeholder groups for the Project in relation to site recording and artefact recording and basic analysis; and
- Provide the opportunity for a representative of the Aboriginal community to sit on the Community Consultative Committee.

8.7 NON ABORIGINAL HERITAGE

A Non Aboriginal Cultural Heritage Impact Assessment was undertaken by Archaeology Australia to determine the potential impacts of the Project on Non Aboriginal heritage items identified within and surrounding the Project Boundary. A summary of the findings of this assessment is provided below with the full report presented in **Appendix L**.

8.7.1 Methodology

This assessment was undertaken in accordance with the *NSW Heritage Office Guidelines for Heritage Impact Studies* (NSW Heritage Office, 2001) and the *NSW Heritage Manual* (NSW Heritage Council) and *The Burra Charter* (The Australia ICOMOS charter for places of cultural significance).

The methodology for the assessment consisted of several phases to ensure that all relevant Non Aboriginal heritage items that had a potential to be impacted by the Project were identified and assessed.

These broadly included:

- Review of historical and archival research and searches of the relevant Commonwealth and State heritage lists were undertaken to identify the known heritage items of significance within 5 km of the Project Boundary that may have a potential to be impacted by the Project; and
- A field survey of the items identified within the desktop reviews with some interviews with some key local people to gather their knowledge of the historical activities and to further recognise any other items of Non Aboriginal heritage.

The first settler in the area was George Clarke who was better known as the '*Barber*'. George was an escaped convict who took up residence in 1825 just to the north of where Boggabri stands today. Edward Cox who took up the '*Namoi Hut*' in 1835 was the first known squatter in the study area. This site was later to become the township of Boggabri. The original township was established about 20 km to the south on the Namoi River however, severe flooding destroyed this settlement in the 1850s. The new site was that of Namoi Hut, around the confluence of the Namoi River and Cox's Creek, an area that was not inundated during times of flooding.

The early Non Aboriginal settlers originally used land to graze their stock (cattle and sheep) and to grow crops. Land was cleared in all but a few areas and the timber cut during this process was used for construction of yards and buildings.

Wool was an important resource and the 'Gullendaddy woolshed' is testament of those activities. Crops were raised from the period of early settlement with much of the produce for local consumption. The first commercial crops were planted around 1890 and the area under cultivation increased over time; in 1907, 18,436 bushels of wheat were harvested in the Boggabri district and by 1939 this had increased to 1,804,073 bushels. A flour mill began operations in 1910 and grain silos were opened at Boggabri in 1944. During the 20th century, intensive irrigation schemes were introduced in the area and cotton became a major income producer in this and surrounding areas.

Logging has been carried out in the local forests since the time of settlement. However it has never been a major industry in the area. The Pilliga Forest was the principal forest in the region although Leard State Forest was dedicated as a forest reserve in 1878 (declared then as the Back Creek Forest Reserve).

8.7.2 Impact Assessment

A total of 12 heritage sites were identified within and surrounding the Project Boundary and have a potential to be impacted by the Project. These heritage items are listed in **Table 38** and are illustrated on **Figure 30**. Of these, eight sites were assessed as being within the Project Boundary (see **Figure 30**).

The remaining heritage items identified outside of the Project Boundary were assessed and will not be impacted as a result of the Project.

8.7.3 Mitigation and Management

For each item of Non Aboriginal Heritage identified, the management and mitigation as mentioned in **Table 38** above will be implemented.

Boggabri Coal will develop and implement a European Heritage Management Plan (EHMP) for the items as identified during this assessment and document the proposed management measures to be implemented for each site. It will document the responsibilities of all personnel, including a training program to ensure that all relevant personnel are aware of their responsibilities.

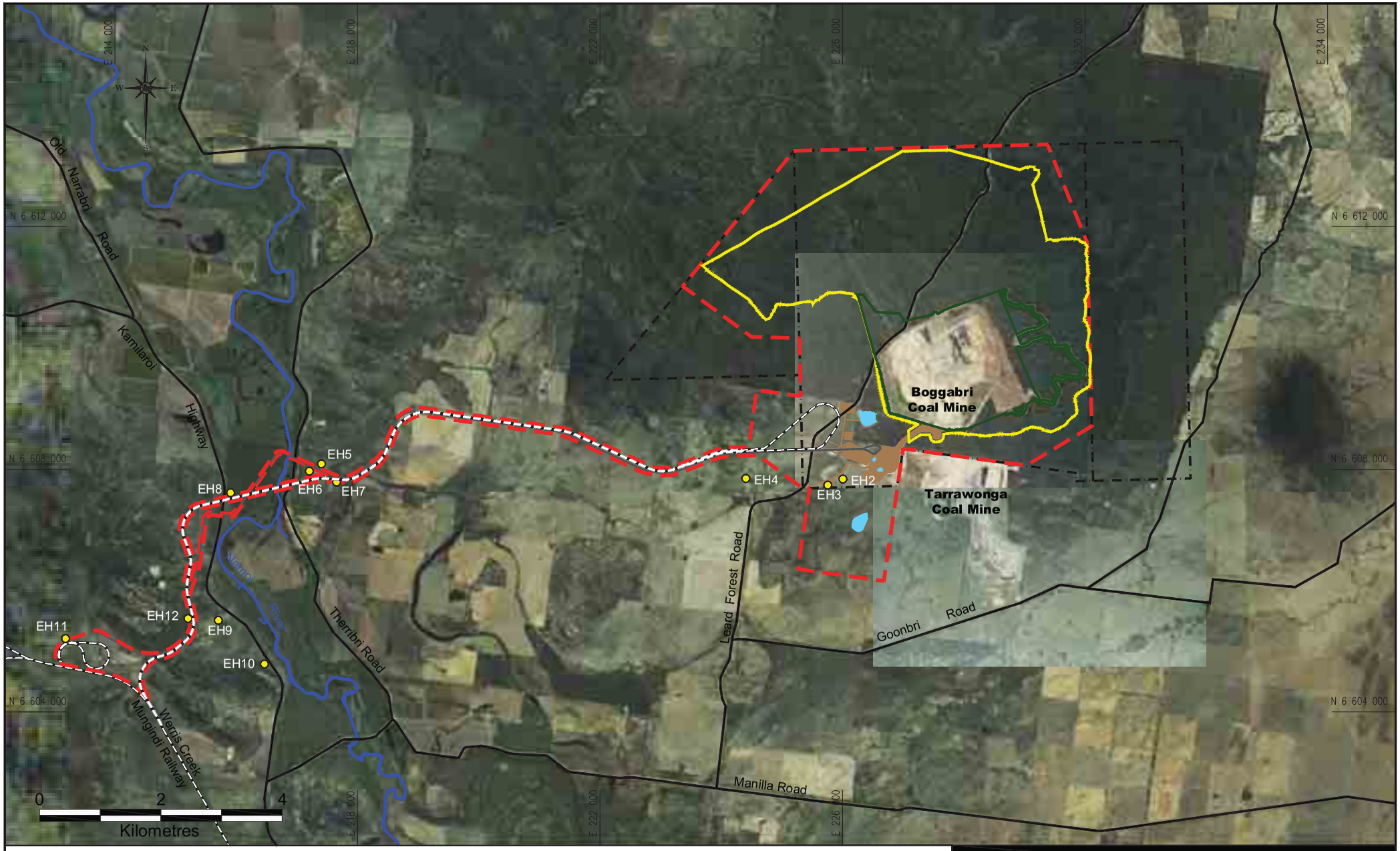
The EHMP will be prepared in consultation with the NSC and the Heritage Council of NSW and to the satisfaction of DoP. It is possible that during construction activities, previously unidentified sites or relics of heritage significance could be identified within the Project Boundary.

As required by Section 146 of the Heritage Act, the discovery of previously unknown relics will be reported to the Heritage Council of NSW within a reasonable time of their discovery by Boggabri Coal. The relevant personnel will be trained in relation to the responsibilities should any Non Aboriginal heritage item be identified.

Table 38
Non Aboriginal Heritage Sites

ID	Site Name	Significance	Management / Mitigation
EH1*	Leard State Forest	Little	Site recorded. The Project will require disturbance of up to 1,503 ha as a result of open cut mining. No significant cultural heritage was identified with this area.
EH2*	Nagero 1 Residence	Little	Site will continue to be utilised as the administration offices for the Project.
EH3*	Nagero 3 Shearing Shed	Little due to condition	Site to be impacted by the Project and will require demolition. Archival recording of the site, including measured drawings and photos will be undertaken prior to demolition.
EH4	Merriown	Moderate within a local context	Site recorded. No Project impact and as such, no management required.
EH5	Daisymede 1 Homestead Complex	Moderate within a local context	Site recorded. No Project impact and as such, no management required.
EH6*	Daisymede 2 Shearing Shed and Yards	Low to moderate	Site to be impacted by the Project and will require demolition. Archival recording of the site, including measured drawings and photos will be undertaken prior to demolition.
EH7*	Daisymede 3 Piggery	Little due to condition	Site to be impacted by the Project and will require demolition. Archival recording of the site, including measured drawings and photos will be undertaken prior to demolition. Additionally, as potential archaeological evidence relating to historical pig farming may be present, monitoring of the site during demolition by a suitably qualified person should be undertaken to recover any potential heritage items.
EH8*	Heathcliff	High – due to research potential	Site to be impacted by the Project and will require demolition. Further works will be undertaken prior to demolition, including: • Archival recording of the site, including site plan, measured drawings (of each building) and photographic record; • Archaeological assessment; • Archaeological investigation including excavations, should evidence of sub-surface relics be located or inferred; • Monitoring during the demolition process for further archaeological investigation should further relics be discovered; and • NSC and Boggabri Historical Society will be consulted regarding the management and significance of any relics that will be removed from the site.
EH9	The Rock 1 Homestead Complex	Moderate within a local context	Site recorded. No Project impact and as such, no management required.
EH10	The Rock 2 'The Rock' / 'Gin's Leap'	High historical value	Site recorded. An archaeological assessment of the cemetery at the Rock will be undertaken by a suitably qualified archaeologist. Any significant areas will be fenced off to prevent any unforeseen impacts.
EH11*	Harvester 1	Moderate	The Project will require the relocation of this heritage item, which will result in minimal impact. No ongoing management measures are proposed for the Project.
EH12*	Harvester 2	Moderate	The Project will require the relocation of this heritage item, which will result in minimal impact. No ongoing management measures are proposed for the Project.

Source: *Archaeology Australia (2009)*
** Site to be disturbed by Project activities.*



Project Boundary
Boggabri Mining Tenements
Project Disturbance Boundary
Mine Disturbance to Nov 2011
Railway
Private Haul Road
Roads
River

Non-Aboriginal Archaeological Site
Proposed Infrastructure Area
Water Management Infrastructure

Source: Google Maps (2009), Boggabri Coal (2010)
Archaeology Australia (2009)

BOGGABRI COAL MINE

Non Aboriginal Heritage

Cad File: 05369l.dwg	Date: 13.05.2010	Drawn: CP	Figure 30

8.8 SURFACE WATER

A surface water impact assessment has been undertaken by Parsons Brinkerhoff for the life of the Project. The assessment incorporates a review of the existing catchment, the layout of the existing water management system, consideration of the proposed additional infrastructure and an overall water balance for the various years of the Project.

This assessment report is provided in **Appendix M**, and is briefly summarised in the following sections.

8.8.1 Background

Catchment Description

Boggabri Coal Mine is contained within the catchments of Nagero Creek and Bollol Creek, which are both small ephemeral tributaries of the Namoi River. The mining area, mine infrastructure area and administration area are all contained within the Nagero Creek catchment, and only a small portion of the irrigation area is contained within the Bollol Creek catchment.

The study catchment area is approximately 4,414 ha to the point where Nagero Creek meets the floodplain, approximately 1 km downstream of the administration area. The study catchment is bounded by the Willow Tree Range to the north north-east and falls generally to the south-west towards the Namoi River floodplain.

The majority of the 4,414 ha study catchment is contained within the Leard State Forest. Leard State Forest has been selectively logged in the past, but is generally forested with the exception of Boggabri Coal Mine, Tarrawonga Mine and Leard Forest Road.

Downstream of the study catchment, Nagero Creek flows across the Namoi River floodplain, which mainly comprises land that has been cleared for farming.

Regional Flooding

The Namoi Valley is subject to regular flooding. The largest recently recorded flood events in the Namoi Valley occurred in February 1955, January 1971, February 1984 and November 2000.

The mining area, mine infrastructure area and administration area are not located within the floodplain, however, the existing product coal haul road crosses the Namoi River floodplain and the proposed rail spur will cross the Namoi River and floodplain and is described in more detail in **Section 8.9**.

Downstream Surface Water Users

On a local level, water from Nagero Creek is used by farms located downstream of Boggabri Coal Mine along the southern end of Therribri Road a section of the Manilla Road and the southern portion of Leard Forest Road. This water is mainly used to fill small farm dams and for stock watering.

On a regional level, Boggabri Coal Mine is located within the Namoi Water Management Area, and drains to the Lower Namoi Regulated River Water Source. The main land use in the Namoi Water Management Area is agriculture, accounting for approximately 96% of water consumption from the Namoi River. Mining, manufacturing and households account for approximately 2% of consumption, and 'other' users account for the remaining 2% of consumption.

Water sharing in the Namoi Water Management Area is regulated by the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003, made under the WM Act. The Water Sharing Plan sets out rules for how water is shared between the environment and water users and different categories of WALs. Water is shared amongst different categories of WALs by means of Available Water Determinations. For the Lower Namoi Regulated River Water Source, Available Water Determinations provide allocations of water equal to 100% of the share component of domestic and stock WALs, local water utility WALs and 1 ML per unit share for high security WALs, in all but the most exceptional drought years. However, the water made available to general security WALs is reviewed monthly and depends upon the amount of water held in Split Rock and Keepit Dams. The water made available to supplementary WALs is set at the start of each water year.

Existing Surface Water Management System

The existing water management system at Boggabri Coal Mine has been designed to segregate clean runoff, dirty runoff and contaminated water generated from rainfall events and mining operations. The following definitions are adopted for the various runoff types:

- Clean water is defined as runoff from undisturbed bushland catchments located upslope of the mine site;
- Dirty water is defined as runoff from disturbed areas within the mine site and includes runoff from the mine infrastructure area, spoil dumps and haul roads. This water is non-saline but contains high levels of suspended solids; and
- Contaminated water is defined as runoff generated from coal stockpiles and the pit floor, as well as groundwater inflows to the pit. This water is mildly saline.

Clean water runoff from undisturbed catchments is currently diverted around the mine working area to Nagero Creek as much as practical.

Dirty water runoff is currently captured in sediment dams, which attenuate peak flows and encourage settling of suspended solids prior to the release of water to Nagero Creek.

Contaminated water is currently captured in sediment dams or mine water storage dams. Contaminated water is stored onsite for reuse, and is not released to Nagero Creek. Surplus contaminated water is currently stored in the mining void.

The existing water management system aims to reuse as much contaminated water as possible onsite. Contaminated water is currently used as a priority to supply dust suppression demands.

Water from offsite sources (comprising groundwater allocations pumped from the Namoi Groundwater Source) is currently only used to meet dust suppression demands when there is an onsite contaminated water deficit.

Water from offsite sources is currently used for vehicle wash down and potable water. A summary of WALs currently held by Boggabri Coal is listed in **Table 4**.

Existing Water Quality

Surface water quality in the vicinity of Boggabri Coal Mine is monitored as part of existing mining operations, as per the conditions of the current EPL.

Surface water monitoring is undertaken at seven sites, including Nagero Creek up and down stream of existing mining operations, and within existing sediment dams and mine water dams.

Monitoring is undertaken for parameters including pH, electrical conductivity, total suspended solids, oil and grease, nitrate, total nitrogen, total phosphorus and reactive phosphorus.

A review of monitoring data for Nagero Creek upstream of existing mining operations indicates that:

- pH ranges from 5.9 to 7.8;
- Electrical conductivity ranges from approximately 30 to 90 µS/cm; and
- Suspended solids concentrations range from approximately 30 to 110 mg/L.

A review of monitoring data for Nagero Creek downstream of existing mining operations indicates that:

- pH ranges from 6.7 to 7.7;
- Electrical conductivity ranges from approximately 60 to 230 µS/cm; and
- Suspended solids concentrations are variable and range from approximately 160 to 2,070 mg/L.

Suspended solids at both the upstream and downstream monitoring sites exceeded the 100th percentile concentration limit of 50 mg/L specified under the current EPL. The upstream monitoring site pH level was outside the 6.5 to 8.5 range specified under the current EPL on one monitoring occasion.

Monitoring results indicate that some parameters have naturally elevated levels that will exceed the existing EPL conditions on occasion.

Water quality in mine water dams is mildly saline and alkaline, which is typical of mine water at other mine sites in the region. A more detailed assessment of water quality data collected as part of the existing monitoring program is provided in **Appendix M**.

8.8.2 Modelling Methodology

Local Catchment Hydrology

A hydrological analysis has been undertaken for the study catchment for Years 1, 5, 10 and 21 of the Project.

The purpose of the analysis was to assess the potential impact of the Project on peak flows at key locations in the study catchment, and to assist with sizing of water management infrastructure.

The analysis was undertaken using a hydrological model of the study catchment developed using XPSWMM software. The 'RUNOFF' mode of the model allows for hydrology generation and the 'HYDRAULICS' mode allows hydraulic simulation of open and closed conduits, and water storages. Design rainfall for the 5, 20 and 100 year ARI storm events was generated using Australian Rainfall and Runoff Volumes 1 (2001) and 2 (1987), and was incorporated into the 'RUNOFF' mode of the model.

Modelling of rainfall runoff was undertaken for undisturbed, industrial, open cut pit, active spoil, rehabilitated spoil and pre-strip land uses.

The Horton Loss Equation was adopted in the XPSWMM model to simulate infiltration losses for these different land uses. In the absence of historical stream flow data, peak flow rates predicted by the XPSWMM model were compared to those predicted by the Rational Method.

Site Water Balance

A long term water balance analysis has been undertaken for Years 1, 5, 10 and 21 of the Project.

The purpose of the analysis was to estimate annual catchment runoff volumes from the study catchment and to identify likely contaminated water deficits and surpluses.

The analysis was undertaken using a water balance model developed using GoldSim software. The model had a daily time step, and was used to calculate the volume of water in sediment dams and mine water storages at the end of each day accounting for daily inflow, evaporation from the storage, water usage, pumping between storages in the form of a pumping policy and storage overflow, if it occurs.

The water balance model incorporated the Australian Water Balance Model (AWBM) to simulate catchment runoff. The AWBM is a nationally recognised catchment scale water balance model that estimates stream flow from rainfall and evaporation.

Modelling of catchment runoff was undertaken for undisturbed, industrial, open cut pit, active spoil, rehabilitated spoil and pre-strip land uses. AWBM modelling parameters were adopted based on past development experience on mine sites in NSW.

A summary of estimated water demands for the various years of the Project is provided in **Table 39**.

The CPP demand was based on a washery make-up water requirement of 205 L per tonne of coal feed, as provided by Boggabri Coal. The washery will not be operational for Year 1 of the Project.

The groundwater inflow to the mining void was obtained from the Project groundwater impact assessment and is discussed in more detail in **Section 8.10**.

The water balance model was run using synthetic daily rainfall and evaporation data for the 109 year period from 1900 to 2009. Synthetic data was obtained from the BoMs Data Drill service, which accesses grids of data derived by interpolating the BoMs station records.

8.8.3 Impact Assessment

The key potential impacts of the Project on surface water resources are:

- Potential for the export of contaminants in mine site runoff and accidental spills (mainly sediment, soluble salts, heavy metals, and oils and greases) causing degradation of water quality in downstream water courses;
- Changes to flow regimes of local watercourses due to alterations to catchment areas, the retention of dirty water runoff in sediment dams, and the detention and onsite reuse of contaminated runoff in sediment dams; and
- Changes to the site water balance increasing the magnitude of contaminated water deficits and surpluses.

For the purposes of the surface water assessment, Year 1 has been adopted as the baseline against which potential impacts for Years 5, 10 and 21 of the Project have been assessed. The proposed Project water management system is summarised in **Section 8.8.1**. Further details of the proposed water management system for Years 1, 5, 10 and 21 of the Project, including sizing of sediment basins and diversion drains, are provided in **Appendix M**.

Catchment Changes

The natural catchment area contributing to Nagero Creek will be reduced over the life of the Project, as the catchment area contributing to the dirty and contaminated water management systems increases.

A summary of the changes to the study catchment area for modelled years of the Project is provided in **Table 40**. The study catchment outlet for the catchment areas is located approximately 1 km downstream of the Project boundary where Nagero Creek meets the Namoi River floodplain.

The decrease in dirty water system catchment area between Years 10 and 21 of the Project can be attributed to the release of runoff from a portion of the rehabilitated spoil dump directly to Nagero Creek in Year 21.

Local Catchment Hydrology

A summary of estimated peak flow rates at the study catchment outlet for various years of the Project is provided in **Table 41**. Percentage reductions between Years 1 and 21 of the Project are also provided.

As shown in **Table 41**, the estimated peak flow rates at the study catchment outlet reduce over the life of the Project. This reduction may be attributed to the following:

- Dirty water runoff from disturbed areas is captured in sediment dams and slowly released to Nagero Creek, which attenuates peak flow rates. The catchment area that contributes to the sites dirty water system increases over the life of the Project. During Years 5 and 10, dirty water from the spoil dump catchment is reused onsite to supplement a water deficit and is not released to Nagero Creek except during large storm events; and
- Contaminated runoff is stored onsite for reuse or disposed of via irrigation, which reduces the volume of runoff discharged to Nagero Creek. The catchment area contributing to the contaminated water system generally increases over the life of the Project.

The increase in 5 year ARI peak flows between Years 10 and 21 of the Project may be attributed to the release of runoff from a portion of the rehabilitated spoil dump directly to Nagero Creek in Year 21. This runoff was captured in a dirty water sediment dam in Year 10. The attenuation affect of sediment dams is greatest for small storm events. This is because flows from small storm events discharge slowly via a pipe (rather than spillway) and a greater portion of total catchment runoff is retained in the 'sediment zone'.

Site Water Balance

A summary of estimated annual contaminated water surplus / deficit for various years of the Project is provided in **Table 42**. Results are provided for representative dry (10^{th} percentile), median (50^{th} percentile) and wet (90^{th} percentile) rainfall years.

Table 39
Summary of Estimated Project Water Demands (ML/yr)

Description	Year 1 (baseline)	Year 5	Year 10	Year 21
CHPP	0	615	513	513
Dust suppression	162	636	493	504
Vehicle washdown	20	20	20	20
Potable water	38	38	38	38
Total	**220**	**1,309**	**1,064**	**1,075**

Table 40
Summary of Changes to Study Catchment Areas

Project Year	Study Catchment Area (ha)			
	Clean Water System	Dirty Water System	Contaminated Water System	Total
Year 1 (baseline)	3,731	165	518	4,414
Year 5	2,911 (-22%)	819 (+396%)	684 (+32%)	4,414
Year 10	2,573 (-31%)	1,257 (+662%)	584 (+13%)	4,414
Year 21	2,782 (-25%)	924 (+460%)	709 (+37%)	4,414

Note: Percentage change from Year 1 is given in brackets

Table 41
Summary of Estimated Peak Flow Rates at Study Catchment Outlet

Project Year	Peak Flow Rate (m^3/s)		
	5 yr ARI Storm Event	20 yr ARI Storm Event	100 yr ARI Storm Event
Year 1 (baseline)	53	111	178
Year 5	47 (-11%)	92 (-17%)	153 (-14%)
Year 10	37 (-30%)	81 (-27%)	137 (-23%)
Year 21	43 (-19%)	80 (-28%)	136 (-24%)

Note: Percentage change from Year 1 is given in brackets

Table 42
Summary of Estimated Project Water Surpluses / Deficits

Project Year	Contaminated Water Surplus / Deficit (ML/yr)		
	Dry Year (1940)	Median Year (1905)	Wet Year (1977)
Year 1 (baseline)	+8	+208	+545
Year 5	-886	-503	+42
Year 10	-497	-173	+325
Year 21	-520	-214	+357

A surplus occurs when the volume of contaminated water exceeds demands. A deficit occurs when the volume of dirty and contaminated water is not adequate to meet demands. The deficits in **Table 42** do not account for the supply of water from external sources, such as WALs currently held by Boggabri Coal.

As shown in **Table 42** above, the estimated annual contaminated water surplus / deficit varies over the life of the Project, and is highly dependent on rainfall throughout the year, total rainfall and soil wetness / dryness.

For median rainfall years, a water surplus is estimated for Year 1, however, water deficits are estimated for Years 5, 10 and 21 of the Project. The highest water deficits are estimated for Year 5, when CPP and dust suppression demands peak.

For Year 5, a total of 944 ML/yr would be required from external sources for a dry rainfall year (including 886 ML/yr for dust suppression and washery demands and 58 ML/yr for potable water and vehicle washdown demands).

Boggabri Coal has access to 194 ML/yr (assuming 1 ML/yr/unit share) through its existing groundwater licenses. Therefore a maximum of 750 ML/yr additional water from external source will be required in Year 5 for a dry year. This requirement will decrease to approximately 361 ML/yr by Year 10 and 384 ML/yr by Year 21 (see **Table 43**).

