Tarrawonga Coal Project

Environmental Assessment

SECTION 4

ENVIRONMENTAL ASSESSMENT

Resource Strategies

Tarrawonga Coal Pty Ltd

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4 ENVIRONMENTAL ASSESSMENT

The following sub-sections present the environmental assessment for the Project, including:

- a description of the existing environment, including descriptions of components of the existing Tarrawonga Coal Mine and its environmental management regime, where relevant;
- an assessment of the potential impacts associated with the Project, including cumulative impacts;
- a description of the measures that would be implemented to avoid, minimise, mitigate and/or offset the potential impacts of the Project; and
- a description of the ongoing management and monitoring measures that would be implemented by TCPL.

The assessment of the potential impacts of the Project was conducted in accordance with the EARs (Section 1.2 and Attachment 1), and in consideration of the outcomes of consultation with key stakeholders, including the community (Section 3) and the results of the Environmental Risk Assessment (ERA) (Section 4.1 and Appendix O).

A summary of other major projects that may interact with the Project and potentially give rise to cumulative impacts is provided in Attachment 3. Potential cumulative impacts have been considered, where relevant, in the specialist studies and are described in the sub-sections below.

TCPL's Statement of Commitments for the Project was developed as a result of the environmental assessment of the Project and is provided in Section 7.

4.1 ENVIRONMENTAL RISK ASSESSMENT

In accordance with the EARs, an ERA was undertaken to identify key potential environmental issues for further assessment in the EA. The ERA was conducted in July 2011, and was facilitated by a risk assessment specialist (Safe Production Solutions, 2011).

The risk assessment team consisted of representatives from:

- Whitehaven;
- Cenwest Environmental Services;
- FloraSearch;
- Gilbert and Associates;
- Heritage Computing; and
- Resource Strategies.

The ERA workshop was used to identify key potential environmental issues for further assessment in this EA. The key potential environmental issues identified during the ERA workshop are summarised in Table 4-1 and addressed in Sections 4.2 to 4.17, as well as the relevant appendices to this EA.

The risks associated with the potential environmental issues shown in Table 4-1 were ranked in accordance with the frameworks detailed in Australian Standard/New Zealand Standard (AS/NZS) 31000:2009 *Risk Management – Principles and Guidelines*, *MDG1010 Risk Management Handbook for the Mining Industry* (DPI, 1997) and Handbook (HB) 203: 2006 *Environmental Risk Management – Principles and Process* (Standards Australia/Standards New Zealand, 2006). All of the potential issues were ranked within the "Medium – As Low as Reasonably Practicable" or "Low" range by the risk assessment team. The ERA is provided in full as Appendix O.

4.2 CLIMATE

4.2.1 Existing Environment

Meteorology

Longer-term local meteorological data are available from Commonwealth Bureau of Meteorology (BoM) meteorological stations (Table 4-2), and short-term records are also available from the on-site automatic weather stations (AWS) located at the Tarrawonga Coal Mine, Boggabri Coal Mine and Maules Creek Coal Project.

The Tarrawonga Coal Mine AWS was installed in 2006 and is operated in accordance with the Development Consent (DA 88-4-2005) and EPL 12365. It monitors a number of meteorological parameters, including rainfall, temperature, barometric pressure, humidity, dew point, solar radiation and wind speed/direction.

Table 4-1
Key Potential Environmental Issues

Environmental Issue Subject Area	Description of Issue	EA Appendix/Section
Groundwater	Potential impacts on alluvial groundwater.	Appendix A and Section 4.4
Groundwater/Surface Water	Final void and associated surface and groundwater management.	Appendices A and B and Sections 4.4, 4.5 and 5
Surface Water	Long-term stability of the permanent Goonbri Creek alignment.	Appendix B and Section 4.5
	Potential for inadequate water supply – for dust suppression and consequent impacts on dust emissions.	Appendix B and Sections 4.5 and 4.7
Noise	Mine site noise emissions – in particular cumulative impacts.	Appendix C and Section 4.6
Air Quality	Blasting effects – in particular fume and dust emissions.	Appendix D and Section 4.7
	Mine site dust emissions – in particular cumulative impacts.	Appendix D and Section 4.7
Biodiversity	Permanent Goonbri Creek Alignment – failure to establish riparian habitat.	Appendix E and Section 4.10
	Biodiversity impacts – in particular cumulative impacts of multiple mines in the Leard State Forest.	Appendices E and F and Sections 4.9 and 4.10
	Loss of biodiversity associated with clearing of a portion of Goonbri Creek (particularly the large trees).	Appendices E and F and Section 4.9 and 4.10
Visual	Visual impacts from lighting and mine landforms.	Appendix J and Section 4.12
Aboriginal Heritage	Effects of the Project on Aboriginal heritage.	Appendix K and Section 4.13
Rehabilitation	Achieving appropriate integration with Boggabri Coal Mine landform.	Section 5

A summary of meteorological parameters in the vicinity of the Project relevant to the environmental studies in this EA are provided below.

Temperature

The closest BoM meteorological stations to the Project recording temperature data are located in Gunnedah (BoM, 2011) (Figure 4-1).

Long-term, monthly-average daily maximum and minimum temperatures from the Gunnedah Pool Station and Gunnedah Resource Centre meteorological stations show that temperatures are warmest from November to March and coolest in the winter months of June, July and August (Table 4-2).

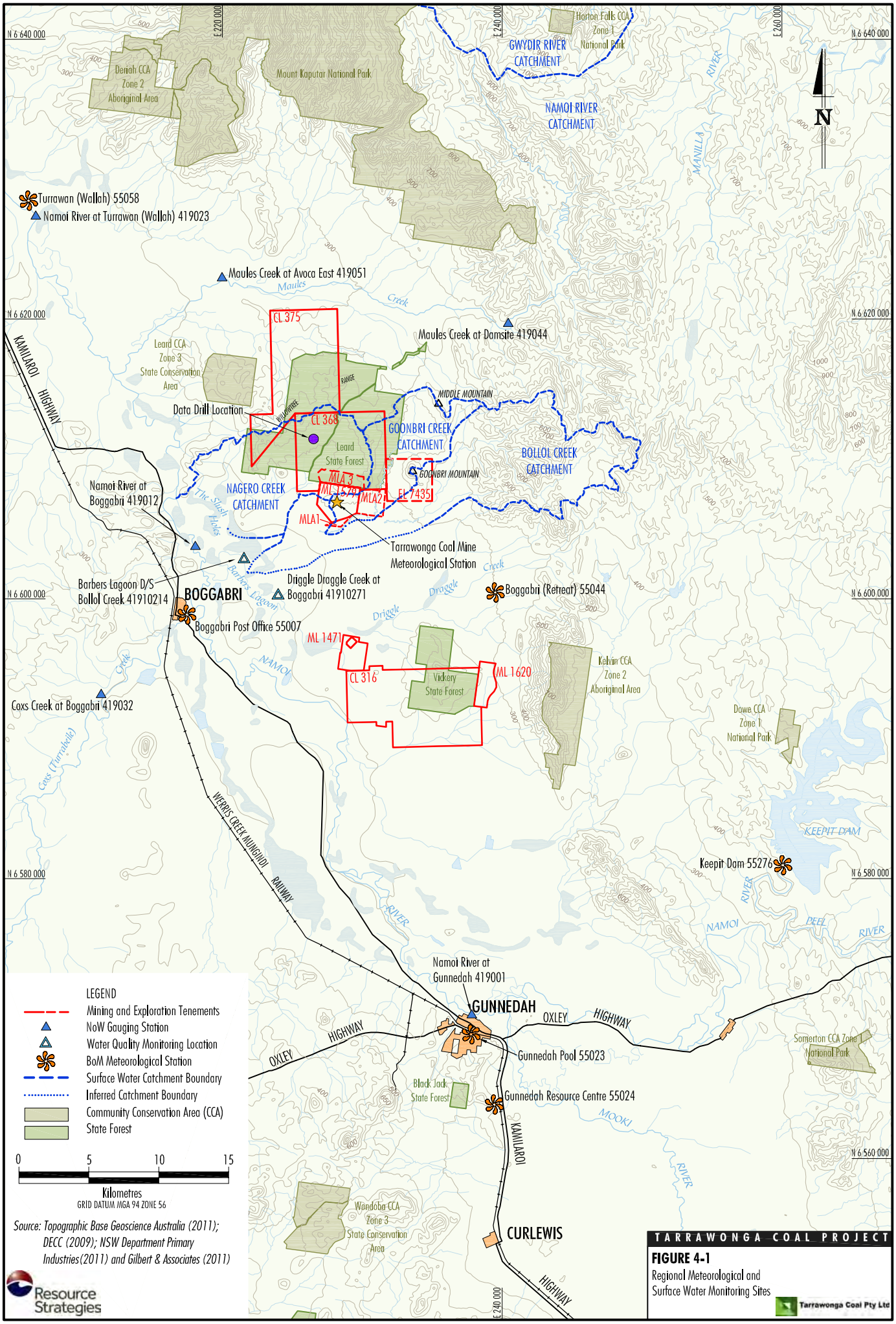
Monthly-average daily maximum temperatures are highest in January (34.0 and 31.9 degrees Celsius [ºC] for the Gunnedah Pool Station and Gunnedah Resource Centre meteorological stations, respectively) and monthly-average daily minimum temperatures are lowest in July (3.0 and 4.7ºC for the Gunnedah Pool Station and Gunnedah Resource Centre meteorological stations, respectively) (Table 4-2).

For the period 2006 to 2011, monthly-average daily minimum temperatures recorded by the Tarrawonga Coal Mine AWS ranged from 2.9°C (July 2007) to 4.8°C (June 2010) and monthly-average daily maximum temperatures ranged from 30.5°C (January 2008) to 34.5°C (January 2007) (TCPL, 2007, 2008, 2009, 2010, 2011a).

Rainfall

The long-term average annual rainfall at meteorological stations in close proximity to the Project (Figure 4-1) varies from approximately 581 mm at the Boggabri (Retreat) meteorological station to approximately 591 mm at the Boggabri Post Office weather station (Table 4-2).

The months with the highest monthly-average rainfalls at the Boggabri Post Office, the Boggabri (Retreat) and Turrawan (Wallah) meteorological stations are January (71.0 mm, 71.5 mm and 81.1 mm, respectively) (Table 4-2).


N 6 640 000
E 220 000
E 240 000
E 260 000
N 6 620 000
N 6 600 000
N 6 580 000
N 6 560 000
Deriah CCA Zone 2 Aboriginal Area
Mount Kaputar National Park
Horton Falls CCA Zone 1 National Park
GWYDIR RIVER CATCHMENT
NAMOI RIVER CATCHMENT
MANILLA RIVER
Turrawan (Wallah) 55058
Namoi River at Turrawan (Wallah) 419023
Maules Creek at Avoca East 419051
Maules Creek
CL 375
Maules Creek at Damsite 419044
Leard CCA Zone 3 State Conservation Area
KAMILAROI HIGHWAY
Data Drill Location
WILGATREE RANGE
CL 368
MIDDLE MOUNTAIN
GOONBRI CREEK CATCHMENT
BOLLOL CREEK CATCHMENT
Leard State Forest
GOONBRI MOUNTAIN
MLA3
ML 1471
MLA2
EL 7435
MLA1
NAGERO CREEK CATCHMENT
Namoi River at Boggabri 419012
The Slush Holes
Tarrawonga Coal Mine Meteorological Station
Barbers Lagoon D/S Bollol Creek 41910214
BOGGABRI
Barbers Lagoon
Driggle Draggle Creek at Boggabri 41910271
Boggabri (Retreat) 55044
Boggabri Post Office 55007
ML 1471
CL 316
Vickery State Forest
ML 1620
Kelvin CCA Zone 2 Aboriginal Area
Coxs Creek at Boggabri 419032
Coxs (Purraikle)
Dowe CCA Zone 1 National Park
KEEPIT DAM
Keepit Dam 55276
WERRIS CREEK MUNGINDI RAILWAY
NAMOI RIVER
PEEL RIVER
Namoi River at Gunnedah 419001
GUNNEDAH
OXLEY HIGHWAY
Gunnedah Pool 55023
Somerton CCA Zone 1 National Park
Black Jack State Forest
Gunnedah Resource Centre 55024
MOOKI RIVER
KAMILAROI HIGHWAY
Wondoba CCA Zone 3 State Conservation Area
CURLEWIS
LEGEND
Mining and Exploration Tenements
NoW Gauging Station
Water Quality Monitoring Location
BoM Meteorological Station
Surface Water Catchment Boundary
Inferred Catchment Boundary
Community Conservation Area (CCA)
State Forest
0 5 10 15
Kilometres
GRID DATUM MGA 94 ZONE 56
Source: Topographic Base Geoscience Australia (2011); DECC (2009); NSW Department Primary Industries(2011) and Gilbert & Associates (2011)
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TARRAWONGA COAL PROJECT
FIGURE 4-1
Regional Meteorological and Surface Water Monitoring Sites
Tarrawonga Coal Pty Ltd

Table 4-2
Relevant Long-term Meteorological Information

Period of Record	Average Daily Temperature (°C)[1]				Average Monthly Rainfall (mm)[2]				Average Monthly Evaporation (mm)[2, 3]	
	Gunnedah Pool Station (55023)		Gunnedah Resource Centre (55024)		Data Drill Sequence[4]	Boggabri Post Office (55007)	Boggabri (Retreat) (55044)	Turrawan (Wallah) (55058)	Keepit Dam (55276)	Gunnedah Resource Centre (55024)
	Minimum	Maximum	Minimum	Maximum						
	1876 to 2011		1948 to 2011		1889 to 2011	1884 to 2011	1889 to 2011	1910 to 2011	1972 to 2006	1971 to 2010
January	18.4	34.0	18.9	31.9	79.4	71.0	71.5	81.1	255.7	248.4
February	18.1	32.9	18.7	31.1	67.0	64.4	61.4	61.2	204.5	202.1
March	15.8	30.7	16.6	29.1	49.9	45.5	42.2	42.5	182.1	196.4
April	11.4	26.4	12.8	25.2	37.0	33.7	35.4	33.4	124.1	138.2
May	7.1	21.3	8.7	20.3	44.4	41.8	38.0	41.9	80.6	90.4
June	4.3	17.6	6.1	16.8	42.5	43.5	43.7	43.0	56.1	61.7
July	3.0	16.9	4.7	16.1	44.2	41.4	42.8	42.3	63.9	64.8
August	4.2	18.9	5.8	17.9	39.7	38.1	37.3	34.8	89.2	91.8
September	7.0	22.8	8.6	21.4	38.9	38.0	39.9	37.2	129.3	127.4
October	10.7	26.7	12.2	25.1	53.2	51.1	50.3	50.9	172.7	174.9
November	14.2	30.3	15.0	28.3	58.3	58.5	56.9	57.6	207.7	206.1
December	16.8	32.9	17.5	31.1	64.0	64.1	61.7	65.3	259.4	250.5
Annual Average Total	**-**	**-**	**-**	**-**	***618.5***	***591.1***	***581.1***	***591.2***	***1,825.3***	***1,852.7***

1 Source: BoM (2011).

2 Source: After Gilbert & Associates (2011).

3 As measured by Class A Evaporation Pan.

4 Data Drill located at 30.6 degrees (°) S, 150.15°E – north of Tarrawonga Coal Mine. The Data Drill sequence is a continuous, synthetic record based on interpolation of data from nearby sites.

The distribution of annual average precipitation across the Project and regional areas is highest in elevated areas associated with the Willowtree Range and the volcanic highlands associated with Mount Kaputar National Park to the north. Average annual rainfall is relatively lower on the floodplains of the Namoi River and areas to the south and east of the Project (Appendix B).

For the period 2006 to 2011, the average annual rainfall recorded by the Tarrawonga Coal Mine AWS ranged from 412.6 mm (2006/2007) to 669.6 mm (2010/2011), with maximum monthly rainfall typically occurring in the summer months (TCPL, 2007, 2008, 2009, 2010, 2011a).

The average annual rainfall as predicted by the BoM Data Drill[1], located in Leard State Forest (Figure 4-1), is 619 mm (Table 4-2).

Evaporation

Evaporation records are available from the Keepit Dam and Gunnedah Resource Centre meteorological stations (Figure 4-1), which have recorded average annual evaporation of approximately 1,825 mm and 1,853 mm, respectively (Table 4-2).

The highest monthly-average evaporation is in December (259.4 mm and 250.5 mm for Keepit Dam and Gunnedah Resource Centre, respectively) and the lowest monthly-average evaporation is in June (56.1 mm and 61.7 mm for Keepit Dam and Gunnedah Resource Centre, respectively) (Table 4-2).

Measured monthly-average evaporation exceeds the measured monthly-average rainfall in all months (Table 4-2).

Wind Speed and Direction

As part of the air quality assessment of this EA (Appendix D), annual and seasonal wind speeds and directions were evaluated using available 15-minute averages of wind speed and direction data for 2010 from the Tarrawonga Coal Mine AWS. The annual and seasonal windroses for Tarrawonga Coal Mine AWS are provided in Appendix D.

For the duration of the collection period the annual windrose indicates that the prevailing wind direction was from the northern quadrant (approximately 16%) with wind speeds generally between 0.5 and 4.5 metres per second (m/s). Calm periods (i.e. wind speed less than 0.5 m/s) were recorded by the Tarrawonga Coal Mine AWS for approximately 18% of time during 2010.

Appendix D also provides windroses developed (using the meteorological model CALMET) from a synthesis of data from the Tarrawonga Coal Mine AWS, Boggabri Coal Mine AWS, Maules Creek AWS and the BoM meteorological station located at Narrabri Airport.

4.2.2 Monitoring

The Tarrawonga Coal Mine AWS would continue to operate for the Project. The data recorded would continue to be used as part of the noise (Section 4.6) and air quality (Section 4.7) management regimes, and to assist in the interpretation of surface water and groundwater monitoring data (Sections 4.4 and 4.5).

4.3 LAND RESOURCES AND AGRICULTURAL PRODUCTION

A description of the existing environment relating to land resources and agricultural production is provided in Section 4.3.1. Section 4.3.2 describes the potential impacts of the Project on land resources and agricultural production, and Section 4.3.3 describes applicable management, mitigation and monitoring measures.

4.3.1 Existing Environment

Landforms and Topography

The Project is situated in the foothills of the Willowtree Range some 12 km east of the Namoi River (Figure 4-1). Areas of higher elevation in the region include peaks on the Willowtree Range approximately 7 km to the north (465 m AHD), and Goonbri Mountain approximately 4 km to the north-east (540 m AHD) (Figure 4-1).

The Project is bounded by the Boggabri Coal Mine and the Leard State Forest to the north and is surrounded by low lying flood plains of Bollol Creek (a tributary of the Namoi River) to the south (Figure 4-1). Nagero Creek drains the southern slopes of the Willowtree Range including the north-western portions of ML 1579.

[1] The Data Drill is a system which provides continuous, synthetic daily data sets for a specified point by interpolation between surrounding point records held by the BoM.

In their lower floodplains, Bollol and Nagero Creeks comprise poorly defined channels and a series of depressions.

The topography of the Project site comprises a series of rolling hills which vary in elevation from about 300 to 380 m AHD. The floodplains of Bollol Creek to the south of the Project vary from approximately 260 to 280 m AHD.

The existing mine landforms of the Tarrawonga Coal Mine have modified the topography within ML 1579 (Figure 2-1). The Northern Emplacement has an approved height of 370 m AHD, while the base of the open cut is currently at approximately 200 m AHD. The Southern Emplacement has an approved elevation of 340 m AHD.

The existing mine landforms of the Boggabri Coal Mine have also modified the topography in the vicinity of the Project area. Their maximum approved height is currently 350 m AHD, however, the proposed Continuation of Boggabri Coal Mine would increase this to 395 m AHD.

Land Use

The study area was part of the tribal lands of the Kamilaroi Aboriginal people who inhabited the Gunnedah basin (Appendix K). The European settlement of the valley began in 1835 with the establishment of a sheep run called Namoi Hut at the confluence of the Namoi River and Cox's Creek (Appendix L).

Contemporary land use in the vicinity of the Tarrawonga Coal Mine is dominated by grazing (primarily cattle) and cereal/fodder cropping in the flatter and more fertile areas to the south, east and west.

Leard State Forest, which is used for forestry, mineral extraction and recreational purposes, is located on the northern border of ML 1579, and is the other main land use in the Project area. With the exception of Leard State Forest, the majority of the land adjacent to the Tarrawonga Coal Mine has been cleared for agricultural purposes.

The Boggabri Coal Mine is located immediately to the north and west of the Project, and is the only other existing mining operation in the immediate vicinity of the Project. Proposed mining developments of particular relevance to potential cumulative impacts include the Continuation of Boggabri Coal Mine and the Maules Creek Coal Project, as described in Attachment 3.

A number of private dwellings are located to the south and east of the Project, however Whitehaven and BCPL own a significant portion of the land adjacent to the Project (Figure 1-2a).

Soils

An Agricultural Resource Assessment was undertaken for the Project area by McKenzie Soil Management (2011) and is presented in Appendix I.

The alluvial plain associated with Goonbri Creek is part of the Central Mixed Soil Floodplain as defined in *Namoi Catchment Water Study Independent Expert Phase 2 Report* (Schlumberger Water Services, 2011).

The main soil types observed during the soil survey were Stratic Rudosols (44%), Tenosols (17%) and Sodosols (16%). Other less prominent soils included Chromosols, Kandosols, Kurosols and Dermosols (Appendix I). These soil types can be described as follows:

- Stratic Rudosols – characterised by a number of alluvial depositional layers that have been little altered by pedogenic processes except at or near the surface.
- Chromosols – characterised by a strong contrast in texture between topsoil and subsoil.
- Tenosols – shallow stony soils with only weak pedological development.
- Sodosols – strong texture contrast between topsoil and sodic subsoil, which is not strongly acidic.
- Kandosols – lack strong texture contrast and have poorly structured massive subsoils.
- Kurosols – duplex soils with strongly acidic subsoil.
- Dermosols – lack strong texture contrast, but had structured B horizons.

These soil types and associated soil landscapes are mapped in Appendix I.

In summary, the distribution of these soils in soil landscape units is as follows:

- crest – dominated by Tenosols; sub-dominant Kurosols and Kandosols.
- upper slope (westerly aspect) – a mosaic of Kandosols, Tenosols, Chromosols and Sodosols.
- upper slope (south-easterly aspect) – dominated by Bleached-Leptic Tenosols.

- lower slope – dominated by Grey, Brown, Yellow and Red Sodosols; sub-dominant Kandosols, Chromosols, and Stratic Rudosols.
- alluvial plain – dominated by Stratic Rudosols; sub-dominant Chromosols, Dermosols and Sodosols.

Rural Land Capability

The Rural Land Capability classification system is used to delineate the various classes of rural land on the basis of the capability of the land to remain stable under particular uses. Land is allocated to one of the following eight classes:

Land Suitable for Regular Cultivation/Cropping

Class I: *No special soil conservation works or practices necessary.*

Class II: *Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations are necessary.*

Class III: *Soil conservation practices such as graded banks and waterways are necessary, together with all the soil conservation practices as in Class II.*

Land Suitable Mainly for Grazing

Class IV: *Soil conservation practices such as pasture improvement, stock control, application of fertiliser, minimal cultivation for the establishment or re-establishment of permanent pasture and maintenance of good ground cover.*

Class V: *Soil conservation works such as diversion banks and contour ripping, in addition to the practices in Class IV.*

Land Suitable for Grazing

Class VI: *Not capable of cultivation. Soil conservation practices include limitation of stock, broadcasting of seed and fertiliser, promotion of native pasture regeneration, prevention of fire, destruction of vermin, maintenance of good ground cover and possibly some structural works.*

Land Suitable for Tree Cover

Class VII: *Land best protected by trees.*

Land Unsuitable for Agriculture

Class VIII: *Cliffs, lakes or swamps where it is impractical to grow crops or graze pasture.*

Rural Land Capability mapping for MLA 1, MLA 2, MLA 3 and the north-eastern section of ML 1579 has been completed by McKenzie Soil Management (2011) and is documented in Appendix I. Mapped Rural Land Capability ranged from Class II to Class VI. No Class V land was identified.

The major factor influencing the classification of the land was slope, with the better classes (i.e. Classes II and III) located on the flatter areas and the poorer classes (i.e. Classes IV and VI) located on the steeper sections (Appendix I).

The presence of dispersive soil, acidic topsoil and major nutrient deficiencies prevented the allotment of higher Rural Land Capability classes (Appendix I).

Agricultural Suitability

The Agricultural Suitability system is used to classify land in terms of its suitability for general agricultural use. Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture.

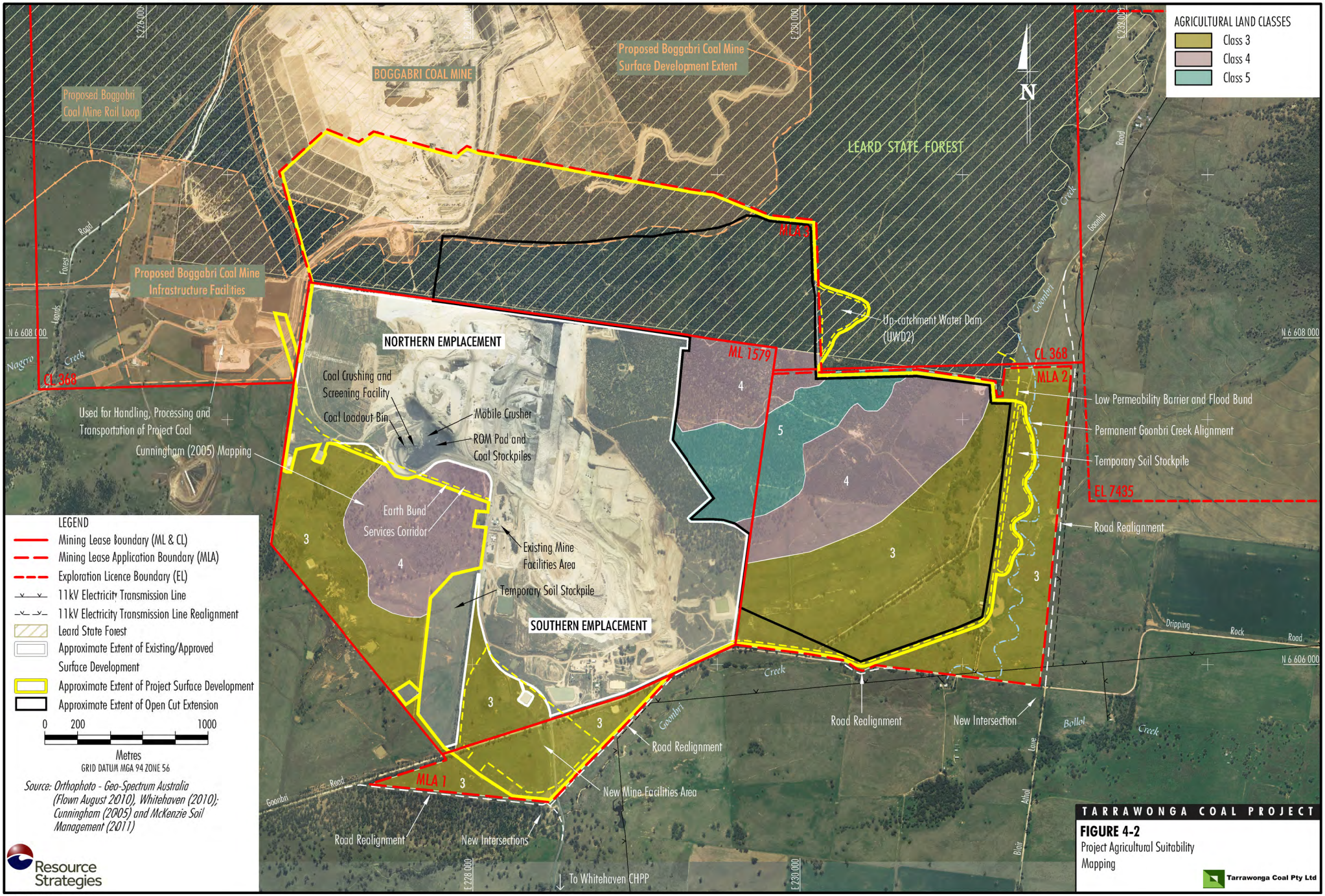
Agricultural Suitability mapping for MLA 1, MLA 2, the south-eastern corner of MLA 3 (i.e. outside of Leard State Forest) and the north-eastern section of ML 1579 has been completed by McKenzie Soil Management (2011) and is documented in Appendix I and shown on Figure 4-2. Agricultural suitability classes identified across the Project site ranged from Class 3 to Class 5. No Class 1 or Class 2 agricultural lands have been identified within the Project area.

Class 3 agricultural suitability is defined as (NSW Agriculture, 2002):

> *Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of soil or environmental constraints. Erosion hazard, soil structural breakdown or other factors, including climate, may limit the capacity for cultivation and soil conservation or drainage works may be required.*

Class 4 agricultural suitability is defined as (NSW Agriculture, 2002):

> *Land suitable for grazing but not for cultivation. Agriculture is based on native pastures and improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.*



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Class 5 agricultural suitability is defined as (NSW Agriculture, 2002):

> *Land unsuitable for agriculture, or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which prevent land improvement.*

The Class 3 areas (i.e. grazing land or land well suited to pasture improvement) are associated with the flatter areas and the alluvial plain and lower slope soil landscape unit in the south-east of MLA 2, MLA 1 and south-west of ML 1579 (Figure 4-2).

Agricultural Activities and Productivity

Agricultural enterprises known to have been conducted on the Project site include a combination of pasture production for grazing and some rain-fed crop production (Appendix I).

Whitehaven also owns approximately 4,000 hectares (ha) of land located to the north-east, east, south-east and south-west of the Project. This area typically comprises the same agricultural-related land uses.

The Project biodiversity offset area, which is located approximately 20 km to the north-east (Section 4.9.4), includes approximately 305 ha of cleared agricultural land. Agricultural activities historically conducted in the biodiversity offset area include grazing livestock on native pastures (Appendix I).

Bushfire Regime

The Bushfire Management Plan (Whitehaven, 2011b) outlines bushfire management measures in place at the Tarrawonga Coal Mine, including:

- Clearing restrictions – clearing will not be undertaken during periods of extreme fire danger as defined by the BoM.
- Controlled grazing – controlled high intensity short-term grazing will be employed to assist in the reduction of vegetative fuel loads on areas on which active mining operations are not occurring and appropriate fencing is available.
- Vehicle movements – all personnel and contractors will be required to use diesel vehicles and/or remain on defined roads or tracks.
- Fire breaks – fire breaks will be maintained around the perimeter of the mining leases.
- No smoking areas – smoking will be prohibited in fire prone areas.
- Fire fighting equipment – on-site fire fighting equipment will be provided, including a fully equipped fire tender to provide immediate response to a bushfire.
- Training – all mine personnel will receive basic fire control training.

An assessment for bushfire prone areas was undertaken in accordance with NSW Rural Fire Service (2001) over an area incorporating the Tarrawonga Coal Mine. This assessment determined that ML 1579 has a low to medium bushfire hazard (Whitehaven, 2011b).

4.3.2 Potential Impacts

Landforms and Topography

The Project would alter the landforms and topography within ML 1579 and MLAs 1, 2 and 3. Some topographic changes would be temporary (e.g. temporary bunds/drains) and some would be permanent (e.g. final mine landforms).

The open cut operations would remove a ridge with an elevation up to approximately 380 m AHD on the eastern edge of ML 1579 (Figures 2-6 and 2-11).

The final elevation of the Northern Emplacement would remain unchanged (370 m AHD) and would be extended to the east and to the north. The Northern Emplacement would be integrated with, and would be lower than, the proposed maximum height of the Continuation of Boggabri Coal Mine waste rock emplacement (i.e. 395 m AHD) (Figures 2-4 to 2-7).

The height of the Southern Emplacement would temporarily increase to a maximum height of 360 m AHD (i.e. an increase of 20 m) (Figure 2-4). However, at the completion of the Project mining activities, earthworks would be undertaken to reduce the elevation of the Southern Emplacement to a final height of approximately 330 m AHD (Section 5.4.2).

These changes, while altering the layout and extent of the approved/existing Tarrawonga Coal Mine, are effectively extensions to existing approved mine landforms and would result in the integration of the Northern Emplacement with the waste rock emplacement at the Continuation of Boggabri Coal Mine (Figure 2-8).

The development of the low flow channel of the permanent Goonbri Creek alignment and the associated flood bund would also have a relatively minor effect on the topography to the east of the Project (Figures 2-7 and 2-8).

A range of lesser topographic changes would be associated with the construction of roads, hardstands, water management, and erosion and sediment control features over the Project life.

At the cessation of mining, a final void would remain at the eastern extent of the open cut (Section 5.4.3). The open cut would be partially backfilled to achieve a suitable post-mining pit-lake equilibrium level (Section 5.4.3).

Soils

Potential impacts of the Project on soils would relate primarily to:

- disturbance of *in-situ* soil resources within additional disturbance areas (e.g. extension of the open cut);
- alteration of soil structure beneath infrastructure items, hardstand areas and roads;
- possible soil contamination resulting from spillage of fuels, lubricants and other chemicals;
- increased erosion and sediment movement due to exposure of soils during construction of mine infrastructure; and
- alteration of physical and chemical soil properties (e.g. structure, fertility, permeability and microbial activity) due to soil stripping and stockpiling operations.

A review of the physical and chemical properties of the soils within the Project site has established that there are soil resources present that would be suitable as a rehabilitation medium for agricultural land uses (including cropping/grazing areas) on the Project site post-mining (Appendix I).

Land Contamination Potential

Potential land contamination risks were identified as part of the Preliminary Hazard Analysis (PHA) (Section 4.17) and includes leaks/spills, fires and explosions associated with the transport, storage and usage of hydrocarbons and chemicals.

Agricultural Activities and Productivity

The Project (including a portion of the biodiversity offset area) would result in the long-term disturbance or alteration of existing agricultural lands. A summary of the area of agricultural lands in these areas before, during the Project life and post-mining is provided in Table 4-3.

The Project would reduce the area of Class 4 agricultural suitability land at the Project site by approximately 125 ha in the long-term. The proposed rehabilitation of Class 3 agricultural suitability lands would result in no long-term change in the area of Class 3 agricultural suitability lands on the Project site (Table 4-3).

The Project biodiversity offset area would result in the sterilisation of approximately 305 ha of agricultural lands (i.e. Class 4 and Class 5 agricultural suitability lands [Table 4-3]) by returning this area to native woodland/open woodland.

Table 4-3
Summary of Agricultural Lands at the
Project Site, Buffer Area and Biodiversity Offset Area

Agricultural Suitability Classification	Area of Agricultural Land (ha)			
	Existing	Project Life	Post-Mining	Net Change
Project Site				
Class 3	210	0	210	0
Class 4	125	0	0	-125
Project Biodiversity Offset Area				
Previous Agricultural Areas (Class 4 and Class 5)	305	0	0	-305

Source: After Appendix I.

The Project would, therefore, result in the sterilisation of approximately 430 ha of Class 4 and 5 agricultural suitability lands in the long-term. These sterilised agricultural lands are not considered to be highly productive, based on their agricultural suitability classification (Appendix I).

The maximum annual value of total agricultural production forgone as a result of the Project would be approximately $310,000 (Appendix I). The present value of the total foregone agriculture production (in perpetuity) as a result of the Project is approximately $1.5 million (M) (Appendix I).

Whitehaven will continue to manage its adjacent agricultural lands (i.e. approximately 4,000 ha) for agricultural use. These lands are generally farmed by local landholders under licence agreement with Whitehaven.

The potential impacts of the Project on the local amenity of adjoining privately-owned land, or water resources available for agricultural use, are considered where relevant in the groundwater, surface water, noise and blasting, and air quality studies (Appendices A to D and Sections 4.4 to 4.7).

Bushfire Hazard

Any uncontrolled fires originating from Project activities may present potentially serious impacts to nearby rural properties and Leard State Forest.

Similarly, fires originating in nearby rural areas could pose a significant risk to Project infrastructure and TCPL staff, contractors and equipment.

The degree of potential impacts of a bushfire would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel.

The continuation and expansion of Tarrawonga Coal Mine operations for the Project could increase the potential for fire generation. However, given the range of management measures in place to manage the behaviour of people in the Project area (Section 4.3.3), the overall risk of increased bush fire frequency due to the Project is likely to be low (Appendix F).

4.3.3 Mitigation Measures, Management and Monitoring

Soils and Erosion Potential

General soil resource management practices would include the stripping and stockpiling of soil resources prior to any mine-related disturbance for use in rehabilitation. The objectives of soil resource management for the Project site would be to:

- Identify and quantify potential soil resources for rehabilitation.
- Optimise the recovery of useable topsoil and subsoil during stripping operations.
- Manage topsoil and subsoil reserves so as not to degrade the resource when stockpiled.
- Establish effective soil amelioration procedures to maximise the availability of soil reserves for future rehabilitation works.

Disturbance areas would be stripped progressively in order to reduce sediment generation and the extent of topsoil stockpiles, and to enable use of stripped topsoil as soon as possible for rehabilitation.

The following management measures would be implemented during the stripping of soils at the Project:

- Areas of disturbance would be stripped progressively, as required, to reduce potential erosion and sediment generation, and to minimise the extent of topsoil stockpiles and the period of soil storage.
- Areas of disturbance requiring soil stripping would be clearly defined following vegetation clearing.
- Topsoil and subsoil stripping during periods of high soil moisture content (i.e. following heavy rain) would be avoided to reduce the likelihood of damage to soil structure.

Any long-term soil stockpiles would be managed to maintain long-term soil viability through the implementation of the following management practices:

- Topsoil and subsoil stockpiles would be retained at a height of 3 m, with slopes no greater than 1:2 (vertical to horizontal [V:H]) and a slightly roughened surface to minimise erosion.

- Topsoil stockpiles would be constructed to minimise erosion, encourage drainage, and promote revegetation.
- Where additions such as lime, gypsum and fertiliser are needed to improve the condition of cut soil, they would be applied to the stockpiles in-between the application of separate layers from the scrapers.
- Wherever practicable, soil would not be trafficked, deep ripped or removed in wet conditions to avoid breakdown in soil structure.
- All topsoil and subsoil stockpiles would be seeded with a non-persistent cover crop to reduce erosion potential as soon as practicable after completion of stockpiling. Where seasonal conditions preclude adequate development of a cover crop, stockpiles would be treated with a straw/vegetative mulch to improve stability.
- Soil stockpiles would be located in positions to avoid surface water flows. Silt stop fencing would be placed immediately down-slope of stockpiles until stable vegetation cover is established.
- An inventory of soil resources (available and stripped) on the Project site would be maintained and regularly reconciled with rehabilitation requirements.
- In preference to stockpiling, wherever practicable, stripped topsoil and subsoil would be directly replaced on completed sections of the final landform.

The Biodiversity Management Plan would be updated to describe the soil resource management measures that would be used during the Project life.

Erosion and sediment control plans would continue to be developed over the life of the Project (as part of the Water Management Plan – Section 2.1.8) to identify and manage activities that could result in soil erosion and generate sediment. These plans would describe the specific controls (including locations, function and water monitoring structure capacities) that would be used to minimise the potential for soil erosion and transport of sediment off-site.

Land Contamination

A number of hazard control and mitigation measures are described in the following existing Tarrawonga Coal Mine management documents:

- Emergency Management System.
- Contractor Management Standard.
- Blast Management Plan.
- Bushfire Management Plan.
- Surface Water and Groundwater Response Plan (part of the Water Management Plan).
- Waste Management Plan.

These documents would be reviewed and revised to incorporate the Project, subject to the conditions of any Project Approval.

General measures to reduce the potential for contamination of land would include the following:

- Contractors transporting dangerous goods loads would be appropriately licensed in accordance with the provisions of the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (ADG Code) (National Transport Commission, 2007).
- On-site consumable storage areas would be designed with appropriate bunding and would be operated, where applicable, in compliance with the requirements of AS 1940 *The Storage and Handling of Flammable and Combustible Liquids* and AS 2187.1 *Explosives – Storage, Transport and Use – Storage*.
- Fuel and explosive storage areas would be regularly inspected and maintained.

In addition, during construction and exploration activities fuels, oils and other hydrocarbons would be managed to minimise the risk of spills which could cause soil contamination.

Agricultural Activities and Productivity

Agricultural land resource management at the Project would include the following key components:

- Minimisation of disturbance to agricultural lands, where practicable.
- Continued use of adjoining Whitehaven-owned land for agricultural uses.
- Management of soil resources at the Project site so that they can be used for rehabilitation.
- Inclusion of agricultural lands in the Project rehabilitation strategy (i.e. some 210 ha of Class 3 agricultural suitability land) (Table 4-3 and Section 5.5.4).

Minimisation of Disturbance to Agricultural Lands

Refinements to the Project layout during the development of this EA included relocation of the infrastructure area from the originally proposed site on the southern side of Goonbri Creek to the currently proposed site on the northern side of Goonbri Road (Section 6.9.1).

The Project biodiversity offset area is located in an area with low agricultural suitability, which means that its restoration to native woodland/open woodland would have a relatively low impact on agricultural lands in the region (Appendix I).

The area of agricultural land disturbed on the Project site at any one time would be minimised so that agricultural uses can continue, where practicable.

Continued Use of Existing Agricultural Areas

Areas owned by Whitehaven that are outside of the Project area would continue to be used for agricultural uses, where practicable.

A Farm Management Plan would be prepared by a suitably qualified person(s) to facilitate the management of agricultural land in the Project area and surrounding Whitehaven-owned land. The Farm Management Plan would include property, grazing and cropping management measures, as well as erosion, weed and pest controls to be applied. Biodiversity management measures would also be included in the Farm Management Plan and these are described in Section 4.10.3.

Management measures under the Farm Management Plan would be implemented progressively on properties under licence agreement with Whitehaven, consistent with the terms of the licence and in consultation with the licensee.

At the completion of the Project, it is expected that Whitehaven would sell the adjoining properties it holds and as a result they would continue to be used for agricultural purposes.

Management of Soil Resources

Soil resource management measures that would be used during the life of the Project are described above.

Re-establishment of Agricultural Lands

The rehabilitation and mine closure strategy for the Project includes restoration of approximately 210 ha of agricultural land suitable for cropping/grazing (Section 5.5.4). The rehabilitation of this land reduces the area of agricultural land that would be sterilised by the Project.

Bushfire Hazard

The Bushfire Management Plan would be reviewed and revised to incorporate the Project, subject to the conditions of the Project Approval.

4.4 GROUNDWATER

A Groundwater Assessment for the Project was undertaken by Heritage Computing (2012) and is presented in Appendix A. The Groundwater Assessment was reviewed by Kalf and Associates (Dr Frans Kalf) and the review report is presented in Attachment 4.

The Project groundwater and surface water studies, and the conceptual design of the low permeability barrier and permanent Goonbri Creek alignment, have been undertaken in an integrated manner. The assessment of potential groundwater impacts included consideration of potential impacts on surface water flows and the post-mining water level of the final void determined by the surface water assessment (Appendix B). The assessment also included consideration of the two-dimensional seepage modelling conducted as part of the design of the low permeability barrier (Appendix R).

A description of existing groundwater resources in the Project area and surrounds, including baseline data and the existing effects of the Tarrawonga Coal Mine and other nearby mining operations is provided in Section 4.4.1. Section 4.4.2 describes the potential impacts of the Project on groundwater resources including cumulative impacts, while Section 4.4.3 outlines mitigation measures, management (including licensing considerations) and monitoring.

4.4.1 Existing Environment

Baseline Groundwater Data

Baseline groundwater data was reviewed and compiled from a number of sources as part of the Groundwater Assessment including:

- existing TCPL exploration program (i.e. geological) data;

- results of searches of NOW PINNEENA database including registered bores and continuous monitoring data;
- NOW (then NSW Department of Natural Resources [DNR]) Upper Namoi Groundwater Flow Model (McNeilage, 2006);
- existing water management records at the Tarrawonga Coal Mine and surrounding mining operations (past and present) including the neighbouring Boggabri Coal Mine;
- groundwater monitoring data from monitoring programs and investigations undertaken at the Tarrawonga Coal Mine, surrounding mining operations (past and present) including the neighbouring Boggabri Coal Mine and Canyon, Vickery and Rocglen Coal Mines, and proposed future projects (i.e. Maules Creek Coal Project);
- groundwater quality data from the above monitoring programs and investigations; and
- other additional geological and regional topographic mapping data.

In addition, the Groundwater Assessment has considered the requirements of the Upper and Lower Namoi Groundwater Water Sharing Plan and Draft Porous Rock Groundwater Water Sharing Plan.

The existing baseline groundwater data was augmented with the results of a Project groundwater investigation program undertaken by RPS Aquaterra in May/June 2011, the results of which are presented in Appendix A. The Project groundwater investigation program included (Figure 4-3):

- core testwork (horizontal and vertical permeability, and porosity measurements) on 33 samples from three drillholes;
- installation of two vibrating wire piezometers and one nested piezometer;
- installation of standpipe piezometers;
- pumping test and rising head test; and
- slug tests.

In addition, and to assist in delineating the extent and depth of the alluvial groundwater system (i.e. Upper Namoi Alluvium) in the vicinity of the Project open cut extent, a transect of shallow drillholes (TAWB17, TAWB18, TAWB20, TAWB21 and TAWB22) was completed and logged (Figure 2-14).

To further define the geometry and properties of the alluvium for the purposes of the low permeability barrier concept design, and to validate and correlate the results from drilling, Groundwater Imaging (2011) completed a TEM survey to depths of up to 58 m (Figure 4-4). The TEM survey results are summarised in Appendix A.

The results of a Project bore census undertaken by TCPL in May 2011 (described further below) were also used to augment baseline groundwater datasets.

Examination of the available baseline groundwater data has enabled an understanding of the existing groundwater systems and the scale and nature of the effects of the existing Tarrawonga Coal Mine and other operations in the region on local and regional groundwater systems.

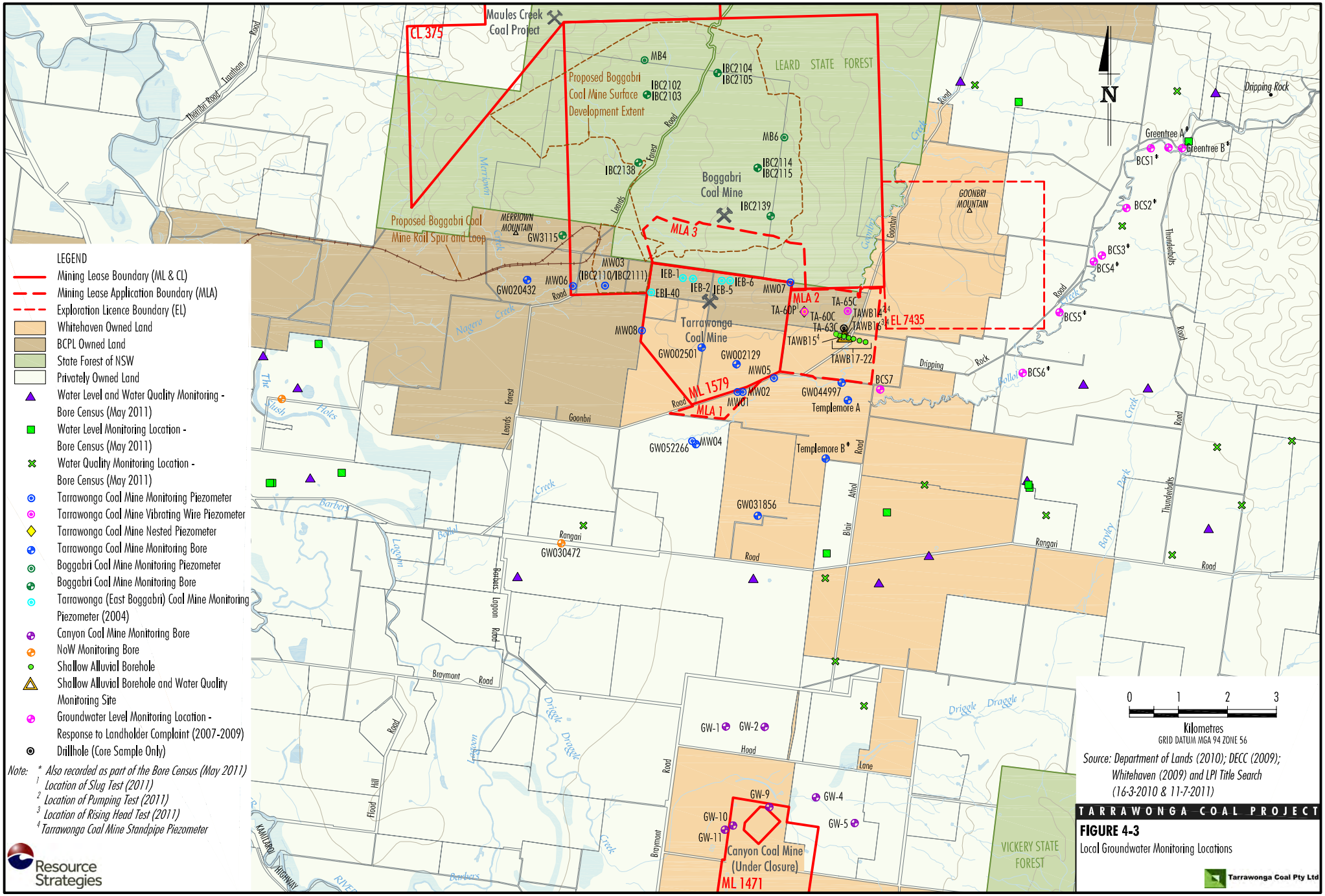
Existing Groundwater Regime

A conceptual geological model of the existing groundwater regime was developed by Heritage Computing (2012), based on the review of the available baseline groundwater data and water sharing plans (Appendix A). The two groundwater systems identified in the relevant water sharing plans are:

- **Porous Rock groundwater system** – including the coal measures of the Maules Creek Formation; and
- **Alluvial groundwater system** – associated with the low-lying flood plains of the Upper Namoi.

