WILPINJONG COAL PROJECT

MAIN REPORT

Section Four
Potential Impacts and Mitigation Measures

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

4 POTENTIAL IMPACTS AND MITIGATION MEASURES

This section describes the potential environmental and socio-economic impacts of the Project and includes an assessment of potential cumulative impacts. Mitigation measures have been developed in consideration of the Project potential impacts. References to environmental management plans and monitoring programmes to be prepared for the Project are provided where relevant.

In each case impact avoidance has been considered as a primary form of mitigation. However, as discussed in Section 1.7 the Project location and the general extent of the open pit development is determined by the coal resource that the NSW Government has tendered to WCPL. Based on this, impact avoidance is limited to adjustments to the open pit footprint and changes to the mining method, scale and rate.

In a number of locations the extent of the open pit has been reduced to avoid disturbance to flora, fauna habitat and Aboriginal heritage. Underground mining methods have been considered to minimise impacts on remnant vegetation, however they were not considered to be technically or economically feasible (Section 1.7.10). The Project Environmental Protection Plan includes rehabilitation of Project disturbance areas and the establishment, enhancement and conservation of areas of woodland vegetation (Section 5). Where practicable, support infrastructure external to the Project open pit areas (e.g. water supply bores, fire access tracks, fencing) would be located to avoid areas of existing vegetation or known heritage sites.

The scale and rate of the mining operation have largely been determined based on consideration of the total Project economics and contractual arrangements with customers. Comprehensive mitigation measures are proposed to minimise the potential emissions from the Project (e.g. dust, noise and lighting).

4.1 LAND RESOURCES

Section 3.1 provides a description of the land resources in the vicinity of the Project. In relation to land resources, the Project has the potential to alter:

- topography and landscape features;
- soils and erosion potential;
- landuse and land capability;
- land contamination potential; and
- the level of bushfire hazard.

These aspects and applicable mitigation measures are provided in the following sub-sections.

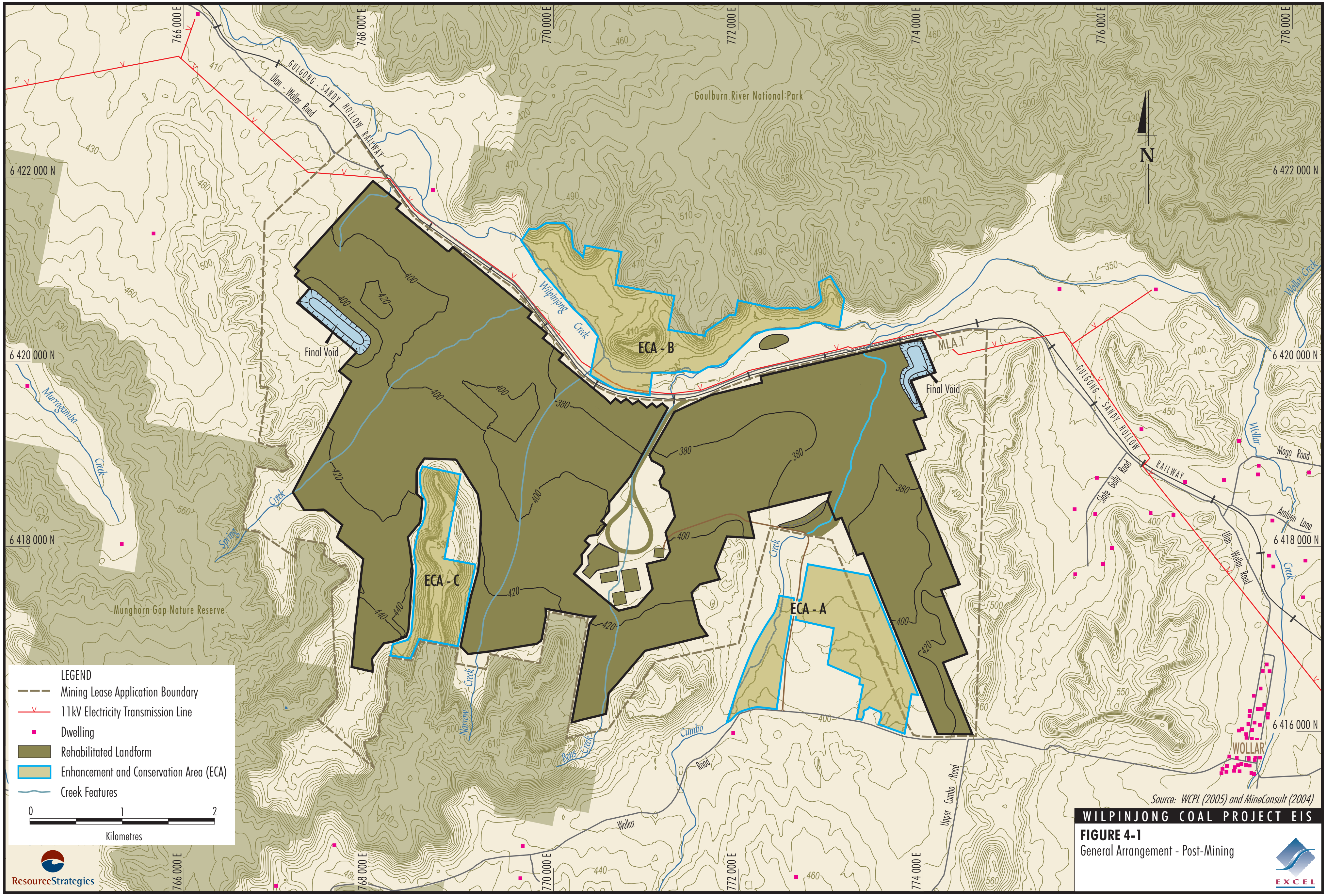
4.1.1 Topography and Landscape Features

Potential Impacts

The main modifications to existing topography that would result from the Project relate to open cut mining operations. Modifications to topography and landscape features would also result from the construction of infrastructure, in particular:

- the CHPP, ROM coal handling areas, and CHPP water supply storage;
- product coal stockpiles/handling area and train loading infrastructure;
- the rail spur and rail loop;
- haul roads and access roads including the mine access road; and
- water management infrastructure including the Cumbo Creek relocation corridor.

At the completion of mining, the majority of the open cut voids would have been backfilled with two final voids retained (Figure 4-1). As discussed in Section 4.3, the final voids would form localised sinks in the groundwater system within which salts would accumulate with time as evapo-concentration occurs. Water balance modelling (Appendix A) indicates that water levels within the two final voids would reach an equilibrium level below their spill levels (Section 4.3). In-pit mine waste rock emplacements would cover an area of approximately 1,800 ha and would be rehabilitated to a final landform that approximates the pre-mining topography. With the exception of mine waste rock used for safety bunds and as construction material, there would be no permanent out-of-pit mine waste rock emplacements associated with the Project. Section 5.2.8 presents the final landform design concepts for the Project.



WIL-04-01 Sect 4_007E

Mitigation Measures

Mine infrastructure and landforms have been designed and located to integrate with existing topography and landscape features via:

- progressive development of mine waste rock emplacements by backfilling behind the advancing open cut to integrate Project landforms with the existing topography and to reduce the need for remnant vegetation clearance associated with out-of-pit mine waste rock emplacements; and
- progressive rehabilitation of Project landforms in a manner that maximises integration with the surrounding landscape.

Project rehabilitation strategies are presented in Section 5.2. Section 4.2.4 discusses additional measures for mitigating potential impacts of the Project on landscape character.

4.1.2 Soils and Erosion Potential

A description of the soils of the Project area is presented in Appendix M and summarised in Section 3.1.4. A survey of the Project area in conjunction with previous mapping identified several soil types including red podzolic, yellow podzolic, earthy sands, brown earths, yellow solodic, lithosols and alluvials.

Potential Impacts

Potential impacts of the Project on soils relate primarily to:

- stripping of *in-situ* soil resources within mining disturbance areas;
- alteration of soil structure beneath infrastructure and hardstand areas (e.g. mine facilities area, CHPP), stockpile areas (e.g. ROM coal, product coal and soil stockpiles) and roads;
- soil contamination resulting from spillage of fuels, lubricants and other chemicals (Section 4.1.4);
- 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) during soil stripping and stockpiling operations.

The alluvial soils associated with drainage lines in the Project area (i.e. Cumbo Creek and Wilpinjong Creek) are not conducive to the formation of acid sulphate soils. The distribution of acid sulphate soils is strongly related to Holocene estuarine sediments which do not occur at elevations above 1 m AHD (DLWC, undated).

Mitigation Measures

Erosion and sediment control strategies for the Project would be developed and documented in an ESCP (Section 5.1.2.2). The measures presented in the ESCP would aim to control soil erosion and sediment generation proximal to the source and thereby minimise the potential for Project activities to adversely affect downstream water quality.

Specific mitigation measures to control soil erosion and sediment migration would include:

- minimising surface disturbance and restricting access to undisturbed areas;
- progressive rehabilitation and revegetation of mine landforms;
- minimising soil compaction during soil excavation and handling;
- use of erosion control features (e.g. silt fences and temporary sediment traps, diversion banks, channels and rip-rap structures) to minimise sediment migration, divert surface water around disturbed areas and to control runoff velocity; and
- use of sediment retention storages to contain runoff from disturbed areas and permit the settling of solids.

In addition to the above, soil resource management practices have been developed and are provided in Appendix M. These practices would be further developed as part of the Project rehabilitation programme and are summarised in Section 5.2.4.

During mining operations, quantification of soil resources available for rehabilitation works, stripping and re-application schedules and stockpiling inventories would be included in the MOP, in accordance with the requirements of the DPI-MR.

Wherever practicable, recovered topsoil and subsoil would be spread directly onto mine waste rock emplacements that have been prepared for rehabilitation. Where direct spreading is not practicable, the material would be stockpiled. Soil stockpiles would be managed to improve the long-term viability of the soil resource through implementation of the following management practices:

- Soil stockpiles to be located outside of active mining areas.
- Stockpiles to be constructed with a rough surface condition to reduce erosion hazard, improve drainage and promote revegetation.
- Stockpiles which are inactive for extended periods to be fertilised and seeded, to maintain soil structure, organic matter and microbial activity.
- Silt fences to be installed around soil stockpiles to control potential loss of soil where necessary.
- Soil stockpiles to be deep-ripped to establish aerobic conditions, prior to soil use in rehabilitation.

Potential soil salinity and dispersivity issues associated with some soil types would be managed during stockpiling as follows:

- Saline soil types to be stockpiled separately and then placed in mine waste rock emplacements below the topsoil/subsoil cover layer.
- Gypsum to be applied at an appropriate rate to stockpiles of dispersive soil types where necessary.

Details of the above management strategies and practices including timing of implementation and relevant methodology would be included in the MOP (Section 5.1.1.1).

4.1.3 Landuse and Land Capability

The general landscape in the Project area is characterised by cleared, predominantly grazing land with most natural vegetation restricted to patches and paddock trees on the valley floor. Denser remnant vegetation occurs on the ridges bounding the Project area and in the south of Pit 3 (Figure 1-4). The dominant landuse in the Project disturbance area is grazing, with some limited cropping.

Land capability and agricultural suitability classifications for the Project area are detailed in Appendix M and are summarised in Section 3.1.4.

Potential Impacts

The potential impacts on landuse would comprise the loss of some grazing (and limited cropping) land and vegetation remnants.

Mitigation Measures

As at 1 May 2005, WCPL controls approximately 4,200 ha of land in the Project area and surrounds, including all lands to be directly affected by mining operations. WCPL would either purchase properties or negotiate lease or compensation agreements with other landowners directly affected by the Project. Negotiations with relevant landowners in this regard are on-going.

Land management practices on WCPL-owned land would be undertaken in accordance with the Land Management Plan (LMP) to be developed for the Project (Section 5.1.2.1).

The progressive development of the Project open cut mining operations, backfilling of the open cut voids with mine waste rock and progressive rehabilitation would limit the Project disturbance area at any one time.

The final landform would approximate the pre-mining topography and would include some permanent creek features (Section 5.2.8). The final voids would form localised groundwater sinks within which salts would accumulate with time as evapo-concentration occurs (Section 4.3). The final voids would be located at the north-eastern extent and at the western extent of the final landform (Figure 4-1).

The final landform design concept proposes a balanced outcome, with the aim of establishing the potential for both sustainable agriculture and areas of woodland vegetation. Following mine closure and final Project rehabilitation, the final landform would include areas of woodland vegetation that would be linked to remnant vegetation that borders the southern Project area, as well as the northern border of the Munghorn Gap Nature Reserve (Section 5.2).

The development of the ECAs and regeneration areas would also result in the alteration of landuse in the Project area, with the management of livestock to encourage natural regeneration and selective planting in parcels of land that are currently used for agriculture (Sections 5.3 and 5.4).

4.1.4 Land Contamination Potential

Section 4.16 summarises the results of the Preliminary Hazard Analysis conducted for the Project (Appendix L) and identifies sources of potential risk to the environment. The following section focuses on management issues related to potential land contamination. A Land Contamination Assessment of the Project area has been conducted in accordance with the requirements of SEPP 55 (Section 1.3.5) and is presented in Appendix O. This assessment concluded that the Project area is considered suitable for a landuse change from predominantly agriculture to the development of the Project (Appendix O).

Potential Impacts

Potential land contamination risks have been identified as including spills, fires or explosions associated with the transport, storage and usage of fuels, chemicals and explosives. In addition, earthworks associated with the Project may expose soil potentially contaminated by past agricultural landuses (e.g. sheep dips and fuel and chemical storage facilities) (Appendix O).

Mitigation Measures

Measures to reduce the potential for contamination of land from fuel, chemicals and explosives include the following:

- Contractors carrying dangerous goods loads would be appropriately licensed in accordance with the provisions of the ADG Code (DTRS, 2000). Contractors would operate under the provisions of WCPL contractor management plans to ensure their safety standards and work procedures meet statutory requirements.
- Carriers of dangerous goods would maintain a communications system (e.g. two-way radio or mobile telephone) in truck cabs to allow for prompt notification in the event of an accident. Trucks would carry fire fighting equipment.
- On-site consumable storage areas would be designed with appropriate bunding and would be operated, where applicable, in compliance with the requirements of AS 1940-1993 *The Storage and Handling of Flammable and Combustible Liquids* and AS 2187.1-1998 *Explosives – Storage, Transport and Use – Storage*. Storage areas would be regularly inspected and maintained as required.
- Project rail infrastructure and signalling systems would be designed in accordance with the relevant rail authority standards. Project train loading activities and rail infrastructure would be regularly inspected and maintained as required. Rail transport contractors would also operate under the provisions of WCPL contractor management plans.

In addition, during development of the Project, areas that have the potential to contain soils contaminated by past agricultural landuses (e.g. sheep dips and fuel and chemical storage facilities) would be further sampled and, if necessary, appropriate management measures would be developed which may include the placement of materials excavated from these areas in the Project tailings disposal areas (Appendix O).

4.1.5 Bushfire Hazard

A description of the existing bushfire regime associated with the Project area and surrounds is presented in Section 3.1.7. The potential impacts of the Project on bushfire hazards and associated mitigation measures are presented below.

Potential Impacts

Fires originating in the Project area present potentially serious impacts to surrounding properties, the Goulburn River National Park and Munghorn Gap Nature Reserve, as well as WCPL personnel and equipment. The operation of mine mobile equipment at the Project could potentially increase the risk of fire initiation. The degree of potential impact would vary with climatic conditions (e.g. temperature and wind) and the vegetative cover present at the time.

Mitigation Measures

A Bushfire Management Plan (BMP) would be developed for the Project (Section 5.1.2.3) to identify bushfire management issues, assess bushfire risk, establish bushfire management measures and outline standard procedures in the event of a bushfire.

Fire awareness and fire safety training would be included in the induction of all WCPL personnel and contractors. In addition to environmental responsibilities, there exists significant economic incentive to prevent fire damage to mining infrastructure and equipment. Suitable fireproofing, fire breaks and fire radiation zones would be established to reduce bushfire hazards (Section 1.3.5).

4.2 VISUAL

Visual impacts that are expected to arise as a result of Project activities were assessed by EDAW Gillespies Australia (EDAW) (Appendix N) in accordance with the methodology presented below.

4.2.1 Assessment Methodology

The assessment methodology employed by EDAW is based on the visual management system developed by the United States of America Forestry Service. Potential visual impacts were assessed by evaluating the degree of visual modification in the context of the visual sensitivity of surrounding landuse areas from which the Project may be visible.

The level of visual modification is a function of the contrast between the proposed Project and the existing visual landscape. The degree of visual modification generally decreases as the distance from the Project increases (Appendix N). The degree of visual modification is considered negligible if the Project is distant and relates to a small proportion of the overall viewscape (*ibid.*).

Visual sensitivity is a measure of how critically a change to the existing landscape would be viewed from surrounding areas, and is a function of both landuse and duration of exposure.

For the purposes of the Visual Impact Assessment (Appendix N), landuses in the vicinity of the Project were characterised in terms of low, moderate or high visual sensitivity, as follows:

- Low visual sensitivity – areas of rural landuse (e.g. agricultural land and local roads such as Ulan-Wollar Road).
- Moderate visual sensitivity – tourist roads/major roads.
- High visual sensitivity – rural residences, townships and natural/recreation areas (e.g. the village of Wollar, Goulburn River National Park and Munghorn Gap Nature Reserve).

However, as distance from the viewer to the Project increases, the level of visual sensitivity is reduced (Appendix N).

Potential visual impacts are determined in accordance with the matrix presented in Table 4-1.

Table 4-1
Visual Impact Matrix

Visual Modification \ Viewer Sensitivity	H	M	L
H	H	H	M
M	H	M	L
L	M	L	L

Source: Appendix N
L = Low; M = Moderate; H = High

The assessment has been undertaken from within regional (>5 km), sub-regional (1 to 5 km) and local (<1 km) settings and includes both qualitative and quantitative assessment components as detailed in Appendix N.

4.2.2 Visual Landscape Alteration

The *Synoptic Plan: Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of New South Wales* (Synoptic Plan) (DMR, 1999) identifies land clearing, modification of landforms, mine infrastructure and night-lighting as potential causes of visual impacts arising from coal mining. Elements of the Project considered to have the potential to impact on the visual landscape include:

- clearance of vegetation within the open cut mine and contained infrastructure area;
- open cut mining, including the construction of safety bunds and the remaining final voids;
- modification of local topographic features (e.g. open cut mining of localised elevated landforms and the relocation of Cumbo Creek);
- progressive development of in-pit waste rock emplacements;
- progressive rehabilitation of completed mine landforms;
- construction of water management structures;
- re-alignment of Ulan-Wollar Road;

- construction and operation of the rail spur and rail loop, train load out infrastructure, CHPP and mine facilities area;
- construction and operation of the mine access road; and
- lighting associated with night-time operations.

The in-pit mine waste rock emplacements would, over time, vary in appearance from freshly placed waste rock to revegetated final landforms (Section 5.2). As such, the level of visual modification created by these emplacements would change, reducing as vegetation establishes.

Progressive development of open cut operations would necessitate the construction of a block bank structure across Cumbo Creek and the relocation of the current flow path to allow the mining of coal reserves located beneath the creek. Some of these features would be visible from Ulan-Wollar Road.

Post-mining landforms would be similar to the pre-mining landforms and no permanent out-of-pit waste rock emplacements would be required (excluding waste rock used for safety bunds and construction material). Following the exhaustion of coal reserves, mining infrastructure including administration areas, CHPP and rail infrastructure would be removed and these areas rehabilitated.

4.2.3 Visual Impact Assessment

Table 4-2 summarises the results of the Visual Impact Assessment undertaken for the Project. Visual simulations were prepared for selected views of the Project area within the sub-regional and local settings and are provided in Appendix N. The viewing locations are shown on Figure 4-2.

Table 4-2
Visual Impact Assessment Summary

Viewing Location (Figure 4-2)	Sensitivity	Visual Modification Level	Impact	Impact After Initial Rehabilitation/ Amelioration	Impact After Final Rehabilitation
Regional Setting (>5 km)	L	L	L	L	L
Sub-Regional Setting (1 to 5 km)					
Village of Wollar	M	Nil	Nil	Nil	Nil
"Yawanna"	H	N	N	N	N
"Castle View"	H	N	N	N	N
"Hillview" (Figure 4-3)	M	L-M	L-M	L-M	L
"Binngarra" (Figure 4-4)	M	L-M	L-M	L-M	L
Ulan-Wollar Road*	L	N	N	N	N
Wollar Road*	L	N	N	N	N
Gulgong-Sandy Hollow Railway*	L	N	N	N	N
Local Setting (<1 km)					
"Wilpin Farm" (Figures 4-5a and 4-5b)	H	M	H	M	L
Ulan-Wollar Road	L	M	L	L	L
Wollar Road	L-M	L	L	L	L
Gulgong-Sandy Hollow Railway	L	M	L	L	L

Source: Appendix N
* Minimal Project visibility.
H – High, M – Moderate, L – Low, N – Negligible.

WILPINJONG COAL PROJECT EIS

FIGURE 4-2
Visual Simulation Points and Location Points of Residences in Close Proximity of the Project

WIL-04-01 Sect 4_008E

Further description is provided below in relation to the assessed impacts from within the regional, sub-regional and local settings.

Regional Settings (>5 km)

Visual simulations from rural residences are shown on Figures 4-3, 4-4, 4-5a and 4-5b. Measures to be employed to mitigate visual impacts are provided in Section 4.2.4 below.

The visual impact of the Project on the regional setting is assessed to be low (Table 4-2) resulting from a low level of visual sensitivity coupled with a low level of visual modification at distance.

Sub-Regional Settings (1 to 5 km)

A number of isolated viewing locations are located within 1 to 5 km of the Project and visual impacts at these locations would vary according to visual sensitivity and the degree of visual screening provided by intervening vegetation and topography.

Village of Wollar

The village of Wollar is visually separated from the Project area by substantial vegetated ridgelines. As such, there would be no viewscape impacts associated with the Project.

Rural Residences in the Sub-Regional Setting

Views from the "Yawanna" residence (Figure 4-2) are obscured and relate to a small proportion of the overall viewscape due to the general flatness of the valley floor and slightly elevated topography resulting from the intrusion of the toe of a ridgeline to the east of the Project area. As such, the level of visual modification would be negligible (Table 4-2).

The level of visual modification due to the Project would also be negligible from the "Castle View" residence (Figure 4-2) given the effectiveness of existing vegetation screening and intervening topography and the distance to the nearest edge of the open cut mining operation (Appendix N).

Visual simulations were prepared for views of the Project area from the "Hillview" and "Binngarra" residences (off Wollar Road) as they would have distant views of a thin band of disturbance associated with open cut operations in Pit 3 (Figures 4-3 and 4-4). The low to moderate visual modification level coupled with moderate level of visual sensitivity would result in a low to moderate visual impact at these residences (Table 4-2).

The visual impact would progressively reduce once vegetative cover is established on mine waste rock emplacements by the rehabilitation programme.

Ulan-Wollar Road and Wollar Road

Views of the Project from Ulan-Wollar Road and Wollar Road within the sub-regional setting (1 to 5 km) would generally be obscured from view and would comprise to a small proportion of the overall viewscape due to the relative flatness of the valley floor. There would be a negligible visual impact within the sub-regional setting (Table 4-2).

Gulgong-Sandy Hollow Railway

Given the relative flatness of the valley floor and the intrusion of the toes of ridgelines at the eastern and western ends of the valley in which the Project lies, views from the Gulgong-Sandy Hollow railway within the sub-regional setting (1 to 5 km) would generally be obscured and would comprise a small proportion of the overall viewscape. As such, there would be a negligible visual impact within the sub-regional setting (Table 4-2).

Local Settings (<1 km)

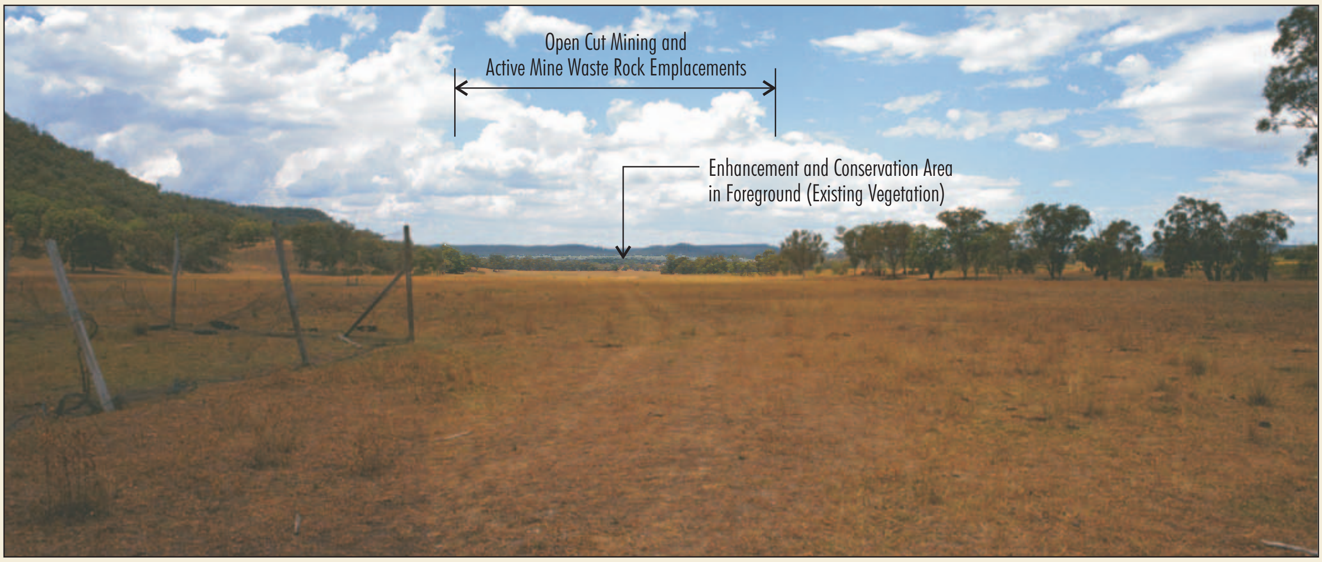
There are limited locations with potential views within the local setting of the Project and these are described below.

Rural Residence in the Local Setting

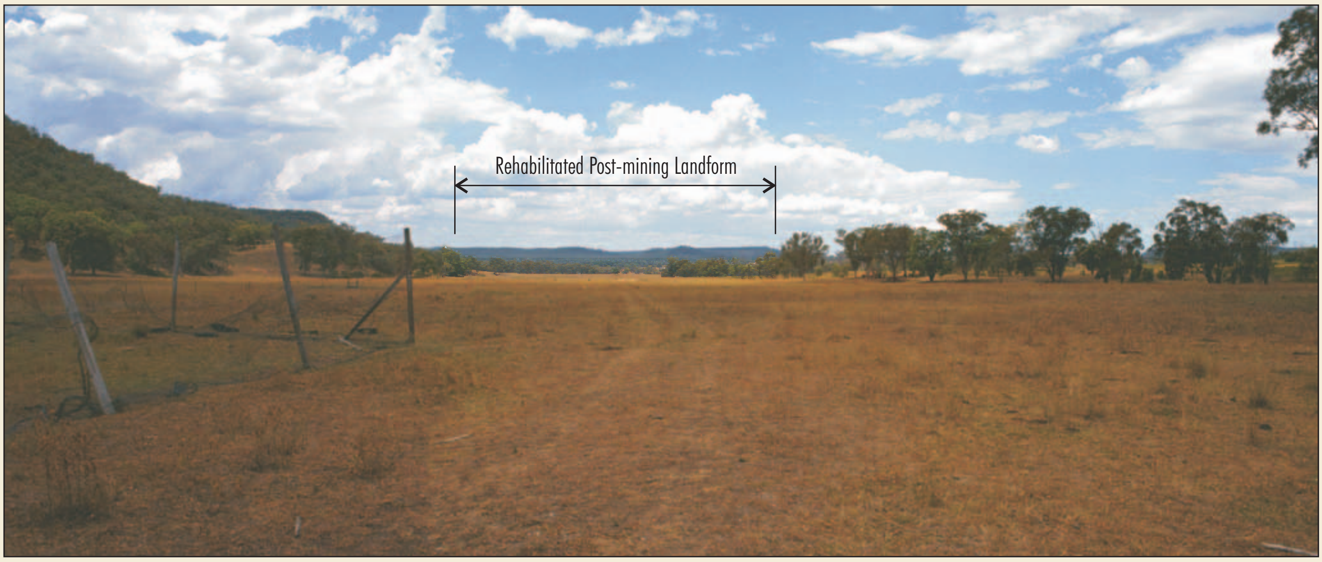
The "Wilpin Farm" residence is located approximately 400 m from the edge of the Project open cut mine and contained infrastructure area (Figure 4-2). The flat topography and intervening Gulgong-Sandy Hollow railway results in a shallow vertical angle of view from the residence to the Project. Existing vegetation in the immediate foreground around the residence, and between the residence and the railway also provides partial screening of views towards the Project.

Visual simulations were prepared for views of the Project from the "Wilpin Farm" residence and are shown on Figures 4-5a and 4-5b. The simulations are presented for Project mine landforms during Year 3, Year 14 and post-mining to represent progressive stages in the Project life. The existing view is also presented for reference purposes. Year 14 represents the greatest potential for visual impact at the "Wilpin Farm" residence. The post-mining simulation takes into account rehabilitation works as described in Section 5.2.