As discussed in **Section 8.8.1**, Boggabri Coal currently holds WALs for the Namoi Groundwater Source and the Namoi Regulated River Water Source. However, these current licenses are not adequate to make-up the estimated annual water deficits for the Project. Additional make-up water from external supplies will therefore be required to meet the water demands for the Project.

Boggabri Coal has been actively pursuing the acquisition of additional water entitlements on the open market since June 2010. Boggabri Coal is currently in discussion with a number of water title holders over the purchase of an additional 400 ML of groundwater. It is anticipated that this additional water allocation will be acquired in 2011.

Further to this, Boggabri Coal has submitted an application for a groundwater interference licence with the NSW Office of Water for an additional 400 ML of deep hard rock aquifer water. Boggabri Coal's total groundwater allocation is expected to reach approximately 1,114 ML by Year 5 of the Project. This will provide adequate water to operate the mine at maximum production in extreme dry years.

The highest surpluses are estimated for Year 1 when dust suppression demands are at their lowest, and the washery is not yet operational. Water balance modelling has indicated that an irrigation rate of 570 ML/yr is required to cater for the predicted surpluses during Year 1 and 21 of the Project.

Table 43
Summary of External Water Requirements for a Dry Year

Landform	Contaminated water surplus / deficit (ML/yr)	External water requirement (ML/yr)	Current water entitlements (ML/yr)^	Requirement for additional water entitlements (ML/yr)
Year 1	+8	58	194	0
Year 5	-886	944	194	750
Year 10	-497	555	194	361
Year 21	-520	578	194	384

A summary of estimated annual runoff volumes in Nagero Creek at the study catchment outlet is provided in **Table 44** for various years of the Project. Percentage reductions between Years 1 and 21 of the Project are also provided.

Runoff to Nagero Creek includes clean water runoff that is diverted around the mine site, and discharges from sediment dams that capture dirty water runoff from disturbed areas.

As shown in **Table 44**, the estimated annual runoff volumes at the study catchment outlet reduce over the life of the Project. This reduction may be attributed to the following:

- Dirty runoff from disturbed areas is captured in sediment dams. Water stored in the 'settling zone' is slowly released to Nagero Creek, which attenuates peak flows. However, water stored in the 'sediment zone' is not released and evaporates over time, causing an overall reduction in runoff volumes to Nagero Creek;
- During Years 5 and 10, dirty water from the spoil dump catchment is reused onsite to supplement a water deficit and is not released to Nagero Creek except during large storm events. This is why reductions are greatest for Years 5 and 10. During Year 21, runoff from a portion of the rehabilitated spoil dump is released directly to Nagero Creek, which is the reason for the increase in runoff volumes compared to Years 5 and 10; and
- Contaminated runoff is stored onsite for reuse or disposed of via irrigation, which reduces the volume of runoff discharged to Nagero Creek.

The reduction in annual runoff volumes will result in reduced environmental flows in Nagero Creek downstream of the site. The maximum reduction will be experienced during Year 10 of the Project, when median stream flows can be expected to reduce by 19% at the study catchment outlet.

The Project will result in a reduction in the volume of water available to downstream water users, including properties to the south of the study catchment outlet that currently use this water to fill farm dams and for stock watering.

During high flow events, water from the Nagero Creek catchment overtops a crest on the floodplain and flows south into the Bollol Creek catchment. This water is currently captured in farm dams on properties located at the north-west corner of the Manilla Road and Leard Forest Road intersection. The volume of flows from the Nagero Creek catchment that overtop and flow south into the Bollol Creek catchment, as well as the frequency of overtopping, can be expected to decrease as a result of the Project.

The maximum annual median runoff volume reduction of 351 ML/yr (or 19%) for Nagero Creek at the catchment outlet is approximately 0.039% of the mean annual stream flow for the Namoi River at Boggabri of 906,470 ML/yr. As such the reduction in runoff volumes associated with the Project is not expected to have a significant impact on environmental flows in the Namoi River.

Table 44
Summary of Estimated Annual Runoff Volumes at the Study Catchment Outlet

Project Year	Annual Runoff Volume (ML/yr)		
	Dry Year (1940)	Median Year (1905)	Wet Year (1977)
Year 1 (baseline)	631	1,812	4,644
Year 5	520 (-18%)	1,517 (-16%)	4,222 (-9%)
Year 10	467 (-26%)	1,461 (-19%)	4,309 (-7%)
Year 21	561 (-11%)	1,690 (-7%)	4,441 (-4%)

8.8.4 Mitigation and Management

Erosion and Sediment Controls

Erosion and sediment control measures will be implemented during the construction, operation and rehabilitation phases of the Project to control the quality of runoff from the site. These measures will be incorporated into an Erosion and Sediment Control Plan to ensure no adverse impacts on water quality adjacent to the Project.

Management strategies for topsoil stripping and handling, respreading, post disturbance regrading, and seedbed preparation will also be implemented to control the quality of runoff from the site.

Project Surface Water Management System

Details of the proposed water management system for Years 1, 5, 10 and 21 of the Project, including sizing of sediment basins and diversion drains, are provided in **Appendix M**.

The proposed Project water management system, with full operation of the CPP, is illustrated in the flow diagram in **Figure 31**. The system aims to segregate clean runoff, dirty runoff and contaminated water generated from rainfall events and mining operations. The system also aims to reuse as much contaminated water onsite as possible to meet dust suppression and CPP demands.

Clean water runoff from undisturbed catchments will be diverted around the mine working area to Nagero Creek as much as practical.

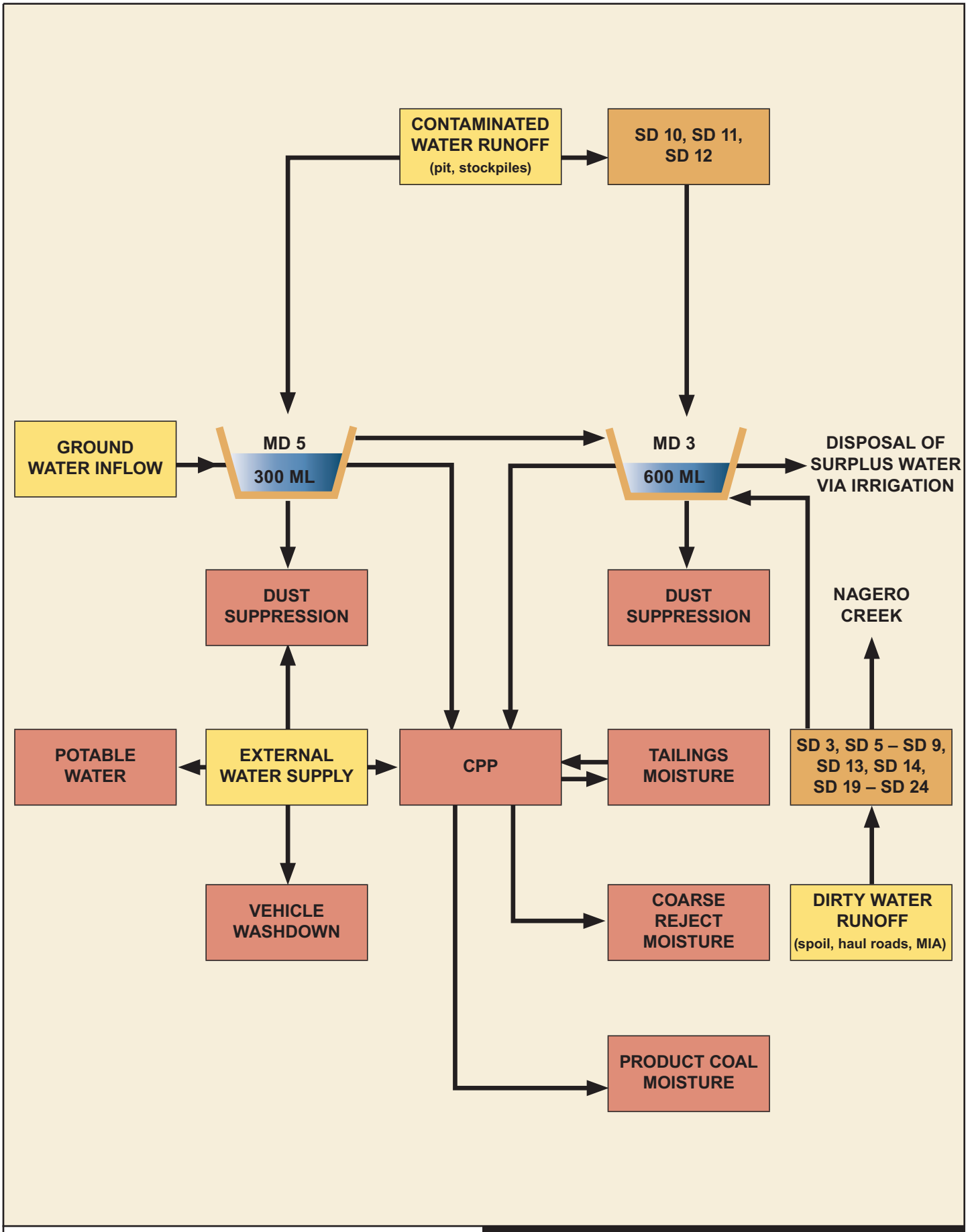
Clean water runoff from the rehabilitated spoil dump will be progressively released back to Nagero Creek when topsoil has stabilised and vegetation cover has established.

Dirty water runoff will be captured in sediment dams to encourage the settling of suspended solids. Runoff from large storm events will overtop sediment dams and discharge to Nagero Creek. Captured water will either be released to Nagero Creek or pumped to mine water dams for storage or reuse. This will depend on water quality and the site water balance.

Dirty water sediment dams have been designed as 'Type F / D' basins (for catchments with fine / dispersible soils), and comprise a 'settling zone' for temporary treatment storage and a 'sediment zone' for storage of sediment. Dirty water sediment dams have been sized in accordance with the guidelines Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries (DECC, 2008). The 'settling zone' has been sized to capture runoff from the 90th percentile 5 day duration storm event, which results in a typical overflow frequency of two to four overflows per year.

Dirty water will be recycled onsite, an additional 'reuse zone' will be required for the storage of this water.

Low flow outlets are proposed for dirty water sediment dams to allow the drawdown of the 'settling zone'. Manually operated valves are proposed on all low flow outlets so that discharge to Nagero Creek can be prevented if water quality is not suitable.



Water Supply/Source
Water Demand
Balanced Supply/Source
Flow Direction

Hansen Bailey

BOGGABRI COAL MINE

Mine Water Management System

Filename: 914_boggabriWATER.indd	Date: 10.5.10	Drawn: MB	Figure 31

Contaminated water will be captured in sediment dams. Contaminated water will be pumped to mine water dams for storage and reuse and will not be released to Nagero Creek. Surplus contaminated water will be stored in-pit or disposed of via irrigation.

The successful operation of the water management system will involve the utilisation of the water balance model as a tool to predict future water demand and supply requirements. The following options are available to cater for an onsite contaminated water deficit:

- Water sharing arrangements with the adjacent Tarrawonga Mine;
- Reduce water demand through operational efficiencies;
- Groundwater and / or surface water extraction using current licenses;
- Obtain additional licenses in conjunction with property acquisition, or from the water market; and
- Reduce coal washing and have a higher percentage of unwashed coal in product coal.

It is likely that additional infrastructure will be required to transfer and storage of make-up water to the site (typically one to two years of demands). The volume of water to be stored onsite will depend on the source of make-up water and reliability of supply.

As part of the ongoing site water management, the security of water supply will be reviewed and decisions to improve this security will be undertaken and coordinated / licensed with the relevant regulatory authorities.

The following options are available to cater for an onsite contaminated water surplus:

- Water sharing arrangements with the adjacent Tarrawonga Mine;
- Disposal by irrigation. Upgrades to the approved irrigation system will be required to achieve the proposed irrigation rate of 570 ML/yr; and
- Temporary storage in mining voids (un-mined and / or mined).

The irrigation system will be developed in consultation with an irrigation specialist, with consideration to the long term soil hydraulic loading capacity and soil chemistry.

Post Mining

The mining area will be progressively rehabilitated over the 21 year life of the Project. Rehabilitated areas will become free draining to Nagero Creek when vegetation cover has established and the final landform is stabilised. The final landform will generally be consistent with the surrounding environment.

Sediment basins will remain in place until rehabilitation success criteria is achieved to encourage the settling of suspended solids prior to the release of water to Nagero Creek.

Temporary erosion and sediment control measures will be required whilst rehabilitation is establishing (e.g. contour banks, contour ripping, graded banks, erosion blankets, ground-cover vegetation, rip-rap). All sediment basins will be removed once rehabilitation has established.

Infiltration characteristics for rehabilitated areas are expected to be similar to pre-mining conditions. However, there will be a reduction in the volume of runoff discharged to Nagero Creek when compared to the pre-mining situation due to the final void.

The quality of runoff from rehabilitated areas is expected to be similar to pre-mining conditions.

Based on the conclusions of the geochemical impact assessment (**Section 8.11**), it is considered unlikely that leachate generated from overburden and coal reject materials would significantly impact surface water quality downstream of the site if these materials are managed in accordance with the recommended mitigation measures.

Monitoring Program

A surface water quality monitoring program will be implemented for the proposed Project water management system, and will include monitoring at sites upstream and downstream of mining operations and within sediment dams and mine water storages.

Monitoring will be developed in consultation with DECCW and undertaken in accordance with relevant licence conditions for parameters including pH, electrical conductivity, total suspended solids, oil and grease, nitrate, total nitrogen, total phosphorus and reactive phosphorus.

The proposed surplus mine water irrigation system will be developed in a staged process in consultation with NOW and Forests NSW to ensure that there are no adverse impacts on the forest plantation or surrounding environment.

8.9 FLOOD ASSESSMENT

A Flood Impact Assessment for the Project was undertaken by WRM Water and Environment Pty Ltd (WRM) to determine the impact from the construction of infrastructure on the Namoi River floodplain on flooding levels and erosion potential.

Infrastructure assessed as part of this study included the proposed rail bridge over the Namoi River and elevated rail spur over the floodplain, widening of the existing haul road and the construction of an overpass on Therribri Road across the existing Haul Road. This assessment is provided in full in **Appendix N** with a summary provided below.

8.9.1 Background

Catchment Characteristics

The Namoi River begins in the Great Dividing Range and extends for over 350 km west where it discharges into the Barwon River near Walgett. It has a total catchment area of approximately 42,000 km^2. The major tributaries of the Namoi River include the Peel River, Mooki River, Manilla River, Coxs Creek, Baradine Creek and Pian Creek.

There are a number of water storages including Lake Keepit, Chaffey and Split Rock Dams located upstream of the Project Boundary on the Namoi River, Peel River and Manilla River. Keepit Dam is the main water storage in the catchment and is located approximately 70 km up stream of the Project Boundary. The Namoi River water levels at Boggabri are heavily regulated by the up stream dams. Most releases are made from Lake Keepit Dam during the summer months for irrigation purposes, the majority of which is used downstream of the Project and west of Narrabri. Lake Keepit Dam releases significantly less water during the winter months when there is less demand for irrigation.

The largest recorded flood event at Boggabri occurred in February 1955. This flood had a peak discharge of 4,300 m^3/s and caused widespread inundation and damage. Other large floods have occurred in January 1971, February 1956, January 1976 and February 1984. The Namoi River flood flows take approximately two days to travel from Gunnedah to Boggabri, a distance of some 40 km.

Floodplain Characteristics

The construction of Project infrastructure across the Namoi River and floodplain is located within a natural constriction zone of the Namoi River formed between two small hills on either side of the Namoi Valley. The floodplain width is approximately 1.2 km at this location and is relatively confined for a distance of about 5 km downstream of the Project Boundary before it expands out to a width of about 4 km. The upstream floodplain has a width of about 3.5 km and includes several remnant channels of the Namoi River. Intensive cropping is evident on both the upstream and downstream floodplains.

The main channel of the Namoi River in the vicinity of the proposed rail bridge has a base width of between 30 m and 50 m and is approximately 7 m deep. The river bank on both sides is relatively stable and well vegetated with large trees. Some minor erosion is evident but is not significant.

8.9.2 Methodology

The construction of infrastructure on the Namoi River floodplain was assessed using the 5 year, 20 year and 100 year ARI design flood. Design discharges were estimated from an annual series flood frequency analysis of the recorded flows using the Australian Rainfall and Runoff (IEAust, 1987) recommendations to fit a Log-Pearson Type III distribution to an annual series of peak flood discharges recorded for the Namoi River at Boggabri (GS419012). These flows were compared with previous flood assessments undertaken and are discussed in more detail in **Appendix N**.

Ground level data was obtained from GPS survey of the left bank (western) floodplain and six cross sections of the channel and eastern floodplain. The data was combined to create a single digital terrain model of the area.

A TUFLOW, two dimensional hydrodynamic model was developed of the Namoi River to effectively represent the water movement across the floodplain.

The 5 year, 20 year and 100 year ARI design flood levels, flood extents and flood velocities were estimated along the Namoi River in the vicinity of the proposed infrastructure for the following scenarios:

- Pre-mine conditions for model verification / calibration purposes;
- Existing conditions (include existing haul road bridge crossing); and
- Proposed conditions (includes rail Bridge and rail spur, widening of Haul Road and Therribri Road overpass).

The results from the model were used to determine whether the proposed works would constrict flows sufficiently to cause increased flooding or erosion to the banks of the Namoi River and floodplain.

8.9.3 Impact Assessment

The rail bridge and rail spur have been designed to minimise potential impacts on the flood levels up stream and down stream of the Project Boundary and avoid erosion of the Namoi River channel.

The rail bridge will be raised above the banks of the Namoi River with supporting piers orientated to minimise disturbance to natural flow in the water channel. The rail spur will be elevated by a gantry across the floodplain and is designed to be above the 100 year ARI design flood. The rail spur will maintain an opening across the floodplain of approximately 1.1 km.

The construction of a rail bridge and rail spur, widening of the product coal haul road and Therribri Road overpass will have no significant impact on flood water levels upstream or down stream of the Project Boundary for either the 5 year, 20 year or 100 year flood events.

The results of the TUFLOW model are described in detail in **Appendix N** and the key findings are summarised below:

- The rail bridge will have an insignificant impact on flood levels (maximum of 0.03 m) and no measurable impact on flood extents up to and including the 100 year ARI design flood. No additional overbank flooding is expected as a result of the rail bridge crossing;
- The rail bridge will have an insignificant impact on flood velocities (less than 0.2 m/s) and therefore on the erosion potential across the floodplain. Build up from debris will not cause a significant change in flow or cause additional erosion;
- The Therribri Road overpass will have no significant impact on flood depths and velocities across the floodplain;
- Widening of the existing haul road will not change the flooding characteristics on the floodplain; and
- The mine infrastructure area is located well above the 100 year ARI design flood of the Namoi River.

8.9.4 Mitigation and Management

Specific management actions and commitments in relation to flooding include:

- Install scour protection on the banks of the Namoi River under the rail bridge and on each pier on the floodplain; and
- Remove the build up of debris from piers as required.

8.10 GROUNDWATER

A groundwater impact assessment was undertaken by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). A full copy of this report is presented in **Appendix O**. The objective of the study was to assess the impact of the Project on the groundwater regime and water users and to quantify predicted inflows into the mining area throughout the mine life.

8.10.1 Background

In order to adequately assess the potential impacts of a proposal on the groundwater regime, it is important to understand the current conditions of the groundwater system. A brief outline to the existing groundwater system within and surrounding the EA Boundary is provided below.

Existing Groundwater System

The regional groundwater system consists broadly of three aquifer systems:

- The extensive and productive Cainozoic Namoi Valley alluvial aquifer system that is associated with the Namoi River floodplain and tributaries;
- A thin veneer of weathered bedrock (regolith) near the ground surface; and
- Permian bedrock aquifers, in particular the coal seams of the Permian Maules Creek Formation.

A conceptual depiction of the aquifer systems is shown in **Figure 32**.

The Namoi Valley alluvial aquifer is an important groundwater resource being widely used for irrigation, stock watering, town water, domestic and industrial purposes. The alluvial aquifer is typically subdivided into two stratigraphic units, the basal Gunnedah Formation and the overlying Narrabri Formation. The Narrabri Formation is up to 70 m thick and is comprised of clayey flood deposits with interbeded sand and gravel deposits which generally form low yielding aquifers.

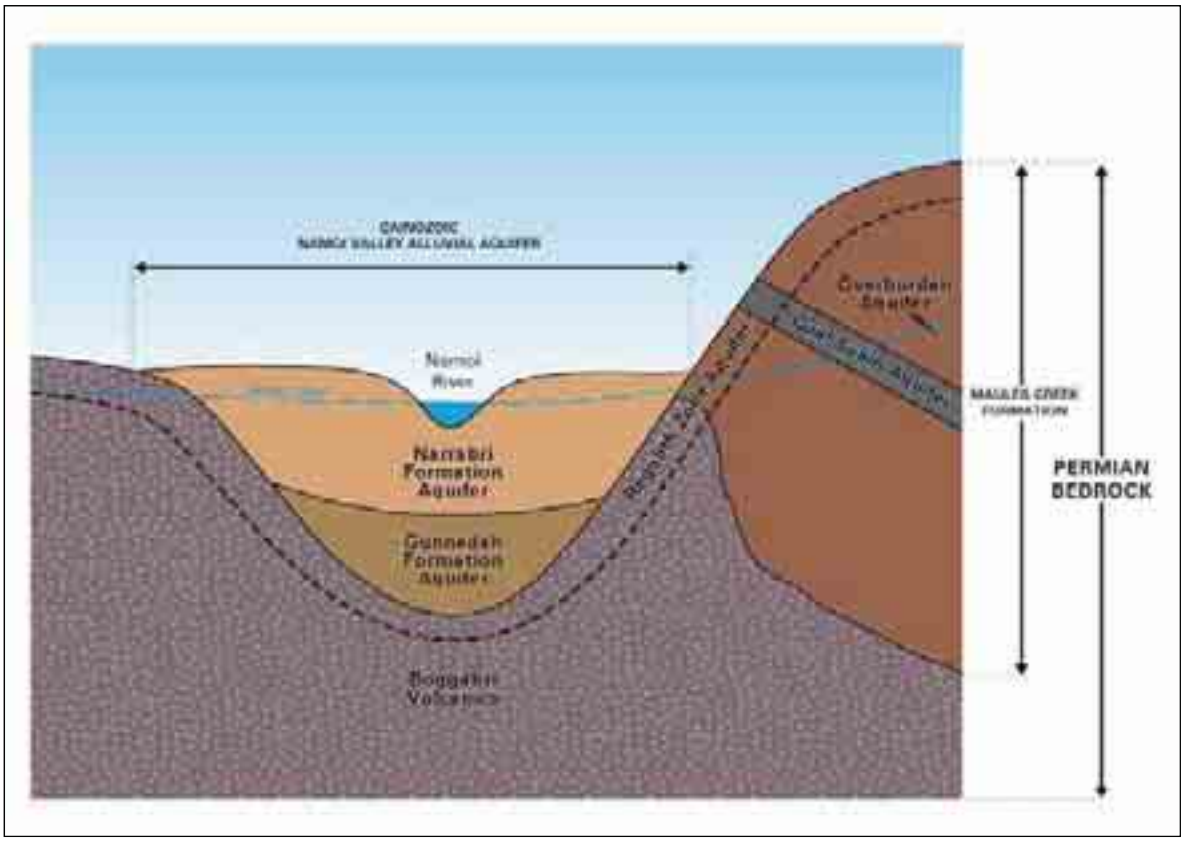
The underlying Gunnedah Formation is up to 115 m thick and dominated by sand and gravel deposits that fill paleo-channels and form a productive aquifer that is targeted for irrigation purposes. Finer grained sediments in the Narrabri Formation can act as a storage zone for salts with water quality varying from fresh to saline.

The coarser sediments in the underlying Gunnedah Formation generally contain better quality low salinity groundwater. The bedrock underlying the alluvial aquifers outcrop as distinctive, sometimes rugged hills surrounded by the generally flat to gently sloping plains of the Namoi Valley alluvial aquifer. The regolith or weathered zone of the bedrock is comprised of superficial soils and weathered rock and averages about 25 m in thickness. The regolith zone aquifer generally acts as a temporary groundwater store during sustained wet periods, providing recharge to the underlying overburden and coal seams.

Rainfall recharge percolates downwards from the regolith at a reducing rate as increasing confinement and reducing permeability impede flow. This vertical flow regime is predominantly fracture flow, where pathways depend upon fracture and joint connectivity within the rock strata.

Coal seams within the Permian Maules Creek Formation act as confined aquifers and have generally poor productivity in comparison to the Namoi Valley alluvial aquifer. While some coal seams may show an elevated hydraulic conductivity, the dominant overburden and interburden sections are of very low hydraulic conductivity.

Figure 32
Cross Section – Main Aquifer Systems



The coal seams are generally low yielding and contain poorer quality water compared to the Namoi Valley alluvial aquifer. Monitoring of bores intersecting the coal seams has found spatially variable water quality from fresh to brackish.

The Permian Boggabri Volcanics form the basement to the overlying more productive aquifers and are generally recognised as a low permeability unit that typically does not supply useable volumes of groundwater.

Recharge to the Namoi Valley alluvial aquifer occurs through direct rainfall seepage, run off from the surrounding hill slopes, and leakage from the beds of rivers and creeks. The coal seam aquifer is recharged through the outcrop and subcrop zones. The rate of recharge is highest over the alluvial deposits, at the contact zone between the hills and the floodplain and through the beds of ephemeral creeks.

