MOOLARBEN COAL PROJECT

Stage 2

SECTION 5

Impact Assessment

SECTION 5 – IMPACT ASSESSMENT

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5. IMPACT ASSESSMENT

The construction and operation of Stage 2 and its integration with Stage 1 has the potential to cause environmental and social impacts. The DGRs require those issues identified as being key issues with potential to cause impact to be assessed in detail. This section presents an assessment of the key issues and a description of the measures that MCM will implement to avoid, mitigate or manage the potential and predicted impacts of the proposed development (being the Stage 2 project, the modification of Stage 1, and their interactions). The monitoring of impacts, proposed contingencies and the rehabilitation of the site are also described and discussed.

As described in Section 1, the Major Project Application (MP 08_0135) and accompanying PEA for Stage 2 (lodged with the DoP on 14 July 2008) considered the need to modify the Stage 1 Project Approval to enable the efficient integration of Stage 2 with Stage 1. Hence, the description of the project provided in these documents included the combined description of Stage 2 with those aspects of Stage 1 requiring modification. This combined project description formed the basis on which the DGRs for Stage 2 (see Appendix 1B) were issued. The DGRs for Stage 2 identified subsidence, soil and water, biodiversity, heritage, noise and blasting, air quality, greenhouse gas, transport, waste, hazards, visual, rehabilitation, and social and economic issues as key issues requiring detailed environmental assessment. These issues have been studied in detail by specialist technical consultants (see Table 1.7 in Section 1), and the combined project description was used to define the scope of these specialist studies. That is, the specialist technical studies included in Appendices 3 to 17 (see Volumes 1, 3, 4, 5 and 6) have considered the impacts of Stage 2, the modification of Stage 1 and, where relevant, the cumulative impact of Stage 2 integrated with Stage 1. This section of the EA is based on these specialist technical studies.

On 2 February 2009, MCM submitted a separate application for the modification of the Stage 1 Project Approval (05_0177 MOD 3) for those elements of Stage 1 that the original Stage 2 Major Project Application (MP 08_0135) was seeking to modify. This separate application was made to enable the envisaged interactions between Stage 2 and Stage 1 to become legally effective. This was necessary, as the Stage 2 Major Project Application did not provide the legal mechanism by which the Stage 1 Project Approval could be modified. This application for the modification of the Stage 1 Project Approval (05_0177 MOD 3) only refined the description of those elements of Stage 1 that the Stage 2 Major Project Application was seeking to modify, and did not include any further modifications to those already contemplated in the Stage 2 Major Project Application. The DGRs in respect of 05_0177 MOD 3 were issued on 18 February 2009 (see Appendix 1C) and reiterated key issues for environmental assessment that the DGRs for Stage 2 had already identified. That is, air quality, noise, soil and water, waste, rehabilitation, and social and economic issues. As these issues were already identified in the Stage 2 DGRs, the specialist studies carried out for Stage 2 also include consideration of the issues reiterated in the DGRs for 05_0177 MOD 3. The impact of both Stage 2 and the modification of Stage 1 are addressed in this section of the EA.

The order in which the issues are addressed in this section is generally indicative of the potential risk the development poses to the environment and surrounding community with respect to each issue, typically considered without appropriate control measures being in place. The presented ordering of issues also reflects a generally ascribed level of importance, although the ordering of issues is not strictly hierarchical but rather an approximate grouping of more important issues first and less important issues second. The ascribed importance of issues is based on the outcomes of the preliminary risk assessment (see Section 1.11), consultation with various stakeholders and the DGRs for Stage 2 and the modification of Stage 1. The issues assessed and the order in which they are considered are as follows:

5.1 Air Quality

5.2 Greenhouse Gas

5.3 Noise and Blasting

5.4 Groundwater

5.5 Surface Water

5.6 Water Demand and Supply

5.7 Ecology

5.8 Subsidence

5.9 Aboriginal Heritage

5.10 Non-Aboriginal Heritage

5.11 Soils

5.12 Transport

5.13 Visual Amenity and Landscape

5.14 Social and Economic

5.15 Hazards and Risks

5.16 Waste

5.17 Land Use

5.18 Rehabilitation

5.19 Mine Closure

The assessment of each issue and accompanying proposed impact control measures are drawn from the detailed technical reports authored by the specialist technical consultants included as appendices, and from professional experience. The assessment of issues concludes with a description of the rehabilitation measures that will be applied to work toward satisfactory mine closure.

5.1 Air Quality

5.1.1 Objectives

The objective of the air quality impact assessment is to determine whether changes to air quality from Stage 1 and Stage 2 will impact sensitive receivers. Project-specific and cumulative impacts (including neighbouring Ulan and Wilpinjong coal mines) were assessed with a focus on dust emissions. Management measures to prevent odour emission from spontaneous combustion of coal were also examined.