EXISTING VIEW



YEAR 9 SIMULATION



POST-MINING SIMULATION (Landform Completed Year 14)

Source: *EDAW Gillespies (2005)*

WILPINJONG COAL PROJECT EIS

FIGURE 4-3
Existing View and Visual Simulations - "Hillview" Residence

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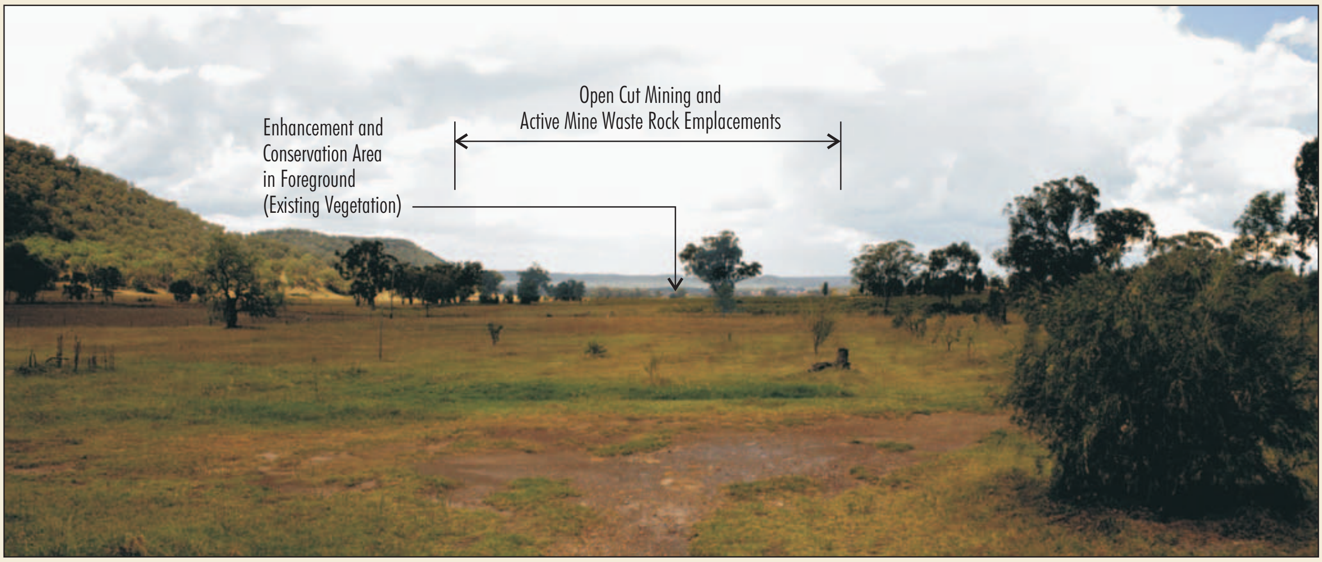
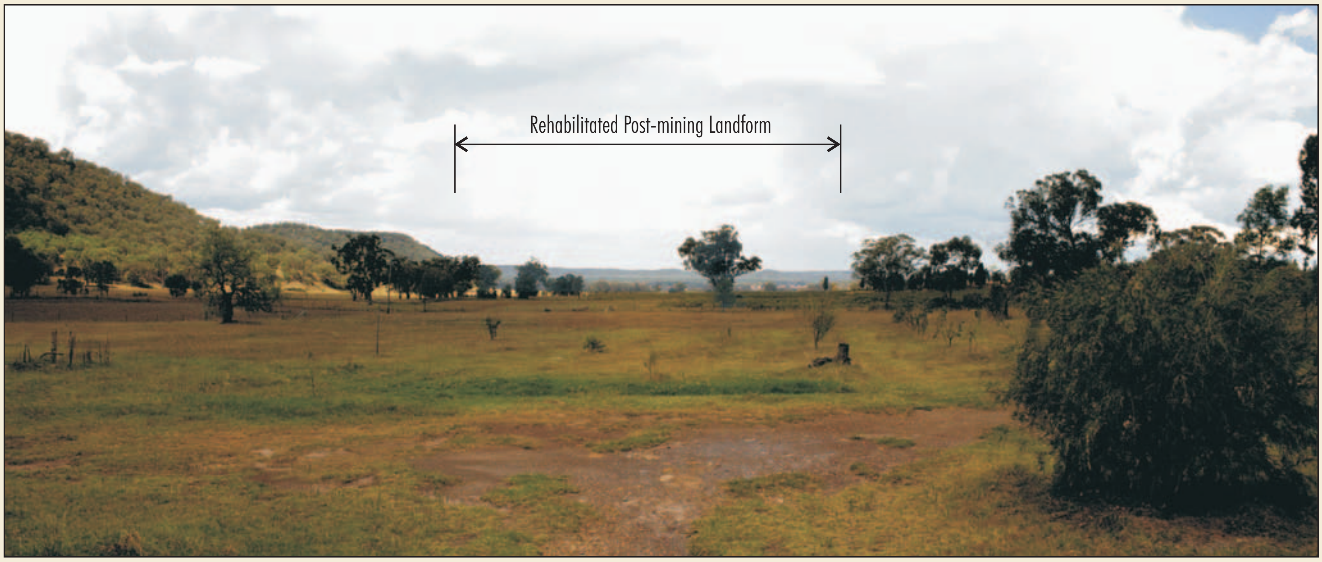
WIL-04-01 Sect 4_009C

EXISTING VIEW



YEAR 9 SIMULATION



POST-MINING SIMULATION (Landform Completed Year 14)

Source: EDAW Gillespies (2005)

WILPINJONG COAL PROJECT EIS

FIGURE 4-4
Existing View and Visual Simulations - "Binngarra" Residence

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EXCEL

WIL-04-01 Sect 4_010D

EXISTING VIEW

YEAR 3 SIMULATION

Source: EDAW Gillespies (2005)

WILPINJONG COAL PROJECT EIS

FIGURE 4-5a
Existing View and Visual Simulation
Year 3 - "Wilpin Farm" Residence

ResourceStrategies

EXCEL

WIL-04-01 Sect 4_011C

YEAR 14 SIMULATION (Without Proposed Foreground Vegetation Screen Shown)

POST-MINING SIMULATION (Landform Completed Year 18)
(Without Proposed Foreground Vegetation Screen Shown)

Source: EDAW Gillespies (2005)

WILPINJONG COAL PROJECT EIS

FIGURE 4-5b
Visual Simulations Year 14 and Post-Mining - "Wilpin Farm" Residence

EXCEL

ResourceStrategies

WIL-04-01 Sect 4_012C

The safety bunds and distant open cut mining operations would be the most visually prominent components of the Project from the "Wilpin Farm" residence in the latter years of the Project life. Grasses, shrubs and trees planted on these bunds would reduce the level of visual modification over time.

The moderate level of visual modification, coupled with a high degree of visual sensitivity at the rural residence, would initially result in a high level of visual impact at the "Wilpin Farm" residence. As vegetation is established on safety bunds, the level of visual impact would reduce (Appendix N).

Ulan-Wollar Road

Within the local setting, views of the Project from Ulan-Wollar Road would include the safety bunds constructed along selected boundary areas of each open pit with distant views of open cut mining operations also available from some elevated areas (Appendix N). As described above, the safety bunds would be revegetated and this would reduce the level of visual impact over time.

Given the low sensitivity coupled with the moderate level of visual modification (with the safety bunds as the most visually prominent component of the Project), a low level of visual impact would result (Table 4-2).

Wollar Road

Within the local setting, views of the Project from Wollar Road would be limited by intervening topography and further restricted by vegetation between the road and the Project area (Appendix N). The existing vegetation along the south-eastern boundary of Pit 3 near Wollar Road would be retained as a screen. The level of visual modification from viewpoints along Wollar Road would therefore be low (*ibid.*).

The low level of visual modification coupled with the low to moderate level of visual sensitivity, would result in a low visual impact on users of Wollar Road within the local setting (Appendix N).

Gulgong-Sandy Hollow Railway

Within the local setting, the safety bunds placed along selected boundary areas of each open pit would be the most visually prominent component of the Project from the Gulgong-Sandy Hollow railway and would reduce direct views into the open cut. More distant views of open cut mining operations would be available from some elevated positions on the railway.

Given the low sensitivity of the Gulgong-Sandy Hollow railway and the moderate level of visual modification, a low level of visual impact would result (Table 4-2).

Night-Lighting

Night-lighting would be emitted from three main sources *viz.*:

- stationary work lights;
- mobile vehicle mounted lights; and
- overhead lighting of the CHPP, coal handling and train loading infrastructure and the mine facilities area.

Direct views of night-lighting sources from Ulan-Wollar Road would generally be screened behind the safety bunds placed along sections of the northern boundary of the open pits. Direct views from Wollar Road would be screened by the ridgeline to the south of the Project area and intervening vegetation. However, lighting on taller infrastructure such as the CHPP, coal handling and train loading infrastructure may be visible at these locations and from the "Wilpin Farm" residence.

Potential night-lighting impacts on the local and sub-regional settings would generally be restricted to the production of a glow above operational areas that contrast with the night sky. This effect would decrease with distance, however, the glow would be visible at nearby residences and along the local road network. Some further light spill may occur on nights when there is a low cloud base and reflection off the cloud base occurs.

4.2.4 Mitigation Measures

The mining method described in Section 2.4 involves progressive backfilling of mined-out voids behind the advancing open cut. Final landform shaping is to approximate existing topographic forms. Regular slopes and sharp transition angles would be varied and rounded to provide a more natural appearance.

The revegetation programme would be progressive, commencing soon after the completion of landform shaping. Visual impacts associated with unvegetated mine landforms would progressively reduce once the vegetative cover begins to establish. Revegetation in woodland areas would utilise native tree/shrub species, as well as grasses, characteristic of the area for consistency of colour and visual texture.

Other measures that would be employed to mitigate visual impacts include:

- design and construction of Project infrastructure in a manner that minimises visual contrasts (e.g. suitably coloured cladding for buildings); and
- early establishment of vegetation on safety bunds.

In addition, it is proposed to establish vegetation screening at the "Wilpin Farm" residence early during the Project life.

Night-lighting would be restricted to the minimum required for operational and safety requirements and would be directed away from roads and sensitive viewpoints. Lighting above topographic screens would be directed downwards and light shields would be used to limit the spill of lighting where practicable.

4.3 SURFACE WATER

A Surface Water Assessment has been undertaken as part of the development of the water management system for the Project and to assess potential impacts on surface water resources (Appendix A).

The assessment included data collation, monitoring of local creeks to characterise baseline conditions, catchment modelling, development of a Project water balance model, water management planning, post-mining water management concepts and final void modelling. A description of the existing water quality and flow characteristics of creeks in the vicinity of the Project is provided in Section 3.2 and Appendix A.

Presented below is a description of the potential impacts of the Project on surface water resources and proposed mitigation measures. An assessment of potential impacts of the Project on aquatic ecosystems is presented in Section 4.9 and Appendix HD. In summary, the potential impacts of the Project on surface water resources include changes to surface water quality and surface water flows, as described in Sections 4.3.1 and 4.3.2, respectively.

4.3.1 Surface Water Quality

Potential Impacts

Surface water runoff from mine landforms and disturbance areas could potentially contain sediments, soluble salts, process reagents (i.e. flocculant/magnetite), fuels, oils and grease. The potential surface water quality impacts of the Project that relate to these contaminants are summarised in Table 4-3.

The results of geochemical testwork undertaken for the Project indicate that mine waste rock is expected to be non-saline and non-acid forming (Appendix C). The coarse reject and tailings materials are expected to have some capacity for acid generation and the tailings material is expected to be moderately saline (Appendix C). Surface water management measures would be implemented to minimise potential surface water quality impacts as described below.

In addition to potential impacts associated with surface water runoff, the long-term water balance of the final voids (Appendix A) indicates that the salinity of void waters would slowly increase with time, as a result of on-going migration of saline groundwater infiltration into the voids. In the longer term, salt concentrations would also be affected by evapo-concentration. The voids would slowly fill with water and approach an equilibrium level below the overflow level of the final voids (Appendix A). Groundwater inflows to the voids are predicted to be small compared with direct rainfall runoff and infiltration through the mine waste rock emplacements. Groundwater inflows would reduce as the water level in the voids reaches the equilibrium level (Appendix A).

The use of groundwater resources by the Project also has the potential to impact on stream water quality as a result of changes in the contribution that groundwater from the Ulan Seam makes to creek baseflow in Wilpinjong and Wollar Creeks (described in Section 4.4). Groundwater quality monitoring records in the Ulan Seam indicate EC ranges from 1,020 to 3,390 µS/cm.

Table 4-3
Potential Surface Water Quality Impacts

Operational Areas	Potential Impact Scenario	Type of Potential Contamination
Open cut and mine waste rock emplacements	Drainage of sediment laden runoff to downstream surface waters during pre-stripping and initial open cut/mine waste rock emplacement development. Uncontrolled drainage to downstream surface waters during operation.	Sediments and soluble salts.
ROM and product coal stockpiles/handling areas	Drainage of sediment laden runoff to downstream surface waters during initial stockpile development. Uncontrolled drainage from coal stockpiles/handling areas to downstream surface waters during operation.	Sediments, soluble salts and reduced pH.
Tailings delivery pipeline and tailings disposal areas	Drainage of supernatant and internal runoff from the tailings disposal areas to downstream surface waters during operation. Spillage to downstream surface waters resulting from a pipeline rupture.	Sediments, soluble salts, process reagents (i.e. flocculant/magnetite) and reduced pH.
Project water supply borefield pipelines and open cut and advance dewatering pipelines	Spillage to downstream surface waters resulting from rupture of pipeline during operations.	Sediments and soluble salts.
CHPP and mine facilities area	Drainage of sediment laden runoff to downstream surface waters during construction. Spillage to downstream surface waters during operation.	Sediments, soluble salts, process reagents (i.e. flocculant/magnetite), fuels, oils and grease.
Train loading infrastructure, haul roads, access roads and hardstand areas	Drainage of runoff to downstream surface waters during construction. Spillage to downstream surface waters during operation.	Sediments, soluble salts, fuels, oils and grease.
Cumbo Creek relocation corridor	Drainage of sediment laden runoff to downstream surface waters during construction and prior to channel stabilisation.	Sediments.
Ulan-Wollar Road re-alignment	Drainage of runoff to downstream surface waters during construction of the road re-alignment. Potential erosion and sedimentation resulting from runoff from the road surface and associated drainage system.	Sediments.
Project rail loop and rail spur	Drainage of sediment laden runoff to downstream surface waters during construction of the rail loop and rail spur. Potential erosion and sedimentation resulting from runoff from the rail surface and associated drainage system.	Sediments.
Effluent from the sewage treatment facility	Spillage of treated or untreated sewage to downstream surface waters during operation.	Nutrients and organic matter.

Source: after Appendix A

The Ulan Seam is a source of the total salt load that is observed in Wilpinjong Creek, when compared to that contributed by the relatively fresher alluvial/colluvial aquifer (Appendix A). Therefore, any reduction in the rate of contribution that groundwater from the Ulan Seam makes to the creek baseflow would result in a corresponding reduction in the salt load in Wilpinjong and Wollar Creeks (Appendix A). This potential reduction in salt load, combined with the Project creek enhancement works, would be beneficial to the aquatic assemblages of Wilpinjong and Wollar Creeks (Appendix HD).

Mitigation Measures

The Surface Water Assessment (Appendix A) was undertaken in order to develop a water management system (Section 2.9.1) for the Project to minimise potential surface water quality impacts. Detailed design of the Project water management system would be undertaken as part of the Project SWMP which is described in Section 5.1.2.4. The water management system would be developed in accordance with accepted water management principles including minimising contamination of water and maximising the re-use of mine water.

Key components of the water management system include: the minimisation of disturbance areas; isolation, containment and recycling; progressive stabilisation and revegetation of disturbed areas; and erosion and sediment control as described below. A surface water monitoring programme would be developed for the Project and detailed in the SWMP. The frequency, parameters and locations monitored as part of the surface water quality monitoring programme would be reviewed on an annual basis. Further details of the monitoring programme are provided in Section 5.1.3.6.

Further to the water management system components described below, handling procedures for mine waste rock, coarse rejects and tailings are presented in Section 2.8. Implementation of these procedures is expected to minimise the potential for acid mine drainage (Appendix C). In addition, geochemical testwork of overburden, interburden, coarse rejects and tailings would be undertaken as the Project develops to confirm the geochemical characteristics of these materials as classified in Appendix C.

Water Management System

<u>Minimising Disturbance Areas</u>

Areas disturbed by active mining would be minimised as far as practicable. In order to minimise and manage waters requiring on-site containment, the Project area would be segregated into several catchment types including:

- undisturbed runoff areas;
- construction/development runoff areas;
- operation runoff areas; and
- rehabilitation areas.

Until the surfaces of rehabilitation areas have stabilised to a satisfactory condition, runoff from these areas would be directed to sediment retention storages prior to release to local drainages. Thereafter, sediment retention storages would be decommissioned (or left in place as farm dams if considered practicable) and the rehabilitated landforms would be allowed to free-drain. As such, the total disturbance area would be minimised as areas undergo progressive rehabilitation.

<u>Isolation, Containment and Recycling</u>

Runoff from catchment areas which are undisturbed by mining activities would be isolated and, where necessary, diverted around disturbance areas. The objective of this strategy is to minimise mixing of runoff from undisturbed areas with waters from construction/development and operation areas and therefore, minimise the volume of water that is required to be managed on-site. Over the life of the Project this would involve the construction of upslope diversion bunds and drains. Isolation bunds and toe drains would also be constructed around areas disturbed by mining to collect and convey drainage from these areas to sediment retention storages.

Runoff from construction/development areas and operation areas would be intercepted and channelled to sediment retention storages across the Project area and/or the CHPP and box cut water supply storages. Sediment retention storages would be sized to contain runoff from design rainfall events and trap silt and other suspended material. Sediment retention storages would be provided for the containment of spills and runoff from within construction/development areas. Water recovered from the open cut operations would be pumped to the CHPP water supply storage for use in the CHPP. During wet periods, when there may be an excess of water being generated on-site, water captured in active open cuts would be pumped to inactive open cut voids and/or tailings disposal areas for temporary storage.

Supernatant from tailings disposal areas, generated by settling and consolidation of tailings, would be decanted and returned to the CHPP water supply storage for re-use. Incident rainfall over tailings disposal areas and any adjacent undiverted catchment would contribute additional water which would combine with the supernatant.

Runoff from haul roads and hardstand areas would be captured in sediment retention storages to provide for the settlement of suspended solids prior to being released. Runoff from the workshop and vehicle re-fuelling areas would be diverted to an oil-water separator and then to the CHPP water supply storage for re-use.

Effluent from the sewage treatment plant would be irrigated within contained catchments over vegetated and garden areas around the administration and workshop facility area.

Runoff from rehabilitation areas would be directed to sediment retention storages prior to being released to local drainages.

<u>Progressive Stabilisation and Revegetation of Disturbed Areas</u>

Progressive rehabilitation of the Project disturbance areas is described in Section 5.2. Construction/development areas and operation areas would be progressively rehabilitated during the Project life. It is anticipated that once vegetation has established in the rehabilitation area, surface runoff would be of comparable water quality to undisturbed areas. Passive treatment systems in the form of temporary sediment retention storages, silt fences and vegetated buffers would be employed as erosion and sediment control measures during the rehabilitation process.

During the progressive rehabilitation of Project landforms, a pattern of creek features (i.e. flow paths) would be formed over the rehabilitated landforms comparable to the pre-mine regime (i.e. in similar locations to the existing Planters Creek, Spring Creek, Narrow Creek and Bens Creek). Revegetation of the permanent creek features would include the use of native riparian species (Section 5.2).

<u>Erosion and Sediment Control</u>

Erosion and sediment control measures would be designed in accordance with the above water management principles and would involve the preparation and implementation of an ESCP (Section 5.1.2.2).

The ESCP would describe the sequencing of construction/development works and mining activities so as to minimise the area of disturbance at any given time in conjunction with the implementation of a progressive rehabilitation programme. Specific mitigation measures to control soil erosion and sediment migration are described in Section 4.1.2.

Cumbo Creek Relocation

As described in Section 2.9.1, the potential environmental impacts associated with the relocation of Cumbo Creek would be minimised through the detailed geotechnical, hydrological and hydraulic design that would be implemented prior to construction. The Cumbo Creek relocation corridor and bunds would be revegetated with native riparian vegetation. A Cumbo Creek Relocation Plan would be developed for the Project as described in Section 5.1.2.6.

4.3.2 Surface Water Flows

Potential Impacts

Creeks situated within the limits of the Project open pits would be removed or altered as a result of open cut mining, including Planters, Spring, Narrow, Bens and Cumbo Creeks. The Project also has the potential to impact on surface water flows in creeks located outside the Project disturbance area. A Surface Water Assessment (Appendix A) and Groundwater Impact Assessment (Appendix B) have been undertaken for the Project and have assessed the potential for the alteration of stream flows. This has been done by comparing the modelled baseline hydrological conditions in the catchment (i.e. without the Project) against that predicted to occur with the affect of the Project included.

The Project has the potential to affect flows in Wilpinjong Creek as a result of reductions in overland flow from the Project catchment and indirectly through reductions in the rate of groundwater discharge to the creek. Flows passing any point in a stream predominantly comprise drainage of water from the upstream catchment which originated as rainfall, but may also include flow derived from discharge from groundwater aquifers which extend beyond surface catchment boundaries (Appendix A). Streamflow can be considered as the combination of different components representing different pathways of water movement through the catchment. The dominant components are usually (Appendix A):

(i) *Overland flow* (or surface runoff) which is water that drains directly from the catchment surface as sheet and channel flow. Overland flow occurs during and for short periods after a rainfall event, as water flowing over the surface of the catchment drains off.

(ii) *Baseflow* is water that discharges from sub-surface storage into a stream. This sub-surface storage may comprise interflow/underflow (see below) as well as deeper groundwater aquifer systems.

(iii) *Interflow/Underflow* is water that infiltrates and moves rapidly through the soil mantle and other permeable strata near or beneath the stream (i.e. bank flow or underflow), reappearing during and for moderate periods after a rainfall event.

Wollar Creek and Goulburn River flow data indicates that baseflow accounts for some 40% of total flow on both streams (Appendix A). Analysis of this data, which features protracted recession flows in the runoff hydrographs, indicates that the dominant proportion of this baseflow is likely to comprise interflow/underflow associated with the alluvial/colluvial deposits in connection with the streams and perching and ponding of water in the near surface soil horizon rather than discharge from the underlying deeper groundwater system. On Wilpinjong Creek, the deeper groundwater inflows are derived in part from the artesian coal seam aquifer (Ulan Seam). The rate of leakage to the creek from this aquifer is limited by the confining nature of the strata overlying the Ulan Seam (Appendix A).

Undiverted surface runoff which reports to active and inactive open cuts would be retained and re-used in the Project water management system (Section 2.9.1). This water includes a proportion that would have originally flowed to Wilpinjong Creek as overland flow. Further, open cut dewatering and operation of the Project water supply borefield would result in a reduction in the deeper groundwater discharge component of creek baseflow (Appendix B). The maximum simulated effects on Wilpinjong Creek flows have been assessed in Appendix B to occur in Year 14. For the predictive groundwater modelling presented in Appendix B, it has been conservatively assumed that extractions from the Project water supply borefield would continue until Year 14 of operations rather than Year 10 as indicated by the water balance model (Appendix A). Once groundwater extractions from the water supply borefield cease, it is expected that the groundwater system directly affected by the borefield would commence a process of gradual recovery (Appendix B). Year 14 also corresponds to the maximum catchment excision due to development of the Project components.

The predicted effect on flows in Wilpinjong and Wollar Creeks is summarised in Table 4-4. The potential maximum flow reduction in Wilpinjong Creek equates to an 11% reduction of annual average flow. Downstream of the confluence of Wilpinjong and Wollar Creeks the affects would diminish due to the inflows from unaffected catchments (Appendix A).

Table 4-4
Potential Maximum Reduction in Wilpinjong Creek and Wollar Creek Annual Average Flow

Catchment	Location	Potential Maximum Reduction in Annual Average Flow (%)
Wilpinjong Creek	Upstream of Wollar Creek Confluence	11%
Wollar Creek	At Goulburn River National Park Boundary	4.8%

Source: Appendix A

Whilst the predicted changes to low flows in Wilpinjong Creek would be expected to be noticeable as reduced flow persistence, the magnitude of predicted effects can be compared to those that occur due to other changes in catchment condition and landuse such as changes in livestocking rates, construction of farm dams, water harvesting or bushfires which can also result in noticeable changes to low flows (Appendix A).

The relative effects on the magnitude and duration of low flows would reduce significantly downstream of the confluence of Wilpinjong and Wollar Creeks due to additional unaffected inflows from Wollar Creek. As such, the effects of flow reductions further downstream in Wollar Creek (and upstream of the Goulburn River National Park) would not be discernible from other normal variations in flows resulting from the types of changes in catchment condition and landuse described above, or from the proposed 10 km of creek enhancement works (i.e. exclusion of livestock and riparian revegetation) on WCPL-owned lands which are described in Section 5.

The actual magnitude of the potential flow reductions in Wilpinjong Creek annual average flow would vary with time and would be less than that described above and presented in Table 4-4, depending on the area of catchment excised by Project operations and on the level of usage of the Project water supply borefield. In periods of the Project life when catchment excision and borefield extractions are less, the reduction in flow would also be expected to be less. Revegetation associated with the creek enhancement works would develop through the Project life in parallel to any flow effects (Sections 5.3 and 5.4).

Potential Cumulative Impacts

The Ulan Coal Mines are located approximately 11 km to the north-west of the Project, near the village of Ulan. The Ulan Coal Mines incorporate both underground and open cut mining areas and associated surface infrastructure including a CHPP, rail loop, rail loading and administrative facilities. The Ulan Coal Mines operate under a number of consents.

The Ulan Coal Mines (including surface infrastructure associated with the as yet undeveloped Ulan Stage 2) are located in the Goulburn River catchment, upstream of its confluence with Wollar Creek (Figure 1-2). Any cumulative surface water impacts would therefore relate to the Goulburn River downstream of the Wollar Creek confluence. Given that the potential effects of the Project on flows in Wollar Creek (upstream of the Goulburn River National Park) would not be discernable (see above), cumulative impacts on the Goulburn River as a result of the Project and the Ulan Coal Mines would also be indiscernible (Appendix A).

Mitigation Measures

Mitigation of the predicted reduction in average annual flows in Wilpinjong Creek would include designing the Project water management system to maximise the diversion of runoff from undisturbed areas around Project construction/development and operational areas, together with progressive rehabilitation to allow the free-draining of completed landforms. These measures would minimise the degree of catchment excision at any one time. Sections 2.9 and 4.3.1 present the design objectives of the Project water management system. Section 5.1.2.4 presents the scope and framework of the proposed SWMP. Section 5.2 presents the rehabilitation programme and concepts for the Project final rehabilitated landforms.

Mitigation measures in the form of exclusion of livestock and the enhancement of riparian vegetation in sections of Wilpinjong Creek and Cumbo Creek are described in Sections 5.3 and 5.4. Approximately 10 km of creekline along Wilpinjong and Cumbo Creeks would be revegetated/enhanced by the Project within the Project ECAs or regeneration areas. Appendix HD and Section 4.9 further discuss the benefit of the enhancement works to stream health.

As described in Section 4.3.1, a Cumbo Creek Relocation Plan would be developed for the Project. The plan would include: design and specifications for creek relocation works; a construction programme for the creek relocation, describing how the work would be staged and progressively integrated with mining operations; design of the block bund foundation to provide for the diversion of any sub-surface flow associated with Cumbo Creek alluvium; water quality, ecological and geomorphic performance criteria for the creek relocation; and a programme to inspect and maintain the creek relocation and revegetation works until they stabilise.

4.4 GROUNDWATER

The Project Groundwater Impact Assessment (Appendix B) has assessed the potential impacts of the Project on groundwater resources. The assessment included:

- the collation of existing geological and hydrogeological data;
- a hydrogeological investigation and groundwater monitoring programme;
- a bore census to identify existing groundwater users in the vicinity of the Project and to obtain relevant data (i.e. bore location, depth, usage and extraction aquifer); and
- the development of a numerical groundwater flow model.

The groundwater flow model was used to simulate the potential effects of the Project on the local aquifer systems and to estimate the potential quantity of groundwater inflow to the Project open cuts and the potential yield from the Project water supply borefield. A summary of the potential impacts of the Project on: local groundwater aquifers; on existing groundwater users; and on the rate of groundwater discharge to Wilpinjong Creek is presented below. Relevant mitigation measures are also presented.

As described in Section 3.3.2, the hydrogeological regime of the Project area and surrounds comprises two main aquifer systems (Appendix B):

- Ulan Seam – within the Illawarra Coal Measures and is to be mined by the Project. Standing water levels in the Ulan Seam within the Project area and surrounds range from 2.73 m above ground to 9.9 m below ground. The Ulan Seam is relatively permeable when compared to the overlying sandstones of the Illawarra Coal Measures.
- Marrangaroo Sandstone – typically separated from the overlying Ulan Seam by a relatively thin siltstone layer, but in some areas both aquifers are in direct contact. Pumping tests indicate that both aquifers are hydraulically connected and have similar groundwater levels.

In addition, alluvial deposits are also present within the Project area and surrounds. Areas of alluvial deposit are associated with Wilpinjong and Cumbo Creeks. Colluvium is also present in the Project area and surrounds, particularly between Wilpinjong Creek and the Goulburn River National Park.

Numerical modelling of the aquifer drawdown in the Ulan Seam and the Marrangaroo Sandstone as a result of the development of the Project open cuts and water supply borefield indicates a cone of depression with a radius of approximately 2.5 km to the east, 5 km to the west and 6.5 km to the north of the extremities of the Project open pit limits (Appendix B). The drawdown in the underlying Marrangaroo Sandstone is expected to be of a similar or slightly larger extent (Appendix B). The numerical modelling showed only a limited effect on the water levels in the alluvium/colluvium aquifer. Large sections of the alluvium remained saturated at the end of the 21 year Project life (Appendix B). The model also indicated that there would be no discernible effect on the groundwater and surface water regimes in the sandstone plateau (i.e. Narrabeen Group) that forms the Goulburn River National Park (Appendix B).

After the cessation of groundwater extractions from the Project water supply borefield (assumed to be Year 14) and the cessation of open cut dewatering in Year 21, the groundwater system would be expected to gradually recover (Appendix B).

4.4.1 Existing Groundwater Users

Potential Impacts

Existing groundwater users in the vicinity of the Project include 14 groundwater bores which extract from the Ulan Seam aquifer within the Year 21 cone of depression (Appendix B). Of these, with the exception of one bore on privately-owned land to the north of Wollar village (property 100 – Figure 1-5) and one bore located on land owned by Ulan Coal Mines to the west of the Project (property 32 – Figure 1-5), all of these bores are on WCPL-owned land (Appendix B). Bores located to the south of the Project open pits are either beyond the extent of the predicted cone of depression or are located in a different aquifer system from those being affected by the Project and are not expected to be impacted. No bores or wells installed in the Wilpinjong Creek alluvium or Wollar Creek alluvium are expected to be affected.

All known springs on privately-owned land are located beyond the extent of the cone of depression and/or in different aquifer systems from those being affected by the Project and are not expected to be impacted.

Mitigation Measures

A groundwater monitoring programme to monitor the impact of mining on existing bores/wells is discussed in Section 5.1.3.7. As discussed above, only two existing groundwater bores not owned by WCPL are expected to be affected by the Project. If the data obtained from the groundwater monitoring programme indicates that the Project is having an adverse effect on existing groundwater users (i.e. reduced groundwater yield from existing bores), then the water supply would be re-instated by WCPL either by deepening the existing bore, construction of a new bore or by providing an alternate water supply.