Recharge is typically very low where Permian bedrock outcrops as hills. The natural groundwater flow from the Permian aquifers in the outcropping hills is to discharge into the alluvial aquifers which in turn discharge to the Namoi River.

Existing Groundwater Users

A search of the NOW database of registered bores and wells indicates that there are 143 registered bores within a 5 km radius of the Project Boundary. About two thirds of these bores (97 bores) are located to the south of the Project Boundary in the Namoi Valley alluvial aquifer area which is part of Groundwater Management Zone 4 under the Water Sharing Plan. The remaining one third (46 bores) are located in the vicinity of the Willow Tree Range to the north where the Permian bedrock outcrops.

A total of 68 registered bores are located on land owned by mining companies or Forests NSW.

The remainder are on private freehold land. The registered bores in the Willow Tree Range area are largely groundwater monitoring bores in used by Boggabri Coal and Tarrawonga Mine, or are abandoned bores. Registered bores in the Namoi Valley alluvial aquifer area are used for domestic, stock, irrigation and groundwater monitoring purposes.

8.10.2 Modelling Methodology

The key objectives of the study were to:

- Determine the existing groundwater environment and to identify any existing users and Groundwater Dependent Ecosystems (GDEs);
- Assess the cumulative impacts that may arise from the Project, together with the existing and approved mines in the region;
- Complete detailed numerical modelling of potential groundwater impacts;
- Interpret data and report on groundwater seepage, drawdown and other impacts on connected groundwaters associated with the Namoi Valley alluvial aquifer;
- Describe any measures that would need to be implemented to avoid, minimise, mitigate and offset the impacts of the Project (subject to more effective measures being identified in the future); and
- Determine groundwater management and monitoring protocols to be adopted to meet licensing conditions.

Data necessary for the assessment of the groundwater regime has largely relied upon publically available geological and hydrogeological data and previous EA reports and routine monitoring data collected by Boggabri Coal.

A numerical model was developed using the finite difference method using recent hydrology, hydrogeology and geological structure data.

The three-dimensional groundwater flow model (MODFLOW SURFACT) was used to simulate the impact of the Project on the groundwater regime over time. The modelling used conservative parameters and values and is considered to represent the worst case scenario for potential groundwater impacts for the Project.

8.10.3 Impact Assessment

The groundwater impact assessment considered the current conditions of the groundwater system to provide predictions of the impacts that may be caused by future mining activities.

Existing Mines and Industry Impacts

Current monitoring is indicating depressurisation of the coal seam aquifers being mined up to 2 km from the open cut mining void. The zone of depressurisation extends to the north and south but does not appear to impact water levels in the Namoi Valley alluvial aquifer. This observation is consistent with the predictions of previous numerical models that have indicated a zone of influence that extends approximately 2 km to 3 km from the open cut mining void during the early stages of mining.

Tarrawonga Mine is located 500 m to the south of the Boggabri Coal Mine. The combined zone of influence created by dewatering of these two mines is expected to be interacting with a cumulative impact on groundwater level developing.

Predicted Project Impacts on Regional Groundwater System

Drainage of groundwater during mining will reduce groundwater pressures in the coal seams and overburden / interburden aquifers around the open cut mining void. A numerical model has been developed to assess the cumulative impact of the Boggabri Coal Mine and the adjacent Tarrawonga Mine on aquifer water levels.

The model has predicted the development of the zone of influence (also referred to as zone of depressurisation) for the Project.

The zone of influence will extend out from the highwall of the open cut void and gradually increase in size as mining progresses over the 21 year life of the Project. The progression of the zone of influence at five yearly intervals is shown in **Figure 33**.

The maximum drawdown is predicted to be about 138 m at the end of Year 10 within the mining void, with the magnitude of drawdown reducing with distance from the mining void. The zone of influence will migrate to the boundary of the Namoi Valley alluvial aquifer to the south of the mining void relatively quickly within the first five years of the Project.

The higher recharge rate from slope wash runoff in this area prevents further propagation of the zone of influence into the Namoi Valley alluvial aquifer. In contrast, to the north in the Willow Tree Range area the zone of influence continues to expand over the life of the Project, as recharge is relatively low, as shown in **Figure 33**. Cumulative impacts with adjacent mining operations will be relatively limited as the only adjacent operating mine is the Tarrawonga Mine and their current planning approval expires on 9 November 2017.

Whilst the Permian aquifers (i.e. coal seams and overburden) will continue to be depressurised during the Project, it is likely that the shallow bedrock (regolith) and alluvial aquifers overlying the depressurised areas will develop a perched water table, and will therefore not be affected to the same degree as that simulated for the coal seam aquifers.

Pit Inflows

Table 45 shows the predicted groundwater inflows into the Project mining void for Years 5, 10, 15 and 21. The groundwater model predicts the inflows will rise gradually over the life of the Project from 0.7 ML/day in Year 5 to 1.2 ML/day in Year 21.

Alluvial Aquifer Water Loss

Under natural conditions the groundwater from the Permian coal seam aquifers in the Project Boundary flows to the south and discharges via vertical flow into the base of the Namoi Valley alluvial aquifer.

However, as mining progresses and the Permian coal seam aquifers are depressurised the rate of groundwater flow will be reduced; and with time reversed in the local area. This reduction in the flow rate from the Permian coal seam aquifers to the base of the alluvial aquifer will result in a reduction in water levels in the alluvial aquifer of less than 1 m, which will be undetectable from seasonal cycles.

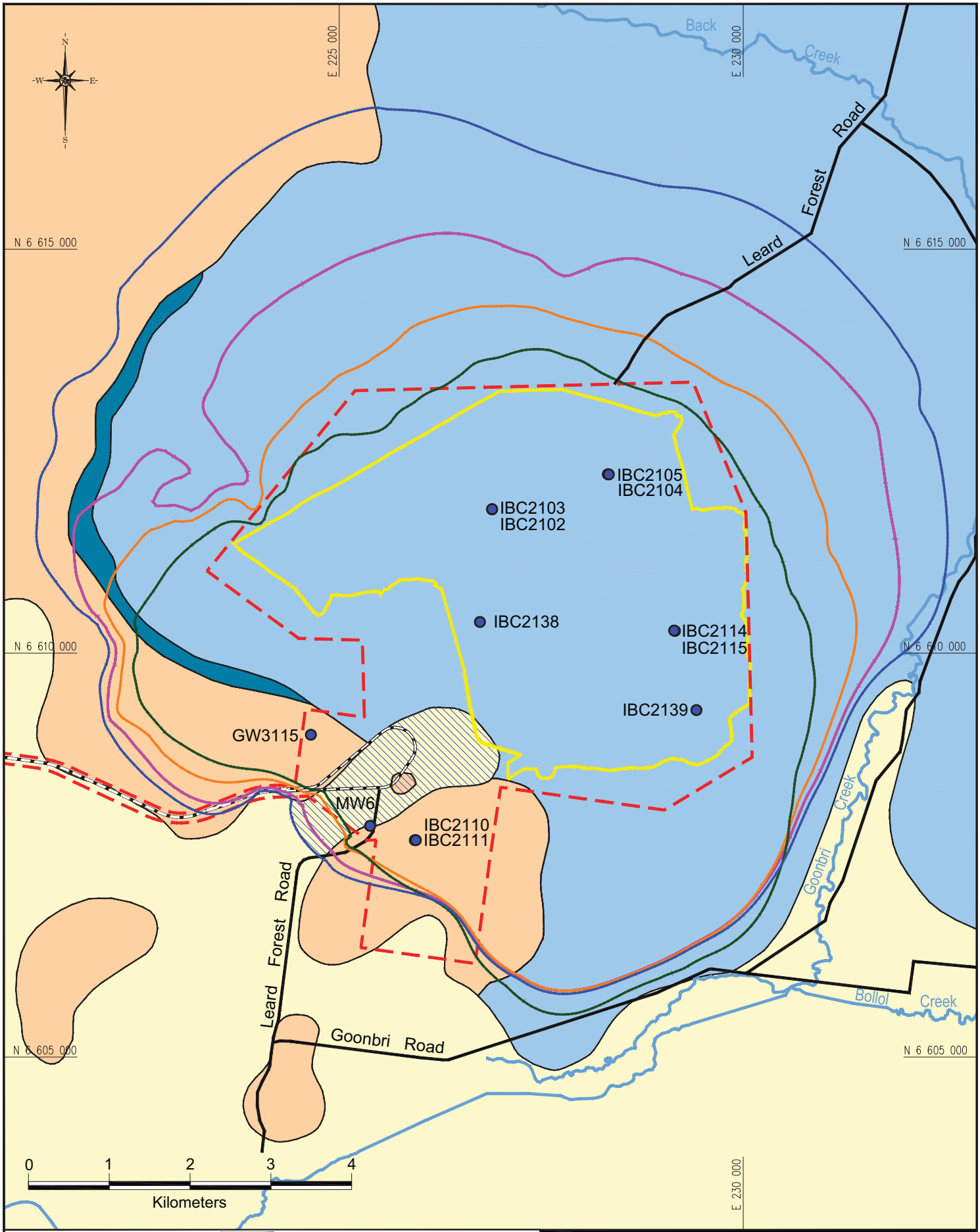
As mining advances to the north and production increases the model predicts approximately 1.6 ML/day flows from the Permian bedrock aquifers and discharges up into the base of the overlying alluvium. This upward flow will gradually reduce over the 21 year approval period to about 1.4 ML/day, a reduction of 0.2 ML/day. This indicates that of the 1.2 ML/day predicted to flow into the mining void in Year 21, about 0.2 ML/day will be from the alluvial aquifer, with the remaining 1.0 ML/day from the Permian bedrock aquifers.

The volume of vertical leakage is considered a worst case scenario as the model assumes direct hydraulic connection between the base of the alluvium and bedrock (i.e. the model does not account for the possible occurrence of a weathered, clay rich transition zone at the base of the alluvium that inhibits leakage).

Impact on Groundwater Users

The depressurisation and leakage of the coal seam aquifers as predicted for the Project will result in a reduction of the water levels in existing bores located in adjacent aquifers within the zone of influence. Modelling indicates the zone of influence will extend to a maximum distance of 3.5 km beyond the open cut void at the end of mining in Year 21. Beyond this zone drawdown will be less than 1 m which is considered undetectable from seasonal fluctuations.

A total of 28 registered bores are located within the zone of influence. The majority of the bores within the zone of influence are located on land owned by Boggabri Coal or other neighbouring mining companies. Fifteen bores are groundwater monitoring sites at either the Boggabri Coal Mine or Tarrawonga Mine.



Project Boundary
Mine Disturbance Boundary
Roads
Creeks
Groundwater Monitoring Site
Zone Of Influence (1m) - Year 5
Zone Of Influence (1m) - Year 10
Zone Of Influence (1m) - Year 15
Zone Of Influence (1m) - Year 21

Alluvial Sediments (Aquifer)
Maules Creek Formation
Boggabri Volcanics
Leard Formation
Interaction with Alluvial Aquifer

Source: Department of Mineral Resources (1998), AGE (2010), Boggabri Coal (2010)

BOGGABRI COAL MINE

Groundwater Depressurisation Zones

Cad File: 06094C.dwg	Date: 13.05.2010	Drawn: CP	Figure 33

Table 45
Predicted Groundwater Pit Inflows

Project (Year)	Predicted Inflow Rate (ML/day)
5	0.7
10	1.0
15	1.1
21	1.2

The remaining bores are located on land owned by local mining companies. No registered irrigation bores constructed in the Namoi Valley alluvial aquifer are present within the zone of influence.

With respect to GDEs, there are no springs identified within the topographically elevated land, (the regolith and Permian sub-crop areas), around which GDEs would develop due to the depth of the groundwater levels. Similarly, no GDEs have been identified in the alluvial areas as water tables are typically greater than 2 m below surface. In any case should they exist it is unlikely that they would be impacted as the modelling indicates drawdown in the alluvial aquifer will be less than 1 m and therefore undetectable and negligible.

Post Mining Recovery of Groundwater Levels

Following the cessation of mining activities, dewatering of the open pit will not be required and a slow recovery in groundwater levels will occur. A final void will remain at the northern extent of the mine footprint with an area of approximately 413 ha and a depth of about 156 m.

The Project assumes that mining will cease at the end of the 21 year approval period. Under this scenario the final void would be backfilled to an RL of 285 m where the ground surface will be above the pre-mining groundwater level of about RL 283 m. This backfilling will prevent the surface pooling of groundwater in the void as the reshaped ground surface will be above the groundwater level.

A depression will remain in the area of the final void after backfilling which may accumulate some runoff, however, this will have very limited connectivity to the underlying aquifer.

In the event that mining continues beyond the 21 year approval period for a further seven years the final void would be much smaller and would provide an even better environmental outcome for the stabilization of groundwater in the region.

Results from the simulation assessment indicate the water level in the Permian bedrock aquifer and mine spoil zone below the final void will require about 50 years to reach an equilibrium level. The groundwater model predicts the water level will stabilise at approximately RL 283 m, which is consistent with the pre-mining water level. As the groundwater level below the void will stabilise close to the surface this will result in some evapo-transpiration.

8.10.4 Mitigation and Management

A Groundwater Water Management Plan will be prepared in consideration of the findings from this assessment. It will ensure that an adequate monitoring network is put in place and is well maintained so that the modelled predictions and assumptions can be verified and any potential unforseen groundwater impacts can be quickly identified and managed.

The Groundwater Water Management Plan will incorporate as a minimum:

- The progressive replacement of monitoring bores which will be mined out or are no longer accessible or unable to be monitored as feasible replacement sites can be determined;

- Installation of 11 additional monitoring bores around the mine to monitor groundwater levels and quality in the Namoi Valley alluvial aquifer and the Permian coal seam and overburden aquifers;
- Installation of data loggers in monitoring bores where practical, to record groundwater fluctuations and salinity on a daily basis; and
- Monitoring of seepage rates and water quality in the open cut mining void.

During the installation of the additional monitoring bores proposed, permeability tests will be undertaken to obtain further knowledge of the characteristics of the aquifers.

In the unlikely event of water levels in existing landholder bores declining as a consequence of the Project, leading to an adverse impact on water supply, the supply will be substituted by Boggabri Coal in consultation with the landholder either by deepening the bore, construction of a new bore or providing comparable water from an external source.

A Final Void Management Plan will be developed in consultation with relevant regulatory authorities to the approval of DoP.

8.11 GEOCHEMICAL

8.11.1 Background

RGS Environmental Pty Ltd (RGS) conducted a geochemical assessment of overburden and potential coal rejects materials for the Project which is presented in full in **Appendix P** with a summary provided below.

This assessment aimed to update and enhance preliminary geochemical assessment work completed on these materials as part of the Boggabri EIS and more recent work (EGi, 2006).

RGS conducted a targeted geochemical characterisation of overburden material and potential coal reject material from the four Project target coal seams (Braymont, Bollol Creek, Jeralong and Merriown).

The results of the characterisation have been used to confirm and update the results of previous investigations and develop any necessary environmental management measures related to overburden and potential coal reject emplacement and rehabilitation.

8.11.2 Methodology

RGS completed a review of available geochemical and geological data associated with the Project to assist in the development of an overburden and coal reject sampling and testing program. Technical guidelines for geochemical assessment of mine waste in Australia (AMIRA, 2002; DITR, 2007) and worldwide (INAP, 2009) were used as a framework for developing the sampling (and geochemical testing) program for the Project.

The program devised ultimately relied upon the results from three previously assessed drill holes and an additionally selected two drill holes at locations with sufficient spread to ensure the lateral coverage of the entire Project area. A total of 69 samples were collected from the additional two drill holes at various depth intervals. The samples represented the range of overburden (and interburden) lithologies (47 samples) found at the mine and also potential coal rejects materials taken from the roof and floor material at the target coal seams (22 samples).

Samples were subjected to a series of geochemical tests at a commercial laboratory in Brisbane. The sampling program from all five drill holes covered the entire spread of the expected geological variability and complexity in rock types and has allowed for an assessment of the potential for significant environmental or health impacts in consideration of the size of operation, statistical sample representation requirements, material volumes, level of confidence in predictive ability and cost.

In particular, the geochemical test program has assessed the degree of risk from Acid Rock Drainage (ARD), oxidation of pyrite, leachability of metals, and characterisation of standard soil parameters including salinity, sodicity, cation exchange capacity, potential nutrients and major metal compositions.

8.11.3 Impact Assessment

Overburden

Most Project overburden is likely to have negligible (< 0.1%) total sulphur content and is therefore classified as Non Acid Forming (NAF) barren. Overburden also appears to have excess acid buffering capacity typical of a moderate Acid Neutralising Capacity (ANC) value, which should more than compensate for any acid that could potentially be generated from the small amount of overburden materials with uncertain acid generating classification.

Most overburden materials generated by the Project are likely to be NAF and have a high factor of safety with respect to potential acid generation and can therefore be regarded as a NAF unit. The concentration of total metals in overburden solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with revegetation and rehabilitation.

Most overburden materials will generate slightly alkaline and relatively low-salinity run-off and seepage following surface exposure. The major ion chemistry of initial surface run-off and seepage from overburden materials is likely to be dominated by sodium, bicarbonate, chloride and sulphate.

The concentration of dissolved metals in initial run-off and seepage from overburden materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.

Most overburden materials are sodic and likely to have structural stability problems related to potential dispersion. Some near surface and conglomerate overburden materials are likely to be less sodic and may be the most suitable materials for revegetation and rehabilitation activities (as a growth medium).

For all other sodic overburden materials, it is likely that treatment would be required if these were to be considered for use as vegetation growth medium.

Coal Rejects

Most potential coal reject materials are likely to have negligible (< 0.1%) total sulphur content and are therefore classified as NAF-barren. These materials have a high factor of safety with respect to potential acid generation. A small proportion of the potential coal reject materials located near the Braymont Seam (roof samples) have a relatively high total sulphur content and negligible buffering capacity (and hence a low factor of safety) and are classified as Potentially Acid Forming - High Capacity (PAF). This finding correlates well with the findings of previous geochemical assessment, however the previous work also indicated the existence of some PAF materials associated with immediate roof and floor materials at both the Braymont and Jeralong seams.

The concentration of total metals in potential coal reject solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with revegetation and rehabilitation. Most potential coal reject materials will generate slightly alkaline and relatively low-salinity runoff and seepage following surface exposure. The exception is potential coal reject material from the Braymont seam (and potentially the Jeralong seam) where PAF materials may generate acidic and more saline run-off and seepage.

For PAF materials, the initial concentration of soluble sulphate in run-off and seepage is expected to remain within the applied water quality guideline criterion, although further exposure to oxidising conditions could lead to increased soluble sulphate concentrations.

The concentration of dissolved metals in initial run-off and seepage from potential coal reject materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.

Most potential coal reject materials are sodic and likely to have structural stability problems related to potential dispersion and as such, these materials are unlikely to be suitable for use as a vegetation growth medium.

8.11.4 Mitigation and Management

Overburden

The ongoing management of overburden will consider the geochemistry of these materials with respect to their potential risk to cause harm to the environment and their suitability for use in construction and revegetation. Boggabri Coal will undertake:

- Pre-stripping topsoil from areas to be mined for use in final rehabilitation activities (surface cover or vegetation growth medium);
- Placement of overburden at the OEA in a manner that limits the risk of surface exposure of highly sodic material and subsequent run-off and erosion; and
- Monitor surface water run-off and seepage from OEA material to ensure that key water quality parameters remain within appropriate criteria for pH, electrical conductivity (EC), total suspended solids (TSS) and dissolved metals, as required.

Potential Coal Reject

The ongoing management of coal reject material will consider the geochemistry of these materials with respect to their potential risk to cause harm to the environment and their suitability for use in construction and revegetation. Boggabri Coal will:

- Ensure placement of reject materials will occur in the open pit and / or co-disposed with overburden;
- Undertake deep (in-pit) burial of PAF potential coal reject materials from the Braymont and Jeralong seams;
- Place NAF potential coal reject material during co-disposal in a manner that limits the risk of surface exposure of highly sodic materials and subsequent run-off and erosion; and
- Confirm geochemical and physical characteristics of coal rejects material when bulk samples become available from the CPP.

8.12 ECONOMICS

An economic assessment was undertaken by Gillespie Economics and is reproduced in **Appendix Q**.

8.12.1 Background

The economic assessment was primarily concerned with the determination of the following two issues:

- The economic efficiency of the Project (i.e. consideration of economic costs and benefits); and
- The economic impacts of the Project (i.e. the economic stimulus that the Project will provide to the regional and State economy using input-output analysis).

8.12.2 Impact Assessment

Benefit Cost Analysis

The Benefit Cost Analysis (BCA) compared the Project (i.e. continuation of mining for a further 21 years with up to 7 Mtpa of product coal) to the Base Case (i.e. cessation of current mining operations in November 2011). The incremental economic costs and benefits of the Project are summarised in **Table 46**.

The BCA identified that the net production benefits of the Project were approximately $1,266 Million.

The Project will have a range of potential external costs, including air quality impacts, noise and vibration impacts, some traffic and transport impacts and ecological offsets, which were included in the estimate of capital and operating costs for the Project and have already been accounted for in the above estimate of net production benefits.

The economic costs associated with greenhouse gas generation were estimated at $138 Million (assuming a conservatively high greenhouse gas social cost).

External benefits associated with employment provided by the Project were estimated based on benefit transfer. Overall the Project is estimated to have net benefits to the community of $1,362 Million and hence is desirable and justified from an economic efficiency perspective.

Regional Economic Impact Assessment

Regional economic impact assessment is primarily concerned with the effect of an impacting development on an economy in terms of a number of specific indicators, such as gross regional output, value-added, income and employment.

The impact study completed for the Project examined the direct and indirect impact of the continuation of the Boggabri Coal Mine on the local region (Narrabri LGA and Gunnedah LGA) and NSW as a whole using input-output analysis. Refer to **Table 47**.

The regional sectors most impacted by output, value-added, income and employment effects are likely to be the coal mining sector, agricultural and mining machinery manufacturing sector, wholesale trade sector, retail trade sector, mining services sector, technical services sector, road transport sector and hotels, cafes and restaurants sector.

8.12.3 Mitigation and Management

The BCA incorporates a range of externality costs into the estimation of the net production benefits of the Project and separately estimates externality costs associated with greenhouse gas generation.

Minimisation of environmental externalities in the most cost effective manner will assist in maximising the net economic benefits of the Project.

Mitigation measures for specific environmental issues are addressed in other sections of the EA as required.

At the end of the Project, in 21 years, the economic stimulus provided by it will largely cease.

It is therefore important for regional authorities and leaders to take every advantage from the stimulation to economic activity including skills and expertise that the Project brings, to strengthen and broaden the region's economic base.

Table 46
Potential Incremental Economic Benefits and Costs of the Project

Category	Costs	Benefits
Production	• Opportunity cost of State Forests land • Opportunity cost of existing land owned by Boggabri Coal • Opportunity cost of capital • Capital costs associated with coal production and ancillary works • Operating costs, including administration, mining, processing, transportation and rehabilitation(ex royalties) • Decommissioning costs	• Avoided decommissioning costs in 2011 • Sale value of coal • Residual value of capital and land at the cessation of the Project
Potential Externalities	• Air quality impacts • Greenhouse gas impacts • Noise and vibration impacts • Ecology impacts (including opportunity cost of production from agricultural land acquired by Boggabri Coal and set aside as ecological offsets) Groundwater impacts • Traffic and transport impacts • Aboriginal archaeology and cultural heritage impacts • Non Aboriginal heritage impacts • Visual impacts • Surface water impacts and sediment / erosion control	• Economic and social benefits of employment provided by the Project

Table 47
Project State and Regional Economic Contributions

Region	State
• $819 Million in annual direct and indirect regional output or business turnover	• $1,527 Million in annual direct and indirect output or business turnover
• $360 Million in annual direct and indirect regional value added	• $689 Million in annual direct and indirect value added
• $120 Million in annual household income; and	• $315 Million in annual household income; and
• 1,171 direct and indirect jobs	• 3,675 direct and indirect jobs

8.13 SOCIAL IMPACT ASSESSMENT

8.13.1 Background

Hansen Bailey completed a SIA for the Project which is presented in full in **Appendix R.** This study aimed to identify any future socio-economic impacts of the Project including any issues raised by stakeholders during the EA consultation program.

The study identified the future effects of the Project on people including; culture (such as traditions), their way of life (lifestyle, working conditions and interactions between each other) and their community (services and structures).

8.13.2 Industry Activities

The Gunnedah Basin is developing as one of the primary coal fields in NSW. Of the 60 coal mines and 30 development projects making up the mining industry, 10 are registered in the Gunnedah Basin.

The Assessment of opportunities for the NSC from Coal Mining and Gas Extraction in the Gunnedah Basin report estimates 270 to 290 people were employed directly in the mines in the Gunnedah Basin in 2007 with a further 230 to 250 people likely to be employed within the next 5 - 7 years (JRA 2007).

The current coal mines in the Gunnedah Basin are predominantly concentrated in the Boggabri and Baan Baa area, to the south south-east of Narrabri, with a secondary node at Werris Creek in the south-east corner of the Basin.

JRA 2007 reports that the regional town of Gunnedah is emerging as the mining service centre for the area with a diverse range of services and facilities supporting not only the mining industry but also related service industries.