The Project coal resource is located within the Maules Creek sub-basin of the Early Permian Bellata Group (Section 2.3), which is within the porous rock (i.e. sedimentary rock) groundwater systems of the Gunnedah Basin, and lies within the boundary defined in the Draft Porous Rock Groundwater Water Sharing Plan. The Project coal resource is wholly located within the Gunnedah-Oxley Basin – Namoi Management Zone of the porous rock groundwater system.

Alluvial sediments associated with the Bollol Creek, Goonbri Creek and Nagero Creek surface drainages exist to the east, south and west of the Project area (Figure 4-5). These alluvial sediments are part of the Upper Namoi Alluvium within the Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source, also known as the Upper Namoi Zone 4 Water Source.



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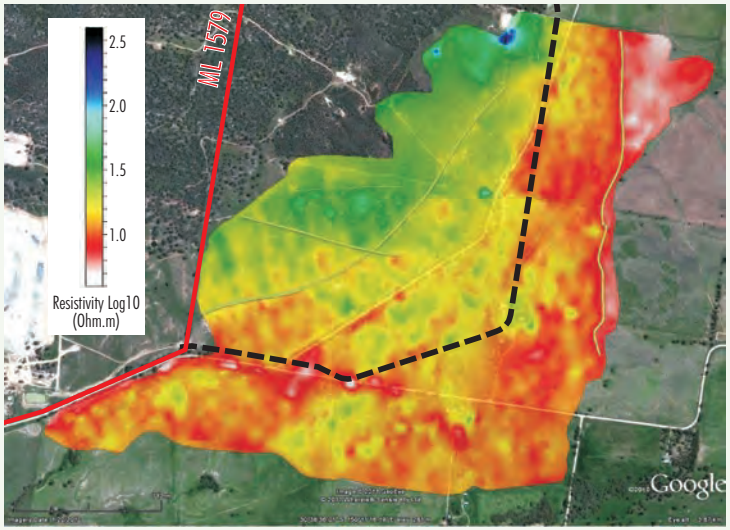
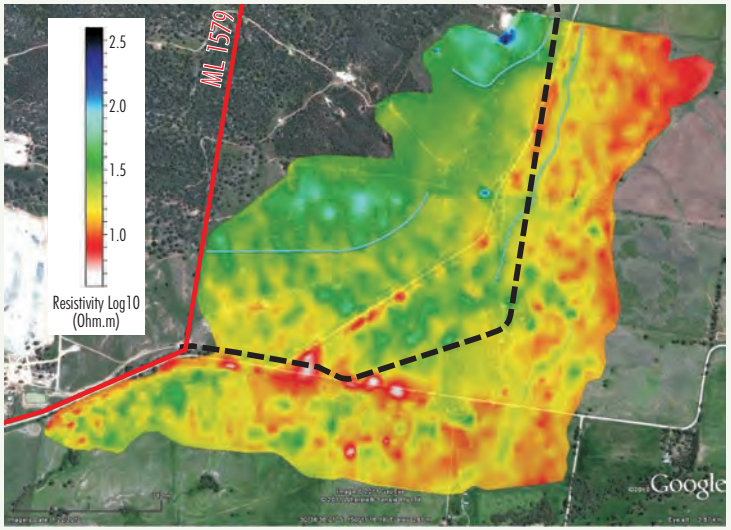
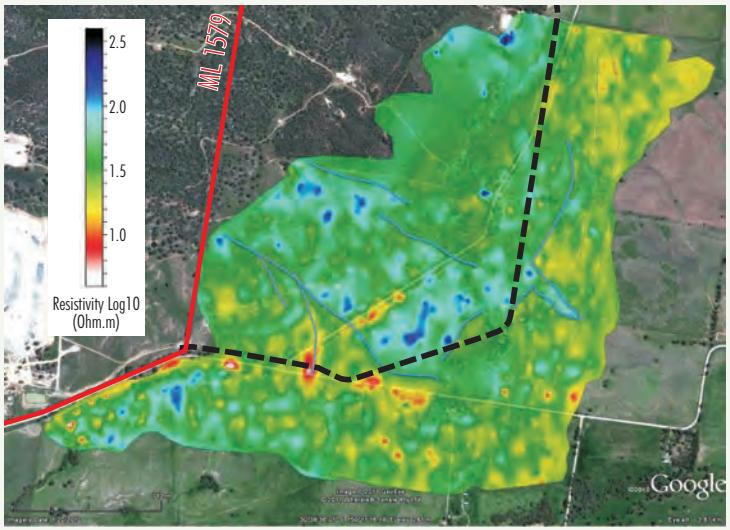


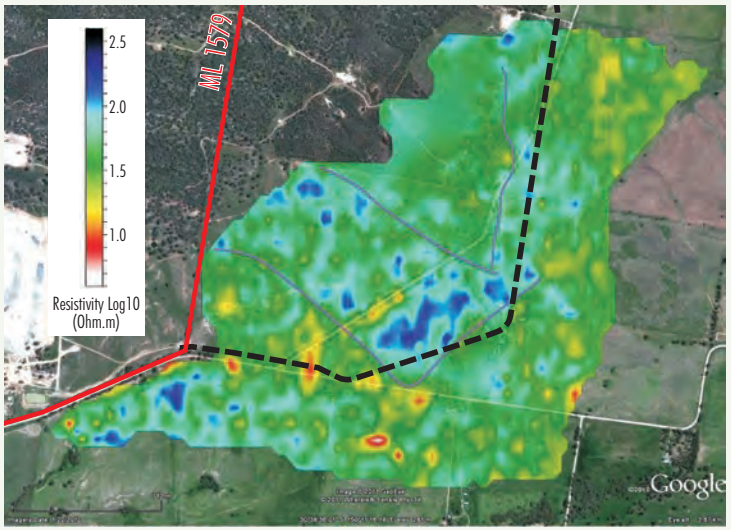
TEM Resistivity Plot at 20m Depth



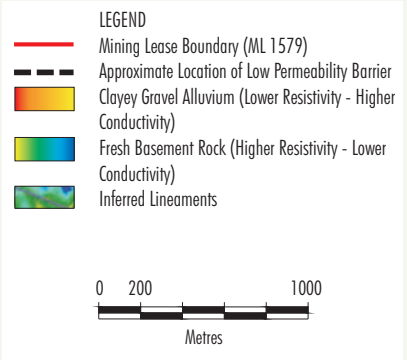
TEM Resistivity Plot at 28m Depth



TEM Resistivity Plot at 45m Depth



TEM Resistivity Plot at 58m Depth



Source: Groundwater Imaging (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-4

Transient Electromagnetic (TEM) Survey Results

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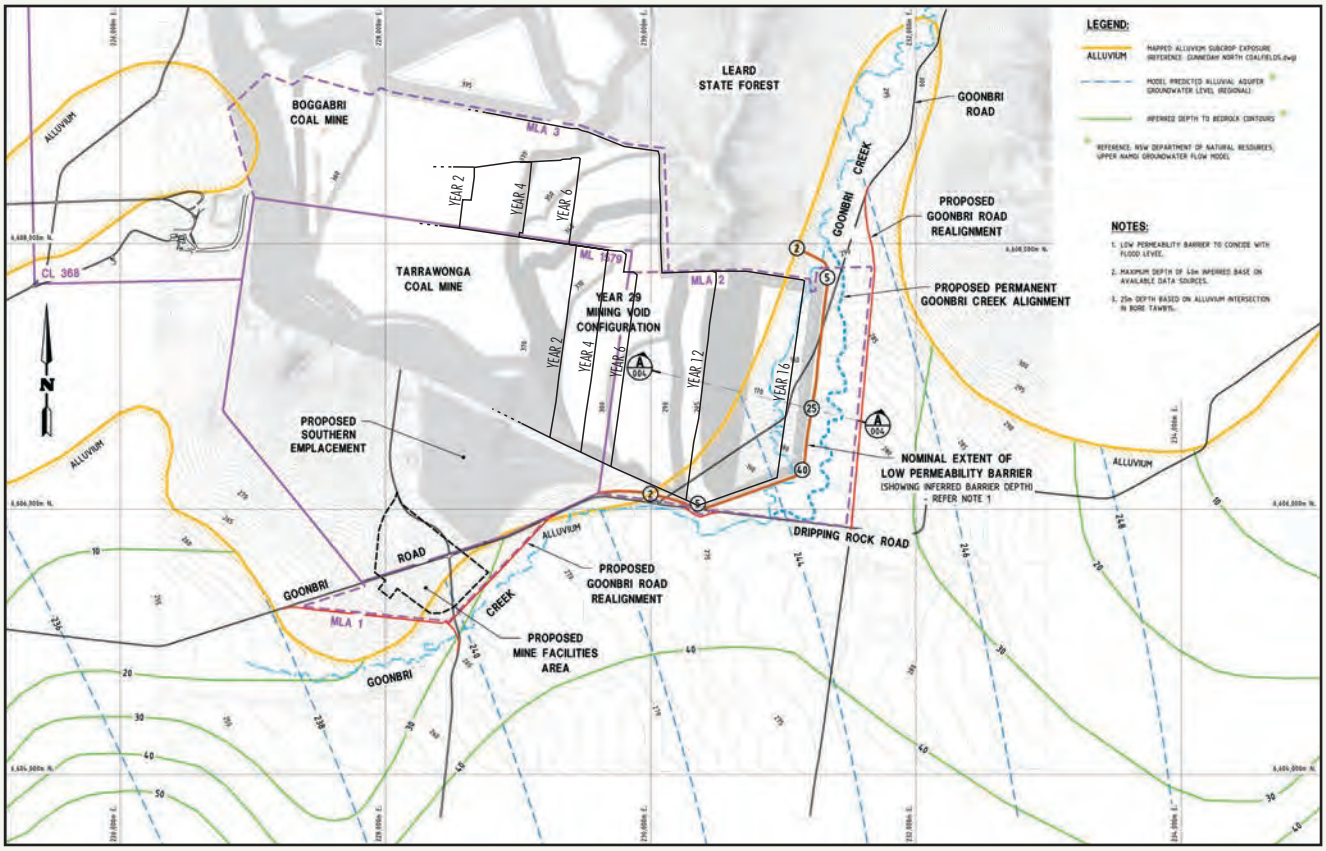
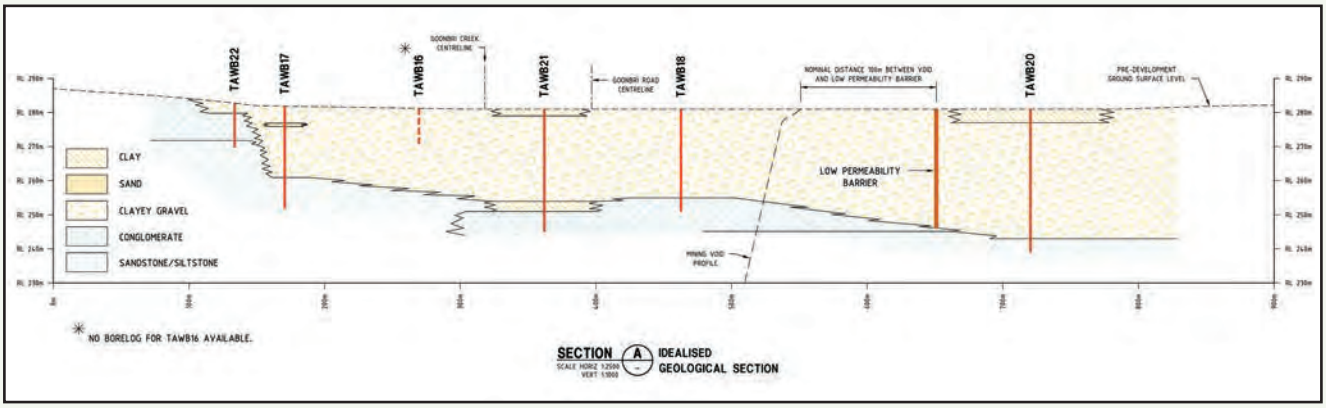
Resource Strategies



Source: Drawing 003 in Allan Watson Associates, 2011 (Appendix R of the EA)

Upper Namoi Alluvium - Plan View



Source: Drawing A1 in Allan Watson Associates, 2011 (Appendix R of the EA)

Upper Namoi Alluvium - Section

TARRAWONGA COAL PROJECT

FIGURE 4-5

Extent of Upper Namoi Alluvium

Resource Strategies

Tarrawonga Coal Pty Ltd

The Bollol Creek, Goonbri Creek and Nagero Creek embayments are reported to have maximum alluvial thicknesses in the order of 30 m (McNeilage, 2006). However, the transect of shallow alluvial drillholes conducted for the Project revealed local alluvial thicknesses from 3 to 38 m, with a median thickness of 26 m.

Groundwater Imaging (2011) also concluded that the TEM survey data in the Project area indicates approximately 30 m of conductive alluvium (clay-bound gravel) overlying more resistive basement rock (Figure 4-4). On the floodplain between Bollol Creek and Driggle Draggle Creek further south, the alluvium is generally 40 to 70 m thick (McNeilage, 2006).

Alluvial sediments of the Upper Namoi are usually subdivided into two formations, although they are not always distinguishable. The uppermost Narrabri Formation consists predominantly of clays with minor sand and gravel beds. Underlying the Narrabri Formation is the Gunnedah Formation which consists predominantly of gravel and sand with minor clay beds. This is the productive aquifer used for irrigation in the region (Appendix A).

More broadly, the Upper Namoi Alluvium can reach maximum thicknesses of 170 m associated with the Namoi River. Separately, the Narrabri Formation has a maximum thickness of 70 m and the Gunnedah Formation peaks at 115 m (McNeilage, 2006).

Recharge to the groundwater systems occurs from rainfall and runoff infiltration, lateral groundwater flow and some leakage from surface water sources (e.g. Namoi River). Although groundwater levels are sustained by rainfall recharge, they are controlled by topography, geology and surface water levels in local drainages (Appendix A).

Local groundwater tends to mound beneath hills, with ultimate discharge to local drainages and loss by evapotranspiration through rock outcrops and vegetation where the watertable is near the ground surface (Appendix A).

Groundwater Dependent Ecosystems

There are currently no high priority groundwater dependent ecosystems identified in the Upper Namoi Groundwater Sources or Porous Rock Groundwater Sources in the Project area (Appendix A). Where relevant, the flora and fauna assessments (Appendices E and F, and Sections 4.9 and 4.10) have considered the potential impacts on local groundwater dependent ecosystems.

Existing Influence of the Tarrawonga Coal Mine

Groundwater levels have been monitored at the MW series of bores at the Tarrawonga Coal Mine since 2006 (Figure 4-3). The existing Tarrawonga Coal Mine acts as a groundwater sink, and groundwater nearby maintains a flow direction towards the open cut.

The vibrating wire piezometer responses at TA60C and TA65C (Figure 4-3) are also presented in Appendix A. No significant mining effects have yet been recorded at these piezometers.

Groundwater Use

A broad search of the NOW PINNEENA Groundwater Works Database identified over 1,000 registered bores within the area covered by the Project regional groundwater model. The majority of these bores were found to be associated with the Namoi River and alluvial groundwater system (i.e. Upper Namoi Zones 4, 5 and 11) (Appendix A).

In consultation with local landholders, TCPL also conducted a bore census in May 2011 of a number of privately-owned bores/wells in the vicinity of the Project. The bore census was used to confirm bore/well locations and take spot water level/water quality measurements. The bore census results have been considered in the development of the regional groundwater model and impact assessment.

A more refined search of the NOW PINNEENA Groundwater Works Database (and incorporating the results of the May 2011 bore census) identified that 121 bores are located within approximately 5 km of the Project, of which some 37 are located on Whitehaven-owned land (Appendix A).

Groundwater use in the Project area is predominantly associated with mine dewatering activities at the Tarrawonga Coal Mine and Boggabri Coal Mine. The majority of groundwater users with privately-owned bores are located in the alluvial groundwater system (i.e. Upper Namoi Zone 4) to the east, south-east and west-southwest of the Project area (Figure 4-3 and Appendix A).

Groundwater Quality

An analysis of water quality attributes of groundwater at the Tarrawonga Coal Mine and surrounds is provided in Appendix A.

The median recorded values for EC at the Tarrawonga Coal Mine and Boggabri Coal Mine are approximately: 1,000 microSiemens per centimetre (µS/cm) in coal (adjacent the existing open cut operations); 2,000 µS/cm in alluvium; 2,000 µS/cm in volcanics; and 2,500 µS/cm in interburden of the porous rock groundwater system.

In the vicinity of the Project, the typical EC of groundwater in coal is in excess of 2,000 µS/cm. The recorded EC values for coal range from 530 to 2,760 µS/cm increasing in the downdip direction (i.e. east and south-east). As the lower values tend to occur up-dip close to coal subcrop limits, this suggests that the inherent salinity in the coal seams is diluted by rainfall recharge (Appendix A).

The recorded EC of groundwater in alluvium ranges from 440 µS/cm (e.g. in the headwaters of Bollol Creek) to 7,460 µS/cm (e.g. in surface/shallower groundwater systems likely to be affected by evapotranspiration effects).

Water quality results available from alluvial and porous rock groundwater system bores indicate sodium/potassium and chloride/bicarbonate are the dominant ionic constituents, with fairly uniform to mildly variable ionic ratios (Appendix A).

The recorded pH of groundwater has a relatively narrow range from 6.9 to 7.8.

Based on the recorded EC values, most groundwaters are at the limit of potable use, but are suitable for livestock, irrigation and other general uses (Appendix A).

4.4.2 Potential Impacts

The Groundwater Assessment has evaluated the potential impacts of the Project on groundwater resources using a numerical regional groundwater model.

The numerical regional groundwater model covers an area of approximately 1,518 square kilometres (km^2) (33 km east-west and 46 km north-south) and incorporates the Maules Creek Coal Project and Boggabri Coal Mine in the north, and Rocglen Mine in the south. During the preparation of this EA, TCPL has consulted with BCPL and Aston Resources and has obtained and incorporated relevant data and information from the mine plans and groundwater models developed for these projects.

The regional groundwater model was calibrated (based on available data from January 2006 to December 2010) and was then used to simulate the potential effects of the Project on the local and regional aquifer systems and groundwater users. It was also used to estimate the potential magnitude of groundwater inflow to the open cut over the life of the Project, as well as post-mining.

A summary of the potential impacts on the porous rock and alluvial groundwater systems, local surface water resources, as well as existing groundwater users is presented below.

Porous Rock Groundwater System

As mining progresses, the open cut would act as a groundwater sink. This would cause a change in groundwater flow direction, and in places a localised reversal of direction. There would also be a change in hydraulic properties over the mine footprint where mine waste rock is used to infill the open cut. As mine waste rock would have a higher permeability than any natural rock material in the area (i.e. associated with the porous rock groundwater system), there would be associated reductions in localised hydraulic gradients (Appendix A).

Numerical modelling conducted as part of the Groundwater Assessment predicts a reduction in potentiometric head in the aquifers of the porous rock groundwater system to the east and north of the Project.

Groundwater drawdown contours during the Project and post-mining are provided in Appendix A.

The numerical model indicates average groundwater inflows to the open cut (prior to it intersecting the alluvial groundwater system) from the porous rock groundwater system would be approximately 0.5 ML/day (ranging from 0.4 to 0.7 ML/day). The predicted groundwater inflows from the porous rock groundwater system over the life of the Project are low and fairly consistent (Appendix A).

Numerical modelling of the post-mining scenario shows that the water levels in the porous rock groundwater system would slowly recover, but their equilibrium level would be slightly below the pre-mining level (i.e. a localised groundwater sink would remain) (Appendix A).

Based on the results of the Geochemical Assessment (Appendix N), it is expected that use of the Project mine waste rock handling practices (Section 2.9.1) would be sufficient to maintain adequate control over acid rock drainage risk on-site. In consideration of the above, there would be negligible impacts to groundwater quality (either directly or via final pit voids).

The Groundwater Assessment concludes that there is expected to be negligible change in groundwater quality as a result of mining in the short-term and in the long-term (Appendix A). However, given higher rainfall infiltration rates through mine waste rock within the mine footprint, it is possible that the groundwater inflows to the open cut during operations could be freshened by lateral flow from mine waste rock (Appendix A).

In the long-term, the salinity in the final void would increase through evaporative concentration, but as the final void would remain a groundwater sink, no impacts to surrounding groundwater quality are expected (Appendix A).

Alluvial Groundwater System

The porous rock groundwater system would be the primary groundwater source of inflows to the open cut until approximately Year 12 of the Project (Figure 4-5), from which point the alluvial groundwater system would also contribute to the total groundwater inflows to the open cut.

The numerical modelling conducted for the Groundwater Assessment, and the low permeability barrier seepage modelling undertaken by Allan Watson Associates (2011) (Appendix R) conclude that the low permeability barrier would significantly reduce local drainage from the alluvial groundwater system into the open cut during operations and post-closure (Appendix A).

Water from the alluvial groundwater system (i.e. Upper Namoi Zone 4 - Namoi Valley [Keepit Dam to Gin's Leap] Groundwater Source) would report to the open cut by two mechanisms (Appendix A):

- direct inflows where the open cut operations intersect the alluvium (i.e. inside of the low permeability barrier); and
- indirect depressurisation via enhanced leakage from the alluvial groundwater system to the underlying porous rock groundwater system.

The numerical modelling predicted that the total inflows to the open cut (from the porous rock and alluvial groundwater systems) would vary between approximately 0.4 and 1.1 ML/day over the life of the Project (Appendix A).

The maximum predicted inflows from the alluvial groundwater system to the open cut (i.e. from aquifer storage due to excavation) would be approximately 198 ML/annum (Appendix A). For comparison purposes, in addition to basic landholder rights and supplementary water access licences, the extraction limit stipulated in the Upper and Lower Namoi Groundwater Water Sharing Plan for Upper Namoi Zone 4 (alluvial groundwater system) is 25,700 ML/annum, comprising of 168 aquifer access licences, and 71 supplementary water access licences.

After the alluvial material in the open cut extent is removed, there would be minimal alluvial groundwater reporting to the open cut and negligible losses from alluvium outside of the low permeability barrier. Based on the area of alluvium inside the low permeability barrier, rainfall recharge that would otherwise report to the alluvial groundwater system would be reduced by up to 6 ML/annum (or 0.016 ML/day), assuming 1.2% recharge (Appendix A).

Numerical modelling of leakage from the alluvial groundwater system to the underlying porous rock groundwater system was also undertaken, with results indicating up to 5 ML/annum (or 0.013 ML/day) of additional leakage would occur as a result of the Project (Appendix A).

Based on a porosity ranging from 10 to 20%, Heritage Computing (2012) estimates that approximately 1.4 to 2.8 gigalitres (GL) of stored alluvial groundwater would be excavated during the life of the Project. This volume would appear partly as mine inflows (Section 4.4.3) or as water contained in excavated material (i.e. remaining within vestiges of alluvium). For comparison purposes, the change in total alluvial aquifer storage volume for the maximum predicted inflows to the open cut (i.e. 198 ML/annum) is provided in Table 4-4.

Table 4-4
Predicted Change in Total Alluvial Aquifer Storage Volumes

Upper Namoi Alluvium	Estimated Total Alluvial Aquifer Volume (GL)*	Change in Total Alluvial Aquifer Storage (%)
Within Model Extent	2,400 to 4,800	0.004 to 0.008
Within Bollol/ Goonbri and Driggle Draggle Creeks Embayment	750 to 1,500	0.013 to 0.026%

Source: Appendix A
* Based on a specific yield ranging from 0.1 to 0.2.

With the low permeability barrier in place, based on the numerical modelling results and experience at other similar projects in NSW and overseas, Heritage Computing (2012) expect that there would be:

- negligible drawdown in the aquifers of the alluvial groundwater system; and
- negligible impact on groundwater levels or groundwater yield to privately owned bores in the alluvial groundwater system.

Groundwater drawdown contours during the Project and post-mining are provided in Appendix A.

There are not expected to be any significant changes in the quality of the alluvial groundwater system as a consequence of the Project (Appendix A).

The low permeability barrier between the final void and the alluvial groundwater system would limit flow of any groundwater from the alluvial groundwater system (and associated water quality effects) to the final void, which would remain a groundwater sink (Appendix A).

Surface Water Resources

The existing surface water resources and their characteristics (i.e. streamflow, water quality and nature) are described in Section 4.5.1. With the exception of the upgradient reaches of each stream (i.e. upstream of the Project), water leaks through the stream bed to the underlying aquifer for most of the length of each stream.

There is expected to be negligible loss of groundwater yield to/from surface stream systems (i.e. Bollol Creek, Goonbri Creek[2], Nagero Creek and the Namoi River) based on the numerical modelling completed for the Groundwater Assessment (Appendix A). Specifically in relation to Goonbri Creek, the depth to water contours presented in the Groundwater Assessment (Figure A-17 in Appendix A) show that Goonbri Creek adjacent to the mine is a 'losing' stream and is supported by the pumping test results that nil connective 'gaining' contribution occurred from groundwaters within the Upper Namoi Alluvium (Appendix A).

The low permeability barrier would allow the hydrological character of the Goonbri Creek system to be maintained, with negligible loss of flow from the creek to the mine workings predicted to occur during operations or post-closure (Appendix A). When the new alignment of Goonbri Creek is established, the new creek would have a different creek-aquifer interaction behaviour as it would pass over different ground and would be situated in a different part of the groundwater flow field. However, from the perspective of an integrated water source, there is expected to be no net change (Heritage Computing, 2012). Further discussion of the predicted creek-aquifer interaction behaviour is provided in Appendix A.

Groundwater Dependent Ecosystems

As described in Section 4.4.1, there are no high priority groundwater dependent ecosystems identified in the Upper Namoi Groundwater Sources or Porous Rock Groundwater Sources in the Project area (Appendix A).

One vegetation community within the Project area and surrounds is considered to be potentially groundwater dependent (i.e. the Bracteate Honeymyrtle low riparian forest). This vegetation community occurs along the 3 km long portion of Goonbri Creek that is located within the proposed open cut extension, and as a result, approximately 15 ha of it would be cleared during mining operations. This would result in a local loss in biodiversity in this section of Goonbri Creek.

[2] Incorporating the permanent Goonbri Creek alignment.

However, this vegetation community also occurs to the north and south of the Project area. In addition, an equivalent length of the stream would be recreated and revegetated with this community in the permanent Goonbri Creek alignment, and TCPL would implement a riparian enhancement program for a further 3.2 km below the re-aligned section.

No significant impacts on groundwater dependent ecosystems (outside the immediate Project area) are anticipated due to the predicted negligible drawdown in the aquifers of the alluvial groundwater system (as presented above).

Further discussion of potential impacts on local groundwater dependent ecosystems is provided in Sections 4.9.2 and 4.10.2.

Groundwater Users

The numerical modelling indicated that the drawdown effects on groundwater users in the vicinity of the Project would not be significant (i.e. would be less than 1 m) and would, therefore, not materially affect the existing or potential future beneficial use of groundwater. The predicted impacts on individual bore/wells within 5 km of the Project are tabulated in Appendix A.

As long as the Project final void remains a groundwater sink, there would be no deleterious effect on the beneficial use of any groundwater source (Appendix A).

Notwithstanding the above, a Groundwater Monitoring Program (Section 4.4.3) would be established to monitor the ongoing groundwater effects of the Project and to enable contingency measures to be implemented, in the event that agreed trigger levels at private bores/wells are reached.

Cumulative Impacts

The Groundwater Assessment included consideration of the cumulative impacts of the Project, Continuation of Boggabri Coal Mine, Maules Creek Coal Project and Rocglen Coal Mine.

Average groundwater inflow to all four mines during the Project period is predicted to be approximately 4% of all groundwater discharge (Appendix A).

Based on the numerical modelling and experience at other similar projects in NSW and overseas, Heritage Computing (2012) concluded that the potential cumulative impact on the alluvial groundwater system or groundwater yield to privately owned bores in the alluvial groundwater system is expected to negligible (Appendix A).

Climate Change and Groundwater

The potential groundwater impacts of the Project, in the context of global climate change, has been considered and is presented in Appendix A.

4.4.3 Mitigation Measures, Management and Monitoring

Low Permeability Barrier

As described in Section 2.10.3, TCPL would construct a low permeability barrier to reduce local drainage from the alluvial groundwater system into the open cut during operational and post-closure periods.

The low permeability barrier would also reduce the potential for impacts on the beneficial use of the regional groundwater resource (through changes in water quality), resulting from flow (if any) from the final void waterbody into the alluvial groundwater system under post-closure conditions.

The performance of the low permeability barrier would be assessed during the life of the Project through monitoring of nearby groundwater levels via established piezometers, pit inflows, and validating/re-modelling seepage predictions. Remedial works would be undertaken, if necessary, if the performance of the low permeability barrier is sub-optimal.

Groundwater Licensing

A summary of groundwater licensing requirements for the Project is provided below, with further discussion of the licences required for each water source associated with the Project provided in Section 6.4.1.

Porous Rock Groundwater System

An appropriate groundwater licence for the open cut dewatering activities at the Tarrawonga Coal Mine would be sought and obtained from NOW pursuant to the NSW *Water Management Act, 2000* once the Draft Porous Rock Groundwater Water Sharing Plan is commenced. The predicted annual groundwater volumes required to be licensed over the life of the Project and post-mining are summarised in Table 4-5.

Table 4-5
Estimated Project Groundwater Licensing Requirements

Water Sharing Plan	Management Zone/ Groundwater Source	Predicted Average Annual Inflow Volumes requiring Licensing (ML/annum)			
		Years 1 to 11	Year 12	Years 13 to 17	Post-Mining
Draft Porous Rock Groundwater Water Sharing Plan	Gunnedah-Oxley Basin – Namoi	209 (Average) 252 (Maximum)	209	209 (Average)	167+ (Maximum)
Upper and Lower Namoi Groundwater Sources 2003	Upper Namoi Zone 4 - Namoi Valley (Keepit Dam to Gin's Leap)	Negligible	198	142 (Average) 169 (Maximum)	Negligible^

Source: Appendix A

+ Groundwater inflows would reduce as the final void water level reaches equilibrium over many decades.

^ The model predicted extra 'alluvium to porous rock' leakage induced beyond low permeability barrier is up to 5 ML/annum (0.013 ML/day) and the reduced recharge due to excavated alluvium up to 6 ML/annum (0.016 ML/day) at 1.2% recharge.

Alluvial Groundwater System

Prior to mining in the saturated alluvial groundwater system associated with the Upper Namoi Zone 4 - Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source (i.e. approximately Year 12), TCPL would obtain and hold appropriate volumetric licences (refer Table 4-5) in accordance with the legislative requirements of the Upper and Lower Namoi Groundwater Water Sharing Plan.

For comparison purposes, in addition to basic landholder rights and supplementary water access licences, the extraction limit stipulated in the Upper and Lower Namoi Groundwater Water Sharing Plan for Upper Namoi Zone 4 (alluvial groundwater system) is 25,700 ML/annum, comprising of 168 aquifer access licences, and 71 supplementary water access licences.

Whitehaven currently holds 526 megalitres (ML) of volumetric licence allocation in the Upper Namoi Zone 4 – Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source. The allocation was approved on 14 October 2011 from WAL12622 (90AL806770) to WAL12714 (90AL807001).

Groundwater Monitoring

The existing Groundwater Monitoring Program, which is included in the Water Management Plan, would be updated to incorporate the Project. The extended Groundwater Monitoring Program would be designed to detect changes in groundwater levels and quality as a result of mining and improve knowledge of aquifer definition and interactions.

The existing TCPL network of piezometers would be augmented, particularly prior to and during Years 12 to 17 of the Project (i.e. coincidental with the anticipated open cut intersection with the alluvial groundwater system inside the low permeability barrier). A network of piezometers would be installed for the purposes of monitoring:

- the construction of the low permeability barrier (to quantify and validate the predicted short-term/localised dewatering impacts);
- groundwater levels and water quality in the alluvial groundwater system on the inside of the low permeability barrier as mining advances (to validate the predicted mine inflow and dewatering rates);
- groundwater pressures in the porous rock groundwater system/coal measures (to validate the predicted depressurisation effects at depth); and
- groundwater levels and water quality in the alluvial groundwater system on the outside of the low permeability barrier as mining advances (to validate the predicted negligible impacts).

Additional piezometers would also be installed in mine waste rock behind the advancing open cut to provide information on recharge rates and mine waste rock permeabilities and to validate groundwater modelling assumptions and predictions with respect to the emplacements.

The Groundwater Monitoring Program would be designed to comply with the *Murray-Darling Basin Groundwater Quality Sampling Guidelines* (Murray-Darling Basin Commission, 1997). Further information on the proposed Groundwater Monitoring Program is provided in Appendix A.

TCPL also proposes to establish, in co-operation with BCPL and the Maules Creek Coal Project, a regional monitoring program for groundwater resources in consultation with the relevant government agencies.

Groundwater Users – Management of Complaints

In the event that a complaint is received during the life of the Project in relation to depressurisation of a privately-owned bore or well, the results of the Groundwater Monitoring Program would be reviewed by TCPL as part of a preliminary evaluation to determine if further investigation, notification, mitigation (e.g. bore re-conditioning), compensation (e.g. alternative water supply) or other contingency measures (refer below) are required.

Numerical Model and Water Balance Review

The Groundwater Assessment numerical model would be used as a management tool for the periodic review and calibration of predicted groundwater impacts through the life of the Project.

The results of the Groundwater Monitoring Program would inform progressive refinement of the numerical model. Revised outputs from the numerical model would be reported periodically over the life of the Project and used to inform the site water balance review (Section 4.5.3).

Groundwater Response Plan

The existing Surface Water and Groundwater Response Plan, which is included in the Water Management Plan, would be reviewed and revised to describe any additional measures/procedures that would be implemented over the life of the Project to respond to potential exceedances of groundwater-related criteria. It would also describe the contingent mitigation/compensation/offset options that would be enacted in the event that groundwater users are adversely affected by the Project, or the low permeability barrier does not perform to specification (e.g. reconstruction of a portion of the barrier or use of an over-excavation option as described in Appendix R).

4.5 SURFACE WATER

A Surface Water Assessment for the Project was undertaken by Gilbert & Associates (2011) and is presented in Appendix B.

The existing Tarrawonga Coal Mine and proposed Project water management systems are described in Sections 2.10.1 and 2.10.2.

A description of existing local and regional surface water resources, including baseline data is provided in Section 4.5.1. Section 4.5.2 describes the potential impacts of the Project including cumulative impacts, and Section 4.5.3 outlines mitigation measures, management and monitoring.

4.5.1 Existing Environment

With the exception of Leard State Forest, the majority of land adjacent to the Project has been cleared for agricultural purposes. The surface water quality and flow regimes in the Project area reflect the influences of the historical clearing and the existing mining operations at the Tarrawonga Coal Mine and Boggabri Coal Mine.

The discussion below presents a summary description of baseline surface water data and the regional and local hydrology. Further detail is provided in Appendix B.

Baseline Surface Water Data

Gilbert & Associates (2011) analysed TCPL databases and data made available by Commonwealth and State government agencies, and surrounding mining operations/projects, including:

- rainfall and evaporation records from the BoM weather stations (Figure 4-1);
- rainfall records from the Tarrawonga Coal Mine AWS (Figure 4-1);
- NOW gauging station flow data on the Namoi River, Maules Creek and Coxs Creek (Figure 4-1);
- aerial photography of the 1998 Namoi River flood event made available by OEH;
- a compendium of data included as part of the *Carroll to Boggabri Flood Study* (NSW Department of Land and Water Conservation [DLWC], 2003);

- regional water quality data from the NSW Government Water Information website including Barbers Lagoon (downstream of Bollol Creek), Driggle Draggle Creek, Maules Creek and Namoi River (Figure 4-1);
- water quality from existing and previous TCPL stream water quality monitoring programs on Nagero Creek, Bollol Creek and Goonbri Creek (Figure 4-6);
- water usage data from the Tarrawonga Coal Mine water management system including haul road dust suppression, historic water usage from the "Thuin" groundwater production bore and movement of water to/from the open cut, storage dams, sediment basins and mine water dams; and
- other additional geological and regional topographic mapping data.

In addition, the Surface Water Assessment has considered the requirements of the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003*.

Regional Hydrology

The Project area is situated within the Namoi River catchment (Namoi Water Management Area under the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003*), which covers an area of some 42,000 km^2 (Appendix B). The Namoi River is a tributary of the Barwon River which ultimately flows to the Murray-Darling System.

Flow in the Namoi River is regulated by three major water storages:

- **Keepit Dam** - constructed on the Namoi River upstream of the Peel River confluence in 1960 with a storage capacity of 427,000 ML.
- **Chaffey Dam** - constructed on the Peel River upstream of Woolomin in 1979 with a storage capacity of 62,000 ML.
- **Split Rock Dam** - constructed on the Manilla River in 1988 with a storage capacity of 397,000 ML.

Water is released from these major water storages for irrigation, for industrial and domestic/urban requirements in the Namoi River catchment, and as environmental flows.

The closest gauging station to the Project site on the Namoi River is located at Boggabri (419012), just upstream of the Bollol Creek confluence with the Namoi River (Figure 4-1). The Boggabri gauging station commands a catchment area of 22,600 km^2 and has an estimated mean annual flow of 836,209 ML or 6% of the average annual rainfall (Appendix B).

Streamflow in the Namoi River at Boggabri is characterised by strong flow persistence with flows exceeding 1.3 ML/day on 95% of days (Figure 4-7). Zero flow is recorded on 1.5% of days. Averaged over the full period of available data, streamflow in the Namoi River at Boggabri is estimated to amount to 1,643 ML/day. These flow characteristics are typical of large regulated catchments (Appendix B).

Additional operational gauging stations have also operated in the region to the north of the Project (Maules Creek gauging stations [419044 and 419051]) and to the south-west of the Project (Coxs Creek gauging station [419032]). The locations of these regional gauging stations relative to the Project are shown on Figure 4-1.

Local Hydrology

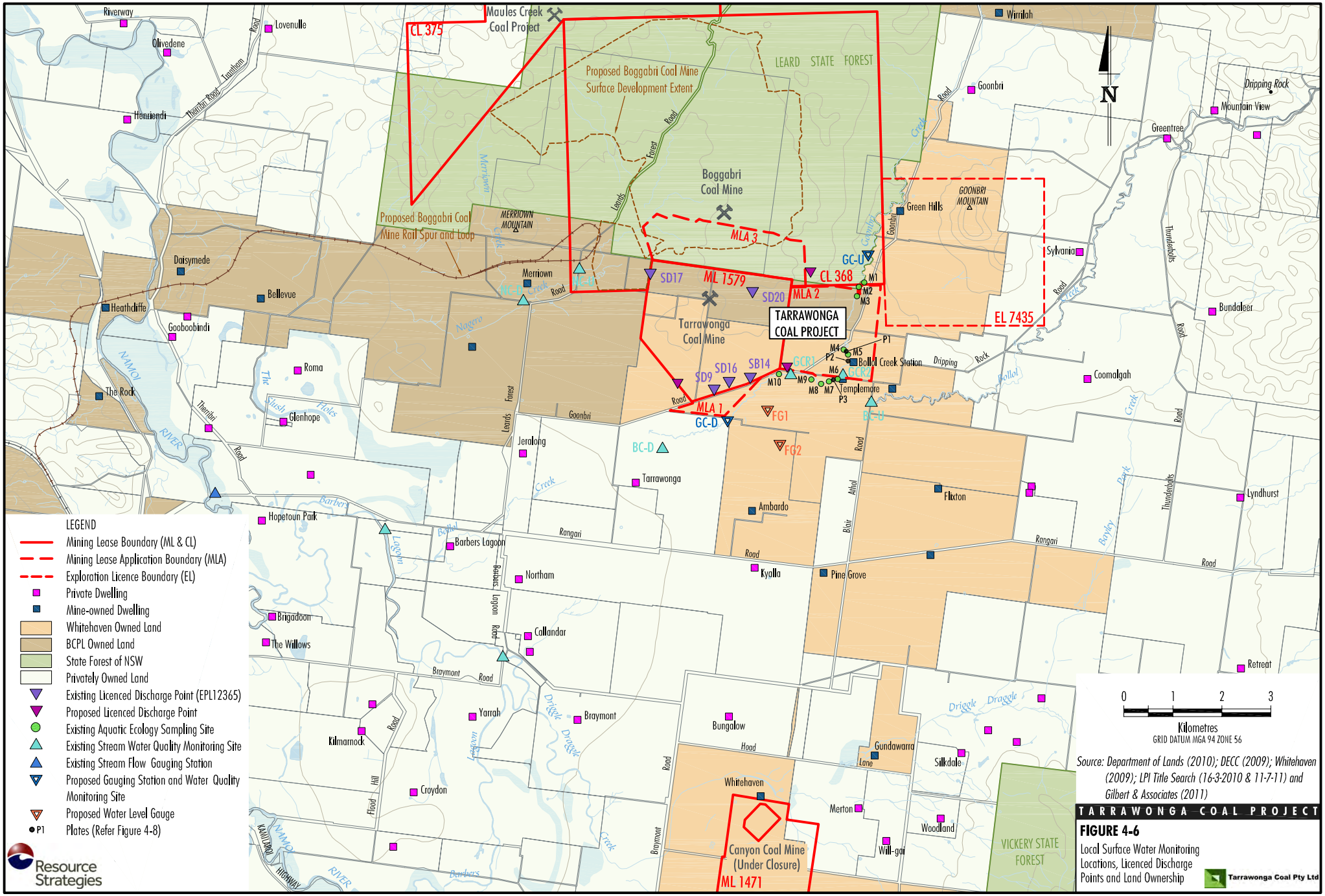
The existing Tarrawonga Coal Mine is located within the Bollol/Goonbri and Nagero Creek sub-catchments which ultimately flow into the Namoi River just north of Boggabri (Figure 4-1).

Bollol/Goonbri Creeks

Bollol Creek rises in the north-south trending range to the east of the Project and is an ephemeral waterway which flows south and west through a confined valley before dispersing onto the alluvial flats. Flows in Bollol Creek generally continue as overland flow in a south-westerly direction to eventually reach Barbers Lagoon, which flows into the Namoi River.

Goonbri Creek rises on the eastern margin of the Willowtree Range and is bounded by Middle Mountain and Goonbri Mountain (Figure 4-1). Goonbri Creek is an ephemeral waterway which flows south along the eastern border of Leard State Forest and through the Project area before trending west and south-west and dispersing as overland flow on the alluvial flats south of the Project area (i.e. Bollol Creek). A series of photographic plates illustrating the ephemeral nature of Goonbri Creek are provided on Figure 4-8.

In their headwaters and mid-reaches, Bollol/Goonbri Creeks exhibit small confined channels with occasional pockets of adjoining floodplain.



Source: Department of Lands (2010); DECC (2009); Whitehaven (2009); LPI Title Search (16-3-2010 & 11-7-11) and Gilbert & Associates (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-6

Local Surface Water Monitoring Locations, Licenced Discharge Points and Land Ownership

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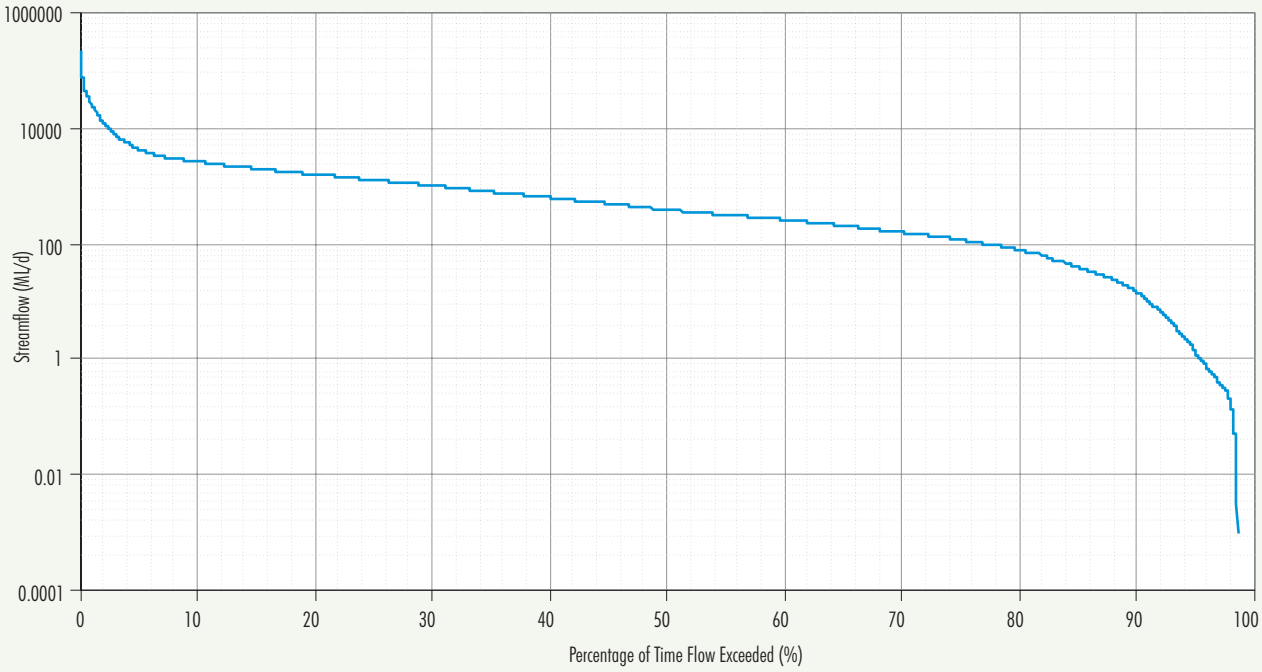
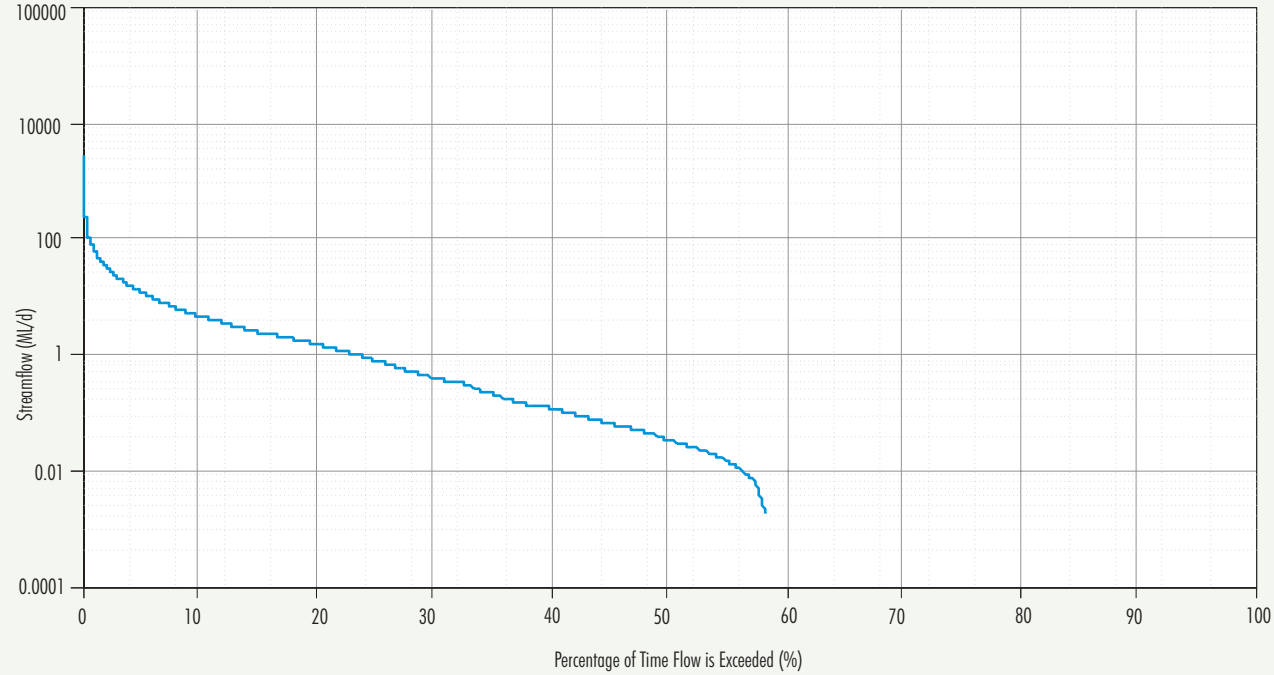
WHC-01-04_EA_Sect4_105D



Recorded Streamflow Characteristics for Namoi River
(GS 419012)



Inferred Streamflow Characteristics for Goonbri Creek
(Scaled from recorded data at Maules Creek [GS 419044])

Source: Gilbert & Associates (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-7
Streamflow Characteristics - Namoi River and Goonbri Creek (Inferred)

Resource Strategies

Tarrawonga Coal Pty Ltd

PHOTOGRAPHS TAKEN DECEMBER 2010

PHOTOGRAPHS TAKEN MAY 2011

Goonbri Creek within Project Open Cut Extent
(Refer P1 on Figure 4-6)

Goonbri Creek within Project Open Cut Extent
(Refer P2 on Figure 4-6)

Goonbri Creek Immediately Downstream of Permanent Goonbri Creek Alignment
(Refer P3 on Figure 4-6)

Source: Gilbert & Associates (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-8
Plates Illustrating the Ephemeral Nature of Goonbri Creek

Resource Strategies

Tarrawonga Coal Pty Ltd

As they descend onto the alluvial flats, the creeks transition into relatively poorly defined drainage paths, which become expansive ponded overland flow areas during and following heavy rainfall events.