4.4.2 Groundwater Inflows to Creeks

Potential Impacts

Groundwater model predictions indicate that mine dewatering and operation of the Project water supply borefield would reduce the average annual baseflow of Wilpinjong Creek due to the reduction in upward leakage from the underlying artesian aquifer formed in the Ulan Seam and underlying Marrangaroo Sandstones. The simulated long-term average annual baseflow in Wilpinjong Creek declined from 2,230 cubic metres per day (m^3/day) in pre-mining conditions to 1,566 m^3/day in Year 14 of the Project, at which time in the simulation it was assumed that extractions from the Project water supply borefield would cease. Results of the groundwater modelling showed that after cessation of borefield extractions, gradual groundwater level recovery was accompanied by a corresponding recovery of creek baseflow. Interflow/underflow associated with the alluvial and colluvial deposits adjacent to the creek and shallow seepage from the adjacent elevated Goulburn River National Park escarpment, which are the dominant contributors to the long-term average annual baseflow of Wilpinjong Creek (Appendix A), would remain relatively unchanged (Appendix B).

Simulation results indicated negligible impact on the rate of groundwater discharge to Wollar Creek which is at the eastern limit of the potential cone of depression and no impact on direct groundwater discharge to Goulburn River.

Further assessment of these flow changes on stream hydrology and aquatic ecosystems along these creeks is provided in Sections 4.3 and 4.9, respectively.

The groundwater in the Ulan Seam is reasonably saline as previously discussed in Section 3.3.4. Consequently, any reduction in the rate of contribution that groundwater from the Ulan Seam makes to the creek baseflow would have a corresponding reduction in the salt load in Wilpinjong Creek and Wollar Creek (downstream of its confluence with Wilpinjong Creek).

Mitigation Measures

Mitigation of the predicted reduction in average annual flows in Wilpinjong Creek would include designing the Project water management system to maximise the diversion of runoff from undisturbed areas around Project construction/development and operational areas, together with progressive rehabilitation to allow the free-draining of completed landforms. These measures would minimise the degree of catchment excision at any one time. Sections 2.9 and 4.3.1 present the design objectives of the Project site water management system. Section 5.1.2.4 presents the scope and framework of the proposed SWMP. Section 5.2 presents the rehabilitation programme and concepts for the Project final rehabilitated landforms.

Mitigation measures in the form of exclusion of livestock and the enhancement of riparian vegetation in sections of Wilpinjong Creek and Cumbo Creek are described in Sections 5.3 and 5.4. Approximately 10 km of creekline along Wilpinjong and Cumbo Creeks would be revegetated/enhanced by the Project within the ECAs or regeneration areas. Appendix HD and Section 4.9 further discuss the benefit of the enhancement works to stream health.

4.4.3 Potential Cumulative Impacts

The Ulan Coal Mines are located approximately 11 km to the north-west of the Project, near the village of Ulan. The Ulan Coal Mines incorporate both underground and open cut mining areas and associated surface infrastructure including a CHPP, rail loop, rail loading and administrative facilities. The Ulan Coal Mines operate under a number of consents.

It is noted that a 2 Mtpa underground mining operation comprising Underground Mine No. 4, a new CHPP, rail loop and train loading facility was approved in October 1985 as part of Stage 2 of the Ulan Coal Mines (hereafter referred to as Ulan Stage 2). The Underground Mine No. 4 and associated surface facilities that comprised part of Ulan Stage 2 were not developed at that time. Underground Mine No. 4 and associated surface infrastructure would be located to the immediate east of the Ulan Coal Mines.

Groundwater assessment studies undertaken for Ulan Coal Mines (including Ulan Stage 2) concluded that "*drawdown induced would tend to be confined to the general area of the mining lease*" (Kinhill Stearns Engineers, 1983). The mining lease referred to in the *Ulan Coal Mines Stage 2 – Colliery Development and Expansion Environmental Impact Statement* (Kinhill Stearns Engineers, 1983) is approximately 4 km further west than the Year 21 maximum extent of groundwater drawdown predicted for the Project. Underground mining at Ulan Coal Mines as stated in *Ulan Coal Mines Mining Lease Application No. 80, Development Application and Environmental Impact Statement* (Kinhill, 1998) is located some 10 km north of Ulan and is further north-west of the predicted cone of depression for the Project. Based on this, it is concluded that there would be no overlap in the cone of depression generated by the Ulan Coal Mines (including Ulan Stage 2) and the Project and therefore no cumulative groundwater impacts are predicted.

4.5 ACOUSTICS

A Construction, Operation and Transportation Noise and Blasting Impact Assessment for the Project is presented in Appendix D.

4.5.1 Construction and Operation Noise Assessment

The noise impact assessment presented in this section has been undertaken in accordance with the DEC INP (EPA, 2000). Sections 4.5.1 to 4.5.3 describe construction and operational noise whilst noise emanating from Project road transportation and train movements are described in Sections 4.5.4 and 4.5.5, respectively.

In accordance with INP objectives, background noise levels for the Project area and surrounds have been characterised (Section 3.4.1). Noise assessment criteria, which form the basis for impact assessment and determining mitigation requirements, have been derived for the Project based on these measured background levels. Project-specific noise assessment criteria derived from this approach are outlined in Table 4-5. Landowner reference numbers are shown on Figures 4-6 to 4-9. Land tenure details of the Project area and surrounds are shown on Figures 1-5 and 1-6.

It should be noted that dwellings WD and WE are owned by WCPL and would not be tenanted after Year 1 of the Project. Dwellings WA and WC are also owned by WCPL and would not be tenanted after Year 3 of the Project. These WCPL-owned dwellings were assessed for the relevant Project years for which they would be occupied. WCPL-owned dwelling WF (Figure 3-1) is no longer tenanted and noise emissions have not been assessed for this dwelling.

In those cases where the INP Project-specific assessment criteria in Table 4-5 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:

- negligible noise level increase (less than 1 dBA) (not noticeable by all people);
- marginal noise level increase (between 1 dBA and 2 dBA) (not noticeable by most people);
- moderate noise level increase (between 3 dBA and 5 dBA) (not noticeable by some people but may be noticeable by others); and
- appreciable noise level increase (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 that 5 dBA above the criteria). Table 3-10 in Section 3.4 presents a qualitative description of noise levels from various common noise sources for comparative reference.

Noise Modelling

An acoustic model was developed that simulates Project components and noise source information (i.e. sound levels and locations). The sources of noise identified for the Project are outlined in Appendix D. The model also considers meteorological effects, surrounding terrain, distance from source to receptor and noise attenuation (i.e. at-source mitigation measures adopted).

Table 4-5
Project-Specific Noise Assessment Criteria (dBA)

Locality (Figure 3-1)	Reference/Land Owner	Project-Specific Noise Assessment Criteria					
		Intrusive $L_{Aeq(15minute)}$[1]			Amenity $L_{Aeq(period)}$[1]		
		Day	Evening	Night-time	Day	Evening	Night-time
Cumbo	6 Langshaw	35	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Wollar (south of the village of Wollar)	Residential	35	35	35	50	45	40
	150A St Luke's Anglican Church (Internal)	Place of Worship[2]			40	40	Not in use[3]
Wollar	Residential	36	35	35	55	45	40
	900 St Laurence O'Toole Catholic Church (Internal)	Place of Worship[2]			40	40	Not in use[3]
	901 Wollar School (Internal)	School Classroom[2]			35	35	
Araluen	60 Reid	35	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Slate Gully	Residential	35	35	35	50	45	40
Wilpinjong (north-east of the Project area)	WB Cumbo P/L	35	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Wilpinjong	Residential	35	35	35	50	45	40
Murragamba	42 Little/Salter	35	35	35	50	45	40
	34 Birt/Hayes	35	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Moolarben	Residential	35	35	35	50	45	40
Goulburn River National Park and Munghorn Gap Nature Reserve	-	Passive Recreation Area[2]			50	50	50

Source: Appendix D

1 Daytime 7.00 am to 6.00 pm, Evening 6.00 pm to 10.00 pm, Night-time 10.00 pm to 7.00 am.

2 Intrusive criteria apply to residential receptors only.

3 It is understood that the churches and school are generally not utilised at night-time (i.e. after 10.00 pm).

Meteorological effects included in the modelling are those characterised as prevailing in accordance with INP assessment methodologies. The definition of prevailing conditions included statistical analysis of site meteorological data (including consideration of wind speed and direction, as well as temperature lapses and inversions).

Noise emissions were modelled for the following prevailing meteorological conditions:

- Daytime (non-adverse condition) – wind speed of 0 metres per second (m/s) and a temperature inversion gradient of 0^{o}C/100 m.
- Evening wind only (winter adverse condition) – wind speed of 3 m/s from the west and a temperature inversion gradient of 0^{o}C/100 m.
- Night-time wind only (summer adverse condition) – wind speed of 3 m/s from the east and a temperature inversion gradient of 0^{o}C/100 m.
- Night-time temperature inversion only (winter adverse condition) – temperature inversion gradient of 3^{o}C/100 m.
- Night-time temperature inversion (winter adverse condition) – temperature inversion gradient of 3^{o}C/100 m and an air drainage of 2 m/s from the west-southwest for noise sensitive receptors (e.g. dwellings, churches, private vacant land, etc.) to the north-east of the Project area.

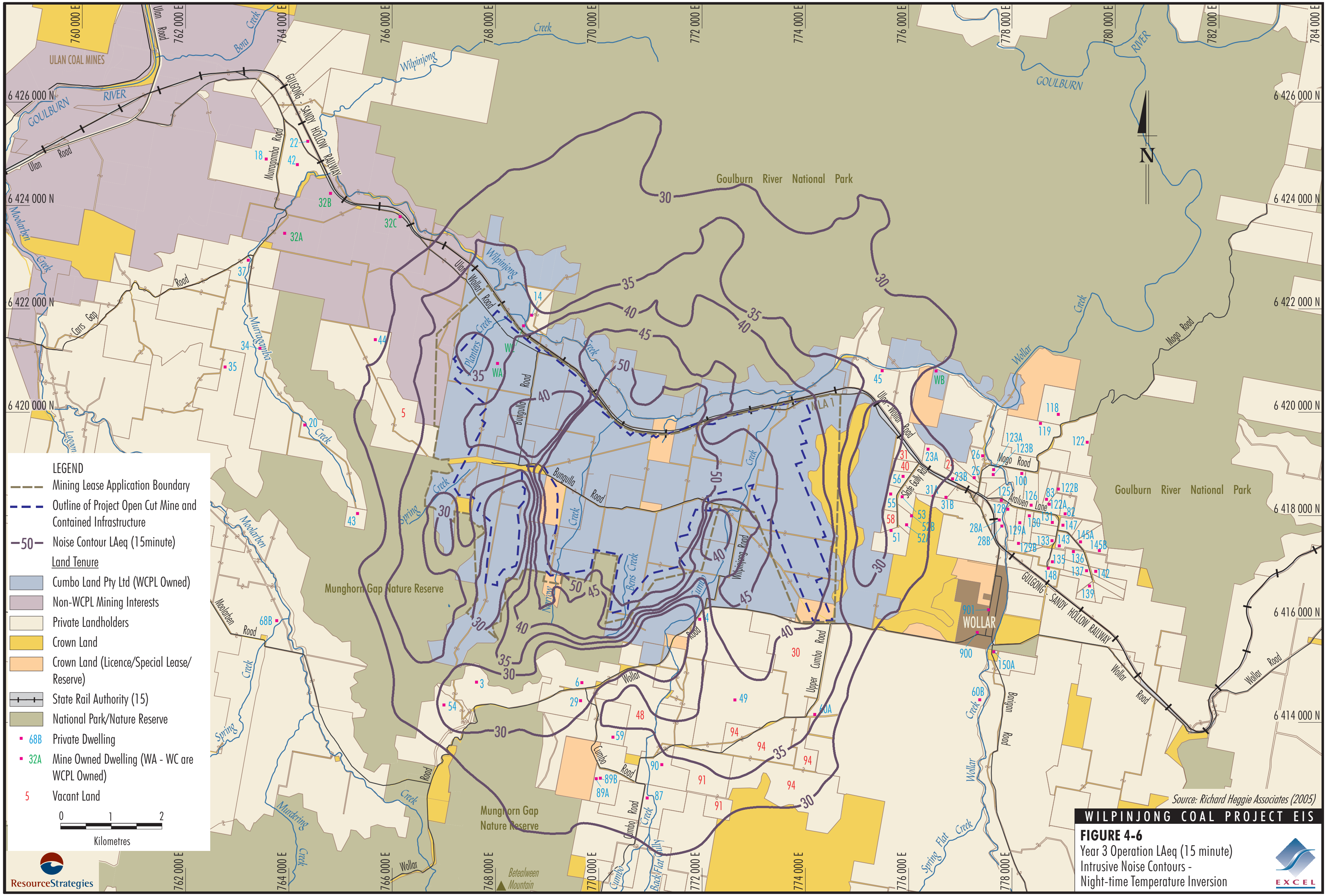


FIGURE 4-6
Year 3 Operation LAeq (15 minute) Intrusive Noise Contours - Night-time Temperature Inversion

WIL-04-01 Sect 4_013E

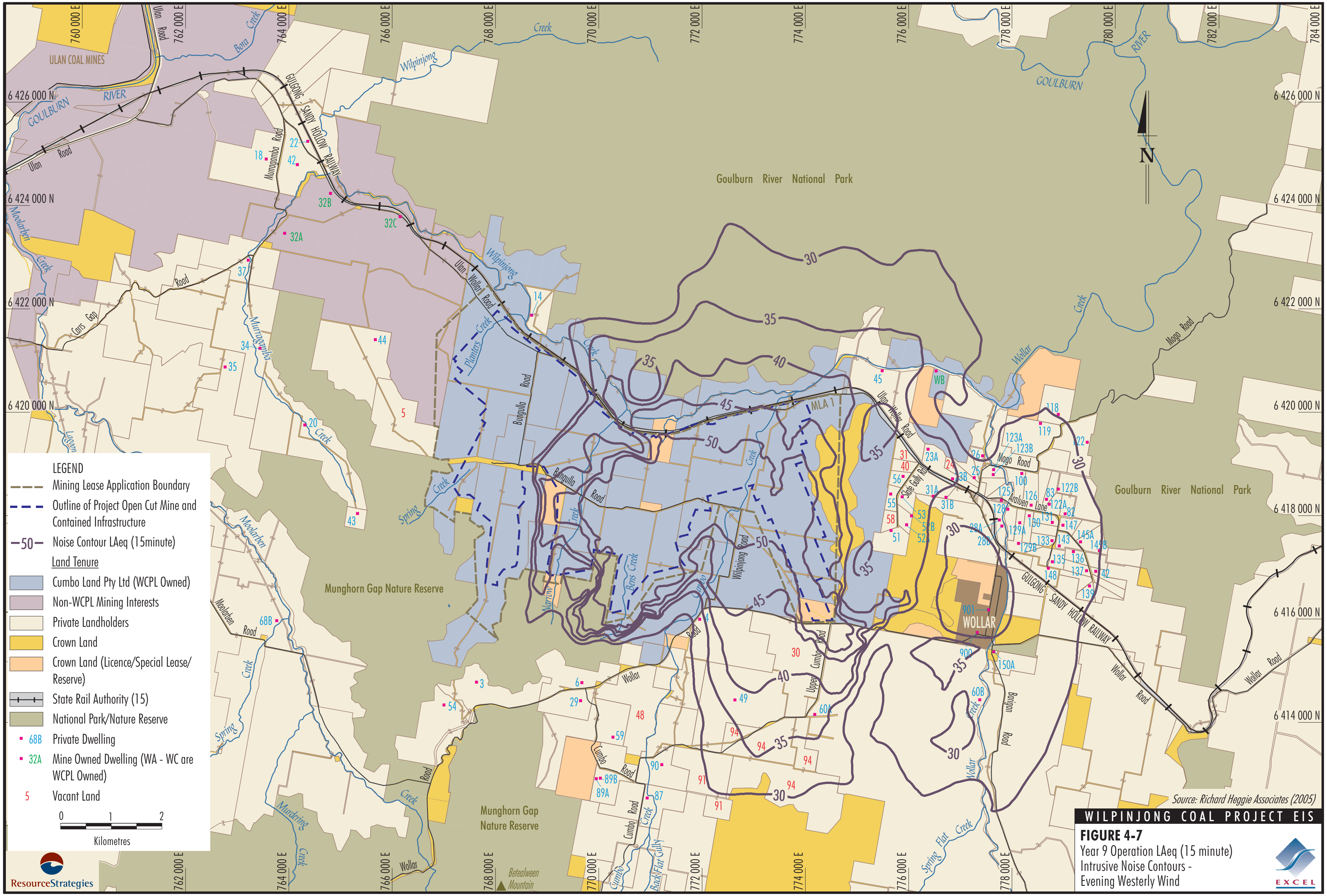
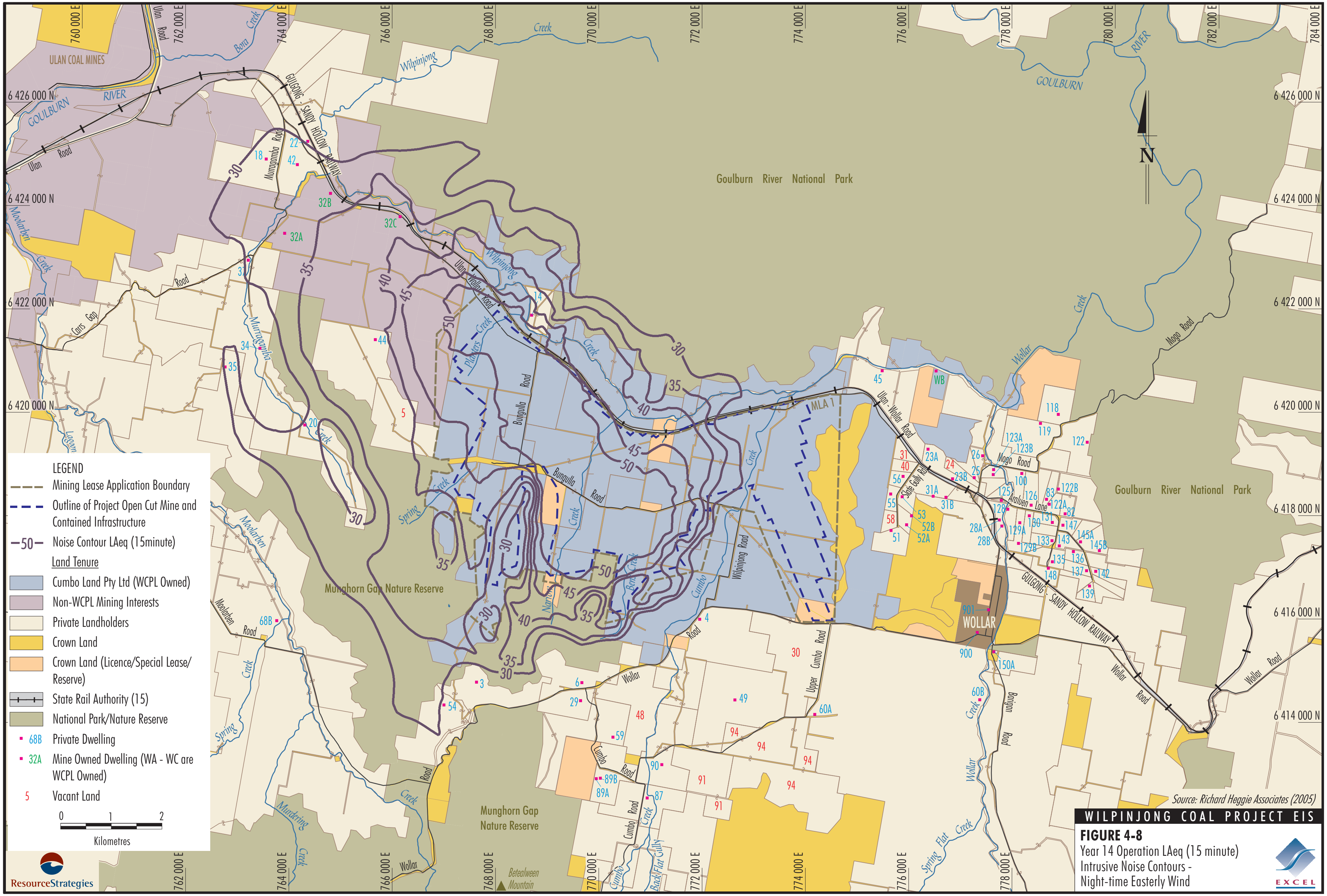


FIGURE 4-7
Year 9 Operation LAeq (15 minute) Intrusive Noise Contours - Evening Westerly Wind



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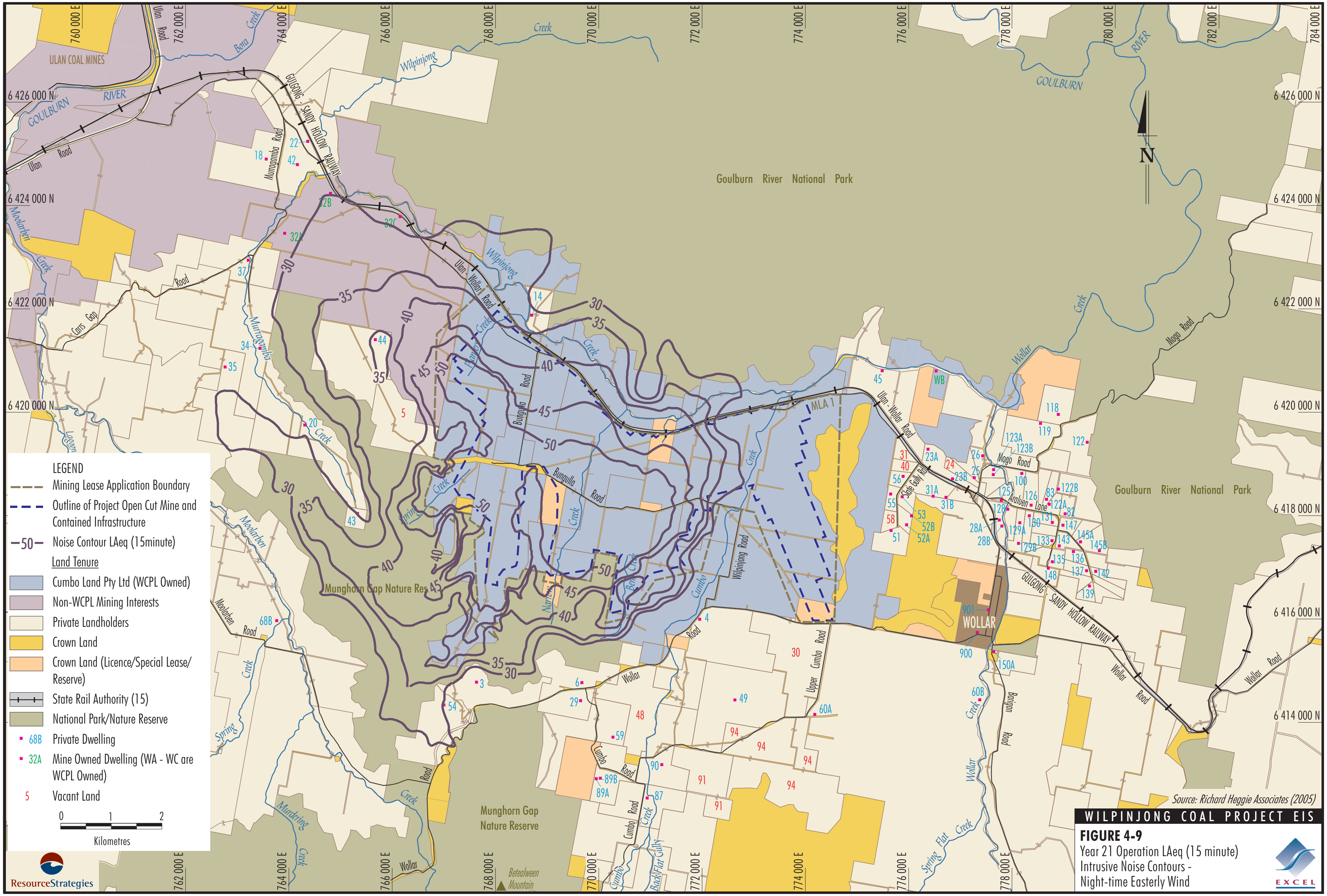

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Noise Emission Scenarios

Predictive noise emission modelling has been undertaken for six snapshots in the Project life, based on the planned Project production. Operational activities as discussed below would be undertaken 24 hours per day, seven days per week and would include noise generated by mining as well as CHPP, coal handling and train loading operations.

Construction (Year 1)

Construction activities would be undertaken during daytime hours up to seven days per week. These activities are described in Section 2.3 and shown on Figure 2-4.

Operation (Year 3)

Open cut operations early in the Project life. In this year of operation, Project noise sources would include mining in Pit 1 and Pit 2 (Figure 2-5).

Operation (Year 9)

The nearest open cut operations to receptors in the Cumbo locality and to the south of the village of Wollar (Figure 2-7). In this year of operation, Project noise sources would include mining in Pit 2, Pit 3 and Pit 4.

Operation (Year 11)

The nearest open cut operations to the Slate Gully, Wollar and Araluen localities. In this year of operation, Project noise sources would include mining in Pit 3 and Pit 4.

Operation (Year 13)

The nearest open cut operations to receptors to the north-east of the Project (Figure 2-9). In this year of operation, Project noise sources would include mining in Pit 3, Pit 4 and Pit 5.

Operation (Year 14)

The nearest open cut operations to receptors in the Wilpinjong and Murragamba localities (Figure 2-10). In this year of operation, Project noise sources would include mining in Pit 5 and Pit 6.

Operation (Year 21)

The nearest open cut operations to the Moolarben locality (Figure 2-11). In this year of operation, Project noise sources would include mining in Pit 5 and Pit 6.

Predicted Noise Emissions

Private Dwellings

Table 4-6 identifies those privately-owned dwellings where $L_{Aeq(15minute)}$ intrusive emissions are predicted to exceed the Project-specific noise assessment criteria (Table 4-5) during open cut operations. Predicted intrusive noise emissions for mine-owned dwellings (i.e. either owned by WCPL or non-WCPL mining interests) are tabulated in Appendix D.

Figures 4-6 to 4-9 present predicted noise emission contours for the following representative operational years and applicable adverse meteorological conditions:

- Year 3 night-time - temperature inversion (winter).
- Year 9 evening - westerly wind.
- Year 14 night-time - easterly wind.
- Year 21 night-time - easterly wind.

The above scenarios have been selected for the purposes of presenting predicted noise emission contours that are representative of the range of potential noise impacts on localities surrounding the Project area.

The noise contours shown on Figures 4-6 to 4-9 may, in some cases, differ slightly from the values that have been individually calculated for receptor locations as presented in Appendix D and summarised in Table 4-6, particularly where topographic effects are prominent. This is because the calculation of the noise contours involves numerical interpolation of noise level arrays with a graphical accuracy of up to approximately ±2 dBA.

Private Vacant Land

Privately-owned vacant land was also assessed against the Project-specific noise assessment criteria. Privately-owned vacant land where the Project-specific noise assessment criteria predicted to be exceeded over more than 25% of the property area is identified in Table 4-7.

Table 4-6
Private Dwellings within Noise Management and Affectation Zones

Locality (Figure 3-1)	Period	Noise Management Zone		Noise Affectation Zone
		1 dBA to 2 dBA above Project-Specific Criteria	3 dBA to 5 dBA above Project-Specific Criteria	>5 dBA above Project-Specific Criteria
Cumbo	Evening/Night-time	59 Langshaw 90 Pattullo 29 Kattau	4 Robinson 49 Harkin 60A Reid	Nil
Araluen	Evening/Night-time	23B Bloomfield	23A Bloomfield	Nil
Slate Gully	Evening/Night-time	31A Conradt 31B Conradt	51 Bailey 52A Long 52B Long 53 Reynolds 55 Fox 56 Roger	Nil
Wilpinjong (north-east of the Project area)	Evening/Night-time	Nil	Nil	45 Smith
Wilpinjong	Evening/Night-time	Nil	Nil	14 Close

Source: Appendix D

Table 4-7
Private Vacant Land within Noise Management and Affectation Zones[1]

Locality (Figure 3-1)	Noise Management Zone		Noise Affectation Zone
	1 dBA to 2 dBA above Project-Specific Criteria	3 dBA to 5 dBA above Project-Specific Criteria	>5 dBA above Project-Specific Criteria
Cumbo	94 McKenzie 91 Gordon 48 Evans	Nil	30 Gaffney
Araluen	24 Peach	Nil	Nil
Slate Gully	Nil	31 Conradt 40 Plummer 58 Maher	Nil
Murragamba	Nil	5 Power	Nil

Source: Appendix D
[1] Where the relevant Project-specific criteria are predicted to be exceeded over more than 25% of the land area.

Recreation Areas

Noise impacts in the Munghorn Gap Nature Reserve and Goulburn River National Park are predicted to be below the relevant INP Passive Recreation Area amenity criteria (Table 4-5).

Wollar Churches and Schools

Noise impacts at the St Laurence O'Toole Catholic Church and St Luke's Anglican Church in Wollar and the Wollar School are predicted to be below their respective INP Place of Worship and School Classroom amenity criteria (Table 4-5).

Cumulative Noise Assessment

The INP (EPA, 2000) provides cumulative noise assessment guidelines that address existing and successive industrial development by setting acceptable and maximum cumulative $L_{Aeq(period)}$ amenity levels for all industrial (i.e. non-transport related) noise in an area.

The potential for the simultaneous operation of adjoining mine developments to exceed amenity criteria can be assessed on a worst case scenario basis by adding the predicted intrusive noise emissions from the Project to the approved noise limits for the Ulan Coal Mines and Ulan Stage 2. The cumulative intrusive level is then adjusted and compared with the INP's relevant amenity criteria (Appendix D).

Using this approach, the cumulative noise levels in the Murragamba locality (the locality between the Project and Ulan Coal Mines) have been assessed to be within the relevant amenity criteria for industrial noise (i.e. non-transport related) during the daytime, evening and night-time.

4.5.2 Noise Mitigation Measures

During the noise impact assessment, a number of iterative steps were taken to develop noise mitigation measures for the Project, including:

- preliminary noise modelling to identify areas of affectation;
- further modelling incorporating various noise mitigation measures to assess their relative effectiveness;
- consideration of various combinations of noise mitigation measures to minimise the potential noise affectation zone; and
- adoption by WCPL of a range of noise mitigation measures that significantly reduce Project noise emissions.