In the Narrabri LGA these changes in industry activities are reflected in employment statistics from the Australian Bureau of Statistics (ABS) in 2006. The primary employment provider still remains the agricultural industry however, as a result of the severe and prolonged drought there has been a decline in the agricultural and wholesale trade employment sectors.

There has also been a reduction in employment in the agriculture and forestry industries, with significant reductions in the manufacturing and wholesale trades.

There has been a corresponding significant increase in employment in the mining industry, with minor increases in employment in the education, health care and administrative services industries.

Boggabri Coal has considered the *Namoi Catchment Management Authority Catchment Action Plan 2007* in the preparation of this SIA.

8.13.3 Socio-Economic Characteristics

The following section provides an overview of the existing socio-economic characteristics of the Narrabri and Gunnedah LGAs and the key existing socio-economic issues facing the local community. These include the main townships of Narrabri and Gunnedah and also the smaller townships of Boggabri, Wee Waa and Curlewis.

Narrabri LGA

The Narrabri LGA is located in the Namoi Valley in north-western NSW and according to ABS Census data from 2006 consists of a population of 13,106 persons. The main township in the LGA is Narrabri which in 2006 had a population of 6,234 persons (47.6% of the total LGA population).

The surrounding townships of Boggabri and Wee Waa contain 6.9% and 12.8% of the total LGA population respectively.

Over the past 20 years, the Narrabri LGA has experienced a loss of population across all towns, which is a trend evident in similar rural NSW LGAs. During the 2001 to 2006 census periods, the Narrabri LGA experienced a decrease in population of 5.1%, a total of 711 people.

Despite the population loss, the economy of the LGA has continued to grow with three coal mines recently commencing operations, another gaining approval, a new supermarket being developed and additional accommodation facilities being established in the town of Narrabri.

The Narrabri LGA has an ageing population, with the median population age increasing from 36 years in 2001, to 38 years in 2006. Unemployment rates are relatively high however they have dropped marginally from 8.1% in 2001 to 7.1% in 2006. The median household weekly income of $792 is 23.6% lower than the NSW median household income of $1,036.

Gunnedah LGA

The 2006 ABS Census data estimates the Gunnedah LGA population to be 11,525 persons. Approximately 75% of the LGA population live in either the township of Gunnedah or the largest outlying village of Curlewis.

The Gunnedah LGA has a declining population which has decreased by 3.8% (a total of 451 people) over the 2001 - 2006 census periods. The area has an ageing population, with the median population age increasing from 37 years in 2001 to 40 years in 2006.

The Gunnedah LGA has similar population demographics to Narrabri with high unemployment rates, a relatively large indigenous population and medium household income levels 31% less than the medium income levels for NSW.

8.13.4 Workforce Impacts

Population changes associated with a large scale project can potentially result in a range of social impacts to the local community.

These impacts may include the lack of capacity for existing infrastructure and services to cope with the increased population and associated impacts to individuals, families and communities.

In the Gunnedah and Narrabri LGAs there is a high level of unemployment and a low rate of workforce participation. It is predicted that as employment opportunities increase many people will re-enter the workforce. An estimated 2,000 people in the region are available for employment which indicates that the increased demand for employees could be absorbed locally.

Estimated workforce numbers and residential trends from the Project has enabled the study to model potential impacts which may result from an influx of construction and operational employees into the area as a result of the Project. The severity of the impacts is assessed on the ability of the existing services and infrastructure to accommodate an increased population.

Outcomes of the population impact analyses are interpreted in light of whether existing service and community infrastructure has the capacity to accommodate the projected population changes during the construction and operational phases of the Project and are discussed below.

Construction Phase

Project construction is anticipated to commence in Year 1 and continue for a period of five years. It is anticipated that peak workforce personnel during the construction phase will be 150 equivalent full time employees.

This assessment assumes that 60% of the construction workforce, a total of 90 employees, will be sourced locally with the remaining 40% (60 employees) of the workforce sourced outside the Region.

As the construction phase is temporary and spread over a period of five years, it is assumed that any non local hires will not be accompanied by their families and are most likely to reside in temporary accommodation in close proximity to the Project.

The demand for short-term accommodation for construction workers will be up to 150 units of accommodation (assuming one single accommodation unit per worker).

Boggabri Coal proposes to construct an accommodation camp for the purposes of housing the non local hires as required. It should be noted that upgrades to existing infrastructure and the construction of the CPP, rail loop and rail spur will occur in a staged approach over a five year period. As such construction workforce numbers will fluctuate as construction works progress during this phase.

Operational Phase

The existing workforce consists of approximately 90 permanent and 20 contract personnel, the majority of which have been sourced locally. The largest portion of employees live in the Narrabri LGA flowed by the Gunnedah LGA.

The Project is expected to employ approximately 234 people in Year 1 with the continuation of the existing Boggabri Coal Mine. The majority of recruitment will occur between Year 1 and Year 10 as production increases. The workforce will increase up to approximately 500 personnel by Year 10 coinciding with the maximum coal production of 7 Mtpa.

It is predicted that 49% (245 employees) of the operations workforce will be local hires and 51% (255 employees) will be non-local hires, with 14.4% (35 employees) of these drawn from outside the region and interstate. Non-local hires will predominantly consist of experienced maintainers, mine operators and professional staff.

Local hires will include local ancillary staff, apprenticeships and graduates. **Table 48** illustrates the existing residential patterns and the predicted percentage of non local personnel which are likely to reside in various townships.

Given that Boggabri Coal predicts that in the operations phase it will employ 245 employees from the local area, there is a potential to impact the availability of skilled labour and small businesses.

As mentioned previously there is a small availability of skilled labour and therefore in the initial stages a large number of non-local hires may be required to develop the Project. Any local skilled labour which is employed may reduce the total employment pool for other industries as a result.

Impacts on Population and Demographics

The Project will require an increase of 255 non-local hires creating an approximate increase in the total residential population of 638 and result in a demand for an addition 255 dwelling units. **Table 49** below summarises the potential estimated population increases within the main settlements of the local area which could be attributed to the operations phase of the Project. This information is based on the potential workforce residential plan described in **Table 48**.

8.13.5 Impact on Community Values, Aspirations and Lifestyle

There are a number of potential positive social impacts of new mining operations on social capital and lifestyle in the local area.

The Project will create additional employment opportunities and increase the number of skilled persons in the workforce in the long term.

As a result of the increased population there will be a number of direct and indirect positive impacts including:

- Increased participation in community service and sporting activities which will develop stronger social networks;
- Strengthening of the local economy through increased spending;

- Act as a catalyst for the development of local business enterprises;
- Act as a catalyst for further subdivision and development of residential and commercial land;
- Reduce social stress through provision of local jobs and enhanced economic well being;
- Encourage young people to stay in the local area through the direct and indirect provision of employment;
- Encourage local women, young people and indigenous people into the workforce; and
- Contribute diversity to the existing economic base of the Narrabri LGA which is currently heavily reliant on the agricultural, forestry and wholesale trade sector.

8.13.6 Local Services Impacts

Both Narrabri LGA and the Gunnedah LGA are well serviced with health and education facilities, a range of recreational facilities along with retail and commercial enterprises. This is demonstrated through the proliferation of community groups and organisations, sporting clubs, industry bodies and support networks.

Education and health services have the capacity to meet any demand generated by the additional population as further discussed below.

Health Services

The local area is served by several local hospitals in the townships of Narrabri, Boggabri, Wee Waa and Gunnedah.

The Narrabri Hospital is a 40 bed facility and the Gunnedah Hospital is a 43 bed facility. Both provide general medical and surgical services and obstetric care. The Boggabri Hospital was constructed in 2002 and provides hospital and health services and 16 aged care places with associated facilities. Additional healthcare facilities are provided at community health centres in the towns of Narrabri, Boggabri, Wee Waa and Gunnedah.

Aged care facilities are also available in the same communities. Home and Community Care provides services in Narrabri, Boggabri and Gunnedah.

The additional population will increase the demand for a range of health services including general practitioner and child health services as well as additional family support and children's services such as playgroups. However, given that the Project and other proposed developments in the Gunnedah Basin will contribute to both economic diversity and economic growth in the local area, more service and facility operators and suppliers such as general practices are likely to be attracted to the area.

Table 48
Existing and Potential Workforce Residential Pattern

Residential Location	Existing Residential Distribution (%)	Predicted Distribution of Local Hires (%)	Predicted Distribution of Non Local Hires (%)
Gunnedah	39	39	30
Narrabri	25	25	55
Boggabri	19	19	10
Other local areas	14	17	5
Other North Western NSW areas	3	-	-

Table 49
Estimated Population Increase of Operational workforce

Workforce Profile 1	Narrabri Township	Gunnedah Township	Boggabri Township	Other Areas	Total Persons
Total Workforce	198	173	72	57	500
Non-local hires	140	77	25	13	255
Total Incoming Population	351	191	64	32	638
Estimated Adults (18+ yrs) – (73.9%)	259	141	47	24	471
Estimated children (<18 yrs) – (26.1%)	92	50	17	8	167
Estimated Children (<18 yrs) Breakdown					
Estimated children <5 yrs – (6.6%)	23	13	4	2	42
Estimated primary school children – (10.2%)	36	20	7	3	66
Estimated secondary school children – (10.5%)	37	20	7	3	67

Note: Population breakdown is based on NSW Northern Statistical Division 2006 ABS Census Age Profile

Education and Childcare

Primary, secondary and tertiary educational facilities are provided in both the Narrabri and Gunnedah LGAs. Many townships have childcare and pre-school facilities. The closest university facilities are provided in Armidale at the University of New England.

Corkery & Co (2009) indicates that there are currently 896 primary school students and 595 secondary school students enrolled in the three primary schools and one secondary school in Narrabri.

It is predicted that an additional 36 primary and 37 secondary school age children may attend schools in Narrabri representing an increase of 4% and 6% respectively to existing enrolments. There are 138 students enrolled in the state and catholic schools in Boggabri with a joint capacity of 205. The estimated additional 7 primary school age children who may attend school in Boggabri represent an additional 3.4 % increase on current primary school enrolments.

There are 1,039 primary school children and 917 secondary school children attending the four primary schools and two high schools in Gunnedah. It has been estimated that there will be an additional 20 primary and 20 secondary school age children who will attend schools in Gunnedah as a result of the Project which is an additional 2%.

The existing education facilities have the current capacity to enrol a further 173 primary students and 603 secondary students within the Narrabri and Gunnedah LGAs.

As a result of the Project there is a total predicted increase in additional enrolments of 63 primary students and 57 secondary students. The existing educational facilities are predicted to be capable of absorbing the increased population associated with the Project and is not expected to create any additional strain on educational facilities.

Residential Housing and Accommodation

The dominant dwelling type in the local area is separate houses which make up 80% of total dwellings with units and flats constituting 15% of dwellings in the local area. The form of accommodation in the local area is changing to reflect the demand by mining and related industries.

A search of the realestate.com.au website on 2 December 2009 for the Narrabri township produced 61 houses / units for sale. A similar search for Gunnedah produced 172 houses / units for sale with an additional 33 houses / units listed for sale in Boggabri. There are a further three hotels / motels and one caravan park in Boggabri. Narrabri and Gunnedah have a further 10 and 23 short term accommodation options respectively.

In Gunnedah, non-private housing options include housing stock held by the NSW Department of Housing, Homes North Community Housing and three indigenous organisations. In 2006, the share of total dwellings in public housing was 4.6%.

There are currently around 378 social housing dwellings in Narrabri. In 2006, public housing represented 4.7% of all housing in Narrabri which is above the average for non-metropolitan NSW of 3.5%.

The Gunnedah LGA does not have a GMS nor has it quantified the amount of residential land available for future development. Corkery and Co (2009) suggests that at least 550 lots are currently available for residential development under the provisions of the current Gunnedah LEP.

It may be assumed that the Gunnedah LGA has a good supply of homes and vacant blocks for sale in town and a relatively stable local housing market.

As discussed above, the Project will draw an additional 638 people to the local area generating a demand for 255 dwellings. Based on the findings of the land use survey, there are a number of large land stocks available in the townships of Wee Waa, Narrabri, Baan Baa and Boggabri, the NSC concluded in the Narrabri Shire Draft GMS (2009) that there is sufficient supply of residential land in the Narrabri LGA to meet the likely demands of the LGA for the next 10 years, even taking account of the potential increase in demand for housing in the Boggabri area.

8.13.7 Cumulative Population Impact

There is potential for cumulative impacts due to the number of other existing and proposed mining operations identified in the Gunnedah Basin. These operations in the future may add pressure to community infrastructure, services and housing and include the Watermark, Maules Creek, Caroona Projects and numerous Whitehaven mines just to name a few. Potential areas of negative cumulative impact in the local area include:

- Housing affordability and accessibility;
- Skill shortages; and
- Supply and demand for community services and facilities.

It must be noted that the potential population increases described above relate solely to the workforce for the Project and do not take into account indirect employment opportunities generated by the Project and the associated workforces. Given the anticipated growth in coal mining in the Gunnedah Basin it is inevitable that there will be growth in the population base which can be attributed to the provision of indirect employment opportunities.

There are concerns that the local community may suffer a skills shortage as people were leaving other industries to join the mines thus causing hardships upon those other industries.

The total number of people potentially available for employment across the local area is over 2,000 people. This indicates that the local area has the capacity to absorb a number of larger scale projects. However, with the number of Projects and the timing of employment coinciding it is highly likely that recruitment strategies for all coal mining companies in the Gunnedah Basin will shift from local labour to imported labour as the major projects move to production.

8.13.8 Mitigation and Management

Boggabri Coal Mine has been operating since 2006 and has a well established presence in the Narrabri LGA. Boggabri Coal has established a VPA with the NSC in relation to the Project pursuant with Section 94 of the EP&A Act. This VPA was developed in consideration of the *NSW Catchment Management Authority Extractive Industry Policy 2009*.

Boggabri Coal has a strong focus on supporting local industry, businesses and employing local people. Boggabri Coal will continue open two way communication with the NSC and broader community and provide further information on issues of interest to the community.

8.14 WASTE

8.14.1 Background

Boggabri Coal has developed and implemented an effective Waste Environmental Management Plan (Waste EMP) for the management of all wastes produced onsite. The Waste EMP has been developed in accordance with objectives of the *Waste Avoidance and Resource Recovery Act 2001* along with other relevant legislative requirements, and is discussed further below.

8.14.2 Waste EMP

Boggabri Coal's Waste EMP utilises an approved, independent waste contractor working within the provisions of the POEO Act to monitor, remove, track and report wastes. Complementing this, the waste segregation component ensures each waste stream is segregated in the appropriate receptacles for recycling, reuse and / or disposal.

In addition, the Waste EMP outlines measures for the prevention and reduction of waste through the improved efficiency in the use of raw materials.

The Waste EMP has documented procedures for the minimisation, storage, transport, disposal, tracking and reporting of waste generated onsite. To ensure the Waste EMP is working effectively and appropriately for the changing needs of the operation, regular inspections and monitoring will be conducted by appropriately qualified personnel.

General Waste

All wastes that are no longer considered usable in its present form will be placed in designated recyclable waste bins, which can receive combined recyclable wastes and includes paper, cardboard, glass, recyclable plastics, scrap metal, timber, green waste, bricks and cladding.

Recyclable wastes will be transported to an appropriate recycling centre for separation and recovery where practical. Other general waste for disposal to landfill will be collected by a licensed contractor.

Hazardous Waste

The disposal of hazardous waste will be undertaken in accordance with DECCW Waste Classification Guidelines and the Australian Dangerous Goods Code. All hazardous wastes will be stored within a bunded storage facility prior to disposal. Detailed records of the type and quantity of hazardous waste transported and disposed of from site will be maintained. Periodic training will be provided to employees and contractors to ensure high standards of safety and waste disposal are achieved.

Boggabri Coal will manage a Bioremediation area for the capture and storage of contaminated material produced at the workshop and wash pad pit. An oil and grease separator will be used to remove any contaminated material from the water with the reclaimed water held in water tanks for dust suppression. Waste grease and bulk waste oil will be held in storage tanks in a bunded area prior to removal from site by a licensed contractor for recycling or disposal at a licensed facility.

Any spills that occur within collection areas will be contained within bunds and managed in accordance with objectives of the Waste EMP.

Sewerage Treatment

Boggabri Coal has an onsite treatment facility for the handling of effluent from staff amenities. The treated effluent is removed from site by a licensed contractor for disposal into a licensed waste treatment facility in Gunnedah. The current capacity of the sewerage treatment facility will need to be increased to facilitate the proposed increase in permanent employment levels and contractors for the Project. The increase in capacity will be designed in accordance with the relevant Australian Standards and to comply with the various regulatory requirements.

Wastewater from the treated effluent will be recycled through the mine water system for use in the CPP or utilised for irrigation on vegetated areas adjacent the mine infrastructure area as part of the irrigation system. Water quality will be monitored on a regular basis as part of the ongoing water monitoring program.

8.14.3 Impact Assessment

The current Waste EMP will continue to be utilised for the Project and upgraded where necessary to cater for the additional workforce required for the Project. The sewerage treatment plant facilities in particular, will be upgraded to cater for the additional construction and operational personnel. Upgrades to these facilities will be commensurate with the increase in production and employee numbers.

8.14.4 Mitigation and Management

The Waste EMP will continue to be utilised for the Project. Training will continue to improve efficiency in the minimisation of waste streams, reuse and recycling options and management strategies for each major waste stream relevant to key work areas.

Treated wastewater will be monitored in accordance with the *Environmental Guideline for the utilisation of Treated Effluent (DEC, 1995).*

8.15 SOILS AND LAND USE

8.15.1 Background

GSS Environmental (GSSE) completed a soil and land capability impact assessment for the Boggabri Coal Mine which is reproduced in full in **Appendix S**.

Major objectives of this assessment for the Project Boundary were to:

- Define the soils types and highlight any areas of unfavourable material which require specific management and handling;
- Describe and delineate agricultural suitability;
- Provide recommendations for stripping depth for proposed disturbance areas, including any recommendations for handling, stockpiling for reuse in rehabilitation; and
- Describe necessary erosion and sediment control measures to manage insitu and stockpiled soil resources.

8.15.2 Methodology

A soil and land capability survey was undertaken in August 2009 by GSSE and included soil mapping and profiling, a soil field assessment and soil laboratory testing to:

- Classify and determine the soil profile types of the study area;
- Assess the suitability of the current topsoil material for future rehabilitation; and
- Identify any potentially unfavourable soil material for rehabilitation.

An initial soil map was developed utilising aerial photography, topographic maps and previous soil survey results. Soil profiling was undertaken with the development of 14 pit sites which were assessed in accordance with Elliot and Veness (1981) and additionally observed through the use of surface exposures located in existing erosion gullies, creek banks, roadway cuttings, and dams. Samples were analysed to establish the suitability of surface and near-surface soil horizons as potential growth media, and identify high value soils and, conversely, soils that may have properties that are deleterious to vegetation establishment.

Land capability was determined in accordance with the Department of Natural Resources (DNR) (formerly the NSW Soil Conservation Service) rural land capability classification system which is comprised of eight classes, classified on the basis of an increasing soil erosion hazard and decreasing versatility of use.

Agricultural suitability was also determined in accordance with the I&I NSW agricultural suitability classification system which consists of five classes, providing a ranking of lands according to their productivity for a wide range of agricultural activities with the objective of determining the potential for crop growth within certain limits.

8.15.3 Impact Assessment

Soil Types

Four distinct soil units were identified within the Project Boundary as shown on **Figure 34**: grey brown gradational loam; light brown uniform gravelly sand; light brown duplex loam; and brown gradational clay with each discussed briefly below.

Grey Brown Gradational Loam

The Grey Brown Gradational Loam soils generally consist of pale brown to light grey gravelly sandy loam to loams overlying a gradual change to light yellowish brown clay loam.

These moderately drained soils range from slightly acidic to neutral in the upper layers to strongly acidic to moderately alkaline at depth. The soils are generally non saline with poor to moderate fertility characteristics. The topsoil is non-sodic tending to moderately sodic in the subsoil.

These soils cover approximately 34% the Project Boundary and are found on the waning mid to lower slopes within the Leard State Forest.

The top 0.15 m of this soil is suitable for stripping and reuse as topdressing in the rehabilitation process with the subsoil not recommended for use due to the limiting factors of stone content and moderate sodicity with depth. This soil requires only the standard erosion and sediment control measures however given the sodicity at depth, if the topsoil is removed, it may lead to erosion in wet conditions.

Light Brown Uniform Gravelly Sand

The Light Brown Uniform Gravelly Sand soils generally consist of light brown to brown very gravelly loamy sands throughout the profile. These are well drained soils ranging from moderately acidic to strongly acidic at depth. The soils are generally non saline with poor fertility characteristics with both topsoil and subsoil non-sodic.

These soils cover approximately 33% of the Project Boundary and are found on the upper slopes, crests and ridgelines within the Leard State Forest. The soil is unsuitable for stripping and reuse as a topdressing material in rehabilitation due to the high stone content. This soil requires only the standard erosion and sediment control measures if disturbed.

Light Brown Duplex Loam

The Light Brown Duplex Loam soils generally consist of a brown to dark yellowish brown sandy loam topsoil overlying pinkish grey sandy loam which overlies a texture contrast to pale brown to yellowish red sandy clay subsoil. These moderately drained soils range from moderately acidic in the upper layers to strongly alkaline at depth. The soils are generally non saline with poor fertility characteristics. The topsoil is non-sodic whilst the subsoil is sodic to very sodic.

These soils cover 21% of the Project Boundary, predominantly on the lower slopes within the Leard State Forest and nearby grazing land. The top 0.10 m of soil is suitable for stripping and reused as a topdressing in rehabilitation with the lower layers generally unsuitable due to limiting factors of massive structure, prohibitive stone content, high sodicity and alkalinity. This soil requires only the standard erosion and sediment control measures however given the sodicity at depth; if topsoil is removed it may lead to erosion in wet conditions.

Brown Gradational Clay

The Brown Gradational Clay soils generally consist of brown loam to clay overlying a clear change to brown clay to clay loam.

These poorly drained soils range from neutral to strong alkaline in the upper layers to moderate to strong alkaline at depth, are generally non saline with good fertility characteristics. The topsoil is non-sodic tending to highly sodic in the subsoil.

These soils cover 12% of the Project Boundary and are found on the lower slope, flats and floodplain of the higher quality grazing and cropping soil. The top 0.20 m of the sections of loamy soil is suitable for stripping and reused as a topdressing in rehabilitation. The sections with clay topsoil and all subsoil is texturally unsuitable and therefore not recommended for reuse in the rehabilitation process. Other factors limiting the subsoil include high sodicity and high alkalinity.

Source: Google Maps (2009), Boggabri Coal (2010) GSSE (2009)

BOGGABRI COAL MINE

Soil Units

Cad File: 05512D.dwg	Date: 13.05.2010	Drawn: CP	Figure 34

This soil requires only the standard erosion and sediment control measures however given the sodicity at depth, if topsoil is removed it may lead to erosion in wet conditions.

Topdressing Suitability and Availability

Appropriate stripping depths for each soil unit are shown in **Table 50**. The potential for acid generation from regolith material (topsoil and subsoil) within the Project Boundary was also assessed to be low for the assessed materials (i.e. above the consolidated bedrock).

Land Capability and Agricultural Suitability

The Leard State Forest has a modified land capability classification of 'State Forest' due to the land use zoning of State Forests, which overrides the general capability of the land for this assessment. Furthermore, areas affected by mining activities also hold unique classification specifically for mined land.

Therefore the assessment of land capability for the Project is restricted to areas not previously zoned state forest or classified as mining land. Immediately south of the Project and Leard State Forest, land capability ranges from Class II and III on the lower slopes and flats to Class VI land on the steeper rocky hills. Following the proposed rail spur to the west, the land varies between Class II – Class VIII to the rail loadout facility.

The agricultural suitability classification within the majority of the Project Boundary consists of Class IV and V agricultural suitability covering areas of 1,164 ha and 990 ha respectively.

These lands are generally located within the Leard State Forest, hilltops and slopes and are marginal (not suitable for cultivation and with a low to very low productivity for grazing).

Class III land covers approximately 726 ha to the south-west of the active mining area within the Project Boundary and includes moderately productive lands suited to improved pasture and rotational cropping. Some Class II highly productive land exists predominantly within the rail alignment.

8.15.4 Mitigation and Management

In order to reduce the potential for degradation at the Project and adjoining lands, the following strategies will be implemented during construction and mining.

This will achieve the desired post mining land capability and agricultural suitability outcomes:

- Materials will be stripped to indicated levels in a moist condition and placed directly onto reshaped areas where practical, generally to the depths as described in **Table 50**;
- Where topsoil must be stockpiled, efforts will be made to reduce compaction with as coarsely textured a condition as possible to a maximum of 3 m in height;
- If topsoil is to be stored for greater than 12 months, it will be seeded, fertilised and treated for weeds prior to respreading at around 0.1 m in depth;
- An inventory of designated areas and available soil will be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities;
- Thorough seedbed preparation will be undertaken to ensure optimum establishment and growth of vegetation with all topsoiled areas lightly contour ripped (after topsoil spreading) to create a "key" between the soil and the spoil. Ripping will be undertaken on the contour and the tynes lifted for approximately 2 m every 200 m to reduce the potential for channelised erosion, preferably when soil is moist. The respread topsoil surface will be scarified prior to, or during seeding, to reduce run-off and increase infiltration via tilling with a fine-tyned plough or disc harrow;

- Regrading will be undertaken where required to produce slope angles, lengths and shapes that are compatible with the proposed land use and not prone to an unacceptable rate of erosion. This will be done in integration with drainage structures and dams capable of conveying runoff from the newly created catchments whilst minimising the risk of erosion and sedimentation (including contour furrows or contour banks at intervals down the slope, contour ripping across the grade, and graded banks where required); and
- Engineered waterways, spillways and sediment control dams (using erosion blankets, ground-cover vegetation and / or rip rap) will also be implemented to capture sediment laden runoff prior to offsite release. These will be designed and located so as to safely convey the maximum anticipated discharge.