A portion of the catchment of Bollol/Goonbri Creeks in the southern part of ML 1579 is captured within the Tarrawonga Coal Mine water management system for on-site usage and to prevent sediment laden runoff entering the creeks.

Observation and anecdotal evidence from TCPL staff and local landholders indicate that streamflows in the local streams are highly ephemeral. The streams respond quickly to rainfall, flow for relatively short periods after rainfall events and exhibit little flow persistence following rainfall. This is considered by Gilbert & Associates (2011) to be due to limited interaction between shallow alluvial aquifers and the bed of the streams.

Water ponding is more prevalent and persistent in the lower alluvial floodplain areas of the Bollol/Goonbri Creek sub-catchment, due to the slow moving nature of flows and the relatively low seepage loss (groundwater recharge) rates in these areas (Appendix B).

Although no direct gauged flow data is available for the Bollol/Goonbri Creek sub-catchment, their likely hydrological characteristics have been extrapolated by assessing the flow records from the existing Maules Creek gauging station (419044) (Figure 4-1) which is likely to have similar hydrological characteristics (Appendix B). Streamflow records are available for this station for the period 1968 to 1992.

The catchment upstream of the Maules Creek gauging station (419044) has an average annual runoff yield per unit catchment area over the gauged period of 40.3 mm/annum, or about 6.45% of rainfall (Appendix B). As shown on Figure 4-7, inferred streamflow characteristics for Goonbri Creek have been derived by Gilbert & Associates (2011) by scaling the observed flows at the Maules Creek gauging station (419044).

Nagero Creek

Nagero Creek rises along the south-western margins of the Willowtree Range, in Leard State Forest (Figure 4-1). Nagero Creek is also an ephemeral waterway, which flows generally south-west into a series of lagoons known as The Slush Holes, before ultimately draining into the Namoi River.

A portion of the catchment of Nagero Creek in the northern part of ML 1579 is captured within the existing/approved Tarrawonga Coal Mine water management system for on-site usage and to prevent sediment laden runoff entering the creek.

A summary of the sub-catchments within the Project area and surrounds, and the proportion of these catchments excised by the approved Tarrawonga Coal Mine, is provided in Table 4-6.

The existing Tarrawonga Coal Mine water management infrastructure and licensed discharge points are described in Section 2.1.6.

Surface Water Quality

Regional Surface Water Resources

The Namoi River, and its associated floodplains and fringing lagoons, are the regional surface water resources of relevance to this Project.

Regional water quality data is available for the Namoi River at Gunnedah (419001), and further downstream at Barbers Lagoon (downstream of Bollol Creek) (41910214) and Driggle Draggle Creek at Boggabri (41910271). Two regional surface water quality monitoring sites are also located on Maules Creek at Damsite (419044) and Avoca East (419051). Maules Creek flows into the Namoi River some 45 km downstream and 15 km to the north-west of the Project.

Figures 4-1 and 4-6 show existing regional and local surface water quality monitoring sites and sample locations in the vicinity of the Project.

Water quality of the Namoi River and Maules Creek is generally characterised by moderate alkalinity and elevated EC relative to Australian and New Zealand Environmental and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) guideline trigger values (Table 4-7). EC values in the Namoi River at Gunnedah (419001) have ranged between 200 µS/cm and 900 µS/cm every year since 2001 and there is no significant trend to the data (Schlumberger Water Services, 2011).

Average total nitrogen and total phosphorous concentrations have also been elevated relative to guideline trigger values for aquatic ecosystems. Phosphorous and nitrogen are sourced from effluent, agricultural runoff and in-stream processes (Schlumberger Water Services, 2011).

Table 4-6
Local Sub-Catchment Area Summary

Sub-Catchment	Location	Total Catchment Area (km^2)	% of Total Catchment Excised by Existing/Approved Tarrawonga Coal Mine
Bollol/Goonbri Creeks	Drains east and south of existing Tarrawonga Coal Mine.	153	1.8%
Nagero Creek	Drains north and west of existing Tarrawonga Coal Mine.	78	2.4%

Source: After Appendix B.

Table 4-7
Summary of Regional Average Water Quality Data

Location (refer Figure 4-1)	Parameter^					
	pH	EC (µS/cm)	Alkalinity (mg/L)	Turbidity (NTU)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)
Namoi River (and Lagoons)						
• Gunnedah (419001)	8.06	497	204	67.3	0.72	0.14
• Barbers Lagoon (Downstream of Bollol Creek) (41910214)	7.70	348	-	304	-	-
• Driggle Draggle Creek at Boggabri (41910271)	6.99	117	-	-	-	-
Maules Creek						
• Damsite (419044)	7.70	537	-	21	-	-
• Avoca East (419051)	7.56	351	141	13.5	0.43	0.15
ANZECC/ARMCANZ (2000) Guideline Trigger Values						
• Aquatic Ecosystems [Default]	6.5-7.5	30-350	-	2-25	0.25#	0.02#
• Primary Industries [Default]	5.0-9.0	-	-	-	-	-
• Livestock Drinking Water [Default]	-	3,125~	-	-	-	-

Source: After Appendix B.

^ Sample counts for each parameter varies for each location and are provided in Appendix B.

95% species protection.

~ Equivalent to 2,000 mg/L total dissolved solids (TDS) with a conversion factor of 1.5625 applied.

mg/L = milligrams per litre.

NTU = nephelometric turbidity unit.

Highest turbidities are recorded in the lower sections of the Namoi River (Schlumberger Water Services, 2011). Most sediment is derived from disturbance within catchments, stream bed and bank erosion, or direct access by livestock (Thoms *et al*., 1999). As stated in Schlumberger Water Services (2011):

> *In summary the early studies, including Nancarrow (1998), concluded that prior to 2000, the chemical water quality of the Namoi River system was generally moderate to poor, with high levels of nutrients, areas contaminated by agricultural chemicals, and areas with on-going salinity problems. While trends for parameters such as salinity, turbidity and nutrients varied in the short term, longer term trends showed little signs of a decline through time.*

As also reported in Schlumberger Water Services (2011), surface water quality data between 2002 and 2007 has been analysed in a study carried out by the NOW in the Namoi catchment (Mawhinney, 2011), with the following conclusions:

- EC values typically exceeded trigger levels for the protection of aquatic ecosystems, but were suitable for irrigation.
- Turbidity levels increased with distance down the catchment and are predicted to fall as beds and banks are stabilised.
- High total phosphorous and nitrogen were detected, although there was no corresponding significant growth of blue/green algae.
- High phosphorous and nitrogen in the Peel River below Tamworth were attributed to sewage treatment discharges and urban runoff.

A full suite of surface water quality results for regional surface water resources is provided in Appendix B.

Local Surface Water Resources

Local water quality sampling has been conducted on Bollol/Goonbri Creeks and Nagero Creek upstream and downstream of the current mining activities. Local water quality monitoring sites and aquatic ecology water quality sample locations are shown on Figure 4-6.

Bollol/Goonbri Creeks and Nagero Creek are ephemeral, and as a result, there have been relatively few opportunities to collect water quality samples during the period since monitoring was initiated at the Tarrawonga Coal Mine. A summary of local surface water monitoring results is provided in Table 4-8.

The available data for Bollol/Goonbri and Nagero Creeks indicate that the local surface water resources are generally characterised by near neutral pH with mildly acidic-neutral pH in reaches of Goonbri Creek (Appendix B). Recorded EC of local surface water resources was generally low.

With the exception of the higher total suspended solids (TSS) concentration recorded in Goonbri Creek at site GCR2 and in Nagero Creek at site NC-U, TSS in local surface water resources have generally been moderately elevated when compared to the EPL licensed discharge point limits (Table 4-8).

Consistent with water quality records for regional surface water resources, average total nitrogen and total phosphorous concentrations have also been elevated relative to guideline trigger values for protection of aquatic ecosystems (Table 4-8).

Table 4-8
Summary of Local Average Water Quality

Site/Location (refer Figure 4-6)	Parameter^					
	pH	EC (µS/cm)	TSS (mg/L)	Grease and Oil (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)
Bollol/Goonbri Creeks						
• BC-U	6.9	139	165	<2	1.4	0.36
• BC-D	7.0	112	49	5	2.25	0.44
• Goonbri Upstream (M1, M2 & M3)	6.4	174	-	-	BD	10[+]
• Goonbri Midstream (M4 & M5)	6.5	184	-	-	BD	>50
• Goonbri Downstream (M6 to M10)	6.3	230	-	-	BD	>50
• Goonbri Downstream (GCR1)	7.0	60	38	-	-	-
• Goonbri Downstream (GCR2)	7.3	531	904	<5	-	-
Nagero Creek						
• NC-U	7.1	78	442	5	3.25	0.17
• NC-D	7.1	148	125	6	3.1	0.60
ANZECC/ARMCANZ (2000) Guideline Trigger Values						
• Aquatic Ecosystems [Default]	6.5-8.0*	30-350	-	-	0.25[#]	0.02[#]
• Livestock Drinking Water [Default]	-	3,125[~]	-	-	-	-
OEH EPL						
• EPL 12365 Licensed Discharge Point Limits	6.5-8.5	-	20 (med); 50 (max)	10	-	-

Source: Appendices B and E.

^ Sample counts for each parameter varies for each location and are provided in Appendix B.

[+] Sites M1 & M2 only.

* Value for NSW Upland Rivers (>150 m AHD altitude).

[#] 95% species protection.

[~] Equivalent to 2,000 mg/L (TDS) with a conversion factor of 1.5625 applied.

BD – Nitrate (NO_3)/nitrogen dioxide (NO_2) below sample detection limit.

Shaded cells - Phosphate (PO_4^-) (Units in parts per million [ppm]).

Water quality samples collected from Bollol/Goonbri Creeks and Nagero Creek were also analysed for a suite of metals and the results are tabulated in Appendix B. With the exception of total aluminium concentrations, the results were below ANZECC default guideline values for protection of aquatic ecosystems.

A full suite of surface water quality results for local surface water resources is provided in Appendix B.

Contained Water Storages

Water quality sampling and analysis is undertaken at the Tarrawonga Coal Mine in accordance with requirements of the Development Consent (DA-88-4-2005) and EPL 12365. A summary of water quality monitoring data ranges from on-site contained water storages is presented in Table 4-9.

A full suite of surface water quality results for contained water storages on-site is provided in Appendix B.

Since the commencement of operations at the Tarrawonga Coal Mine in 2006, there have been several water-related EPL non-compliances for elevated TSS being released from licensed discharge points (SD9, SD14, SD16 and SD17) during significant rainfall events in 2008 and 2010.

Acid Rock Drainage Management

As described in Section 2.9.1, the practice of ROM blending of overburden and interburden is currently used at the Tarrawonga Coal Mine to manage any potential acid rock drainage issues. Historically recorded pH levels in contained water storages at the Tarrawonga Coal Mine have typically been near-neutral to moderately alkaline (Table 4-9).

Previous geochemical testwork (Geo-Environmental Management, 2010) identified the potential for As, Mo and Se in mine waste rock to be slightly soluble under near-neutral pH conditions. TCPL monitors these solute concentrations in contained mine water storages at the Tarrawonga Coal Mine as part of the existing Surface Water Monitoring Program, the results of which are summarised in Table 4-9. For comparison purposes, the recorded solute concentrations within contained water storages on-site have remained below the ANZECC guideline trigger values (low risk) for livestock drinking water quality (Appendix B).

Table 4-9
Tarrawonga Coal Mine – Summary Ranges of Contained Water Quality

Location[#]	Parameter^						
	pH	EC (µS/cm)	TSS (mg/L)	Grease and Oil (mg/L)	As (mg/L)	Mo (mg/L)	Se (mg/L)
Contained Water Storages							
• Open Cut/Pit Dewatering	6.5-8.9	78-3,970	8-293	<2-30	<0.001-0.015	-	-
• Nagero Creek Sub-catchment	7.5-8.9	197-1,210	7-524	<2-13	0.005-0.007	0.006	<0.01
• Bollol/Goonbri Creek Sub-catchment	6.8-9.2	190-1,450	5-1,940	<2-6	0.001-0.007	0.003-0.028	<0.01
OEH EPL							
• EPL 12365 Licensed Discharge Point Limits	6.5-8.5	-	20 (med); 50 (max)	10	-	-	-

Source: Appendix B.

[#] On-site mine water storage locations are shown/provided in Appendix B.

^ Sample counts for each parameter varies for each location and are provided in Appendix B.

Flooding

The Namoi River valley has experienced a number of significant floods. The largest confirmed flood occurred in February 1955, with significant floods also being recorded in January 1971, February 1984 and November 2000 (Appendix B).

Flooding along the reaches of the Namoi River nearest to Boggabri is characterised by outbreaks from the main river channel, and associated inundation of the extensive floodplain areas on both sides of the river. Floodplain flow is dominated by flow in flood runners (i.e. overland preferential flow paths). Flow patterns are affected by a series of relic channels which form semi-permanent lagoons between floods (DLWC, 2003).

A rural floodplain management plan has not yet been prepared by the OEH for the rural floodplains between Boggabri and Narrabri, where the Project is located. Floodplain management plans do however exist upstream and downstream on the Namoi River (respectively) as follows:

- *Carroll to Boggabri Floodplain Management Plan* (DNR, 2006); and
- *Narrabri – Wee Waa Floodplain Management Plan* (DNR, 2005).

In the absence of a rural floodplain management plan in the Project area, consultation was undertaken by TCPL during the preparation of this EA with local landholders and local council representatives to identify and describe the dominant overland flow paths on the alluvial floodplains in the vicinity of the Project.

Based on anecdotal evidence from local landholders compiled during the EA consultation, large areas south of the Project become inundated during intense and prolonged rainfall events, such as those that occurred in July 1998, February 2003 and February 2007. It is understood that during these events large slow moving sheets of water formed which slowly dissipated by evaporation and seepage into the alluvial plains and by slow drainage through relic lagoons into the Namoi River.

During these events, flows from the various source streams follow a number of overland flow paths on the alluvial flats. The dominant flow paths follow shallow natural swales and subtle depressions in the terrain and are influenced by the location of public roads, local cropping activities and the location of farm dams (Appendix B).

4.5.2 Potential Impacts

The following sub-sections describe the potential operational and post-mining impacts of the Project on surface water flow regimes and surface water quality.

Surface Water Flow Regimes

The Project would result in changes to flows in local creeks due to the progressive extension of the open cut and associated capture and re-use of drainage from operational disturbance areas and controlled releases from licensed discharge points. Changes to groundwater baseflow contributions to local creeks were also identified as a potential impact of the Project. These potential impacts of the Project are discussed in the sub-sections below.

Changes in Contributing Catchment

The surface water flow regimes in Nagero Creek and Bollol/Goonbri Creeks would be affected by progressive changes in catchment area as a result of runoff capture in Project disturbance areas. Table 4-10 summarises the potential progressive changes in catchment area reporting to these creeks as a result of the Project and potential cumulative impacts with the Continuation of Boggabri Coal Mine and Maules Creek Coal Project.

As shown in Table 4-10, the reduction in contributing catchment reporting to Nagero Creek as a result of the Project in Years 2 to 12 would be progressively reduced as a result of returning runoff from rehabilitated and free-draining mine landforms via licensed discharge points.

The maximum predicted impact over the life of the Project when compared to the total catchment of the Namoi River is 0.02%.

Following the completion of rehabilitation post-mining, only the catchment area of the final void would remain excised from the Namoi River catchment (approximately 155 ha, or 0.004% of the total catchment of the river).

Potential cumulative impacts of the Project considering the Continuation of Boggabri Coal Mine and Maules Creek Coal Project are discussed below.

Table 4-10
Progressive and Maximum Changes to Contributing Catchment of Local Creeks and the Namoi River

Mine/Project	Percentage Reduction in Contributing Catchment		
	Nagero Creek	Bollol/Goonbri Creeks	Namoi River
Tarrawonga Coal Mine/Project			
Tarrawonga Coal Mine (existing/approved)	2.4%	1.8%	0.01%
Project – Year 2	**6.9%**	2.5%	**0.02%**
Project – Year 4	6.3%	2.6%	0.02%
Project – Year 6	4.5%	2.8%	0.02%
Project – Year 12	2.9%	2.3%	0.01%
Project – Year 16	3.0%	**3.0%**	0.02%
Post-Mining	6.0%	-2.1%*	0.004%
Continuation of Boggabri Coal Mine			
Maximum	21.1%	0.9%	0.04%
Maules Creek Coal Project			
Maximum	0.8%	-	0.04%
Potential Maximum Cumulative Impact	28.8%^	3.9%	0.10%

Source: Appendix B.

Note: Bolded values indicate mine/Project only maximum values.

* Based on the post-mine landform design (Section 5) there would be a gain of 2.1% of contributing catchment reporting to Bollol/Goonbri Creeks.

^ Assuming the maximum reduction in contributing catchments for each individual mine was to occur at the same time.

Potential Impacts on Groundwater Baseflow Contributions

Appendix A concluded that potential impacts of the Project on Goonbri Creek (incorporating the permanent Goonbri Creek alignment), Bollol Creek and Nagero Creek would be negligible and therefore the downstream potential impacts on the Namoi River would be negligible (Section 4.4.2).

Permanent Goonbri Creek Alignment

The Project would involve removal of a 3 km section of Goonbri Creek within the Project open cut and the establishment of a permanent Goonbri Creek alignment and associated flood bund to the east and south-east of the open cut.

As described in Section 2.10.3, the permanent Goonbri Creek alignment would be constructed in a manner so as to avoid and minimise any disruption to flows reporting to the downstream portions of Goonbri Creek.

Surface Water Quality

Potential impacts of the Project on surface water quality include the reduction in surface water quality due to controlled licensed discharges to receiving waters, uncontrolled runoff from disturbed areas and/or release of contaminants, acid rock drainage from mine waste rock emplacements, saline runoff from Project irrigation areas and/or alteration of groundwater quality affecting baseflow in surface water resources.

Runoff and Contaminants

Surface water runoff from disturbed areas could potentially contain sediments, dissolved solids, oil, grease, metals and salts. Erosion and sediment controls and land contamination controls that would be applied to the Project are described in Section 4.3.

The Geochemistry Assessment (Appendix N) concluded that the mine waste rock materials are typically alkaline and are expected to be generally non-saline.

TCPL would continue to operate the Project in accordance with the requirements of EPL 12365. The Project water management system is described in Section 2.10.2.

Provided the water management system is constructed and operated in accordance with its design and operational criteria, Gilbert & Associates (2011) consider that there would be a low risk of adverse water quality impacts from controlled releases at licensed discharge points in accordance with EPL 12365. Releases from passively managed storages are also considered to have a very low risk of adversely affecting downstream waters (Appendix B).

The risk of an uncontrolled release (i.e. spill) from the Project was evaluated as part of the site water balance (Appendix B). The Project water management system (including mine water surge dams) has been designed with the objective to securely contain mine water on-site, and minimise the potential for spills off the Project site.

Acid Rock Drainage

A Geochemical Assessment was conducted by Geo-Environmental Management and is presented in Appendix N.

The geochemical testing results indicate that mine waste rock material generated by the Project would generally be expected to be NAF. As described in Section 2.9.1, a small quantity of mine waste rock (including some strata immediately adjacent the targeted coal seams) was however identified as PAF-LC and may require specific controls (e.g. identification, selective handling and emplacement below at least 15 m NAF mine waste rock material).

Consistent with previous geochemical testwork (Geo-Environmental Management, 2010), the geochemical testing for the Project showed that As, Se and Mo concentrations in mine waste rock are likely to be slightly soluble under the prevailing near-neutral pH conditions (Appendix N). As a consequence there could potentially be slightly elevated concentrations of these analytes in waters released from licensed discharge points.

Irrigation

Irrigation activities to assist in revegetation establishment would be limited to mine landforms that drain to sediment basins and storage dams where existing and/or proposed licensed discharge points are operated.

Based on the recorded ranges of contained water quality on-site (Table 4-9), the mine waters are considered suitable for irrigation purposes when compared to soil salinity tolerances of pasture grasses used as cover crops at the Tarrawonga Coal Mine (DPI, 2005). For example, rootzone soil salinity (i.e. EC) levels of 3,000 to 6,600 µS/cm may result in yield reductions of approximately 10 to 25% for Green Panic grass (DPI, 2005), which is used at the Tarrawonga Coal Mine as a cover crop. In comparison, the maximum recorded EC level of contained water quality on-site is approximately 4,000 µS/cm (Table 4-9). Average recorded sodium and chloride concentrations are also within the range for moderately tolerant pasture species such as lucerne and sorghum (i.e. 230 to 460 mg/L for sodium and 350 to 700 mg/L for chloride) (National Resource Management Ministerial Council *et al.*, 2006). The pH recorded in contained water storages (6.5 to 9.2) has generally been within the recommended pH range of 5 to 8.5 for irrigation (DEC, 2003).

Irrigation activities would be undertaken to maximise evapotranspiration but avoid surface runoff (due to irrigation). Therefore, the risk of impacts on downstream surface water resources due to Project irrigation activities are considered to be negligible (Appendix B).

Alteration of Groundwater Quality

No measurable changes in the quality of groundwater (alluvial and porous rock) are predicted to occur as a consequence of mining (Appendix A). As a result, there would be negligible impact on surface water quality in local creeks (i.e. Bollol/Goonbri Creeks and Nagero Creek) due to the interaction of surface water flows and groundwater (Appendix A).

Flooding

The Project area is predominantly on land with elevations greater than 275 m AHD, and therefore would be above any conceivable flooding of the Namoi River (Appendix B). Lower sections of the Project site could however be affected by extreme flooding from Bollol/Goonbri Creeks and would be protected by both temporary and permanent flood bunds as described in Sections 2.10.3 and 4.5.3.

The impacts of the flood bunds and Goonbri Road re-alignments on the adjacent and downstream Goonbri/Bollol Creek floodplain would be minimal (Appendix B).

Post-Mining Surface Water Impacts

The potential post-mining surface water impacts primarily relate to the design of the final void and performance of the permanent Goonbri Creek alignment and rehabilitated mine landforms in the long-term and are discussed below.

Final Void

Post-mining inflows to the final void would comprise three contributing sources:

- incident rainfall;
- surface water runoff (albeit from a minimised reporting catchment); and
- groundwater inflows from the porous rock groundwater system as it recovers and adjacent mine waste rock emplacement infiltration (reducing with time).

As described in Section 4.4.3 (Table 4-5), groundwater inflows from the alluvial groundwater system post-mining would be negligible.

Water would be lost from the final void through evaporation only. The final void would not overflow to downstream watercourses (Appendix B).

A final void water recovery analysis, including model predicted groundwater inflows (Appendix A), has been conducted as part of the Surface Water Assessment (Appendix B). The final void water recovery analysis also includes predictions for water quality (salinity).

The results of the final void water recovery analysis are presented in Section 5.

Permanent Goonbri Creek Alignment

Without the application of the Project water management mitigation measures described in Sections 2.10 and 4.5.3, including the low permeability barrier, permanent flood bund and suitable performance of the permanent Goonbri Creek alignment, surface water and alluvial groundwater associated with Goonbri Creek could drain directly to the final void.

A description of the low permeability barrier, permanent Goonbri Creek alignment and associated flood bund is provided in Section 2.10.3, with further detail of the conceptual designs contained in Appendix R.

Rehabilitated Mine Landforms

The Geochemistry Assessment (Appendix N) concluded that Project waste rock materials are typically alkaline and are expected to be generally non-saline. Sodicity test results also indicated that a relatively high proportion of the mine waste rock material generated by the Project is likely to be moderately to highly sodic and if left exposed on the surface of the final mine landforms could become dispersive (Appendix N). Therefore, specific rehabilitation management measures (e.g. gypsum treatment and/or construction methods for final surfaces of mine waste rock emplacements) would be required to manage sodic materials and would be documented in the Project Rehabilitation Management Plan (Section 5.7).

The existing storage dams and sediment basins would be retained until the revegetated surface of the mine waste rock emplacements are stable and runoff water quality reflects runoff water quality from similar unmined areas. At this time these drainage controls would be removed and the rehabilitated areas would be free-draining.

Cumulative Impacts

The Surface Water Assessment included an evaluation of the cumulative impacts of the Project (including the existing Tarrawonga Coal Mine) and the Continuation of Boggabri Coal Mine and Maules Creek Coal Project. As indicated in Table 4-10, the maximum cumulative reduction in contributing catchments to the Namoi River during the life of the Project would be 0.1%.

Potential surface water impacts of the Project have been considered in the context of potential alterations to groundwater baseflow contributions at a regional scale (considering both the Continuation of Boggabri Coal Mine and the Maules Creek Coal Project), and are discussed in Appendix A.

Climate Change and Surface Water

Potential effects of climate change on the predicted Project surface water impacts (i.e. sensitivity analysis) are considered in Appendix B.

4.5.3 Mitigation Measures, Management and Monitoring

Low Permeability Barrier

As described in Section 2.10.3, TCPL would construct a low permeability barrier to the east and south-east of the open cut. The design objectives of the low permeability barrier are described in Section 2.10.3 and include minimising the potential for drainage of alluvial groundwater into the open cut during operations and post-mining, and maintaining the hydraulic character of Goonbri Creek by minimising loss of baseflow.

Permanent Goonbri Creek Alignment and Associated Flood Bund

As described in Section 2.10.3, in approximately Year 15, open cut mining would remove a section of Goonbri Creek. Prior to the open cut advancing into this section of Goonbri Creek, the permanent Goonbri Creek alignment would be established to the east of the open cut, low permeability barrier and permanent flood bund. The permanent flood bund would be constructed to prevent inundation of the open cut both during operations and post-mining.

A Goonbri Creek Management Plan would be developed for the Project prior to the commencement of construction activities associated with the permanent Goonbri Creek alignment, low permeability barrier and flood bund. It would include the detailed design and specifications for the permanent Goonbri Creek alignment, including a program for the staging of construction works and their integration with the mining operations.

The Goonbri Creek Management Plan would also describe:

- revegetation objectives and activities;
- water quality, ecological, hydrological and geomorphic performance and completion criteria for the permanent Goonbri Creek alignment based on baseline conditions; and
- a monitoring/maintenance program for water quality, ecological, hydrological and geomorphic integrity of the permanent Goonbri Creek alignment.

Additional streamflow, water level and water quality monitoring sites for the Project would be established upstream and downstream of the permanent Goonbri Creek alignment. Water level (flood) gauges would also be installed in the lower reaches and overflow areas of Bollol/Goonbri Creeks. The monitoring data from these sites would be used to inform the detailed design and to monitor the hydrological performance of the permanent Goonbri Creek alignment.

Water quality sampling of sites on Goonbri Creek would continue to be event based. The analysis of samples would comply with the current regime of combined field sampling for salinity (EC), pH and suspended solids and laboratory analysis for common cations, anions, metals (including As, iron, chromium, cadmium, zinc, aluminium, Mo and Se) and bulk nutrients (total nitrogen, total phosphorus).

In order to progressively monitor the geomorphic performance of the permanent Goonbri Creek alignment, erosion and condition surveys would be conducted for the first five significant flow events following commissioning.

Water Quality Management Measures

Mine Water Management System

As described in Section 2.10.2, the Project water management system would be used to control runoff generated from surface development areas, while minimising (where practicable) the mixing/capture of upslope surface water runoff by installation of upslope bunds and drains.

The water management system would include a combination of permanent structures (i.e. permanent Goonbri Creek alignment) that would continue to operate post-mine closure, and temporary structures that would only be required until the completion of the rehabilitation works (e.g. sediment control structures).

Water quality monitoring sites for the contained water management system would be expanded to include all new on-site storages and licensed discharge points. Sampling in on-site storages would be consistent with the existing regime of quarterly and event based sampling.

The analysis of quarterly samples would comply with the current regime of combined field sampling as described above.

Acid Rock Drainage Management

The current practice of ROM blending of overburden and interburden at the Tarrawonga Coal Mine would continue to be undertaken for the Project. TCPL would continue to monitor the water quality of contained water storages during the life of the Project as part of the Surface Water Monitoring Program.

If in the event acid rock drainage is identified through the Surface Water Monitoring Program, a testwork program for identification of any PAF-LC material would be undertaken and specific controls (e.g. selective handling and emplacement below at least 15 m NAF mine waste rock material) would be implemented.

Irrigation Management

Irrigation activities to assist in revegetation establishment would be limited to mine landforms that drain to sediment drains and storage basins where existing and/or proposed licensed discharge points are operated. Irrigation activities would be undertaken to maximise evapotranspiration but avoid surface runoff (due to irrigation).

Water Management Plan

The existing Water Management Plan would be reviewed and revised to incorporate the Project. As described in Section 2.1.8, the Water Management Plan incorporates the Site Water Balance, Erosion and Sediment Control Plan, Surface Water Monitoring Program, Groundwater Monitoring Program, and the Surface Water and Groundwater Response Plan.

Site Water Balance

Periodic review and revision of the Site Water Balance would be undertaken over the life of the Project to record and document the status of inflows (water capture), storage and consumption (e.g. dust suppression and crushing activities) and to optimise water management performance. Monitoring would be undertaken over the life of the Project to provide data for refinement of the Site Water Balance, including:

- records of pumped water volumes;
- storage levels in mine water dams and other containment storages;
- haul road water usage rates;
- crusher usage rates; and
- revegetation establishment irrigation usage rates.

Erosion and Sediment Control

The proposed sediment control storages have sufficient capacity to manage disturbed area runoff in accordance with design criteria recommended in the Landcom (2004) guidelines (Appendix B).

The Project sediment and erosion control system would be managed through the Erosion and Sediment Control Plan, which is a component of the Water Management Plan. These plans would be reviewed and revised periodically to address changes over the Project life.

The operational sediment and erosion control works would be retained and maintained during the revegetation establishment phase. Once rehabilitation areas are stable and the revegetation is established, operational sediment control structures would either be left as passive water control storages or would be removed (Section 5.4.6).

Surface Water Monitoring Program

The Surface Water Monitoring Program would be updated to include the additional monitoring sites to be installed during the life of the Project, including:

- two new surface water flow gauging stations on Goonbri Creek upstream (GC-U) and downstream (GC-D) of the permanent Goonbri Creek alignment;
- two water level (flood) gauges in the lower reaches and overflow areas of Bollol/Goonbri Creek (FG1 and FG2);
- water quality monitoring on Goonbri Creek at the two new gauging stations;
- water quality monitoring in new on-site water storages and licensed discharge points; and
- two pluviometers in the upper (PV1) and mid (PV2) reaches of the Goonbri Creek catchment.

On-site meteorological monitoring would also continue and is discussed in Section 4.2.1.

Surface Water Response Plan

The existing Surface Water and Groundwater Response Plan would be reviewed and revised to describe the measures/procedures that would be implemented over the life of the Project. In particular, it would describe how TCPL would respond to any potential exceedances of surface water related criteria, and it would describe the contingency mitigation/compensation/offset measures that would be implemented in the event that downstream surface water users or riparian vegetation is adversely affected by the Project.

Surface Water Licensing

As no water is proposed to be extracted from a regulated source (i.e. Namoi River), the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003* would not apply to the Project.

The Project is located within the Maules Creek Tributaries Management Zone defined in the *Draft Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2011*.

The *Draft Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources 2011* is currently on public exhibition until 2 December 2011 and is anticipated to be commenced in mid-2012 (NOW, 2011).

Until such time that the Water Sharing Plan is commenced, the Project would continue to involve capture and use of water from on-site mine water storages, dams and sediment basins in accordance with the NSW *Water Act, 1912*.

Based on the area of Whitehaven's contiguous land holdings in the Nagero Creek and Bollol/Goonbri Creeks sub-catchments (Figure 1-2a), the total harvestable right (i.e. maximum dam capacity) is 36 ML in the Nagero Creek sub-catchment, and 199 ML in the Bollol/Goonbri Creeks sub-catchment (Appendix B).

Further discussion regarding licences required for each water source associated with the Project is provided in Section 6.4.1.

Post-Mining Surface Water Management

The management of surface water resources post-mining, including drainage across the final mine landform, final void management and the performance of the permanent Goonbri Creek alignment are discussed in Section 5.

4.6 NOISE AND BLASTING

A Noise and Blasting Impact Assessment for the Project was undertaken by Wilkinson Murray (2011) and is presented in Appendix C. It was conducted in accordance with the *NSW Industrial Noise Policy* (INP) (NSW Environment Protection Authority [EPA], 2000), *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990), *NSW Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999) and the *Interim Construction Noise Guideline* (DECC, 2009).

Section 4.6.1 provides a description of the existing noise environment, including a description of the existing Tarrawonga Coal Mine noise and blasting management and monitoring regime. Section 4.6.2 describes the potential impacts of the Project. Section 4.6.3 outlines mitigation measures, management and monitoring.

4.6.1 Existing Environment

Noise and Blasting Management and Monitoring Regime

Noise management at the Tarrawonga Coal Mine is currently undertaken in accordance with the Noise Management Plan (TCPL, 2011b) which outlines:

- noise mitigation measures and controls;
- the noise monitoring and reporting regimes; and
- the management of exceedances and complaints.

The Noise Management Plan describes general noise management and mitigation measures including:

- Required compliance with approved hours for operational and maintenance activities.
- Contractor environmental training on noise control and awareness.
- Periodic noise emission testwork on mobile mining equipment.
- Consideration of sound power levels in equipment selection, and maintaining equipment in good order.
- Monitoring for adverse weather conditions and adjusting mining operations where necessary.

- Managing complaints in accordance with the complaints management process outlined in the Noise Management Plan.
- Monitoring emitted noise levels during mining operations to verify compliance with noise criteria and to assess the need, if any, for additional noise attenuation measures.

In addition, the Noise Management Plan details the following reasonable and feasible noise mitigation measures implemented at the Tarrawonga Coal Mine, in accordance with the *Tarrawonga Coal Mine Section 75W Modification Environmental Assessment* (Whitehaven Coal Limited, 2010):

- installation of a 6 m high bund on the southern side of selected portions of the haul roads (where the haul roads run east-west);
- where required by real-time noise monitoring, cessation of waste emplacement activities within the Southern Emplacement during evening and night-time periods;
- modification to the alignment of haul routes (in particular, relocating the haul route from the pit floor to the Northern Emplacement to its northern face, away from receivers to the south);
- orientation of ROM coal stockpiles to screen the primary crusher; and
- modification of the fleet during the evening and night-time periods, including a reduction in the number of water carts, dozers and loaders, and cessation of scrapers.

A mobile real-time noise monitor has recently been procured by TCPL. Consistent with the Noise Management Plan, the real-time monitor is located at selected nearby receivers in response to complaints. Currently (October 2011), the real-time noise monitor is situated at the Sylvania residence, due east of MLA 3 (Figure 4-9).

As discussed in the Noise Management Plan (TCPL, 2011b), the real-time noise monitoring system provides real-time access to noise data, and provides the capacity to set the monitoring unit to a target noise goal.

Upon noise emissions reaching the identified target level, an automated SMS message is delivered to operational personnel on-site which triggers an investigation into the prevailing weather conditions and noise source, both through review of relevant monitoring data/files, and on-site knowledge of surface operations. Upon determination that the noise source is mine site related, active measures can be put in place to modify operations, or stand down the noise source to ensure compliance with noise criteria is maintained.

The *Tarrawonga Coal Mine Blast Management Plan* (TCPL, 2011c) describes the blast monitoring regime and general blast management measures. It also describes the process for notifying landowners of upcoming blast events, flyrock distribution monitoring, reporting and complaint management procedures.

Compliance and Complaints

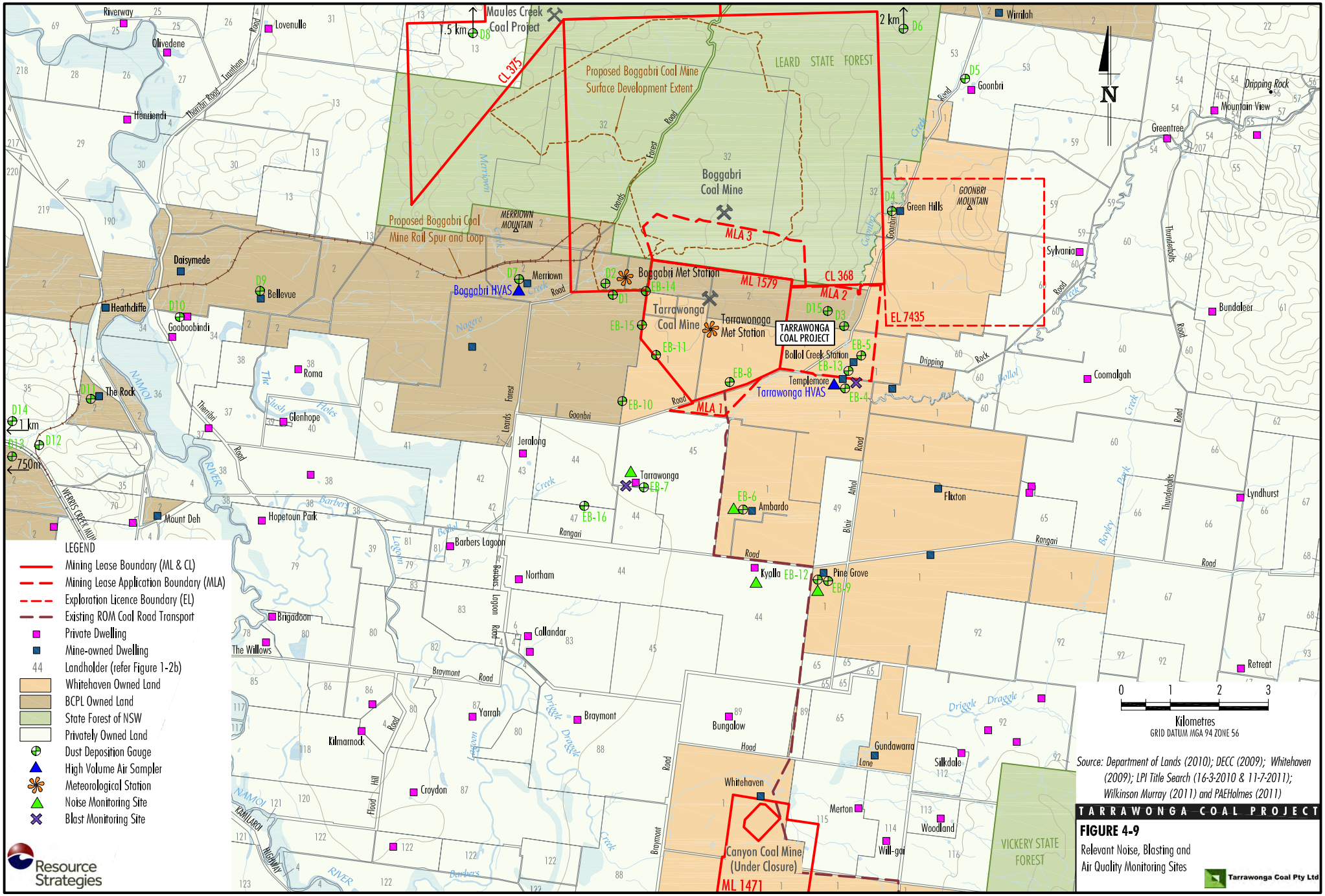
Attended noise monitoring and vibration/air blast monitoring has been undertaken at the Tarrawonga Coal Mine since 2006 at the locations shown on Figure 4-9.

Quarterly attended noise monitoring has been conducted at the Tarrawonga Coal Mine since the commencement of mining operations. Wilkinson Murray has reviewed available monitoring data between 2006 and August 2011 and a number of exceedances have been recorded (Appendix C).

The majority of recorded exceedances were attributed to road haulage operations along the sized ROM coal road transport route. In response to these exceedances, Whitehaven has acquired several properties in close proximity to the transport route, and also negotiated private agreements with some landowners. TCPL currently holds a private noise agreement with the owner of the Kyalla property (receiver 44a) (Figure 4-9). TCPL also had private noise agreements with the owners of the Ambardo and Pine Grove properties prior to them being acquired in 2011.

Generally, mining operations were found to comply with operational noise criteria, with the exception of two monitoring periods during 2009 (Appendix C).

Blast monitoring is also conducted at two locations for each blast event at the Tarrawonga Coal Mine (Figure 4-9). Appendix C reports that whilst minor exceedances of the human annoyance airblast criterion have been recorded, these exceedances were within allowable limits.



Source: Department of Lands (2010); DECC (2009); Whitehaven (2009); LPI Title Search (16-3-2010 & 11-7-2011); Wilkinson Murray (2011) and PAEHolmes (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-9

Relevant Noise, Blasting and Air Quality Monitoring Sites

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_Sect4_117E

TCPL manages complaints in accordance with the Noise Management Plan. A summary of noise and blasting-related complaints is provided in Appendix C.

In the five years since April 2006, 11 complaints were received in relation to on-site noise and blasting. Of these, four complaints specifically referred to operational noise (Appendix C).

TCPL has also received a number of complaints during this period in relation to sized ROM coal road haulage noise and/or operating hours.

Noise Measurement and Description

The assessed noise levels presented in Appendix C and summarised in this section are expressed in A-weighted decibels (dBA). The logarithmic dBA scale simulates the response of the human ear, which is more sensitive to mid to high frequency sounds and relatively less sensitive to lower frequency sounds. Table 4-11 provides information on common noise sources in dBA for comparative reference.

Hearing "nuisance" for most people begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}) which are the levels exceeded for a specified percentage (N) of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is considered to be the average maximum noise level.

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating levels recorded over the sampling period.

Background Noise Levels

The Rating Background Level is the background noise level determined without the subject premises in operation, in accordance with the INP.

Given that the construction of the Tarrawonga Coal Mine commenced in 2006 and operations are ongoing, Wilkinson Murray referred to background noise surveys conducted prior to the establishment of the mine (Appendix C).

Review of these background noise levels indicated that background noise levels for the locality were 30 dBA during daytime, evening and night-time periods, and these have been adopted for the Project (Appendix C).

Table 4-11
Relative Scale of Various Noise Sources

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 to 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Internal demolition work (jackhammer)	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0 to 10	Silent	Threshold of hearing	-

Source: After United States Department of the Interior (1994) and Richard Heggie Associates (1995).

4.6.2 Potential Impacts

The Noise and Blasting Impact Assessment (Appendix C) included assessment of the following potential impacts:

- on-site operational and construction noise;
- off-site road traffic noise;
- off-site rail noise; and
- blasting.

Operational Noise

Noise Criteria

The INP assessment procedure for industrial noise sources has two components (EPA, 2000):

- controlling potential intrusive noise impacts in the short-term for residences; and
- maintaining noise level amenity for particular land uses, for residences and other land uses.

The INP prescribes detailed calculation routines for establishing Project-specific $L_{Aeq(15minute)}$ intrusive criteria and $L_{Aeq(period)}$ amenity criteria. The INP Project-specific intrusive and amenity assessment criteria for the Project are presented in Table 4-12. Intrusive criteria are applied on a Project-only basis whilst amenity criteria are applied cumulatively.

As the applicable Project-specific intrusive criteria are the most stringent, Appendix C assesses Project-only noise levels against the intrusive criteria and cumulative noise levels against the amenity criteria.

In those cases where the INP Project-specific assessment criteria are exceeded, it does not automatically follow that all people exposed to the noise would find the noise noticeable or unacceptable.

In subjective terms, exceedances of the INP Project-specific assessment criteria can be generally described as follows (Appendix C):

- negligible noise level exceedance (less than 1 dBA) (not noticeable by all people);
- marginal noise level exceedance (between 1 and 2 dBA) (not noticeable by most people);
- moderate noise level exceedance (between 3 and 5 dBA) (not noticeable by some people but may be noticeable by others); and
- appreciable noise level exceedance (greater than 5 dBA) (noticeable by most people).

For the purposes of assessing potential noise impacts, exceedances can be separated into a Noise Management Zone (i.e. 1 to 5 dBA above the criteria) and a Noise Affectation Zone (i.e. greater than 5 dBA above the criteria).

Table 4-13 presents the methodology used for assessing operational noise against the INP Project-specific noise assessment criteria (Table 4-12).

Table 4-12
INP Project-specific Intrusive and Amenity Assessment Criteria (dBA)

Receiver	Land Use	Intrusive $L_{Aeq(15\ minute)}$[1]			Amenity $L_{Aeq(period)}$[1] (Recommended Acceptable)			Amenity $L_{Aeq(period)}$[1] (Recommended Maximum)		
		Day	Evening	Day	Evening	Night	Night	Evening	Night	Night
All residential receivers	Rural Residential	35	35	35	50	45	40	55	50	45

Source: Appendix C.

[1] Daytime – 7.00 am to 6.00 pm; evening – 6.00 pm to 10.00 pm; and night-time – 10.00 pm to 7.00 am.

Table 4-13
Project-specific Noise Assessment Methodology

Assessment Criteria	Project-specific Criteria	Noise Management Zone		Noise Affectation Zone
		Marginal	Moderate	
Intrusive $L_{Aeq(15\ minute)}$	35 dBA	1 to 2 dBA above Project-specific criteria	3 to 5 dBA above Project-specific criteria	> 5 dBA above Project-specific criteria

Source: Appendix C.

Blasting Measurement and Description

Overpressure (or airblast) is reported in linear decibels (dBL) and is the measurable effect of a blast on air pressure, including generated energy that is below the limit of human hearing. Ground vibration is the measurable movement of the ground surface caused by a blast and is measured in millimetres per second (mm/s) as Peak Vector Sum (PVS) vibration velocity.

Discernible blast emission effects can be divided into the three categories listed below:

1. Occupants of a building can be inconvenienced or disturbed (i.e. temporary amenity effects).
2. Contents of a building can be affected.
3. Integrity of a building structure can be affected.

An individual's response to blasting vibration and overpressure is highly dependent on previous experience and expectations.

Operational Noise Modelling

An acoustic model was developed by Wilkinson Murray (2011) that simulates the Project components using noise source information (i.e. sound levels and locations) and predicts noise levels at relevant receiver locations. The model considers meteorological effects, surrounding terrain, distance from source to receiver and noise attenuation.

The locations of modelled receivers (dwellings) are shown on Figure 4-9.

Noise Modelling Scenarios

Three scenarios based on the progressive development of the Project were assessed:

- Project Year 2 (Figure 2-4) – which represents the first year that the Project reaches the maximum ROM coal production, mining operations in the western Project area and considers waste rock emplacement works on the Southern Emplacement.
- Project Year 4 (Figure 2-5) – is equivalent to the maximum year of production at the Continuation of Boggabri Coal Mine (BCPL, 2010), and has been included in consideration of potential cumulative noise impacts.
- Project Year 16 (Figure 2-8) – represents mining operations in the eastern Project area.