The noise mitigation and management measures included in the predictive modelling and which would be adopted for the Project, are described below.

Fixed plant and mobile equipment would be commissioned and maintained to remain below the specified maximum operating L_{Aeq} sound power levels detailed in Appendix D.

Based on current mine planning and predictive noise modelling, some Project mobile equipment would be modified from Year 6 to meet more stringent maximum operating L_{Aeq} sound power levels to further reduce noise emissions as the open cut operations move towards the extremities of the Project area and closer to receptors. The timing of this would be confirmed based on noise monitoring data collected as the Project progresses.

As detailed in Table 4-6, the private dwellings where noise emissions are predicted to be above Project-specific noise assessment criteria can be divided into a noise management zone (1 to 5 dBA above Project-specific criteria) and a noise affectation zone (greater than 5 dBA above Project-specific criteria). Proposed noise management procedures for these zones are detailed below.

Noise Management Zone

Depending on the degree of exceedance of the Project-specific criteria, noise impacts in the noise management zone could range from negligible 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 community;
- prompt response to any community issues of concern;
- refinement of on-site noise mitigation measures and mine operating procedures, where practicable;
- discussions with relevant landowners to assess concerns;
- consideration of acoustical mitigation at receptors; and
- consideration of negotiated agreements with landowners.

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 assess concerns and develop practical mitigation;
- implementation of acoustical mitigation at receptors (e.g. double glazing of windows); and
- negotiated agreements with landowners.

4.5.3 Recommended Project Noise Limits

In accordance with procedures described in the INP, recommended noise limits for privately-owned dwellings and other sensitive noise receptors have been assessed using the following procedure:

- Where the predicted noise emission is less than (or equal to) the Project-specific criteria then the Project-specific criteria is the proposed noise limit.

- Where the predicted noise emission is within the noise management zone then the predicted noise level is applied as the proposed noise limit.
- Where the predicted noise emission is within the noise affectation zone then the upper limiting level applying to the noise management zone is the proposed noise limit (i.e. $L_{Aeq(15\ minute)}$ 40 dBA).

Based on the above, the proposed operating noise limits are presented in Table 4-8. Figures 4-6 to 4-9 show the location of these receptors. Appendix D tabulates proposed operating noise limits for mine-owned dwellings (i.e. owned by WCPL or non-WCPL mining interests) in the vicinity of the Project.

4.5.4 Road Transportation Noise Assessment

The predicted Project traffic increase on Ulan Road (Main Road 208) represents a much smaller proportional increase in traffic flow in comparison to the predicted traffic increase on Wollar Road as Ulan Road already carries approximately 3,480 vehicles per day (Table 3-21). These roads are shown on Figure 3-11. The relative increase in traffic flows associated with the Project on Ulan Road is predicted to be minor (less than 6%). The road transportation noise assessment therefore focussed on Wollar Road (Appendix D).

Based on the ECRTN (EPA, 1999), Wollar Road is classified as a "collector road", that is a road which connects the subarterial roads to the local roads. The applicable road traffic noise criteria are presented in Table 4-9.

Table 4-9
DEC Criteria for Road Traffic Noise

Road	Descriptor	Noise Criteria (dBA)
Wollar Road (Main Road 208)	Daytime[1] $L_{Aeq(1hour)}$	60
	Night-time[2] $L_{Aeq(1hour)}$	55

Source: after Appendix D
[1] 7.00 am to 10.00 pm.
[2] 10.00 pm to 7.00 am.

Daytime peak Project-related traffic movements would be between 6.00 pm and 7.00 pm and the night-time peak movements would be between 6.00 am and 7.00 am. These times coincide with the expected traffic associated with changes in operational shifts. Under the ECRTN, traffic flows in the early morning (i.e. prior to 7.00 am) are considered under the more stringent night-time criteria.

Road transport noise impacts have been considered for three sections of Wollar Road as described below (Figure 3-11). Predictions were calculated using equations presented in Appendix D. These equations take into account various traffic characteristics, including traffic volume, vehicle speed and type, passby duration and location. The predicted $L_{Aeq(1\ hour)}$ noise levels for Wollar Road are shown in Table 4-10. Existing noise levels for Wollar Road are presented in Appendix D.

Section A - West of the Mine Access Road

Peak hour daytime noise levels are predicted to increase by up to 11 dBA (due to the Project) but remain below the 60 dBA $L_{Aeq(1hour)}$ criterion at distances of 25 m or more from the road.

Peak hour noise levels are predicted to increase by up to 6 dBA (due to the Project) and are marginally (1 dBA) above the 55 dBA $L_{Aeq(1hour)}$ night-time criterion at 25 m from the road. However, the criterion would be achieved at distances greater than 25 m from the road.

Section B - West of Cooyal

Peak hour daytime noise levels are predicted to increase by up to 6 dBA (due to the Project) but remain below the 60 dBA $L_{Aeq(1hour)}$ criterion at 25 m or more from the road.

Peak hour noise levels are predicted to increase by up to 5 dBA (due to the Project) and are marginally (1 dBA) above the 55 dBA $L_{Aeq(1hour)}$ night-time criterion at 25 m from the road. However, the criterion would be achieved at distances greater than 25 m from the road.

Table 4-8
Proposed Operating Noise Limits (dBA)

Locality (Figure 3-1)	Reference/Land Owner	NSW INP (2000) Noise Amenity Area	$L_{Aeq(15minute)}$ Intrusive Noise Level	
			Calm[1]	Noise Enhancing[1]
			Daytime	Evening/Night-time
Cumbo	Other Residential	1(a) Rural	35	35
	29 JH & ME Kattau		35	37
	59 RW & DG Langshaw		35	37
	90 CA & CD Pattullo		35	36
	4 EJ & JE Robinson		35	40
	49 RSM & LD Harkin		35	39
	60A RWB & NJ & DB Reid		35	39
Wollar (south of the village of Wollar)	Other residential	1(a) Rural	35	35
	60B RWB & NJ & DB Reid		35	36
	150A St Luke's Anglican Church (Internal)[2]		40	40
Wollar	Residential	2(v) Residential	36	35
	900 St Laurence O'Toole Catholic Church (Internal Amenity)[2]		40	40
	901 School (Internal Amenity)[2]		35	35
Araluen	Other Residential	1(c1) Rural	35	35
	23A PA & ID Bloomfield	1(a) Rural	35	38
	23B PA & ID Bloomfield		35	37
Slate Gully	31A DE & AM Conradt	1(c1) Rural	35	37
	31B DE & AM Conradt		35	36
	53 RW & JL Reynolds		35	39
	52A CR Long		35	39
	52B CR Long		35	39
	51 P Bailey		35	39
	55 SC & M Fox		35	39
	56 GJ & GR Rogers		35	39
Wilpinjong (north-east of the Project area)	45 JAW Smith	1(a) Rural	35	40
Wilpinjong	14 SJ Close	1(a) Rural	40	40
Murragamba	Residential	1(a) Rural	35	35
Moolarben	Residential	1(a) Rural	35	35
Goulburn River National Park/ Munghorn Gap Nature Reserve[2]	-	8(a) National Park	50	50

Source: Appendix D
1 Calm and noise enhancing conditions defined in Appendix D.
2 $L_{Aeq(period)}$ noise amenity level criteria.

Table 4-10
Wollar Road Estimated Peak $L_{Aeq(1hour)}$ Noise Levels (dBA)

Distance from Road	Vehicles Cumulative[1]	
	Night-time 6.00 am to 7.00 am	Daytime 6.00 pm to 7.00 pm
Section A - West of Wilpinjong Road		
25 m	56	57
50 m	52	53
75 m	49	51
Section B - West of Cooyal		
25 m	56	58
50 m	52	54
75 m	50	52
Section C - East of Ulan Road		
25 m	57	59
50 m	53	55
75 m	51	52

Source: Appendix D
1 Project-related traffic and existing traffic noise.

Section C - East of Ulan Road

Peak hour daytime noise levels are predicted to increase by up to 4 dBA (due to the Project) but would remain below the 60 dBA $L_{Aeq(1hour)}$ criterion at distances of 25 m or more from the road.

Peak hour noise levels are predicted to increase by up to 3 dBA (due to the Project) and are marginally (2 dBA) above the 55 dBA $L_{Aeq(1hour)}$ night-time criterion at 25 m from the road. However, the criterion would be achieved at distances greater than 25 m from the road.

Peak cumulative daytime levels on all three sections of Wollar Road are below the 60 dBA $L_{Aeq(1hour)}$ criterion at distances of 25 m or more from the roadway. Night-time peak cumulative noise levels are no more than 2 dBA above the 55 dBA $L_{Aeq(1hour)}$ criterion for peak hour flows (i.e. between 6.00 am and 7.00 am).

4.5.5 Rail Transportation Noise/Vibration Assessment

Product coal would be transported along the Gulgong-Sandy Hollow and Main Northern railways (Figure 1-1). The ARTC operates the Gulgong-Sandy Hollow and Main Northern railways. Rail noise emissions for railways operated by the ARTC are regulated via ARTC's EPL (3142). Within this EPL, rail noise for selected railways is regulated through a pollution reduction programme (PRP).

At present neither the Gulgong-Sandy Hollow nor Main Northern railways are the subject of the PRP. However, the stated objectives of the abovementioned PRP (for other sections of railway) have been adopted as a guide to assess rail noise on the Gulgong-Sandy Hollow and Main Northern railways. Noise assessment criteria adopted from the stated objectives of the PRP are presented in Table 4-11.

Table 4-11
Railway Guideline Noise Assessment Criteria

Railway	Licence Holder	Descriptor	Rail Traffic Goal (dBA)
Gulgong-Sandy Hollow and Main Northern	ARTC (EPL 3142)	Daytime $L_{Aeq(15hour)}$	65
		Night-time $L_{Aeq(9hour)}$	60
		Maximum L_{Amax}	85

Source: Appendix D

Gulgong-Sandy Hollow Railway

Existing and consented train movements (Section 3.11.4) in addition to Project-related train movements (Section 2.7) and the associated rail noise levels have been determined for the Gulgong-Sandy Hollow railway. Predicted cumulative rail noise impacts are summarised below.

Daytime

A comparison of the combined existing and consented average rail movement $L_{Aeq(15hour)}$ noise emissions against the cumulative rail noise emissions (which include the average movements of four trains per day associated with the Project) indicates that existing noise levels are predicted to increase by 1 dBA and would meet the daytime 65 dBA criterion at a distance of 30 m from the track. Similarly, peak rail movement $L_{Aeq(15hour)}$ noise emissions would increase by between 1 dBA and 2 dBA and meet the daytime 65 dBA criterion at a distance of 30 m from the track with the addition of Project peak rail movements (i.e. six trains per day).

Night-time

A comparison of the consented average rail movement $L_{Aeq(9hour)}$ noise emissions with the cumulative train noise emissions (including average Project movements) indicates that existing noise levels would increase by up to 1 dBA and would meet the night-time 60 dBA criterion at a distance of 70 m (and greater). Similarly, peak rail movement $L_{Aeq(9hour)}$ noise emissions would increase by between 1 dBA and 2 dBA and meet the night-time 60 dBA criterion at a distance of 80 m (and greater) with the addition of Project peak rail movements (i.e. six trains per day).

Passby Noise

As is the case for the consented train noise emissions, the maximum (L_{Amax}) noise criterion of 85 dBA would be achieved by all train movements at a distance of 30 m (and greater).

Main Northern Railway

The cumulative rail noise impacts on the Main Northern railway are summarised below.

Daytime

A comparison of the existing $L_{Aeq(15hour)}$ noise emissions with the cumulative train noise emissions (including peak Project movements) indicates that existing noise levels would increase marginally (1 dBA to 2 dBA) and would meet the daytime 65 dBA criterion at a distance of 35 m (and greater).

Night-time

A comparison of the existing $L_{Aeq(9hour)}$ noise emissions with the cumulative train noise emissions (including peak Project movements) indicates that existing noise levels would increase marginally (1 dBA) and would meet the night-time 60 dBA criterion at a distance of 90 m (and greater).

Passby Noise

As is the case for the existing train noise emissions, the maximum (L_{Amax}) noise criterion of 85 dBA is likely to be achieved by train movements at a distance of 60 m (and greater).

Mitigation Measures

WCPL and the rail service provider would liaise with the ARTC to establish appropriate timetabling with the objective of reducing night-time train movements, particularly in relation to the Gulgong-Sandy Hollow railway. In addition, as noted above, the noise emissions from the Gulgong-Sandy Hollow and Main Northern railways would continue to be regulated via ARTC's EPL 3142.

4.5.6 Blast Impact Assessment

Criteria for Dwellings

Calculated blasting emissions, based on the proposed blast configuration (Section 2.4.5), were compared against building damage criteria and human comfort criteria. The DEC advocates the use of ANZECC guidelines for assessing potential residential disturbance (human comfort) arising from blast emissions.

The ANZECC guidelines for the control of blasting impact at a dwelling are as follows:

- The recommended maximum level for airblast is 115 dBL.
- The level of 115 dBL may be exceeded in up to 5% of the total number of blasts over a period of 12 months, however the level should not exceed 120 dBL at any time.

- The recommended maximum level for ground vibration is 5 mm/s PVS vibration velocity. It is recommended, however, that 2 mm/s PVS vibration velocity be considered as the long-term regulatory goal for the control of ground vibration.
- The PVS level of 5 mm/s may be exceeded in up to 5% of the total number of blasts over a period of 12 months, however the level should not exceed 10 mm/s at any time.

In addition, the ANZECC guidelines specify that blasting should generally only be permitted between 9.00 am and 5.00 pm Monday to Saturday. Blasting should not take place on Sundays and public holidays and should generally take place no more than once per day. Blasting may however be conducted outside of these hours in accordance with the applicable blast emission assessment criteria provided in the *Environmental Noise Control Manual* (EPA, 1994).

AS 2187.2-1993 *Explosives – Storage, Transport and Use – Use of Explosives* nominates blast vibration building damage assessment criteria which range from 5 mm/s to 25 mm/s PVS according to building type and use. The damage criteria adopted in accordance with AS 2187.2-1993 are 5 mm/s for St Laurence O'Toole Catholic Church and St Luke's Anglican Church and 10 mm/s for all dwellings. The airblast criteria for building damage is 133 dBL (peak).

Criteria for Aboriginal Rock Art Sites

A vibration assessment was undertaken for three rock shelters that contain Aboriginal rock art, *viz*. sites 72, 152 and 153 (Figure 3-10). There are no regulatory criteria nominated in Australia for the assessment of damage to archaeological/geological structures from vibration. Research, however, has been undertaken by the US Army Corps of Engineers into the effects of large surface blasts on the dynamic stability of unlined tunnels of various diameters in sandstone and granite (Dowding, 1985). The results of the research indicated that intermittent rock fall or observable damage did not occur until vibration levels exceeded 460 mm/s.

The German Standard DIN 4150-3 *Structural Vibration Part 3: Effects of Vibration on Structures* (February 1999) includes a vibration velocity guideline of 80 mm/s for evaluating the effects of "short-term" vibration on buried clay and concrete pipework. The application of this criterion to geological structures is considered conservative and introduces a five-fold safety factor by comparison to the observed damage value of 460 mm/s (as described above) (Appendix D).

Predicted Blast Emission Levels and Mitigation Measures

The Project open cut development would require an average of one blast per week (Section 2.4.5). The blast emission assessment found that the building damage criteria of 10 mm/s and 133 dBL (peak) would be met at all dwellings. Similarly, all emission levels would be well below the AS 2187.2-1993 damage criteria (5 mm/s and 133 dBL [peak]) for the two churches in Wollar.

Preliminary modelling indicated that the ANZECC human comfort vibration criterion of 5 mm/s, the long-term regulatory target of 2 mm/s and the human comfort airblast criterion of 115 dBL would be exceeded at a number of dwellings without the application of special blasting techniques. The predicted peak linear airblast and PVS vibration levels are described below.

Human Comfort – Vibration

The vibration velocities would be at or below the 5 mm/s criterion at all dwellings. Incorporating blast design modifications for selected dwellings (i.e. detonating no more than approximately 342 kg [or 2 blast holes] within 8 milliseconds in the delay sequence), the recommended long-term regulatory target of 2 mm/s would be achieved at all receptors except for Close (14) (Figure 1-5). The PVS vibration level at Close (14) during Year 14 (Pit 6) is predicted to be 5.0 mm/s. Changes to the blast design to achieve the 2 mm/s criterion at Close (14) are not considered to be practicable.

Human Comfort – Airblast

Incorporating blast design modifications for selected dwellings (i.e. detonating no more than approximately 171 kg [or 1 blast hole] within 8 milliseconds in the delay sequence), the 115 dBL airblast criterion would be achieved at all receptors except for Close (14). The airblast level at Close (14) during Year 14 (Pit 6) is predicted to be 127 dBA. Changes to the blast design to achieve the 115 dBL airblast criterion at Close (14) are not considered to be practicable.

Aboriginal Rock Art Sites

The maximum predicted vibration velocities for blasts in proximity to the Aboriginal rock art sites (sites 72, 152 and 153) are predicted to be below the 80 mm/s geological damage criterion. A monitoring programme would be implemented for these sites (Section 5.1.3.4).

Flyrock Impacts

Consideration of potential flyrock impacts would be incorporated into the blast design, particularly in regard to stemming length and bench spacing. Notwithstanding, given the proximity of the Close (14) dwelling, notification of the occupants of the Close (14) dwelling would be undertaken for blast events within 1,000 m of the dwelling.

Wollar Road, Ulan-Wollar Road and the Gulgong-Sandy Hollow railway would be temporarily closed during blast events within 500 m of the road or railway, as discussed in Sections 4.12.1 and 4.13.1.

Given the location and nature of the rock art sites and surrounds, it is considered that the potential for flyrock damage occurring at these sites would be limited. Notwithstanding, for blasts within 500 m of these sites appropriate stemming length and burden spacing would be incorporated into the blast design in order to reduce the potential for flyrock (Appendix D).

4.6 AIR QUALITY

The Air Quality Impact Assessment is presented in Appendix E. The assessment considered the air quality emissions likely to be generated by the Project and the predicted impact of these emissions in combination with existing background air quality in the vicinity of the Project (Section 3.5). Emissions associated with the Project include particles that are derived primarily from the mechanical disturbance of soils, overburden/ interburden and coal as well as a relatively small contribution of particles from diesel exhausts (i.e. where diesel powered equipment is used).

Project impacts were modelled for Years 3, 9, 13, 14 and 21. These years were selected to assess the variability in emissions over the life of the Project, as follows:

- Year 3 was selected as it represents a period where mining occurs in Pits 1 and 2 which are located proximal to the CHPP and other Project infrastructure.
- Year 9 is representative of open cut operations proximal to receptors in the Wollar and Cumbo localities.
- Year 13 is representative of open cut operations proximal to receptors to the north-east of the Project and the Slate Gully and Araluen localities.
- Year 14 is representative of open cut operations proximal to receptors in the Murragamba locality.
- Year 21 is representative of open cut operations proximal to receptors in the Moolarben locality.

A full description of the dispersion model and the emissions inventory (including the location of fixed and mobile dust sources) is provided in Appendix E.

Receptors assessed in the Air Quality Impact Assessment included nearby occupied dwellings (including private and mine-owned), Wollar School, St Luke’s Anglican Church and St Laurence O’Toole Catholic Church.

The mine waste rock at the Project typically comprises claystone, carbonaceous/claystone and siltstone. These are common materials found in overburden and interburden at NSW coal mines (Appendix E). The air quality standards described in Section 4.6.1 are appropriate for assessing the potential impacts of the TSP and PM_{10} fractions of mine generated dust (*ibid.*).

The air quality assessment focussed on dust emissions. The sulphur content of Australian diesel is too low and mining equipment is too widely dispersed over mine sites to cause sulphur dioxide (SO_2) goals to be exceeded even in mines that use large quantities of diesel for mobile equipment and blasting (Appendix E). For this reason, no detailed study of SO_2 emissions from the mine has been undertaken (*ibid.*). For the same reason, nitrous oxides (NO_x) and carbon monoxide (CO) modelling is not considered necessary (*ibid.*).

4.6.1 Air Quality Criteria

Dust Deposition

The DEC amenity criteria for dust deposition seek to limit the maximum increase in the mean annual rate of dust deposition from a new development to 2 grams per square metre per month (g/m^2/month) and total dust deposition (i.e. including background air quality) to 4 g/m^2/month.

Concentrations of Suspended Particulate Matter

Human health effects of dust are related to exposure to suspended particulates rather than deposited dust. The effects of dust particles when inhaled are related to the types of particles inhaled, particle sizes and the ability of the respiratory tract to capture and eliminate the particles.

Such particles (TSP) are typically less than 50 micrometers (µm) in size and can be as small as 0.1 µm. PM_{10} particles are of particular importance in air quality assessments because they can reach the sensitive regions of the respiratory system.

Air quality criteria used in the assessment comprised the following:

- The United States (US) EPA 24 hour 150 µg/m^3 PM_{10} standard has been utilised as a target that should be met at all dwellings in the vicinity of the Project (for concentrations due to the Project and background air quality).
- The National Environment Protection Measure (NEPM) 24 hour reporting standard for PM_{10} of 50 µg/m^3 (with five exceedances allowed per year) and the DEC 24 hour PM_{10} assessment criterion of 50 µg/m^3 (for concentrations due to the Project alone).
- The DEC annual assessment criterion for PM_{10} of 30 µg/m^3 has been interpreted as a concentration that should be met within the region (concentrations due to the Project and background).
- The National Health and Medical Research Council's (NHMRC) annual goal for Total Suspended Particulate (TSP) of 90 µg/m^3 (which has been adopted by the DEC as the assessment criterion for TSP concentrations due to the Project and background air quality).

Details of the air quality criteria for concentrations of particulate matter are provided in Table 4-12.

Table 4-12
Air Quality Standards/Assessment Criteria for Particulate Matter Concentrations

Pollutant	Standard/Goal/Criterion	Agency
Total Suspended Particulate Matter (TSP)	90 µg/m^3 (annual mean)	NHMRC
Particulate Matter < 10 µm (PM_{10})	150 µg/m^3 (average of 99th percentile of 24 hour averages over three years)	US EPA standard
	50 µg/m^3 (24 hour average – maximum)	DEC assessment criterion
	30 µg/m^3 (annual mean)	DEC assessment criterion
	50 µg/m^3 (24 hour average, 5 exceedances permitted per year)	NEPM reporting standard

Source: Appendix E

4.6.2 Dust Deposition

Potential Impacts

The Project would produce two primary sources of dust, *viz.* wind blown dust from exposed areas and dust generated from mining (including haulage of ROM coal and waste rock) activities. Dust deposition impacts for the Project in isolation and the Project including background air quality were assessed. The annual average background dust deposition rate is 1.5 g/m^2/month (Section 3.5.1).

Construction

A qualitative assessment of dust impacts from construction activities (Section 2.3) was undertaken (Appendix E). This assessment concluded that assuming water sprays (i.e. water trucks) and other standard dust suppression methods are utilised, dust generation during construction would not be significant and would be less than during the operational phase.

Year 3

Incremental increases in annual average dust deposition due to the Project only are predicted to remain below the applicable 2 g/m^2/month DEC amenity criterion at all receptors. Predicted incremental increases in annual average dust deposition during Year 3 are illustrated on Figure 4-10.

Annual average dust deposition due to the Project plus background is predicted to remain below the applicable 4 g/m^2/month DEC amenity criterion at all receptors in the vicinity of the Project in Year 3.

Year 9

Incremental increases in annual average dust deposition due to the Project only are predicted to remain below the applicable 2 g/m^2/month DEC amenity criterion at all receptors. Predicted incremental increases in annual average dust deposition during Year 9 are illustrated on Figure 4-11.

Annual average dust deposition due to the Project plus background is predicted to remain below the applicable 4 g/m^2/month DEC amenity criterion at all receptors in the vicinity of the Project in Year 9.

Year 13

Incremental increases in annual average dust deposition due to the Project only are predicted to remain below the applicable 2 g/m^2/month DEC amenity criterion at all receptors in Year 13.

Annual average dust deposition due to the Project plus background is predicted to remain below the applicable 4 g/m^2/month DEC amenity criterion at all receptors in the vicinity of the Project in Year 13.

Year 14

Incremental increases in annual average dust deposition due to the Project only are predicted to exceed the applicable 2 g/m^2/month DEC amenity criterion at one receptor (Close [14]) (6.8 g/m^2/month Project only). All other receptors are predicted to remain below the relevant criterion. Predicted incremental increases in annual average dust deposition during Year 14 are illustrated on Figure 4-12.

Annual average dust deposition due to the Project plus background is predicted to exceed the applicable 4 g/m^2/month DEC amenity criterion in Year 14 at one receptor (Close [14]) (8.3 g/m^2/month Project plus background). All other receptors are predicted to remain below the relevant criterion.

Year 21

Incremental increases in annual average dust deposition due to the Project only are predicted to remain below the applicable 2 g/m^2/month DEC amenity criterion at all receptors. Predicted incremental increases in annual average dust deposition during Year 21 are illustrated on Figure 4-13.

Annual average dust deposition due to the Project plus background is predicted to remain below the applicable 4 g/m^2/month DEC amenity criterion at all receptors in the vicinity of the Project in Year 21.

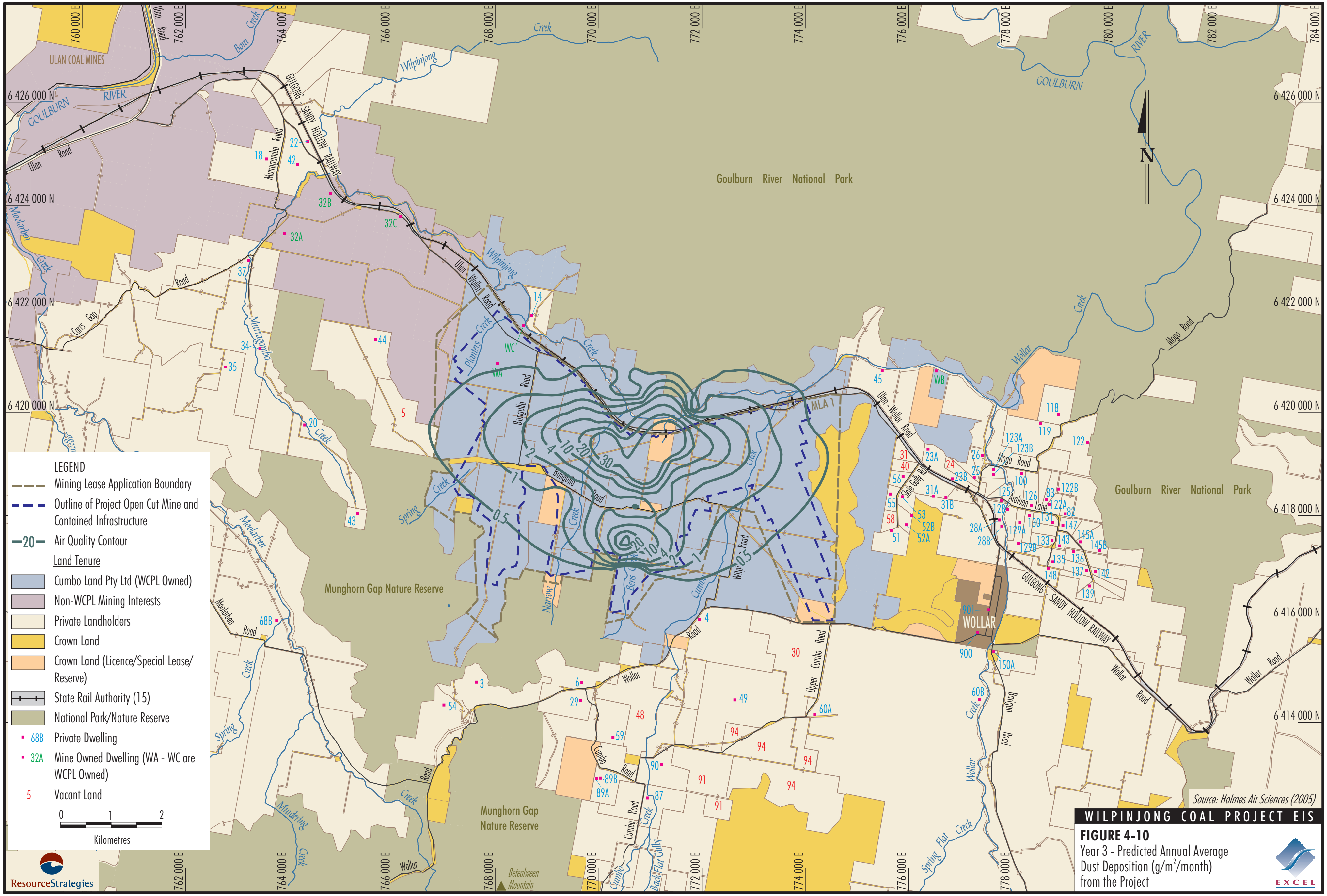
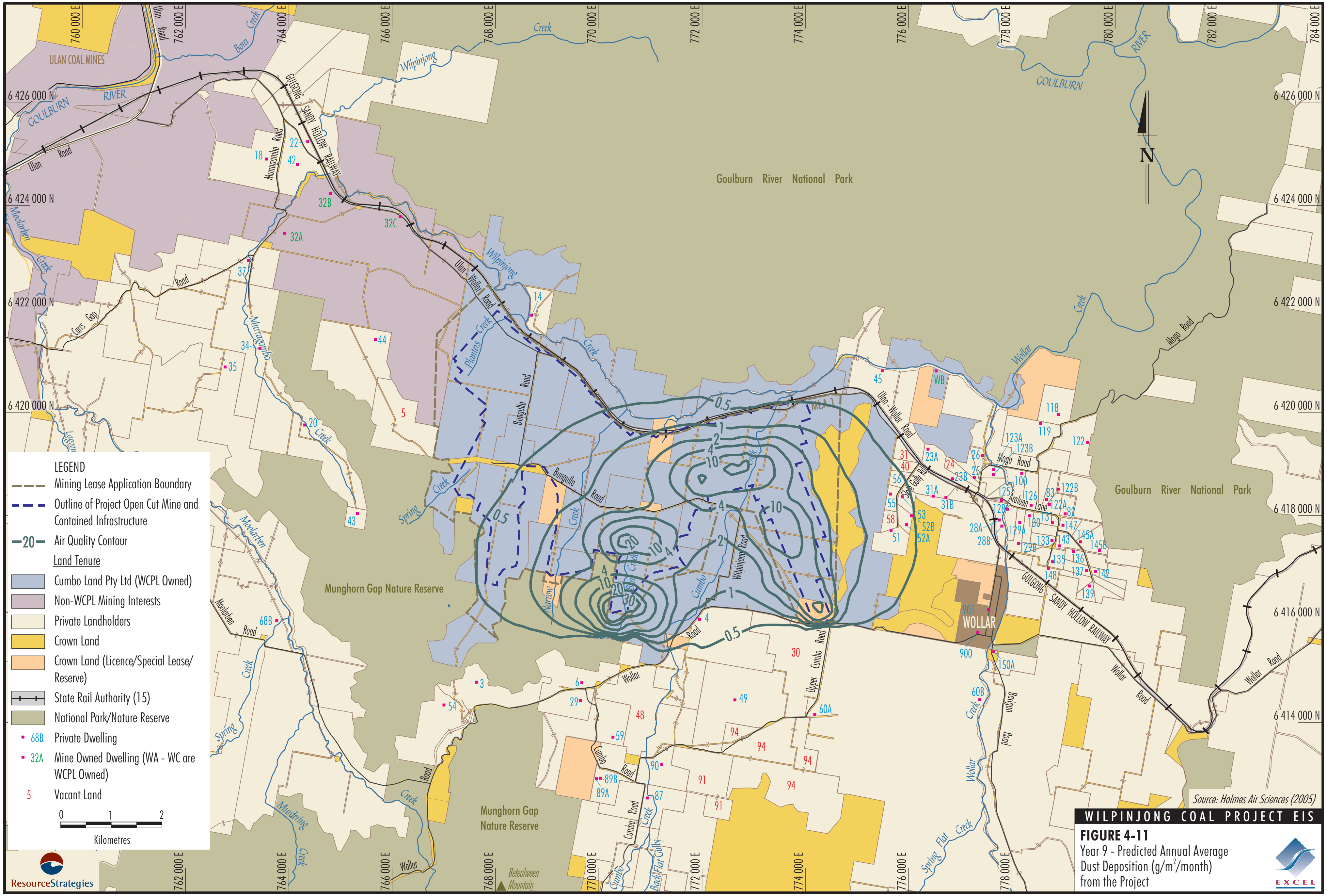