5.1.2 Assessment Method

Holmes Air Sciences undertook an air quality impact assessment for the Stage 2 project (**Appendix 3A** in Volume 1).

Since Stages 1 and 2 will operate concurrently, the assessment considers the MCP as a single integrated mining operation. That is, the impact of dust-generating activities from both Stages 1 and 2 are assessed together.

The air quality assessment is based on dispersion model simulations of dust emissions using a modified version of the US Environmental Protection Agency ISC computer model. The modification improves the model's ability to predict short-term (24-hour) average particulate concentrations. The modified model has been used to predict dust impacts at other NSW coal mines, and is accepted by the DECC and DoP as being a suitable model for predicting off-site dust impacts.

Total dust emissions were determined by considering the types of dust generating activities and processes taking place at the site, and then applying accepted emission factors. For the MCP, this included consideration of a range of activities (overburden stripping, overburden placement, blasting, excavating of coal, truck loading, hauling, tipping of coal into receiving hoppers, stockpiling, handling, processing and train loading); equipment (dozers, graders, excavators and trucks); site features (stockpiles, overburden dumps, open cut mines and other exposed areas); length of unsealed roads (e.g., haul roads); operating hours; prevailing weather conditions; and the application of dust control measures. The total generated dust load for representative mining scenarios was modelled to predict off-site air quality impacts under time-varying meteorological conditions.

Initially, air quality modelling assumed that standard dust suppression measures typical of those undertaken at other coal mines in NSW (e.g., road watering, sprays on stockpiles and revegetation of bare ground and disturbed areas) are employed. It is generally accepted that these control measures achieve a 50% reduction in estimated dust emissions from the activities on which they are applied. Under this scenario, air quality criteria were predicted to be exceeded at a number of non mine-owned residences. To avoid these predicted exceedences, particularly at residences that do not have Stage 1 acquisition rights, MCM will further control dust emissions by the application of chemical dust suppressants during Stage 1 and Stage 2. The final air quality modelling was undertaken based on the use of chemical dust suppressants on trafficked areas. It was assumed there will be an 85% reduction in estimated dust emissions on trafficked areas. This assessment is presented in Appendix 3A in Volume 1.

Air quality modelling was undertaken based on the indicative mine schedule presented in Figure 4.4 in Section 4. The impact of total MCP (project-specific) and cumulative dust emissions for mining Years 2, 7, 12, 16, 19 and 24 were assessed. These are considered representative years when dust-generating activities will be at their greatest.

The following air quality concentrations were modelled for each scenario:

- Annual average sub-10 micrometer (μm) particulate matter (PM_{10}) concentrations.
- Average maximum 24-hour PM_{10} concentrations.
- Annual average total suspended particulate (TSP) matter concentrations.
- Annual average dust deposition (insoluble solids) rates.

The assessment follows the DECC's Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC, 2005).

5.1.3 Air Quality Criteria

A summary of applicable NSW air quality criteria is provided in **Table 5.1.1**. These are statutory standards and are applied to protect the community from the potential health, amenity and nuisance effects of dust emissions.

Table 5.1.1 NSW air quality standards for particulate matter concentrations and dust fallout

Pollutant	Maximum Concentration	Averaging Period
Particulate matter <10 μm (PM_{10})	50 μg/m^3	24-hour
	30 μg/m^3	Annual
Total suspended particulate matter (TSP)	90 μg/m^3	Annual
Deposited dust (DD)	2 g/m^2/month (maximum allowed increase)	Annual
	4 g/m^2/month (maximum total level)	

The NSW Government recognises that there are inherent difficulties in eliminating short-term (24-hour) dust impacts. Over such short time periods, it is often difficult to determine the exact source of dust emissions, particularly in areas where multiple independent mines are operating and where other dust and particulate generating activities may also be occurring (such as agricultural activities and bushfires). The NSW Government has developed approaches to regulating the short-term (24-hour) dust impacts from mines to address this issue. There is an allowance for a mine to exceed the 24-hour PM_{10} criterion of 50 μg/m^3 on up to five occasions per year (1.4% of the time), with an added allowance of permitting the 24-hour PM_{10} concentration to exceed 150 μg/m^3 on up to 3.7 occasions a year (1% of the time) (**Table 5.1.2**). However, where these short-term criteria are exceeded, the mine is required to purchase any impacted properties if requested by the land owner (see Section 5.1.7). The annual TSP and annual PM_{10} criteria form the equivalent long-term land acquisition criteria (see Table 5.1.1).