Assessment of Feasible and Reasonable Noise Mitigation Measures

Wilkinson Murray (2011) conducted an investigation of feasible and reasonable noise mitigation measures for the Project, particularly in relation to night-time operations.

A number of iterative steps were undertaken to develop noise mitigation measures for the Project, including:

1. Preliminary noise modelling of scenarios representative of the maximum noise emissions from the Project to identify the potential for noise exceedances.
2. Evaluation of various combinations of noise management and mitigation measures to assess their relative effectiveness.
3. Review of the effectiveness of these measures and assessment of their feasibility by TCPL.
4. Adoption by TCPL of management and mitigation measures to appreciably reduce noise emissions associated with the Project, including:
    - installation of an earth bund on the southern side of exposed sections of the services corridor (i.e. ROM coal haul road to the Boggabri Coal Mine);
    - modified alignment of haul routes to reduce their exposure relative to nearby receivers; and
    - a reduction in the number of mobile fleet items operating during the evening and night-time periods.

These feasible and reasonable mitigation measures are generally consistent with the existing noise control measures (Section 4.6.1) and were included in noise modelling for the Project.

Assessment of Meteorological Conditions

The INP generally directs the use of a single set of adverse meteorological data in the assessment of noise impacts (EPA, 2000). However, for noise modelling in this and other projects, Wilkinson Murray has adopted the methodology of predicting noise levels at nearby receivers for a range of meteorological conditions based on local meteorological data. A 10^{th} percentile exceedance noise level is then calculated (i.e. the level that is exceeded 10% of the time), which is compared with relevant criteria.

Details of meteorological analysis and modelled meteorological conditions are provided in Appendix C.

Predicted Noise Emissions

In summary, the operational noise assessment indicates the following (Appendix C):

- During the daytime, operational noise from the Project would comply with the 35 dBA $L_{Aeq(15\ minute)}$ operational noise criterion at all privately-owned residences.
- Operational noise from the Project would also comply with the 35 dBA $L_{Aeq,15\ minute}$ night-time operational noise criterion at all privately-owned residences during periods of calm meteorological conditions.
- During evening and night-time periods with adverse meteorological conditions, operational noise would exceed the relevant criterion at three privately-owned receivers (i.e. residences 43, 44a and 45).
- Receivers 43 (Suey) and 45 (McGregor) would exceed the criteria by greater than 5 dBA and would be in the noise affectation zone, whilst receiver 44a (Crosby) would be in the moderate noise management zone (3 to 5 dBA above the criteria).

Table 4-14 presents a summary of potential exceedances of criteria under adverse meteorological conditions. Indicative noise contours for night-time operations under adverse meteorological conditions for Years 2 and 16 are presented in Figures 4-10 and 4-11, respectively.

Table 4-14
Summary of Potential Operational Noise Exceedances at Private Receivers under Adverse Meteorological Conditions

Noise Management Zone		Noise Affectation Zone
1 to 2 dBA exceedance	**3 to 5 dBA exceedance**	**> 5 dBA exceedance**
Nil	Receiver 44a (Crosby)	Receivers 43 (Suey) and 45 (McGregor)

Source: Appendix C.

Of the receivers listed in Table 4-14, receiver 45 (McGregor) is in the existing Tarrawonga Coal Mine affectation zone and receiver 44a (Crosby) has a private agreement with TCPL in relation to road haulage noise.

Vacant Land Assessment

Wilkinson Murray (2010) also reviewed potential impacts on private vacant land and concluded that greater than 25% of vacant property 49 (Laird) is predicted to be affected by Project noise in excess of 40 dBA $L_{Aeq,15\ minute}$ (Appendix C). In addition, vacant properties 42 (Pryor) and 41 (Jones and Woodward) are predicted to exceed the criterion of 35 dBA $L_{Aeq,15\ minute}$ by between 1 and 5 dBA for greater than 25% of the properties (Appendix C).

Cumulative Noise Emissions

The Continuation of Boggabri Coal Mine and Maules Creek Coal Project are not yet approved projects, however, they were conservatively assessed as cumulative noise sources (Appendix C).

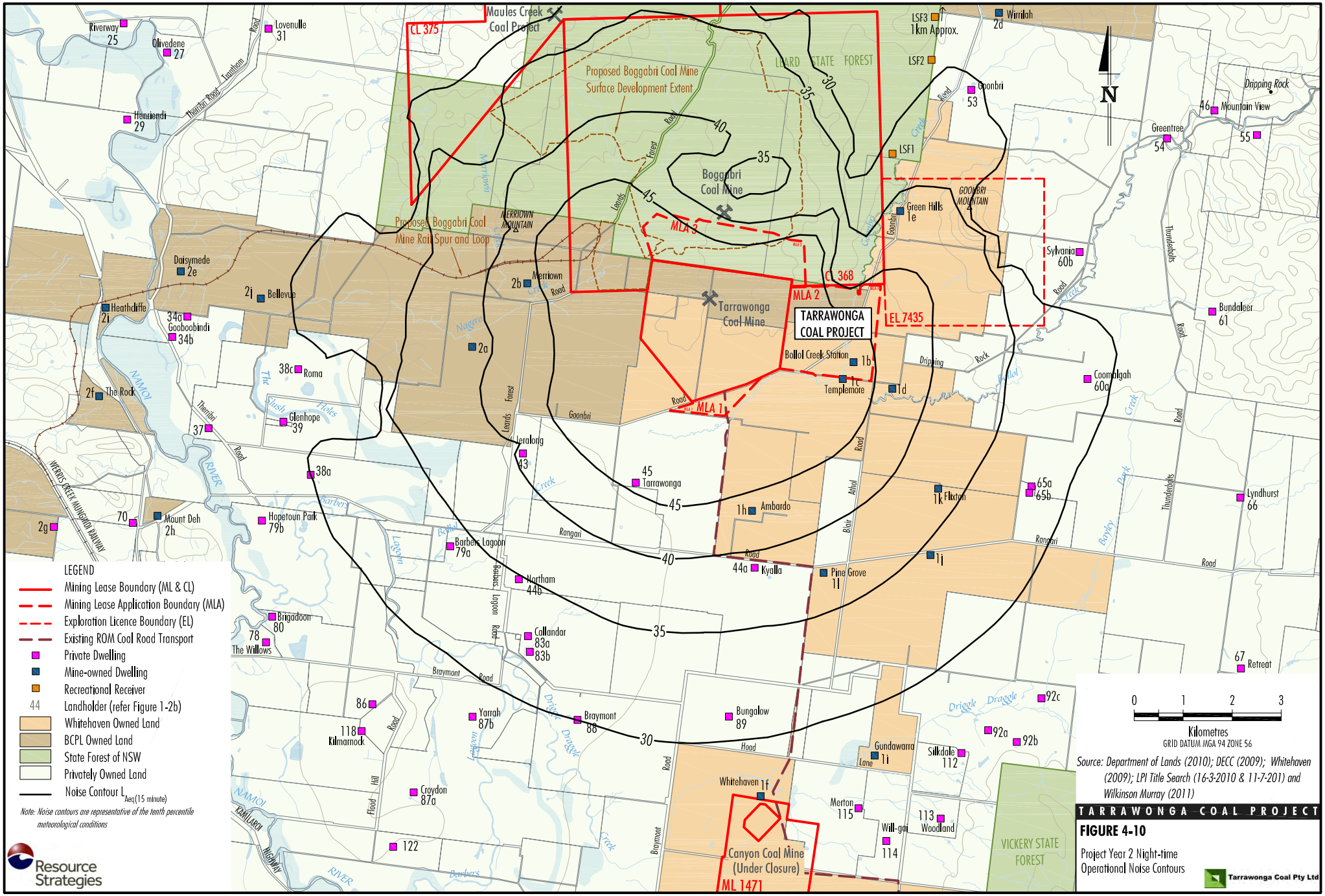
Cumulative noise impacts resulting from the concurrent operation of the Project, Continuation of Boggabri Coal Mine and the Maules Creek Coal Project were assessed against the INP recommended acceptable and recommended maximum amenity criteria.

The methodology used for cumulative assessment was to logarithmically add the respective noise predictions for the three projects and compare the results for each receiver against the INP amenity criteria.

This assessment focussed on night-time noise levels. This was because Project noise levels are predicted to be most pronounced in this period, and consequently the Project has the highest potential to contribute to cumulative noise levels (Appendix C).

The assessment indicated that cumulative noise levels resulting from the concurrent operation of the Project, Continuation of Boggabri Coal Mine and Maules Creek Coal Project would comply with the night-time recommended maximum amenity criterion (45 dBA) at all receivers and with the night-time recommended acceptable amenity criterion (40 dBA) for all but two privately-owned receivers. Cumulative exceedances of this criterion are predicted at receiver 43 (Suey) (1 dBA exceedance) and receiver 45 (McGregor) (5 dBA exceedance) (Appendix C).

Receivers 43 (Suey) and 45 (McGregor) are identified as falling within the Project's noise affectation zone and are also within the Continuation of Boggabri Coal Mine's noise affectation zone (Appendix C).



Source: Department of Lands (2010); DECC (2009); Whitehaven (2009); LPI Title Search (16-3-2010 & 11-7-201) and Wilkinson Murray (2011)

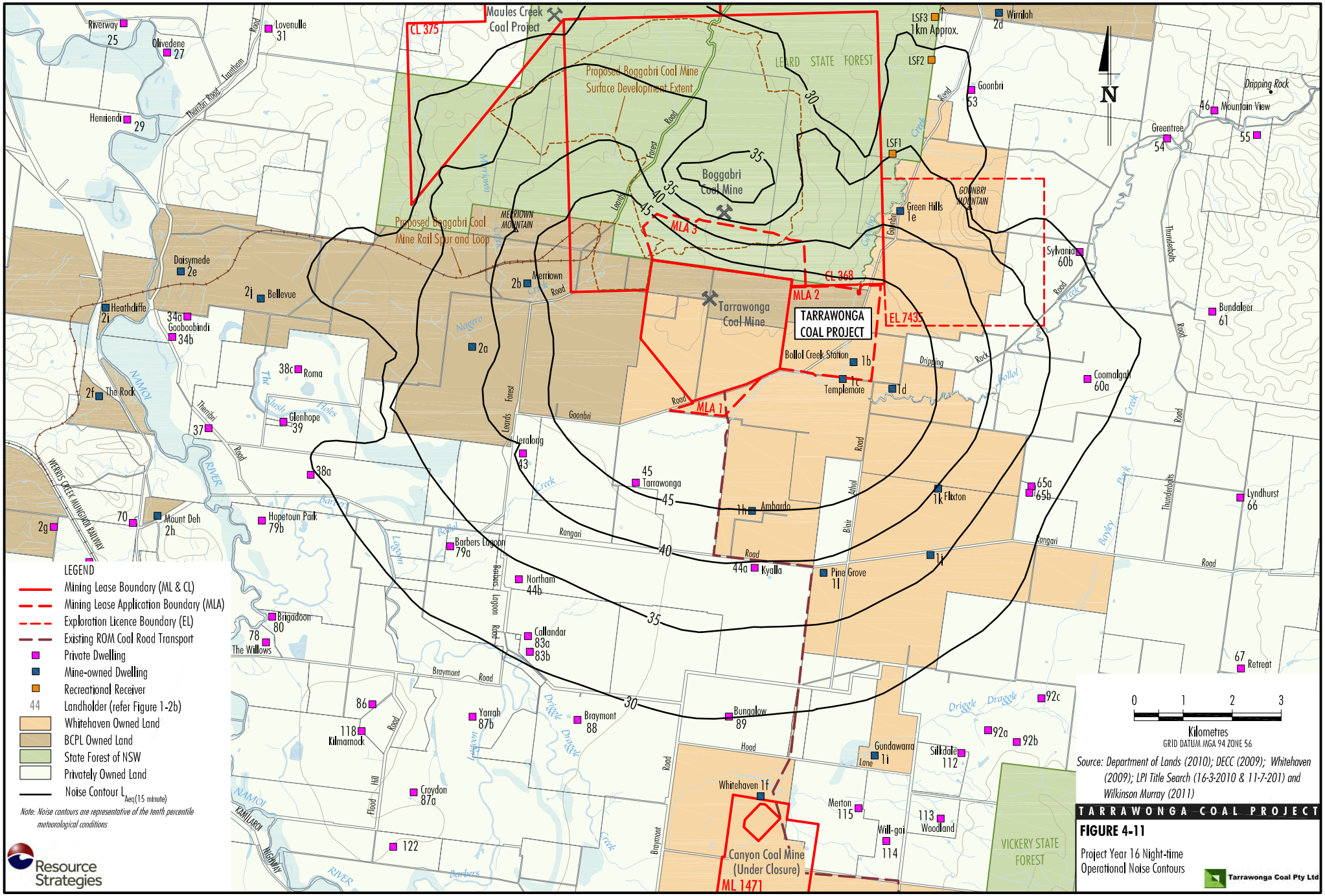
TARRAWONGA COAL PROJECT

FIGURE 4-10

Project Year 2 Night-time Operational Noise Contours

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_Sect4_118D



LEGEND

- Mining Lease Boundary (ML & CL)
- Mining Lease Application Boundary (MLA)
- Exploration Licence Boundary (EL)
- Existing ROM Coal Road Transport
- Private Dwelling
- Mine-owned Dwelling
- Recreational Receiver
- 44 Landholder (refer Figure 1-2b)
- Whitehaven Owned Land
- BCPL Owned Land
- State Forest of NSW
- Privately Owned Land
- Noise Contour $L_{Aeq(15\ minute)}$

Note: Noise contours are representative of the tenth percentile meteorological conditions

Resource Strategies

0 1 2 3

Kilometres

GRID DATUM MGA 94 ZONE 56

Source: Department of Lands (2010); DECC (2009); Whitehaven (2009); LPI Title Search (16-3-2010 & 11-7-201) and Wilkinson Murray (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-11

Project Year 16 Night-time Operational Noise Contours

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_Sect4_119E

Construction Noise

Assessment of the potential for noise impacts from daytime construction of the permanent Goonbri Creek alignment, associated flood bund and low permeability barrier, indicated that no receiver would be either 'highly noise affected' or 'noise affected' as defined in the *Interim Construction Noise Guideline* (DECC, 2009) (Appendix C).

In practice, noise resulting from construction of these structures would be largely indistinguishable from operational noise emissions of the Project. Wilkinson Murray (2011), therefore, conservatively summed construction noise emissions from these activities with daytime operational noise predictions for Year 16. No exceedances of the daytime 35 dBA $L_{Aeq,15\ minute}$ operational noise criterion would occur when predicted construction noise emissions are added to Year 16 daytime operational noise predictions (Appendix C).

Road Traffic Noise

Road Noise Criteria

Road traffic noise along public roads has been assessed in accordance with the ECRTN which establishes criteria for the assessment of road noise in NSW (Appendix C). These criteria are provided in Table 4-15.

Generally, traffic noise levels along the existing sized ROM coal haulage route would reduce due to the cessation of sized ROM coal road transport to the Whitehaven CHPP once approvals and upgrades are in place for the transfer of Project ROM coal to the Boggabri Coal Mine Infrastructure Facilities (Appendix C).

Predicted Road Noise Emissions

Key sections of Rangari Road, Blue Vale Road and the Kamilaroi Highway were selected for assessment due to the higher proportion of Project-related traffic on these roads (Appendix C).

For each section, the methodology for assessment was to calculate existing traffic road noise levels and road noise levels in Project Years 1, 4 and 17 at the closest receiver, and then compare these noise levels with the relevant ECRTN criteria. In summary, the following sections of road were assessed (ECRTN road designation provided in parentheses) (Appendix C):

- Rangari Road along the ROM Coal Road Transport Route (collector road);
- Blue Vale Road south of Shannon Harbour Road (collector road);
- Blue Vale Road north-east of Kamilaroi Highway (collector road);
- Kamilaroi Highway between Blue Vale Road and Whitehaven CHPP (arterial road); and
- Kamilaroi Highway south of Rangari Road (arterial road).

The road noise assessment indicates that the closest receivers to these sections of road achieve the relevant ECRTN criteria for the existing traffic and all assessed Project traffic scenarios (Appendix C)

Table 4-15
Relevant Criteria for Road Traffic Noise – Residences

Type of Development	Noise Level Criterion		Where Criteria are already Exceeded
	Day (7.00 am-10.00 pm)	Night (10.00 pm-7.00 am)	
Land use developments with potential to create additional traffic on existing arterial roads (or sub-arterial roads)	$L_{Aeq,15\ hour}$ 60 dBA	$L_{Aeq,9\ hour}$ 55 dBA	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB.
Land use developments with potential to create additional traffic on existing local road	$L_{Aeq,1\ hour}$ 55 dBA	$L_{Aeq,1\ hour}$ 50 dBA	Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies.
Land use developments with potential to create additional traffic on existing collector road	$L_{Aeq,1\ hour}$ 60 dBA	$L_{Aeq,1\ hour}$ 55 dBA	

Source: Appendix C.

Rail Noise

Project product coal would be transported via rail from the Boggabri Coal Mine rail loop once approvals and upgrades are in place for the transfer of Project ROM coal to the Boggabri Coal Mine Infrastructure Facilities (Section 2.8.2). Consequently, a rail noise assessment was undertaken for the Werris Creek Mungindi Railway (Appendix C).

Rail Noise Criteria

The OEH's rail noise assessment trigger levels are presented in Table 4-16. An assessment of rail noise impacts against the ARTC's EPL is presented in Appendix C.

Table 4-16
Werris Creek Mungindi Railway Noise Assessment Trigger Levels

Descriptor	Rail Traffic Goal
$L_{Aeq,24\ hour}$	60 dBA
Maximum Pass-by L_{Amax} (95^{th} percentile)	85 dBA

Source: Appendix C.

Predicted Rail Noise Emissions

A rail noise assessment was conducted in accordance with OEH requirements for rail traffic-generating development (OEH, 2011a). The rail noise assessment focuses on the Werris Creek Mungindi Railway between the Boggabri rail spur and Werris Creek (Appendix C).

Using data on existing, approved and proposed train movements, Wilkinson Murray (2011) modelled cumulative train movements and the distance from the rail line at which OEH trigger levels would be exceeded using predicted energy average L_{Aeq} and sound exposure level noise levels from the RailCorp NSW standard rail noise database for passenger trains, locomotives and freight wagons.

The results of modelling indicated that increases in rail noise due to the Project would be minor and less than 2 dBA for relevant sections of the Werris Creek Mungindi Railway. The distance from the rail line at which the relevant OEH trigger levels would be met would increase by a negligible 2 m as a result of the additional four Project train movements per day between the Boggabri rail spur and Werris Creek (Appendix C).

In addition, the L_{Amax} passby noise levels would not change due to the Project (Appendix C).

Blasting

Blasting Criteria

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria generally means that the potential to cause structural damage to buildings is minimal.

The OEH adopts the ANZECC (1990) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* for assessing potential annoyance from blast emissions during daytime hours, as follows:

- The recommended maximum level for airblast is 115 dBL.
- The level of 115 dBL may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dBL at any time.
- The recommended maximum for ground vibration is 5 mm/s, PVS vibration velocity.
- The PVS level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* provides guidance in assessing blast-induced ground (and structural) vibration and airblast effects on buildings and their occupants. In relation to building damage airblast criteria, AS 2187 recommends a maximum airblast of 133 decibels (dB) (peak linear [pkLinear]). In accordance with AS 2187, Wilkinson Murray (2011) also adopted 10 mm/s as the building damage vibration criterion.

Predicted Blasting Emissions

Blast sizes would typically be in the range of:

- intermediate interburden blasts with a MIC of approximately 1,365 kg; and
- deep overburden/interburden blasts with an MIC of approximately 2,275 kg.

Appendix C predicts that no exceedances of relevant airblast or vibration criteria (described above) would occur at any privately-owned residences. Marginal exceedance of the structural damage vibration criteria is predicted at the mine-owned receiver 1d (Figure 4-10).

A survey marker tree of potential local heritage significance (Section 4.14.2) is located near receiver 1d (Figure 4-10). Blasting emissions at this location are predicted to marginally exceed the building damage vibration criterion of 10 mm/s. It is noted however that, generally speaking, trees are less susceptible to blast vibration damage than buildings (Appendix C).

Based on the proposed construction methodology for the low permeability barrier (i.e. soil-bentonite mixture), and in the context of predicted blasting emissions, it is expected that the barrier would perform similar to an earthen fill structure (e.g. embankment), providing a flexible (elastic/plastic) structure at the typically low strains exerted from blasting, particularly at distances greater than 100 m (Allan Watson Associates, pers. comm., 2012).

Flyrock

Flyrock is any material ejected from the blast site by the force of the blast. Flyrock is managed by appropriate blast design and execution in accordance with the Blast Management Plan.

4.6.3 Mitigation Measures, Management and Monitoring

Noise and blasting mitigation and management measures for the existing Tarrawonga Coal Mine are described in the Noise Management Plan and the Blast Management Plan (Section 4.6.1). These plans would be reviewed and updated to address the Project, subject to the conditions of any Project Approval.

Noise Mitigation Measures

As described in Section 4.6.2, the private receivers where noise emissions are predicted to exceed the Project-specific criteria can be divided into a Noise Management Zone and a Noise Affectation Zone (Table 4-13). Proposed management procedures for receivers in these zones are described below.

Noise Management Zone

Depending on the degree of exceedance of the Project-specific criteria, potential noise impacts in the Noise Management Zone could range from marginal to moderate (in terms of the perceived noise level increase). In addition to the noise mitigation measures included in the predictive modelling, noise management procedures would include:

- noise monitoring on-site and within the vicinity of the mine;
- prompt response to any community concerns or complaints;
- refinement of on-site noise mitigation measures and operating procedures where practicable; and
- implementation of reasonable and feasible acoustical mitigation at receivers (which may include measures such as enhanced glazing, insulation and/or air-conditioning), in consultation with the relevant landowner, where noise monitoring shows noise levels which are 3 to 5 dBA above Project-specific noise criteria.

Noise Affectation Zone

Exposure to noise levels greater than 5 dBA above Project-specific criteria may be considered unacceptable by some landowners. Management procedures for the Noise Affectation Zone would include:

- discussions with relevant landowners to identify and assess any concerns or complaints;
- implementation of reasonable and feasible acoustical mitigation at receivers (which may include measures such as enhanced glazing, insulation and/or air-conditioning), in consultation with the relevant landowner, where noise monitoring shows noise levels from the mine which are greater than 5 dBA above Project-specific noise criteria; and
- negotiated agreements with landowners where required.

The Noise Management Plan would be revised for the Project to include the following:

- The Project feasible and reasonable noise mitigation and operational management measures (Section 4.6.2).
- Revised private locations for continuous operational noise monitoring to assist with noise management and operator attended compliance monitoring as mining progresses.
- Details of triggers for the Project real-time monitoring and management system. As described in Section 4.6.1 and the Noise Management Plan (TCPL, 2011b), this would include trigger-based protocols incorporating review of prevailing weather conditions, identification of on-site noise sources responsible for elevated noise levels and shut-down of relevant sources, where necessary, to achieve the relevant noise criteria.

- Methodology for measuring temperature inversions, including direct measurement of temperature lapse rate.

TCPL also proposes to establish, in co-operation with BCPL and the Maules Creek Coal Project, a cumulative impact monitoring program comprising a real-time monitoring network.

Blasting Mitigation Measures

The existing Blast Management Plan would be revised for the Project to include the following:

- Safety control measures and notification/closure procedures in relation to blasting within 500 m of Goonbri Road.
- Procedures for the management of livestock in close proximity to blast events.
- Blast controls and/or blast optimisation measures for use later in the Project life to minimise potential impacts on the low permeability barrier. As described in Section 2.10.3, the final design of the low permeability barrier would consider the potential impacts of blasting on the consolidation of the soil-bentonite mixture and the subsequent differential settlement to the adjacent geological sequences/interfaces and keying-in of the cut-off barrier.
- Extension of the blast notification list to include any new landowners within 2 km of Project blasting areas.

Blast management measures that relate to blasting fumes are provided in Section 4.7.3.

4.7 AIR QUALITY

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by PAEHolmes (2012) and is presented as Appendix D. The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) (DEC, 2005b).

A description of the existing environment relating to air quality is provided in Section 4.7.1. Section 4.7.2 describes the potential impacts of the Project, and Section 4.7.3 outlines air quality mitigation, management and monitoring measures.

Project greenhouse gas emissions are discussed in Section 4.8.

4.7.1 Existing Environment

Air Quality Management Regime

Air quality mitigation and management measures currently employed at the Tarrawonga Coal Mine are described in the Air Quality and Greenhouse Gas Management Plan (TCPL, 2011d). The Air Quality and Greenhouse Gas Management Plan includes management and mitigation measures, air quality monitoring requirements and a complaints response protocol. Existing key air quality management and mitigation measures are provided in Table 4-17.

Six complaints relating to air quality were received by TCPL between May 2006 and April 2009. Of these, five were received from the occupant of a single residence which has subsequently been purchased by Whitehaven.

No complaints regarding air quality were received by TCPL during the 2008/2009 or 2009/2010 AEMR reporting periods (Appendix D).

During the 2010/2011 AEMR period (up to April 2011) one complaint was received. Between April and August 2011, a further four complaints were received, with three of these complaints from a single residence to the east of the Project.

Air Quality Criteria

Concentrations of Suspended Particulate Matter

The Project mining activities described in Section 2 have the potential to generate particulate matter (i.e. dust) emissions in the form of:

- total suspended particulate matter (TSP); and
- particulate matter with an equivalent aerodynamic diameter of 10 micrometres (μm) or less (PM_{10}) (a subset of TSP).

Exposure to suspended particulate matter can result in adverse health impacts. The likely risk of these impacts to a person depends on a range of factors including the size, chemical composition and concentration of the particulate matter, and the existing health of the person (NSW Health and NSW Minerals Council, 2011).

Table 4-17
Existing Tarrawonga Coal Mine Air Quality Mitigation and Management Measures

Emission Source	Mitigation Measures
Vegetation Clearing and Soil Stripping	• Where practicable, soil stripping is undertaken at a time when there is sufficient soil moisture to prevent significant dust lift-off. • Stripping of soil is avoided in periods of high winds. • Dust suppression by water application is used to increase soil moisture if stripping occurs during periods of high wind or low soil moisture
Drilling and Blasting Activities	• Drill rigs use water injection or alternatively, are fitted with dust collectors. • Blast hole stemming is used to prevent venting of explosion gases. • Blasting is conducted both before the establishment, and after the break-up of low-level atmospheric temperature inversions.
Overburden Ripping and Coal Mining	• Ripping of softer overburden material is avoided during periods of high wind. • Low moisture coal is sprayed with water prior to excavation to raise moisture content to greater than 5.5%.
Internal Road and Hardstand Area Construction	• Clearing ahead of construction activities is minimised. • Cleared areas are watered regularly during any construction activities, where appropriate.
Coal Processing Area	• Water is applied to the coal at the feed hopper, crusher and at all conveyor transfer and discharge points. • All conveyors are fitted with appropriate cleaning and collection devices to minimise the amount of material falling from the return of conveyor belts. • Some flexibility exists to temporarily cease operation in the event of protracted dry periods, high winds, or significant dust generation and dispersal towards the surrounding residences. • Trucks transporting coal offsite from the Coal Processing Area must be covered immediately after loading to prevent windblown emissions and spillage. The covering must be maintained until immediately before unloading the trucks (as per Condition O3.2 of EPL 12365).
Wind Erosion Management	• The extent of clearing/site preparation in advance of mining is minimised. • Progressive rehabilitation of areas of disturbance, including topsoil and subsoil stockpiles is undertaken. • Bund walls and windbreaks are constructed as required.
Internal Transport	• The road for the transportation of coal product between the mine facilities area and mine entrance is sealed. • Internal roads are regularly watered. • Earthmoving equipment and on-site vehicles: – are fitted with exhaust controls which satisfy OEH engine emission requirements; and – have the exhausts directed upwards or to the side (where applicable) so as not to cause dust lift-off.

Source: TCPL (2011d).

OEH assessment criteria are generally based on thresholds relating to human health effects. These criteria have been developed to a large extent in urban areas, where the primary pollutants are the products of combustion, which are more harmful to human health than particulates of crustal origin, such as particulate matter from mining operations (Appendix D).

Relevant health based air quality criteria (i.e. they are set at levels to reduce the risk of adverse health effects) for particulate matter concentrations, as specified by the OEH in the Approved Methods (DEC, 2005b), are provided in Table 4-18.

Table 4-18
OEH Criteria for Particulate Matter Concentrations

Pollutant	Averaging Period	Criteria
TSP	Annual mean	90 µg/m^3
PM_{10}	24-hour maximum[1]	50 µg/m^3
	Annual mean	30 µg/m^3

Source: After Appendix D.

µg/m^3 = micrograms per cubic metre.

[1] The 50 µg/m^3 24-hour maximum PM_{10} criteria are cumulative (i.e. include background concentrations but exclude regional dust events such as bushfires) in the Development Consent (DA-88-4-2005), however property acquisition criteria in the Development Consent are specifically Project-only.

As there are no criteria for particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$) in NSW and $PM_{2.5}$ assessment is not required by the EARs, no assessment of $PM_{2.5}$ is required (Appendix D).

Dust Deposition

Particulate matter has the potential to cause nuisance (amenity) effects when it is deposited on surfaces.

The amenity criteria for the maximum increase in dust deposition and maximum total dust deposition, as specified by the OEH in the Approved Methods (DEC, 2005b) are provided in Table 4-19.

Table 4-19
OEH Criteria for Dust (Insoluble Solids) Deposition

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level (g/m^2/month)	Maximum Total Deposited Dust Level (g/m^2/month)
Deposited dust	Annual	2	4

Source: After Appendix D.

g/m^2/month = grams per square metre per month.

Existing Air Quality

PM_{10}

Long-term PM_{10} monitoring data have been collected by the Tarrawonga and Boggabri Coal Mines at two locations (Figure 4-9) using high volume air samplers (HVASs). The monitoring captures particulate matter from sources including current mining operations, other localised particulate matter sources (e.g. vehicles using unsealed roads, stock movements, cropping and exposed areas) and regional particulate matter sources (e.g. bushfires and dust storms).

Recorded annual average PM_{10} concentrations in the period 2007 to 2011 are provided in Table 4-20.

Table 4-20
Annual average PM_{10} Concentrations (µg/m^3)

HVAS	Year				
	2007	2008	2009	2010	2011
Tarrawonga Coal Mine	16	13	21	13	14[1]
Boggabri Coal Mine	14[2]	11	20	12	13.5[3]

Source: After Appendix D.

[1] Data available until June 2011.

[2] Data available from July 2007.

[3] Data available until July 2011.

The annual average PM_{10} concentrations increased in 2009 at both the Tarrawonga and Boggabri Coal Mines, and decreased in 2010. The similar pattern seen at both sites suggests that the increased annual average PM_{10} concentration in 2009 is likely to be a result of external factors (i.e. dry conditions that prevailed during 2009) as opposed to increased emissions from mining activities (Appendix D). The annual average PM_{10} concentrations shown in Table 4-20 are well below the OEH criteria of 30 µg/m^3.

In addition, the Maules Creek Coal Project has measured PM_{10} concentrations using a HVAS between November 2010 and September 2011. The average PM_{10} concentration recorded at the Maules Creek Coal Project during this period was 11 $\mu g/m^3$ (Appendix D).

There have been five elevated recordings above the OEH 24-hour average PM_{10} criterion recorded by the Tarrawonga Coal Mine HVAS. Four recordings occurred between September and December 2009, a period when a number of dust storms were experienced across NSW (Appendix D). The maximum 24-hour average PM_{10} concentration recorded was 97 $\mu g/m^3$ on 8 December 2009. This event coincided with a regional bushfire in the Kelvin Range to the east of the Tarrawonga Coal Mine (Appendix D).

TSP

There are no TSP data collected in the vicinity of the Project. Studies indicate that in regions of mining activity, approximately 40% of the TSP is PM_{10} (Appendix D). This relationship has been used to determine TSP levels for this assessment.

Dust Deposition

The Tarrawonga and Boggabri Coal Mines dust deposition monitoring networks consist of 13 and 15 dust deposition gauges, respectively (Figure 4-9). A summary of the dust deposition data collected from the gauges between 2005 and 2011 is provided in Table 4-21.

A number of Tarrawonga Coal Mine dust gauges including EB-8, EB-11, EB-14 and EB-15 are located within ML 1579 (Figure 4-9). In particular, EB-15 has exhibited elevated dust deposition levels over the last three years. These gauges are often in close proximity to active mining operations, therefore these data provide diagnostic data only and are not indicative of dust deposition levels in the wider area (Appendix D).

Site EB-13 exhibits consistently higher dust deposition levels relative to the adjacent sites EB-4 and EB-5 (Figure 4-9). This is likely to be due to a localised particulate matter source on the Bollol Creek Station property, rather than a larger scale effect (Appendix D).

Dust deposition levels have also been recorded at the Maules Creek Coal Project at four locations between October 2010 and September 2011. Results from the Maules Creek Coal Project dust monitoring indicate annual average dust deposition levels of 1.0 to 2.2 g/m^2/month (Appendix D).

Background Air Quality for Assessment Purposes

The assessment of Project and cumulative annual average air quality impacts requires background particulate matter concentrations and dust deposition levels to be defined. The proximity of local dust gauges and HVASs to existing mining operations means that the recorded air quality data includes particulate and dust contributions from the existing Tarrawonga and Boggabri Coal Mines (Appendix D).

Use of data from the existing Tarrawonga and Boggabri Coal Mines, therefore, has the potential to result in double-counting of Project and cumulative emissions. Therefore, background levels excluding mine contributions have been estimated from available data to minimise the potential for double-counting, whilst still providing conservative background levels for assessment purposes (Appendix D).

The PM_{10} concentration average for the Tarrawonga and Boggabri Coal Mines HVASs (all years) is approximately 14.8 $\mu g/m^3$. As described above, the average PM_{10} concentration recorded at the Maules Creek Coal Project to date is 11 $\mu g/m^3$.

For assessment of annual-average PM_{10}, a background concentration of 12 $\mu g/m^3$ has been selected to represent local and regional particulate matter sources (other than local mining activities) as it is close to the combined annual average PM_{10} concentrations measured at the Tarrawonga Coal Mine and Boggabri Coal Mine HVASs and is higher than levels recorded at the Maules Creek Coal Project (which is not currently influenced by mining operations) to date.

TSP concentrations have been calculated from this level (using the established 40% relationship between PM_{10} and TSP) and a background TSP concentration of 30 $\mu g/m^3$ has been adopted (Appendix D).

The dust deposition average for the Tarrawonga Coal Mine and Boggabri Coal Mine sites (all years) is approximately 2.6 g/m^2/month. This level reduces to 2.1 g/m^2/month when sites EB-15 (which is located in ML 1579 in close proximity to the Northern Emplacement) and EB-13 (which exhibits dust levels consistently higher than the adjacent EB-5 and EB-4) are excluded.

Table 4-21
Annual Average Dust Deposition (Insoluble Solids) Levels (g/m^2/month)[1]

	Dust Gauge	Year						
		2005	2006	2007	2008	2009	2010	2011[2]
Tarrawonga Coal Mine	EB-3[3]	-	1.6	2.6	**4.2**	-	-	-
	EB-4	1.4	1.4	1.4	2.0	3.2	2.6	**5.7**
	EB-5	**5.8**	1.6	2.2	2.3	**4.4**	2.9	3.4
	EB-6	1.3	1.1	1.0	1.3	2.1	1.0	0.7
	EB-7	0.8	1.1	1.1	1.2	2.3	1.0	0.7
	EB-8	1.3	1.0	1.1	2.5	**4.7**	2.1	**4.1**
	EB-9	1.2	0.9	1.2	1.0	2.3	0.8	0.6
	EB-10	-	-	1.0	2.9	3.1	**4.5**	1.8
	EB-11	-	-	1.4	1.4	3.2	2.0	1.8
	EB-12	-	-	1.0	1.7	3.1	2.1	1.3
	EB-13	-	-	-	**12.9**	**7.3**	**4.7**	2.3
	EB-14	-	-	-	2.7	**4.8**	3.3	1.6
	EB-15	-	-	-	2.7	**6.5**	**4.3**	**4.7**
	EB-16	-	-	-	-	-	1.6	1.6
Boggabri Coal Mine	D1	0.7	0.9	1.8	2.6	2.6	**4.3**	1.4
	D2	0.7	1.5	2.0	2.4	2.1	2.7	1.4
	D3	2.1	1.6	2.9	**5.6**	**4.1**	**9.1**	**5.5**
	D4	2.2	1.5	2.3	3.9	2.2	2.9	**4.2**
	D5	1.4	1.3	1.7	1.4	2.2	0.8	0.9
	D6	1.5	1.0	1.7	1.9	2.6	0.9	1.1
	D7	0.8	1.2	1.5	1.6	2.4	0.8	1.0
	D8	1.1	1.1	1.3	1.2	2.0	0.9	1.1
	D9	1.1	1.3	1.0	2.3	2.3	1.5	**4.4**
	D10	1.1	0.8	1.1	1.1	2.0	0.4	0.5
	D11	1.5	1.2	1.0	1.4	2.6	0.7	0.4
	D12	1.1	1.6	1.9	2.9	**4.8**	**5.0**	1.6
	D13	1.5	1.8	2.2	2.4	2.9	1.6	0.4
	D14	0.9	0.9	1.6	**7.4**	**4.7**	**5.7**	1.0
	D15	-	-	-	1.1	**22.4**	1.1	1.8

Source: After Appendix D.

Notes: Bolded values exceed OEH criteria of 4 g/m²/month.

[1] Reported contaminated results have been removed from the annual averages.

[2] Data available until June/July 2011.

[3] EB-3 discontinued, and is not shown on Figure 4-9.

A background dust deposition level of 2 g/m^2/month has, therefore, been adopted for assessment. This level is close to the average of Tarrawonga Coal Mine and Boggabri Coal Mine sites (when excluding the two sites with anomalously high levels), and is higher than the majority of records at the Maules Creek Coal Project to date (Appendix D).

In summary, for the purposes of assessing Project and cumulative impacts, PAEHolmes (2012) has assumed the following background air quality concentrations/levels for sources other than local mining activity:

- annual average PM_{10} concentration of 12 µg/m³;
- annual average TSP concentration of 30 µg/m³; and
- annual average dust deposition of 2 g/m²/month.

4.7.2 Potential Impacts

Assessment Methodology

Modelling Scenarios

Potential air quality impacts were assessed for Years 2, 4, 6 and 16 of the Project. These years were chosen to account for potential worst case impacts at any particular residential receiver, based on the following:

- Project Year 2 (Figure 2-4) – which represents the first year that the Project reaches the maximum ROM coal production, mining operations in the western Project area and considers waste rock emplacement works on the Southern Emplacement.
- Project Year 4 (Figure 2-5) – is equivalent to the maximum year of production at the Continuation of Boggabri Coal Mine (BCPL, 2010), and has been included in consideration of potential cumulative impacts.
- Project Year 6 (Figure 2-6) – the year of maximum materials (i.e. ROM coal and waste rock combined) movements.
- Project Year 16 (Figure 2-8) – represents mining operations in the eastern Project area.

Emission Inventories

Emission inventories were prepared for Years 2, 4, 6 and 16 in consideration of the anticipated mining activities for each year, including ROM coal extraction, waste rock removal rates, haul road distances and routes, stockpile and pit areas and equipment operating hours. The major emission sources were associated with the following activities (Appendix D):

- hauling of waste rock and ROM coal in trucks on unpaved roads;
- dozer operations;
- wind erosion of exposed areas; and
- loading/unloading of ROM coal.

Potential emissions associated with the handling, processing and transportation of coal from the Project at the upgraded Boggabri Coal Mine Infrastructure Facilities were also conservatively included in the Project emissions inventories.

Comparison with Best Practice Mitigation Measures

For each source of emissions identified in the Project emissions inventories, existing mitigation measures employed at the Tarrawonga Coal Mine (Table 4-17) were benchmarked against best practice mitigation measures described in the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone Environmental, 2011).

For the majority of emission sources, best practice mitigation measures are currently employed at the Tarrawonga Coal Mine.

Preliminary modelling indicated that of the potential dust sources on-site, emission from the haulage of waste rock and ROM coal contributes more than any other source group to short-term PM_{10} impacts at the closest residential receivers. Therefore, the key additional best practice mitigation measure identified for the Project was additional water application and/or the application of chemical dust suppressants on haul roads to achieve 90% control of these emissions. This additional Project mitigation measure was included in the dispersion modelling.

Appendix D shows that 90% control can be achieved through the application of water, provided the moisture content of the surface material is approximately 8%. Alternatively, chemical dust suppressants would be used to achieve 90% control (Appendix D).

Dispersion Modelling

The CALMET/CALPUFF modelling system was used by PAEHolmes to assess potential air quality impacts associated with the Project. CALPUFF is a multi-layer, non-steady state puff dispersion model that is approved by the OEH (DEC, 2005b) and endorsed by the United States Environmental Protection Agency.

CALMET is a meteorological pre-processor that produces the three-dimensional meteorological fields that are used in the CALPUFF dispersion model. Observed hourly meteorological data from the Tarrawonga Coal Mine AWS, Boggabri Coal Mine AWS, Maules Creek AWS, and the BoM site located at Narrabri Airport were used as input for CALMET.

Cumulative Impacts

Cumulative impacts associated with the Continuation of Boggabri Coal Mine and the Maules Creek Coal Project were conservatively included in the air quality assessment (Appendix D), even though these projects have not yet been approved.

The cumulative assessment considers emissions from the Project, the Continuation of Boggabri Coal Mine and the Maules Creek Coal Project, and the background levels in the absence of these mining operations (Section 4.7.1).

Potential Project Only Impacts

No exceedance of the OEH criteria was predicted at any privately owned residence for the Project Years 2, 4, 6 and 16 for PM_{10} concentrations (24-hour average and annual average), TSP concentrations or dust deposition levels (Appendix D).

In addition, no exceedances of the OEH annual average criteria for PM_{10} and TSP concentrations and dust deposition are predicted when accounting for background concentrations and levels (Appendix D).

Figures 4-12 and 4-13 show the predicted maximum Project only 24-hour PM_{10} contours for Years 2 and 16, respectively. Additional air quality contour plots are provided in Appendix D.

Vacant Land

Recent conditions of consent in relation to air quality have included reference to vacant land in air quality criteria. Specifically, vacant land is considered to be affected if greater than 25% of a property is predicted to exceed the impact assessment criteria.

PAEHolmes (2012) has reviewed the relevant air quality contours and land tenure information for the Project. From this review, it is concluded that property 49 (Laird) (Figure 4-9) is likely to be affected by Project-only 24-hour PM_{10} emissions in Year 16 of the Project (i.e. potentially exceeds 50 $\mu g/m^3$ for greater than 25% of the property) (Appendix D). No other potential vacant land air quality impacts have been identified for the Project.

Potential Cumulative Impacts

Annual Average PM_{10}

The annual average PM_{10} concentration at one privately owned receiver 45 (McGregor) is predicted to exceed the OEH annual average criterion (30 $\mu g/m^3$) due to the cumulative contributions from the Project, the Continuation of Boggabri Coal Mine, the Maules Creek Coal Project and background levels.

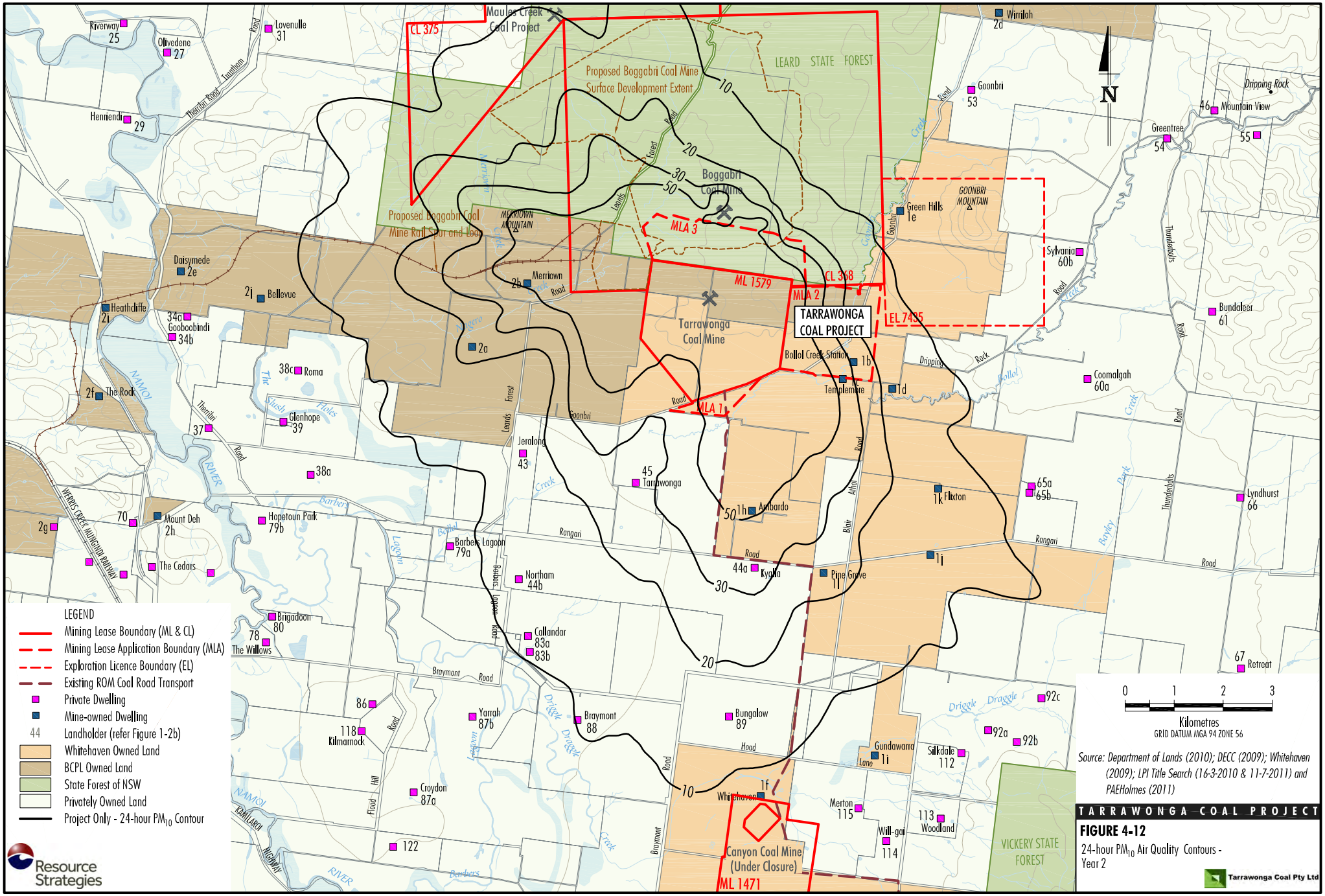
It should be noted that the predicted contribution from the Project (7 $\mu g/m^3$) at this receiver is less than half of the predicted contribution from the Continuation of Boggabri Coal Mine (15 $\mu g/m^3$) (Appendix D).

24-hour Average PM_{10}

Potential cumulative 24-hour PM_{10} impacts have been considered by PAEHolmes (2012) for receivers to the south of the Project.

During winds from the northern quadrant, receivers to the south of the Project would potentially be cumulatively impacted by mining operations from both the Project and the Continuation of Boggabri Coal Mine, given its location to the immediate north of the Project (Appendix D).

The Maules Creek Coal Project would not be a significant contributor to cumulative 24-hour average PM_{10} impacts in the vicinity of the Project, given its location and the observed variation in meteorological conditions (due to topographical effects) between the Project site and the Maules Creek Coal Project site (Appendix D).