8.16 REHABILITATION AND FINAL LANDFORM

8.16.1 Rehabilitation Objectives

Boggabri Coal is in the early stages of rehabilitation trials as part of its current operational requirements. Rehabilitation strategies have been documented and reported on an annual basis to regulators since 2006. The land within the Project Boundary has been significantly altered from previous land use including forestry, agriculture and mining.

The Leard State Forest has been logged intermittently over the past century for its valuable timber resource. The Leard State Forest is a heavily impacted ecosystem which has maintained some high biodiversity values.

To date, under agreement with the land manager (Forests NSW), Boggabri Coals existing rehabilitation strategy has focused on the establishment of commercial timbers for future forestry activities based on best practise research into growth rates of various canopy tree species.

Going forward, as a consequence of the outcome from the Boggabri Coal Biodiversity Offsets Strategy Working Group, the rehabilitation strategy for the Project will focus on biodiversity and the establishment of habitat for Threatened species. The strategy will build on the successes from previous rehabilitation trials.

Boggabri Coal's key rehabilitation objective will now be to ensure that all processes undertaken are consistent with SEWPaC National Recovery Plan for White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Grassy Woodland) (2010). This will include:

- The rehabilitation of disturbed areas to form part of a regional east-west wildlife corridor created as part of the Boggabri Coal Biodiversity Offset Strategy. This will create a linkage to remnant vegetation between the Namoi River to the west through the Leard State Forest to the Nandewar Range to the east;
- Revegetation of the post mine landscape with native vegetation, comprising a mixture of native grassy woodland, shrubby woodland / open forest, riparian forest vegetation types and Box-Gum Woodland with fauna habitat for Threatened species to encourage the re-establishment of pre-mining biodiversity values;

Table 50
Project Topsoil Stripping Depths

Soil Type	Depth (m)
Grey Brown Gradational Loam	0.15
Light Brown Uniform Gravelly Sand	Stripping Not Recommended
Light Brown Duplex Loam	0.10
Brown Gradational Clay	0.20

- Ensuring the sustainability of the post mining ecological values of the landscape; and
- The establishment of a clear set of indicators and completion criteria to be met.

The rehabilitation strategy will be integrated with the Boggabri Coal Biodiversity Offset Strategy to create the proposed regional wildlife corridor.

8.16.2 Rehabilitation Techniques

The following broad rehabilitation techniques and criteria will be applied to all rehabilitation areas for the Project.

Rehabilitation techniques and strategies with a particular focus on the establishment of the Threatened Box-Gum Woodland community using native species common to the region will be developed during the first three years of the Project.

Prior to the clearing of any native vegetation, in particular pre strip clearing activities in advance of mining, the following strategies will be implemented:

- Undertake pre clearing wildlife surveys and fauna management, incorporating a two stage clearing protocol for all hollow-bearing trees;
- Relocate and store transportable habitat features such as large logs and boulders, for reuse as future potential fauna refuge sites;
- Minimise disturbance of vegetation for each stage of clearing;
- Collect native seed prior to clearing, for use in the revegetation of disturbed areas; and
- Remove and store topsoil.

Rehabilitation

Vegetation and topsoil will be removed prior to mining activities occurring. The topsoil will contain a valuable native vegetation seedbank that will enhance the rehabilitation works.

Where practical, topsoil will be immediately spread over rehabilitation areas to enhance the rehabilitation outcomes. Where stockpiling is required, measures to protect its quality by retaining soil microbes and maintaining a viable soil seedbank will be implemented.

These will include minimising the age of stockpiles (each to be signposed), maintaining height between 2 to 3 m and vegetating stockpiles with native grass species endemic to the area if left for longer than six months.

Geochemical assessments have confirmed that there is no acid bearing overburden material within the Project Boundary. Overburden most suitable for plant growth will be spread over the surface areas of the spoil dumps prior to the application of topsoil.

Topsoil will be spread and contour ploughed to a minimum of 100 mm thickness. Soil testing will be undertaken on an annual basis to ensure a suitable growth medium exists to meet the objectives of the rehabilitation strategy.

Revegetation

Previous experience has shown that revegetation works are best carried out in spring and autumn, when conditions are optimal. The revegetation works will aim to establish three broad native vegetation classes, including the Threatened Box-Gum woodland community. A summary of the indicative species and structures of these three broad vegetation types is provided in **Table 51**. The three proposed vegetation types to be recreated are representative of existing vegetation communities within the local landscape.

The design of the vegetation types has taken into consideration the pre-mining landscape and potential future forestry resource requirements. Approximately 437 ha of shrubby woodland community is proposed to be rehabilitated on the steeper slopes of the final landform. Approximately 1,019 ha of grassy woodland on the lower slopes and the flat top areas will be rehabilitated and 52 ha of riverine woodland are proposed to be rehabilitated within the existing and proposed drainage lines (**Figure 35**).

The seed mix will contain species which are representative of these communities. The commercial timber species such as *Eucalyptus crebra* (Narrow-leafed Ironbark) and *Callitris glaucophylla* (White Cypress Pine) will be planted in higher densities on the lower slopes of the Leard State Forest to facilitate easy access for possible future logging activities.

Revegetation works will involve direct native seeding and / or supplementary tube stock planting. Native groundcover vegetation will be established to prevent raindrop and sheet erosion from occurring.

In the event that native grass cover is initially insufficient to stabilise sloped areas due to slow growth rates, introduced sterile ground covers such as a sterile millet may be used to supplement plantings. Natural seed germination from the soil seed bank will be assisted with direct seeding and where applicable seed will be treated to enhance germination rates. Planting of tubestock will supplement areas of low success rates from the natural regeneration from the seedbank and direct seeding. The existing Rehabilitation Management Plan will be revised and updated to accommodate the objectives of the rehabilitation management strategy and findings from the EA.

The rehabilitation works will continue to evolve over time and build on knowledge and success from previous experience. Rehabilitation may include trial plots testing different methodologies such as pre-treatment of seed (i.e. smoke water treatment, boiling, scarification), nutrient regimes, different methods of establishment, the use of sterile cover crops, soil additives (such as gypsum) and the addition of mychorrizal fungi to the soil.

Habitat material such as fallen hollow logs will be retained and stockpiled from the mine disturbance area and placed throughout the rehabilitation area to provide erosion control, microhabitat and terrestrial fauna habitat. Rehabilitation strategies common to all domains will include the following:

- Seed collection program of local provenance seeds to maximise germination rates;
- Seeding rates for cover crops approximately 50 kg/ha and native seeds 15 kg/ha;
- Re-establish fauna habitat including the installation of nest boxes, hollow logs and felled vegetation;
- Shape landform to ensure it is safe, stable, non-erosive and free draining;
- Test spoil and subsoils annually;
- Ameliorate subsoils and spoil, contour and rip as required;
- Apply topsoil evenly over surface at no less than 100 mm depth;
- Spread woody debris, rock and seed with cover crop;
- Seed and plant with natives; and
- Ensure ongoing monitoring and maintenance of the revegetated areas to ensure rehabilitation is progressing towards achieving specified success criteria.

8.16.3 Final Landform and Domain Specific Rehabilitation

Boggabri Coal will maximise opportunities for a diverse post-mining landscape and land-use where possible. It is proposed that the final land use of the rehabilitated site will include those similar to pre-mining land uses including biodiversity, pastoral, forestry and recreational opportunities.

Four key rehabilitation domains have been identified in the rehabilitation strategy based on the Project impacts, post mine landform, future land use and biodiversity values. These are discussed below.

Mine Disturbance Area

The final landform has been developed to promote visual characteristics that generally conform to the existing landscape. To ensure long term stability and sustainability the slopes of the final landform within the mine disturbance area will have a maximum slope of 10 degrees. It is expected that the steeper slopes will develop greater biodiversity than the more easily accessible sites.

The conceptual final landform will be free draining and designed to integrate with the surrounding catchments by channelling water towards natural drainage lines of the Nagero Creek. The final landform will contain gentle slopes to allow drainage to preferential paths on the slopes (see **Figure 35**).

Table 51
Broad Vegetation Types within Project Boundary

	Vegetation Type		
Structure	**Grassy Woodland on Fertile Soils**	**Shrubby Woodland / Forest Skeletal Soils**	**Riverine Woodland**
Canopy	*To 20 m in height and 60% cover dominated by* E. albens *and* E. crebra *with a sub-canopy of* Callitris glaucophylla.	*To 20 m in height and 65% cover dominated by* E. crebra, E. dwyeri, E. albens, E. melanophloia *and* Notelaea macrocarpa	*To 20 m in height and 70% cover dominated by* E. blakelyi *and occasional* E. melliodora
Shrub layer	*Generally sparse, however contains* Dodonaea *spp.,* Cassinia *spp., and* Acacia *spp*	*Moderately dense* cover containing Notelaea macrocarpa, Bursaria spinosa, Dodonaea *spp.,* Cassinia *spp., and* Acacia *spp*	*Moderately dense* cover containing Dodonaea *spp., and* Acacia deanei
Ground layer	*A diverse range of grasses with forbs and sedges including;* Cyperus gracilis, Aristida ramosa, Cymbopogon refractus *and* Austrostipa scabra	*A diverse range of grasses with forbs and sedges including;* Aristida ramosa, Austrodanthonia racemosa, Cheilanthes distans *and* Rostellularia adscendens	*A diverse range of grasses with forbs and sedges including;* Chloris truncata, Bothriochloa macra, Lomandra longifolia *and* Austrostipa verticillata

The final land use of this area will comprise a mixture of the native vegetation communities including, grassy woodland (70%), shrubby woodland / open forest (25%) and riparian forest (5%) for conservation and forestry. OEAs will be progressively rehabilitated over the life of the mine.

This staged approach will minimise the mine disturbance area at any one time and reduce the environmental impacts from the open cut operations. The rehabilitation strategy will be reviewed on a regular basis to ensure disturbed areas are kept to a minimum. The indicative schedule of progressive rehabilitation is shown in **Figure 36** and will be updated in accordance with the objectives of the rehabilitation strategy and changes in the mine plan.

Mine Infrastructure Area

This domain comprises the areas immediately to the south of the Leard State Forest associated with existing mine infrastructure and cleared land for agricultural purposes. It incorporates the current site offices, equipment and maintenance sheds, loading facilities, and entrance roads that will be decommissioned and rehabilitated as part of the mine closure strategy.

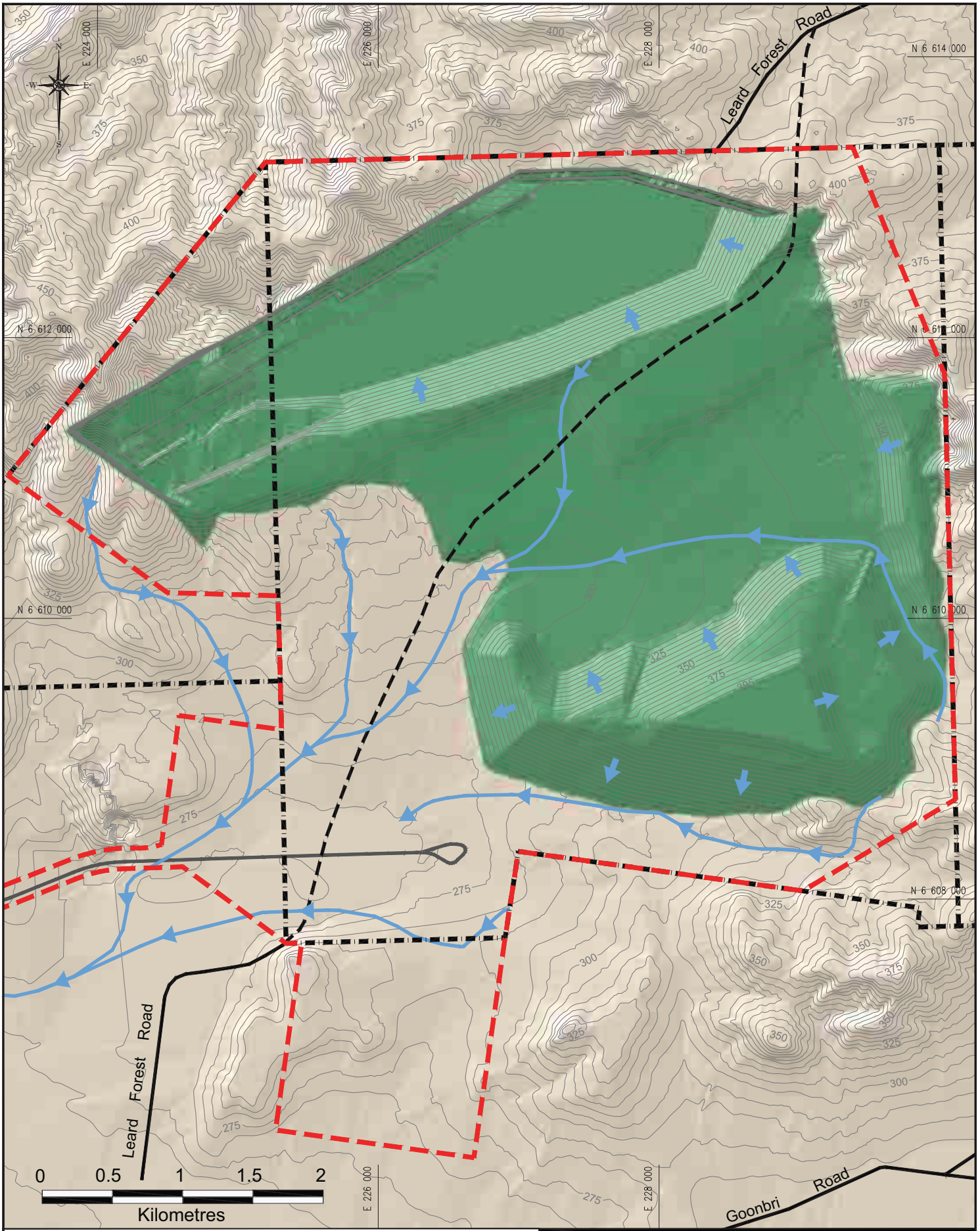
The final land use will incorporate a mixture of land capability classes III, IV and V for grazing pasture.

Haul Route / Rail Spur Corridor

This domain comprises existing and proposed transport corridors including the haul route and rail spur between the mine infrastructure area and the Boggabri Coal Terminal. The majority of this domain contains the existing haul route and cleared grazing pastures with isolated pockets of remnant vegetation and derived grassland. This domain also incorporates the area of the Namoi River floodplain that will be impacted by the Project.

The final land use will incorporate a mixture of land capability classes including class III, IV and V agricultural lands. A substantial area of this domain adjoins remnant native vegetation, the proposed regional wildlife corridor or is identified in the proposed Offset Strategy for the re-establishment of native vegetation communities.

The rehabilitation strategy will, where practical, revegetate the haul route and rail spur corridor to maximise its ecological contribution to the proposed east-west wildlife corridor.



BOGGABRI COAL MINE

Conceptual Final Landform

Cad File: 06100E.dwg	Date: 19.10.2010	Drawn: CP	Figure 35

All mining infrastructure will be removed in accordance with an agreed mine closure management plan with I&I NSW, the NSC and other relevant stakeholders.

Final Void

A final void will remain in the northern section of the Project Boundary (**Figure 35**). The final void will have a catchment area of approximately 413 ha with a surface area of up to 120 ha.

In the event that open cut or highwall mining does not precede beyond this point the final void will be reshaped to ensure that the land form is safe, stable, non-erosive and revegetated as is practical. In the event that mining ceases following the 21 year approval period the final void will be back filled to RL 280 m. This will ensure the final void does not remain a groundwater sink in the landscape and is discussed further in **Section 8.8** and **Section 8.10**.

Catchment areas that are not free draining will report to the reshaped final void. A discussion of the post-mining management of surface water and final voids is presented in **Appendix M**. It should be noted that there is up to a further seven years of mining within Boggabri Coal's mining lease beyond the Project Mine Disturbance Boundary.

Should mining continue into this area the proposed final void would be significantly reduced in size and potentially could be rehabilitated with limited void remaining in the landscape.

A conceptual final landform for Year 28 assuming mining was to continue beyond the 21 year approval period is shown in **Figure 36**. Any future mining beyond the 21 year approval period will be the subject of a modification or new planning approval.

8.16.4 Cumulative Final Landform

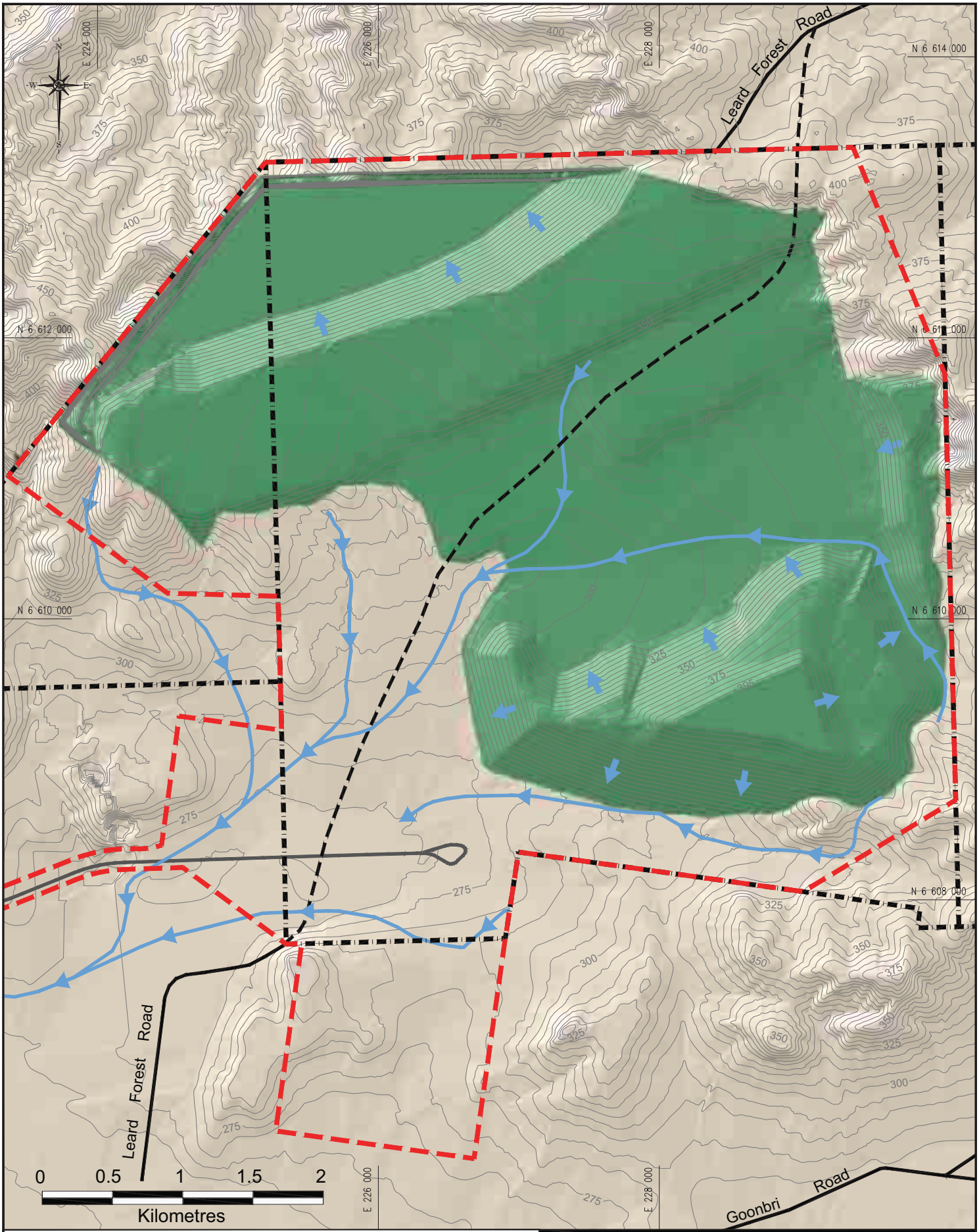
The final landform for the Project has been considered in relation to the adjacent Tarrawonga Mine and the proposed Maules Creek Coal Project to ensure an integrated final landform across the local region can be achieved. Information was sourced from the *Tarrawonga Coal Mine Modification Environmental Assessment* (April 2010) and the *Maules Creek Coal Project Preliminary Environmental Assessment* (July 2010).

An indicative cumulative final landform is shown in **Figure 37** and accompanying cross sectional view shown in **Figure 38**.

As shown in **Figure 37** a corridor of natural landform will remain insitu between each of the three mining operations. The final landform and rehabilitation for the Project will seek to meld into the surrounding landscape reducing potential adverse cumulative impacts with adjoining operations. Boggabri Coal will liaise with adjacent mining operations to ensure any potential deleterious final landform issues are mitigated.

Table 52
Indicative Land Disturbance and Mine Rehabilitation Schedule

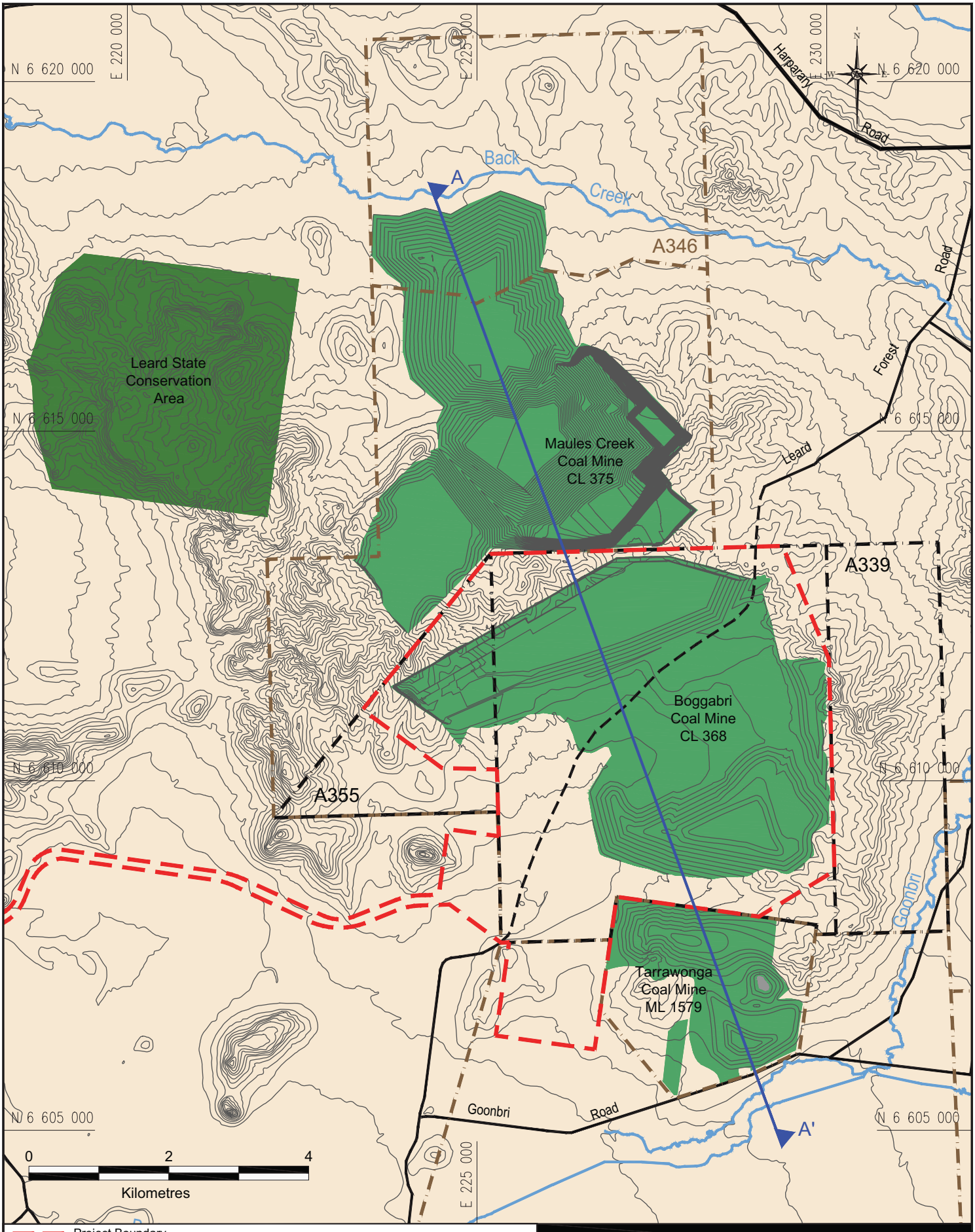
Area	Year 1 (ha)	Year 5 (ha)	Year 10 (ha)	Year 21 (ha)
Infrastructure Area	31	51	51	51
Active Mining Area	81	150	155	212
Overburden Emplacement (unshaped)	165	216	197	271
Overburden Emplacement (shaped)	0	175	232	186
Sub Total Disturbance Area	**277**	**592**	**635**	**720**
Cumulative Rehabilitation	77	138	414	1166