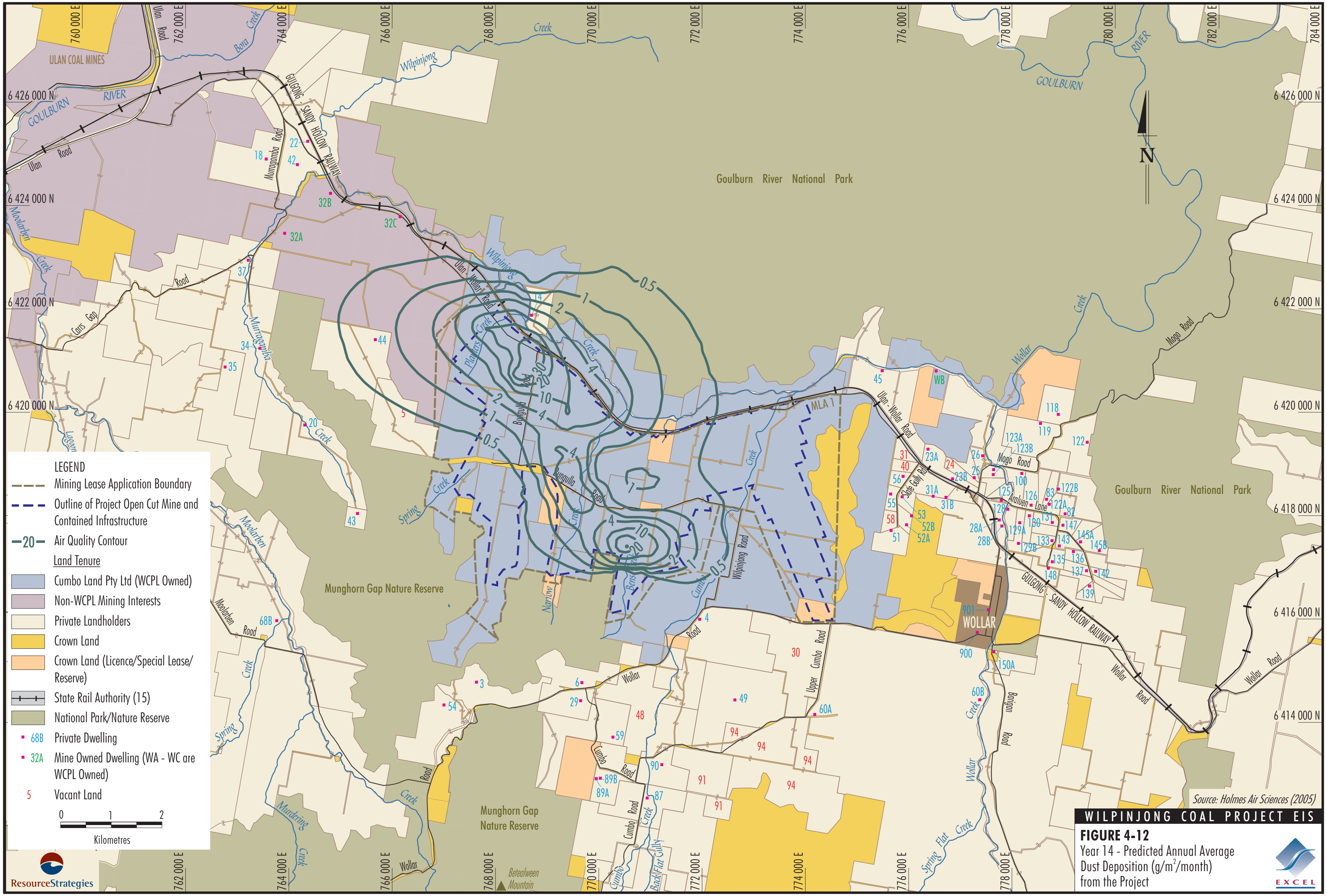
FIGURE 4-10
Year 3 - Predicted Annual Average Dust Deposition ($g/m^2/month$) from the Project



WILPINJONG COAL PROJECT EIS

FIGURE 4-11
Year 9 - Predicted Annual Average Dust Deposition ($g/m^2/month$) from the Project

WIL-04-01 Sect 4_023F



WILPINJONG COAL PROJECT EIS

FIGURE 4-12
Year 14 - Predicted Annual Average Dust Deposition (g/m²/month) from the Project

WIL-04-01 Sect 4_019F

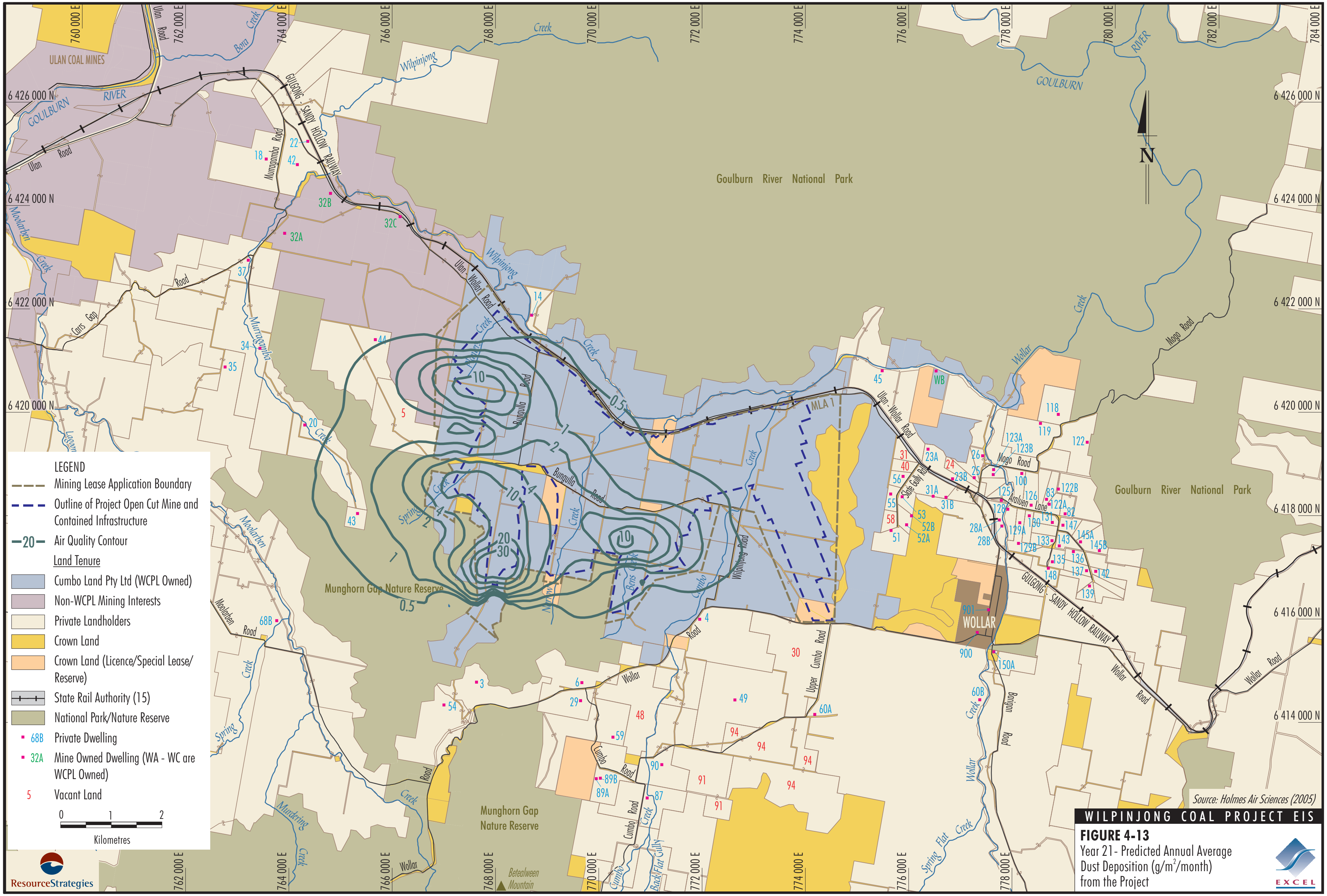


FIGURE 4-13
Year 21- Predicted Annual Average Dust Deposition ($g/m^2/month$) from the Project

Mitigation Measures

Dispersion modelling has been undertaken in several stages for the Project. The first stage involved preliminary modelling assuming standard dust controls (e.g. moderate level haul road watering). If exceedances of the goals/criteria were predicted following this stage, further mitigation measures were investigated and modelled to gauge their effectiveness. The mitigation measures were then further evaluated where necessary. The controls described below were identified as a result of this process.

A range of controls would be employed by WCPL to reduce dust emissions from the Project. These controls are based on procedures developed at contemporary NSW coal mines and techniques recommended by the DEC.

The main controls for wind blown dust would include:

- areas disturbed by active mining would be minimised as far as practicable;
- topsoiling and rehabilitation of mine waste rock emplacements progressively and as soon as practicable;
- maintaining coal-handling areas in a moist condition using water carts to minimise wind blown and traffic generated dust; and
- maintaining water sprays on product coal stockpiles.

Controls for mine generated dust would include the following:

- All active roads and traffic areas would be watered using water carts to minimise the generation of dust.
- During Years 14 to 20, surface moisture levels along selected haul roads would be maintained at elevated levels and/or chemical treatments would be applied to achieve 80 to 90% dust suppression.
- During Year 21, surface moisture levels on all haul roads would be maintained at elevated levels and chemical treatments would be applied to achieve 90% dust suppression.
- The number of active haul roads would be minimised and haul roads would be clearly defined.
- Development of minor roads would be limited and the locations of these would be clearly defined.
- Minor roads used regularly for access would be constructed so as to minimise dust generation (e.g. by using well-compacted select material) and watered as required.
- All obsolete roads would be rehabilitated.
- Access tracks used by topsoil stripping equipment during their loading and unloading cycle would be watered.
- A cover crop would be established over topsoil and subsoil stockpiles that are not to be used in less than six months to minimise potential dust emissions due to wind erosion.
- Dust aprons would be lowered during drilling.
- Drill rigs would be equipped with dust suppression equipment which would be operated whenever the potential for high levels of dust generation is identified.
- Blast stemming would be designed to provide optimum confinement of the blast charge.
- Automatic sprays or other dust control mechanisms would be used when tipping raw coal into the ROM dump hopper.
- Spillage of CHPP materials would be promptly cleaned up to prevent dust.
- Dust suppression systems would be fitted at transfer points to prevent high dust levels, where necessary.

A Project dust monitoring programme is described in Section 5.1.3.2.

4.6.3 Concentrations of Suspended Particulate Matter

Potential Impacts

Concentrations of suspended particulate matter were calculated as 24 hour average and annual average PM_{10} concentrations and annual average TSP concentrations for comparison against the applicable criteria (Table 4-12) for Years 3, 9, 13, 14 and 21. As noted in Section 4.6.1, the maximum 24 hour average PM_{10} criteria is assessed for the Project alone, whilst the annual average PM_{10} and TSP assessment criterion/standards relate to Project emissions in addition to background concentration levels (Appendix E).

On the basis of the baseline air quality monitoring programme (Section 3.5) the background annual average PM_{10} concentration for the Project area is estimated at 11 µg/m^3. The inferred annual average TSP background level is 28 µg/m^3 (Section 3.5.2).

Discussions in regard to potential human health impacts due to dust emissions are located in Appendix E.

Year 3

Predicted annual average PM_{10} (Project plus background) concentrations were predicted to remain below the DEC assessment criterion for all receptors. Figure 4-14 illustrates the predicted Project only incremental annual average PM_{10} concentrations for Year 3.

Maximum 24 hour average PM_{10} concentrations were not predicted to exceed the DEC assessment criterion (Project only) of 50 µg/m^3 at any receptor for Year 3.

Similarly, annual average TSP (Project plus background) concentrations were not predicted to be above the NHMRC reporting standard at any receptor for Year 3.

Year 9

Predicted annual average PM_{10} (Project plus background) concentrations remained below the DEC assessment criterion for all receptors. Figure 4-15 illustrates the predicted Project only incremental annual average PM_{10} concentrations for Year 9.

Maximum 24 hour average PM_{10} concentrations were not predicted to exceed the DEC assessment criterion (Project only) of 50 µg/m^3 at any receptor for Year 9.

Similarly, annual average TSP (Project plus background) concentrations were not predicted to be above the NHMRC reporting standard at any receptor for Year 9.

Years 13 and 14

Predicted annual average PM_{10} (Project plus background) concentrations were calculated to be above the DEC assessment criterion of 30 µg/m^3 at Close (14) (40.3 µg/m^3 Project only [51.3 µg/m^3 including background]) for Year 13. All other receptors are predicted to remain below 30 µg/m^3.

Annual average TSP (Project plus background) concentrations were not predicted to be above the NHMRC reporting standard at any receptor for Year 13.

Predicted annual average PM_{10} (Project plus background) concentrations were calculated to be above the DEC assessment criterion of 30 µg/m^3 at Close (14) for Year 14 (160.7 µg/m^3 Project only [171.7 µg/m^3 including background]). All other receptors remained below 30 µg/m^3. Figure 4-16 illustrates the predicted Project only incremental annual average PM_{10} concentrations for Year 14.

Predicted annual average TSP (Project plus background) were calculated to be above the applicable NHMRC reporting standard of 90 µg/m^3 at Close (14) for Year 14 (176.3 µg/m^3 [204.3 µg/m^3 including background]). All other receptors remained below 90 µg/m^3.

During Years 13 and 14, PM_{10} levels at Close (14) were predicted to exceed the 24 hour average PM_{10} (Project-only) DEC assessment criterion of 50 µg/m^3. The 24 hour PM_{10} levels at Close (14) during Years 13 and 14 were predicted to be 108.0 µg/m^3 and 237.7 µg/m^3, respectively. All other receptors were predicted to comply with this criterion during Years 13 and 14.

In addition, during Year 14, Close (14) is predicted to experience maximum 24 hour PM_{10} concentrations above the US EPA Standard of 150 µg/m^3.

Year 21

Predicted annual average PM_{10} (Project plus background) concentrations remained below the DEC assessment criterion for all receptors. Figure 4-17 illustrates the predicted Project only incremental annual average PM_{10} concentrations for Year 21.

Similarly, cumulative annual average TSP (Project plus background) concentrations were not predicted to be above the NHMRC reporting standard at any receptor for Year 21.

Maximum 24 hour average PM_{10} concentrations were not predicted to exceed the DEC assessment criterion (Project only) of 50 µg/m^3 for Year 21 at any receptor. However, 24 hour average PM_{10} concentrations (Project only) and annual average PM_{10} (Project plus background) were predicted to be above the DEC assessment criterion at one parcel of private vacant land (Power [5]) in Year 21.

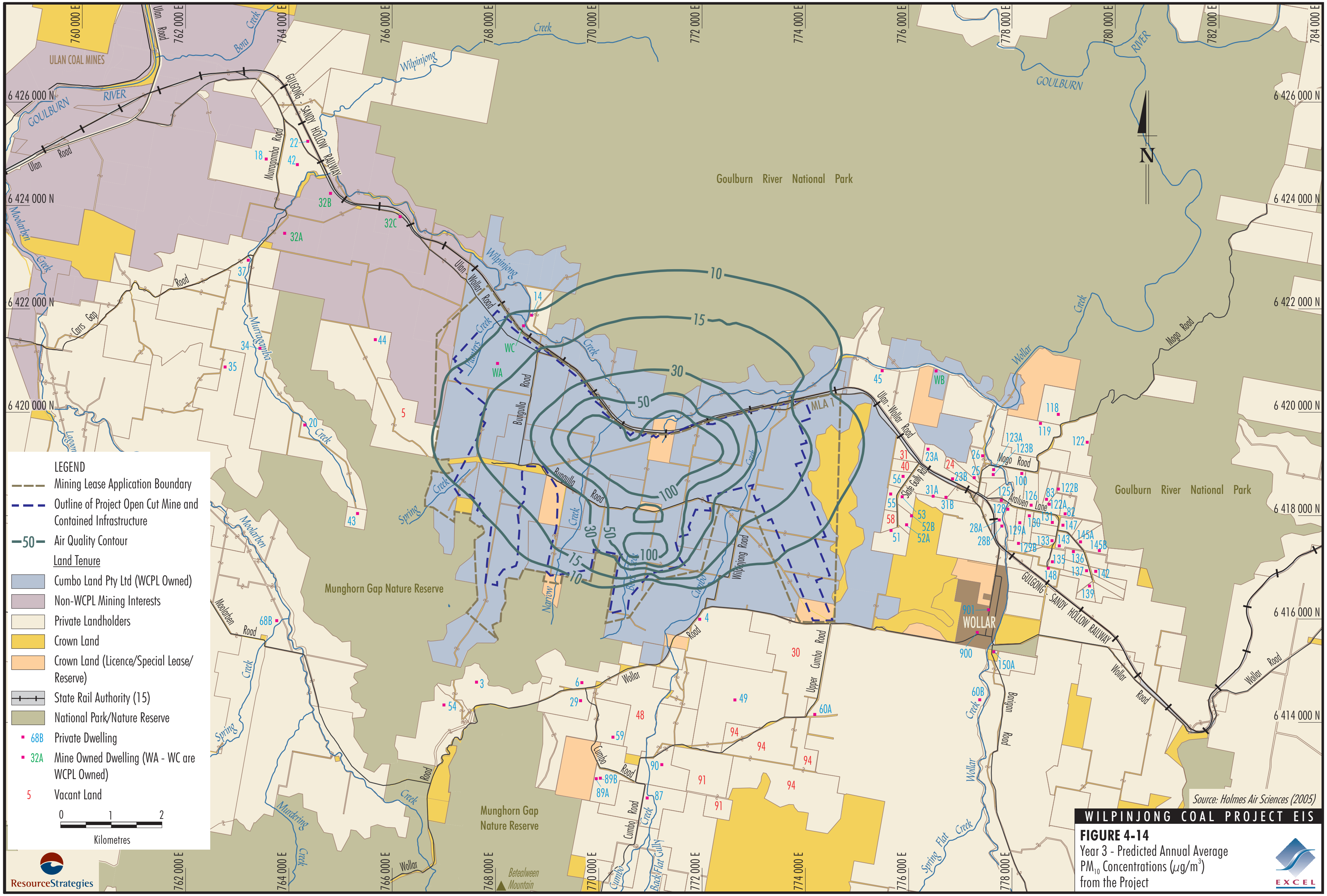


FIGURE 4-14
Year 3 - Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) from the Project

WIL-04-01 Sect 4_002F

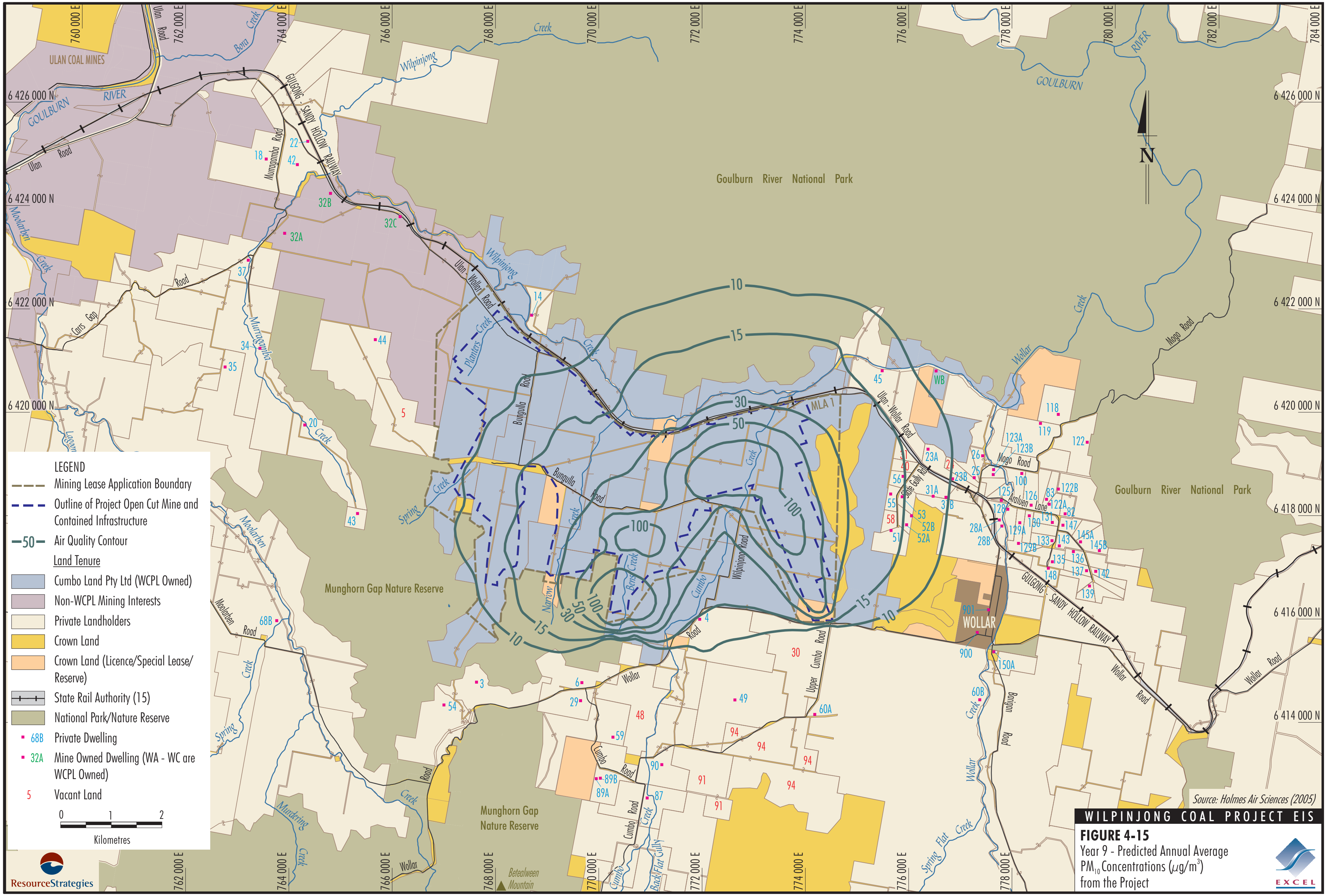


FIGURE 4-15
Year 9 - Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) from the Project

WIL-04-01 Sect 4_003G

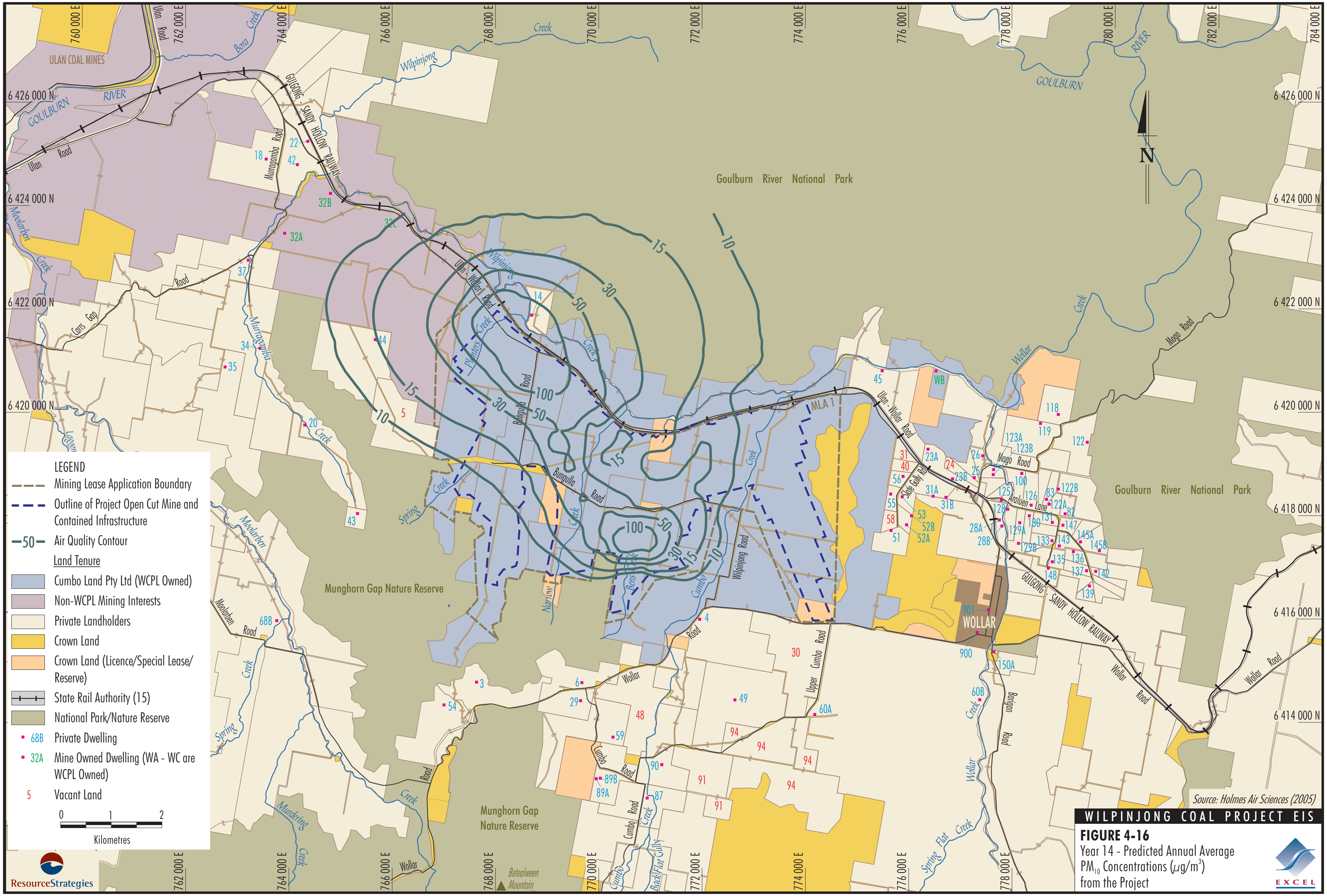


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FIGURE 4-16
Year 14 - Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) from the Project

WIL-04-01 Sect 4_004F

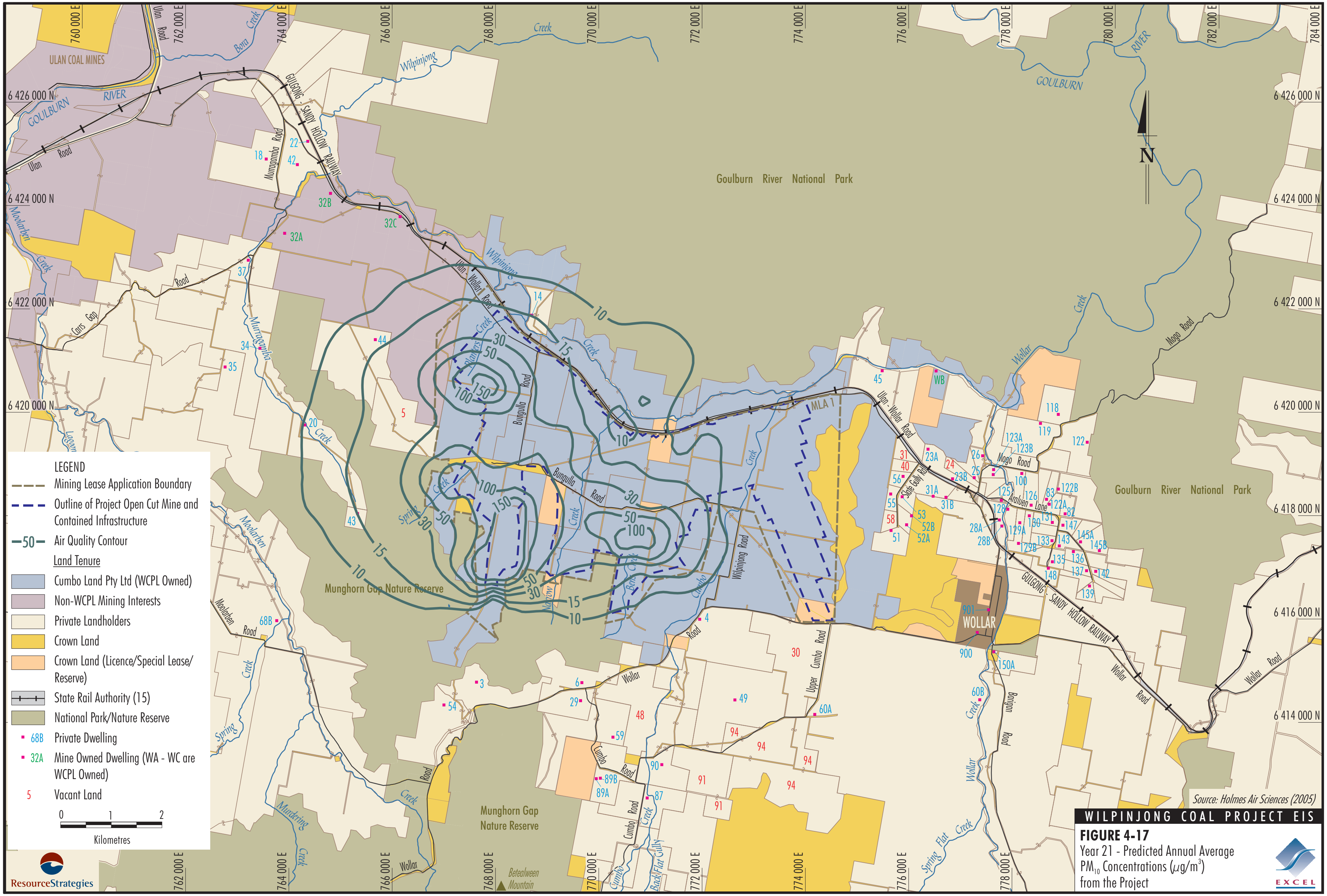

FIGURE 4-17
Year 21 - Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) from the Project

WIL-04-01 Sect 4_005G

Mitigation Measures

The mitigation measures outlined in Section 4.6.2 would also be effective in reducing the potential for generation of suspended particulate matter. A Project PM_{10} monitoring programme is provided in Section 5.1.3.2.