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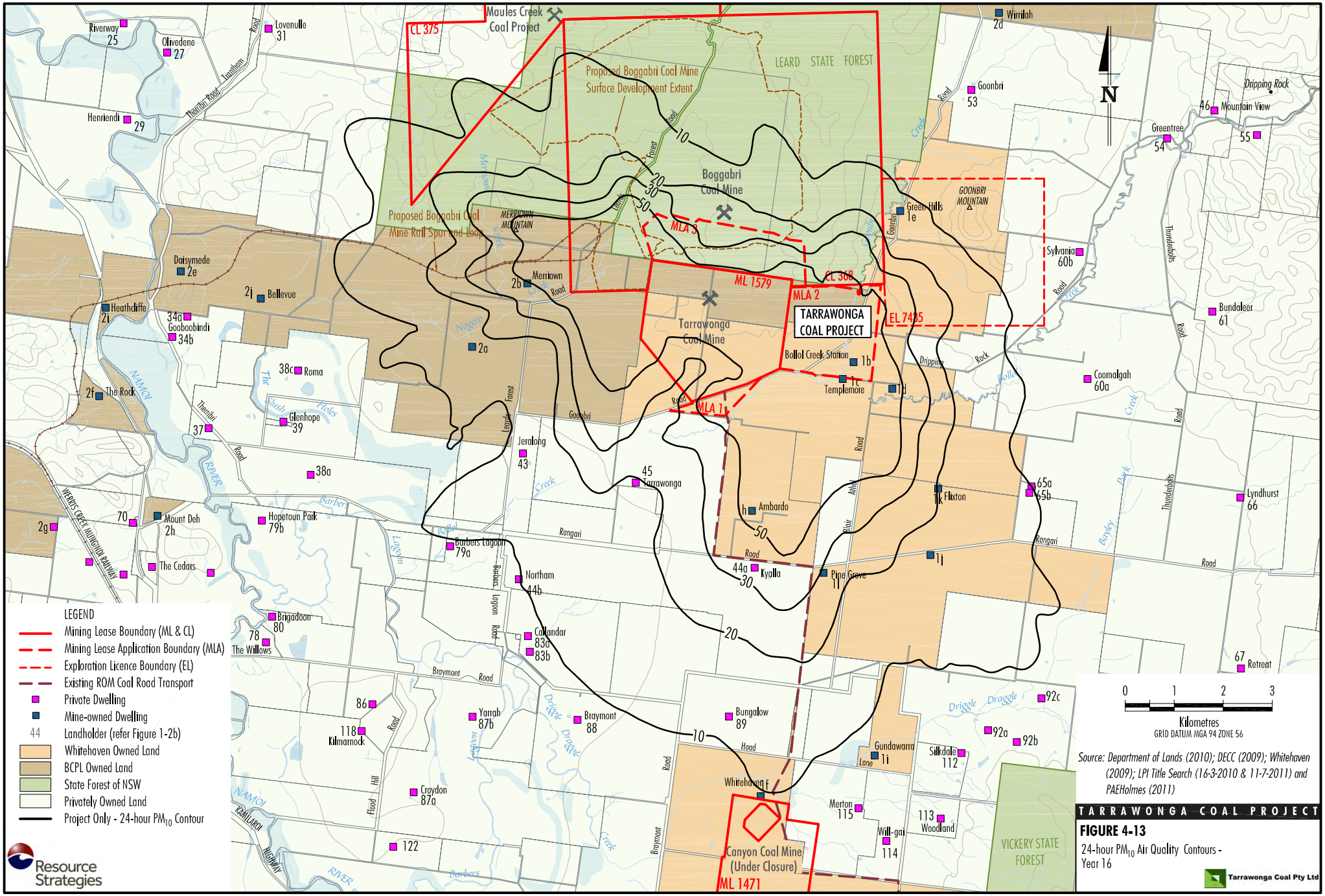


Source: Department of Lands (2010); DECC (2009); Whitehaven (2009); LPI Title Search (16-3-2010 & 11-7-2011) and PAEHolmes (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-13

24-hour PM_{10} Air Quality Contours - Year 16

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_Sect4_116D

This was confirmed by indicative modelling predictions for the Maules Creek Coal Project, which indicated that this Project is not a significant contributor to cumulative impacts at receivers to the south of the Project (Appendix D).

To provide a conservative assessment, the maximum 24-hour PM_{10} concentrations predicted for the Project have been added to the maximum concentrations predicted for the Continuation of Boggabri Coal Mine to predict the potential cumulative impacts for receivers to the south of the Project.

The results indicate (Appendix D):

- receiver 45 (McGregor) exceeds the 50 µg/m³ criterion as a result of the Continuation of Boggabri Coal Mine alone (i.e. this receiver already exceeds the criteria without the Project emissions);
- cumulative impacts would potentially occur at receiver 44a (Crosby) to the south of the Project; and
- cumulative impacts are not expected at receivers located to the south-east and south-west of the Project.

Potential cumulative impacts would also be greatly influenced by elevated background levels due to short-term non-mining events (e.g. bushfires and dust storms). These events cannot be predicted in the medium/long-term, and as such have not been included in the cumulative 24-hour PM_{10} assessment. Statistical analysis of historical data from the Tarrawonga Coal Mine HVAS indicates that the probability of the HVAS recording elevated 24-hour PM_{10} concentrations (greater than 40 µg/m^3) is approximately 4% (Appendix D).

TCPL proposes to contribute to a local network of real-time PM_{10} monitors which would be used to assist with management of potential short-term cumulative PM_{10} impacts (Section 4.7.3).

Annual Average TSP

No exceedance of the OEH annual average TSP criterion (90 µg/m³) is predicted at any privately owned residence due to the cumulative contributions from the Project, the Continuation of Boggabri Coal Mine, the Maules Creek Coal Project and background levels.

Dust Deposition

No exceedance of the OEH maximum total deposited dust level criterion (4 g/m²/month [annual average]) is predicted at any privately owned residence due to the cumulative contributions from the Project, the Continuation of Boggabri Coal Mine, the Maules Creek Coal Project and background levels.

Potential Blasting Fume Emissions

Blasting activities have the potential to result in fugitive fume and particulate matter emissions. Particulate matter emissions from blasting are included in dispersion modelling results and are controlled by adequate stemming of the blast.

Imperfect blasts (e.g. when the explosive product is incorrectly formulated) may result in nitrogen oxide (NO_x) fumes (Australian Explosives Industry and Safety Group Inc., 2011). Measures to minimise or avoid imperfect blasts would be implemented in accordance with *Code of Good Practice: Prevention and Management of Blast Generated NO_x Gases in Surface Blasting* (Australian Explosives Industry and Safety Group Inc., 2011), and these measures would be incorporated into the Project Blast Management Plan (Section 4.7.3).

Potential Construction Impacts

Construction activities would potentially generate particulate matter emissions.

Particulate matter emissions from construction activities would typically be contained to specific areas, and would be of limited duration (Appendix D). Construction dust emissions would be effectively managed through best practice mitigation measures, as described in Section 4.7.3 and Appendix D.

Coal Transport

Prior to the transfer of Project ROM coal to the Boggabri Coal Mine Infrastructure Facilities, sized ROM coal would continue to be transported to the Whitehaven CHPP using covered, on-highway haul trucks. No increase in the currently approved amount of sized ROM coal transported to the Whitehaven CHPP would occur in this period. Potential air quality impacts associated with sized ROM coal haulage were assessed in Richard Heggie Associates (2005), which concluded that on-highway haul trucks travelling on paved roads would not adversely impact air quality at residences close to the haulage route.

Once approvals and upgrades are in place for the transfer of Project ROM coal to the Boggabri Coal Mine Infrastructure Facilities, product coal would be transported by train via the Boggabri Coal Mine private rail spur and Werris Creek Mungindi Railway to the Port of Newcastle.

The Werris Creek Mungindi Railway is owned and operated by the ARTC and it is responsible for any air quality emissions that may arise from coal transportation. The potential for exceedances of the OEH air quality criteria caused by the increased coal train movements from the Project would be low beyond distances of approximately 15 m from the railway (Appendix D).

This issue is the subject of a Pollution Reduction Program in the ARTC's EPL 3142, which aims to determine whether coal trains are a significant contributor to particulate matter emissions at receivers in close proximity to the rail network.

4.7.3 Mitigation Measures, Management and Monitoring

Air quality management measures are currently implemented at the Tarrawonga Coal Mine in accordance with the Air Quality and Greenhouse Gas Management Plan (Section 4.7.1).

The management measures in the Air Quality and Greenhouse Gas Management Plan would be revised and implemented during construction and operation of the Project. This would include the additional best practice mitigation measures identified and included in the air quality assessment (e.g. additional water application and/or the application of chemical dust suppressants on haul roads).

The existing Air Quality and Greenhouse Gas Management Plan would also be updated to include details of the network of real-time particulate matter monitors proposed by TCPL, BCPL and Aston Resources in the vicinity of the Project. These monitors would enable TCPL to pro-actively manage the potential short-term particulate matter emissions from the Project, to prevent or minimise potential impacts at privately-owned receivers to the greatest practical extent.

Although the locations of the real-time monitoring network would be subject to landowner consent and technical considerations, at least one real-time monitor would be located at a privately-owned receiver to the south of the Project. The details of the network would be provided in the revised Air Quality and Greenhouse Gas Management Plan.

In addition, the existing Blast Management Plan would be revised to include measures for the minimisation of fume and particulate matter emissions from Project blasts.

Fume emissions would be managed in accordance with Australian Explosives Industry and Safety Group Inc. (2011). Measures that would be implemented include:

- formulation of explosive products to an appropriate oxygen balance to reduce the likelihood of fumes;
- reviewing geological conditions in the formulation of blast designs;
- minimising the time between drilling and loading, and loading and shooting of the blast; and
- consideration of meteorological conditions in blast scheduling.

4.8 GREENHOUSE GAS EMISSIONS

4.8.1 Quantitative Assessment of Potential Scope 1, 2 and 3 Greenhouse Gas Emissions

A quantitative assessment of Project greenhouse gas emissions is provided in Appendix D. A summary of the assessment is summarised below.

Greenhouse Gas Protocol Emission Scopes

The Greenhouse Gas Protocol (GHG Protocol) (World Business Council for Sustainable Development [WBCSD] and World Resources Institute [WRI], 2004) defines three 'scopes' of emissions (scope 1, scope 2 and scope 3). Scopes 1 and 2 have been defined such that two or more entities would not account for emissions in the same scope.

Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the entity (WBCSD and WRI, 2004). Direct greenhouse gas emissions are those emissions that are principally the result of the following types of activities undertaken by an entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources (e.g. boilers, furnaces, turbines).

- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials (e.g. the manufacture of cement, aluminium, adipic acid and ammonia, or waste processing).
- Transportation of materials, products, waste, and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).
- Fugitive emissions. These emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; hydroflurocarbon emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport) (WBCSD and WRI, 2004).

Scope 2: Electricity Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that accounts for greenhouse gas emissions from the generation of purchased electricity consumed by the entity.

Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity (WBCSD and WRI, 2004). Scope 2 emissions physically occur at the facility where electricity is generated (WBCSD and WRI, 2004). Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as Scope 2.

Scope 3: Other Indirect Greenhouse Gas Emissions

Under the GHG Protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions.

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of Scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services (WBCSD and WRI, 2004).

The GHG Protocol provides that reporting Scope 3 emissions is optional (WBCSD and WRI, 2004). If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and 2. However, the GHG Protocol notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or projects difficult because reporting is voluntary.

Greenhouse Gas Emissions Estimation

Project and Scope 3 greenhouse gas emissions have been estimated by PAEHolmes (2012) using published emission factors from the *National Greenhouse Accounts Factors July 2011* (NGA Factors) (Commonwealth Department of Climate Change and Energy Efficiency [DCCEE], 2011a), where possible. Where NGA emission factors were not available (e.g. for rail transport of product coal) other published emissions factors have been used.

The NGA Factors gives greenhouse gas emission factors for carbon dioxide, methane and nitrous oxide. Emission factors are standardised for each of these greenhouse gases by being expressed as a carbon dioxide equivalent (CO_2-e) based on their Global Warming Potential. This is determined by the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation (e.g. methane has a Global Warming Potential 21 times that of carbon dioxide) (DCCEE, 2011b).

Emissions of carbon dioxide and methane would be the most significant greenhouse gases for the Project (Appendix D).

Project Greenhouse Gas Emissions

A summary of potential Project greenhouse gas emissions sources and their respective scopes is provided in Table 4-22.

The total direct (i.e. Scope 1) emissions over the life of the Project are estimated to be approximately 3.5 Mt CO_2-e, which is an average of approximately 0.2 Mt CO_2-e per annum over the life of the Project (Appendix D).

Annual average Scope 1 emissions would represent approximately 0.03% of Australia's Kyoto Protocol commitment (an average of 591.5 Mt CO_2-e per annum for the period 2008 to 2012) and a very small portion of global greenhouse emissions.

Table 4-22
Summary of Potential Project Greenhouse Gas Emissions

Component	Direct Emissions	Indirect Emissions
	Scope 1	Scope 3
Fugitive Emissions	Emissions from the release of coal seam methane and carbon dioxide as a result of the Project.	N/A
Diesel Consumption	Emissions from the combustion of diesel at the Project.	Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Project.
Explosives Consumption	Emissions from explosives used at the Project.	N/A
Vegetation Clearance	Emissions from vegetation clearance associated with the Project.	N/A
Electricity Consumption for the Processing of Project ROM Coal	N/A	Emissions from the generation of purchased electricity at the Whitehaven CHPP or Boggabri Coal Mine Infrastructure Facilities[1]. Estimated emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed, and the electricity lost in delivery in the transmission and distribution network.
Sized ROM Coal and Product Coal Transport	N/A	Emissions from the combustion of diesel used by the road haulage contractor (ROM coal to the Whitehaven CHPP) and rail haulage contractor (product coal to the Port of Newcastle).
Combustion of Coal	N/A	Emissions from the combustion of product coal from the Project.

Source: After Appendix D.

[1] As electricity for the processing of Project ROM coal would not be purchased by TCPL, these emissions would be scope 3 and not scope 2.

The major source (approximately 65%) of estimated direct greenhouse gas emissions from the Project would be fugitive emissions from coal seams (Appendix D). These emissions were estimated using a state-wide average emission factor sourced from the NGA Factors.

A site specific emission factor was derived for the Maules Creek Coal Project based on measurements of gas content for borehole samples in the same coal seams as those proposed to be mined for the Project (PAEHolmes, 2012), and was 45 times lower than the state-wide average emission factor. As such, fugitive emissions from coal seams for the Project are likely to have been overestimated (Appendix D).

The total indirect emissions (i.e. Scope 3) over the life of the Project are estimated to be approximately 126 Mt CO_2-e, which is an average of approximately 7.4 Mt CO_2-e per annum. Approximately 99.6% of these emissions would be associated with the combustion of product coal by third parties.

Project Greenhouse Gas Emissions Intensity

Using the annual emission calculations, the estimated greenhouse gas emissions intensity of the Project is approximately 0.08 t CO_2-e/t saleable coal (this includes all Scope 1 emissions and the Scope 3 emissions associated with ROM coal processing) (Appendix D).

The estimated emissions intensity of the Project product coal is comparable with the average emissions intensity of existing open cut coal mines in Australia (0.05 t CO_2-e/t saleable coal) (Deslandes, 1999) and the estimated emissions intensity of the Continuation of Boggabri Coal Mine (Appendix D).

Based on state-wide emission factors, fugitive emissions from coal seams are the major contributor to the estimated Project emissions (refer discussion above) and therefore are the major contributor to the estimated emissions intensity of the Project.

If the site specific emission factor determined at the Maules Creek Coal Project was used, the estimated emissions intensity of the Project would be approximately 0.03 t CO_2-e/t saleable coal, which is lower than the average Australian open cut coal mine intensity and comparable with the estimated emissions intensity of the Maules Creek Coal Project (Appendix D).

Potential Impacts of Greenhouse Gas Emissions on the Environment

The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions (Appendix D).

The Project's contribution to Australian and global emissions would be relatively small. Estimated average annual Scope 1 emissions from the Project (0.2 Mt CO_2-e) represent approximately 0.03% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) (Appendix D), and a very small portion of global greenhouse emissions, given Australia contributed approximately 1.5% of global greenhouse gas emissions in 2005 (Commonwealth of Australia, 2011).

Increased greenhouse gas levels have the potential to alter climate variables such as temperature, rainfall and evaporation. Projected changes to climate variables would have associated impacts, including to land, settlements and ecosystems, as described in Section 6.9.2.

4.8.2 Australian Greenhouse Gas Emission Reduction Targets and Proposed Carbon Pricing Mechanism

The potential impacts of greenhouse gas emissions from all Australian sources will be collectively managed at a national level, through initiatives implemented by the Commonwealth Government. The Commonwealth Government has committed to reduce greenhouse gas emissions by between 5 to 25% below 2000 levels by 2020, with the level of reduction dependent on the extent of reduction actions undertaken internationally (Commonwealth of Australia, 2011).

The Federal Opposition has committed to a 5% reduction below 1990 levels by 2020 (Liberal Party of Australia, 2010).

Greenhouse gas emissions from the Project would contribute to Australia's greenhouse gas emissions inventory, and would be considered in these emission reduction targets.

The commitment from the Commonwealth Government to reduce greenhouse gas emissions is proposed to be achieved through the introduction of proposed carbon pricing mechanisms, as detailed in the *Clean Energy Bill, 2011,* which was introduced into Parliament by the Commonwealth Government on 13 September 2011 (Section 6.4.2).

From 1 July 2012, this will involve a fixed price on greenhouse gas emissions, with no cap on Australia's greenhouse gas emissions, or emissions from individual facilities (Commonwealth of Australia, 2011). From 1 July 2015 (i.e. during Project Year 3) an emissions trading scheme is proposed to be implemented. As such, Australia's greenhouse gas emissions, inclusive of emissions associated with the Project, would be capped at a level specified by the Commonwealth Government.

Under the emissions trading scheme, there would be no limit on the level of greenhouse gas emissions from specific individual facilities, with the incentive for facilities to reduce their greenhouse gas emissions driven by the carbon pricing mechanism (Commonwealth of Australia, 2011).

It is expected that the Project would trigger the facility threshold of 25,000 t CO_2-e per annum for participation in the proposed carbon pricing mechanisms. As such, Whitehaven would contribute to Commonwealth revenue generated in the scheme, which is to be used to fund the following initiatives designed to reduce Australia's greenhouse gas emissions (Commonwealth of Australia, 2011):

- $1.2 billion Clean Technology Program to improve energy efficiency in manufacturing industries and support research and development in low-pollution technologies.
- $10 billion Clean Energy Finance Corporation to invest in renewable energy, low-pollution and energy efficiency technologies.
- $946M Biodiversity Fund (over the first six years) to protect biodiverse carbon stores and secure environmental outcomes from carbon farming.

TCPL would also implement Project-specific greenhouse gas mitigation measures, as described below.

4.8.3 Project Greenhouse Gas Mitigation Measures, Management and Monitoring

The potential for reducing greenhouse gas emissions at the Project is related predominantly to consumption of diesel use by plant and equipment. Methods are in place at site to maximise efficiency of the mining fleet through regular maintenance scheduling and, where possible, minimising the gradient and length of loaded haul runs for the operating haul trucks. This is achieved by appropriate mine scheduling and planning.

In addition, TCPL continues to run a fleet of Terex (diesel/electric) haul trucks which have proven to burn less diesel fuel as compared to the standard mechanical drive fleet at other Whitehaven operations (TCPL, 2009).

The revegetation of previously cleared areas at the proposed Project biodiversity offset would also assist with reducing the Project's net greenhouse gas emissions. This revegetation in the biodiversity offset area would be in addition to the extensive on-site revegetation of Project disturbance areas (Section 5).

Ongoing monitoring and management of greenhouse gas emissions and energy consumption at the Project would occur through Whitehaven's participation in the Commonwealth Government's National Greenhouse and Energy Report System (NGERS) (Section 6.4.2).

Under NGERS requirements, relevant sources of greenhouse gas emissions and energy consumption must be measured and reported on an annual basis, allowing major sources and trends in emissions/energy consumption to be identified. As part of ongoing NGERS measurement and reporting requirements, a site specific emission factor for fugitive emissions from coal seams would be determined for the Project.

Whitehaven is also a participant in the Commonwealth Government's Energy Efficiency Opportunities (EEO) Program (Section 6.4.2). As such, Whitehaven would assess energy usage from all aspects of its operations, including the Project, and publicly report the results of energy efficiency assessments, and the opportunities that exist for energy efficiency projects with a financial payback of up to four years.

As part of its obligations under the EEO Program, Whitehaven has set up an internal steering committee with the objective of identifying and implementing greenhouse gas mitigation initiatives. The initial EEO Program report will be provided to the Commonwealth Department of Resources, Energy and Tourism by the end of December 2011.

4.9 FLORA

A Flora Assessment has been prepared for the Project by Dr. Colin Bower of FloraSearch (2011) and is presented in Appendix F. The Flora Assessment was prepared in accordance with the EARs for the Project.

A description of the existing environment relating to flora is provided in Section 4.9.1. Section 4.9.2 describes the potential impacts of the Project, Section 4.9.3 outlines mitigation measures, management and monitoring, and Section 4.9.4 describes the Project biodiversity offset strategy.

Existing Biodiversity Management

TCPL currently implements the following environmental management plans relevant to the management of potential impacts on biodiversity:

- Flora and Fauna Management Plan (Geoff Cunningham Natural Resource Consultants and Country Wide Ecological Services, 2007); and
- Bushfire Management Plan (Whitehaven, 2011b).

As described in Section 2.1.8, TCPL is in the process of reviewing and revising several of the management plans at the Tarrawonga Coal Mine. As part of this process, the current 2007 revision of the Flora and Fauna Management Plan would be reviewed and updated to incorporate the Project activities, and its name would also be changed to the Biodiversity Management Plan to be consistent with the Development Consent (DA-88-4-2005).

The Bushfire Management Plan (Whitehaven, 2011b) was recently prepared for the Tarrawonga Coal Mine in consultation with the NSW Rural Fire Service and Narrabri Shire Council. The Bushfire Management Plan describes the bushfire controls (including fire equipment and locations), emergency response procedures, emergency telephone numbers, bushfire training requirements and restrictions in heavily vegetated areas during total fire bans. The Bushfire Management Plan would continue to be implemented during the life of the Project.

4.9.1 Existing Environment

Regional and Local Setting

The Project area is in the Namoi CMA region and is also located within the Gunnedah Basin geological formation on the North West Slopes Botanical Division (Anderson, 1968; Harden, 1990-2002). It lies within the Liverpool Plains subregion of the Brigalow Belt South Bioregion close to the eastern boundary with the Nandewar Bioregion, as defined in the *Interim Biogeographic Regionalisation of Australia* (Thackway and Cresswell, 1995; SEWPaC, 2011a).

On a local scale, the Project is positioned on the foothills and slopes in and adjoining the southern boundary of Leard State Forest. The land use to the east, south and west is dominated by grazing (primarily cattle) and cereal/fodder cropping on the flatter and more fertile areas. Logging of Ironbark and White Cypress Pine has previously occurred in the Leard State Forest and on privately-owned land.

Flora Surveys

The vegetation survey of the Project area was carried out by FloraSearch (2011) over 17 days spread over November 2010, and January, May, July and August 2011. The survey encompassed all patches of native vegetation within the Project area in order to sample and identify all species present. All habitat types were surveyed to maximise the chance of finding populations of any threatened species.

Vegetation sampling methods used during the surveys included quadrat sampling, spot sampling, random meanders, shrub cover transects and line intercept transects. A detailed description of the survey methods is provided in Appendix F.

A vegetation survey of the Project biodiversity offset area has also been conducted by FloraSearch (2011). The survey was conducted over 12 days in May and August 2011, and the results are reported in Appendix F. Further discussion of the Project biodiversity offset strategy is provided in Section 4.9.4.

In addition to the recent Project flora surveys, various surveys were conducted prior to the commencement of the Tarrawonga Mine (e.g. Geoff Cunningham Natural Resource Consultants, 2005) and during operation of the mine (e.g. EcoLogical Australia, 2010). Leard State Forest has also been surveyed on multiple occasions over the past few years (Parsons Brinkerhoff, 2010). This survey information from other studies has been considered in the Flora Assessment.

Vegetation Communities

The following vegetation communities have been mapped by FloraSearch (2011) as occurring within the Project area (Figure 4-14):

- Community 1: White Cypress Pine - Narrow-leaved Ironbark Shrubby Open Forest.
- Community 2: White Box - White Cypress Pine Shrubby Woodland.
- Community 3: White Box - White Cypress Pine Grassy Woodland.
- Community 4: Narrow-leaved Grey Box - Poplar Box - White Cypress Pine Grassy Open Woodland.
- Community 5: Bracteate Honeymyrtle Low Riparian Forest.
- Community 6: Cleared Farmland.

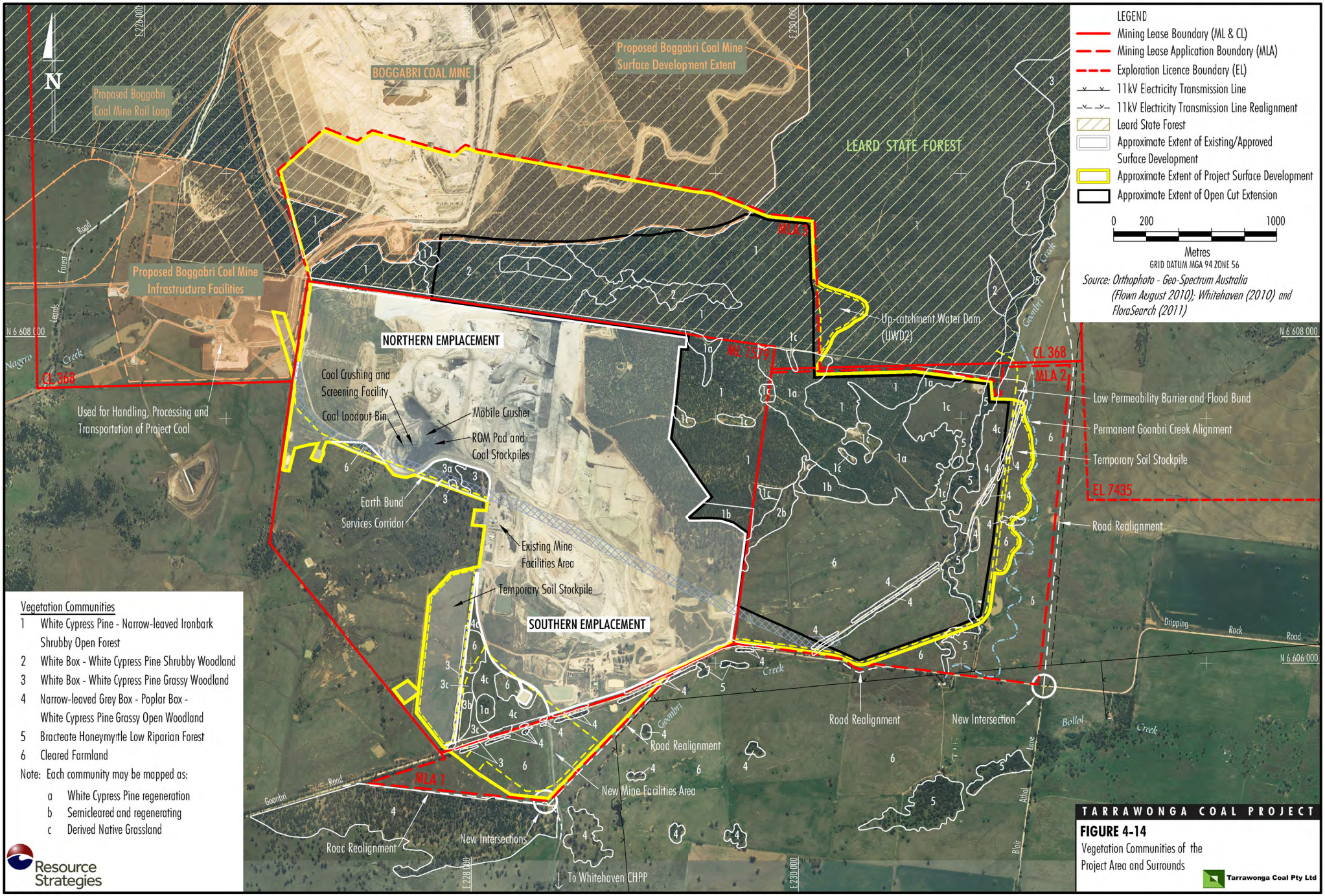
Detailed descriptions of each of these communities are provided in Appendix F.

A vegetation condition assessment was also undertaken by FloraSearch (2011) and condition classes are mapped on Figure 4-14. The condition classes reflect the degree of past disturbance and the nature of regeneration currently present. These condition classes are designated on Figure 4-14 by the letters a, b and c after the community number as follows:

a. White Cypress Pine regeneration: Most patches comprise trees of relatively uniform age suggesting large patches underwent uniform regeneration following clearing.

b. Semi-cleared and regenerating: This condition class comprises regeneration of diverse components of the original community following clearing or semi-clearing, such that, in time, full recovery of the original diversity can be expected.

c. Derived native grasslands: Vegetation condition class ‘c’ comprises derived native grasslands that have resulted from clearing of the original community.



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Vegetation patches considered to be in good condition with high native plant diversity and high resilience are shown in Figure 4-14 without a letter suffix.

Threatened Ecological Communities

One vegetation community in the Project area (Community 3 - White Box – White Cypress Pine grassy woodland) is listed as a threatened ecological community under both the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and the EPBC Act as:

- White Box-Yellow Box-Blakely's Red Gum Woodland Endangered Ecological Community (Box-Gum Woodland EEC), listed under the TSC Act; and
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands Critically Endangered Ecological Community (Box-Gum Woodland CEEC), listed under the EPBC Act.

The patches of Box-Gum Woodland EEC/CEEC in the Project area have been considerably disturbed and degraded by past land use practices including clearing of trees and shrubs, cropping and heavy grazing by domestic animals. Most of the areas mapped are derived grasslands (Figure 4-14).

Regionally Significant Vegetation and Vegetation Corridors

The Project area is part of a large remnant of native vegetation, in the order of 8,648 ha (excluding areas approved to be cleared by other mining operations [i.e. Boggabri Coal Mine]), which includes the Leard State Forest and the Leard State Conservation Area (located approximately 7 km to the north-west). The native vegetation remnant is surrounded by cleared agricultural lands, which effectively isolate it from other large remnants to the west (Pilliga Scrub), the north (Mount Kaputar and the Nandewar Range) and to the east (southern extensions of the Nandewar Range).

Flora Species Composition

A complete list of flora species identified during the Project flora surveys is provided in Appendix F. A total of 363 plant species were identified by the surveys, of which 269 (approximately 74%) were native and 94 (approximately 26%) were introduced.

Introduced Flora Species and Noxious Weeds

Of the 94 introduced species recorded, nine are listed as noxious under the NSW *Noxious Weeds Act, 1993*, *viz.* African Boxthorn, Bathurst Burr, Blue Heliotrope, Galvanised Burr, Golden Dodder, Johnson Grass, Mexican Poppy, Prickly Pear and Spiny Burrgrass (Appendix F). None of the noxious weeds recorded were abundant within the Project area, although Prickly Pear is widespread (Appendix F). Bathurst Burr, Blue Heliotrope and Galvanised Burr were relatively common in Community 6 Cleared Farmland.

Threatened Flora Species and Populations

Targeted surveys were undertaken in the Project area to identify potentially occurring threatened flora species listed under the TSC Act and/or the EPBC Act. No threatened flora species were recorded, and no threatened flora populations listed under the TSC Act are considered by FloraSearch (2011) to be relevant to the Project.

Critical Habitat

No critical habitat occurs within the vicinity of the Project as designated by the Register of Critical Habitat held by the Commonwealth Minister, Register of Critical Habitat held by the Director-General of OEH, the Register of Critical Habitat held by the Director-General of the DPI (Fisheries and Aquaculture Branch) or identified within the *Narrabri Local Environmental Plan 1992* (Narrabri LEP).

Conservation Areas

A number of reserved areas are located in the region, including the Leard State Forest, the Leard State Conservation Area, the Vickery State Forest (located approximately 10 km to the south-east) and Mount Kaputar National Park (located approximately 18 km to the north-east).

The Project is situated on the southern boundary of Leard State Forest. The Leard State Forest is a Zone 4 community conservation area and covers a total area of 7,472 ha (NSW *Brigalow and Nandewar Community Conservation Area Act, 2005*).

Forestry, recreation and mineral extraction are permissible land use categories within this zone. A portion of Leard State Forest is a declared hunting reserve and the area has been subject to firewood collection, commercial logging of Cypress Pine and logging for railway sleepers (Forests NSW, pers. comm., 2011).

4.9.2 Potential Impacts

Native Vegetation/Habitat Clearance

The Project would require the progressive removal of approximately 397 ha of native vegetation (Table 4-23). Of this area, approximately 145 ha occurs within the Leard State Forest, which equates to approximately 1.9% of its total area.

Threatened Ecological Communities

Approximately 13 ha of the Box-Gum Woodland EEC/CEEC would be cleared for the Project (Figure 4-14). This area would include:

- 5 ha of the mature form of Community 3 (White Box - White Cypress Pine grassy woodland) located along a portion of the Goonbri Road reserve and within a grazing paddock.
- 5 ha of the semi-cleared and regenerating forms of Community 3 (i.e. variants 3a and 3b) in a paddock previously used for grazing and cropping.
- 3 ha of the derived native grassland form of Community 3 (i.e. variant 3c) in a paddock previously used for grazing and cropping.

The potential impacts of the Project on threatened ecological communities have been assessed in detail by FloraSearch (2011), based on the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and the *Threatened Species Assessment Guideline – The Assessment of Significance* (DECC, 2007a) with consideration of the *EPBC Act Policy Statement 3.5: Box-Gum Grassy Woodlands and Derived Native Grasslands* (Commonwealth Department of the Environment and Heritage, 2006).

Groundwater Dependent Vegetation

One vegetation community within the Project area and surrounds is considered to be potentially groundwater dependent, *viz.* Community 5, Bracteate Honeymyrtle low riparian forest (Figure 4-14). This vegetation community occurs along the 3 km long portion of Goonbri Creek that is located within the proposed open cut extension, and as a result, approximately 15 ha of it would be cleared during mining operations. This would result in a local loss in biodiversity in this section of Goonbri Creek. However, this vegetation community also occurs to the north and south of the Project area. In addition, an equivalent length of the stream would be recreated and revegetated with this community in the permanent Goonbri Creek alignment, and TCPL would implement a riparian enhancement program for a further 3.2 km below the re-aligned section.

Table 4-23
Clearing of Native Vegetation Required by the Project

Vegetation Community[1]		Area (ha)	Area (ha)
1	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (mature community)	189	278
1a	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (regeneration - mainly White Cypress Pine)	55	
1b	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (semi-cleared and regenerating)	9	
1c	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (derived grassland)	25	
2	White Box - White Cypress Pine shrubby woodland	41	46
2b	White Box - White Cypress Pine shrubby woodland (semi-cleared and regenerating)	5	
3	White Box - White Cypress Pine grassy woodland	5	13
3a	White Box - White Cypress Pine grassy woodland (regeneration – mainly White Cypress Pine)	3	
3b	White Box - White Cypress Pine grassy woodland (semi-cleared and regenerating)	2	
3c	White Box - White Cypress Pine grassy woodland (derived grassland)	3	
4	Narrow-leaved Grey Box - Poplar Box - White cypress Pine grassy open woodland	12	45
4c	Narrow-leaved Grey Box - Poplar Box - White cypress Pine grassy open woodland (derived grassland)	33	
5	Bracteate Honeymyrtle low riparian forest	15	15
Total		**397**	**397**

Source: Appendix F.

[1] Equivalent vegetation types are described in Appendix F.

The permanent Goonbri Creek alignment and low permeability barrier (Section 2.10.3) have been designed to minimise changes/disruption to the near surface groundwater flow along the retained sections of Goonbri Creek and associated alluvium, which would minimise the potential impacts of the Project on flora upstream and downstream of the Project during operations and post-closure.

Consequently, and as described in Section 4.4.2, there is expected to be negligible drawdown to the aquifers of the alluvial groundwater system outside of the low permeability barrier (Appendix A), and as a result groundwater dependent vegetation outside the Project disturbance footprint would be protected (Appendix F).

The failure to establish riparian habitat within the permanent Goonbri Creek alignment was identified in the ERA (Section 4.1 and Appendix O). This risk would be managed by installing and revegetating the new section of the creek two to three years before it is required in Year 15. The revegetated sections would be monitored and remedial works conducted as required to maximise revegetation success.

Threatened Flora Species

As stated in Section 4.9.1, no threatened flora have been recorded in the Project area, however, three species were considered by FloraSearch (2011) to have a medium to high potential to occur (i.e. *Thesium australe, Diurus tricolor* and *Pomaderris queenslandica*) (Appendix F).

In the OEH's comments and input to the EARs for the Project, documented in the letter dated 31 March 2011 (Attachment 1), it requested an assessment of the significance of impacts in accordance with Section 5A of the EP&A Act and the *Threatened Species Assessment Guidelines – The Assessment of Significance* (DECC, 2007a). These flora assessments are provided in Appendix F and conclude that the Project would be unlikely to significantly affect any threatened flora species listed under the TSC Act or EPBC Act.

Introduced Flora

Vegetation clearing and soil disturbance is considered likely to create opportunities for weed establishment around the margins of the Project disturbance areas, which would increase the potential for weed incursion into the native habitats of Leard State Forest (Appendix F).

However, the potential risk is considered by FloraSearch (2011) to be low due to the predominantly poor soils in the Leard State Forest area, and through the continuation of the existing weed control measures currently used at the Tarrawonga Coal Mine (Section 4.9.3).

Vegetation and Dust

Studies have shown that excessive dust generation can adversely affect the health and viability of surrounding vegetation. Dust can affect vegetation by inhibiting physiological processes such as photosynthesis, respiration and transpiration, and allow penetration of phytotoxic gaseous pollutants (Appendix F).

Dust emissions associated with the Project would originate predominantly from activities such as blasting, materials handling and vehicle movements. However, with the implementation of Project air quality control measures described in Section 4.7.3, dust-related impacts on adjoining vegetation would be minimised.

Bushfire Risk

High intensity fires can adversely impact flora. The risk of a fire would be reduced through the management measures described in Section 4.3.3. The likelihood that the Project would result in a significant impact on flora through a change in the frequency of fires is considered to be very low (Appendix F).

Cumulative Impacts

As described in Section 2.5 and Attachment 3, there are two other mining proposals located in close proximity to the Project, namely the proposed Continuation of Boggabri Coal Mine and the proposed Maules Creek Coal Project.

The Project, the Continuation of Boggabri Coal Mine and the Maules Creek Coal Project would all result in direct impacts on the flora of Leard State Forest. If approved (and including disturbance associated with the currently approved Boggabri Coal Mine), the Continuation of the Boggabri Coal Mine and the Maules Creek Coal Project would collectively clear approximately 1,802 ha and 992 ha, respectively, or a total of 2,794 ha (37.4%) of the Leard State Forest (BCPL, 2010; Aston Resources, 2011). The Project includes the clearing of approximately 145 ha of additional vegetation within the Leard State Forest. This equates to 1.9% of the total area or 3.1% of the residual area, should the Continuation of Boggabri Coal Mine and the Maules Creek Coal Project be approved.

The Project contribution of vegetation clearance within the Leard State Forest (1.9%) is considered to be small when compared against these other mining proposals. In addition, the scale and nature of clearing required by the Project is considered to be minor when compared with past and current land clearing/disturbance processes throughout the region associated with agriculture.

4.9.3 Mitigation Measures, Management and Monitoring

This section provides a description of the measures that have been implemented to minimise potential impacts on flora through refinements to the Project design. It also describes the existing flora management and monitoring programs that are used at the Tarrawonga Coal Mine. A range of additional mitigation measures and monitoring programs are proposed as part of the Project and are described below.

Refinements to the Mine Design to Minimise Land Clearance

Several refinements to the Project have been made during the feasibility studies and preparation of this EA to minimise the overall environmental impacts associated with the proposal. Some of these refinements have reduced or avoided potential impacts on flora and fauna. In particular:

- Maximising the area of the open cut that is backfilled to minimise the overall mine footprint.
- Integrating the Northern Emplacement with the Boggabri Coal Mine waste rock emplacement landform (Section 2.5.1) to minimise the overall mine footprint.
- Temporarily increasing the height of the Southern Emplacement to 360 m AHD (rather than expanding its footprint onto adjoining lands).
- Designing the new mine facilities area to be located in cleared farmland and to avoid a mature remnant of Box-Gum Woodland EEC/CEEC located along a north-south fenceline adjacent to the mine access road.
- Selecting an alignment for the Goonbri Road that minimises disturbance of the Goonbri Creek corridor and makes use of the existing Dripping Rock Road.

Proposed Biodiversity Management Plan

TCPL would prepare and implement a Biodiversity Management Plan for the Project that covers the following aspects relevant to flora:

- protection of vegetation and soil outside of disturbance areas;
- conservation and re-use of topsoil;
- revegetation along the low flow channel of the permanent Goonbri Creek alignment;
- revegetation within the Goonbri Creek enhancement area; and
- weed control.

The Biodiversity Management Plan for the Project would also cover the following aspects relevant to fauna:

- adopting land clearing strategies to minimise impacts on fauna;
- salvaging and re-using material from the site for habitat establishment;
- implementing a nest box program;
- enhancing farm dams;
- managing artificial lighting;
- controlling feral animals;
- managing grazing and agricultural practices on Company-owned land; and
- limiting vehicle speed limits.

The measures relevant to flora are discussed below and the measures relevant to fauna are discussed in Section 4.10.3.

Protecting Vegetation and Soil Outside of Disturbance Areas

Land clearance for the Project would be undertaken progressively. The area cleared at any particular time would generally be no greater than that required to accommodate the mine's needs for the following twelve months. Areas to be cleared would be delineated, restricting clearing to the minimum area necessary to undertake the approved activities.

Vegetation clearance protocols would be used to minimise the impact on flora. Key components of the vegetation clearance protocols would include aspects such as the clear delineation of areas to be cleared of native remnant vegetation, timing and methods to be used, and re-use of cleared vegetation in revegetation programs.

Conserving and Reusing Topsoil

Topsoil would be stripped from disturbance areas following vegetation clearance and stockpiled for use in rehabilitation. Topsoil stockpiles would be temporary structures with topsoil progressively reclaimed and used in rehabilitation. The incorporation of the ground-layer vegetation and low shrubs into the topsoil when it is stripped would be used to assist rehabilitation by increasing the seed bank and organic matter within the stockpiled soil.

Revegetation of the Permanent Goonbri Creek Alignment

The design objectives for the permanent Goonbri Creek alignment are described in Appendix B and summarised in Section 2.10.3. One of these objectives is to revegetate the low flow channel of the permanent Goonbri Creek alignment and thereby extend the vegetated higher value habitat conditions of the upper reaches of Goonbri Creek through to the Bollol Creek floodplain area.

The revegetation would be carried out within and approximately 40 m either side of the low flow channel using species characteristic of the Bracteate Honeymyrtle *(Melaleuca bracteata*) community.

A monitoring program would be designed and implemented to track the progress of the revegetation (in terms of plant growth, species diversity and fauna usage) in both instream and riparian habitats. Remedial works would be undertaken as required in order to maximise revegetation success. A monitoring report would be prepared annually that includes a summary of previous monitoring reports, results of that year's monitoring and planned remedial works, if required. The monitoring results would be summarised in the AEMR.

The Goonbri Creek revegetation activities and monitoring program would be documented in the Goonbri Creek Management Plan.

Revegetation of the Goonbri Creek Enhancement Area

A riparian vegetation enhancement program would also be implemented along the 3.2 km section of Goonbri Creek within the "Templemore" property, which is owned by Whitehaven. The works would extend from where Goonbri Creek crosses the southern boundary of MLA 2, to the point where Goonbri Creek crosses the sized ROM coal transport route. The majority of this section of Goonbri Creek would be fenced to preclude grazing by livestock (with some access points left for stock watering).

The fencing would be installed approximately 40 m either side of Goonbri Creek. The fenced area would be revegetated using species characteristic of the Bracteate Honeymyrtle (*Melaleuca bracteata*) community. Minor remedial earthworks would also be undertaken within the fenced area, where necessary, to rectify any significant areas of existing erosion.

The Goonbri Creek enhancement activities would be documented in the Goonbri Creek Management Plan, with reference to the Farm Management Plan where appropriate (i.e. where enhancement activities integrate with ongoing agricultural activities).

Weed Control

Weed control measures that would be undertaken as part of the Project would include:

- regular inspections of revegetated areas and other parts of the mining tenements to identify and demarcate areas of noxious and environmental weeds;
- regular liaison with local landholders and relevant government agencies to monitor the spread and management of weeds within the local area;
- mechanical removal and/or the application of approved herbicides in areas identified as being affected by weeds;
- follow-up site inspections to evaluate the effectiveness of weed control programs;
- follow-up weed control in previously treated areas where weed management has been sub-optimal; and
- minimisation of potential seed transport to or from the site through the inspection of vehicles and use of the site's vehicle wash bay.

Proposed Rehabilitation Management Plan

A Rehabilitation Management Plan for the Tarrawonga Coal Mine is required under the Development Consent (DA-88-4-2005). TCPL would prepare and implement a Rehabilitation Management Plan for the Project that would describe the revegetation program for the mine landforms. Further information on the content of the Rehabilitation Management Plan is provided in Section 5.

The Project revegetation program would provide for a combination of native woodland/forest (752 ha) and agricultural (210 ha) post-mining land uses. The agricultural land would comprise predominantly native grasses for grazing with some areas of potential cropping.

Revegetation of woodland/forest areas would include the planting of species characteristic of the local vegetation communities, including species from the Box-Gum Woodland EEC/CEEC (e.g. White Box overstorey as well as appropriate understorey). Other species would include Bulloak (*Allocasuarina luehmannii)* and Belah (*Casuarina cristata*).

The rehabilitation monitoring program for the Project (Section 5.6) would be designed to track the progress of revegetation (in terms of plant growth, species diversity and fauna usage) and to determine the requirement of intervention measures such as thinning to reduce locked-regrowth, or additional plantings that may be required.

Annual surveys would be undertaken by an appropriately qualified and experienced person to evaluate the success of rehabilitation and identify any additional measures required to achieve ongoing rehabilitation success. A detailed monitoring report would be prepared annually that includes a summary of previous monitoring reports, results of that years monitoring and planned remedial works, if required. The monitoring results would be summarised in the AEMR.

Other Management Measures Relevant to Flora

Dust mitigation and management measures to be undertaken as part of the Project are described in Section 4.7.3.

4.9.4 Offset Strategy

The EARs (Attachment 1) state that the EA must include an offset strategy to address the residual impacts of the Project, and describe how the Project would maintain or improve the biodiversity values of the region in the medium to long-term.

The biodiversity offset strategy for the Project has been developed in consideration of:

- the EARs;
- relevant Part 3A development guidelines (e.g. DEC and DPI, 2005);
- OEH's principles for the use of biodiversity offsets in NSW (OEH, 2011b);
- SEWPaC's Consultation Draft Environmental Offsets Policy and supporting documentation (SEWPaC, 2011b, 2011c; Commonwealth Department of the Environment, Water, Heritage and the Arts, 2007a, 2007b);
- the draft *Namoi Catchment Action Plan 2010-2020* (Draft Namoi CAP) (Namoi CMA, 2011); and
- ecological principles commonly used in the design of reserves for wildlife conservation.

Biodiversity Offset

The biodiversity offset for the Project is located on freehold land owned by Whitehaven, and is situated approximately 20 km to the north-east (Figure 4-15). The proposed biodiversity offset is a portion of the former "Willeroi" property. It adjoins Mount Kaputar National Park to the west, and prior to its recent purchase by Whitehaven, was used for agricultural purposes, mainly grazing.

Flora and Fauna Values within the Project Biodiversity Offset Area

Similar to the Project area, the biodiversity offset is situated in the Namoi CMA Region. It is located on the south-eastern boundary of Mount Kaputar National Park, and is also located directly south of an area proposed as a conservation area for the Maules Creek Coal Project (Aston Resources, 2010a, 2010b) (Figure 4-15).