BOGGABRI COAL MINE

Conceptual Year 28 Final Landform

Cad File: 06845B.dwg	Date: 19.10.2010	Drawn: CP	Figure 36



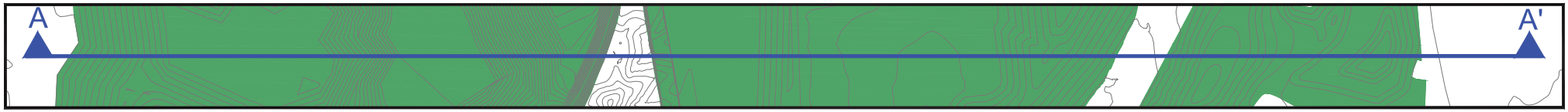
- Project Boundary
- Boggabri Mining Tenements
- Other Mining Tenements
- Roads
- Indicative Road Re-alignment
- Creeks
- Indicative Final Rehabilitation
- Indicative Final Voids

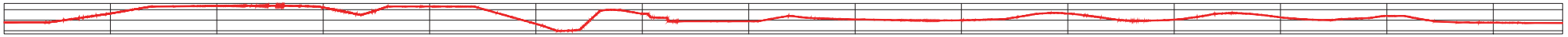
Coordinate System: MGA Zone 56
Source: Boggabri Coal 2009/2010, LPI 2009/2010
Maules Creek PEA 2010 , Tarrawonga Modification 2010

BOGGABRI COAL MINE

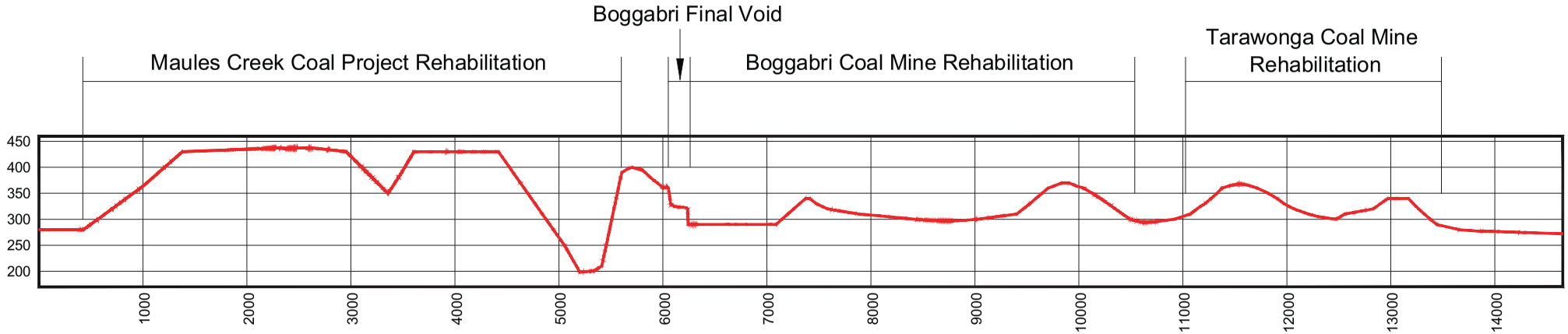
Indicative Cumulative Final Landform

Cad File: 06661B.dwg	Date: 18.10.2010	Drawn: CP	Figure 37





Section AA'
Vertical Exaggeration 1:1



Section AA'
Vertical Exaggeration 5:1

Coordinate System: MGA Zone 56
Source: Boggabri Coal 2009/2010, LPI 2009/2010
Maules Creek PEA 2010 , Tarrawonga Modification 2010

BOGGABRI COAL MINE

Indicative Cumulative Landform Cross Section

Cad File: 06663E.dwg	Date: 19.10.2010	Drawn: CP	Figure 38

8.16.5 Rehabilitation Completion Criteria

Completion criteria for mine closure will be developed and agreed in consultation with the relevant government agencies and community. These criteria will continue to be revised and developed to demonstrate that the rehabilitation objectives have been achieved. The achievement of the completion criteria will be monitored and reported both internally and externally to the relevant stakeholders. Boggabri Coal is committed to the achievement of best practice completion criteria, as this will ensure the long-term protection and management of the post mine landscape and its biodiversity conservation values. A list of preliminary rehabilitation completion criterion is outlined in **Table 53**.

The gradual achievement of these completion criteria will be assessed and discussed within annual rehabilitation monitoring reports. Improvement in flora and fauna species diversity will be plotted by year in these reports. Annual reports will include details of any successes or failures of the criteria and measures taken to address any issues.

8.16.6 Monitoring and Mitigation

In accordance with existing site procedures, rehabilitation areas will be monitored on a regular basis to ensure that rehabilitation objectives are being met and that sustainable revegetation and long term landform sustainability is achieved. Rehabilitation monitoring will include regular inspections of rehabilitated areas to assess:

- Structural stability;
- The effectiveness of erosion and sediment control measures;
- Revegetation success and the establishment of Box-Gum Woodland understorey and fauna habitat; and
- The effectiveness of weed and pest management measures.

Maintenance works in rehabilitation areas will be completed as required to address any issues of concern identified during monitoring.

Maintenance activities may include a range of responses, including:

- Supplementary seeding of vegetated areas;
- Weed and pest control;
- The application of fertiliser;
- De-silting or repairing drainage structures and sedimentation dams; and
- The infill and re-grading of any eroded areas.

Boggabri Coal will continue to undertake rehabilitation maintenance works as required. The results of rehabilitation and landform monitoring and the effectiveness of any maintenance activities required for the Project will be assessed and utilised in the continual refinement of rehabilitation techniques and reported against in the Boggabri Coal AEMR.

8.17 BUSHFIRE

The mining area of the Project is located entirely within the Leard State Forest which is dominated by dry eucalypt woodlands and open forests.

Due to the relatively low rainfall and dry nature of the landscape combined with the build up of high fuel loads (leaf drop and tinder) over time, a significant risk of bushfire presents itself from time to time.

The bushfire season experienced in the North West Region of NSW occurs predominantly during the hotter months from September to April. Depending on factors such as temperature, available fuel loads and rainfall the frequency and intensity of bushfires will vary.

The land outside of the Leard State Forest within the Project Boundary consists of more open grassy woodland and is a much lower bushfire hazard.

Onsite bushfires and potential bushfire hazards are managed in accordance with the *Rural Fires Act* 1999 and regulated by the NSW Rural Fire Service.

Fire controls and emergency systems are in place in accordance with the *Coal Mines Health and Safety Act* 2002.

Table 53
Preliminary Rehabilitation Criteria

	Domain		
	Mine Disturbance Area	**Mine Infrastructure Area**	**Haul Route / Rail Spur**
Aspect	**Criteria**		
Landform	• Slopes 10 degrees or less • No erosion channels or bare areas • 5 m^2 Contour banks are stable and uniform • Surface layer is free from hazardous materials • All drill holes sealed	• Relatively flat plains with no slopes > 5 degrees • No significant erosion present that would comprise the final land use • Contour banks are stable, revegetated and uniform • Surface layer is free from hazardous materials • Riparian areas are stable with no bank erosion and similar pre-mining flows	
Soil	• Topsoil has been spread on all rehabilitation surface areas • The topsoil to be contour ploughed to a minimum 100 mm thickness over all disturbed surfaces including any drainage works • Soil shall be suitable for re-establishing vegetation • pH is at an acceptable range for plant growth and similar to that of analogues sites • Annual monitoring shows the development of soil profile (e.g. litter, organic matter)		
Water	• Runoff water quality from rehabilitated areas not pose a threat to downstream water quality • Catchment areas are free draining with low velocity to minimise surface erosion		
Vegetation	• Rehabilitated areas will contain the desired flora species characteristic of the pre-mining vegetation assemblages • Rehabilitated vegetation contain the desired structure (i.e. shrubby forest or grassy woodland) • Rehabilitated vegetation will contain viable timber resources suitable for forestry as indicated by long term monitoring • Second generation seedling are present • More than 75% of trees are healthy and growing as indicated by long-term monitoring • No significant weed infestations or noxious weeds present • 70% soil surface cover maintained	• Rehabilitated areas will contain pastures characteristic of pre-mining land capability • Rehabilitated creek lines will contain the desired vegetation structure (i.e. shrubby forest or grassy woodland) and characteristic species	• Rehabilitated areas will contain characteristics of pasture associated with land capability pre-mining • Rehabilitated areas adjoining Biodiversity offsets or regional wildlife corridors will contain native vegetation with the desired structure and floristic characterises of adjoining remnant areas

	Domain		
	Mine Disturbance Area	**Mine Infrastructure Area**	**Haul Route / Rail Spur**
Aspect	**Criteria**		
Fauna	• Vertebrate pests are kept under control • Rehabilitated areas contain a range of habitat structures for native fauna (e.g. eucalypts, shrubs, groundlayer, developing litter) • Native fauna use of rehabilitated areas is increasing or supporting stable populations as indicated by long term monitoring	• Vertebrate pests are absent or kept under control as indicated by annual monitoring	• Vertebrate pests are kept under control as indicated by annual monitoring • Rehabilitated riparian areas and areas adjoining biodiversity offsets contain a range of habitat structures for native fauna (e.g. eucalypts, shrubs, groundlayer, developing litter) • Rehabilitated areas will support regional wildlife corridors and where possible reduce barrier effects in landscape
Land Capability	• Rehabilitated areas are of a land capability class of SF for sustainable forestry and biodiversity conservation	• Rehabilitated areas are representative of a suitable land capability class of VI or better for agricultural use • Native grass species typical of the local area have been used in the establishment of native pastures in areas of pre-mining land capability class of VI • Improved pastures and forage crops have been considered in areas of pre-mining land capability Class IV and III	• Rehabilitated areas are representative of a suitable land capability class of VI or better for agricultural use. • Native grass species typical of the local area have been used in the establishment of native pastures in areas of pre-mining land capability class of VI • Improved pastures and forage crops have been considered in areas of pre-mining land capability Class IV and III

Boggabri Coal has in place a Public Safety EMP which aims to:

- Monitor and maintain areas and equipment where bushfire hazards are present to prevent and minimise the potential outbreak of bushfire;
- Control the outbreak of fires in an effective manner; and
- Minimise the risk of bushfires spreading from the Project to adjacent private properties.

Other fire control strategies and mitigation management methods in place include:

- Issuance of 'hot work permits' for welding and other potential fire risk activities;
- Provide dedicated fire fighting water tankers;
- Ensure general purpose fire extinguishers are available on all mobile equipment and other appropriate locations;
- Segregate and store all flammable materials in accordance with Work Cover Dangerous Goods licence; and
- Maintain access tracks and fire breaks around surface facilities and the mining area.

Undertake back burning as required in consultation with the local Rural Fire Service, Forests NSW and neighbouring landowners.

8.18 HAZARD ANALYSIS

8.18.1 Introduction

A relevant level of assessment has been undertaken to determine any potential hazards associated with the Project. This assessment was undertaken in accordance with *SEPP 33 – Hazardous and Offensive Development Application Guidelines* (DUAP, 1994) (SEPP 33 Guidelines), and the *Hazardous Industry Planning Advisory Paper No 6 – Guidelines for Hazard Analysis* (Planning NSW, 1997).

8.18.2 Methodology

Boggabri Coal primarily manages hazardous materials onsite in accordance with site procedures, relevant standards and legislation. All chemicals used, or proposed to be used onsite are verified for their safety and potential environmental effects by the safety and environmental departments. Hazardous material storage facilities are currently located onsite at the workshop and explosives magazine area. These facilities will continue to be used and upgraded for the Project as required.

A database is utilised by Boggabri Coal to assist in the recording and management of chemicals.

This chemical management system contains a Material Safety Data Sheet (MSDS) for all chemicals used onsite.

8.18.3 Impact Assessment

Previous risk assessments undertaken for the Boggabri Coal Mine have confirmed that no aspect of the operations is considered to be hazardous or offensive under the relevant guidelines.

The Project will require the transport and storage of additional diesel, materials for explosives (including initiating products, detonators and emulsion explosives), and some other goods which may be considered to be potentially hazardous. The current capacity of diesel storages will need to be increased to facilitate the proposed increase in production levels for the Project. The increase in storage capacities will be designed in accordance with the relevant Australian Standards and to comply with the various regulatory requirements. No flammable liquids will be stored in the vicinity of these diesel storages. As such in accordance with the SEPP 33 Guidelines this component is not considered to be potentially hazardous.

The transport of diesel to the site will continue to be undertaken by licensed contractors which will comply with the relevant Occupational Health and Safety (OH&S) standards and procedures.

Boggabri Coal will continue to utilise explosive products (including initiating products, detonators, and emulsion explosives) for blasting activities to facilitate open cut coal mining. These commonly used forms of explosives have successfully been managed in accordance with existing OH&S procedures and legislative requirements.

Boggabri Coal currently has a fully bunded onsite explosives magazine (managed by site personnel) for the storage of detonators and other materials. An independent, licensed contractor is currently utilised to supply emulsion explosives and other initiating products to the site on an as required basis. A similar type arrangement for the management of the explosives facility will be utilised for the Project.

A review of the relevant components of the Project has confirmed that the Project is not considered to be Potentially Hazardous or Offensive.

As such, a detailed preliminary hazardous analysis is not required. Further, as SEPP 33 applies only to proposals that are potentially hazardous or offensive, and the Project does not constitute a potentially hazardous or offensive industry under Clause 3, SEPP 33.

8.18.4 Mitigation and Management

All hazardous materials associated with the Project will continue to be transported by a licensed contractor in accordance with the relevant Australian Standards and legislation.

Boggabri Coal will continue to utilise its EMPs and OH&S procedures to manage the hazards and risks associated with the Project. These procedures and management plans are regularly reviewed and updated to include any changes that have the potential to result in hazards.

Boggabri Coal will continue to ensure all carriers of dangerous goods are licensed and ensure that relevant procedures are followed when travelling to and from the site.

8.19 TRAFFIC AND TRANSPORT

8.19.1 Background

A Traffic Impact Assessment has been undertaken for the Project by Parsons Brinckerhoff Australia in accordance with the RTAs *Guide to Traffic Generating Developments* (2002). A summary of the report is provided below and the full report is presented in **Appendix T**.

The regional transport network in the vicinity of the Project is shown on **Figure 1**. The main vehicular access to the Project will be via the existing connections to the Kamilaroi Highway, Manilla Road and then the remaining open southern section of Leard Forest Road.

8.19.2 Methodology

The Traffic Impact Assessment for the Project included an assessment of the following:

- The existing road network;
- Baseline traffic volumes in 2009;
- Existing road and traffic statistics;
- Predicted future background traffic volumes;
- Predicted increase in road traffic due to the construction and operation of the Project;
- Predicted impacts on traffic conditions, level of service and intersection operation;
- Predicted impact on the road network due to the closure of a section of Leard Forest Road;
- Potential impacts on school bus routes and public utilities;
- Potential road safety issues associated with the Project;
- Existing and proposed rail movements associated with the haulage of additional coal produced by the Project; and
- The train operation impacts on the at-grade crossings of roads in the towns of Boggabri, Gunnedah and Curlewis due to expanded rail operations.

As part of this assessment existing traffic volumes and intersection movements were obtained from Annual Average Daily Traffic (AADT) data published by the RTA in conjunction with traffic counts undertaken at a range of locations on the surrounding road network in October 2009. The recorded volumes were then used to calculate baseline traffic volumes in future years.

Future intersection performance was then predicted by using the baseline intersection results and adding traffic performance predicted to be generated with and without the Project and allowing for annual traffic growth (1% in accordance with RTA guidelines).

As discussed in **Section 4**, the Project is predicted to employ a maximum of 500 mining related personnel and up to 150 full time equivalent construction staff by Year 5.

The Project will progressively increase operations from Year 1 and is expected to achieve maximum production of 7 Mtpa product coal by Year 5.

On this basis the critical year subject to assessment for the Project's traffic-generated impacts is Year 5, when the additional traffic volumes generated by construction and operations will be highest compared with background traffic volumes on the surrounding road network.

As part of this assessment, intersection performance was assessed using the intersection traffic modelling software SIDRA to determine the level of performance of an intersection.

The SIDRA intersection analysis used four performance indicators including level of service (LoS), degree of saturation (DoS), average intersection delay and queue length each of which is discussed below.

Level of Service

The LoS is defined in the Austroads (1988) *Guide to Traffic Engineering Practice* as 'a qualitative measure of the operational conditions within a traffic stream as perceived by motorists and passengers'. There are six levels of service range from A to F. Level A represents the best operating condition of free traffic flow and virtually unaffected by the presence of other vehicles, while Level F represents unsatisfactory operating conditions with forced or break-down traffic flow (see **Table 54**). At signalised intersections, the LOS criteria are related to average intersection delay (seconds per vehicle).

Degree of Saturation

The DoS is a ratio of demand flow to capacity, and therefore has no unit. As it approaches 1.0, extensive queues and delays could be expected.

For a satisfactory situation the DoS should be less than 0.9.

Delay

Delay is the difference between interrupted and uninterrupted travel times through an intersection and is measured in seconds per vehicle.

Queue Length

Queue length is usually quoted as the 95th percentile back of queue, which is the value below which 95% of all observed queue lengths fall.

8.19.3 Impact Assessment

Road Traffic Volumes

Traffic volumes recorded on the Boggabri Coal Mine Access Road during the 2009 SIDRA intersection analysis were used in the prediction of traffic volumes which may be generated by the Project. Traffic volumes generated by the SIDRA analysis were used to determine the impact the Project will have on the LoS, DoS, delay and queue length.

Boggabri Coal Mine Access Road will continue to be the principal access point to the Project. However it is noted that other points of access used for minor purposes such as drilling, land management and plant establishment or relocation will be used.

Existing Traffic Conditions

SIDRA modelling was conducted on each of the key intersections under current traffic conditions. Results indicate that all of the intersections currently operate well below their capacity, with all intersections having a DoS equal or less than 3%. The current LoS for all intersections is A, with practically no queuing and delays of less than 14 seconds per vehicle.

Intersection Performance

An investigation to measure the impacts from Project generated traffic on the surrounding road network and key intersections were identified for assessment and are included in **Table 55** and **Table 56**.

Traffic counts and turning movement surveys were conducted during October 2009, from 5:00 am to 9:00 am and from 3:00 pm to 8:00 pm. Analysis of the surveys showed traffic peak periods coincided with the change of shift at the Boggabri Coal Mine and Tarrawonga Mine with maximum traffic levels occurring during the following periods:

- AM peak hour fell between 5:45 am and 6:45 am; and
- PM peak hour fell between 5:00 pm and 6:00 pm.

While roads were busiest at different times, the highest hourly volumes occurred in the morning, between 5:45 am and 6:45 am.

A comparison of the intersection performance of the surrounding road network without and with the Project is discussed below.

Year 5 without the Project

A SIDRA analysis (equivalent to Year 5 of the Project) assuming the Project did not go ahead was conducted to determine future performance of key intersections without additional traffic generated by the Project and no changes to Leard Forest Road (see **Table 55**).

The results indicate that all of the intersections would continue to operate well below their capacity and show similar results to existing conditions, with all intersections having a DoS equal or less than 3%.

In addition the LoS would be A, with practically no queuing and delays of less than 14 seconds per vehicle. This would be consistent with current existing traffic conditions.

Table 54
RTA Levels of Service

Level of Service	Average Delay per vehicle (seconds)	Description
A	Less than 14	Good
B	15 to 28	Acceptable
C	29 to 42	Satisfactory
D	43 to 56	Near capacity
E	57 to70	At capacity
F	Greater than 71	Unsatisfactory

Source: RTAs Guide to Traffic Generating Developments (2002)

Table 55
Predicted Year 5 Traffic Conditions without Project

Intersection	Peak Hour	DoS	Delay (sec)	LoS	Queue (m)
Kamilaroi Highway / Manilla Road	AM	0.02	14	A	1
	PM	0.04	13	A	1
Manilla Road / Therribri Road	AM	0.03	12	A	1
	PM	0.01	12	A	0
Manilla Road / Leard Forest Road	AM	0.02	12	A	0
	PM	0.03	12	A	1
Leard Forest Road / Goonbri Road	AM	0.02	14	A	1
	PM	0.03	11	A	0
Leard Forest Road / Boggabri Coal Mine Access Road	AM	0.03	13	A	1
	PM	0.00*	12	A	1
Leard Forest Road / Harparary Road	AM	0.00*	12	A	0
	PM	0.00*	12	A	0
Harparary Road / Therribri Road	AM	0.00*	12	A	0
	PM	0.00*	12	A	0

**DoS less than 0.01*

Table 56
Predicted Year 5 Traffic Conditions with Project

Intersection	Peak Hour	DoS	Delay (sec)	LoS	Queue (m)
Kamilaroi Highway / Manilla Road	AM	0.10	14	A	3
	PM	0.08	13	A	3
Manilla Road / Therribri Road	AM	0.15	12	A	5
	PM	0.05	12	A	0
Manilla Road / Leard Forest Road	AM	0.08	13	A	0
	PM	0.11	12	A	4
Leard Forest Road / Goonbri Road	AM	0.10	15	B	5
	PM	0.07	12	A	0
Leard Forest Road / Boggabri Coal Mine Access Road	AM	0.15	17	B	6
	PM	0.00*	16	B	4
Leard Forest Road / Harparary Road	AM	0.00*	12	A	0
	PM	0.00*	12	A	0
Harparary Road / Therribri Road	AM	0.00*	12	A	0
	PM	0.00*	12	A	0

**DoS less than 0.01.*

Year 5 with the Project

As discussed in **Section 8.19.2** SIDRA intersection modelling of the Project at Year 5 was conducted as it correlates with peak employment and construction staff travelling to and from the Boggabri Coal Mine.

Modelled results show that the intersections will continue to operate well below their capacity with the additional traffic volumes generated by the Project with all intersections having a DoS equal or less than 15% (see **Table 56**). The majority of intersections will have LoS A.

The Leard Forest Road / Goonbri Road in AM peak and the Leard Forest Road / Boggabri Coal Mine Access Road in both AM and PM peak periods will have a LoS B.

Results from the SIDRA modelling clearly indicate that there would be no significant impact on the intersections and the road network adjacent to the Project site as a result of any increase in employment levels and coal production.

The current LoS experienced by road users is likely to be very similar to the Year 5 without the Project scenario.

This shows that the predicted increase in traffic volumes on the adjacent road network during construction of the Project will only result in a minor change to the LoS experienced at two intersections including Leard Forest Road / Goonbri Road and Leard Forest Road / Boggabri Coal Mine Access Road.

Results from Year 5 incorporating the two modelled scenarios without the Project (background) and with the Project are summarised in **Table 57**.

Table 57 shows that the predicted increase in traffic volumes on the adjacent road network generated by the Project will not cause any change to the LoS experienced by road users, with the exception of two intersections including the Leard Forest Road / Goonbri Road and the Leard Forest Road / Boggabri Coal Mine Access Road, where the LoS will change from A to B with the Project.

The intersection of Therribri Road and the Private Coal Haul Road will continue to accommodate both private traffic and product coal haul trucks.

Boggabri Coal proposes to build an overpass on Therribri Road across the Private Coal Haul Road when coal haulage by trucks exceeds 5.5 Mtpa.

Leard Forest Road Closure

The Project will require the closure of a section of Leard Forest Road between the Boggabri Coal Mine Access Road and the northern extent of the Project Boundary a distance of approximately 7 km.

The assessment found that traffic redistribution due to this closure would not be significant due to the following:

- During the AM (5:00 am – 9:00 am) and PM (3:00 pm – 8:00 pm) peak periods the majority of the Leard Forest Road users are coming from the south and use the road on their way to and from the Boggabri Coal Mine Access Road;
- During the AM peak period only four out of 13 road users used the northern part of Leard Forest Road, south of its intersection with Harparary Road, for purposes not associated with mining; and
- During the PM peak period only 11 out of 31 used the northern part of Leard Forest Road, south of its intersection with Harparary Road, for purposes not associated with mining.

To assess the impact that the closure of a section of Leard Forest Road would have on the associated travel times in the area, a floating vehicle travel time survey was conducted by driving the routes numerous times and taking an average of the resultant travel times. When Leard Forest Road is closed traffic will be diverted along Therribri Road and will result in:

- The public travel time from Maules Creek to the Leard Forest Road / Manilla Road intersection would increase by approximately 6 minutes and add an additional 6.7 km of travel; and
- The public travel time from Leard Forest Road / Harparary Road intersection to the Leard Forest Road / Manilla Road intersection would increase by approximately 22 minutes and add an additional 24.7 km of travel.

The closure of the section of Leard Forest Road would not have a significant impact on the community as few drivers use this route for journeys other than mine related activities. However, some local residents who do use the road would be inconvenienced by the closure and could have to travel for up to an additional 22 minutes to reach their destination.