Cumulative Impacts

The Ulan Coal Mines are located approximately 11 km to the north-west of the Project. The background air quality in the vicinity of the Project would include the emission contribution of the existing Ulan Coal Mines. Due to dispersion effects, this contribution to background air quality levels in the Project area is considered to be very low (Appendix E). Ulan Coal Mines are, however, consented to operate at higher production levels and to develop the as yet undeveloped component of Ulan Stage 2 as previously discussed.

Holmes Air Sciences (Appendix E) has considered potential cumulative impacts (including the potential for a future increase in emissions from Ulan Coal Mines consistent with existing consents) and concluded that cumulative effects on receptors in the Project area (particularly in the Murragamba locality [Figure 3-1]) would be negligible (below 0.2 g/m^2/month dust deposition and less than 1 $\mu g/m^3$ PM_{10} and TSP) and would not lead to any additional exceedances of DEC criteria.

4.6.4 Greenhouse Gas

An assessment of Project greenhouse gas emissions is provided in Appendix E. The outcomes of this assessment are summarised below.

Potential Impacts

The major source of Project-related emissions of greenhouse gases would be the combustion of diesel fuel (used in diesel-powered equipment and in blasting). In addition, emissions would occur indirectly from the use of electricity to power mining equipment and to operate the CHPP and conveyors. Open cut mining can also result in emissions of methane (CH_4) and carbon dioxide (CO_2) that is currently trapped in the coal matrix and would be released as fugitive emissions as the coal is mined.

An assessment of Project greenhouse gas emissions was conducted in accordance with the provisions of the Australian Greenhouse Office (2003) (Appendix E). The emission estimate for the life of the Project is 1,948,473 tonnes CO_2 equivalent (t CO_2-e), which equates to an average of 92,784 t CO_2-e per year over 21 years (*ibid.*).

The estimated annual average greenhouse gas emission of 92,784 t (0.093 Mt) of CO_2-e can be compared with the following estimates for 1990, provided by the Australian Greenhouse Office (2002):

- current estimate of Australia's 1990 emissions – 532.1 Mt CO_2-e;
- current estimate of Australia's 1990 emissions for the energy sector – 286.2 Mt CO_2-e; and
- current estimate of Australia's 1990 emissions for the industrial processes sector – 26.1 Mt CO_2-e.

Mitigation Measures

Minimising fuel usage by mobile plant (and associated greenhouse gas emissions) is an objective of mine planning and Project cost control systems. Additional controls on greenhouse gas emissions associated with the Project would include:

- regular maintenance of plant and equipment to minimise fuel consumption and associated emissions;
- consideration of energy efficiency in plant and equipment selection/purchase; and
- establishment of significant areas of woodland vegetation over the Project life (Sections 5.2 and 5.3).

In addition, consideration would be given to the further usage of solar power for specific site applications. The existing Project meteorological station and stream gauging stations are solar powered.

4.6.5 Odour and Spontaneous Combustion

Odour emissions from coal mines are typically limited to emissions resulting from the uncontrolled self-heating of coal. Self-heating gives rise to smouldering fires in stockpiles, or the coal seam, which can lead to significant emissions of smoke and odour.

The propensity for spontaneous combustion at the Ulan Coal Mines was previously assessed (Kinhill, 1998). The testwork indicated a moderate susceptibility to spontaneous combustion (*ibid.*).

A Spontaneous Combustion Management Plan would be developed for the Project (Section 5.1.2.11) and would include the following:

- coal stockpile and emplacement management measures;
- commitments to monitor potential causes of spontaneous combustion events; and
- corrective action in the event of spontaneous combustion.

4.7 FLORA

A description of the flora in the vicinity of the Project is presented in Appendix HA and summarised in Section 3.6. Section 4.7.1 describes the potential impacts of the Project on flora and Section 4.7.2 outlines the mitigation measures developed in response to the potential impacts.

4.7.1 Potential Impacts

Vegetation Clearance

The Project disturbance area predominantly covers cleared agricultural land (mapped as vegetation community 7 on Figure 3-7). Approximately 290 ha of remnant vegetation would be cleared by the Project as follows (Figure 3-7):

- approximately 38 ha of the Yellow Box and Blakely's Red Gum Woodlands (vegetation community 1), which represents the WBYBBRG EEC (Section 3.6.3);
- approximately 88 ha of Coast Grey Box Woodlands (vegetation community 2);
- approximately 63 ha of Rough-barked Apple Woodlands (vegetation community 3);
- approximately 30 ha of Narrow-leaved Ironbark Forest (vegetation community 4);
- approximately 9 ha of Grassy White Box Woodlands (vegetation community 5a), which represents the WBYBBRG EEC;
- approximately 60 ha of Shrubby White Box Woodlands (vegetation community 5b); and
- approximately 2 ha of Secondary Shrubland (vegetation community 8).

The majority of vegetation disturbance would occur within the open cut mine and contained infrastructure area. Section 1.7.10 discusses the potential Project alternatives investigated by WCPL to avoid disturbance to remnant vegetation, including that which occurs in Pit 3.

Habitat Fragmentation and Connectivity

There is considerable information about the value of vegetation corridors to flora and fauna in Australia (Saunders and Hobbs, 1991). As described above, the majority of vegetation clearance would occur within the open cut mine and contained infrastructure area. A corridor has been defined as a "*linear two-dimensional landscape element that connects two or more patches of wildlife habitat that have been connected in historical time*" (Soule and Gilpin, 1991). Vegetation clearance associated with the Project has the potential to fragment vegetation remnants and impact on the continuity of corridors.

Threatened Flora Species

In accordance with the provisions of Section 5A of the EP&A Act, Eight Part Tests of Significance were completed (Appendix HE) for 15 threatened flora species (including Cannon's Stringybark which was recorded outside the Project disturbance area) considered to possibly occur within the Project area or surrounds. Based on the information presented in the Eight Part Tests, it was determined that the Project is unlikely to significantly affect any threatened flora species.

Endangered Ecological Communities

The WBYBBRG EEC is represented by vegetation communities 1 and 5a (Figure 3-7). Some 38 ha of the Yellow Box and Blakely's Red Gum Woodlands and some 9 ha of the Grassy White Box Woodlands would be removed by the Project. A number of measures have been developed to mitigate potential impacts on the WBYBBRG EEC which are outlined in Section 4.7.2. In accordance with the provisions of Section 5A of the EP&A Act, an Eight Part Test of Significance was prepared for the WBYBBRG EEC (Appendix HE). Based on the information presented in the Eight Part Test, it was determined that the Project is unlikely to significantly affect the WBYBBRG EEC.

Introduced Species

A total of 403 plant taxa were recorded in the Project area and surrounds. Of these, the natural vegetation communities surveyed contained approximately 26% introduced plant taxa (Appendix HA). A number of species recorded by the flora surveys are regarded as noxious in the Mudgee LGA (now part of the MWRLGA). The presence and possible introduction of weed species poses a threat to native vegetation in the area (including vegetation in the Munghorn Gap Nature Reserve and Goulburn River National Park) by reducing floristic structure and diversity. Disturbance can act as a catalyst for weed incursion and if management initiatives are not implemented, proliferation of weeds can occur.

Dust and Vegetation

Studies have shown that excessive dust generation can impact on 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 (Farmer, 1993; Eller, 1977). Open cut mining operations have the potential to result in the generation and dispersion of atmospheric dust. The effect of dust caused by the Project on the health and viability of surrounding vegetation is likely to be localised. Further, any potential dust-related effects on vegetation (including vegetation on the edges of the Munghorn Gap Nature Reserve and Goulburn River National Park) are likely to be short in duration given the progressive mining of the Project open pits. Further, a range of dust controls would be employed, including watering of potential dust generating surfaces, use of dust control equipment and progressive revegetation, as outlined in Section 4.6.

Groundwater Dependent Terrestrial Vegetation

Terrestrial vegetation that use groundwater include plants that grow where groundwater discharges to the surface (i.e. river baseflow systems) and other plants whose roots are tapped into the water table at some depth (DLWC, 2002a). Examples of terrestrial vegetation dependent on groundwater in NSW include those on the coast (e.g. Melaleuca communities), in some types of hilly country (e.g. rainforest plants along spring-fed creeks) and inland (e.g. River Red Gums along river banks and on floodplains of large rivers in the Murray Darling Basin). The only terrestrial vegetation in the Project area or surrounds that may be dependent on groundwater occurs in the riparian zone of local creeks.

Changes to the groundwater system have the potential to impact on riparian vegetation by de-saturating the alluvial and colluvial deposits adjacent to streams. Results of the groundwater modelling predicted only a limited affect on alluvial and colluvial deposits adjacent to Wilpinjong Creek, with no discernible affect on the shallow seepage from the adjacent elevated Goulburn River National Park to the alluvial/colluvial aquifer (Appendix B). As a result, it is considered that riparian vegetation would not be deleteriously affected by the Project.

Cumulative Impacts on Flora

Cumulative impacts of the Project on flora predominantly relate to impacts on diversity and abundance associated with habitat disturbance and alteration. The assessment of cumulative impacts has taken into consideration the characteristics of the existing vegetation, existing landuses, the extent and type of vegetation disturbance associated with the Project and the Project ameliorative measures. The Project would involve the removal of approximately 290 ha of remnant vegetation. A range of mitigation and ameliorative measures have been incorporated into the Project to minimise the potential impacts of the Project, including regional cumulative impacts on flora. The Project EPP (Section 5) provides for environmental management of the Project area and surrounds, the rehabilitation of the Project disturbance areas (i.e. rehabilitation areas), the establishment of woodland vegetation (i.e. regeneration areas) and the enhancement and conservation of remnant vegetation (i.e. ECAs). These initiatives would result in an overall net increase in woodland vegetation of some 1,095 ha. The mitigation measures developed for flora are detailed in Section 4.7.2.

4.7.2 Mitigation Measures

Flora management strategies, including those listed below would be detailed in the Flora and Fauna Management Plan (FFMP) to be prepared for the Project prior to construction. Section 5.1.2.7 contains further detail regarding the contents of the FFMP.

The following measures have been developed to mitigate the potential impacts (including cumulative impacts) of the Project on flora:

- Wherever practicable, existing native vegetation would be retained. As a component of the vegetation clearance protocol to be developed for the Project, vegetation adjoining proposed clearance areas would be delineated and clearly marked to prevent accidental damage. Vegetation clearance would be undertaken progressively.
- In circumstances where vegetation removal is necessary, clearing operations would be managed to maximise the re-use of cleared vegetative material. This would include implementation of a seed collection programme for use in the rehabilitation programme and the re-use of cleared vegetation (e.g. provision of habitat for fauna associated with the rehabilitation programme and management of the ECAs, fence posts etc.), wherever practicable.
- In areas of significant earthworks, topsoil resources would be identified, stripped and stockpiled. Soil resources would be stockpiled for short time periods, where practicable, and would be re-spread and seeded.
- A weed management programme would be implemented to limit the spread and colonisation of weeds on WCPL-owned land. A Weed and Animal Pest Control Plan (WAPCP) (Section 5.1.2.8) would be prepared for the Project prior to construction.
- An environmental education programme would be included in the employee and contractor inductions and would provide relevant training in the management of native flora.
- The EPP developed for the Project (described in Section 5) provides for environmental management of the Project area and surrounds, the rehabilitation of the Project disturbance areas (i.e. rehabilitation areas), the establishment of woodland vegetation (i.e. regeneration areas) and the enhancement and conservation of remnant vegetation (i.e. ECAs).
- Rehabilitation areas - rehabilitation and revegetation of areas disturbed by the Project would be undertaken progressively as mining proceeds, with coal removal and the formation of final (mine waste rock emplacements) landforms behind the advancing face of the open cut. Rehabilitation and revegetation of infrastructure areas would also be undertaken progressively as infrastructure is decommissioned. The revegetation programme for Project rehabilitation areas provides for a combination of woodland and pasture outcomes. Some 850 ha of the Project final landform would be revegetated with woodland vegetation and some 1,070 ha would be revegetated to mixed woodland/pasture. The revegetation programme would aim to establish floristic diversity within the woodland areas.
- Regeneration areas - regeneration areas would be established on areas of WCPL-owned land situated proximal to Project disturbance/rehabilitation areas. The regeneration areas contain predominantly cleared agricultural land in which woodland vegetation (some 350 ha) would be established through natural regeneration/selective planting.
- Enhancement and Conservation areas - three ECAs would be established by the Project on areas of WCPL-owned land containing remnant vegetation and proximal grazing land, as shown on Figure 4-1. The specific flora values of the ECAs are described in Table 4-13; associated vegetation mapping is shown on Figure 3-7. The ECAs comprise a variety of vegetation communities including those that would be disturbed by the Project. Some 295 ha of remnant vegetation would be conserved and enhanced by the ECAs, including more than 80 ha of the WBYBBRG EEC. Further, some 185 ha of woodland vegetation would be established in the ECAs through natural regeneration/selective planting, including some 50 ha of the WBYBBRG EEC. Enhancement of the ECAs would be achieved by the implementation of appropriate land management practices such as weed control, management of livestock access to encourage natural regeneration and selective planting. Conservation of the ECAs would be achieved through a rezoning application, as described in Section 5.

Table 4-13
Flora Attributes of the Enhancement and Conservation Areas

ECA	Flora Attributes
ECA-A	The flora attributes of ECA-A include the occurrence of: • approximately 45 ha of Yellow Box and Blakely's Red Gum Woodlands (vegetation community 1), which represents the WBYBBRG EEC; and • Coastal Grey Box Woodlands (vegetation community 2), Rough-barked Apple Woodlands (vegetation community 3) and Narrow-leaved Ironbark Forest (vegetation community 4).
ECA-B	The flora attributes of ECA-B include the occurrence of: • more than 30 ha of Yellow Box and Blakely's Red Gum Woodlands (vegetation community 1), which represents the WBYBBRG EEC; and • Coastal Grey Box Woodlands (vegetation community 2), Rough-barked Apple Woodlands (vegetation community 3) and Sandstone Range Shrubby Woodlands (vegetation community 6).
ECA-C	The flora attributes of ECA-C include the occurrence of: • approximately 3 ha of the WBYBBRG EEC represented by the Yellow Box and Blakely's Red Gum Woodlands (vegetation community 1) and Grassy White Box Woodlands (vegetation community 5a); and • Rough-barked Apple Woodlands (vegetation community 3), Shrubby White Box Woodlands (vegetation community 5b) and Sandstone Range Shrubby Woodlands (vegetation community 5b).

Source: after Appendix HA

- The revegetation programme for Project rehabilitation areas and the selective planting of woodland vegetation in the regeneration areas and ECAs would include endemic plant species including those characteristic of the vegetation communities to be disturbed by the Project.
- Revegetation in the rehabilitation areas and natural regeneration/selective planting in the regeneration areas and ECAs would include the establishment of native riparian vegetation. Riparian vegetation would be established along the permanent creek features formed within the rehabilitation areas and along Wilpinjong and Cumbo Creeks in the regeneration areas and ECAs. These initiatives would result in an increase in riparian vegetation along these watercourses and includes the enhancement of some 10 km of creekline along Wilpinjong and Cumbo Creeks.
- While some 290 ha of remnant woodland would be removed by the Project, the Project EPP would result in an overall net increase in woodland vegetation of some 1,095 ha.
- In recognition of the importance of vegetation corridors to regional biodiversity, the Project EPP aims to contribute to the continuity of woodland vegetation by establishing links between the rehabilitation areas, regeneration areas and existing remnant vegetation in Munghorn Gap Nature Reserve, Goulburn River National Park and the ECAs. Further, two of the three ECAs have been positioned on the margins of Goulburn River National Park or Munghorn Gap Nature Reserve, which is considered beneficial in terms of the strategic role of the ECAs in the region.
- A flora monitoring programme would be developed for the rehabilitation areas, regeneration areas and the ECAs to monitor the effectiveness of the revegetation or enhancement initiatives. The monitoring programme would be outlined in the FFMP. A description of the flora monitoring programme for the rehabilitation areas, regeneration areas and ECAs is provided in Sections 5.2, 5.3 and 5.4, respectively.
- Management of the rehabilitation areas would be detailed in the MOP, while the management of the regeneration areas and ECAs would be detailed in the FFMP.

4.8 TERRESTRIAL FAUNA

A description of terrestrial fauna recorded in the vicinity of the Project is presented in Appendices HB and HC and summarised in Section 3.7. The potential impacts of the Project on terrestrial fauna are discussed in Section 4.8.1 and mitigation measures developed for the Project in Section 4.8.2.

4.8.1 Potential Impacts

Habitat Disturbance

In terms of terrestrial fauna habitats, the Project area and surrounds comprise: woodland on undulating and level land; woodland on slopes and steep hills; rocky hills and escarpment; watercourses; and cleared agricultural land with scattered trees. The condition of the habitats available to terrestrial fauna varies. In general, the most disturbed areas occur along watercourses and on flat and undulating areas which have been cleared for agriculture. Most natural vegetation is restricted to the steep hills and slopes outside of Project disturbance areas. From a broader perspective, larger remnants situated in the surrounding area (e.g. within Goulburn River National Park and Munghorn Gap Nature Reserve) would be expected to have a greater habitat complexity and provide similar and higher quality habitat than those remnants situated within, and immediately proximal to, the Project disturbance area. Notwithstanding, the Project area and surrounds provides (to varying degrees) opportunities for foraging, breeding, nesting, predator avoidance and movement between areas, thus promoting genetic diversity and facilitating dispersal/migration. These opportunities could potentially be reduced as a result of habitat disturbance associated with the Project.

Habitat Fragmentation and Connectivity

Vegetation clearance can fragment remnant vegetation and as a result create a barrier to the movement/dispersal of fauna. In relation to the movement of fauna, different species possess a variety of dispersal mechanisms by which they are able to colonise new habitats or maintain genetic health. For example, amphibians are typically restricted to water bodies such as rivers, creeks or lagoons; however they may undertake forays across elevated terrain in damp conditions.

By comparison, birds are generally highly mobile and are able to cover relatively large areas of land. The type of barrier and the species involved would determine the level of impact on dispersal capability, or the degree of isolation. Notwithstanding, the Project has the potential to fragment habitat, impact on the continuity of corridors and affect the movement/dispersal of fauna.

Threatened Fauna Species

Seventeen threatened fauna species were recorded in the vicinity of the Project, including 10 birds and seven mammals (Table 3-15). In accordance with the provisions of Section 5A of the EP&A Act, Eight Part Tests of Significance were completed (Appendix HE) for 36 threatened fauna species considered to possibly occur within the Project area or surrounds. Based on the information presented in the Eight Part Tests, it was determined that the Project is unlikely to significantly affect threatened fauna species.

Introduced Terrestrial Fauna Species

Eleven introduced terrestrial fauna species were recorded in the vicinity of the Project including one bird and 10 mammal species (Appendix HB). Introduced fauna species can present significant risks to native fauna. Predation by the Red Fox and the Feral Cat, competition and grazing by the European Rabbit, competition and habitat degradation by Feral Goats, and predation, habitat degradation, competition and disease transmission by Feral Pigs, are listed in Schedule 3 of the TSC Act as key threatening processes. All of the abovementioned introduced fauna species have been recorded in the vicinity of the Project. Due to the potential for habitat disturbance, increased refuge and scavenging areas (i.e. discarded food scraps and other rubbish), populations of introduced species could increase or become concentrated in the vicinity of the Project (including in Munghorn Gap Nature Reserve and Goulburn River National Park).

Fauna and Noise

Numerous studies have been undertaken on the effects of noise on wildlife (e.g. Algers *et al.*, 1978 in Richard Heggie Associates, 1997; Allaire, 1978; Ames, 1978; Busnel, 1978; Lynch and Speake, 1978; Shaw, 1978; Streeter *et al.*, 1979; Poole, 1982 in Richard Heggie Associates, 1997).

In essence, the studies indicate that many species are well adapted to human activities and noise. Notwithstanding, the Project would increase the existing level of noise, which has the potential to disrupt the routine activities of vertebrate fauna.

Fauna and Road Traffic

The movement of vehicles, both within the Project area and transport to and from the site (including travel through the Munghorn Gap Nature Reserve), has the potential to increase the incidence of fauna mortality via vehicular strike.

Fauna and Artificial Lighting

Project lighting has the potential to affect the behavioural patterns of some species. Some bird and bat species, for example, are attracted to insects around lights. As a consequence of this, they could become prey for larger predators (e.g. owls) which may lead to changes in population structure and community composition.

State Environmental Planning Policy No. 44 (Koala Habitat Protection)

In response to a state-wide decline of Koala populations, the Department of Urban Affairs and Planning (DUAP) (now part of DIPNR) gazetted the SEPP 44 in January 1995. The policy aims to:

> "….*encourage the conservation of proper management of areas of natural vegetation that provide habitat for Koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline*."

In order to determine whether SEPP 44 applies to the Project, it is necessary to consider the following points:

(1) *Does the subject land occur in a Local Government Area identified in Schedule 1?*

The Project and surrounds are located within the recently formed MWRLGA. The Project and surrounds were formerly located within the Mudgee LGA, which is listed within Schedule 1 of SEPP 44.

(2) *Is the landholding to which the DA applies greater than 1 hectare in area?*

The Project DA area is larger than one hectare in area.

(3) *Is the land potential Koala habitat? That is, does the site "contain areas of native vegetation where the trees of types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component?*"

In accordance with Schedule 2 of SEPP 44, potential Koala food trees present in the vicinity of the Project include Grey Gum (*E. punctata*) and White Box (*E. albens*) (Appendix HA). These species represent less than 15% of the upper or lower strata tree component in the DA area. Based on this the land is not potential Koala habitat.

(4) *Is there core Koala habitat on the subject land and is there a requirement for the preparation of a Plan of Management for the identified core Koala habitat?*

SEPP 44 describes core Koala habitat as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (i.e. females with young), recent sightings and historical records of a population.

The Project does not fall within the definition of core Koala habitat and does not have a resident population of Koalas. The Koala has not been recorded in the vicinity of the Project and no recent records exist of a population occurring in the area.

Based on the above, it is concluded that the provisions of SEPP 44 do not apply.

Groundwater Dependent Terrestrial Fauna

Watercourses provide sources of drinking water for terrestrial fauna. In addition, riparian vegetation provides terrestrial fauna with potential habitat resources for lifecycle components such as foraging and nesting/breeding. As a result, disturbance to aquatic and riparian ecosystems that are dependent on groundwater also has the potential to impact on terrestrial fauna. Section 4.9.1 discusses the potential impact of the Project on groundwater dependent aquatic and riparian ecosystems. In view of the predicted small changes to average annual flow in Wilpinjong Creek and that modelling showed only a limited effect on the water levels in the alluvial/colluvial aquifer (Sections 4.3 and 4.4), it is considered that the Project would not impact upon any terrestrial fauna that utilise habitat resources associated with Wilpinjong Creek.

Cumulative Impacts on Terrestrial Fauna

Cumulative impacts of the Project on terrestrial fauna predominantly relate to habitat disturbance and fragmentation which are primarily associated with the clearance of vegetation. The cumulative impacts of Project vegetation clearance are discussed in Section 4.7.2. Similarly to the assessment for flora, the EIS has assessed the cumulative impacts of the Project on fauna by taking into consideration the terrestrial fauna species recorded in the vicinity of the Project, existing landuses, the extent and type of habitat disturbance associated with the Project and the proposed ameliorative measures. A range of mitigation and ameliorative measures have been incorporated into the Project to minimise the potential impacts of the Project, including regional cumulative impacts on terrestrial fauna. The mitigation measures developed for terrestrial fauna are described in Section 4.8.2.

4.8.2 Mitigation Measures

Fauna management strategies, including those listed below would be detailed in the FFMP to be prepared for the Project prior to construction. The proposed content of the FFMP is described in Section 5.1.2.7.

In addition to the measures presented in regard to flora (Section 4.7.2), the following initiatives have been developed to mitigate the potential impacts (including cumulative impacts) of the Project on terrestrial fauna:

- The FFMP would include a vegetation clearance protocol to minimise the potential impacts of vegetation clearance on fauna. The Protocol would include the delineation of areas to be cleared of vegetation, a pre-clearance survey, identification of fauna management strategies and specific procedures for vegetation clearance.
- The removal of native vegetation would be undertaken, where practicable, in consideration of seasonal factors to minimise disturbance to potential breeding and hibernation activities.
- Fauna management strategies would be developed to minimise the impact of clearing activities on resident fauna in the short-term and minimise the impact of loss of habitat in the long-term. Fauna management strategies would be implemented in accordance with the FFMP developed for the Project.
- Where practicable, habitat features (e.g. large hollows) would be salvaged during vegetation clearance activities and utilised in the rehabilitation areas, regeneration areas or ECAs.
- A Threatened Species Management Protocol (TSMP) would be developed as a component of the FFMP to facilitate the implementation of threatened species management strategies to minimise potential impacts on threatened fauna species.
- A clean, rubbish-free environment would be mandated to discourage scavenging and reduce the potential for colonisation of these areas by non-endemic fauna (e.g. introduced rodents, birds). An animal pest control programme would be implemented in accordance with the control strategies detailed in the WAPCP to be prepared for the Project prior to construction (Section 5.1.2.8).
- Speed limits would be imposed on roads and tracks on WCPL-owned land to reduce the potential for vehicle strike on native fauna. Prior to the commencement of construction, WCPL would consult with the RTA, MWRC and the DEC regarding the installation of native fauna warning signs on Wollar Road through the Munghorn Gap Nature Reserve.
- An environmental education programme would be included in the employee and contractor inductions relevant to native fauna and would include an awareness of the potential to encounter native animals whilst commuting to and from the Project site and relevant actions to be taken in the event of an incident involving native fauna.
- Domestic pets would be prohibited from the Project area and employees and contractors would not be permitted to encourage fauna through feeding.
- As described in Section 4.7.2, the EPP developed for the Project provides for environmental management of the Project area and surrounds, the rehabilitation of the Project disturbance areas (i.e. rehabilitation areas), the establishment of woodland vegetation (i.e. regeneration areas) and the enhancement and conservation of remnant vegetation (i.e. ECAs). The Project EPP is detailed in Section 5.

- Rehabilitation areas - rehabilitation of Project disturbance areas would be undertaken progressively as mining proceeds. The revegetation programme would establish significant areas (some 850 ha) of woodland vegetation.
- Regeneration areas - the regeneration areas established on WCPL-owned land provide further opportunity to provide terrestrial fauna, including threatened species, with woodland habitat. Some 350 ha of woodland vegetation would be established in the regeneration areas through natural regeneration/selective planting.
- Enhancement and Conservation Areas - the ECAs would help conserve regional biodiversity, whilst enhancing the habitat available to flora and fauna (Figure 4-1). The fauna attributes of the three ECAs are summarised and presented in Table 4-14. Some 295 ha of remnant vegetation would be conserved and enhanced by the ECAs, including more than 80 ha of the WBYBBRG EEC. Further, some 185 ha of woodland vegetation would be established in the ECAs through natural regeneration/selective planting, including some 50 ha of the WBYBBRG EEC. Management measures to be implemented in the ECAs would be detailed in the FFMP. Management measures relevant to fauna would include the fencing of remnants to restrict livestock access and encourage natural regeneration of native species and the implementation of animal pest control measures.
- While some 290 ha of remnant woodland would be removed by the Project, the Project EPP would result in an overall net increase in woodland vegetation of some 1,095 ha.
- Revegetation in the rehabilitation areas and selective planting in the regeneration areas and ECAs would include the use of native species characteristic of the Project area and surrounds, with the potential to offer habitat resources for native wildlife (e.g. breeding, roosting/nesting or foraging resources), including threatened fauna species. For example, the use of winter flowering eucalypts such as White Box (*E. albens*) for the Swift Parrot and Box, Ironbark and She-oak species for species such as the Regent Honeyeater, Brown Treecreeper, Black-chinned Honeyeater, Turquoise Parrot, Hooded Robin, Diamond Firetail, Speckled Warbler, Grey-crowned Babbler and Squirrel Glider.
- Revegetation in the rehabilitation areas and natural regeneration/selective planting in the regeneration areas and ECAs would include the establishment of native riparian vegetation. Riparian vegetation would be established along the permanent creek features formed within the rehabilitation areas and along Wilpinjong and Cumbo Creeks in the regeneration areas and ECAs. These initiatives would increase the quantity of riparian vegetation along these watercourses and provide potential habitat for a number of fauna species (e.g. the Regent Honeyeater and Glossy Black-cockatoo).