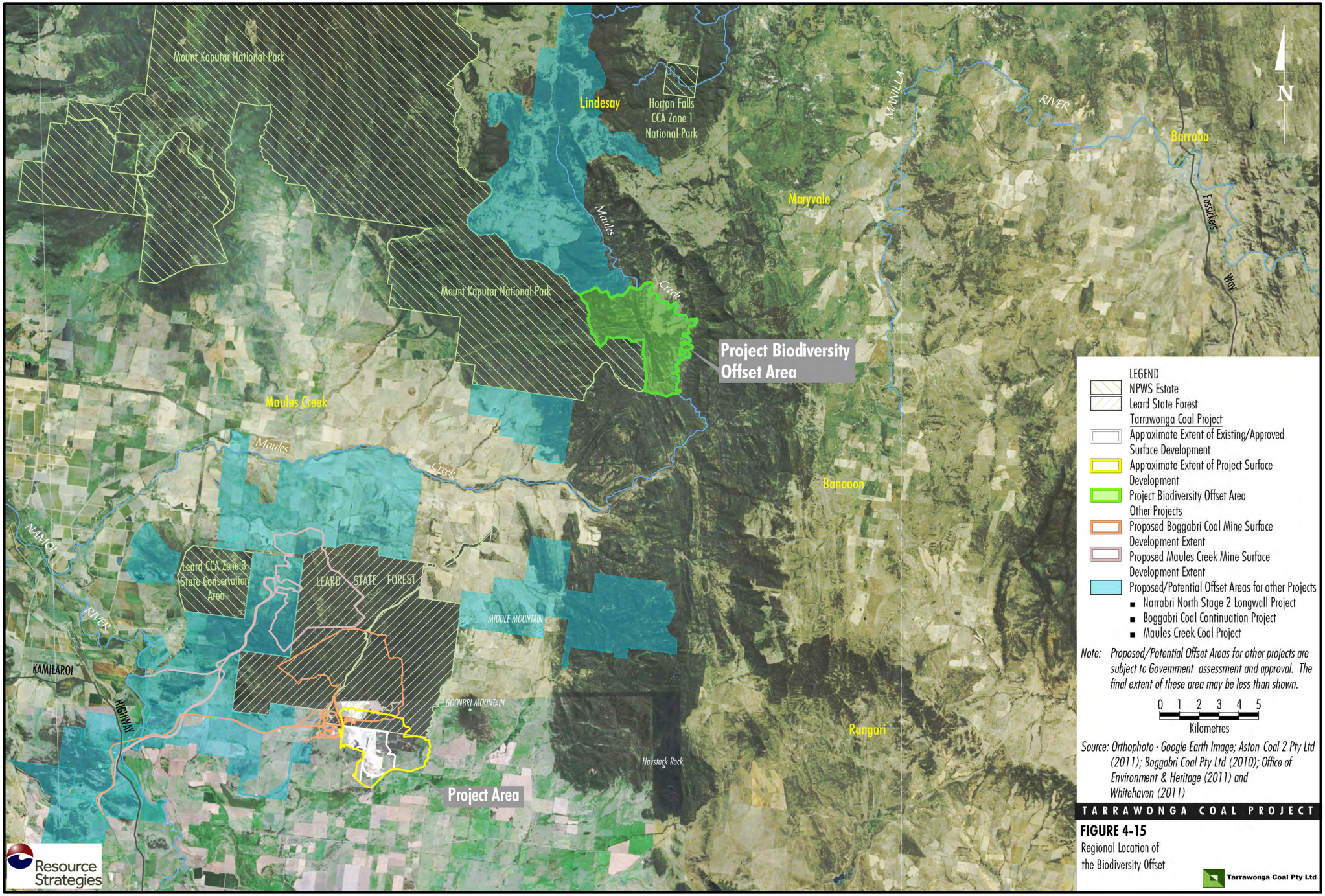
There are a number of regional priorities for biodiversity conservation in the Namoi CMA Region, including the buffering of habitat from the potential impacts of climate change (Namoi CMA, 2011).

The proposed biodiversity offset area is located within an OEH recognised 'high priority area', 'regional key fauna habitat' and climate change linkage as described and mapped in the *Wildlife Corridors for Climate Change – New England Tablelands and Nandewar bioregions - Landscape Selection Process, Connectivity for response to Climate Change* (DECC, 2007b) (Appendix F).

Two creek lines occur in the Project biodiversity offset area (i.e. Maules Creek and its tributary Teatree Gully). Approximately 13.5 km of Maules Creek and 6 km of Teatree Gully (its entire length) are located within the biodiversity offset.

Eight native vegetation communities are present within the biodiversity offset, including:

- Narrow-leaved Ironbark - White Box - White Cypress Pine Shrubby Open Forest.



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- White Box - White Cypress Pine Shrubby Woodland.
- White Box - White Cypress Pine Grassy Woodland.
- Bracteate Honeymyrtle Low Riparian Forest.
- Silver-leaved Ironbark - Narrow Leaved Ironbark - White Box Shrubby Open Forest.
- Yellow Box – Rough-barked Apple Grassy Woodland.
- River Oak - River Red Gum Riparian Forest.
- Rough-barked Apple Riparian Forb/Grass Open Forest.

Detailed descriptions of each of these communities are provided in Appendix F.

Figure 4-16 shows their location within the biodiversity offset.

The biodiversity offset is 1,660 ha in area. Tables 4-24 and 4-25 provide a summary of the native vegetation communities and EEC/CEEC present within the biodiversity offset compared to those to be cleared for the Project.

As described in Section 4.9.2, the Project would clear approximately 13 ha of Box-Gum Woodland EEC/CEEC. Approximately 232 ha of Box-Gum Woodland EEC/CEEC has been mapped at the biodiversity offset (Table 4-25, Figure 4-16), of which 195 ha is derived native grassland and 37 ha is relatively undisturbed.

Appendix F provides a detailed comparison of the flora located within the Project area and the biodiversity offset.

The Project area supports a range of flora species known from the lower Western Slopes and Plains that are absent from the proposed biodiversity offset, primarily due to the difference in altitude between the two areas. Notwithstanding, FloraSearch (2011) consider the vegetation in the biodiversity offset to be an acceptable match for that at the Project (Appendix F).

In 2011, Cenwest Environmental Services recorded a range of vertebrate fauna species during surveys of the biodiversity offset area. There were many similarities between the vertebrate species present within the biodiversity offset and the Project area. Vertebrate fauna species in the biodiversity offset are represented by amphibians, reptiles, woodland and forest birds and arboreal and ground dwelling mammals (Appendix E).

Ecological gains from the biodiversity offset would include:

- Similar vegetation communities/fauna habitats, compared to the Project area, would be conserved/enhanced in the biodiversity offset.
- The biodiversity offset is suitably located to benefit flora and fauna populations (biodiversity values) potentially impacted by the Project.
- The biodiversity offset removes a substantial area of native vegetation from the deleterious effects of livestock grazing, thereby allowing it to recover and improve over time.
- The biodiversity offset is located within the same CMA region as the Project area.
- It is located adjacent to Mount Kaputar National Park and compliments the existing reserve system.
- The biodiversity offset has the capacity to improve (with moderate to high resilience) through removal of threatening process and active management.
- Ephemeral creeks such as Maules Creek and Teatree Gully occur within the biodiversity offset providing a diversity of habitats.
- Substantial areas of Box-Gum Woodland EEC/CEEC (232 ha) occur in the biodiversity offset.
- The biodiversity offset is surrounded on three sides by largely undisturbed natural vegetation. Consequently, it is not isolated in the landscape and its high connectivity would help its long-term viability.

The proposed biodiversity offset is therefore considered to be a suitable offset against the residual flora and fauna impacts associated with the Project. Particularly, given the anticipated improvement in the flora and fauna habitat value that could reasonably be expected in the biodiversity offset over the medium to long-term.

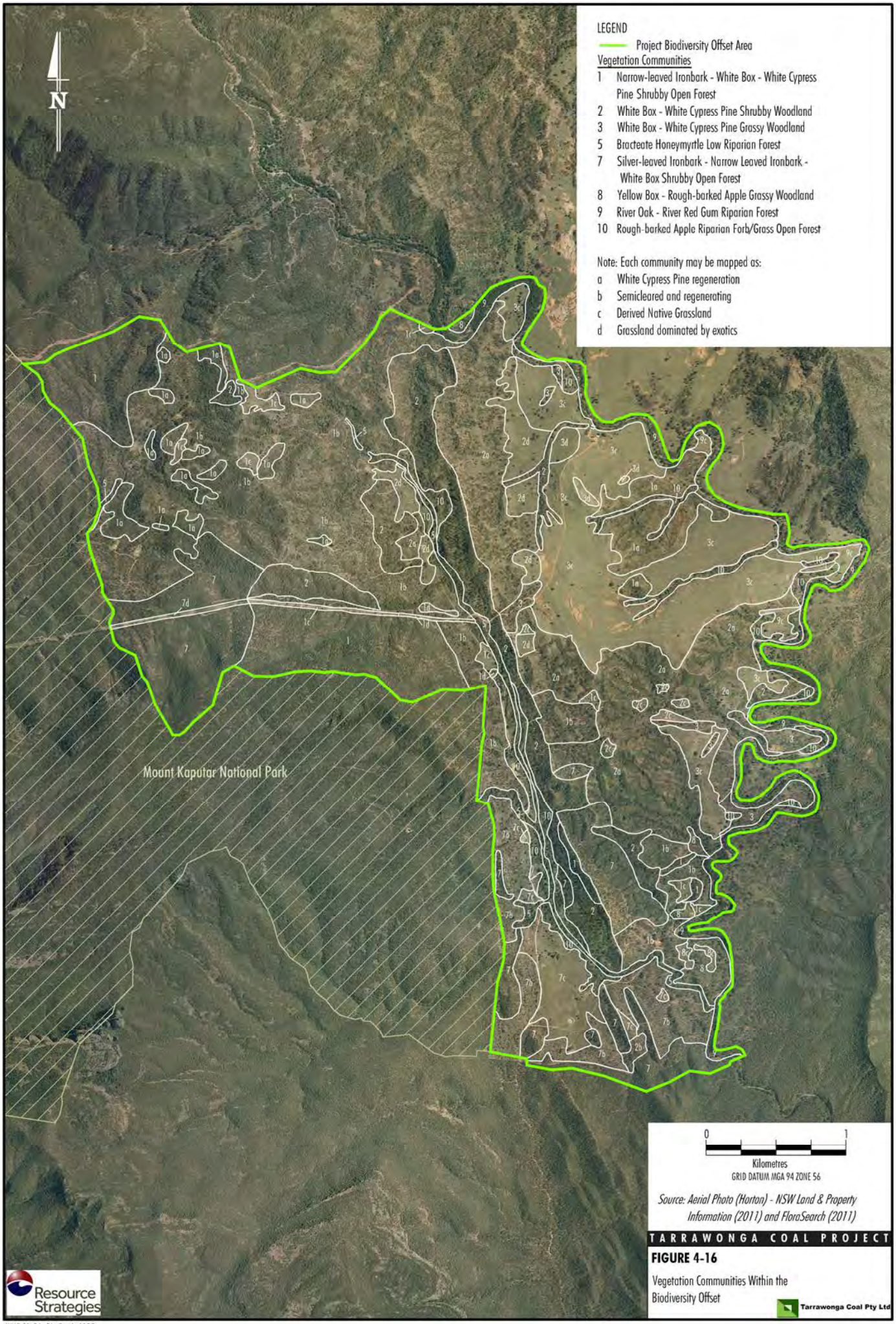

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Table 4-24
Native Vegetation Communities – Project and Biodiversity Offset Areas

Community Number[1]	Community Name	Area (ha)	
		Project[2]	Offset[2]
1	White Cypress Pine - Narrow-leaved Ironbark ± White Box Shrubby Open Forest	278	568
2	White Box - White Cypress Pine Shrubby Woodland	46	382
3	White Box - White Cypress Pine Grassy Woodland	13	216
4	Pilliga Box - Poplar Box - White Cypress Pine Grassy Open Woodland	45	0
5	Bracteate Honeymyrtle Low Riparian Forest	15	27
7	Silver-leaved Ironbark - Narrow Leaved Ironbark - White Box Shrubby Open Forest	0	260
8	Yellow Box – Rough-barked Apple Grassy Woodland	0	16
9	River Oak - River Red Gum Riparian Forest	0	89
10	Rough-barked Apple Riparian forb/grass Open Forest	0	58
Total		**397**	**1,616**

[1] Vegetation Community 6 is Cleared Farmland and is not considered to be a native vegetation community

[2] Excludes cleared land with introduced grasses.

Table 4-25
Box-Gum Woodland EEC/CEEC at the Project and the Biodiversity Offset

Community Number	Community Name	Area (ha)	
		Tarrawonga	Offset
3	**White Box - White Cypress Pine Grassy Woodland**	5	23
3a	White Cypress Pine Regeneration	3	0
3b	White Box - White Cypress Pine Regeneration	2	0
3c	Derived Native Grassland	3	193
8	**Yellow Box – Rough-barked Apple Grassy Woodland**	0	14
8c	Derived Native Grassland	0	2
Total		**13**	**232**

Security of the Biodiversity Offset

TCPL intends to reach an agreement with the NSW Government so that the biodiversity offset can be permanently added to the adjoining Mount Kaputar National Park. However, TCPL recognises that the formal process of incorporating the area into the National Park may take some time, and as a result an interim conservation arrangement would be made to ensure protection and management of the biodiversity offset (e.g. a voluntary conservation agreement with the NSW Minister for the Environment).

Management of the Biodiversity Offset

A Biodiversity Offset Strategy would be prepared by a suitably qualified person(s) to facilitate the management of the biodiversity offset prior to integration into the Mount Kaputar National Park. The Biodiversity Offset Strategy would be developed within 12 months of Project Approval.

Based on the findings of the detailed flora and fauna surveys of the biodiversity offset, a number of management measures are proposed to enhance its flora and fauna values. These measures would be detailed in the Biodiversity Offset Strategy and would include:

- promotion of natural regeneration and revegetation;
- habitat enhancement;
- control of weeds;
- pest management; and
- fire management.

Further detail of each of the above management measures is provided in Appendix E.

Monitoring and Completion Criteria

The Biodiversity Offset Strategy would also include a program to monitor the effectiveness of the management measures and to evaluate performance against specified completion criteria. The monitoring would be undertaken by a suitably qualified person(s), and independent audits would be performed as necessary.

Completion criteria would be developed in consultation with the relevant government agencies to define the required condition of the biodiversity offset before it could be added to the Mount Kaputa National Park.

Proposed completion criteria for the biodiversity offset are presented in Table 4-26.

Offset Principles Reconciliation

Table 4-27 provides a reconciliation of the proposed offset strategy against OEH Offset Principles.

4.10 FAUNA

A Fauna Assessment has been prepared for the Project by Resource Strategies and Cenwest Environmental Services (2011) and is presented in Appendix E. The Fauna Assessment was prepared in accordance with the EARs for the Project.

A description of the existing environment relating to fauna is provided in Section 4.10.1. Section 4.10.2 describes the potential impacts of the Project, Section 4.10.3 outlines mitigation measures, management and monitoring, and Section 4.10.4 describes the aspects of the Project biodiversity offset strategy relevant to fauna.

4.10.1 Existing Environment

Regional and Local Setting

There are various regional delineations in NSW that can be used to predict which native fauna are likely to occur within a particular area. The Project occurs within the Namoi CMA region, which covers the Namoi Catchment. The Project is also within the Brigalow Belt South Bioregion (Thackway and Cresswell, 1995; SEWPaC, 2011a).

Another useful regional boundary for predicting fauna composition is the zoogeographic region (Spencer, 1896; Schodde, 1994). The Project area is located within the Bassian Zoogeographic Region.

Fauna Surveys

Cenwest Environmental Services undertook terrestrial and aquatic surveys within the Project area and the immediate surrounds in 2011. The terrestrial vertebrate fauna surveys were conducted over multiple seasons considering the relevant State and Commonwealth survey guidelines. The survey techniques included: Elliot trapping, cage trapping, bat call recording, harp traps, hair tubes, spotlighting, herpetological searches, bird census, call playback and searches for tracks and traces (Appendix E).

Aquatic ecology surveys were also undertaken by Cenwest Environmental Services along Goonbri Creek in 2011. The aquatic ecology surveys involved standard survey techniques, including: a condition assessment of the Goonbri Creek; water quality analysis; and a fish and macroinvertebrate survey according to the *NSW AUSRIVAS Sampling and Processing Manual* (Turak *et al.*, 2004) (Appendix E).

Table 4-26
Proposed Biodiversity Offset Completion Criteria

Component	Completion Criteria
Enhancement Areas (i.e. existing woodland/forest)	Areas of existing remnant vegetation within the biodiversity offset (1,355 ha) have been conserved and enhanced.
Revegetation Areas (i.e. derived native grasslands and cleared land)	Revegetated woodland/open woodland habitat areas (305 ha) have been restored to a self-sustaining ecosystem[1], or show sufficient progression towards this status.

[1] The methodology for determining a self-sustaining ecosystem would be to the satisfaction of the Director-General.

Table 4-27
Reconciliation of the Proposed Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2011b)	Description of How the Proposed Offset Addresses the OEH Offset Principles
Impacts must be avoided first by using prevention and mitigation measures.	Measures to avoid and mitigate Project impacts on flora and fauna are described in Sections 4.9.3 and 4.10.3, respectively. The proposed offset strategy is proposed to address residual impacts.
All regulatory requirements must be met.	TCPL is required to meet all statutory requirements. The proposed offset strategy is not proposed to substitute other licence/approval requirements.
Offsets must never reward ongoing poor performance.	The proposed offset strategy is proposed to address residual impacts associated with the Project only.
Offsets will complement other government programs.	The proposed offset strategy compliments the current reserve system in NSW by providing long-term security and management of a significant area of vegetation/habitat adjoining Mount Kaputar National Park. The biodiversity offset is located within an OEH recognised 'high priority area', 'regional key fauna habitat' and climate change linkage as described and mapped in the *Wildlife Corridors for Climate Change – New England Tablelands and Nandewar bioregions - Landscape Selection Process, Connectivity for response to Climate Change* (DECC, 2007b). TCPL intends to reach an agreement with the NSW Government so that the biodiversity offset can be added to the adjoining Mount Kaputar National Park. In the interim, protection and management of the offset area would be via a voluntary conservation agreement with the NSW Minister for the Environment (or equivalent).
Offsets must be underpinned by sound ecological principles.	The biodiversity offset is underpinned by sound ecological principles such as: • consideration of structure, function and compositional elements of biodiversity, including threatened species, through flora and fauna surveys (Appendices E and F); • enhance biodiversity at a range of scales through a number of proposed management measures (e.g. revegetation); • consideration of the conservation status of ecological communities (e.g. through inclusion of large areas of Box-Gum Woodland EEC/CEEC); and • measures to protect the long-term viability and functionality of biodiversity (e.g. enhancing the existing habitat as well as securing and managing the land for conservation purposes).
Offsets should aim to result in a net improvement in biodiversity over time.	The biodiversity offset would result in the conservation and enhancement of existing remnant vegetation within the biodiversity offset (1,355 ha) and revegetation of woodland/open woodland habitat areas (305 ha). A number of measures are proposed to manage the area for conservation purposes. An assessment of the resilience of the vegetation in the biodiversity offset is provided in Appendices E and F. The offset strategy would commence 12 months after Project approval, where as vegetation clearance for the Project would occur progressively over 17 years.
Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.	TCPL intends to reach an agreement with the NSW Government so that the biodiversity offset can be added to the adjoining Mount Kaputar National Park.
Offsets should be agreed prior to the impact occurring.	The offset strategy is proposed as part of the Project. The implementation of the biodiversity offset is likely to be a condition of Project Approval.

Table 4-27 (Continued)
Reconciliation of the Proposed Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2011b)	Description of How the Proposed Offset Addresses the OEH Offset Principles
Offsets must be quantifiable. The impacts and benefits must be reliably estimated.	The area of the biodiversity offset is specified in this section of the EA. Benefits of the offset strategy are described in this section and detailed in Appendices E and F. The offset strategy has been prepared based on the following: • characteristics of the habitat to be cleared and the flora and fauna (including threatened species and communities) likely to be impacted; • characteristics and condition of the vegetation/habitat as well as the species present in the biodiversity offset and current threats requiring management; • proposed management measures to avoid and mitigate impacts from the Project; • proposed management measures to enhance the biodiversity of the biodiversity offset; and • the level of security on the biodiversity offset (e.g. extension to the Mount Kaputar National Park or voluntary conservation agreement). Flora and fauna surveys have been undertaken in both the disturbance area and the biodiversity offset by FloraSearch (Appendix F) and Cenwest Environmental Services (Appendix E). The offset strategy includes a proposed framework for development and implementation of a management plan, monitoring program, independent auditing and completion criteria.
Offsets must be targeted.	The biodiversity offset was specifically targeted to address the residual impacts associated with the Project. It includes consideration of: • biodiversity priorities in the area (e.g. the proposed offset area is located within an OEH recognised 'high priority area', 'regional key fauna habitat' and climate change linkage as described and mapped in the *Wildlife Corridors for Climate Change – New England Tablelands and Nandewar bioregions - Landscape Selection Process, Connectivity for response to Climate Change* [DECC, 2007b]); • the conservation status of the ecological community present within the Project area (e.g. the biodiversity offset includes large areas of Box-Gum Woodland EEC/CEEC); • the presence of threatened fauna species or their habitats (Appendix E); • connectivity (e.g. the biodiversity offset is adjacent to Mount Kaputar National Park); • long-term viability (i.e. the biodiversity offset is surrounded on three sides by dense vegetation and is located adjacent to the Mount Kaputar National Park); and • the potential to enhance condition by management actions and the removal of threats (i.e. clearing and grazing).
Offsets must be located appropriately.	The proposed biodiversity offset is located within the same CMA region as the Project area (i.e. the Namoi CMA Region) and therefore has the capacity to benefit biodiversity values in the same region as the Project. Vegetation communities present are considered to be an acceptable match to those to be disturbed by the Project (Appendix F) and each of the broad fauna habitat types disturbed by the Project are represented in the biodiversity offset (Appendix E).
Offsets must be supplementary.	The implementation of the offset strategy is beyond existing requirements, in that the biodiversity offset area is not subject to an existing conservation agreement and prior to acquisition was subject to active clearing and grazing.
Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	Measures to monitor and independently audit the biodiversity offset are provided. The implementation of the biodiversity offset is likely to be a condition of Project Approval.

In addition to the recent fauna surveys, other surveys had been conducted prior to the establishment of the Tarrawonga Mine (e.g. Countrywide Ecological Service, 2005) and during operation of the mine (e.g. EcoLogical Australia, 2010). Leard State Forest has also been surveyed on multiple occasions over the past few years (Parsons Brinkerhoff, 2010; Cumberland Ecology, 2011). This survey information from other studies has been considered in Appendix E.

Broad Fauna Habitat Types

Seven broad fauna habitat types were identified in the Project area (Appendix E) (Figure 4-17):

- Dry Sclerophyll Forest Habitat - The upper slopes, and an area south of MLA 1, contain dry sclerophyll forest habitat in reasonably mature formation, although it has previously been cleared and/or logged.
- Dry Sclerophyll Forest Habitat (Cypress Monoculture Regrowth) - The dry sclerophyll forest habitat grades into this habitat type further down the slopes. It is dominated by White Cypress Pine (*Callitris glaucophylla*) with less habitat complexity than the dry sclerophyll forest habitat.
- Grassy Woodland Habitat - A small area of this habitat type occurs near the existing mine facilities area.
- Riparian/Floodplain Habitat - This habitat type occurs along the upper sections of Goonbri Creek in the Project area, to the north of MLA 2, and along other creeks in the locality.
- Grassland Habitat - Agricultural land dominates the plains to the south and south-east where there has been almost a complete removal of tree and shrub cover. These lands mainly comprise introduced grassland habitat but some less-cultivated areas contain derived native grassland.
- Farm Dams - A number of farm dams are located within the Project area and the immediate surrounds. These provide habitat resources for a range of vertebrate species.

The grassy woodland habitat and a component of the derived native grassland in the Project area meet the criteria for the Box-Gum Woodland EEC/CEEC. These listed communities are a comparatively minor component of the fauna habitats in the Project area, but nevertheless provide some habitat resources (e.g. nectar, pollen, invertebrates, hollows) likely to be used by native fauna including some threatened species (Appendix E).

Goonbri Creek

The existing condition of Goonbri Creek varies from good to degraded (Appendix E). Stream condition generally worsens downstream of the Leard State Forest boundary, as livestock grazing becomes the dominant surrounding land use. Bracteate Honeymyrtle low riparian forest occurs along Goonbri Creek in the Project area and upstream of MLA 2 (Figure 4-14). The understorey consists of shrubs, grasses and herbs along with a significant number of weed species. The riparian vegetation in the Project area has been subject to past clearance (in part) and grazing by livestock.

The in-stream habitat is variable. As an ephemeral creek system, Goonbri Creek provides episodic conditions that facilitate breeding events for frogs such as the Peron's Tree Frog and Spotted Grass Frog. Intermittent pools are present, but under prolonged drought conditions can completely dry out. Scattered logs of variable length and diameter are located in places within the Project area. The stream bed is mobile with a sandy-gravel base with little to no established vegetation. Patches of *Carex* spp. are present along the stream bed. The stretch of Goonbri Creek in the Project area is a partly degraded 'cut and fill' stream system with both primary and secondary incisions present.

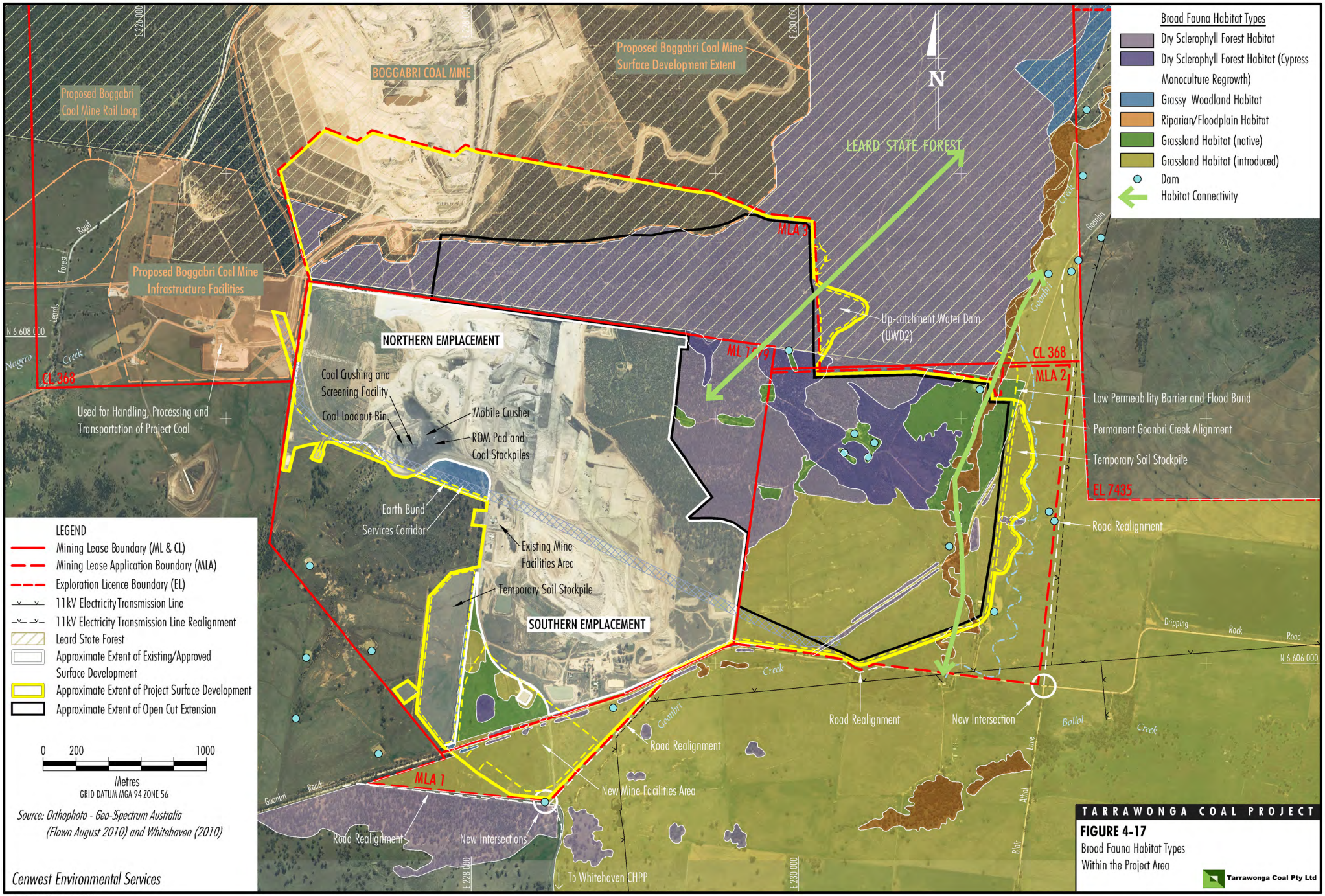
Fauna Species Composition

A total of 190 vertebrate fauna species were recorded by Cenwest Environmental Services in 2011 in the Project area and immediate surrounds, including 181 native species (comprising one fish, 11 amphibians, 25 reptiles, 120 bird species and 24 mammal species), as well as nine introduced species (Appendix E).

Goonbri Creek was found to have low fish species diversity with only one native species and one exotic species recorded, both being present in low numbers. Macroinvertebrate species richness was also low, and absent in some sites sampled (Appendix E).

Exotic Fauna

Nine introduced species were located during the survey. These included one fish (*Gambusia holbrooki*), one bird (Common Starling [*Sturnus vulgaris*]), and seven mammal species (Red Fox [*Vulpes vulpes*]; Brown Hare [*Lepus capensis*]; Rabbit [*Oryctolagus cuniculus*]; Black Rat [*Rattus rattus*]; House Mouse [*Mus musculus*]; Feral Pig [*Sus scrofa*]; and Feral Cat [*Felis catus*]) (Appendix E).



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Threatened Fauna Species under the TSC Act

Nine threatened fauna species listed under the TSC Act have been recorded in the Project area (Figure 4-18). These comprise seven birds, one glider and one bat (Appendix E):

- Turquoise Parrot (*Neophema pulchella*);
- Masked Owl (*Tyto novaehollandiae*);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- Speckled Warbler (*Pyrrholaemus saggitatus*);
- Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Squirrel Glider (*Petaurus norfolcensis*); and
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

The Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) was also recorded in the immediate surrounds during the surveys. All of these species, and eleven other threatened vertebrate fauna species, have been previously recorded within Leard State Forest: Spotted Harrier (*Circus assimilis*), Little Eagle (*Hieraaetus morphnoides*), Little Lorikeet (*Glossopsitta pusilla*), Barking Owl (*Ninox connivens*), Painted Honeyeater (*Grantiella picta*), Diamond Firetail (*Stagonopleura guttata*), Koala (*Phascolarctos cinereus*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Greater Long-eared Bat (south-eastern form) (*Nyctophilus timoriensis*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and Eastern Cave Bat (*Vespadelus troughtoni*) (Appendix E).

There are also potential habitat resources in the Project area for an additional nine threatened fauna species listed under the TSC Act: the Grey Falcon (*Falco hypoleucos*), Square-tailed Kite (*Lophoictinia isura*), Glossy Black-cockatoo (*Calyptorhynchus lathami*), Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*), Regent Honeyeater (*Anthochaera phrygia*), Spotted-tailed Quoll (*Dasyurus maculatus*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and Little Pied Bat (*Chalinolobus picatus*). The Square-tailed Kite was recently recorded flying over the Leard State Forest to the north of the Project area. For some of these species the limited habitat resources present in the Project area are unlikely to be sufficient to support a resident population.

All of the above mentioned threatened fauna species are listed under the TSC Act as 'Vulnerable', except the Swift Parrot (listed as 'Endangered') and Regent Honeyeater (listed as 'Critically Endangered').

Potential habitat for 30 threatened fauna species has been mapped within the Project area and the Project biodiversity offset area. Further information on threatened fauna species (including figures showing their local and regional records) is provided in Appendix E.

Aquatic Threatened Species under the* NSW *Fisheries Management Act, 1994

No threatened species or ecological communities listed under the NSW *Fisheries Management Act, 1994* were considered to be relevant to the Project fauna assessment (Appendix E).

Threatened Ecological Communities under the* NSW *Fisheries Management Act, 1994

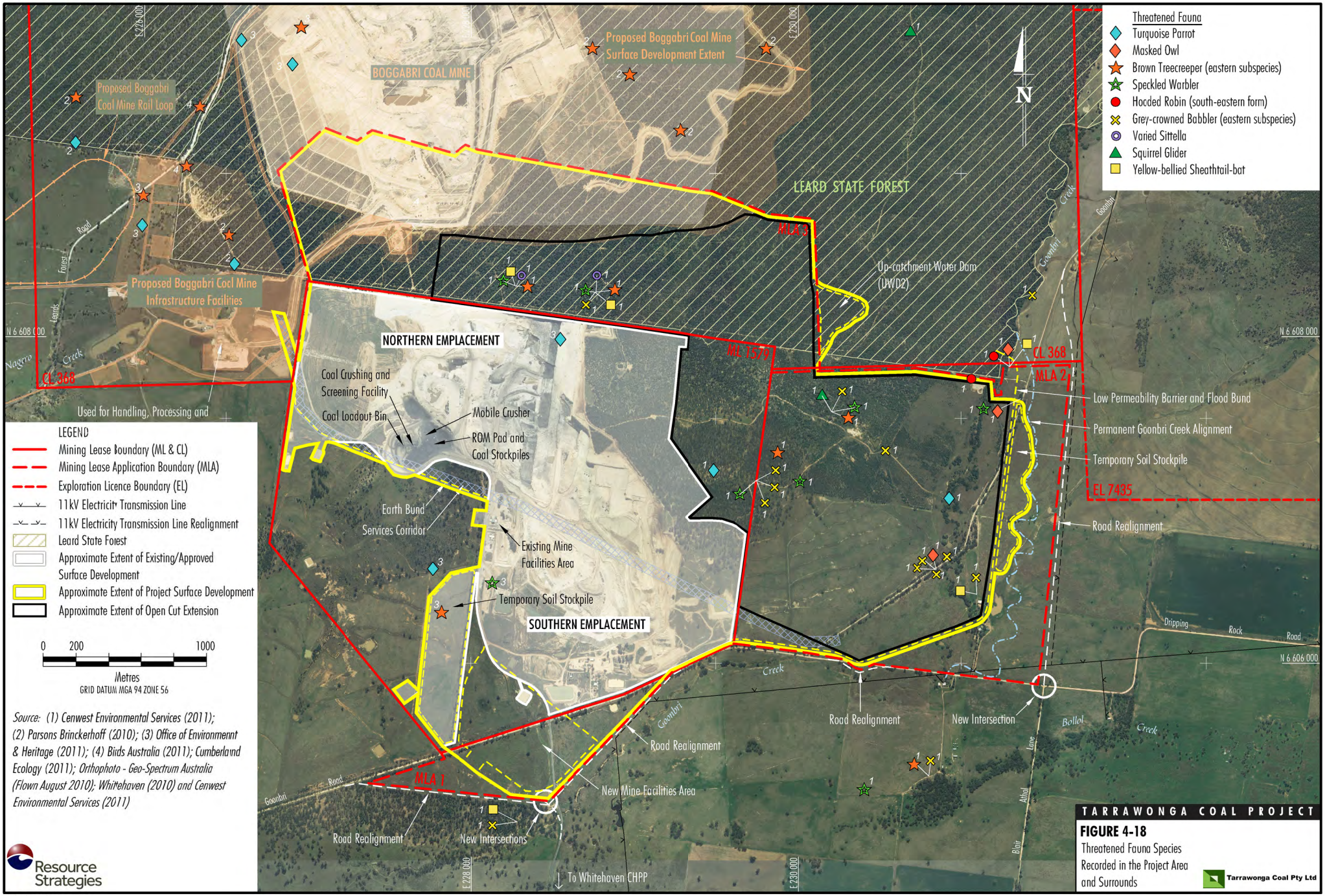
The Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River EEC (Lowland Catchment of the Darling River EEC) is listed under the NSW *Fisheries Management Act, 1994* and includes *all native fish and aquatic invertebrates within all natural creeks, rivers, streams and associated lagoons, billabongs, lakes, anabranches, flow diversions to anabranches and floodplains of the Darling River within NSW*.

The Namoi River catchment is included in the listing of the Lowland Catchment of the Darling River EEC. The lower reaches of Goonbri Creek traverse the Project area as an incised channel owing to the existence of a low landscape gradient.

Threatened Fauna Species under the Commonwealth EPBC Act

No threatened fauna species listed under the EPBC Act have been recorded in the Project area.

The Greater Long-eared Bat (south-eastern form) and Large-eared Pied Bat are listed as 'Vulnerable' under the EPBC Act and are known from within Leard State Forest (mainly towards the north). The Swift Parrot, Superb Parrot, Regent Honeyeater and Spotted-tailed Quoll are also listed under the EPBC Act, but there have been no recorded local sightings of these species. Matters of National Environmental Significance under the EPBC Act are further discussed in Appendix G.



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Migratory Species under the Commonwealth EPBC Act

Two migratory species were located during the survey, the Rainbow Bee-eater (*Merops ornatus*) and White-throated Needletail (*Hirundapus caudacutus*). A number of other migratory species are known to occur in the wider area (Appendix E). Matters of National Environmental Significance under the EPBC Act are further discussed in Appendix G.

4.10.2 Potential Impacts

Fauna Habitat Removal and Modification

Animals can use native vegetation for foraging, roosting, movement, shelter and breeding. The Project would require the progressive removal of approximately 334 ha of woodland and forest habitat and approximately 223 ha of grassland habitat (Table 4-28).

Table 4-28
Broad Fauna Habitat Types Proposed to be Cleared for the Project

Broad Fauna Habitat Types	Area (ha)
Dry Sclerophyll Forest Habitat	256
Dry Sclerophyll Forest Habitat (Cypress Monoculture Regrowth)	55
Grassy Woodland Habitat	8
Riparian/Floodplain Habitat	15
Grassland Habitat (native)	63
Grassland Habitat (introduced)	160
Total	**557**

Source: After Appendix E.

The Project area would be cleared progressively over the 17 year mine life, but would be accompanied by progressive rehabilitation of woodland/forest and riparian areas. The aim would be to reinstate cleared habitats over the medium to long-term.

Leard State Forest, and the adjoining Leard State Conservation Area, contain a large area of woodland and forest habitat that is relatively isolated in a predominantly agricultural landscape in the Liverpool Plains CMA Sub-region. Its uniqueness in the landscape adds to its conservation value, and its isolation means that cumulative impacts on its habitats are likely to adversely impact both resident fauna populations as well as species that may use Leard State Forest primarily as a movement pathway.

The portion of the proposed Project area (145 ha) that would impact Leard State Forest is elongated, relatively narrow, and located on the mid-southern edge of the forest. This area is situated between two existing mining operations and has lost habitat connectivity to the west, north-west and south-west.

Hollow-bearing Trees, Dead Wood and Dead Trees

Loss of hollow-bearing trees is a key threatening process listed under the TSC Act. A range of hollow-nesting birds, bats and arboreal mammals were recorded within the Project area, including cockatoos, parrots, gliders, possums and microbats (Appendix E). Five threatened fauna species that nest or roost in tree hollows were recorded in the Project area (not necessarily using tree hollows): Turquoise Parrot, Brown Treecreeper (eastern subspecies), Masked Owl, Squirrel Glider and Yellow-bellied Sheathtail-bat.

Removal of dead wood and dead trees is also a key threatening process listed under the TSC Act. Dead trees can provide tree hollows for a range of fauna as described above. Dead standing trees (stags) are generally uncommon across the range of habitats but nevertheless are present in small numbers. Fallen wood can provide habitat resources for fauna (e.g. lizards and nesting birds) (Appendix E).

Natural Flow Regimes

The *Alteration to the Natural Flow Regimes of Rivers and Streams and their Floodplains and Wetlands* is a key threatening process listed under the TSC Act and *Degradation of Native Riparian Vegetation along NSW Watercourses* is a similar Key Threatening Process under the NSW *Fisheries Management Act, 1994*.

In order to maintain flow downstream in Goonbri Creek, the Project would include the establishment of a permanent Goonbri Creek alignment adjacent to, and east of, the proposed open cut extent. The permanent alignment of Goonbri Creek would comprise a meandering re-constructed creekline within a broader corridor to direct surface water and sub-surface flows around the mine development areas.

Construction of the permanent Goonbri Creek alignment (including the low permeability barrier) would commence in approximately Year 12 of the Project (i.e. approximately three years prior to the open cut approaching the existing Goonbri Creek alignment, to allow sufficient time for the permanent Goonbri Creek alignment to be established) and constructed in a staged manner.

The Project is unlikely to adversely change the macroinvertebrate or fish community composition of Goonbri Creek given the current condition of the creek and the proposed management approach (Section 4.9.3).

The *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation* (DPI, 1999) has been considered in the Fauna Assessment. It was not considered to be relevant to the Project as no new waterway road crossings are proposed (Appendix E).

Groundwater Dependent Fauna

Stygofauna are aquatic subterranean invertebrate animals found in groundwater systems. As the open cut involves direct excavation into the alluvial groundwater systems (Section 4.4.2), any stygofauna that inhabit this portion of the aquifer would be lost. However, the alluvial groundwater system extends upstream, downstream and to the east of the planned open cut and is therefore likely to provide continuous habitat for stygofauna (i.e. species that may occur within the open cut are also likely to occur outside it). In addition, the permanent Goonbri Creek alignment and low permeability barrier have been designed to minimise changes/disruption to near surface groundwater flow along the retained sections of Goonbri Creek and associated alluvium.

Consequently, and as described in Section 4.4.2, there is expected to be negligible drawdown to the aquifers of the alluvial groundwater system (Appendix A), and as a result, no significant impacts on stygofauna outside the Project disturbance footprint are expected to occur.

High Frequency Fire

High frequency fire resulting in the disruption of lifecycle processes in plants and animals, and loss of vegetation structure and composition is a key threatening process listed under the TSC Act. High fire frequency is not likely to occur as a result of the Project as a Bushfire Management Plan (Whitehaven, 2011b) has been prepared for the Tarrawonga Coal Mine (Section 4.3.3).

Exotic Animals

The Rabbit, Red Fox, Feral Cat and Feral Pig have been recorded during surveys undertaken in the Project area. The land clearance associated with the Project is likely to displace any resident foxes and cats. If not controlled, there is a potential for an increase in the pressure on native fauna in the Leard State Forest. Also, activities associated with the Project may provide increased refuge and scavenging resources (e.g. discarded food scraps) for these species, unless appropriately managed to discourage exotic animals.

Fauna and Noise, Dust and Artificial Lighting

There is a potential for increased disruption to fauna surrounding the mine due to dust, noise, and artificial lighting. Measures would be adopted to minimise noise (Section 4.6.3), dust (Section 4.7.3) and artificial lighting (Section 4.12.3).

Fauna and Vehicular Traffic Movements

Vehicular traffic movements associated with the construction and operation of the Project have the potential to result in the mortality of some fauna species. Vehicular speed limits would be used to minimise these potential impacts (Section 4.10.3).

Potential Impacts on Threatened Fauna

A total of 30 threatened fauna species are considered likely to be affected or have the potential to be affected to some degree by the Project, either through loss of known or potential habitat and/or direct loss of individuals (Appendix E). In its letter dated 31 March 2011 attached to the EARs (Attachment 1), the OEH requested an assessment of the significance of impacts in accordance with Section 5A of the EP&A Act and the *Threatened Species Assessment Guidelines – The Assessment of Significance* (DECC, 2007a). These fauna assessments are provided in Appendix E.

The Project would result in the removal of known habitat for the following resident species recorded on-site:

- Turquoise Parrot – a moderately abundant parrot, both inside and outside of Leard State Forest.
- Masked Owl – a sparsely distributed owl that occupies a large territory in breeding pairs.
- Brown Treecreeper (eastern subspecies) – a small bird that depends on large areas of continuous woodland and open forest habitat.

- Speckled Warbler – a bird that requires large areas of continuous woodland and open forest habitat with a well developed grassy, part shrub understorey.
- Hooded Robin (south-eastern form) – a woodland bird that inhabits woodland, dry forest and semi-cleared farmland.
- Grey-crowned Babbler (eastern subspecies) – a woodland bird that occupies open woodland, edge habitats and farmlands with isolated trees.
- Varied Sittella – a small bird that resides in woodland and dry forest.
- Squirrel Glider – a hollow-dwelling mammal usually located in a range of woodland and forest habitats.
- Yellow-bellied Sheathtail-bat – a hollow-dwelling bat that can inhabit a variety of habitats.

None of these species are confined to the Project area since there are records of each outside of the Project area. Furthermore, it is considered likely that sufficient connectivity currently exists between the habitats within and outside of the Project area to enable movements of these species between areas (Appendix E).

The Project is unlikely to cause a net impact on any threatened fauna species over the medium to long-term since:

- clearing would be staged over a 17 year period;
- progressive rehabilitation of the post-mine landforms would result in re-establishment of woodland/forest; and
- conservation of the Project biodiversity offset area would restore and maintain 1,660 ha of woodland/forest over the medium to long-term.

Further information on threatened fauna species is provided in Appendix E. Threatened fauna listed under the EPBC Act are further discussed in Appendix G.

Cumulative Impacts

The main potential impact of the Project on fauna is considered to be the loss of habitat and the cumulative impact on the surrounding environment, particularly Leard State Forest. A cumulative impact assessment has been conducted that considers the incremental impacts of the Project added to other existing impacts, as well as proposed (but not yet approved) developments in the local area (Appendix E).

Each of the three developments that would impact Leard State Forest (the Project, proposed Continuation of Boggabri Coal Mine and the proposed Maules Creek Coal Project) would likely impact the Leard State Forest proportionally to the proposed land clearing (145 ha [1.9%] by the Project, 1,802 ha [24.1%] by the proposed Continuation of Boggabri Coal Mine and 992 ha [13.3%] by the proposed Maules Creek Coal Project).

The cumulative impact assessment considers the species present (species diversity, abundance and dynamics), patterns of species distribution, broad habitat types and ecosystem processes.

The cumulative impacts on habitat and fauna without consideration of the proposed mitigation outcomes would likely result in adverse changes to the resident fauna populations, including some threatened fauna species.

4.10.3 Mitigation Measures, Management and Monitoring

Existing Management of Biodiversity

An overview of the existing measures used at the Tarrawonga Coal Mine to manage potential impacts on biodiversity is provided in Section 4.9.3.

Proposed Biodiversity Management Plan

As described in Section 4.9.3, TCPL would prepare and implement a Biodiversity Management Plan for the Project that would cover the following aspects relevant to fauna:

- adopting land clearing strategies to minimise impacts on fauna;
- salvaging and re-using material from the site for habitat establishment;
- revegetation and habitat creation along the low flow channel of the permanent Goonbri Creek alignment;

- revegetation within the Goonbri Creek enhancement area;
- implementing a nest box program;
- enhancing farm dams;
- controlling feral animals;
- managing grazing and agricultural practices on Whitehaven-owned land;
- managing artificial lighting; and
- limiting vehicle speed limits.

The measures relevant to fauna are discussed below.

Land Clearing Strategies

Clearing of trees and shrubs would, where practicable, be restricted to late summer and autumn in order to avoid the spring when birds are nesting, winter when bats are hibernating and early to mid-summer when bats are bearing young.

Land clearance for the Project would be undertaken progressively, and the area cleared at any particular time would generally be no greater than that required to accommodate the mine's needs for the following twelve months.

Measures that would be used at the Project to minimise potential impacts on fauna during land clearing would be described in the Biodiversity Management Plan, and are summarised below:

- Areas requiring clearing would be delineated and would be restricted to the minimum area necessary to undertake the approved activities.
- Suitably trained or qualified person(s) would be present during the felling of identified hollow bearing trees to provide assistance with the identification, and if necessary, rescue and care of any injured fauna.
- The species, number and condition of fauna identified during clearing activities would be recorded and a summary provided in the AEMR.

Translocation of fauna would not be undertaken unless appropriate licences have been obtained from OEH. Although unlikely, if a Koala is found, it would be left to move away from the clearance area on its own accord.

Salvage of Habitat Features

Forests NSW, or a nominated contractor, would selectively salvage firewood and timber prior to clearing the proposed disturbance areas within Leard State Forest. The remaining vegetation from Project areas in Leard State Forest, plus the vegetation within other Project disturbance areas, would be re-used in the mine rehabilitation program. The ground-layer vegetation and low shrubs would be incorporated into the topsoil when it is stripped. Habitat features (e.g. trunks, logs, branches, small stumps and roots) would be salvaged during vegetation clearance activities and relocated to areas undergoing rehabilitation.

Where insufficient area is available for the direct transfer of cleared debris, the material would be stockpiled for later use in rehabilitating the post-mining landform. Tree hollows and logs would be selectively chosen for placement in areas where habitat enhancement is required. These features would be fixed to mature trees or placed on the ground.

Permanent Goonbri Creek Alignment

Establishment and rehabilitation of the permanent Goonbri Creek alignment is outlined in Sections 2.10.3, 4.9.3 and 5.

The low flow channel within the permanent Goonbri Creek alignment would be designed to follow a meandering path that mimics the existing channel alignment and thereby optimises in-stream and riparian habitats. This would include the creation of a pool-riffle system. It would include the construction of a system of leaky weirs (either constructed of log or loose rock) and keyed into banks to create a series of semi-permanent pools along the alignment. These 'weirs' would be designed to de-energise water flow and to facilitate some build up of sediment and vegetation in the base of the creek.

Riparian vegetation would be planted within the low flow channel and along its banks as described in Sections 4.9.3 and 5.