Table 57
Summary of Levels of Service

Intersection	2009 Background LOS	Year 5		Change in LOS
		Without Project	With Project	
Kamilaroi Highway / Manilla Road	A	A	A	No Change
Manilla Road / Therribri Road	A	A	A	No Change
Manilla Road / Leard Forest Road	A	A	A	No Change
Leard Forest Road / Goonbri Road	A	A	B	A to B
Leard Forest Road / Mine Access Road	A	A	B	A to B
Leard Forest Road / Harparary Road	A	A	A	No Change
Harparary Road / Therribri Road	A	A	A	No Change

Proposed Leard Forest Road Closure Strategy

Based on the mine schedule and anticipated production levels it is expected that mining will truncate Leard Forest Road by Year 5.

A detailed closure strategy will be developed in accordance with relevant guidelines and regulatory requirements and in consultation with the NSC, RTA and the local community prior to closure.

The Closure strategy will include:

- Public advertisements, notifications and newsletters;
- Meetings with key stakeholders and regulators;
- The implementation of an identified and NSC agreed mitigation and management strategy;
- Construction of turning circles where the road ends, drainage, earthworks and fencing;
- Installation of appropriate signage; and
- Completion of a road safety audit.

Road Safety

A Road Safety Audit of the primary access route used by traffic between the Kamilaroi Highway and the Boggabri Coal Mine was undertaken as part of the Traffic Impact Assessment.

The majority of the identified road safety deficiencies were not related to or caused by mine traffic nor were any deficiencies found that would deteriorate as a consequence of increase traffic volumes generated by the Project. However, current deficiencies may put the safety of current and future traffic at risk.

The following safety deficiencies in the existing road network were identified in the Road Safety Audit (see **Appendix T**) as affecting current road users, these included:

- Significant pavement bleeding;
- Loose gravel on the road surface;
- Unprotected culverts;
- Inefficient drainage infrastructure;
- Pavement edge drop-offs;
- Surface fatigue cracking;
- Poor road markings; and
- Signage deficiencies.

The majority of the identified road safety deficiencies were not caused by existing mining related traffic and it is not expected to deteriorate further as a result of the Project. However, Boggabri Coal will commit to a financial contribution to the upgrade of the intersections identified in the road safety audit commensurate with the impacts of the Project. Boggabri Coal will consult with the RTA and NSC in this regard as required.

An analysis of crash data between 2004 and 2008 indicated 11 crashes occurred on the study area road network and its key intersections. Of the 11 recorded crashes eight occurred on the Kamilaroi Highway and one crash occurred on each the Manilla Road (Rangari Road), Narrabri Road and Harparary Road. There were no crashes recorded by Police on the remaining surrounding road network to the Project Boundary.

Public Utilities

School buses are the only public transport service in the vicinity of the Project. The school bus service is unlikely to be affected by the Project as:

- No school buses were identified to use Leard Forest Road; and
- The forecast increase in traffic volumes is not significant and any increase in traffic is likely to occur outside the times when school buses operate given the proposed shift arrival and departure times of the Project.

The opportunities for walking and cycling to the Boggabri Coal Mine to relieve traffic growth are limited due to the lack of dedicated facilities and distances from residential areas.

The location of the Project, need for contractors to have access to tools, and poor network facilities, even if routes were improved in the immediate vicinity of the mine, combine to make investment in cycle and pedestrian facilities an ineffective traffic management approach.

Rail Transport

It is proposed that product coal produced by the Project will be railed via the Werris Creek Mungindi Railway Line to the port of Newcastle for export. The Project includes the construction of a rail spur and rail loop across the Namoi River and associated floodplain including overpasses across Therribri Road, the Namoi River and the Kamilaroi Highway, connecting the mine to the Werris Creek Mungindi Railway Line adjacent to the Boggabri Coal Terminal.

A Train Operations Traffic Impact Study was undertaken to assess the likely future impact and potential delays to road traffic within the townships of Gunnedah (at three railway crossings), Boggabri and Curlewis. The study found that:

- The existing single coal train per day servicing Boggabri Coal Mine closes the railway crossings on average twice a day with each closure resulting in traffic delays of approximately 7.5 minutes;
- The increased coal production from 1.5 Mtpa to 7 Mtpa would increase the number of coal trains required from the current one per day up to two to three per day (5.5 train movements daily);
- Each railway crossing closure would delay traffic for approximately eight minutes;
- ARTC propose to upgrade both track and coal trains by 2015 by increasing both the length and load capacity; and
- The increased length of coal trains would increase the time vehicles are held at the five studied railway crossings by approximately 30 seconds.

The number of train movements for the Project is discussed in **Section 4.4**. The impact on the investigated railway crossings is likely to be minimal.

Average traffic queues at these railway crossings could increase by approximately three vehicles in each direction per train with a high growth scenario of 5% with each crossing having sufficient space for significantly more than three vehicles.

The impact of the increased length and number of coal trains on traffic at the railway crossing on the Kamilaroi Highway in Curlewis would be minor.

Average traffic queues are estimated to increase by approximately 16 vehicles per direction per train with a high growth scenario of 5%. It is anticipated that there is sufficient room to accommodate the additional vehicle queue.

The vehicle delay associated with increased predicted rail movements and train lengths were estimated based on the following observations:

- The average queues at the level crossings in Boggabri and Gunnedah could increase by up to 3 vehicles in each direction. All approaches to the level crossings in these towns have sufficient storage space for significantly more than an additional 3 vehicles without delay to side traffic;
- The average queues at the level crossing of the Kamilaroi Highway, in Curlewis, could increase to approximately 16 vehicles per direction per train. The Kamilaroi Highway has road space to accommodate this length of queue, so the impact to network congestion would be minor; and
- The two to three coal trains per day required to transport the 7 Mtpa of coal from Boggabri Coal mine would close each of the railway crossings in the study area between four to six times. Each of these closures could delay traffic by up to eight minutes.

Consultation with adjacent approved mining operations and ARTC will continue to occur to ensure increase levels of production are congruent with proposed rail infrastructure upgrades and port capacities to ensure impacts to traffic are minimised.

8.19.4 Mitigation and Management

Results from the Traffic Impact Assessment conducted has identified that the Project will not have any significant traffic impacts associated with the closure of a section of Leard Forest Road, increased coal production or additional employees and construction staff.

Residents of the Maules Creek community have raised concerns regarding access to their properties during flood events as low level crossings on the Harparary Road are often inundated. Residents have indicated that the Leard Forest Road is the only alternative access for some residents during flood events.

As such Boggabri Coal proposes to upgrade the level crossings on Harparary Road between the intersection with the Leard Forest Road and the Kamilaroi Highway.

Boggabri Coal also proposes to replace the Bridge over the Namoi River on the Harparary Road prior to the closure of Leard Forest Road.

Prior to the construction of the rail spur overpass across the Kamilaroi Highway Boggabri Coal will consult with all relevant regulatory authorities and will develop a rail construction and traffic management plan in consultation with the RTA prior to any construction activities commencing within the easement of the Kamilaroi Highway.

The following traffic management measures for the Project are summarised below:

- Consultation with NSC, RTA and other local authorities as necessary prior to the movement of over size loads on public roads;
- Address the deficiencies identified in the Road Safety Audit where appropriate;
- Develop a detailed Road Closure plan for the closure of a section of Leard Forest Road;
- Consultation with NSC, RTA and the local community prior to the closure of a section of Leard Forest Road;
- Upgrade the Harparary Road and Bridge over the Namoi River prior to the closure of a section of Leard Forest Road;
- Replace the at grade crossing of Therribri Road and the Private Coal Haul Road with an overpass prior to coal haulage exceeding 5.5 Mtpa;
- Maintenance of the existing road network on route to Boggabri Coal Mine to increase traffic safety; and
- Continued encouragement of car-pooling amongst the mine workforce.

9 STATEMENT OF COMMITMENTS

In addition to conditions of Project Approval, Boggabri Coal commits to the operational controls outlined in **Section 4.1** and **Section 8** of the EA for all activities associated with the Project.

This SoC summarises the major aspects of the Project as described throughout the EA and summarises the key proposed management and mitigation measures.

The aim of this SoC is to ensure that any potential environmental impacts resulting from the Project are minimised and managed by implementing relevant environmental management, mitigation and monitoring strategies.

Table 58
Statement of Commitments

Ref	Commitment	Section
	Mining Operations	
1.	Boggabri Coal will continue to operate in accordance with its existing approval until it expires on 14 November 2011. Any new Project Approval will take effect following the expiry of DA 36/88.	**4.0**
2.	Boggabri Coal will operate under the new Project approval for up to a maximum of 21 years from 14 November 2011 producing up to a maximum of 7 Mtpa product coal in any one calendar year.	
	Environmental Management and Monitoring	
3.	Boggabri Coal 's Environmental Monitoring Programs for air quality, water quality, noise and blasting will be reviewed and updated as required, in consultation with the relevant regulators for approval by DoP prior to November 2011.	**8.0**
4.	Boggabri Coal's EMPs will be revised and updated as required, in consultation with the relevant regulators for approval by DoP prior to November 2011 for Surface and Groundwater Management, Flora and Fauna, Rehabilitation and Landscape Management (including Void Management) and Aboriginal Archaeology and Cultural Heritage Management.	
	Air Quality	
5.	Boggabri Coal will utilise technologies and initiatives as required to ensure that the air quality outcomes described in the EA are achieved.	**8.1.3**
6.	Boggabri Coal will undertake regular monitoring of greenhouse gas emissions and energy efficiency initiatives to ensure that greenhouse gas emissions per tonne of product coal are kept to the minimum practicable level.	
7.	Boggabri Coal will install a TEOM air quality monitoring unit(s).	
	Noise and Blasting	
8.	Boggabri Coal will implement the necessary noise control and management measures to ensure that the EA predicted noise levels at private receivers as listed in **Table 25** are not exceeded.	**8.2.4**
9.	Boggabri Coal will manage its blasting practices such that the recommended DECCW guidelines, existing at the time of approval; will be met at all privately owned receivers.	
10.	Boggabri Coal will install a real time noise monitoring system and a real time meteorological monitoring system with predictive software capabilities.	
	Water Resources	
11.	Boggabri Coal will continue to monitor groundwater ingress and impacts on surrounding privately owned bores. In the event that monitoring confirms a deleterious impact on any privately owned water bore Boggabri Coal will meet the cost of modifying the bore or replace any water loss.	**8.10.4**
12.	Boggabri Coal will use best endeavours to acquire additional water entitlements to ensure maximum operational capabilities in extreme dry years.	

Ref	Commitment	Section
	Traffic	
13.	To offset the closure of a section of Leard Forest Road Boggabri Coal will upgrade Harparary Road including three culverts and a new bridge over the Namoi River as described in its VPA with NSC.	**8.19**
14.	Boggabri Coal will construct an overpass on Therribri Road across the Private Coal Haul Road should road coal haulage reach 5.5 Mtpa.	
15.	Boggabri Coal will commit to a financial contribution to the upgrade of the intersections identified in the road safety audit commensurate with the impacts of the Project.	
16.	Prior to the construction of the rail spur overpass within the easement of the Kamilaroi Highway Boggabri Coal will consult with all relevant regulatory authorities and will develop a rail construction and traffic management plan in consultation with the RTA.	
	Ecology	
17.	To offset impacts on fauna and flora from the Project, Boggabri Coal will establish a Regional East-West Wildlife Corridor which will be proactively managed to enhance its ecological values as detailed in **Section 8.5**.	**8.5**
18.	The mine rehabilitation program will focus on the re-establishment of Boxed-Gum Woodland.	
19.	Boggabri Coal will establish a 186 ha hardwood commercial forest in consultation with Forest NSW.	
	Visual	
20.	Boggabri Coal will progressively rehabilitate the mining and OEAs to minimise visual impact.	**8.3**
	Aboriginal Archaeology and Cultural Heritage	
21.	The salvage and the protection of all known Aboriginal objects within the Project Boundary will continue to be managed in accordance with a revised Aboriginal Archaeology and Cultural Heritage Management Plan in consultation with the local Aboriginal community and DECCW.	**8.6.3**
22.	Boggabri Coal will establish a keeping place for the purpose of housing salvaged Aboriginal artefacts from the mine site.	
	Non Aboriginal Heritage	
23.	Boggabri Coal will undertake archival recordings of the Daisymede shearing shed and yards, Daisymede piggery and the Heathcliff property residence prior to any disturbance or relocation of these sites.	**8.7**
	Community	
24.	Boggabri Coal will enter into a Voluntary Planning Agreement with NSC with regard to the Project including a commitment of up to $9.67 Million to be contributed to NSC for the purpose of funding the following upgrades or works to NSC infrastructure: • Upgrades to the Boggabri Caravan Park; • Erection of a monument in recognition of the achievements of Ben Lexcen; • Improve public seating throughout Boggabri; • Support for the Boggabri Home and Community Care organisation; • Upgrades to Harparary Road and Bridge over the Namoi River; and • In full satisfaction of any requirements under Section 94 of the EP&A Act.	**8.13.8**
	Reporting	
25.	Boggabri Coal will prepare an AEMR (which summarises monitoring results and reviews performance) and distribute it to the relevant regulatory authorities and the Boggabri CCC.	**8.0**

10 PROJECT JUSTIFICATION

10.1 INTRODUCTION

In accordance with the requirements of the EARs, a justification for the Project taking into consideration the environmental impacts of the Project, suitability of the site, and any social, economic and / or environmental benefits that may arise as a result of the Project, is provided below and confirms the Project is consistent with the objectives of the EP&A Act.

It should be reiterated that further to the Project Need described in **Section 4.11**, the Project will ensure the orderly continuation of open cut coal mining within Boggabri Coal's current Mining Lease. It will also ensure the progressive rehabilitation of the mine site to a predetermined final landform and use.

10.2 SITE SUITABILITY

Boggabri Coal Mine is an existing mining operation, which has successfully operated since 2006 under its original planning approval. On this basis, it is recognised that the Project represents the continuation of previously anticipated mining to ensure the total extraction of all economically viable open cut coal reserves within the current Mining Lease and exploration lease as the mine progresses further to the north.

The Project is a natural progression of the intended land use which will initially utilise the existing employee resource, infrastructure and equipment fleet in operation at the mine prior to its supplementation. Whilst allowing current mining operations to progress in an orderly manner, the Project will provide the mine the flexibility to increase its coal production rate in response to international energy and metallurgical coal demands. The fact that the foundation elements of required infrastructure are in place and the open cut mining area is partially disturbed, results in a substantial amount of the development impact having been previously incurred thus lessening the impact of the natural progression of the mine.

The Project therefore provides for orderly and economic use of the land.

The Project Boundary is located between two previously approved mining operations; the Tarrawonga Mine to the south and the Maules Creek project to the north-west. The area has been identified as containing a valuable coal resource and is recognised as Zone 4 under the BNC Act which dedicates the area as State Forest for the purposes of forestry, recreation and mineral extraction thus acknowledging the suitability of the site for mining purposes on a regional level.

The other flexibilities sought by this Project will ensure that Boggabri Coal can effectively handle and process product coal and respond to market demands ensuring Boggabri Coal's competitiveness and therefore longevity.

10.3 ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS

The EA has assessed all of the economic, social and environmental impacts associated with the Project by applying the following principles:

- Application of an environmental risk assessment process throughout the Project planning, design and assessment process;
- The consideration of ESD principles and best practice environmental and social standards in the development of project specific mitigation and management measures;
- Undertaking comprehensive stakeholder consultation and addressing issues raised; and
- Optimising social and economic benefits associated with the Project.

As highlighted throughout the EA, all environmental impacts have been assessed on a worst case scenario, assuming the Project will reach the proposed maximum production rate of 7 Mtpa of product coal.

The conceptual mine plan presented for the Project has been specifically designed to support the economic productivity of the Project within the constraints of the mine site, whilst complying with all relevant environmental criteria presented in the EA.

The Project will deliver significant socio-economic benefits to both the Narrabri and Gunnedah Regions and the State of NSW more generally through the generation of additional employment, export revenue, taxes and royalties. Specifically the Project will result in the economic benefits to the state economy of the following approximate values:

- $1,527 Million in annual direct and indirect output or business turnover;
- $689 Million in annual direct and indirect value added;
- $315 Million in annual household income; and
- 3,675 direct and indirect jobs.

These very significant economic benefits to the State of NSW will be foregone if the Project does not proceed. The VPA reached with NSC will provide up to $9.67 Million to address the increased impacts on any local community infrastructure associated with the Project. In particular the immediate local community will benefit substantially from the proposed investment in the local road network and within the township of Boggabri.

The application of a stringent, contemporary EA has not identified any significant adverse economic, social or environmental impacts associated with the Project apart from that of the impact on the current ecological value of the Leard State Forest. The ecological impact of the Project has largely been recognised on a regional level by the zoning of the Leard State Forest as Zone 4 land under the BNC Act.

The mine plan has been specifically designed to minimise adverse economic, social and environmental impacts, optimise the final landform outcome and end land use and provide suitable offsets.

Boggabri Coal is proposing to establish a Biodiversity Offset Area on its existing landholdings which will include the conservation of existing remnant vegetation and the revegetation of previously cleared land. Further to this Boggabri Coal is committed to creating a Regional East-West Wildlife Corridor of high ecological value land to be dedicated as a long term ecological Offset Area.

In summary therefore the impact of the Project on the current ecological values of the Leard State Forest is:

- Offset by the Boggabri Coal Biodiversity Offset Strategy which adds to and enhances regional offsets already implemented by the BNC Act; and
- Justified and balanced by social and economic welfare brought to the community by the Project.

Due to the substantive positive economic and social impacts associated with the Project and the nature of the environmental impacts resulting from the Project (in consideration of the mitigative measures proposed) it can be concluded that the Project is well justified on socio-economic and environmental grounds.

10.4 CONSISTENCY WITH THE OBJECTIVES OF THE EP&A ACT

Section 5 of Part 1 of the EP&A Act describes its objectives which are reproduced below followed by comment on their consideration as part of the assessment:

> *"To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment."*

The Project will facilitate the ongoing orderly and logical extraction of a thermal and metallurgical coal resource within Boggabri Coal's Mining Lease, the benefits of which will promote social and economic welfare:

> *"To encourage the promotion and co-ordination of the orderly and economic use and development of land."*

The Project will result in the logical progression of existing mining development in an area previously identified for this purpose by the NSW Government:

> *"To encourage the protection, provision and co-ordination of communication and utility services."*

The Project will not disrupt communication or utility services:

> *"To encourage the provision of land for public purposes."*

The Project will result in the establishment of a Regional East-West Wildlife Corridor Biodiversity Offset Area and the establishment of an Aboriginal keeping place:

> *"To encourage the provision and co-ordination of community services and facilities."*

The Project includes a commitment to enter into a VPA with NSC for the provision of contributions to community services and facilities:

> *"To encourage the protection of the environment, including the protection and conservation of native animals and plants, including Threatened species, populations and ecological communities, and their habitats."*

The Project will result in the implementation of a Biodiversity Offsets Strategy specifically designed to protect and conserve native animals and plants:

> *"To encourage ecologically sustainable development."*

The Project and its assessment appropriately address ESD principles as discussed in **Section 4**.

Impacts of the Project have been identified with certainty and measures to address them incorporated into the Project, thus addressing the Precautionary Principle.

The maximised recovery of the insitu coal resource and the optimisation of final rehabilitation and landform of the proposed mining area address the principles of Intergenerational Equity and Improved Valuation.

The principle of Conservation of Biological Diversity and Ecological Integrity is addressed by the Project in the commitment to implement the proposed Biodiversity Offset Strategy:

> *"To encourage the provision and maintenance of affordable housing."*

As stated above the Project includes a commitment to NSC to enter into a VPA for the provision of contributions to community services and facilities. Further to this, at a State level, the economic benefits that will flow from the Project to the NSW Government will assist in ensuring the provision and maintenance of affordable housing. As the Project is a continuation of an existing operation, the employees are to a large extent already engaged and housed in existing facilities.

In the event of an influx of employees provision has been provided through the construction of a temporary contractor's camp:

> *"To promote the sharing of the responsibility for environmental planning between the different levels of government in the State."*

The consultation required during the preparation and assessment of an EA under Part 3A of the EP&A Act demonstrates that environmental planning is shared between the different levels of government in NSW.

The preparation of the EA has followed this due process and seized every opportunity for stakeholder engagement over the Project with all levels of Government as described in **Section 6**:

> *"To provide increased opportunity for public involvement and participation in environmental planning and assessment."*

Section 6 of the EA describes the stakeholder engagement process relied upon during the preparation of the EA.

It can be concluded by an analysis of the comments following each stated objective of the EP&A Act that each has been comprehensively met during the preparation of the EA.

CONCLUSION

In conclusion, the Project encompasses the logical and systematic progression of the exploitation of the valuable open cut coal resource in the Leard State Forest. The mine plan put forward considers and balances the maximisation of coal recovery with the minimisation of environmental impacts as described in **Section 4.12**. Where impacts have been identified these have been already contemplated by previous measures and instruments or are proposed to be mitigated with further best practice environmental management initiatives. In that context, the benefits to the social and economic welfare of the community from the annual direct and indirect output of business turnover identified by the EA studies of $1,527 Million annually throughout the State of NSW for the life of the Project and the BCA (in **Section 8.12**) identifying net benefits from the Project of $1,362 Million provide a compelling justification for the Project to proceed.

11 WORST CASE CUMULATIVE IMPACT SCENARIO

11.1 BACKGROUND

In August 2009 Boggabri Coal commenced consultation with DoP regarding a new project approval for the continuation of the Boggabri Coal Mine. To progress that proposal, the following steps were taken:

1. 26 August 2009 PEA submitted;
2. 9 September 2009 PFM;
3. 25 September 2009 Revised PEA and Project Application submitted;
4. 15 December 2009 EPBC Referral submitted;
5. 17 December 2009 DGRs issued;
6. 2 July 2010 EA submitted for adequacy; and
7. 20 August 2010 NSW DoP letter requesting further information.

During the course of the above approval process further information has come to the attention of Boggabri Coal relating to other large scale coal mining projects in the immediate vicinity of the Boggabri Project which have since sought or may seek approval at some time in the future (Other Projects).

The DoP have requested that Boggabri Coal should consider the Other Projects in a Simultaneous Worst Case Cumulative Impact Scenario (SWCCIS). Accordingly, this SWCCIS review has been undertaken in order to attempt to gain a very high level appreciation of the potential worst case cumulative impacts if all of those Other Projects were to proceed in conjunction with the Project.

The SWCCIS is necessarily high level and based upon some highly speculative assumptions which are detailed in this review.

This SWCCIS review is separate to the EA for the Project. Whilst it draws upon the findings made from the assessments in the Boggabri EA for the Project, this review is prepared on a different basis to the quantitative environmental assessments in the Boggabri EA. The SWCCIS is making qualitative assessments for the purposes of a high level review.

11.2 OTHER PROJECTS

The following are the Other Projects (in the immediate vicinity of the Boggabri Project which have come to the attention of Boggabri Coal and as requested by DoP are considered for the purposes of the SWCCIS review).

Proponents of the Other Projects have lodged preliminary applications of one type or another relating to their projects after Boggabri Coal received its Director-General's Requirements regarding its EA or Boggabri Coal has become aware of the Other Projects from media statements more generally. The Other Projects are as follows:

Maules Creek Coal Project

The Maules Creek Coal Project is a proposed new open cut coal mine project described in a PEA dated July 2010 which, at the time, was on public exhibition as part of a Referral to the Commonwealth SEWPaC (formerly DEWHA).

The project description for this project is described in high level terms based upon the information available in the PEA and summarised in **Table 59**. These documents have been used for the purposes of this SWCCIS review.

As at the date of the SWCCIS review the application and formal PEA had not been exhibited on the DoP website.

Table 59
Maules Creek Coal Project

Attribute	Assumption	Source
Mine Life	21 years	PEA July 2010
Production Levels	Up to 13 Mtpa by Year 5	PEA July 2010
Type of Mine	Open cut	PEA July 2010
Method of mining	Truck and shovel / excavator	PEA July 2010
Coal Reserves	240 Mt within the Project Boundary	PEA July 2010
Coal Seams	15 – Mining down to the Templemore Seam	PEA July 2010
Workforce	400	PEA July 2010
Operating Hours	24 hours, 7 days / week	PEA July 2010
Blasting Hours	Monday – Saturday (excluding public holidays) during daylight hours	PEA July 2010
Number of Blasts	Up to 3 per day	PEA July 2010
Equipment Fleet	6 Hydraulic Excavators	PEA July 2010
	28 Overburden trucks	
	6 Coal Trucks	
	3 Graders	
	9 Bulldozers	
	3 Watercarts	
	4 Drills	
Project Boundary	Approximately 3,500 ha	EPBC Referral (July 2010)
Project Footprint	Approximately, 2,000 ha	EPBC Referral (July 2010)
ROM Hoppers	2 x 450 t	PEA July 2010
CHPP Capacity	1,750 tph and Bypass Circuit of 1,600 tph	PEA July 2010
Reject Bin Capacity	600 t	PEA July 2010
ROM Stockpile	N/A	PEA July 2010
Product Stockpile	600,000 t	PEA July 2010
Rail Loadout Capacity	5,000 tph	PEA July 2010
Construction Commencement Date	During the fourth quarter of 2011	EPBC Referral (July 2010)
Operation Commencement Date	N/A	N/A

Tarrawonga Modification

This Project includes the Modification to an existing open cut coal mine as described in the *Tarrawonga Coal Mine Modification EA* (Tarrawonga Modification EA) date April 2010. The project description in the Tarrawonga Modification EA has been used to develop the project description for the purposes of this review. The Tarrawonga modification is summarised in **Table 60**.