Table 4-14
Fauna Attributes of the Enhancement and Conservation Areas

ECA	Fauna Attributes
ECA-A	The fauna attributes of area ECA-A include the occurrence of: • Known habitat for threatened species including the Brown Treecreeper, Diamond Firetail, Regent Honeyeater, Hooded Robin, Yellow-bellied Sheathtail Bat and Large Bentwing Bat. • Potential habitat for a number of other threatened species (e.g. the Square-tailed Kite, Speckled Warbler, Glossy Black-cockatoo and Painted Honeyeater).
ECA-B	The fauna attributes of area ECA-B include the occurrence of: • Known habitat for threatened fauna species such as the Brown Treecreeper, Yellow-bellied Sheathtail Bat, Large Bentwing Bat and Little Bentwing Bat. • Potential habitat for a number of other threatened species (e.g. the Diamond Firetail, Hooded Robin and Turquoise Parrot).
ECA-C	The fauna attributes of area ECA-C include the occurrence of: • Known habitat for threatened fauna species such as the Large-eared Pied Bat, Yellow-bellied Sheathtail Bat, Large Bentwing Bat, Little Bentwing Bat and East-coast Freetail Bat. • Potential habitat for a number of other threatened species (e.g. the Regent Honeyeater, Black-chinned Honeyeater, Masked Owl and Squirrel Glider).

Source: after Appendices HB and HC

- A key objective of the Project EPP is to increase the continuity of woodland vegetation, thereby maximising pportunities for the creation of wildlife corridors. This would be achieved by establishing links between the rehabilitation areas, regeneration areas and existing remnant vegetation in Munghorn Gap Nature Reserve, Goulburn River National Park and the ECAs.
- Conservation and enhancement of the ECAs would strengthen the linkages between the woodland rehabilitation areas, regeneration areas, Goulburn River National Park and Munghorn Gap Nature Reserve, as well as assist in the faunal recolonisation of Project rehabilitation areas and regeneration areas.
- The quality of rehabilitation (i.e. woodland areas including riparian vegetation) and regeneration areas would be monitored using Ecosystem Function Analysis or a similar systems-based approach. Flora survey quadrats would also be utilised to obtain data on flora species diversity and abundance. Consideration would also be given to monitoring fauna species usage of the rehabilitation areas and regeneration areas.
- A flora and fauna monitoring programme would also be developed for the ECAs to assess the performance of the management measures in enhancing/improving habitats for flora and fauna. In areas of existing woodland vegetation, flora survey quadrats would be utilised to monitor flora species diversity and abundance. Terrestrial fauna surveys would also be conducted to monitor the usage of the ECAs by vertebrate fauna. Monitoring may include fauna species diversity and abundance, or alternatively, the use of indicator species to measure the effectiveness of the enhancement measures.
- An overview of the flora and fauna monitoring programmes for the rehabilitation areas, regeneration areas and ECAs is provided in Sections 5.2, 5.3 and 5.4, respectively.

4.9 AQUATIC ECOSYSTEMS

A detailed description of the aquatic ecosystems of the Project area and surrounds is presented in Appendix HD and summarised in Section 3.8. Section 4.9.1 describes the potential impacts of the Project on aquatic ecosystems and Section 4.9.2 provides an overview of the mitigation measures developed in response to the potential impacts.

4.9.1 Potential Impacts

Disturbance and Alteration of Aquatic Habitat

Aquatic habitat in the Project disturbance area would be removed or altered as a result of open cut mining. This would include the relocation of Cumbo Creek to enable flows from the south to continue through the Project area and into Wilpinjong Creek. An unsealed two-lane mine access road would also be constructed to connect the mine facilities area to Wollar Road, which would require a low level floodway crossing to be installed across Cumbo Creek and one of its tributaries. The alteration of natural flow regimes of rivers and streams is recognised as a key threatening process under the TSC Act and *Fisheries Management Act, 1994.* The degradation of native riparian vegetation along NSW watercourses is also listed as a key threatening process under the *Fisheries Management Act, 1994.*

As described in Section 3.8, aquatic habitats in the Project disturbance area are generally in poor condition, reflecting the degraded nature of their immediate catchments. The banks of the creeks have been subject to erosion and grazing by cattle and invasion by introduced species such as Blackberry (*Rubus fruticosus*) and the Rush (*Juncus acutus*). Riparian vegetation is sparse and discontinuous. The relatively low richness and abundance of macroinvertebrates in creeks in the Project disturbance area indicates that most of these sites are disturbed or degraded in some manner. The richness and abundance of assemblages of fish was also quite poor with only one native species recorded in the Project disturbance area and three native species in the surrounds. The disturbance of the aquatic systems has also favoured the proliferation of the introduced Mosquito Fish (*Gambusia holbrooki*).

Notwithstanding the existing degraded nature of the creeks located in the Project disturbance area, the Project would result in the loss of habitat for aquatic biota (e.g. farm dams situated on Planters and Spring Creeks) and the alteration of aquatic habitat (e.g. the relocation of Cumbo Creek), which has the potential to result in a loss of aquatic biodiversity. Ameliorative measures have been developed to minimise the potential impacts of the Project on aquatic ecosystems and are described in Section 4.9.2.

Surface Water Flows and Aquatic Biota

As described above, aquatic habitat within the Project disturbance area would be removed or altered as a result of the Project. Changes to surface water flows in creeks located outside the Project disturbance area also has the potential to impact on aquatic ecosystems. Surface water (Appendix A) and groundwater (Appendix B) studies conducted for the Project have assessed the potential for the alteration of stream flows. The assessments indicated that the development of the Project open cuts and water supply borefield would result in a reduction in the deeper groundwater sourced (i.e. Ulan Seam) component of baseflow in Wilpinjong Creek.

The potential maximum flow reduction in Wilpinjong Creek equates to an 11% reduction of annual average flow. Whilst the predicted changes to low flows in Wilpinjong Creek would be expected to be noticeable as reduced flow persistence, the magnitude of predicted effects can be compared to those that occur due to other changes in catchment condition and landuse such as changes in livestocking rates, construction of farm dams, water harvesting or bushfires which can also result in noticeable changes to low flows (Appendix A). The relative effects on the magnitude and duration of low flows would reduce significantly downstream of the confluence of Wilpinjong and Wollar Creeks due to additional unaffected inflows from Wollar Creek. As such, the effects of flow reductions further downstream in Wollar Creek (and upstream of the Goulburn River National Park) would not be discernible from other normal variations in flows resulting from the types of changes in catchment condition and landuse described above, or from the proposed 10 km of creek enhancement works (i.e. exclusion of livestock and riparian revegetation) which are described in Section 5. The actual magnitude of the potential reductions in Wilpinjong Creek annual average flow would vary with time and would be less than that described above depending on the area of catchment excised by Project operations and on the level of usage of the Project water supply borefield. In periods of the Project life when catchment excision and borefield extractions are less, the reduction in flow would also be expected to be less.

The flow of rivers and creeks is often unpredictable and highly variable and the distribution and abundance of aquatic organisms can be affected by significant changes in the intensity and pattern of flows. However, the predicted changes to flows in Wilpinjong Creek associated with the Project are small and would not alter the physical structure of the habitats in the creek. The small-scale predicted changes are unlikely to affect the existing aquatic ecological components and, furthermore, it is considered that the revegetation/enhancement initiatives described in Section 4.9.2 are expected to have a positive effect on the instream ecology of Wilpinjong Creek. As the predicted changes in flow diminish downstream of the Wollar Creek confluence (Appendix A), it is considered that there would be no discernible effect on aquatic ecological components downstream of Wilpinjong Creek (Appendix HD).

Stream Water Quality and Aquatic Biota

Surface water runoff from mine landforms and disturbed areas has the potential to contain sediments, soluble salts, process reagents, fuels, oils and grease. The potential surface water quality impacts of the Project that relate to these contaminants are described in Section 4.3.1. A range of measures would be implemented to minimise the potential for impacts on creek water quality, as outlined in Section 4.3.1.

The use of groundwater resources by the Project also has the potential to impact on stream water quality. Groundwater quality monitoring records in the Ulan Seam indicate EC ranges from 1,020 to 3,390 μS/cm. The Ulan Seam is a source of the total salt load that is observed in Wilpinjong Creek (Appendix A). Therefore, any reduction in the rate of contribution that groundwater from the Ulan Seam makes to the creek baseflow would have a corresponding reduction in the salt load in Wilpinjong and Wollar Creeks (Appendix A). An assessment of the potential impacts of the Project on stream water quality as a result of groundwater use and open cut mining is provided in Appendices A and B.

High salinity concentrations can have a deleterious affect on assemblages of macroinvertebrates, fish and aquatic plants. The effects of increased salinity on aquatic macroinvertebrates have been well documented in the Hunter region (Chessman *et al*., 1997). The potential reduction in salt load described above, combined with the Project creek enhancement works described in Section 4.9.2, would be beneficial to the aquatic assemblages of Wilpinjong and Wollar Creeks (Appendix HD).

Barriers to Fish Movement

Some Project activities have the potential to impact on the movement of fish. These include:

- the construction of a low level floodway crossing for the mine access road across Cumbo Creek and one of its tributaries;
- the burial of pipelines from the Project water supply borefield across Wilpinjong Creek to supply water to the CHPP; and
- the relocation of Cumbo Creek to enable flows from the south to continue through the Project area and into Wilpinjong Creek.

As described in the discussion of habitat disturbance/alteration above, fish would also be restricted from the creeks situated in the Project disturbance area during mining operations. Mitigation measures to minimise Project impacts on the movement of fish are described in Section 4.9.2.

Threatened Aquatic Biota

No threatened aquatic biota listed in the schedules of the TSC Act, *Fisheries Management Act, 1994* or EPBC Act were identified during surveys or are considered likely to occur in the Project area or surrounds given the distribution of listed species, populations or ecological communities and the degraded nature of the aquatic habitats in the Project area and surrounds (Appendix HD).

Introduced Aquatic Biota

Disturbance within aquatic ecosystems can favour the proliferation of introduced aquatic species which can impact on aquatic ecosystems. For example, predation by the Mosquito Fish (*Gambusia holbrooki*) is listed as a key threatening process in Schedule 3 of the TSC Act. This species has been implicated in the decline of some 35 fish species world-wide due to competition for resources and predation (Faragher and Lintermans, 1997). Aquatic ecosystems in the vicinity of the Project have been subject to extensive disturbance as a result of past landuse practices, including a proliferation of introduced species such as the introduced Mosquito Fish and introduced emergent species, *Juncus acutus*. It is considered unlikely that the Project would have a significant effect on the occurrence of introduced aquatic biota.

Groundwater Dependent Aquatic and Riparian Ecosystems

River flow is often maintained by groundwater, which provides baseflows long after a rainfall event (DLWC, 2002a). The baseflow typically emerges as springs or as diffuse flow from saturated sediments or rock underlying the stream and banks (*ibid*.). In addition, water exchange occurs between the surface and groundwater in the hyporheic zone[1], which provides habitat for aquatic invertebrates (Boulton *et al*., 1998 in DLWC, 2002a). As a result, aquatic and riparian ecosystems can be dependent on the baseflows supplied by groundwater to a stream.

Potential impacts of the Project on aquatic biota associated with changes in creek flow are discussed above. In summary, the predicted changes to flows in Wilpinjong Creek associated with the Project are small and would not alter the physical structure of the habitats in the creek. The small-scale predicted changes are considered unlikely to affect the existing aquatic ecological components (Appendix HD).

Changes to the groundwater system also have the potential to impact on riparian vegetation by de-saturating the alluvial and colluvial deposits adjacent to streams. Results of the groundwater modelling predicted only a limited affect on alluvial and colluvial deposits adjacent to Wilpinjong Creek, with no discernible affect on the shallow seepage from the adjacent elevated Goulburn River National Park to the alluvial/colluvial aquifer (Appendix B). As a result, it is considered that riparian vegetation would not be deleteriously affected by the Project.

Cumulative Impacts on Aquatic Biota

Cumulative impacts of the Project on aquatic ecosystems predominantly relate to habitat disturbance and alteration. The assessment of cumulative impacts has taken into consideration the extent and type of habitat disturbance associated with the Project, the existing assemblages of aquatic biota, the condition of the streams and the Project ameliorative measures. A range of mitigation and ameliorative measures have been incorporated into the Project to minimise the potential impacts of the Project, including regional cumulative impacts on aquatic ecosystems.

[1] Hyporheic zone - the saturated interstitial sediments below streams and their banks where water exchanges between the surface and sub-surface.

During the progressive rehabilitation of Project landforms, a pattern of creek features (i.e. flow paths) would be formed over the rehabilitated landforms comparable to the pre-mine regime (i.e. in similar locations to the existing Planters Creek, Spring Creek, Narrow Creek and Bens Creek). These reconstructed creek features would convey upslope runoff across the Project area to Wilpinjong Creek. Revegetation of the permanent creek features would include the use of native riparian species. Further to riparian revegetation in the rehabilitation areas, riparian vegetation would also be established along Wilpinjong and Cumbo Creeks in the regeneration areas and the ECAs through natural regeneration/selective planting. These initiatives would increase the quantity of riparian vegetation along these watercourses and improve the condition of habitats available to aquatic biota. Some 10 km of creekline along Wilpinjong and Cumbo Creeks would be revegetated/enhanced by the Project. Measures developed to mitigate the potential cumulative impacts of the Project on aquatic ecosystems are outlined in Section 4.9.2.

4.9.2 Mitigation Measures

Management measures relevant to aquatic ecosystems would be outlined in a number of management plans to be prepared for the Project, including the ESCP, SWMP, WAPCP, FFMP and CCRP. The proposed content of the abovementioned plans is described in Section 5.

The following measures have been developed to minimise the potential impacts (including cumulative impacts) of the Project on aquatic ecosystems:

- Mitigation of the predicted reduction in average annual flows in Wilpinjong Creek would be in the form of designing the Project water management system to maximise the diversion of runoff from undisturbed areas around Project construction/development and operational areas, together with progressive rehabilitation to allow the free-draining of completed landforms. These measures would minimise the degree of catchment excision at any one time.
- A number of measures would be implemented to minimise potential impacts on surface water quality and are described in Section 4.3.1. For example, surface water management structures would be utilised to control erosion and water runoff in accordance with the ESCP and to minimise the potential for Project activities to adversely affect downstream water quality. A water management system would be developed as a component of the Site Water Management Plan to minimise potential surface water quality impacts.
- In order to minimise the length of time fish passage may be restricted during construction activities, construction of the floodway crossing across Cumbo Creek and burial of pipelines across Wilpinjong Creek would be scheduled during periods of no/low flow. Works associated with the relocation of Cumbo Creek would also be scheduled so as to minimise the interruption of flows and fish passage in Cumbo Creek.
- Further to riparian revegetation in the rehabilitation areas, riparian vegetation would also be established along Wilpinjong and Cumbo Creeks in the regeneration areas and the ECAs through natural regeneration/ selective planting. These initiatives would increase the quantity of riparian vegetation along these watercourses and improve the condition of habitats available to aquatic biota. Some 10 km of creekline along Wilpinjong and Cumbo Creeks would be revegetated/ enhanced by the Project. The Wilpinjong Creek and Cumbo Creek revegetation/enhancement initiatives in the regeneration areas and ECAs would be detailed in the FFMP.
- The CCRP would also include a revegetation programme for the Cumbo Creek relocation corridor and would use native riparian species consistent with upstream regeneration works. The CCRP would also include: design and specifications for creek relocation works; a construction programme for the creek relocation, describing how the work would be staged and progressively integrated with mining operations; design of the block bund foundation to provide for the interception of sub-surface flow associated with Cumbo Creek alluvium; water quality, ecological and geomorphic performance criteria for the creek relocation; and a programme to inspect and maintain the creek relocation and revegetation works until they stabilise.

An aquatic monitoring programme would be developed to monitor the aquatic macroinvertebrate assemblages, *in-situ* water quality, characteristics and health of Wilpinjong and Cumbo Creeks. The ecological integrity of the Cumbo Creek relocation would also be monitored. Components of the aquatic monitoring programme would be detailed in either the FFMP or CCRP. Consideration would also be given to monitoring creek features established in the final landforms later in the Project life to assess their provision of habitat for aquatic biota. Surface and groundwater monitoring programmes would be developed for the Project to monitor Wilpinjong, Cumbo and Wollar Creeks, as described in Sections 5.1.3.6 and 5.1.3.7.

4.10 ABORIGINAL CULTURAL HERITAGE

A survey and assessment of Aboriginal cultural heritage in the Project area was conducted (Appendix F) and the findings are summarised in Section 3.9. The survey and assessment was conducted in conjunction with local Aboriginal groups (MLALC, MGATSIC and WBNTCAC) with a number of Aboriginal cultural heritage sites being identified.

The following discussion focuses on potential impacts and management and mitigation measures applicable to the Aboriginal cultural heritage sites identified in the surveys (Figure 3-10).

4.10.1 Potential Impacts

In the Aboriginal Cultural Heritage Assessment (Appendix F), recorded Aboriginal cultural heritage sites were separated into a number of categories in relation to their proximity to the Project disturbance area. In this sub-section, these categories have been simplified and sites are either presented as inside or outside of the proposed Project disturbance area.

Of the 235 sites recorded, some 144 are located in the Project disturbance area. A further 91 recordings are located outside of the Project disturbance area on adjacent WCPL-owned lands and in the ECAs.

As shown in Table 4-15, no rock shelters with rock art, rock shelters with surface artefacts or rock shelters with confirmed or potential archaeological deposits are within the Project disturbance area.

As Project development works would damage or destroy Aboriginal objects, appropriate approvals for all sites located within the Project disturbance area would be sought under sections 87/90 of the *National Parks and Wildlife Act, 1979* (NPW Act).

As part of the Project detailed design phase, the final alignment of some of the ancillary infrastructure (e.g. road re-alignments, relocation of the 11 kV electricity transmission line, the on-site temporary construction camp and water supply bores and associated pump and pipeline system) would be determined. In addition, during the life of the Project, various works such as fencing and selective tree planting would be conducted in rehabilitation areas, regeneration areas and the ECAs as described in Sections 5.2.5, 5.3 and 5.4.

Prior to ancillary works occurring, pre-clearance Aboriginal heritage surveys would be conducted to identify Aboriginal objects located within the footprint of these works, and where practicable, Aboriginal objects would be avoided. Appropriate approvals would be sought under section 90 of the NPW Act for Aboriginal objects unable to be avoided by these Project components.

Blasting and Rock Art Sites

Three rock shelters that contain rock art have been identified by the Aboriginal cultural heritage survey. The sites (72, 152 and 153) are in sandstone/conglomerate rock formations and are located outside of the Project disturbance area (Figure 3-10). Sites 152 and 153 occur in rock tors facing west on slopes to the east of Pit 5 and Site 72 faces east and is situated at the base of a local escarpment outlier to the east of Pit 2 (Figure 3-10).

The blasting assessment (Section 4.5.6) indicates that blasting associated with the Project mining operations can be undertaken in a manner that does not result in an exceedance of the relevant vibration criteria (Section 4.5.6). Notwithstanding, a monitoring and blast management programme for these sites would be implemented as discussed in Section 4.10.2 and Section 5.1.3.4.

Table 4-15
Aboriginal Cultural Heritage Sites in the Project Area

Description	Aboriginal Cultural Heritage Site Number (Figure 3-10)	
	Inside Project Disturbance Area	Outside Project Disturbance Area
Rock shelter with rock art, surface artefacts and potential archaeological deposit	-	152
Rock shelter with rock art and potential archaeological deposit	-	72
Rock shelter with rock art	-	153
Rock shelter with surface artefacts and confirmed or potential archaeological deposit	-	36-39, 45, 48-49, 115-116, 118-120, 137, 140, 144, 173, 178, 192
Rock shelter with potential archaeological deposit	-	44, 47, 82, 85[1], 117, 141, 143, 145-148, 154, 164-165, 168, 172, 228-233
Open artefact scatters with 500+ estimated surface artefacts	134	174
Open artefact scatter with up to 500 estimated surface artefacts	216	136, 227
Open artefact scatters with up to 100 estimated surface artefacts	1, 3, 33	-
Open artefact scatters with up to 50 estimated surface artefacts	12, 57, 81, 87, 123, 126, 198, 208, 213-214, 220, 224	158-159, 162
Open artefact scatters with up to 20 estimated surface artefacts	2, 11, 29, 151, 176, 179, 184, 219	128, 138-139, 156-157, 190, 209
Open artefact scatters with up to 5 estimated surface artefacts	4, 13, 15, 22, 25-26, 31, 34-35, 42, 66-67, 78, 83, 86, 105-106, 108, 121, 125, 188-189, 202, 217, 226	127, 185, 191, 193, 195, 211, 222
Open artefact scatter and procurement site	88	-
Isolated find	5, 8, 10, 14, 16-21, 23-24, 27-28, 30, 32, 40-41, 43, 50-51, 54, 65, 74, 76, 80, 84, 102-104, 107, 109-110, 175, 177, 180, 182-183, 186, 199-201, 203-206, 218, 221, 223, 225, 237-238	46, 56, 70, 71, 73, 135, 155, 181, 187, 210, 215, 235
Isolated find (debated origin)	60, 212	-
Possible Aboriginal scarred tree	53, 55, 69, 89, 91, 93-97, 100-101, 111-112, 122, 129, 130, 196-197, 207	6, 114, 149, 160
Probable Aboriginal scarred tree	75, 90, 98, 99, 169-171	64, 150, 161, 163, 166-167, 234, 236
Probable surveyor scarred tree (debated origin)	7, 68, 77	-
Scarred tree (debated origin)	52, 113, 124	-
Indeterminate tree feature	63	-
Potential archaeological deposit (open context)	9, 92	-
Reported place of cultural significance by some members of the Aboriginal community (Section 3.9.2)	59	58
Reported 'spring' or waterhole	62	61, 79
Probable modern scatter of crushed rock (debated origin)	194	-
Probable European clearing mounds (debated origin)	-	142

Source: after Appendix F
[1] This site is listed in Appendix F as being on the open cut pit boundary. WCPL propose to avoid this site.

Dust and Rock Art Sites

Dust deposition on rock art panels can obscure artwork and accelerate natural degradation of applied pigment (Appendix F). For example, Site 72 is already in a poor state of preservation, due in part to the accumulation of dust, caused by domestic livestock, which use the site for shelter. WCPL proposes to fence the rock art sites to restrict livestock access and minimise these effects as described in Section 4.10.2.

Project mining activities could potentially contribute to dust levels within the rock shelters when mining activities are undertaken adjacent to these sites.

Dust monitoring and mitigation measures are described in Sections 5.1.3.2 and 4.6.2.

Inappropriate Site Visitation/Vandalism

During construction and operation of the Project there is some potential that the presence of the Project could increase the risk of inappropriate visitation of Aboriginal cultural heritage sites on WCPL-owned lands. Rock art sites are particularly vulnerable to vandalism and graffiti (Appendix F).

WCPL would implement staff education programmes and would implement access restrictions to minimise the potential for inappropriate visitation of Aboriginal sites as described in Section 4.10.2.

4.10.2 Management, Mitigation and Conservation Measures

The management and mitigation measures detailed below were developed in consultation with the MLALC, MGATSIC and WBNTCAC both during the Aboriginal cultural heritage survey and in subsequent heritage management workshops. The consultation process and the proposed management and mitigation measures are described in more detail in Appendix F.

In recognition of issues raised during the consultation process with Aboriginal groups and based on the results of the archaeological and cultural heritage studies and consideration of the mine economic feasibility, a number of modifications were made to the Project layout during the EIS process to avoid Aboriginal cultural heritage sites. These modifications are described in Appendix F.

Aboriginal Cultural Heritage Management Plan

An ACHMP would be developed in consultation with the Aboriginal community for management of Aboriginal cultural heritage at the Project and may be completed in stages as mine planning progresses. The ACHMP would be periodically updated over the Project life. Further detail on the content of the AHCMP is provided in Section 5.1.2.10.

Aboriginal Involvement in Project Cultural Heritage Management

It is proposed that the Aboriginal community would continue to be involved in the management of Aboriginal cultural heritage over the life of the Project. Community involvement would be described in the ACHMP and would include:

- participation of local Aboriginal community representatives in Project Aboriginal cultural heritage salvage, monitoring and field management works (at a level of representation as defined in the ACHMP);
- establishment of an Aboriginal cultural heritage liaison committee for cultural heritage management and continuing Aboriginal involvement in the Project (Section 5.1);
- WCPL support for the nomination of an Aboriginal community representative to the Project CCC so that the Aboriginal community can be informed of on-going Project planning, environmental monitoring and management; and
- provision of site access protocols for Aboriginal people wishing to access Aboriginal cultural heritage sites located within the Project area and WCPL-owned lands to perform cultural practices or visit places of significance to them (these site access protocols would require compliance with applicable occupational health and safety and operational constraints).

Management of Impacted Sites and Potential Archaeological Deposits

Management measures for Aboriginal cultural heritage sites, potential archaeological deposits (PADs) and geomorphic features with considered archaeological potential were discussed during consultation with the Aboriginal community (Appendix F). Consent would be sought under section 87/90 of the NPW Act to cover the life of the mine and to allow staged archaeological works.

These measures would be described in the ACHMP (Section 5.1.2.10) and would include the following activities:

- Prior to disturbance, selected Aboriginal objects located within the Project disturbance area would be collected and relocated to a "Keeping Place" where the objects would be documented and stored.
- Collected Aboriginal objects would be replaced onto completed landforms as part of the rehabilitation programme. This process may be undertaken progressively.
- Salvage excavation, analysis and reporting would occur for selected sites/areas prior to disturbance. This programme would be developed and described in the ACHMP in consultation with the Aboriginal community.
- Selective salvage and further investigation would be undertaken into the age and origin of the scarred trees in the Project area and some examples would be re-placed onto rehabilitation areas.

Management of Other Potential Impacts

Other potential impacts would be mitigated by the implementation of the following management measures:

- Pre-development baseline recording and blast vibration and dust monitoring at the rock shelters with rock art (Sites 72, 152, and 153) (Sections 5.1.3.2 and 5.1.3.4).
- Regular monitoring of rock art sites that are located in relative proximity to the Project disturbance area (Section 5.1.2.10) and the implementation of further mitigation measures if the potential for adverse impacts is identified.
- Conduct of further archaeological survey on slopes up to and including the escarpments within 500 m of the open cut mining area to identify any additional sites that are outside of the Project disturbance areas. The survey programme would be conducted progressively prior to the commencement of mining adjacent to these areas. WCPL has committed to complete this survey work within two years of the commencement of Project mining activities.
- A programme of conservation management would also be implemented at selected sites in relative proximity to mining or infrastructure areas. This would include:
  - the installation of fencing with the aim of excluding livestock from rock art sites (72, 152 and 153);
  - the installation of an appropriate form of demarcation (e.g. temporary fencing or flagging) around sites which are located in close proximity to the Project disturbance area; and
  - the conduct of Aboriginal cultural awareness training as part of the induction of Project personnel which communicates the need for, and the various management strategies to be conducted for the management of Aboriginal cultural heritage.

Enhancement and Conservation Areas

As described in Section 5, WCPL would apply to rezone the land in the ECAs for the purpose of conservation.

The ECAs include a range of identified Aboriginal cultural heritage sites including rock shelters with rock art, a range of other rock shelters (with or without archaeological deposits, surface artefacts or potential archaeological deposits), large and small open artefact scatters and isolated finds. In addition, part of the Cumbo Creek riparian corridor is located in ECA-A. Landforms in this context are considered to have the potential to contain large open artefact scatters and *in-situ* deposits (Appendix F).

The Aboriginal cultural heritage survey has demonstrated that the ECAs contain Aboriginal cultural heritage sites of significant conservation value and landforms with archaeological value. The local Aboriginal community believe these areas provide a valuable opportunity to conserve a sample of sites from the Project area (Appendix F). The long-term conservation management of these areas represents a significant positive outcome for Aboriginal cultural heritage in the Project area (*ibid*.).

It is proposed to manage Aboriginal cultural heritage values of the ECAs according to measures to be outlined in the ACHMP including:

- the restriction of livestock access to some areas;
- integrating the management of the ECAs with the maintenance of Aboriginal archaeological sites; and
- assessment of potential cultural heritage impacts prior to any works involving significant ground surface in the ECAs.

4.11 NON-ABORIGINAL HERITAGE

4.11.1 Potential Impacts

As outlined in Section 3.10.2, nine non-Aboriginal heritage items were identified in the Project area that are considered of local heritage significance. No sites of higher (regional or state) heritage significance were identified.

Four buildings of local significance were identified within the open cut mine and contained infrastructure area. These sites include (Figure 3-10):

- Site 2 "Hillside" – located in the north-eastern corner of Pit 4;
- Site 4 "Warrawong" – located near Bens Creek in the southern part of Pit 2 ;
- Site 5 Atcheson's Cottage – located near Bungulla Road in Pit 5; and
- Site 6 Loys Cottage – located near the western boundary of Pit 5.

Of the four sites, only Warrawong (Site 4) remains in fair to good condition, with the other three sites being in poor or ruined condition (Appendix G). These sites would be demolished when mining through these locations.

In addition, Site 8, which is a post and rail fence, is located in the open cut mine and contained infrastructure area in the vicinity of the rail loop (Figure 2-3). The post and rail fence is in poor condition (Appendix G). It is likely that the majority of the post and rail fence would be disturbed by rail construction activities.

One heritage site (Site 9 – Wilpinjong Road Stone Embankment) is located on the existing alignment of Wilpinjong Road (Figure 3-10) and could potentially be damaged or demolished during road construction works for the mine access road. The stone embankment is in good condition (Appendix G).

4.11.2 Mitigation Measures

The following mitigation measures (Appendix G) would be implemented for the non-Aboriginal heritage items identified within the Project disturbance area:

- All the heritage sites that are considered to be of local heritage significance (Sites 1 to 9) have been recorded to an archival standard (written description, plans [where applicable] and detailed photographic record). These records will be provided to the Mudgee Historical Society.
- During the mine access road detailed design, Site 9 would be identified and avoided by a minor road deviation.
- When "Warrawong" and "Hillside" need to be demolished for mining, materials such as stone and wooden slabs would be offered to local landowners or the Mudgee Historical Society for conservation or re-use.

4.12 ROAD TRANSPORT

Potential traffic impacts on the local road network are assessed in Appendix K and summarised below.

4.12.1 Potential Impacts

Project Traffic Generation

Table 4-16 summarises predicted daily vehicle movements (traffic in both directions) generated by the peak construction phase and peak operational phase of the Project.

Construction of the Project would be undertaken up to seven days per week between the hours of 7.00 am and 6.00 pm (Section 2.12.1). Predicted traffic generation for this period would comprise both light vehicles and small truck/heavy vehicle movements associated with deliveries and services.