Revegetation of the Goonbri Creek Enhancement Area

A riparian vegetation enhancement program would be implemented along a 3.2 km section of Goonbri Creek downstream of the permanent Goonbri Creek alignment, as outlined in Sections 4.9.3 and 5.

Nest Box Program

A nest box program would be implemented in the Leard State Forest. The program would comprise:

- a pre-installation assessment of proposed nest box placement areas (e.g. to identify areas with low hollow abundance and with semi-mature regenerated vegetation);
- installation of a variety of nest boxes for use by birds, arboreal mammals, and bats;
- installation of similar types of nest boxes in groups;
- design of nest boxes to maximise the likelihood that local hollow-dwelling fauna would use them for shelter and breeding, in particular threatened species such as the Little Lorikeet, Turquoise Parrot, Brown Treecreeper (eastern subspecies), Masked Owl, Barking Owl and Squirrel Glider; and
- installation of bat boxes for potential use by the Yellow-bellied Sheathtail-bat, Greater Long-eared Bat (south-eastern form) and Little Pied Bat.

Once installed, the nest boxes would be monitored by an appropriately qualified and experienced person to observe fauna usage. If the nest box has not been occupied after two years, consideration would be given to moving the nest box to an alternative location within the Leard State Forest.

A detailed monitoring report would be prepared annually that includes a summary of previous monitoring reports, results of that years monitoring and proposed intervention strategies, if required. The monitoring results would be summarised in the AEMR.

Farm Dam Enhancements

The fauna habitat value of suitable farm dams surrounding the Project area would be enhanced by one or more of the following:

- installing plain wire fencing to exclude livestock grazing and incorporating external troughs for cattle outside the enclosure;
- planting a range of submerged and fringing vegetation (rushes);
- placing a partially submerged log(s) in the dam for use by a variety of fauna;
- placing a log pile for refuge habitat on the edge of the dam; and
- selective woodland tree plantings, including some shrub species.

Feral Animal Control

Feral animal control measures to be undertaken as part of the Project include:

- trapping and/or baiting of animal pests (e.g. Rabbits and Red Foxes); and
- follow-up site monitoring to determine the effectiveness of trapping and/or baiting programs.

Feral animal control measures would be implemented in accordance with the requirements of the Livestock Health and Pest Authorities. A summary of the monitoring results would be reported in the AEMR.

Artificial Lighting

Lighting strategies/control measures to minimise potential night-lighting impacts are described in Section 4.12.3.

Vehicle Speed Limits

The on-site speed limit of 40 kilometres per hour (km/hr) would continue to be applied to new haul roads and internal roads.

Proposed Rehabilitation Management Plan

Progressive rehabilitation and revegetation of the Project areas is outlined in Sections 4.9.3 and 5.

Proposed Farm Management Plan

Whitehaven owns and manages several properties around the Project area. These properties are used for grazing of livestock and some cropping. Various measures would be adopted to manage the Whitehaven-owned properties to optimise both farming and biodiversity outcomes, including:

- proactive management of stock (cell grazing, low intensity grazing in overgrazed areas);
- enhancement of farm dams;
- selected areas of natural regeneration (e.g. along watercourses or within or adjacent to) existing remnant woodland patches, native plant windbreaks;
- nest box placements; and
- riparian restoration along semi-permanent creek/drainage lines.

Components of the Farm Management Plan (Section 4.3.3) that relate to biodiversity outcomes would be prepared by a suitably qualified person(s) within 12 months of Project approval to facilitate the management of Whitehaven-owned properties.

Other Management Measures Relevant to Fauna

Weed control measures that would be implemented during the life of the Project are described in Section 4.9.3.

4.10.4 Offset Strategy

As described in Section 4.9.3, the EARs (Attachment 1) state that the EA must include a description of the measures that would be implemented to offset the impacts of the Project. The biodiversity offset is described in Section 4.9.3 and Appendices E and F. In summary, the biodiversity offset has the following values relating to fauna:

- It is located within the same CMA region as the Project area and therefore has the capacity to benefit biodiversity values in the region.
- It is located adjacent to Mount Kaputar National Park and compliments the existing reserve system.
- All broad fauna habitat types present in the Project area are represented in the biodiversity offset.
- The biodiversity offset has the capacity to improve (with moderate to high resilience) through continued removal of the threatening processes and active management.
- Ephemeral creeks such as Maules Creek and Teatree Gully occur within the biodiversity offset, providing a diversity of habitats.
- Most of the threatened species recorded in the Project area have also been recorded within the biodiversity offset, and those that haven't have potential habitat in the biodiversity offset (Figures 4-19 and 4-20).
- A substantial area of Box-Gum Woodland EEC/CEEC occurs in the biodiversity offset (226 ha) and is more diverse than that which would be cleared.

4.11 ROAD TRANSPORT

A Road Transport Assessment for the Project was undertaken by Halcrow (2011) and is presented in Appendix H.

The assessment was prepared in accordance with the *Guide to Traffic Generating Developments* (RTA, 2002), and where relevant, makes reference to the RTA's (1996) *Road Design Guide* and Austroads standards.

Section 4.11.1 provides a description of the existing road network and traffic volumes. Section 4.11.2 provides an assessment of the potential impacts of the Project to the road network in the vicinity of the Tarrawonga Coal Mine. Section 4.11.3 provides relevant mitigation, management and monitoring measures for road transport.

4.11.1 Existing Environment

Haul Route

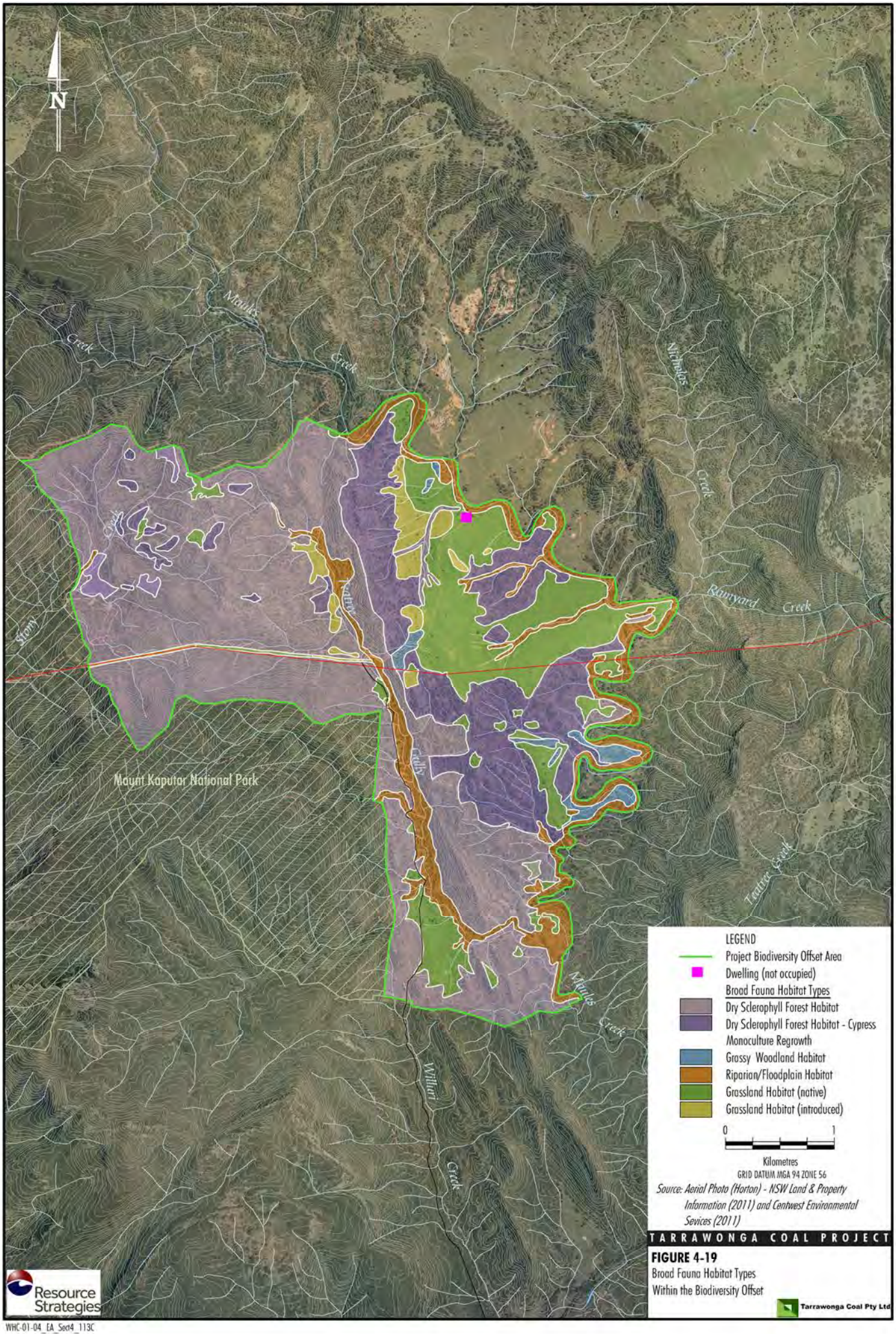
Sized ROM coal produced at the Tarrawonga Coal Mine is loaded into trucks and transported to the Whitehaven CHPP via the ROM coal road transport route (Figure 4-21), which consists of a combination of public and private roads. The public roads on the route include Rangari Road, Hoad Lane, Blue Vale Road and the Kamilaroi Highway (Figure 4-21).

Road Hierarchy and Conditions

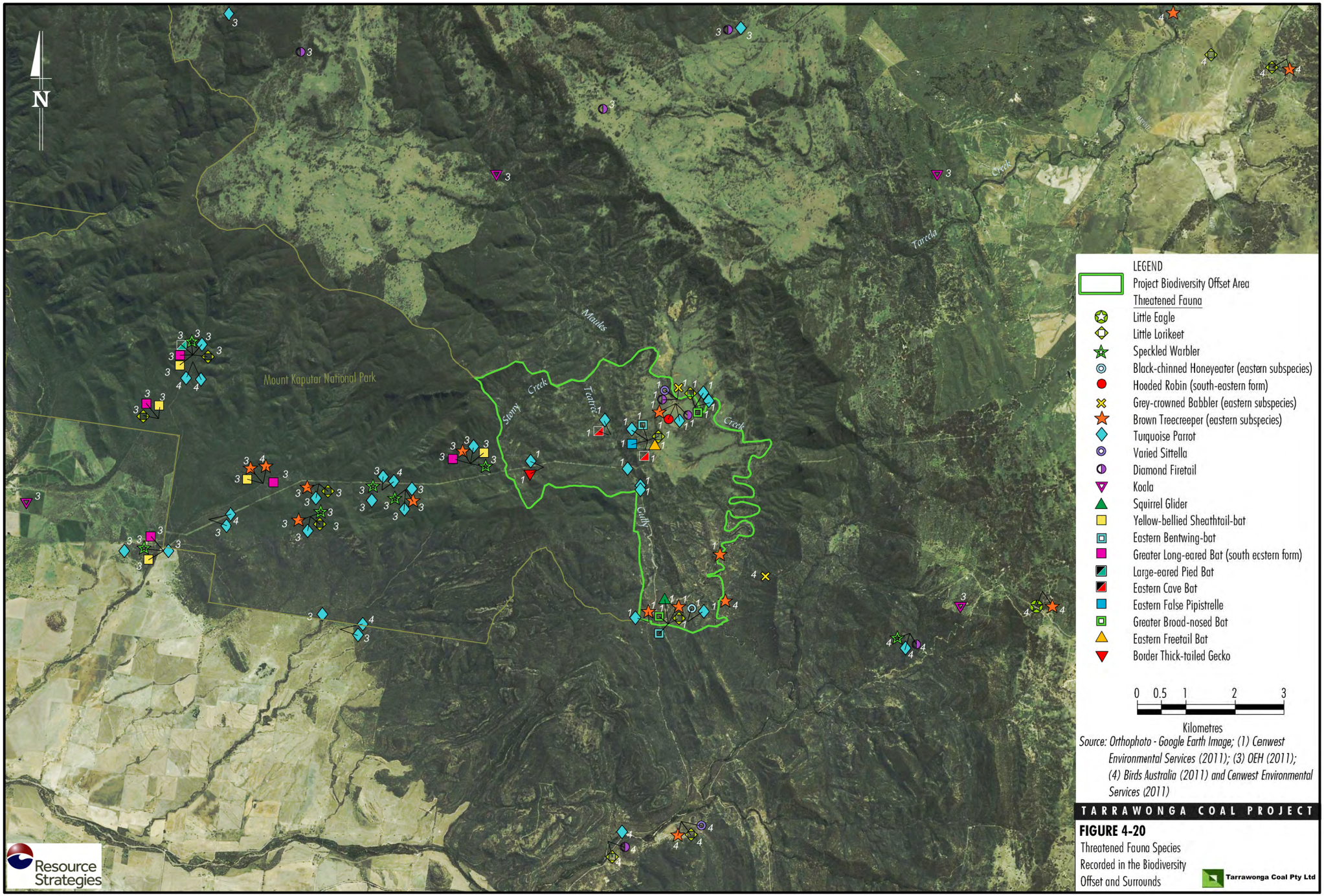
State Roads

Kamilaroi Highway (State Highway 29) runs generally north-south to the west of the Tarrawonga Coal Mine and provides a link between the Upper Hunter region and the north-west of NSW. The Kamilaroi Highway provides access to regional centres such as Gunnedah, Boggabri, Narrabri and Bourke.

In the vicinity of the Tarrawonga Coal Mine, the Kamilaroi Highway has a single travel lane in each direction and a posted speed limit of 100 km/hr. At its intersection with Rangari Road, a separate right turn lane and a left turn deceleration lane are provided on the Kamilaroi Highway. The intersection with Blue Vale Road has separate deceleration and acceleration lanes to accommodate the slower moving coal trucks on the haul route with minimum disruption to through traffic (Appendix H).



WHC-01-04_EA_Sect4_113C



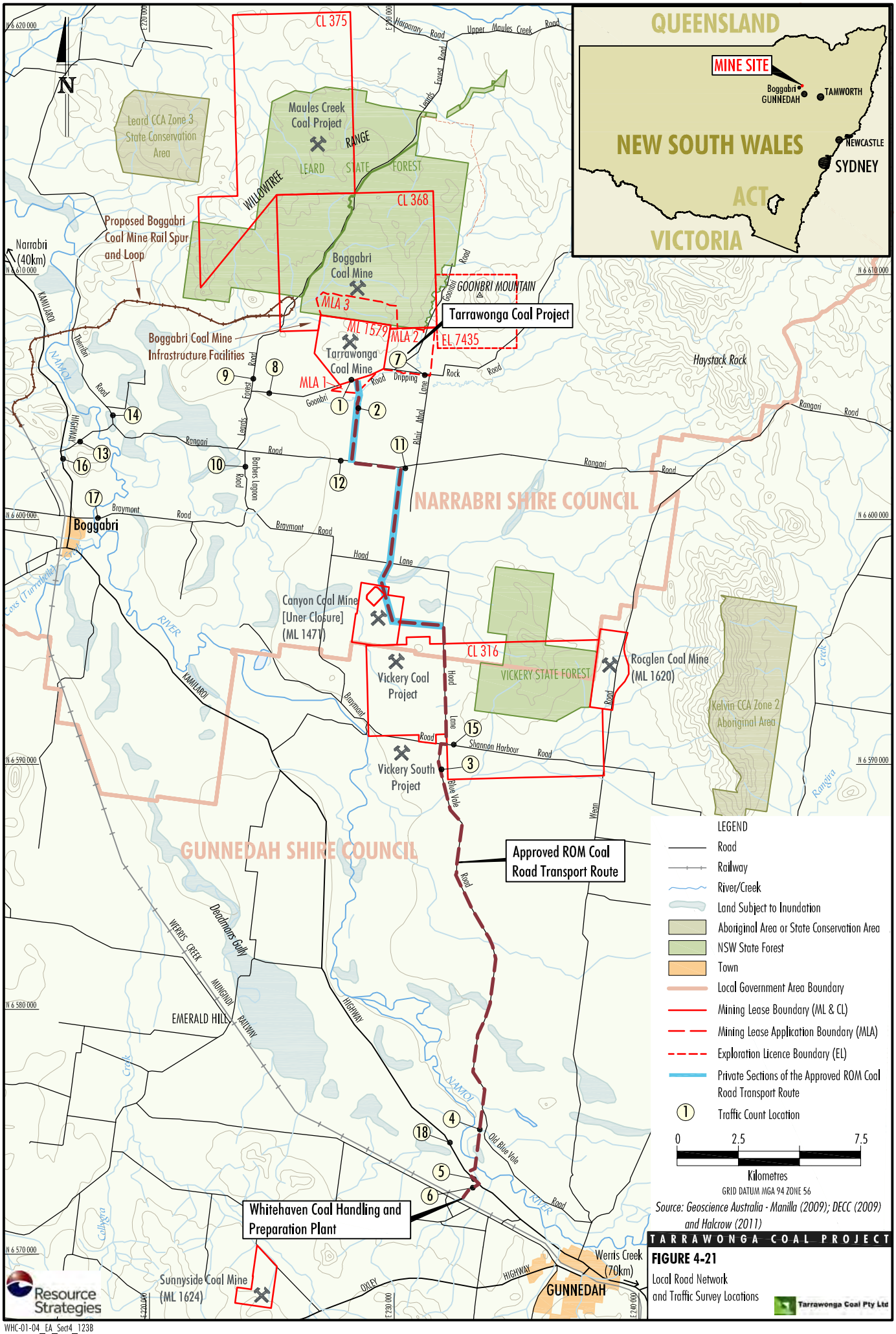
TARRAWONGA COAL PROJECT

FIGURE 4-20

Threatened Fauna Species Recorded in the Biodiversity Offset and Surrounds

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_Sect4_121C



WHC-01-04_EA_Sect4_123B

Regional Roads

Rangari Road (Main Road 357) runs in an approximately east-west direction and is located to the south of the Tarrawonga Coal Mine (Figure 4-21) and links between the Kamilaroi Highway and Manilla.

Rangari Road typically has a single travel lane in each direction, and a posted speed limit of 80 km/hr. Rangari Road crosses the Namoi River about 1.6 km to the east of its intersection with the Kamilaroi Highway. At this bridge, Rangari Road is narrowed to a single lane with a 10 km/hr speed limit, and eastbound traffic is required to give way to westbound traffic (Appendix H).

Traffic associated with the Boggabri Coal Mine uses Rangari Road to access Leards Forest Road.

Local Roads

Blue Vale Road provides a north-south connection from the Kamilaroi Highway near Gunnedah to the intersection of Hoad Lane, Shannon Harbour Road and Braymont Road (Figure 4-21). At this intersection, Hoad Lane and Blue Vale Road form the main road, with Shannon Harbour Road and Braymont Road forming staggered tee intersections. Blue Vale Road has a sealed surface with a single travel lane in each direction and centre line marking along much of its length (Appendix H).

Hoad Lane provides a connection from Blue Vale Road at the Braymont Road/Shannon Harbour Road intersection northwards and reconnects with Braymont Road to the north-west of the former Canyon Coal Mine (Figure 4-21). A private access road to the Canyon Coal Mine intersects with Hoad Lane at a tee intersection.

South of the Canyon Coal Mine access road, Hoad Lane has a sealed surface, with a single travel lane in each direction, and centre road markings along most of its length. A right turn lane is provided in Hoad Lane for vehicles turning into Shannon Harbour Road, and an acceleration lane is provided for vehicles turning left into Hoad Lane/Blue Vale Road from Shannon Harbour Road. To the north of the Canyon Coal Mine access road, Hoad Lane has an unsealed surface.

Braymont Road provides a link from Boggabri east and south-east to Blue Vale Road (Figure 4-21). Along its length it intersects with Barbers Lagoon Road at a three way intersection and Hoad Lane at a tee intersection (Figure 4-21). To the west of the Namoi River, Braymont Road has a sealed surface with a single travel lane in each direction, and to the east of the Namoi River, it has an unsealed surface (Appendix H).

Barbers Lagoon Road is a local road that extends in a north-south direction between Braymont Road in the south and Rangari Road in the north (Figure 4-21). The northernmost 700 m of Barbers Lagoon Road has a sealed surface with a single travel lane in each direction and a marked centre line on its approach to Rangari Road. The remaining length of Barbers Lagoon Road has an unsealed surface (Appendix H).

Goonbri Road provides access to the Tarrawonga Coal Mine (Figure 4-21) and has a single travel lane in each direction. Apart from a short section near its intersection with Leards Forest Road, Goonbri Road is unsealed (Appendix H).

Leards Forest Road extends northwards from Rangari Road and connects to Harparary Road in the north (Figure 4-21). It has a single travel lane in each direction and typically does not have road markings. Its intersection with Rangari Road is a give way controlled tee intersection with no additional turn lanes or deceleration lanes (Appendix H).

The Boggabri Coal Mine has its vehicular access point on Leards Forest Road.

Existing Traffic Volumes

Available traffic flow data was reviewed and additional traffic counts were conducted in November and December 2010 and February 2011. Relevant traffic counter locations are shown on Figure 4-21 and the existing daily traffic volumes are summarised in Table 4-29.

Roadway Capacity

Austroads (2009) defines a Level of Service as a qualitative measure describing operational conditions within a traffic stream (in terms of speed, travel time, room to manoeuvre, safety and convenience) and their perception by motorists and passengers. Level of Service A provides the best traffic conditions, with no restriction on desired travel speed or overtaking. The existing Level of Service at each of the survey locations in Table 4-29 would be A (Appendix H).

Table 4-29
Existing Average Weekday Traffic Volumes

Site[1]	Road and Location	Surveyed Total Traffic (vehicles/day)
Haul Route		
1	Tarrawonga Coal Mine Access Rd	564
2	Haul Route south of Dripping Rock Rd	540
3	Blue Vale Rd south of Shannon Harbour Rd	480
4	Blue Vale Rd northeast of Kamilaroi Hwy	1,515
5	Kamilaroi Hwy between Blue Vale Rd and CHPP	3,188
6	CHPP Access Rd	673
Other Locations		
7	Dripping Rock Rd east of Goonbri Rd	21
8	Goonbri Rd east of Leards Forest Rd	57
9	Leards Forest Rd north of Goonbri Rd	311
10	Barbers Lagoon Rd south of Rangari Rd	51
11	Rangari Rd east of Haul Route	67
12	Rangari Rd west of Haul Route	637
13	Rangari Rd east of Kamilaroi Hwy	369
14	Therribri Rd north of Rangari Rd	62
15	Shannon Harbour Rd east of Blue Vale Rd	217
16	Kamilaroi Hwy south of Rangari Rd	2,028
17	Braymont Rd at Namoi River Bridge[2]	122
18	Kamilaroi Hwy north of Blue Vale Rd	2,488

Source: After Appendix H.
[1] Refer to Figure 4-21.
[2] Data available for Tuesday to Friday only.

Road Safety

A review of RTA road accident data in the vicinity of the Tarrawonga Coal Mine for the period October 2005 to September 2010 has been undertaken by Halcrow (2011) as a component of the Road Transport Assessment. The review of the RTA accident data identified no particular accident pattern or causation factors in the local area (Appendix H).

School Buses

A number of school buses operate in the vicinity of the Tarrawonga Coal Mine, however, the majority of these do not operate on the sized ROM coal road transport route (Appendix H).

In accordance with Condition 38(b) of the Development Consent (DA 88-4-2005), coal trucks must reduce speed to 40 km/hr in the vicinity of the school bus when it is operating on Hoad Lane.

Road Maintenance Agreements

TCPL and Whitehaven have entered into road maintenance agreements with both the Narrabri Shire Council and Gunnedah Shire Council.

The road maintenance agreement with Narrabri Shire Council covers the section of the sized ROM coal road transport route within the Narrabri Shire, and requires the road and intersections to be maintained in good condition at all times at TCPL's cost.

The road maintenance agreement with Gunnedah Shire Council covers the maintenance of roads used by Whitehaven in the Gunnedah Shire. Under this agreement, Whitehaven is required to pay 95% of road maintenance costs incurred by Gunnedah Shire Council for Hoad Lane and Blue Vale Road.

4.11.2 Potential Impacts

Potential traffic impacts of the Project on traffic generation, roadway capacity and safety are assessed in Appendix H and summarised below.

Project Traffic Generation

Table 4-30 summarises the estimated existing Tarrawonga Coal Mine and projected Project daily vehicle movements (traffic in both directions).

The Project would reduce the vehicle kilometres travelled by coal trucks transporting sized ROM coal from the Tarrawonga Coal Mine to the Whitehaven CHPP by approximately 3.6 million vehicle kilometres travelled per year, once suitable approvals and upgrades are in place for the transfer of ROM coal to the Boggabri Coal Mine. This reduction in truck movements would improve the efficiency of the relevant roads for the remaining road users (Appendix H).

Cumulative Traffic Increases

The Project life would be approximately 17 years. In order to conservatively consider the potential impacts of the Project in the context of potential background traffic growth and traffic growth associated with other proposed projects, an annual baseline growth rate and the expected traffic generation from key projects has been considered (Appendix H).

Based on an analysis of RTA traffic volume data, a 1% pa baseline traffic growth rate was applied to the existing traffic volumes provided in Table 4-29 (Appendix H). In addition, the expected traffic movements generated from the proposed Continuation of Boggabri Coal Mine and the Maules Creek Project have been estimated.

Table 4-31 presents the predicted traffic flows in 2013, 2016 and 2029 on key roads including additional Project traffic flows, traffic flows from these other proposed projects and estimated background traffic growth.

Table 4-30
Existing Tarrawonga Coal Mine and Predicted Project Traffic Volumes (Vehicles/Day)

Site[1]	Road and Location	Existing	Project Year 1 (2013)	Project Year 4 (2016)	Project Year 17 (2029)
Haul Route					
1	Tarrawonga Coal Mine Access Rd	564	746	370	370
2	Haul Route south of Dripping Rock Rd	541	713	339	339
3	Blue Vale Rd south of Shannon Harbour Rd	480	607	217	217
4	Blue Vale Rd northeast of Kamilaroi Hwy	480	607	217	217
5	Kamilaroi Hwy between Blue Vale Rd and CHPP	478	607	217	217
6	CHPP Access Rd	312	312	0	0
Other Locations					
7	Dripping Rock Rd east of Goonbri Rd	2	2	2	2
8	Goonbri Rd east of Leards Forest Rd	20	29	27	27
9	Leards Forest Rd north of Goonbri Rd	0	0	0	0
10	Barbers Lagoon Rd south of Rangari Rd	10	15	15	15
11	Rangari Rd east of Haul Route	12	18	18	18
12	Rangari Rd west of Haul Route	48	87	102	102
13	Rangari Rd east of Kamilaroi Hwy	56	100	114	114
14	Therribri Rd north of Rangari Rd	0	0	0	0
15	Shannon Harbour Rd east of Blue Vale Rd	0	0	0	0
16	Kamilaroi Hwy south of Rangari Rd	32	50	38	38
17	Braymont Rd at Namoi River Bridge	10	15	15	15
18	Kamilaroi Hwy north of Blue Vale Rd	2	0	0	0

Source: After Appendix H.

[1] Refer to Figure 4-21.

Table 4-31
Predicted 2013, 2016 and 2029 Cumulative Traffic Volumes

Site[1]	Road and Location	Existing	Project Year 1 (2013)	Project Year 4 (2016)	Project Year 17 (2029)
Haul Route					
1	Tarrawonga Coal Mine Access Rd	564	746	370	370
2	Haul Route south of Dripping Rock Rd	540	713	339	339
3	Blue Vale Rd south of Shannon Harbour Rd	480	677	221	221
4	Blue Vale Rd northeast of Kamilaroi Hwy	1,515	1,743	1,318	1,452
5	Kamilaroi Hwy between Blue Vale Rd and CHPP	3,188	3,468	3,093	3,445
6	CHPP Access Rd	673	684	383	430
Other Locations					
7	Dripping Rock Rd east of Goonbri Rd	21	68	97	78
8	Goonbri Rd east of Leards Forest Rd	57	113	141	123
9	Leards Forest Rd north of Goonbri Rd	311	928	1,080	897
10	Barbers Lagoon Rd south of Rangari Rd	51	128	62	68
11	Rangari Rd east of Haul Route	67	150	227	189
12	Rangari Rd west of Haul Route	637	768	876	908
13	Rangari Rd east of Kamilaroi Hwy	369	847	1,045	929
14	Therribri Rd north of Rangari Rd	62	64	144	152
15	Shannon Harbour Rd east of Blue Vale Rd[2]	217	224	230	258
16	Kamilaroi Hwy south of Rangari Rd	2,028	2,430	2,592	2,740
17	Braymont Rd at Namoi River Bridge	122	131	134	149
18	Kamilaroi Hwy north of Blue Vale Rd	2,488	2,749	3,011	3,223

Source: After Appendix H.

[1] Refer to Figure 4-21.

It is expected that for all survey locations shown on Figure 4-21 the future Level of Service would remain A, with the predicted traffic volumes shown in Table 4-31.

ROM Coal Road Transport Route Intersections with Kamilaroi Highway

The ROM coal road transport route intersects with the Kamilaroi Highway at the Whitehaven CHPP access road and the intersection with Blue Vale Road. The two intersections are each tee intersections, with the Kamilaroi Highway being the road with priority.

The intersections are both constructed to a good standard, with deceleration and acceleration lanes to accommodate the slower moving coal trucks. The traffic generated by the Project does not warrant an upgrade of these intersections (Appendix H).

Proposed Road Realignments and New Intersections

As described in Section 2.6.3, the extent of the Project open cut and mine waste rock emplacements would require the realignment of sections of Goonbri Road and establishment of a new intersection with Dripping Rock Road to provide for continued public road accessibility around the southern and eastern extents of the Project (Figures 2-1, 2-4 and 2-8).

The new sections of road and the intersections would be designed to the same standard as the existing roads, and in accordance with the requirements of the Narrabri Shire Council and the RTA's (1996) *Road Design Guide* (Appendix H).

Road Safety Review

The Road Transport Assessment did not identify any particular accident patterns or causation factors in the vicinity of the Project (Section 4.11.1). The increases in traffic resulting from the Project would be minimal and with sized ROM coal haulage ceasing after the initial period, Halcrow (2011) anticipates that no significant road safety issues would occur as a result of the Project.

Temporary Road Closures Associated with Blasting

When blasting is undertaken within 500 m of Goonbri Road, temporary closure of the road for short periods (i.e. approximately 15 minutes) would be required. Approval would be sought from the Narrabri Shire Council to temporarily close sections of Goonbri Road to allow blasting to occur.

School Buses

Based upon shift times, the Project's morning peak traffic would occur between 6.00 am and 7.00 am and afternoon peak traffic would occur between 5.00 pm and 7.00 pm. This is outside of the hours that the school bus operates on the route that runs along and across the haul route, and therefore, the potential for conflict between Project traffic and school buses is low (Appendix H).

In addition, the Project would result in the cessation of the transport of sized ROM coal on the road transport route once suitable approvals and upgrades are in place for transfer of ROM coal to the Boggabri Coal Mine.

Oversize Vehicles

A number of oversize loads would be generated during the life of the Project. It is expected that oversize vehicles would approach the Project via Kamilaroi Highway and the ROM coal road transport route. All such loads would be transported with the relevant permits, licences and escorts as required by the government agencies. The proposed route would be negotiated with the relevant local councils on a case-by-case basis.

4.11.3 Mitigation Measures, Management and Monitoring

The Project would result in minor impacts on the operation of the surrounding road network.

Additional traffic associated with construction, increased number of employees and increased deliveries and visitors would be offset by the cessation of coal trucks hauling sized ROM coal to the Whitehaven CHPP. As such, no significant impacts on the performance, capacity, efficiency and safety of the local road network are expected as a result of the Project, and no specific monitoring or mitigation measures are considered warranted (Appendix H).

Notwithstanding, TCPL would implement the following road transport management measures:

- Temporarily close Goonbri Road when blasting is undertaken within 500 m of the road (Section 4.11.2).
- All oversized vehicles would have the relevant permits, licences and escorts, as required by the government agencies and the proposed route would be negotiated with the relevant local councils.
- All oversize vehicles loads would be appropriately secured and covered.
- The Goonbri Road re-alignment would be designed and constructed in accordance with the requirements of Narrabri Shire Council and the RTA's (1996) *Road Design Guide*.

As described in Section 4.11.1, TCPL and Whitehaven currently have road maintenance agreements with the Narrabri Shire Council and the Gunnedah Shire Council. It is anticipated that road maintenance agreements would continue to be maintained over the life of the Project, based on the levels of Project traffic generated.

4.12 VISUAL CHARACTER

A Visual Assessment for the Project was undertaken by Urbis (2011) and is presented in Appendix J.

A description of the existing visual setting of the Project is provided in Section 4.12.1. Section 4.12.2 describes the potential visual impacts of the Project and Section 4.12.3 outlines visual impact mitigation measures, management and monitoring.

4.12.1 Existing Environment

The Project area and surrounds comprise a number of distinct land use types and landscape units.

These include agricultural areas, the existing Boggabri Coal Mine and Tarrawonga Coal Mine, Leard State Forest, residential dwellings, Goonbri Mountain, ridgelines (i.e. Willowtree Range) and streams including Goonbri Creek, Bollol Creek and Nagero Creek. Land use and key landscape features that contribute to visual character and scenic quality are described below in the context of the regional, sub-regional and local settings.

Views of the Tarrawonga Coal Mine from the surrounding area are generally limited due to the flat to slightly undulating topography and the presence of scattered vegetation along roadsides and around dwellings that partially or wholly screen potential views (Appendix J).

Topographic features in the vicinity of the Project are described in Section 4.3.1.

Regional Setting (>5 km)

The regional setting has attributes of moderate scenic quality due to the presence of an unnamed wooded range 9 km to the east of the Project and the Willowtree Range to the north. The contrast between the vegetation and topography of the ranges and agricultural areas of the valley adds to visual interest.

A number of reserved areas (Vickery State Forest, Leard State Conservation Area, Kelvin CCA Zone 2 Aboriginal Area and Mount Kaputar National Park) are located in the regional setting.

The regional setting also has many attributes of low scenic quality due to the generally flat, cleared dryland agricultural areas that dominate the landscape (Appendix J).

Sub-regional Setting (1 to 5 km)

The sub-regional setting has many attributes of low scenic quality due to the generally flat, cleared dryland agricultural areas, but also has attributes of moderate scenic quality due to the presence of Goonbri Mountain and other smaller localised hills and associated areas of dense vegetation (Appendix J).

Local Setting (<1 km)

The local setting has been heavily modified over time with the majority of vegetation disturbed by historic agricultural clearing, and the presence of the Tarrawonga Coal Mine. The overall visual character of the local setting is considered to be of low scenic quality (Appendix J).

To the immediate north of the Project, is the Leard State Forest which predominantly comprises of native woodland and forest vegetation and is of moderate scenic quality.

The Leard State Forest is zoned for the purposes of forestry, recreation and mineral extraction. The existing Boggabri Coal Mine, located in the Leard State Forest to the immediate north-west of the Project, also comprises part of the existing local visual setting.

4.12.2 Potential Impacts

The major aspects of the Project considered to have the potential to impact on the visual landscape include (Appendix J):

- modification of topographic features including:
  - the extension of the open cut;
  - the extension of the Northern and Southern Emplacements;
  - a temporary increase in height of the Southern Emplacement prior to a reduction in final height during rehabilitation;
  - construction of the permanent flood bund;
  - construction of the noise control earth bund; and
  - establishment of the permanent Goonbri Creek alignment;
- re-alignment of sections of Goonbri Road; and
- extension of lighting associated with extended night-time mining operations.

The final elevation of the Northern Emplacement would remain unchanged at a height of 370 m AHD. The height of the Southern Emplacement would temporarily increase to a maximum height of 360 m AHD (i.e. an increase of 20 m) during the operational life of the Project. During rehabilitation the elevation of the Southern Emplacement would be reduced to a final height of approximately 330 m AHD (Section 5.4.2).

The changes described above, while altering the layout and extent of the approved/existing mine, are effectively extensions to, and consolidation of, existing approved mine landforms (Appendix J).

Visual Assessment Methodology

The potential visual impacts of the Project were assessed by evaluating the level of visual modification of the development in the context of the visual sensitivity of relevant surrounding land use areas.

The degree of visual modification of a proposed development can be measured as an expression of the visual interaction, or the level of contrast between the development and the existing visual environment, and is generally considered to decrease with distance (Appendix J).

Visual (viewer) sensitivity is a measure of how critically a change to the existing landscape would be viewed from various use areas, where different activities are considered to have different sensitivity levels (Appendix J). Visual impacts were determined generally in accordance with the matrix presented in Table 4-32.

Table 4-32
Visual Impact Matrix

Visual Modification \ Viewer Sensitivity	H	M	L
H	H	H	M
M	H	M	L
L	M	L	L
VL	L	VL	VL

VL = Very Low
L = Low
M = Moderate
H = High

Source: Appendix J.

Visual Impact Assessment

Visual simulations were prepared for the locations identified in Table 4-33 and shown on Figure 4-22. The simulations of the Project landforms during Year 12 are when the landforms would be at their maximum heights, and therefore, represent the greatest potential for visual impact. The post-mining simulation illustrates the conceptual landform following completion of mining and rehabilitation activities.

Table 4-33
Locations of Visual Simulations

Visual Simulation Location	Potential View of Project Landforms	Figure
Dwelling – Bellevue	East over cleared agricultural land towards the Northern and Southern Emplacements.	4-23
Dwelling – Coomalgah	West over cleared agricultural land towards the Northern and Southern Emplacements.	4-24
Dwelling – Ambardo	North over cleared agricultural land towards the Northern and Southern Emplacements.	4-25
Road – Goonbri Road (south of Project)	North-east over cleared agricultural land towards the Northern and Southern Emplacements.	4-26

Source: After Appendix J.

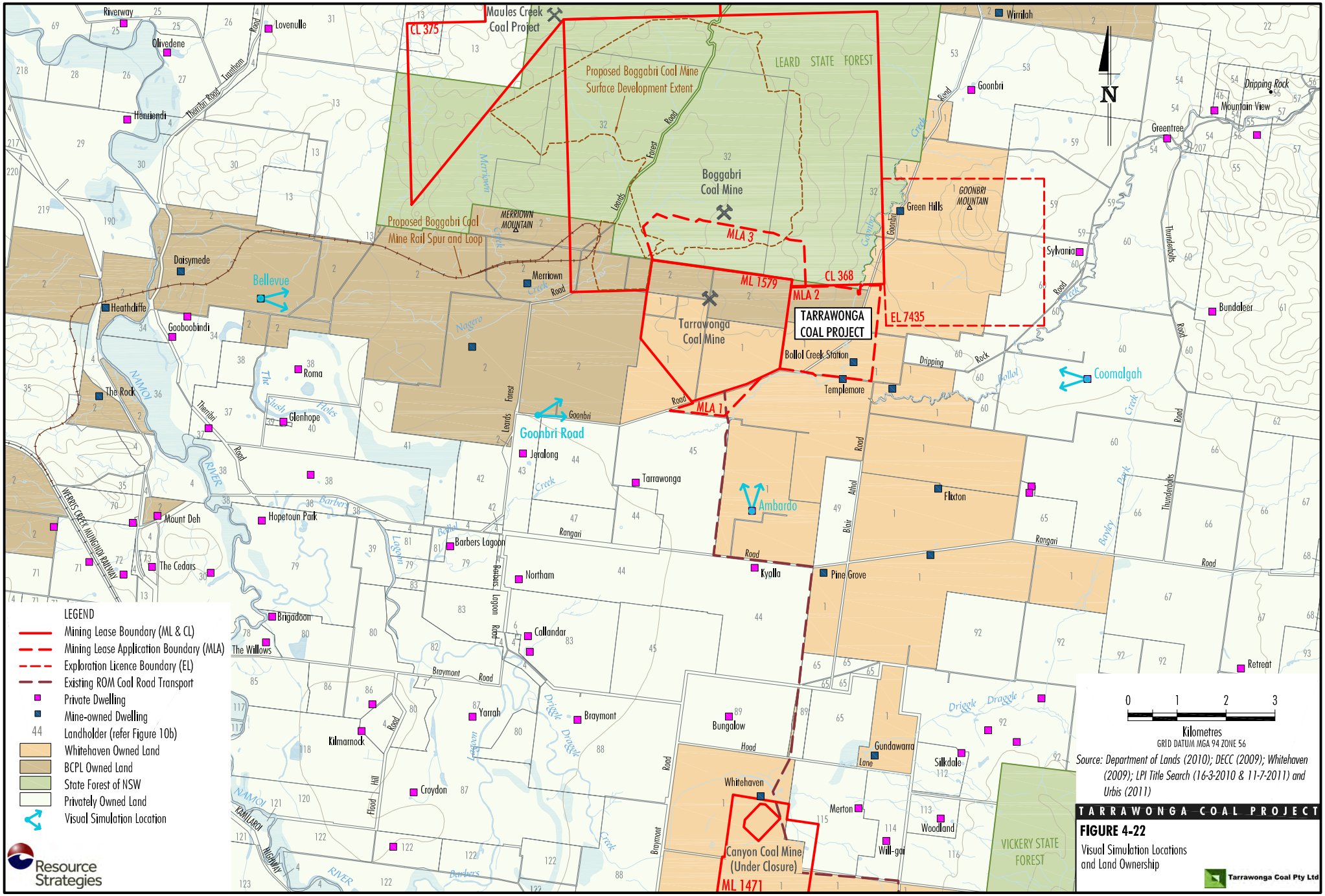
Predicted visual impacts at the four locations are summarised in Table 4-34 and discussed below. In addition, potential impacts at the Leard State Forest and the relocated Goonbri Road to the east of the Project are also considered in the local setting (Table 4-34) and described below.

Dwellings

The low level of visual modification coupled with the low visual sensitivity at the "Bellevue" dwelling means a low level of potential visual impact would be expected (Table 4-34). With progressive and final rehabilitation the level of visual impact would reduce to very low (Figure 4-23) (Appendix J).

Given the moderate level of visual modification coupled with the moderate visual sensitivity at the "Coomalgah" dwelling, a moderate level of potential visual impact would be expected (Table 4-34). The level of visual impact is expected to reduce to low following progressive and final rehabilitation of the Project landform components (Figure 4-24) (Appendix J).

The low to moderate level of visual modification coupled with the high visual sensitivity at the "Ambardo" dwelling means a moderate to high level of potential visual impact would be expected (Table 4-34). With progressive and final rehabilitation the level of visual impact would reduce to low (Figure 4-25) (Appendix J).



Source: Department of Lands (2010); DECC (2009); Whitehaven (2009); LPI Title Search (16-3-2010 & 11-7-2011) and Urbis (2011)

TARRAWONGA COAL PROJECT

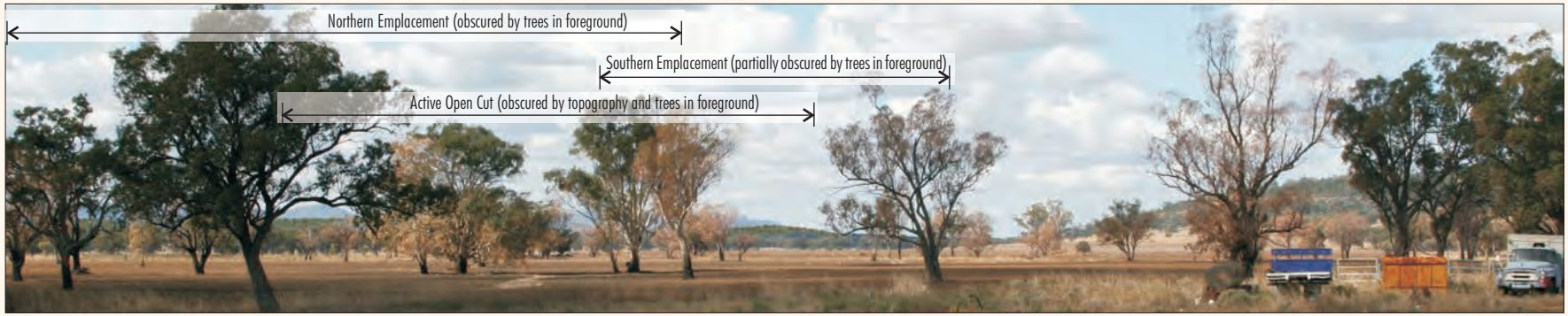
FIGURE 4-22

Visual Simulation Locations and Land Ownership

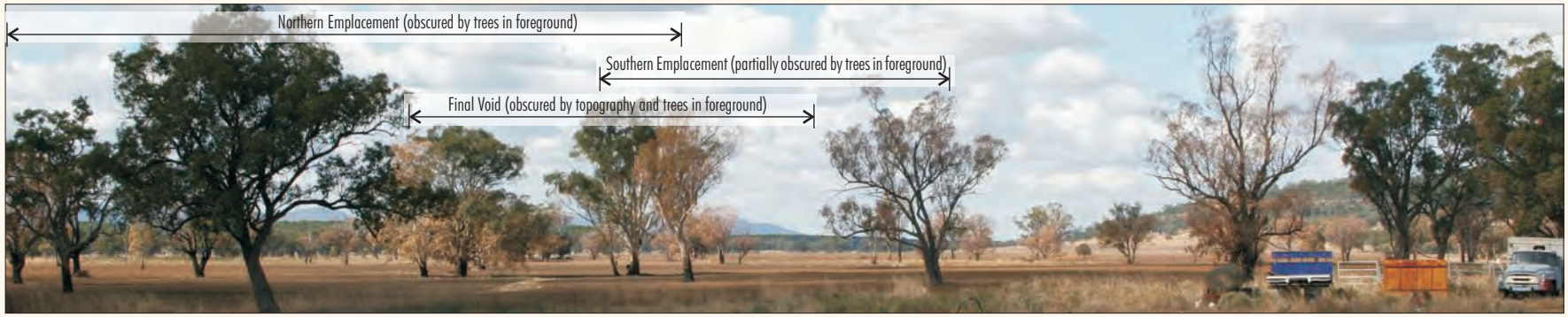
Tarrawonga Coal Pty Ltd

WHC-01-04_EA_Sect4_102D

Existing View



Year 12 Simulation



Post-Mining Simulation

Source: Urbis (2011)

TARRAWONGA COAL PROJECT

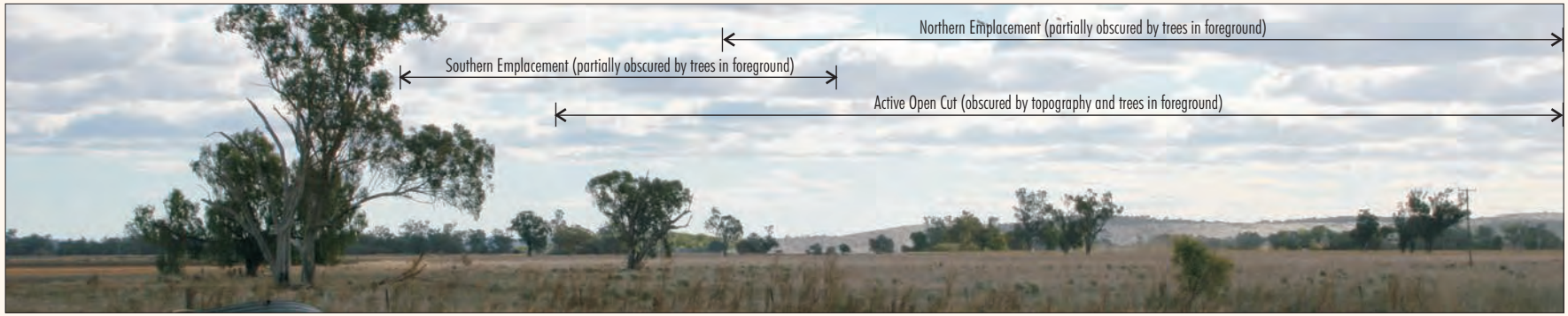
FIGURE 4-23

Existing View and Visual Simulations - Bellevue

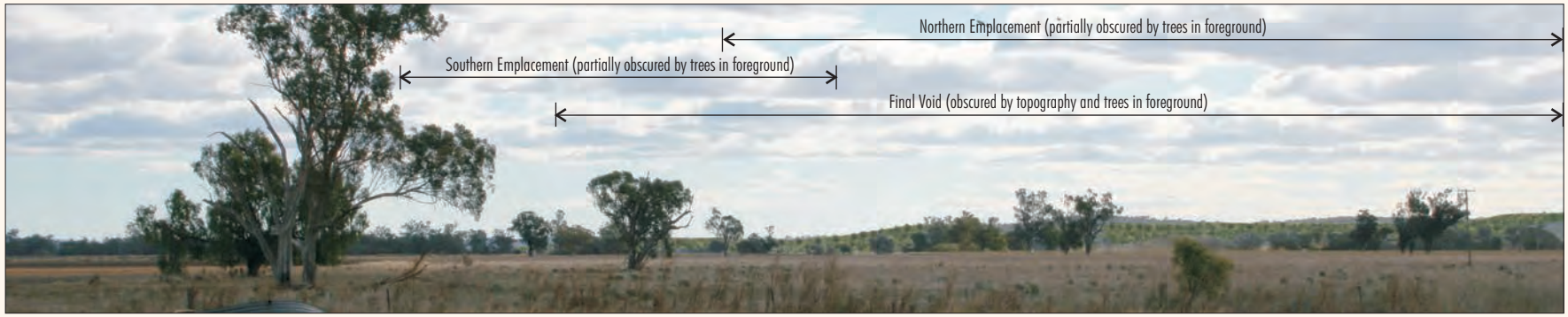
Tarrawonga Coal Pty Ltd

Resource Strategies

Existing View



Year 12 Simulation



Post-Mining Simulation

Source: Urbis (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-24

Existing View and Visual Simulations - Coomalgah

Tarrawonga Coal Pty Ltd

Resource Strategies

WHC-10-04 EA Sect 4_003C

Existing View

Year 12 Simulation

Post-Mining Simulation

Source: Urbis (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-25

Existing View and Visual Simulations - Ambardo

Tarrawonga Coal Pty Ltd

Resource Strategies

WHC-10-04 EA Sect 4_004C

Existing View

Year 12 Simulation

Post-Mining Simulation

Source: Urbis (2011)

TARRAWONGA COAL PROJECT

FIGURE 4-26

Existing View and Visual Simulations - Goonbri Road

Tarrawonga Coal Pty Ltd

Resource Strategies

WHC-10-04 EA Sect 4_005C

Table 4-34
Summary of Visual Assessment

Location	Visual Sensitivity	Visual Modification Level	Potential Visual Impact	Impact After Final Amelioration
Regional Setting (>5 km)				
Bellevue Dwelling	L	L	L	VL
Sub-Regional Setting (1 – 5 km)				
Coomalgah Dwelling	M	M	M	L
Ambardo Dwelling	H	L – M	M – H	L
Goonbri Road (south of Project)	L	M – H	L – M	L
Local Setting (< 1 km)				
Leard State Forest	M	L – M	L – M	L
Relocated Goonbri Road (east of Project)	L	M – H	L – M	L

Source: Appendix J.