As the Tarrawonga Modification EA was placed in the public arena prior to the completion of this document it has been fully assessed on a cumulative basis with the Project throughout the Continuation of Boggabri Coal Mine EA.

Tarrawonga Extension

It is possible that Tarrawonga Mine will be expanded further into Exploration Lease (EL) 5967, whether by new project approval or further modification of the existing approvals. There have been no approvals issued or applications made for this proposal to date that are publically available. All that is known of this proposal at the date of this report is the existence of EL 5967. As such, a detailed project description is not available. Any assumptions regarding this Project are detailed in the relevant technical report.

Goonbri Project

It is possible that a future open cut or underground coal mine will be developed within EL 7435 under a new project approval which may be made at some time in the future.

There have been no approvals issued or applications made for this proposal to date that are publically available. All that is known of this proposal at this time is the existence of EL 7435. As such, a detailed project description is not available. Any assumptions regarding this Project are detailed in the relevant technical report.

The approximate locations of the Other Projects and their respective mining authorisations are shown on **Figure 1**.

Summary

The definition of each element of the Other Projects for the purposes of the SWCCIS review has been from the documents or sources mentioned in each relevant table. It is acknowledged that these assumptions are in many cases speculative and based on the best information available at the time.

Whilst the methodology used to assess the Other Projects is considered to be best practice and scientifically sound, the opinions and forecasts made in this SWCCIS review are based upon speculative assumptions and therefore are very high level and do not (and cannot) constitute a conventional and very detailed methodical assessment.

11.3 METHODOLOGY

The Other Projects are constructed from a combination of published information and from the author's speculation as described in each technical report and the definitions above.

The results of these SWCCIS assessments are therefore speculative, qualitative in nature and should not be relied upon to accurately predict environmental impacts.

This is not a fully quantitative report created using the normal scientific methodology for preparing formal environmental assessments in the context of a known, detailed project. This is because project descriptions of the Other Projects are speculative.

Quantitative information has been used where possible and the assessment methodology is sound. However, base data is reliant on assumptions (defined in the Other Projects) not on legal commitments inherent in approved conditions or obligations.

11.4 IMPACT ASSESSMENT

This SWCCIS is a high-level regional review of cumulative impacts and regional planning issues taking into account or assuming the existence of the Boggabri Project (as described in the Boggabri EA) and the Other Projects as defined in **Section 11.2**.

Table 60
Tarrawonga Modification

Attribute	Assumption	Source
Mine Life	8 -10 Years	2005 EIS
Production Levels	Up to 2 Mtpa	2005 EIS
Type of Mine	Open cut	2005 EIS
Method of mining	Truck and shovel	2005 EIS
Coal Reserves	16.4 Mt	EA April 2010
Overburden Material Generated	123.3 Mbcm	EA April 2010
Coal Seams	8 – Mining down to the Nagero Seam	2005 EIS
Workforce	67 Full time equivalent plus additional contractors on a as-needs-basis	2005 EIS
Operating Hours	7:00 am – 12:00 am Monday to Friday, 12:00 am to 3:30 am Tuesday to Saturday and 7:00 am to 6:00 pm Saturdays	2005 EIS
Blasting Hours	9:00 am to 5:00 pm, Monday to Friday	2005 EIS
Number of Blasts	150	AEMR 2009
Equipment Fleet	See Table 2 and 3 of Tarrawonga EA	EA April 2010
Project Boundary	N/A	N/A
Project Footprint	See Figure 1-3 of Tarrawonga EA	EA April 2010
Open Cut Disturbance Area	198 ha	EA April 2010
Maximum Height of OEAs	Northern Emplacement 370 m AHD	EA April 2010
	Southern Emplacement 340 m AHD	2005 EIS
ROM Stockpile	150,000 t	2005 EIS
ROM Hoppers	1 x 40 t capacity	EA April 2010
Onsite Crusher Hours of Operation	7:00 am – 12:00 am Monday to Friday, 12:00 am to 3:30 am Tuesday to Saturday and 7:00 am to 6:00 pm Saturdays	EA April 2010
Product Coal loadout	150 t -200 t	2005 EIS
Construction Commence Date	2006	EA April 2010

This SWCCIS assesses potential cumulative impacts on the environment from the Boggabri Project assuming the Other Projects were to proceed and be in operation at the same time as the Project. This is a 'worst case' assessment.

The assumptions underlying the assessments undertaken for the Project in this EA have all assumed worst case environmental impacts for the Project based upon very conservative values and parameters.

All assessments in the SWCCIS have considered the *'Cumulative Impacts - A Good Practice Guide for the Australian Coal Mining Industry'* (Franks et al, 2010) and other relevant guidelines when preparing this high level cumulative impact assessment.

The key environmental impacts have been assessed (qualitatively) by each of the relevant scientific specialists and reported on in the Appendices separately from the Project EA and include cumulative:

- Air Quality impacts Appendix G;
- Noise impacts Appendix H;
- Ecological impacts Appendix J;
- Surface Water impacts Appendix M;
- Groundwater impacts Appendix O; and
- Traffic impacts (including rail) Appendix T.

11.4.1 Air Quality

There is potential for additional cumulative impacts to occur to properties to the south of the Boggabri Project due to the combined impacts of Boggabri Coal, Maules Creek and Tarrawonga Extension.

Due to the minimal winds from the east, there is limited potential for any significant cumulative impacts to properties to the west of Boggabri Coal Mine and Maules Creek Coal Project by the Goonbri Project.

Any additional dust emissions from the Tarrawonga Extension and / or the "Goonbri" Project, could potentially result in cumulative impacts to properties to the south-east of Boggabri Coal. This is due to the prevalence of winds from the north and west (most evident in spring and winter).

The Maules Creek Project, Tarrawonga Extension and/or the "Goonbri" Project could potentially result in cumulative impacts to properties to the north-west of Boggabri Coal. This is due to predominant winds from the east and south (most evident in summer and autumn).

The SWCCIS in regards to potential air quality impacts is included in full in **Appendix G**.

11.4.2 Acoustics

The SWCCIS review indicated that four properties (Belleview, Jeralong, Goonbri and Sylvania) may be subjected to cumulative noise impacts assuming simultaneous operation of all five coal mines in the area at some time in the future (**Table 61**). **Table 61** also shows that any property subjected to cumulative noise impacts is also within the Zone of Affectation (ZOA) from one or more of the assessed coal mining operations.

The SWCCIS for noise indicates that all properties remaining outside the ZOA for each separate mining operation are unlikely to be subjected to cumulative noise impacts from two or more coal mine projects. The cumulative noise from two or more coal mines is therefore, unlikely to cause significant noise impacts at any privately owned property that is not already identified within a ZOA.

The SWCCIS in regards to potential noise impacts is included in full in **Appendix H**.

11.4.3 Ecology

The proposed projects considered for the SWCCIS are all largely located within or adjoining Leard State Forest, which comprises a very large remnant patch of vegetation surrounded by a landscape that has been significantly affected by past land uses. The Leard State Forest has been intensively logged for its valuable timber resources on a regular basis up until the early 1980s. These activities have affected the quality and diversity of habitats for locally occurring Threatened species and it is likely that in the absence of future mining projects, these activities would continue throughout the Forest as productive timber develops.

Table 61
Indicative Cumulative Mining Noise Levels, LAeq Night

Receiver	Boggabri Project	Tarrawonga Modification	Maules Creek Project	Tarrawonga Extension	Goonbri Project	Combined Noise Level
Belleview	38 *	<25	33	27	<25	40
Jeralong	38 *	33	31	40 *	<25	43
Goonbri	37	<25	35	31	38 *	42
Cooboobindi	35	<25	31	26	<25	37
Roma	34	<25	31	28	<25	37
Glenhope	33	<25	30	28	<25	36
Sylvania	27	29	28	30	40 *	41

* *Indicates the property would lie within the ZOA of the relevant mining operation based on the indicated or assumed noise levels.*

Despite the impacts of past forestry operations within the Leard State Forest and in the absence of any amelioration works or offset areas, the cumulative impacts of the projects would have a substantial impact on the ecology of the local area. They would remove nearly 2,981 ha of native vegetation within or adjoining Leard State Forest and as much as 5,067 ha if including the potential development of the Goonbri and Tarrawonga Expansion Projects (yet to be detailed).

Proposed future mining projects are likely to impact similar local Threatened biodiversity and remnant vegetation types to those identified for the Boggabri Coal Project. Given this, the contribution of these projects to additional biodiversity offsets may encompass up to approximately 18,155 ha at an average ratio of 5:1.

In accordance with current regulatory requirements and policies from the DoP and DECCW any future mining projects in the area would likely be required to set aside biodiversity offsets as compensation for the impacts identified with each project. If the combination of existing and potential future biodiversity offset strategies for each project were to complement each other, then the long term biodiversity of the region could potentially be improved. This would also provide the opportunity for larger contiguous parcels of land to be placed under long term conservation management strategies in perpetuity for the future.

The SWCCIS in regards to potential ecology impacts is included in full in **Appendix J**.

11.4.4 Surface Water Impacts

The Boggabri Coal Project is largely located within the Nagero Creek catchment. The SWCCIS would potentially capture runoff from an additional 170 ha of the Nagero Creek catchment, further reducing runoff volumes to Nagero Creek. The combined area captured in water management systems of coal mines within the Nagero Creek catchment would be approximately 1,803 ha (22.5% of the total catchment a 2.1% increase).

A sensitivity analysis was undertaken to assess the response of the Boggabri Coal Mine water balance to changes in groundwater make from the mining void.

In the absence of data from groundwater modelling incorporating the SWCCIS, nominal groundwater make reductions of 10% and 20% were adopted for the sensitivity analysis.

For a nominal 20% (worst case) reduction in groundwater make, the outstanding water deficit during Year 5 would increase by 50 ML (**Table 62**).

This is not considered a significant volume and would not change any of the findings in the surface water assessment for the Continuation of Boggabri Coal Mine Project. It is unlikely there will be any adverse cumulative impacts associated with water quality on the Namoi River from mining activities.

The SWCCIS in regards to potential surface water impacts is included in full in **Appendix M**.

11.4.5 Groundwater

The SWCCIS review of groundwater identified that interactions between the zone of depressurisation of the Maules Creek Coal Project and the Tarrawonga Modification will occur.

The modelling indicates depressurisation would extend under the alluvial aquifers to the north of the Maules Creek Coal Project and to the south of the Tarrawonga Mine outcrop area. However, the resultant drawdown in groundwater levels in the alluvial aquifers would be less than 1 m, and therefore unlikely to be detectable from seasonal fluctuations.

The net volume of groundwater flowing from the Permian bedrock aquifer (Boggabri volcanic and Permian coal measures) into the overlying alluvial aquifer would be reduced. The modelling indicates that in the absence of mining, the natural net seepage rate from the bedrock aquifer to the alluvial aquifer is about 1.25 ML/day. It is estimated in the SWCCIS at Year 21 of the Boggabri Project, this natural seepage would reduce by about 0.35 ML/day (from 1.25 ML/day to 0.9 ML/day). This reduction in natural seepage would result in a drawdown in the alluvial aquifer which would be less than 1 m, and therefore unlikely to be detectable from seasonal fluctuations.

The model assumed a hydraulic connection between the alluvial aquifer and the Permian bedrock aquifer based on evidence from existing monitoring data. A reduction in the yield from the alluvial aquifer and Permian bedrock aquifer would be unlikely to impact on neighbouring landholder bores and is therefore not considered to be a significant impact.

The SWCCIS modelling indicates that the zone of depressurisation at 100 years after mining ceases would be larger than that predicted for the 21 year active mining period for the Project. This is predominantly due to the evaporation from the ponded groundwater in the Maules Creek Coal Project final void. Evaporation from the Maules Creek Coal Project final void will act as an evaporative sink removing groundwater from the Permian bedrock aquifer.

This will allow the zone of depressurisation to slowly increase in area over time. The zone of depressurisation will reach a maximum extent at the interface between the outcropping Permian bedrock aquifer and alluvial aquifer. The higher recharge rate of the alluvial aquifer will prevent the further progression of the zone of depressurisation in the Permian bedrock aquifer.

The long term reduction in groundwater levels in the alluvial aquifer is predicted to be less than 1 m and therefore the yields from bores constructed in this zone are not expected to be impacted in the long term.

The SWCCIS in regards to potential surface water impacts is included in full in **Appendix O**.

11.4.6 Traffic

The Simultaneous Worst Case Cumulative Impact Scenario would be unlikely to have any significant impact on the performance or safety of the local road network. The traffic performance of all the key intersections would remain excellent. The worst performing would be the Leard Forest Road / Boggabri Mine Access Road intersection (which is a private access) with DoS of 0.3 and a LoS B in both the AM and PM peak hour periods.

No public transport services were identified in the vicinity of the Boggabri Project that would be adversely impacted by the simultaneous operation of the Other Projects.

The worst case cumulative traffic impact scenario at studied level crossings on the Mungindi to Werris Creek Railway in Boggabri, Gunnedah and Curlewis would not be significant.

The increase in the number of trains, from an average of 1.2 coal train trips per day to transport 1.5 Mtpa of coal from the existing Boggabri Coal Mine up to 11.6 coal train trips per day to service the estimated 22 Mtpa from the future projects would increase the daily delay to traffic at these crossings. However, because existing traffic volumes are low and coal trains often run over night when traffic volumes are lower still, the impact of the increase in trains is likely to be small.

Table 62
Water Balance for 10th Percentile (Dry) Rainfall Year - Sensitivity Analysis

Landform	Annual Site Water Demand (ML)	Base Scenario		Scenario A (-10% g/w make)		Scenario B (-20% g/w make)	
		Ground Water Make^ (ML/yr)	Out-standing Water Deficit^^ (ML/yr)	Ground Water Make (ML/yr)	Out-standing Water Deficit^^ (ML/yr)	Ground Water Make (ML/yr)	Out-standing Water Deficit^^ (ML/yr)
Year 5	1,309	250	750	225	775	200	800
Year 10	1,064	342	361	308	395	274	429
Year 21	1,075	410	384	369	425	328	466

Notes. ^Predicted groundwater make for base scenario sourced from Continuation of Boggabri Coal Mine Groundwater Assessment (Australasian Groundwater and Environmental Consultants, February 2010). ^^Existing water entitlements held by Boggabri Coal have been considered when calculating the outstanding water deficit.

It is acknowledged that some road users may notice additional delays at level crossings due to an increase in rail movements. It should be noted that the capacity of the road network at low level crossings to accommodate traffic cues from additional assessed rail movements is sufficient. The SWCCIS in regards to potential surface water impacts is included in full in **Appendix T**.

11.5 MITIGATION AND MANAGEMENT

'The Cumulative Impacts – A good guide for the Australian coal mining industry' (Franks *et al. 2010*.) notes that cumulative impacts can be both positive and negative and can vary in both intensity as well as in spatial and temporal extent. This is generally consistent with the findings of the SWCCIS.

It should be recognised that the findings from the SWCCIS review should not be relied upon to make changes to the mine plan or regional planning decisions as the Other Projects are speculative and no definitive data was available at the time of the review.

The SWCCIS review provides an indication of the potential cumulative impacts relating to coal mining in the vicinity of the Leard State Forest.

The SWCCIS identified that there would be very low if any adverse cumulative impacts associated with traffic and rail movements.

The SWCCIS review identified that there is potential for some cumulative impacts with Other Projects assuming all projects are operational at the same time as the Project.

While this scenario is unlikely to occur the SWCCIS provides an indication of potentially sensitive environmental aspects that may be subject to adverse cumulative impacts under this scenario.

In recognition of potential cumulative impacts being realised Boggabri Coal is committed to adopting best practice environmental management practices to minimise any potential adverse impacts resulting from the Project.

Beyond this Boggabri Coal will actively participate in the sharing and exchange of relevant information and data to further assess and understand any potential cumulative impacts in the local area as required.

Boggabri Coal will continue to liaise with the community, NSC, GSC, industry, regulators and other relevant stakeholders to ensure any potential cumulative impacts are managed in a coordinated fashion for the Project and future mining developments in the area.

Boggabri Coal will continue to participate in relevant strategic and regional planning forums to ensure cumulative impacts are well considered in regards to future mining in the Gunnedah Basin.

12 ABBREVIATIONS

Abbreviation	Description
ABS	Australian Bureau of Statistics
ACHMP	Aboriginal Cultural Heritage Management Plan
AEMR	Annual Environmental Management Report
AGE	Australasian Groundwater and Environmental Consultants Pty Ltd
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ANC	Acid Neutralising Capacity
ANTC	Aboriginal Native Title Consultants
ANZECC	Australian and New Zealand Environment Conservation Council
ARD	Acid Rock Drainage
ARI	Average Recurrence Interval
AWBM	Australian Water Balance Model
AWT	Average weekly traffic
BBTP	Bigundi Biame Traditional People
BCA	Benefit Cost Analysis
bcm	bank cubic metres
Boggabri CCC	Community Consultative Committee
Boggabri Coal	Boggabri Coal Pty Limited
Boggabri EIS	Boggabri Coal Project Environmental Impact Statement 1987
BoM	Bureau of Meteorology
CCC	Cacatua Cultural Consultants
CCL	Consolidated Coal Lease
CEEC	Critically Endangered Ecological Community
CH_4	Methane
CL	Coal Lease
CMHS Act	Coal Mines Health and Safety Act 2002
CO_2	Carbon dioxide
CO_{2e}	Carbon dioxide equivalent
CPP	Coal Preparation Plant
Dams Safety Act	Dams Safety Act 1978
dBA	The peak sound pressure level, expressed as decibels (dB) and scales on the 'A-weighted' scale, which attempts to closely approximate the frequency response of the human ear

Abbreviation	Description
DECCW	NSW Department of Environment, Climate Change & Water (formerly known as Department of Environment & Climate Change, previously known as Department of Conservation)
DECC Guidelines	Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (2005)
DMC	Dense Medium Cyclone
DoP	NSW Department of Planning (Incorporates former DIPNR, Planning NSW and DUAP)
DSC	Dams Safety Committee
EA	Environmental Assessment
EARs	Environmental Assessment Requirements
EC	Electrical conductivity
ECRTN	Environmental Criteria for Road Traffic Noise 1999
EEC	Endangered Ecological Community
EHMP	European Heritage Management Plan
EIS	Environmental Impact Statement
ELCHC	Elli Lewis Cultural Heritage Consultants
EMP	Environmental Monitoring Program
EMS	Environmental Management System
ENM	Environmental Noise Model
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	NSW Environmental Protection Authority (incorporated in DECC)
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)
EPI	Environmental Planning Instrument
EPL	Environmental Protection Licence
ESD	Ecologically Sustainable Development
GDE	Groundwater Dependent Ecosystem
GGAC	Gunida Gunyah Aboriginal Corporation
GNAC	Gomeroi Narrabri Aboriginal Corporation
Gunnedah RC	Gunnedah Resource Centre
GWP	Global Warming Potential
ha	Hectare
HMZ	Heritage Management Zones
HVAS	High Volume Air Sampler
IAR	Idemitsu Australia Resources Pty Limited
INP	NSW Industrial Noise Policy 2000
ISO	International Standards Organisation
LA_1	The noise level exceeded for 1% of the time
LA_{10}	A noise level exceeded for 10% of the time

Abbreviation	Description
LA_{90}	Commonly referred to as the background noise, this is the level exceeded 90% of the time
LA_{eq}	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period
LEP	Local Environment Plan
LGA	Local Government Area
LOS	Level of Service
m	Metre
Mining Act	Mining Act 1992
ML	Megalitres
ML/day	Megalitres per day
ML/year	Megalitres per year
mm	Millimetre
mm/s	Millimetres per second
MMAC	Min Min Aboriginal Corporation
MNES	Matter of National Environmental Significance
MOP	Mining Operations Plan
MSDS	Material Safety Data Sheet
MSDS	Material Safety Data Sheet
Mt	Million tonnes
Mtpa	Million tonnes per annum
N2O	Nitrous oxide
NAF	Non Acid Forming
NGA	National Greenhouse Accounts
NMP	Noise Management Plan
NOW	NSW Office of Water
NPW Act	National Parks and Wildlife Act 1974
NSC	Narrabri Shire Council
NSW I&I	NSW Industry and Investment (previously Department of Primary Industries)
OEA	Overburden Emplacement Area
OREP	Orana Regional Environmental Plan – Siding Springs
PAF-HC	Potentially Acid Forming - High Capacity
PCI	Pulverised coal injection
PEA	Preliminary Environmental Assessment
PFM	Planning Focus Meeting
Planning Approval	Project Approval document
PM_{10}	Particulate Matter <10 microns

Abbreviation	Description
POEO Act	Protection of the Environment Operations Act 1997
RBL	Rating Background Level
RCLALC	Red Chief Local Aboriginal Land Council
Receiver	Private property adjacent the EA Boundary containing a receiver
Roads Act	Roads Act 1993
RTA	NSW Roads and Traffic Authority
SCA	State Conservation Area
SCMP	Spontaneous Combustion Management Plan
SEPP	State Environmental Planning Policy
SEPP 33	Hazardous and Offensive Development
SEPP 44	Habitat Koala Protection
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities. Previously known as Department of Environment, Water, Heritage and Arts (DEWHA)
SIA	Social Impact Assessment
SIGNAL	Stream Invertebrate Grade Number Average Level
SO_2	Sulphur dioxide
SoC	Statement of Commitments
SODAR	Sonic Detection and Ranting
tph	tonnes per hour
TSC Act	Threatened Species Conservation Act 1995
TSP	Total Suspended Particulates
TSS	Total suspended solids
VPA	Voluntary Planning Agreement
WAL	Water Access Licence
Water Act	Water Act 1912
WM Act	Water Management Act 2000
WRM	WRM Water and Environment Pty Limited

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14 STUDY TEAM

Section	EA Component / Role	Team Member and Company	
Project Management			
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	Executive General Manager	Peter Wilkinson	
	General Manager	Thor Berding	Boggabri Coal
	Environmental Coordinator	Joe Rennick	
EA Management			
	Project Director	James Bailey	Hansen Bailey
	Project Manager	Ben Eastwood	
Stakeholder Engagement			
	General Manager	Thor Berding	Boggabri Coal
	Environmental Coordinator	Joe Rennick	
	Director	James Bailey	Hansen Bailey
	Senior Environmental Scientist	Ben Eastwood	
EA Sections			
	Executive Summary	Ben Eastwood	Hansen Bailey
1.0	Background	Jason Martin	Hansen Bailey
2.0	Existing Environment	Jason Martin	Hansen Bailey
3.0	Approved Operations	Ben Eastwood	Hansen Bailey
4.0	The Project	Ben Eastwood	Hansen Bailey
5.0	Regulatory Framework	James Bailey	Hansen Bailey
6.0	Stakeholder Consultation	Ben Eastwood	Hansen Bailey
7.0	Risk Assessment	Ben Eastwood	Hansen Bailey
8.0	Impacts, Management and Mitigation	Ben Eastwood, Jason Martin, Nathan Cooper, Dianne Munro	Hansen Bailey
9.0	Statement of Commitments	James Bailey	Hansen Bailey
10.0	Project Justification	Ben Eastwood	Hansen Bailey
11.0	Simultaneous Worst Case Cumulative Impact Assessment	Ben Eastwood	Hansen Bailey
12.0	Abbreviations		
13.0	References		
14.0	EA Study Team		
Appendices			
Appendix A	Existing Boggabri Coal Planning Approvals		

Section	EA Component / Role	Team Member and Company	
Appendix B	Schedule of Land to which the EA Applies		
Appendix C	Underground Concept Study		WDS Consulting
Appendix D	Regulatory Correspondence		
Appendix E	Stakeholder Consultation		
Appendix F	Revised Environmental Risk Assessment		
Appendix G	Air Quality Impact Assessment	Judith Cox	PAE Holmes
Appendix H	Acoustic Impact Assessment	Mark Bridges	Bridges Acoustics
Appendix I	Visual Impact Assessment	John van Pelt	Integral Landscape Architecture and Visual Planning
Appendix J	Biodiversity Impact Assessment	Alex Cockerill	Parsons Brinckerhoff
Appendix K	Aboriginal Cultural Heritage Impact Assessment	Angela Besant	Insite Heritage
Appendix L	Non Aboriginal Cultural Heritage Assessment	Chris Carter	Archaeology Australia
Appendix M	Surface Water Impact Assessment	Shane Scott	Parsons Brinckerhoff
Appendix N	Namoi River Flood Impact Assessment	Greg Roads	WRM Water & Environment
Appendix O	Groundwater Assessment	James Tomlin	Australasian Groundwater and Environmental Consultants
Appendix P	Geochemical Assessment	Alan Robertson	RGS Environmental
Appendix Q	Economic Assessment	Robert Gillespie	Gillespie Economics
Appendix R	Social Impact Assessment	Bronwyn Pressland	Hansen Bailey
Appendix S	Soil Survey and Land Resource Assessment	Clayton Richards	GSS Environmental
Appendix T	Traffic Impact Assessment	Zoran Bakovic	Parsons Brinckerhoff
Legal Advice provided by Sparke Helmore Drafting and Graphics Design by Pegasus Technical Pty Limited and Melissa Bahur Ecological Peer Review Advice by Dr David Robertson, Cumberland Ecology			