Table 4-16
Predicted Peak Daily Project Traffic Flows* – Construction and Operational Phases

Traffic Type	Peak Construction Phase	Peak Operational Phase
Light Vehicles (workers)	248	200
Light Vehicles (visitors)	40	20
Small Truck/Heavy Vehicles (deliveries and service vehicles)	24	16
Total	**312**	**236**

Source: after Appendix K
* Movements in both directions (in and out).

Traffic generated by the Project during the construction phase would have a slightly different pattern than during the operational phase, as there would be a temporary construction camp located on-site (Section 2.3.1). A large proportion of non-local workers would stay at the construction camp, arriving at site on Monday mornings and leaving on Friday afternoons.

During the operational phase, lower levels of employment would result in lower light vehicle traffic movements. Table 4-16 is based on the assumption that 90% of operational staff access the site on any given day and that some car pooling would occur.

During the operational phase, some 80% of the workforce would be expected to access the site to and from Mudgee on a daily basis and this would result in a more concentrated distribution of Project traffic to and from Mudgee on Wollar Road/Ulan Road (Main Road 208) (Figure 3-11).

Table 4-17 presents the predicted impact of Project traffic flows on the local road network during peak construction and operational phases. During non-peak times, Project traffic flows would be lower.

In addition to the traffic flows listed in Table 4-17, traffic to and from the construction camp and the mine facilities area would utilise a short section of Ulan-Wollar Road (Figure 2-3). Traffic using this temporary access would be predominantly workforce movements. These movements would be linked to construction shift start and finish times (i.e. the traffic would be expected to be mainly prior to 7.00 am and after 6.00 pm).

Examination of peak hour movements at the Wollar Road/mine access road intersection and the major intersections on the route to the site from Mudgee indicate that critical intersections would continue to operate effectively with a Level of Service A (Level of Service is a comparative measure which provides an indication of the operating performance of an intersection) and minimal delays during peak periods (i.e. between 6.00 am to 8.00 am in the morning and between 6.00 pm and 7.00 pm in the evening) (Appendix K).

Temporary Construction Camp Access

As described in Section 2.3.2, the primary access to the Project would be provided from the south via the mine access road. However, an existing access track and road-rail crossing from the north off Ulan-Wollar Road would also be temporarily utilised during the construction phase to provide for direct access for employees transiting between the temporary construction camp and the Project site. This would avoid unnecessary traffic movements through the village of Wollar.

The intersection of the temporary access road with Ulan-Wollar Road would be constructed with suitable geometry in consultation with the MWRC. The temporary access road would be closed following decommissioning of the construction camp.

Table 4-17
Predicted Peak Period Daily Traffic Flows on the Local Road Network

Road	Station Number (Figure 3-11)	Road Name Location	Current Traffic Volume*	With Project Construction	% Change Construction	With Project Operation	% Change Operation
Main Road 208	5474	West of Golden Highway	300	333	11.0	308	2.7
	99286	East of Bylong	141	174	23.4	149	5.7
	Survey Site 4	Wollar Road - West of Wollar (near Wilpinjong Road)	166	295	77.7	358	115.7
	Survey Site 3	Wollar Road - West of Cooyal	352	481	36.6	544	54.5
	99222	Wollar Road - East of Ulan Road	613	742	21.0	805	31.3
	99906	Ulan Road - North of Mudgee	3,482	3,611	3.7	3,674	5.5
Main Road 214	92268	Ulan-Cassilis Road - North of Ulan	597	696	16.6	601	0.7
	Survey Site 2	Ulan Road - South of Ulan	790	790	0.0	790	0.0
	99221	Ulan Road - North of Wollar Road/Budgee Budgee	1,321	1,321	0.0	1,321	0.0
Main Road 598	99510	Cope Road - East of Gulgong Centre	1,119	1,146	2.4	1,141	2.0
Henry Lawson Drive	Survey Site 1	North of Main Road 208	953	953	0.0	953	0.0
Main Road 215	99301	Bylong Road - North of Rylstone	359	371	3.3	363	1.1
Wollara/ Ringwood Road	-	North of Wollar Road	100	112	12.0	106	6.0
Ulan-Wollar Road	-	East of Main Road 214	175	301	72.0	201	14.9

Source: Appendix K
* Based on recent traffic counts and estimates.

Oversize Traffic

A number of over-width, over-height or over-weight loads would be generated during the construction phase, however, the number of these oversize loads would be small. All such loads would be transported with the relevant permits, licences and escorts, as required by the relevant regulatory authorities. The proposed route for these oversize loads would be selected in consultation with the relevant local councils. However, it is expected that they would travel only along State Highways and Main Roads to the Project site.

Re-alignment of Ulan-Wollar Road – Later in the Project Life

As described in Section 2.3.9, open cut operations in the north of the Project area would require the re-alignment of two sections of Ulan-Wollar Road in Year 8 and Year 13 (Figure 2-3). Along with these re-alignment works, the existing railway level crossings on Ulan-Wollar Road would also be relocated.

Detailed design of the re-alignments would be undertaken later in the Project life as design requirements are likely to be dictated by traffic flows and rail movements at that time. At the detailed design phase, WCPL would undertake consultation with the MWRC, RTA and relevant rail authorities to determine the extent of level crossing protection and other safety and design requirements.

Temporary Road Closures Associated with Project Blasting

For periods when mine blasting is undertaken within 500 m of Ulan-Wollar Road or Wollar Road, temporary closure of these roads for short periods (i.e. less than 15 minutes) would be required while blasting is undertaken and to allow for post-blasting inspections. These temporary closures would be conducted in accordance with a Traffic Management Plan (TMP) (Section 4.12.2 and Section 5.1.2.9).

Product Coal Transport

WCPL does not propose to haul coal along public roads. All coal would be hauled on internal roads on WCPL-owned land and transported externally by rail (Section 2.7).

Cumulative Traffic Increases

Other developments in the Project area have the potential to add additional traffic flows that may result in cumulative impacts on the local road network. The existing Ulan Coal Mines form part of the existing baseline for the Project, as the traffic counts undertaken for the Project and RTA traffic counts (Section 3.11) include traffic movements associated with this existing development.

Notwithstanding, the Ulan Coal Mines has a number of consents (Section 1.4) and the potential for some additional traffic generation associated with this development has been identified. The transport assessment (Appendix K) has considered the potential for additional mine related traffic and concluded that:

- Potential cumulative impacts with Project traffic flows would be largely limited to the section of Ulan Road between Mudgee and Budgee Budgee (Main Road 208) (Figure 3-11), as the majority of Project traffic would utilise Wollar Road to access the Project.
- Depending on the level of Ulan Coal Mines related traffic increases, there could be minor increases in delays at relevant intersections at peak times, however, the additional traffic would not lead to any capacity issues along the route (Appendix K).

4.12.2 Traffic Management Measures

Ulan Road/Wollar Road Intersection Upgrade

The existing traffic flows at the Ulan Road/Wollar Road intersection (Main Road 208) already requires an upgrade of the intersection geometry to provide a passing lane for traffic on Ulan Road (Appendix K). As the construction and operational phases of the Project would contribute additional traffic to this intersection the Road Transport Assessment (Appendix K) recommends upgrading of this intersection.

Mine Access Road and Associated Intersection

The mine access road geometry would be designed to comply with the *Rural Road Design – Guide to Geometric Design of Rural Roads* (Austroads, 1993). Alignment of the intersection of the mine access road with Wollar Road would be undertaken to improve visibility (from the current Wilpinjong Road intersection) and the intersection would be designed as a “Type B” (basic) intersection incorporating a “Type AUR” (auxiliary turn lane) right turn treatment from Wollar Road and a “Type BAL” (basic left turn treatment) from Wollar Road, in accordance with the *Road Design Guide* (RTA, 1996) (Appendix K).

The detailed design of the intersection should accommodate turning manoeuvres of B-Doubles as defined by the *Guide to Traffic Engineering Practice: Part 5 – Intersections at Grade* (Austroads, 1988) with these vehicles turning without crossing the centrelines of the intersection approaches in Wollar Road. This would require the widening to be sealed and extended over a distance of about 190 m, subject to detailed design. Intersection pavement design would be prepared in accordance with *A Guide to the Structural Design of Road Pavements* (Austroads, 1992).

Approximately 100 m of the mine access road would be sealed on the approach to the intersection with Wollar Road to minimise transport of gravels onto the Wollar Road pavement.

Wollar Road Upgrade

Two short sections of Wollar Road have a pavement width of below 6 m (Section 3.11) and the Road Transport Assessment (Appendix K) recommends the upgrade of these substandard sections of the road to provide a minimum 6 m pavement width on the main access route from Mudgee to the Project in accordance with relevant design standards and quality assurance specifications.

Traffic Management Plans

A TMP would be developed to address blasting-related road closures on Wollar Road and Ulan-Wollar Road (when blasting is undertaken within 500 m of these roads) in consultation with the MWRC and RTA and in accordance with the RTA *Traffic Control at Worksites Manual* (RTA, 2003) (Section 5.1.2.9). Traffic Management Plans would also be completed to address any other roadworks on public roads (e.g. the re-alignment of Ulan-Wollar Road) in consultation with the MWRC and RTA prior to these works being undertaken.

Traffic Minimisation

A proportion of car pooling has been incorporated in the assessment for the operational phase traffic generation (1.43 persons per workforce light vehicle). As approximately 80% of the operational phase workforce would be expected to commute from a single source (Mudgee), the level of car pooling has the potential to increase. WCPL would encourage car pooling to minimise Project traffic generation during the life of the Project.

Cumulative Traffic Impacts

WCPL would consult with the MWRC, RTA, Ulan Coal Mines and other mining interests in the Project area during the Project life to manage cumulative traffic issues, should they arise.

4.13 RAIL TRANSPORT

Potential Impacts

As stated in Section 2.7, product coal would be transported by rail to either the Bayswater/Liddell rail unloader or the Port of Newcastle located approximately 155 km and 260 km, respectively from the Project rail loop (Figure 1-1). Product coal would be transported via the Gulgong-Sandy Hollow railway, which adjoins the Merriwa railway, which in-turn adjoins the Main Northern railway. As described in Section 3.11.4, existing rail movements along the Gulgong-Sandy Hollow railway and the Main Northern railway are understood to be 16 and 46 passbys per day, respectively.

In addition to these existing rail movements, an average of four Project trains would be loaded each day, with a maximum of six (based on an 8,500 t train capacity). This would correspond to a maximum of 12 train passbys in any one day (i.e. six arrivals and six departures) (Section 2.7).

Mitigation Measures

For blast events within 500 m of the Gulgong-Sandy Hollow railway, temporary closure of the railway for short periods (i.e. less than 15 minutes) would be required while blasting is undertaken and to allow for post-blasting inspections of the railway. These temporary closures would be conducted in consultation with the ARTC.

The *Hunter Valley Capacity Improvement Strategy* (ARTC, 2005) five year plan for the Hunter Valley rail corridor makes specific reference to the Project with regard to the potential increase in train movements along the Gulgong-Sandy Hollow railway and the Main Northern railway. Specifically, this strategy identified that the train movements along the Gulgong-Sandy Hollow railway would increase from 14 (2005) to 29 (2009) (*ibid.*) and attributes this increase predominantly to the Project (*ibid.*).

The *Hunter Valley Capacity Improvement Strategy* (*ibid.*) also describes additional train usage of the Main Northern railway. The strategy outlines the infrastructure improvements and the timing necessary to accommodate Project trains and additional demand from other projects in the region. Hence, the ARTC has considered the Project in its five year infrastructure improvements plan and it is understood that the relevant railways would have sufficient capacity to accommodate Project trains.

4.14 COMMUNITY INFRASTRUCTURE ASSESSMENT

The results of the Community Infrastructure Assessment conducted for the Project are summarised below and are presented in full in Appendix J. Potential Project impacts on housing, education facilities and community services are addressed as well as potential direct and indirect impacts on employment and population.

For the purpose of the Community Infrastructure Assessment, the local region is taken to include the former LGAs of Mudgee, Rylstone and Merriwa.

The Project also has significant potential to generate employment outside of the local region. Gillespie Economics (Appendix I) has estimated some 121 and 257 jobs would be expected to be created outside of the local region (but within NSW) as a consequence of the Project construction and operational phases, respectively.

Potential employment effects, population effects and community infrastructure demands that take place outside of the local region are expected to be largely concentrated in major centres such as Sydney, and hence in relative terms are likely to be minor in nature (Appendix J). The following assessment therefore concentrates on potential impacts in the local region.

4.14.1 Construction Phase

Workforce

It is anticipated that 200 people would be employed on average over a six month period to undertake Project construction activities. During short-term peaks in construction activity, up to a maximum of 250 people may be employed.

A significant proportion of the construction workforce is expected to be sourced from the local region. Following consideration of alternatives for accommodation of the non-local construction workforce, an on-site construction camp to accommodate up to 100 employees is proposed to alleviate short-term accommodation requirements in the general community (Section 2.3.1).

Population and Housing

The construction camp would accommodate the majority of the non-local workforce and as a result, the predicted impact of the construction phase on local populations and housing demand is expected to be relatively minor.

Notwithstanding, a small component of the directly employed workers and workers attracted to the local region to satisfy demand in other sectors of the economy (i.e. flow-on employment) would require conventional housing (rental houses and flats) during the construction phase. The estimate of the total demand for housing in the general community during Project construction is 55 housing rental units (Appendix J).

During short-term peak construction periods, demand for accommodation for up to 30 additional non-local workers would be provided by WCPL-owned houses in the Project area or accommodation in hotels and motels in the local region.

Based on the results of a social survey conducted by Martin and Associates in June 2004, and discussion with local real estate agents in June 2004 and January 2005, the rental demand associated with the Project construction phase may cause some pressure on the existing rental market, particularly at the lower end (Appendix J).

Community Infrastructure

The estimated number of school age children coming into the local region during the construction phase is 16 and would not have any significant impact on the wide range of education facilities currently available in the primary study area (Appendix J).

The transient nature of construction workers may also lead to occasional social impacts of a nuisance nature such as noise and traffic (Appendix J).

4.14.2 Operational Phase

Workforce

Operational phase population and housing impacts were assessed for both average and peak expected employment levels to investigate the range of potential impacts on population, housing and community infrastructure.

Population and Housing

For both scenarios, it was estimated that 50% of the operational workforce (i.e. 50 to 81 employees) and 70% of flow-on jobs would be sourced from within the local region (Appendix J). The following sections assess the potential impact on community infrastructure of direct Project-generated employment and flow-on employment that would be sourced from outside the local region (Table 4-18).

Flow-on employment generation resulting from the Project has been estimated at 1.5 times direct Project employment levels in the local region (Appendix I). Of these additional full-time jobs, it is assumed that approximately 30% (i.e. 45 to 73 jobs) would be filled by people who originate from outside the local region. The total population effects of the Project have therefore been calculated to range from 193 to 312 people for the average and peak employment scenarios, respectively (Table 4-18).

Table 4-18
Operational Phase Population Effects – Direct and Flow-on Employment
Average and Peak Employment Scenarios

	Employment Type	Source	Workers/ Jobs	Spouses	Children	Total Population Increase
Operational Phase – Average Employment	Direct Employment	Local	50	-	-	-
		Non-local	50	35	35	120
	Flow-on Employment	Local	105	-	-	-
		Non-local	45	14	14	73
	Total		**250**	**49**	**49**	**193**
Operational Phase – Peak Employment	Direct Employment	Local	81	-	-	-
		Non-local	81	57	57	195
	Flow-on Employment	Local	170	-	-	-
		Non-local	73	22	22	117
	Total		**405**	**79**	**79**	**312**

Source: Appendix J

Consideration of likely settlement patterns of the incoming workforce by Martin and Associates (Appendix J) indicates that approximately 80% of the workforce would be expected to settle in Mudgee due to the array of facilities available and the higher likelihood of spouse employment opportunities. Gulgong is expected to gain approximately 10% of the non-local workforce and the remainder would be spread throughout the local rural community. On the basis of these assumptions, Table 4-19 provides a summary of the housing demand for the average and peak scenarios.

The likely demand for housing in Mudgee, Gulgong and the surrounding rural areas associated with the Project operational phase direct workforce and flow-on employment would be in the range of 95 to 154 housing units (Table 4-19). This includes accommodation for families and individuals who may be attracted to Mudgee to fulfil flow-on employment.

As Mudgee has over 1,500 houses in the rental market, and the normal annual rate of residential building activity in the Mudgee LGA has been approximately 120 building applications per annum for new housing (with approximately 50 per year in Mudgee), the increase in demand is expected to be able to be serviced without any undue pressure on land and physical infrastructure services (Appendix J).

Community Infrastructure

In both Mudgee and Gulgong, elements of community infrastructure such as education, health and other community services and recreational services generally have sufficient excess capacity to accommodate the increase in population and housing/land demand that would be caused by the Project.

Table 4-19
Estimates of Total Operational Phase Housing Impact
Allocated to Centres and Rural Areas

	Housing Type	Mudgee	Gulgong	Rural Areas	Total*
Operational Phase – Average Employment	Family/Couple Houses/Units	39	5	5	49
	Single Houses/Units	37	5	5	47
	Total*	**76**	**10**	**10**	**95**
Operational Phase – Peak Employment	Family/Couple Houses/Units	63	8	8	79
	Single Houses/Units	60	8	8	76
	Total*	**123**	**16**	**16**	**154**

Source: Appendix J
* Numbers rounded.

Notwithstanding, existing shortages in General Practitioners and childcare places may be exacerbated by the moderate increase in population associated with the Project. Community organisations and support services are expected to experience a negligible impact as a result of the moderate population increases in the local region (Appendix J).

4.14.3 Potential Cumulative Impacts

Other developments in the Project area have the potential to add additional pressure on community infrastructure and housing, if additional demand for workers and housing were to coincide with the Project demand (which would occur primarily in the first few years of development).

The existing Ulan Coal Mines form part of the existing baseline for the Project. Notwithstanding, the Ulan Coal Mines has a number of consents (Section 1.4) and demand for additional workforce/housing associated with the Ulan Coal Mines has been identified as a potential cumulative issue.

The assessment concluded that if a Ulan Coal Mines related expansion in workforce were to coincide with the Project construction or early operational phase, then cumulative impacts on employment, population and housing could occur, including:

- an increased demand for unemployed and under-employed workers in the local region;
- a larger non-local workforce component would be drawn to the local region and along with associated employment flow-on effects, would lead to population increases; and
- the additional population coming into the local region would increase demand and competition for rental and owner occupied housing (particularly in Mudgee).

4.14.4 Mitigation Measures

As described above, the population effects of the direct and flow-on employment associated with the Project would be moderate. The development of an on-site construction camp would significantly reduce accommodation demand during the six month period of peak employment associated with the construction phase. During the operational phase, direct and flow-on employment in the local region is expected to increase the demand for existing and new housing.

WCPL would consult with the MWRC and other government agencies during the construction and operational phases to manage any community infrastructure issues should they arise. WCPL will continue to consult with the MWRC in relation to a dedication or contribution for the provision, extension or augmentation of public services by the MWRC, having regard to the additional demand on these services that could potentially result from the Project (Section 1.3.5).

WCPL would develop a Mine Closure Plan (MCP) before mine closure. The MCP would be developed in consultation with regulatory agencies and would include consideration of the potential impacts of reductions in employment that would occur at the end of the Project life.

Given the uncertainty of the timing or nature of any cumulative employment, population and housing demand in the local area (Section 4.14.3), WCPL would consult with the MWRC, DIPNR and other mine operators to plan for and manage any cumulative issues, should they arise.

4.15 BENEFIT COST ANALYSIS AND REGIONAL ECONOMIC IMPACT ASSESSMENT

Economic analysis is primarily concerned with weighing up the potential economic costs and benefits of a project to the community (i.e. consideration of economic efficiency) (Appendix I). The primary technique used to evaluate proposals with respect to economic efficiency is a benefit cost analysis. As part of the Economic Assessment presented in Appendix I, a benefit cost analysis was performed for the Project.

Information on the regional economic impact or economic activity generated by development proposals is also of interest to decision-makers. A regional economic impact analysis that considers the likely contribution of the Project to annual direct and indirect output, value-added, income and employment (refer Section 8 for definition of terms) is also presented in Appendix I. The regional impact assessment considers the impact of the Project on the regional economy (former LGAs of Mudgee, Merriwa and Rylstone) and on the State of NSW.

A summary of the assessment within these two frameworks is presented below.

4.15.1 Benefit Cost Analysis

In benefit cost analysis, a resource is anything that is capable of affecting the utility of individuals and the community (through direct use of the resource as well as non-use) and includes man-made as well as natural resources. Benefit cost analysis is essentially concerned with how a change in the allocation of resources affects the net benefits (benefits minus costs) to consumers and producers, referred to as consumers' surplus and producers' surplus, respectively.

Identification and measurement of the changes in consumers' surplus and producers' surplus that may result from a proposal requires an examination of a range of information on physical, ecological, cultural and social impacts. This information is then interpreted in terms of economic efficiency.

As part of a benefit cost analysis it is necessary to identify the incremental costs and benefits of a proposal over time, which in turn requires the identification of the "base case" or "without" Project option. For the purposes of the benefit cost analysis conducted in Appendix I the "without" Project case involves continuation of the existing agricultural use of the Project area (Section 3.1).

The main potential economic benefits and costs of the Project are discussed below.

Economic Costs

Opportunity Cost of Land

There is generally an opportunity cost associated with the use of land for mining or other purposes instead of its next best economic use permissible under existing landuse regulations and limitations. An indication of the opportunity cost of the land can be gained from its current market value, which reflects its potential uses.

Opportunity Cost of Capital

Similar to land, capital equipment has an opportunity cost of using it for mining instead of sale. The correct measure of opportunity cost of capital equipment is its resale value. All mining equipment that would be purchased for the Project is included in the estimate of capital costs.

Capital Cost of Mine and Infrastructure Establishment

This includes capital costs associated with the Project (i.e. open cut mine development, CHPP, internal road systems and construction of rail and train loading infrastructure).

Annual Mine and Processing Operating Costs

The annual operating costs of the Project include on-site operating costs, which contain an allowance for rehabilitation, as well as off-site operating costs such as transportation.

It should be noted that while royalties are a cost to WCPL, they are part of the overall producer surplus benefit of the mining activity that is redistributed by government. Royalties have therefore not been included in the calculation of operating costs.

Economic Benefits

Sale Value of Mine Products

Estimated average annual revenue derived from planned production rates and projected coal prices.

Residual Value at the End of the Evaluation Period

At the end of the Project, capital equipment and land may have some residual value that is of benefit to WCPL. For the purpose of this analysis, capital equipment is assumed to have no residual value.

External Costs and Benefits

Potential external environmental impacts were also identified as part of the analysis. These impacts are only considered economic costs to the extent that they have the potential to affect individual and community wellbeing through direct use or non-use of resources by individuals. Where the potential impacts are mitigated such that community wellbeing is insignificantly affected, no external economic costs arise (Appendix I).

Benefit Cost Analysis

The Project would result in incremental production benefits of approximately $1,454M (Appendix I).

The main decision criterion for assessing the economic desirability of a proposal is usually the Net Present Value (NPV), which is the sum of the discounted benefits less the sum of the discounted costs. A positive NPV indicates that it would be desirable from an economic perspective for society to allocate resources to a project, because the community would obtain net benefits. In this instance, because the potential residual (i.e. post-mitigation) environmental impacts of the proposal have not been valued, the NPV represents a threshold value. The figure of $1,454M therefore represents the opportunity cost to society of not proceeding with the proposal. Interpreted another way, any residual environmental impacts from the proposal, after mitigation by WCPL, would need to be valued at greater than $1,454M to make the proposal questionable from an economic efficiency perspective.

This is equivalent to each household in the regional economy (former LGAs of Mudgee, Merriwa and Rylstone) being willing to pay $154,000 to avoid any of the residual environmental and social impacts of the Project, after mitigation by WCPL (Appendix I). For NSW households the equivalent figure is $575 (Appendix I).

4.15.2 Regional Economic Impact

Regional economic impact assessment is primarily concerned with the effect of an impacting agent on an economy in terms of specific indicators, such as employment, income, gross regional product and gross regional output. The assessment in Appendix I included consideration of the regional economic impacts of the construction and operational phases on both the regional economy (former LGAs of Mudgee, Merriwa and Rylstone) and the State of NSW.

Project Construction Phase

Using input-output analysis, it was estimated that the construction of the Project would contribute the following to the regional economy and NSW economy, respectively:

Regional Economy – Construction Phase

- $40M in annual direct and indirect regional output or business turnover;
- $19M in annual direct and indirect regional value added;
- $11M in annual direct and indirect household income; and
- 270 in direct and indirect employment.

NSW Economy – Construction Phase

- $83M in annual direct and indirect regional output or business turnover;
- $31M in annual direct and indirect regional value added;
- $17M in annual direct and indirect household income; and
- 391 in direct and indirect employment.

The main sectors of the regional economy that would be stimulated by the construction phase of the Project are: the other construction sector; cement manufacturing sector; wholesale and retail trade sectors; road transport sector; and accommodation, cafes and restaurants sector.

Project Operational Phase

Operation of the Project was estimated to have the following impacts on the regional economy and NSW economy, respectively:

Regional Economy – Operational Phase

- $244M in annual direct and indirect regional output or business turnover;
- $158M in annual direct and indirect regional value added;
- $14M in annual household income; and
- 250 in direct and indirect employment.

NSW Economy – Operational Phase

- $359M in annual direct and indirect regional output or business turnover;
- $186M in annual direct and indirect regional value added;
- $25M in annual household income; and
- 507 in direct and indirect employment.

The main sectors impacted by the operation of the Project are likely to be the services to mining sector; agricultural and mining machinery manufacturing sector; electricity supply sector; wholesale and retail trade sectors; rail and road transport sectors; other property services sector; and legal, accounting, marketing and business management services sector.

End of Mine Life

The construction and operation of the Project would stimulate demand in the regional and NSW economies leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the Project would, however, lead to a reduction in economic activity.

The regional economic impetus of the Project may also stimulate a "virtuous cycle" of growth. This theory of regional economic growth suggests that places that are able to attract population migration create increased demands for goods and services and thus more jobs (Appendix I). The socio-economic significance of cessation of the Project would depend on the relative significance of the Project to the regional economy and other regional economic factors at the time. Impacts associated with Project cessation are likely to be greater in a declining economy than in a growing diversified economy.

The magnitude of the regional economic impacts of cessation of the Project would largely depend on whether affected workers and families leave the region. Minimisation of the impacts for the regional economy associated with mine cessation can occur through retention of displaced workers within the region, even if they remain unemployed. This is because continued expenditure by the unemployed who stay in the region would contribute to the final demand. Additional economic activities or developments would also assist in enticing displaced workers to remain in the region.

As described in Section 4.14.4, WCPL would develop a MCP before mine closure in consultation with regulatory agencies and would include consideration of the potential impacts of reductions in employment that would occur at the end of the Project life.

4.16 HAZARD AND RISK

A PHA was conducted to gain an understanding of the potential hazards and risks associated with the Project (Appendix L). As discussed in Section 1.3.5, the PHA is a requirement of SEPP 33 and was conducted in accordance with the general principles of risk evaluation and assessment provided in the DIPNR guidelines for *Multi-Level Risk Assessment* (DUAP, 1999).

4.16.1 Hazard Identification and Risk Assessment

Potentially hazardous materials required for the Project are generally limited to the storage and usage of explosives, diesel, petrol and hydrocarbons. Risks posed by the usage of these materials for the Project would include transport, handling and consumption.

For the purposes of risk identification, the Project was subdivided into a number of operational areas (Appendix L) and potential incidents were identified and divided into generic classes for each operational area including:

- fire;
- explosion;
- leaks/spills;
- theft;
- unplanned movement to off-site;
- excessive vibration; and
- vehicle accident.

The potential risks identified in the PHA related to the following Project elements/activities:

- diesel, explosives, petrol and hydrocarbon use and storage facilities (e.g. fires and leaks/spills);
- general operations, including construction activities (e.g. vehicle accidents, fires and leaks/spills);
- open cut operations (e.g. fires, leaks/spills, explosions and unplanned movement to off-site);
- CHPP (e.g. leaks/spills);
- transport of general or potentially hazardous goods to site, and on-site (e.g. fires, leaks/spills, theft and vehicle accident); and
- rail operations (e.g. leaks/spills).

Following the identification of the potential hazards associated with the Project, a qualitative assessment of risks to the public, property and the environment associated with the development and operation of the Project was undertaken (Appendix L).

The assessment evaluates the risk of the Project impacting on the environment, members of the public and their property. Preventative measures (outlined below) have been proposed, where required, to produce a low level of risk in accordance with the risk acceptance criteria (Appendix L).

4.16.2 Hazard Prevention and Mitigation Measures

A number of hazard preventative and mitigative measures would be described in management plans for the Project, including the following:

- Blast Management Plan;
- Bushfire Management Plan (BMP);
- SWMP; and
- TMP.

These plans are described in Section 5.1.2.

In addition, the following hazard mitigation/ preventative measures would be adopted for the Project:

- **Maintenance** – On-going and timely maintenance of all mobile and fixed plant and equipment in accordance with the recommended maintenance schedule, and consistent with the maintenance schemes required by legislation. Only vehicles permitted to carry dangerous goods would be used for explosives transport.
- **Staff Training** – Operators and drivers would be trained and (where appropriate) appointed for their positions. Only those personnel appointed to undertake skilled and potentially hazardous work would be permitted to do so.
- **Engineering Structures** – Mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, WCPL would obtain the necessary licences and permits for engineering structures.
- **Blast Management** – As reported in Appendix D, site specific management measures would be implemented to reduce the potential for off-site impacts of blast vibration and overpressure. Management measures in relation to flyrock impacts are described in Section 4.5.6.
- **Contractor Management** – All contractors employed by WCPL would be required to operate in accordance with the relevant Australian Standards, NSW legislation and WCPL contractor management plans.
- **Water Management** – As discussed in Section 2.9, water management structures would be constructed to separate runoff from undisturbed areas and disturbed areas. The collection drain and sediment dam system would be designed and constructed with capacity to contain potential spills or fire suppression water runoff within operational areas.
- **Coal Stockpile Management** – Coal stockpiles would be managed to reduce the potential for spontaneous combustion.
- **CHPP Management** – CHPP management procedures would be developed to reduce the potential for spillages of contaminated water.
- **Emergency Response** – Emergency response procedures manuals and systems would be developed.
- **Storage Facilities** – Storage and usage procedures for potentially hazardous materials (i.e. fuels and lubricants) would be developed.