H – High; M – Moderate; L – Low; VL – Very Low.

There are no privately-owned dwellings within the Project local setting. The level of potential impact at other dwellings in sub-regional and regional settings where views of the Project are available would generally be expected to be equivalent to, or less than, the impacts of the "Ambardo", "Coomalgah" and "Bellevue" dwellings (Appendix J). In addition, dwellings in the regional setting are typically set within a house paddock which has perimeter vegetation and combined with the flat topography tends to screen views of the Project.

Roads

The potential visual impacts of the Project from Goonbri Road to the south and east of the Project were assessed as part of the Visual Assessment. The moderate to high level of visual modification coupled with the low level of visual sensitivity at these locations means a low to moderate level of potential visual impact would be expected for users of Goonbri Road (Table 4-34). As shown in Table 4-29, traffic levels on this local road are low. With progressive and final rehabilitation the level of visual impact on Goonbri Road would reduce to low (Figure 4-26).

The re-aligned sections of Goonbri Road would also be subject to the establishment of vegetation screens in advance of construction works (Section 4.12.3).

The level of potential visual impact at other locations on roads in the local, sub-regional and regional setting where partial views of the Project are available would generally be expected to be equivalent to, or less than, the impacts predicted for Goonbri Road (Appendix J).

Leard State Forest

The low to moderate level of visual modification coupled with the moderate level of visual sensitivity means a low to moderate level of potential visual impact would be expected for users of the Leard State Forest (Table 4-34). With progressive and final rehabilitation the level of visual impact would reduce to low.

A visual simulation was not prepared for this location on the basis that views of the Project from the Leard State Forest for recreational users would be largely restricted due to the forest vegetation and relatively few users would be exposed to the views, due to the difficulty in accessing exposed viewpoints in the forest.

Night-Lighting

The Project would vary the potential effects of existing Tarrawonga Coal Mine night-lighting (i.e. lighting from the Project may be visible at additional locations due to the increased elevation of light sources on the Southern Emplacement and the increased extent of the mine waste rock emplacements).

In addition, the Project would include an increase in the mine fleet and operational hours and consequently there would be an increase in mobile vehicle-mounted night-lighting effects.

However, the nature of the night-lighting for the Project would be similar to the existing night-lighting at the Tarrawonga Coal Mine (Appendix J).

It is considered night lighting produced by the Project would not be visible from the Siding Springs Observatory, which is located approximately 125 km to the south-west of the Project (Appendix J).

Cumulative Impacts

The assessment of cumulative visual impacts has considered the combined effects of the Project with the effects of the proposed Continuation of Boggabri Coal Mine.

It is expected that views of both the Project and the Continuation of Boggabri Coal Mine landforms would generally be only available from viewpoints from the southern and western sides of the Project. As with views of the Project, these viewpoints would typically be associated with elevated areas where no vegetation screening is present (e.g. from portions of cleared paddocks and private roads).

The potential night-lighting impacts associated with the Continuation of Boggabri Coal Mine would be of a similar level to that of the currently approved Boggabri Coal Mine operations. The Project is therefore not expected to result in significant cumulative night-lighting impacts with the Continuation of Boggabri Coal Mine (Appendix J).

4.12.3 Mitigation Measures, Management and Monitoring

The mitigation and management measures that would be implemented for the maintenance of visual amenity at the Project are described below.

Progressive Rehabilitation

Progressive rehabilitation of the Northern Emplacement, Southern Emplacement, open cut and mine infrastructure areas would be undertaken in order to reduce the contrast between the Project landforms and the surrounding environment.

Rehabilitation would be conducted in accordance with the Rehabilitation Strategy and Rehabilitation Management Plan described in Section 5.

Visual Screening

Visual screening (e.g. a vegetation screen consisting of native plants that are compatible with the existing surrounding vegetation) would be used to reduce potential visual impacts from local sensitive viewpoints.

Vegetation screens would be established on the permanent flood bund, noise control earth bund and along the re-aligned sections of Goonbri Road to reduce potential views of Project landforms. For the re-aligned sections of Goonbri Road, the vegetation screens would be planted in advance of the re-alignment works, in order to reduce direct views of the Project once the re-alignments are completed.

Night-Lighting

TCPL would seek to minimise light emissions from the Project by carefully selecting the sites where lighting plants or permanent lighting installations would be placed.

Measures that would be employed to mitigate potential impacts from night-lighting would include one or more of the following, where practicable:

- All external lighting associated with the Project would comply with AS 4282: 1997 – *Control of the Obtrusive Effects of Outdoor Lighting*.
- Night-lighting would be restricted to the minimum required for operations and safety requirements.
- Directional lighting techniques would be used.
- Light shrouds and reflectors would be used to limit the spill of lighting.
- The permanent flood bund and the noise control earth bund would be revegetated to establish visual screens.

- In consultation with the landholder, trees would be planted at nearby private dwellings to help screen identified adverse night-lighting impacts in the event that significant direct night-lighting views are available.
- In consultation with the landholder, curtains, cladding and/or screens would be provided at nearby private dwellings to help screen identified adverse night-lighting impacts in the event that significant direct night-lighting views are available.

4.13 ABORIGINAL HERITAGE

An Aboriginal Cultural Heritage Assessment was undertaken for the Project by Kayandel Archaeological Services (2011) and is presented in Appendix K.

The Project Aboriginal Cultural Heritage Assessment has been undertaken in accordance with the following guidelines:

- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW [now referred to as the OEH], 2010a);
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW, 2010b);
- *Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (DEC, 2005a);
- The Australian International Council on Monuments and Sites (ICOMOS) *Burra Charter* (ICOMOS Australia, 1999);
- *Aboriginal Cultural Heritage: Standards and Guidelines Kit* (NSW National Parks and Wildlife Service, 1997);
- *Ask First: A Guide to Respecting Indigenous Heritage Places and Values* (Australian Heritage Commission, 2002); and
- *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects* (NSW Minerals Council, 2010).

A description of Aboriginal heritage (including cultural and archaeological) in the vicinity of the Project is provided in Section 4.13.1. Section 4.13.2 describes the potential impacts of the Project and Section 4.13.3 outlines mitigation measures, management and monitoring.

4.13.1 Existing Environment

Aboriginal History

The study area is located on lands covered by the Kamilaroi (or Gamilaraay) dialect of the "Darling Tributaries" languages (Wafer and Lissarrague, 2008). Written records and reports of Aboriginal people at the time of early European occupation make only occasional comments about Aboriginal people.

There are, however, several reports of villages of circular huts with conical roofs made from reeds, grass and boughs, or sometimes of bark, with bark floors. The reports by Allan Cunningham and Major Thomas Mitchell indicate that such villages were associated with substantial permanent water supplies, such as at Barbers Lagoon on the Namoi River (Appendix K).

It is expected that traditional values and activities remained on the Liverpool Plains, practiced by the Kamilaroi people up until the 20th century. In the early 20th century Aboriginal people in the area were settled on a reserve located near the Namoi River approximately 20 km from the Project area. The Baan Baa Aboriginal Reserve operated between 1901 and 1918 (Appendix K).

The number of Kamilaroi people is reported to have declined over time due to the loss of land, disturbance to the environment and to social networks and the influence of disease.

Post-contact, many Kamilaroi people are reported to have worked in association with pastoral stations and homesteads (O'Rourke, 1997).

Natural Resources

Ephemeral water sources were available to Aboriginal groups in the drainage lines located within and surrounding the Project area. Variable climatic conditions likely affected the availability of water, and may have influenced the way Aboriginal people moved through the landscape over time (Appendix K).

Exploitation of animal food resources in the past is likely to have included a range of vertebrates, molluscs and crustaceans. Local available plant foods are also likely to have been used. Mature trees found in the area would have been used for their bark in the manufacture of watercraft while nets and fishing line made out of local resources would have been used to catch fish or waterbirds (Appendix K).

Sections 4.9 and 4.10 and Appendices D and E provide information on the flora and fauna (including aquatic) ecological attributes of the Project area and surrounds.

Previous Archaeological Investigations

A number of Aboriginal heritage surveys and assessments have previously been undertaken in the Project area and surrounds, including:

- Hamm (2005) *Aboriginal Cultural Heritage Assessment Report, Boggabri Coal Project*.
- Archaeological Surveys & Reports (2005) *Archaeological Investigation for Sites of Indigenous Cultural Significance for the Proposed East Boggabri Coal Mine.*
- Insite Heritage (2010) *Aboriginal Cultural Heritage Impact Assessment Report for the Continuation of Boggabri Coal Mine.*
- Cupper (2010) *Tarrawonga Coal Mine Modification Cultural Heritage Assessment.*
- AECOM Australia (2010) *Aboriginal Archaeology and Cultural Heritage Impact Assessment for the Maules Creek Coal Project.*

In addition to the above, a number of relevant investigations have been undertaken in the wider region, including: Kamminga (1978), Thompson (1981), Haglund (1985), Purcell (2000), Navin Officer Heritage Consultants (2007), Archaeological Surveys and Reports (2007) and Archaeological Surveys and Reports (2009) (Appendix K).

An Aboriginal Heritage Information Management System (AHIMS) database request was also completed for the Project area and surrounds. The AHIMS search area was 15 km by 10 km. It encompassed the Project area and surrounds and was used to assist with the understanding of the local cultural and archaeological context. One site returned by the AHIMS search was listed as 'restriction applied'. This site was further investigated and was determined to be a potential quarry located approximately 1.4 km west of the Project disturbance area. This site would not be impacted by the Project.

This extensive body of existing information and AHIMS database search assisted with providing a regional context for the Project area and in developing a model of the likely archaeological and cultural significance of the Project area (Appendix K).

Aboriginal Heritage Management Plan

The *Tarrawonga Coal Mine Aboriginal Heritage Management Plan* (Whitehaven, 2011c) describes measures that are currently employed at the mine for the management and conservation of Aboriginal heritage sites. These measures include:

- recording, salvaging and managing Aboriginal heritage sites and potential archaeological deposits within the approved disturbance area;
- conserving, managing and monitoring the Aboriginal heritage sites outside the approved disturbance area;
- responding to the discovery of any new Aboriginal objects or skeletal remains during the development;
- enabling the Aboriginal community to access Aboriginal sites within the Tarrawonga Coal Mine site;
- implementing cultural awareness programs for the Tarrawonga Coal Mine workforce via the induction process to avoid accidental damage to Aboriginal heritage sites; and
- involving the Aboriginal community in the conservation and management of Aboriginal cultural heritage on-site.

Cultural Heritage Assessment

Assessment Program

The Aboriginal Cultural Heritage Assessment used relevant information from previous assessments and the results of Project field surveys and associated consultation with the Aboriginal community.

Table 4-35 summarises the main stages of the Aboriginal heritage consultation/survey program undertaken as part of the Project.

The nine Aboriginal stakeholders who registered an interest in being consulted in relation to the Aboriginal Cultural Heritage Assessment process were:

- Aboriginal Native Title Consultants;
- Bigundi Biame Traditional People;
- Bullen Bullen Consultants;
- Cacatua Culture Consultants;
- Giwiir Consultants;
- Gunida Gunyah Aboriginal Corporation;
- Minnga Consultants;
- Min-Min Aboriginal Corporation; and
- Red Chief LALC.

Table 4-35
Summary of the Project Aboriginal Heritage Consultation/Survey Program

Date	Consultation/Survey Conducted
Project Consultation/Survey	
23 September 2010	Letters requesting the names of Aboriginal parties or groups that may have been interested in registering in the consultation process were sent to the Red Chief LALC, Office of the Registrar, NTS Corp, DECCW Dubbo EPRG, the National Native Title Tribunal, Namoi CMA and the Narrabri Shire Council to identify Aboriginal parties.
28 October 2011	Letters seeking registrations of interest were sent to Aboriginal parties or groups identified by the above step and any additional Aboriginal parties previously consulted for either the Tarrawonga Coal Mine or the Rocglen Coal Mine.
2 November 2011	Public advertisement published in the Namoi Valley Independent inviting interested Aboriginal parties or groups to register.
7 December 2011	Record of names of registered stakeholders provided to OEH and the Red Chief LALC, in accordance with DECCW (2010a).
4 January 2011	Provision of a draft methodology for undertaking the Aboriginal Cultural Heritage Assessment distributed to registered stakeholders.
25 January 2011	On-site Project information session held at the Tarrawonga Coal Mine with the following registered stakeholders attending: Aboriginal Native Title Consultants, Bullen Bullen Consultants, Cacatua Culture Consultants, Gunida Gunyah Aboriginal Corporation and the Red Chief LALC.
January/February 2011	Feedback from the registered stakeholders in regard to the proposed methodology received. Consideration given to all comments received on the proposed methodology.
24 February 2011	Record of outcomes from the Project information session provided to all registered stakeholders.
24 February 2011	Invitation to registered stakeholders to attend the Aboriginal cultural heritage survey and inspection.
14-17 March 2011	Aboriginal and cultural heritage survey and inspection. Cultural significance of the area and Aboriginal heritage sites discussed with the Aboriginal participants.
27 June 2011	Draft Aboriginal Cultural Heritage Assessment issued to the registered stakeholders for review, including survey results, archaeological and cultural significance assessment (based on feedback received during consultation and fieldwork), potential impacts and proposed management and mitigation measures.
July 2011	Further consultation with the registered stakeholders to discuss the draft Aboriginal Cultural Heritage Assessment.
July 2011	Written feedback and advice received from registered stakeholders (including comments on the consultation, survey, assessment and proposed management and mitigation measures).
August 2011	Comments received from registered stakeholders on the draft Aboriginal Cultural Heritage Assessment (in relation to cultural heritage) were considered and/or addressed in the Aboriginal Cultural Heritage Assessment.

Source: After Appendix K.

Archaeological Findings

Previous archaeological investigations identified approximately 36 Aboriginal heritage sites within the Project area and surrounds (Figure 4-27). These sites include isolated finds, artefact scatters and modified trees (scar trees).

Surveys undertaken for the Project identified an additional 57 sites (Figure 4-27) including 25 isolated finds, 21 artefact scatters and 11 scar trees. Further description of these sites is presented in Appendix K.

Archaeological and Cultural Heritage Values

The archaeological significance rankings for each of the 57 sites recorded by the Project surveys, and four sites previously recorded and located within the Project disturbance area, are provided in Table 4-36. No Aboriginal heritage sites of high archaeological significance were recorded, however, 12 sites of moderate archaeological significance and 49 sites of low archaeological significance were identified (Table 4-36) (Appendix K).

No Aboriginal heritage sites within the Project area or immediate surrounds are listed on the NSW State Heritage Inventory or the Australian Heritage Database.

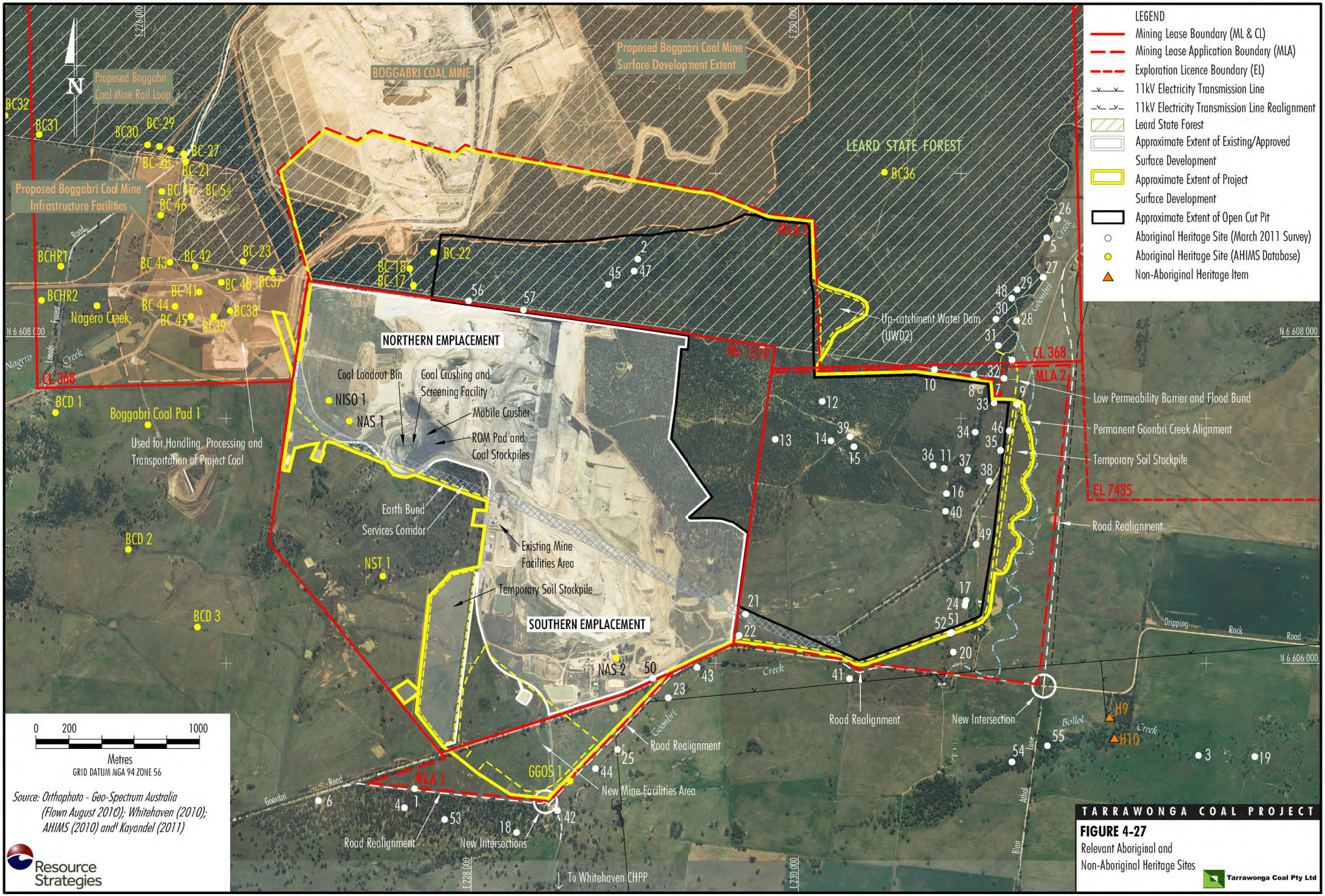


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Table 4-36
Archaeological Significance of Relevant Aboriginal Heritage Sites[1]

Archaeological Significance Ranking	Aboriginal Heritage Site Code	Number of Sites
High	-	-
Moderate	19, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57.	12
Low	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, BC17, BC18, BC22, GGOS1.	49

Source: After Appendix K.

[1] Includes sites recorded by the Project surveys and sites previously recorded in the Project disturbance area.

The Aboriginal Cultural Heritage Assessment (including a specific assessment of cultural significance via consultation with the Aboriginal community) was undertaken in accordance with the relevant requirements of the various advisory documents and guidelines, as listed above.

Table 4-35 summarises the main stages of the Aboriginal heritage consultation/survey program undertaken as part of the Project, with further detail provided in Section 4 of Appendix K. The registered Aboriginal parties were asked to contribute their cultural knowledge on the subject area, and the Aboriginal sites within it, at all stages during the consultation process (i.e. during the initial information session, as part of the review of the draft methodology during the field survey, as part of reviewing the draft Aboriginal Cultural Heritage Assessment, during phone calls to request comments on the draft Aboriginal Cultural Heritage Assessment and at meetings). The information presented in Appendix K (and summarised below) is the only information that was provided from the Aboriginal parties either verbally or in writing.

Aboriginal heritage sites within or surrounding the Project area have been identified as being of cultural significance to registered stakeholders. Comments received from the registered stakeholders in relation to cultural significance are detailed in Appendix K. In summary, the Aboriginal community identified that:

- All sites/artefacts have some cultural significance to Aboriginal people.
- Artefacts found in the subject area were of a similar cultural value to other artefacts known from the region.
- Areas with reduced visibility would likely have artefacts of a similar cultural significance to those recorded by the surveys.

4.13.2 Potential Impacts

Potential Direct Impacts

The Project would result in the disturbance of 38 known Aboriginal Heritage sites and the possible disturbance of an additional site (due to its proximity to the proposed Project).

These sites include seven sites of moderate archaeological significance (i.e. sites 47, 49-52 and 56-57) and 32 sites of low archaeological significance (i.e. sites 1-2, 7-17, 21-22, 24, 32-40, 42, 45-46, BC17, BC18, BC22 and GGOS1).

These sites are located either within the footprint of the proposed open cut, Goonbri Creek permanent alignment and associated flood bund and low permeability barrier, road realignments or the mine waste rock emplacements and would therefore be subject to direct disturbance by the Project (Figure 4-27).

Sites that have been identified outside of, but in close proximity to, the direct disturbance areas may potentially also be subject to accidental disturbance during ongoing exploration and general land management activities, however, would not be directly impacted by the Project.

Potential Indirect Impacts

The site types within the Project area and immediate surrounds (i.e. open artefact scatters, modified trees and isolated artefacts) are not considered to be particularly sensitive to potential indirect effects (e.g. blasting vibration) and hence the potential impacts of the Project on these sites would be largely limited to direct impacts.

4.13.3 Mitigation Measures, Management and Monitoring

The mitigation, management and monitoring measures detailed below have been developed in consultation with the registered Aboriginal stakeholders and in consideration of the cultural and archaeological significance of the Aboriginal heritage sites to be impacted. The consultation process with registered Aboriginal stakeholders is described in Appendix K.

As part of the Project, the existing Aboriginal Heritage Management Plan (Whitehaven, 2011c) would be revised in consultation with the Aboriginal community and the OEH to specify management and mitigation measures relevant to the Project area. The Aboriginal Heritage Management Plan would be revised prior to works that would impact Aboriginal heritage sites in the Project area and would include:

- A protocol for the involvement of Aboriginal stakeholders in field salvage/investigations.
- Updated tables/figures identifying the known Aboriginal heritage sites located within the Project area.
- A program for developing updated AHIMS site cards, as required.
- A protocol for managing Aboriginal heritage during the installation/construction of required ancillary surface infrastructure (e.g. road re-alignments and the permanent Goonbri Creek alignment).

A summary of specific measures that would be included in the revised ACHMP and implemented over the life of the Project is provided below. Further detail is provided in Appendix K.

Surface Disturbance

The following measures would be detailed in the Aboriginal Heritage Management Plan and undertaken to manage potential impacts to Aboriginal heritage for surface disturbance throughout the life of the Project:

- TCPL would maintain a record of known Aboriginal heritage sites (including maps and site plans) and make relevant site personnel aware of the site locations.
- Where practicable, known Aboriginal heritage sites would be avoided during Project construction and operation works.
- The location of known Aboriginal heritage sites would be considered when preparing the final detailed engineering designs of the road re-alignments and permanent Goonbri Creek alignment, and the sites would be avoided where practicable.
- Where avoidance of known Aboriginal heritage sites is not practicable, site(s) would be subject to baseline recording, in consultation with representatives of the Aboriginal community, prior to disturbance and artefacts would be salvaged for safekeeping in accordance with the wishes of the Aboriginal community and OEH.
- Baseline recording of impacted sites would include completing an Aboriginal Site Impact Recording Form (or its equivalent) and submitting it to the AHIMS Registrar for each relevant site.
- TCPL would design and implement, in consultation with the Aboriginal community and OEH, a program for undertaking sub-surface investigations (i.e. representative test pits and/or grader scrapes), recording and salvage of artefacts along Goonbri Creek, prior to disturbance.
- Culturally modified trees located outside of (but in close proximity to) Project disturbance areas would be suitably demarcated and signed to reduce the risk of accidental damage.
- If appropriate in the context of the trees condition, scar trees subject to direct disturbance would be considered for salvage. A suitable location for the storage and/or display of the salvaged sections would be identified and managed in consultation with the Aboriginal community and OEH.

It is anticipated that the Aboriginal community would also provide advice on the management of salvaged artefacts at the completion of Project activities (e.g. artefact replacement onto the post-mining landscape).

General Management Measures

The following general approach would be taken to manage Aboriginal cultural heritage during the life of the Project:

- A record of known Aboriginal sites, their status and location would be maintained by TCPL.
- Ongoing consultation would be undertaken with the Aboriginal community over the life of the Project. Appropriate Aboriginal representation would be facilitated during archaeological fieldwork (e.g. salvage of artefacts prior to disturbance).
- TCPL would provide opportunities for Aboriginal community members to access known Aboriginal sites located on Whitehaven-owned land (e.g. for cultural reasons or as part of scheduled field activities). Such access would be subject to Occupational Health and Safety requirements.

- Erosion and sediment control works would be undertaken in accordance with the requirements of the Erosion and Sediment Control Plan and in consideration of Aboriginal cultural heritage management measures.
- Any additional Aboriginal heritage sites which may be identified during the development of the Project would be recorded and registered with the OEH in consultation with Aboriginal stakeholders. Should additional Aboriginal heritage sites be identified, they would be managed in accordance with the measures described in the ACHMP.

The measures presented above are considered by Kayandel Archaeological Services (2011) to be best practice in the mining industry. They are effective and reliable, as demonstrated by their continued use and inclusion in management plans and strategies developed in consultation with the Aboriginal community and to the satisfaction of government departments (Appendix K).

4.14 NON-ABORIGINAL HERITAGE

A Non-Aboriginal Heritage Assessment for the Project was undertaken by Dr Michael Pearson of Heritage Management Consultants and is presented as Appendix L.

The assessment was prepared in consideration of the relevant principles and articles contained in the *Burra Charter* (Australia ICOMOS, 1999) and the *NSW Heritage Manual* (NSW Heritage Office and NSW Department of Urban Affairs and Planning [DUAP], 1996).

A description of existing non-Aboriginal heritage within the Project area and surrounds is provided in Section 4.14.1. Section 4.14.2 describes the potential impacts of the Project, while Section 4.14.3 outlines mitigation measures, management and monitoring.

4.14.1 Existing Environment

Historical Overview

Surveyor-General John Oxley passed through the Gunnedah Basin during his 1818 expedition, however it was Alan Cunningham during his 1827 expedition to the Darling Downs who discovered the Namoi River. The first European in the area however, was not an explorer, but the escaped convict George 'the Barber' Clarke, who lived with the Kamilaroi Aboriginal people for five years from 1826.

Clarke based himself at Barbers Lagoon on Wilberoi Reserve (approximately 6.4 km south-east of Boggabri and approximately 15 km south-west of the Project) and rustled cattle from the squatters further south (Appendix L).

In 1829 the Colonial Government established the 'Limits of Location', bounding nineteen counties within which settlement could be sanctioned and more easily controlled. The promise for better grazing land enticed pastoralists to send their stock beyond the 'Limits of Location' (i.e. to the Boggabri region), which resulted in the squatting boom.

Further discussion on the early European settlement and the pastoral history of relevance to non-Aboriginal items in the vicinity of the Project is provided in Appendix L.

Heritage Items of Relevance to the Project

Heritage Management Consultants completed historical and archival research and review of heritage registers prior to survey of the Project area.

No items of state or regional non-Aboriginal heritage significance were identified in the vicinity of the Project (Appendix L).

Two items, the former Blair Athol schoolhouse (H9) and an associated survey marker demarking the boundary of the school block (H10), were identified as being of potential local significance (Appendix L). These items are located outside of the Project disturbance area and south-east of the proposed Goonbri Road re-alignment (Figure 4-27).

The former Blair Athol schoolhouse is a weatherboard clad, single-roomed building which was used as a small rural school in the early 20th century (i.e. up until 1958). The building has an open porch/verandah to the north and a corrugated, galvanised iron roof (Appendix L). The schoolhouse has been extended twice to the east for use as a private residence, with the eastern side of the schoolhouse penetrated to provide hallway access to the adjacent extension.

The survey marker comprises a dead tree with blaze and survey details engraved into the bark. It is located approximately 150 m to the south-east of the former Blair Athol schoolhouse.

The former Blair Athol schoolhouse and associated survey marker are of local significance as schoolhouses of this early 20th century era are now uncommon, and despite the extensions to it, the former schoolhouse and associated former school reserve, in part demarked by the surviving survey tree, demonstrate principal characteristics of early 20th century small rural schools (i.e. schoolhouse, dedicated land block, sufficient land for play and enclosed pasturage of horses) (Appendix L).

Since it was recorded by Heritage Management Consultants, the former Blair Athol schoolhouse residence has been relocated to Boggabri for ongoing use as a residence, in accordance with consent from the Narrabri Shire Council (DA 59/2012).

4.14.2 Potential Impacts

As described above, the former Blair Athol schoolhouse residence has been relocated to Boggabri for ongoing use as a residence and, therefore, would not be impacted by the Project.

The survey marker (H10) is located approximately 500 m south-east of the proposed road realignment and approximately 1 km south-east of the proposed open cut extent. This item would not be directly impacted by the Project and potential impacts from blasting induced vibration are expected to be minimal (Appendix L).

4.14.3 Mitigation Measures, Management and Monitoring

Potential impacts of the Project on the survey marker were assessed to be minimal.

While it has no heritage significance, a rubbish dump identified within the Project area contains objects that may be of interest to local historical collectors (e.g. old car and truck bodies, farm equipment, an oil engine and building materials). Prior to Project disturbance of the rubbish dump, these objects would be offered to the Boggabri Historical Society and the Gunnedah Museum.

4.15 REGIONAL ECONOMY

A Socio-Economic Assessment (including a regional economic impact assessment) was undertaken for the Project by Gillespie Economics (2011) and is presented in Appendix M.

The regional economic assessment was conducted at two different scales to assess the potential impact of the Project on the region and in NSW. The local region adopted for the Project was the combined Statistical Local Areas (SLA) of Narrabri and Gunnedah.

Regional economic assessment is primarily concerned with the effect of a proposal on an economy in terms of specific indicators, such as gross regional output (business turnover), value-added, income and employment. The regional economic assessment is based on analysis of a 2005 to 2006 input-output table prepared by Gillespie Economics for the regional (i.e. Narrabri and Gunnedah SLAs) and NSW economies.

A summary of the existing regional and NSW economy is provided in Section 4.15.1. The potential impacts of the Project on the regional and NSW economies are described in Section 4.15.2, while mitigation measures are provided in Section 4.15.3.

4.15.1 Existing Environment

The gross regional product for the regional economy (i.e. Narrabri and Gunnedah SLAs) is estimated at $917M, comprising $468M to households as wages and salaries (including payments to self employed persons and employers) and $449M in other value-added contributions (Appendix M).

The agriculture sector is of greater relative importance to the regional economy than it is to the NSW economy (Table 4-37), while the services and building sectors are of less relative importance than they are to the NSW economy (Table 4-37). Mining, manufacturing and utilities sectors in the region are of similar relative importance as they are to NSW.

In terms of gross regional output and value-added, grains, other agriculture, business services and retail trade are the most significant sectors to the regional economy (Appendix M). Imports and exports are spread across many sectors with major contributors being the grains, other agriculture, food and textile manufacturing, retail trade and business services (Appendix M).

Table 4-37
Contributions to Employment, Gross Regional Product and Output by Industry Sector – Regional and NSW Economies (2005 to 2006)

Sector	Total Employment (%)		Contribution to GRP (%)		Contribution to Output (%)	
	Regional	NSW	Regional	NSW	Regional	NSW
Agriculture, Forestry and Fishing	24	3	22	2	21	2
Mining	1	1	4	2	2	2
Manufacturing	8	11	11	11	19	19
Utilities	1	1	2	2	4	3
Building	5	7	4	6	6	9
Services	62	77	53	71	48	65

Source: After Appendix M.
Note: Rows may not sum to 100% due to rounding.

The retail trade sector is the most significant sector in terms of regional employment, while the retail trade and business services sectors are the most significant sectors in terms of income (Appendix M).

4.15.2 Potential Impacts

The regional economic impact assessment in Appendix M included consideration of the impacts of the Project (including construction) on both the regional (i.e. Narrabri and Gunnedah SLAs) and NSW economies, and also potential impacts at the cessation of the Project.

Construction

The construction of the Project is predicted to have the following impacts on the regional economy (Appendix M):

- $8.1M in annual direct and indirect output;
- $3.4M in annual direct and indirect regional value added;
- $2.2M in annual direct and indirect household income; and
- 34 direct and indirect jobs.

In total, the construction of the Project is predicted to have the following impacts on the NSW economy (Appendix M):

- $14.9M in annual direct and indirect output;
- $6.6M in annual direct and indirect regional value added;
- $4.6M in annual direct and indirect household income; and
- 55 direct and indirect jobs.

Operation

The operation of the Project is predicted to have the following impacts on the regional economy (Appendix M):

- $490M in annual direct and indirect regional output or business turnover;
- $246M in annual direct and indirect regional value-added;
- $27M in annual household income; and
- 300 direct and indirect jobs.

Businesses that can provide the inputs to the production process required by the Project and/or the products and services required by employees would directly benefit by way of an increase in economic activity. However, because of the inter-linkages between sectors, many indirect businesses would also benefit (Appendix M).

Flow-on impacts from the Project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the other property services sector; wholesale mechanical repairs sector; agricultural, mining and construction machinery, lifting and material handling equipment manufacturing sector; scientific research, technical and computer services sector; wholesale trade sector; and retail trade sector (Appendix M).

The Project would provide additional direct employment for 34 people during operations (i.e. TCPL staff and on-site contractors). Of the 120 direct jobs provided by the Project, 106 employees are assumed to reside in the region, based on existing distribution of employees (Appendix M).

In total, the operation of the Project is predicted to have the following impacts on the NSW economy (Appendix M):

- $901M in annual direct and indirect output or business turnover;
- $442M in annual direct and indirect value-added;
- $147M in annual household income; and
- 1,772 direct and indirect jobs.

The potential impacts of the Project on the NSW economy are expected to be substantially greater than for the regional economy alone, as more Project and household expenditure would be captured, and there is a greater level of inter-sectoral linkages in the larger NSW economy (Appendix M).

End of Project Life

The establishment and operation of the Project would stimulate demand in the regional and NSW economy leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the mining operations would result in a contraction in regional economic activity.

The magnitude of the regional economic impacts of cessation of the Project would depend on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the regional economy at the time (Appendix M).

New mining resource developments in the region would help broaden the region's economic base and buffer against impacts of the cessation of individual activities (Appendix M). The Gunnedah Basin is a prospective location with a range of coal and coal seam methane resources, with a range of development proposals pending (Appendix M).

4.15.3 Mitigation Measures, Management and Monitoring

TCPL would develop a Rehabilitation Management Plan for the Project which would include details of the mine closure strategy (Section 5). The plan would be developed in consultation with the Narrabri and Gunnedah Shire Councils, DP&I and the local community, and would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.

4.16 EMPLOYMENT, POPULATION AND COMMUNITY INFRASTRUCTURE

Gillespie Economics (2011) has considered the potential impacts of the Project on existing regional community infrastructure as a result of employment and population change (Appendix M).

For the purposes of the employment, population and community infrastructure assessment, the combined Narrabri and Gunnedah SLAs were considered to be the local region.

The Project contributions to regional employment, population and community infrastructure demand are likely to be modest, as the additional Project workforce would be modest (Section 2.14).

The Project would however potentially occur in the context of other regional employment, population and community infrastructure demands, in particular demands associated with the proposed Continuation of Boggabri Coal Mine and the Maules Creek Coal Project.

Potential estimated cumulative and Project only employment, population and community infrastructure demands are described in Section 4.16.2. Proposed Project mitigation measures are provided in Section 4.16.3.

4.16.1 Existing Environment

TCPL plays an active role in local communities through financial contributions to regional events and facilities, and by funding contributions to community programs and groups (Section 3.2.3).

The populations of Narrabri and Gunnedah SLAs declined between 2001 and 2006 by 5.8% and 4.7% respectively, illustrating the trend of depopulation of many inland rural areas in NSW (Appendix M).

A description of the existing population profile, employment, housing, health and education resources in the Narrabri and Gunnedah SLAs is provided in Appendix M.

4.16.2 Potential Impacts

As the impacts of Project construction on regional employment and population would be minor, the following discussion focuses on population and community infrastructure effects during the operation of the Project. Further detail on Project construction community infrastructure effects is provided in Appendix M.

Based on workforce projections and assumptions detailed in Appendix M, Gillespie Economics (2011) has estimated the workforce demand, population change and potential impacts on community infrastructure that may arise from the proposed Continuation of Boggabri Coal Mine, Maules Creek Coal Project and the Project as described below.

Workforce Demand

The workforces of the three mining projects would vary over time, and the potential impacts of new workforce demand on the regional population are highly dependent on assumptions regarding the percentage of new employees that would be sourced from within the region.

The operation of the Project would require an additional workforce of some 34 employees (of which 30 are assumed to be non-local), increasing the total operational workforce at the Tarrawonga Coal Mine from 86 to 120.

The direct non-local workforce demand of the Maules Creek Coal Project is expected to be high relative to the Project, comprising some 463 additional construction and operational employees in 2013, and 376 additional operational employees thereafter (Appendix M).

The direct non-local workforce demand of the Continuation of Boggabri Coal Mine is expected to be more modest, comprising some 105 additional construction and operational employees in 2013, and up to 181 additional operational employees in 2021 (Appendix M).

Table 4-38 summarises estimated incremental non-local employment associated with Year 2021 (Project Year 9), when the greatest cumulative operational employment demand from the three projects is expected to occur.

Table 4-38
Direct Incremental Non-Local Workforce Requirements – 2021

Proposal	Non-local Hires
Maules Creek Coal Project	376
Continuation of Boggabri Coal Mine	181
Project	30
Total	**587**

Source: After Appendix M.

Note: Only includes non-local workforce that are assumed to relocate into the region.

Table 4-38 indicates the Project non-local operational workforce demand (30 people) would comprise approximately 5% of the direct cumulative non-local workforce demand of the three mining projects.

Operational direct non-local workforce demands also potentially increase the regional population when new workers bring spouses and children with them to the region, which is less common during construction activities.

In addition, during operations indirect employment generation from the three projects would be expected to result in more flow-on jobs in the region, a proportion of which are expected to be filled by non-locals.

These employment and population flow-on effects have been estimated in the Socio-Economic Assessment (Appendix M), and are summarised below.

Population Effects

Table 4-39 illustrates Gillespie Economics (2011) upper level estimates of the total population effects that may arise as a result of the three mining projects in 2021, based on conservative assumptions regarding indirect employment, availability of local labour and family size.

The Project maximum direct and indirect population change to the region is estimated to be approximately 212 people (Appendix M) which is approximately 6.5% of the cumulative total in Table 4-39.

For both Narrabri LGA and Gunnedah LGA, the additional population influx for the Project in isolation would only partially offset historic population decline (Appendix M).

Community Infrastructure Effects

Housing

There is considerable short-term and rental accommodation in Narrabri and Gunnedah (Appendix M). However, considering the construction workforce associated with the three projects, there is potential that cumulative construction related demand would impact on the availability of short-term accommodation for tourism (Appendix M).

Table 4-39
Estimated Upper Bound Cumulative Regional Population Change – 2021

Location	Direct Population	Indirect Population	Total Population
Narrabri LGA	**934**	**1,133**	**2,068**
Narrabri	777	935	1,712
Boggabri	157	199	356
Gunnedah LGA	**464**	**583**	**1,046**
Other – not specified	**70**	**83**	**153**
Region Total	**1,467**	**1,799**	**3,267**

Source: After Appendix M.

Note: Totals may have minor discrepancies due to rounding.

Cumulative direct and indirect demand for operational housing is likely to be significant. Up to 1,307 accommodation units (e.g. houses, units, hotel rooms) would be required in the region as a result of the combined direct and indirect effects of the three projects at maximum operational employment levels in 2021 (Appendix M).

The direct and indirect demand for housing from the Project in isolation (85 accommodation units) is largely insignificant in the context of the total housing stock, rental stock and unoccupied dwellings (Appendix M) and would be approximately 6.5% of the identified cumulative demand for the three projects.

Where housing supply is insufficient to meet demand, even temporarily, this may manifest itself in increased property prices and higher rent prices. While this may be seen as beneficial for property owners, it can adversely affect existing tenants, particularly those on lower incomes who can be priced out of the market (Appendix M).

Because of higher relative wages in the mining sector, the demand for rental accommodation and to purchase is likely to be at the higher end of the market, where supply is more limited (Appendix M).

Education and Training

Cumulative potential developments in the region would contribute to greater demand for education in both the public and private sectors.

Provision of education services is primarily the responsibility of the public sector, although there is an increasing role for the private sector, with planning and development driven by population changes (Appendix M).

It is recognised that there may be a lag between population growth and the provision of additional education services resulting in temporary education access issues. In other regions where mining has resulted in rapid population growth, it has been suggested that increasing child aged population has ultimately had positive education benefits such as more teachers, reduced class sizes and broader curriculum (Appendix M).

The direct and indirect increase in demand for educational facilities for the Project in isolation is generally considerably less than the decline in demand for education places between 2001 and 2006 (Appendix M).

Health

The estimated cumulative changes in population levels (Table 4-39) would substantially increase demand for health services and facilities.

Provision of health services is primarily the responsibility of the public sector, although some aspects of these services are also provided by the non-government sector.

It is recognised that there may be a lag between population growth and the provision of additional health services resulting in temporary health care access issues, but ultimately increased populations result in the provision of more health facilities for the community (Appendix M).

There is also the potential to indirectly positively impact on public health through the provision of employment opportunities and the reduction in unemployment (Appendix M).

There is potential for the Project in isolation to increase the demand for public health services and facilities in the region (Appendix M). However, the Project contribution to this demand would be in line with its relative contribution to predicted cumulative population growth associated with the three projects (i.e. approximately 6.5%).

Community Services and Recreation Facilities

From a cumulative impact perspective there may be considerable increase in demand for community services and recreation facilities that would require detailed planning by local and State Government agencies (Appendix M).

The maximum direct and indirect increase in population from the Project in isolation is very small. No additional investment in community services and recreation facilities infrastructure would therefore be anticipated as a result of the Project in isolation (Appendix M).

Social/General Community

The demand for mining labour can result in skilled labour being bid away from other professions (e.g. domestic trade services) which can result in shortages of these services in the region. It is anticipated that the cumulative impact of the three projects in the region may contribute to local skills shortages (Appendix M).

A changing sense of place for existing residents may also be caused by cumulative influxes in populations associated with mining projects, as towns move away from their historical focus on servicing agricultural and forestry enterprises, to an increased focus on servicing mining activities (Appendix M).

The high wages in the mining sector relative to other sectors can also potentially result in social divisions between those involved in the mining sector and those who are not (Appendix M).

Both these effects can be heightened during construction of projects, when there are high numbers of unattached construction workforces, who may only partially integrate into the community (Appendix M).

End of Mine Life

Potential socio-economic impacts associated with the end of Project life are described in Section 4.15.2.

4.16.3 Mitigation Measures, Management and Monitoring

As described in Section 4.16.2, some population growth would occur as a result of the Project employment and associated flow on effects.

Appendix M indicates only negligible impacts on community infrastructure demand would arise as a result of the Project in isolation. However, cumulative impacts with the Continuation of Boggabri Coal Mine and Maules Creek Coal Project would be more significant.

TCPL would work in partnership with the Narrabri and Gunnedah Shire Councils and the local community so that the benefits of the projected economic growth in the region are maximised and impacts minimised.

In this respect, a range of general and specific social impact mitigation and management measures are proposed and would include:

- Continuation of the current donations policy which supports education, health and community causes.
- Employ local residents preferentially (where they have the required skills and experience and demonstrate a cultural fit with the organisation), as the employment of local residents reduces potential population effects.
- Purchase local non-labour inputs to production preferentially where local producers can be cost and quality competitive.
- A code of conduct for construction workers with regard to behaviour in the contractor induction program.

It is expected that as with other recent coal mining projects in NSW, a planning agreement in accordance with Division 6 of Part 4 of the EP&A Act would be required by the Project Approval for the Project. The planning agreement would be negotiated between TCPL, the DP&I, Narrabri Shire Council and Gunnedah Shire Council.

4.17 HAZARD AND RISK

A PHA to evaluate the potential hazards associated with the Project was conducted by a multi-disciplinary team, including technical advisors from TCPL. The PHA was conducted in accordance with the general principles of risk evaluation and assessment outlined in the DP&I *Multi-Level Risk Assessment* (DP&I, 2011).

The PHA also addresses the requirements of *State Environmental Planning Policy No. 33 (Hazardous and Offensive Development)* (SEPP 33) and has been assessed in general accordance with *Hazardous Industry Planning Advisory Paper No. 6: Hazard Analysis* (DoP, 2011a).

Potential incidents and hazards identified for the Project are described in Section 4.17.1. Proposed preventative and control measures to address potential hazards are discussed in Section 4.17.2.

4.17.1 Hazard Identification and Risk Assessment

Potentially hazardous materials handled at the Project include hydrocarbons (petrol, diesel, oils, greases, degreasers and kerosene), explosives and chemicals (Appendix P).

In accordance with DP&I (2011), the PHA specifically covers the risks from fixed installations. As such, the main focus of the assessment was the on-site storage of the potentially hazardous materials (Appendix P).

The following generic classes of incident associated with on-site storage were identified:

- leaks/spills;
- fire;
- explosion; and
- theft.

Following identification of the potential hazards associated with the Project, a qualitative assessment of the risks to the public, property and the environment associated with the Project was undertaken (Appendix P).

An assessment of the combination of the consequence and probability rankings concluded that the overall risk rankings for the identified hazards would be low, and therefore tolerable (Appendix P).

4.17.2 Hazard Prevention and Mitigation Measures

A number of hazard control and mitigation measures are in-place for the existing Tarrawonga Coal Mine, and are described in the following existing documents:

- Blast Management Plan.
- Bushfire Management Plan.
- Water Management Plan (incorporating a Surface Water and Groundwater Response Plan.
- Waste Management Plan.

Additional hazard control and mitigation measures would be incorporated into existing management plans or new management plans where required for the Project.

In addition, the following hazard treatment measures would be adopted for the Project (Appendix P):

- Engineering Structures – Mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, TCPL would obtain the necessary licences and permits for engineering structures.
- Contractor Management – All contractors employed by TCPL would be required to operate in accordance with the relevant Australian Standards and NSW legislation.
- Storage Facilities – Storage and usage procedures for potentially hazardous materials (i.e. fuels and lubricants) would be developed in accordance with Australian Standards and relevant legislation.
- Emergency Response – Emergency response procedures manuals and systems would continue to be implemented.