Table 5.1.2 Short-term land acquisition criteria for particulate matter

Pollutant	Averaging Period	Criteria	Percentile[1]	Basis
Particulate matter <10 μm (PM_{10})	24-hour	150 μg/m^3	99[2]	Total[3]
Particulate matter <10 μm (PM_{10})	24-hour	50 μg/m^3	98.6[2]	Increment[4]

[1] Based on the number of block 24-hour averages in an annual period.

[2] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed by the Director-General in consultation with the DECC.

[3] Background PM_{10} concentrations due to all other sources plus the incremental increase in PM_{10} concentrations due to the mine alone.

[4] Incremental increase in PM_{10} concentrations due to the mine alone.

5.1.4 Existing Environment

5.1.4.1 Meteorology

Climate and meteorology are described in Appendix 3A in Volume 1 and are summarised below.

There are two Stage 1 meteorological stations (see **Plan 16** in Volume 2):

- WS1 in Ulan Village (established in July 2005).
- WS2 at Property 36 on Moolarben Road (established in December 2004).

Each station measures and records wind speed and direction, temperature at 2 and 10 m above the ground, atmospheric pressure and inversions, sigma theta, rainfall, and total solar radiation 10 m above the ground.

During spring, summer and autumn, the average maximum temperatures range from the high twenties to the low thirties, with temperatures during summer reaching more than 38°C. Conditions during late autumn, winter and early spring are milder, and average winter maximum temperatures are approximately 10°C cooler than summer temperatures. Overnight temperatures occasionally drop below freezing point. Frosts may occur from mid-April through to September and as late as mid-November. For the Ulan area, the average frequency of frosts is about 45 days per annum.

The average relative humidity varies throughout the year. Winter months are typically about 20% more humid than summer months, most likely due to hot dry winds during summer. During the daytime, humidity varies significantly between 60% and 80% in the mornings and between 40% and 60% in the afternoons for winter and summer, respectively.

The predominant winds are from the northeast and east on an annual basis. During summer, autumn and spring the predominant winds are from the east to northeast, while during winter the predominant winds are from the southwest. It is calm (winds are less than 0.5 m/s) approximately 9 to 15% of the year.

Rainfall and evaporation are described in Section 5.5.3.

5.1.4.2 Air Quality

The background air quality of the area surrounding the MCP comprises dust and particulate matter derived from a range of sources. This includes existing mining operations (Ulan and Wilpinjong coal mines), agricultural activities (e.g., ploughing, vehicles travelling on dirt roads and fires) and natural sources (e.g. wind erosion from bare soil, bushfires and dust storms).

Since January 2005, MCM has collected dust deposition data at eight locations around the MCP (see Plan 16 in Volume 2). For the past four years, the annual total dust levels (see **Table 5.1.3** and Appendix 3A) were well below the DECC deposited dust amenity criteria of 4 g/m^2/month.

Since October 2005, MCM has also monitored background PM_{10} concentrations in the vicinity of the Ulan village (see Plan 16 in Volume 2). Monitoring results indicate that the annual average background particulate concentration over the last three years is 16.8 $\mu g/m^3$, with a maximum 24-hour concentration of 44.5 $\mu g/m^3$ (recorded in February 2008). At no time over this monitoring period were the DECC PM_{10} concentration (24-hour or annual) criteria exceeded.

Table 5.1.3 Annual background dust deposition levels

Year	Annual Background Dust Deposition Levels (g/m^2/month)							
	Background Dust Deposition Gauge							
	D1	D2	D3	D4	D5	D6	D7	D8
2005	1.3	3.1	2.2	2.1	1.5	1.0	1.6	1.1
2006	0.9	1.0	1.9	1.1	1.3	0.8	1.3	0.9
2007	1.1	1.9	2.1	1.7	1.6	1.0	1.3	1.5
2008 up to June	0.8	-	-	2.0	1.7	0.9	1.7	1.0

Source: Holmes Air Sciences, Appendix 3A in Volume 1.

5.1.5 Issues

The following issues were addressed as part of the air quality assessment:

- Short term and long term impacts of dust emissions on sensitive receivers.
- Spontaneous combustion of coal.

5.1.6 Impact Assessment

5.1.6.1 Predicted Dust Impacts

The predicted annual average cumulative PM_{10} concentrations in Years 2, 7, 12, 16, 19 and 24, based on the use of chemical dust suppressants on trafficked areas are shown in contour form in **Plans 17, 18, 19, 20, 21** and **22** in Volume 2. Predicted exceedences of dust criteria at privately-owned residences for each modelled year are summarised in **Table 5.1.4**. Tables showing predicted dust levels at all premises, including those owned by MCM, Ulan and Wilpinjong coal mines are presented in Appendix 3A in Volume 1.

Dust criteria are predicted to be exceeded at five privately-owned residences: Property 5, Property 25, Property 29A, Property 29B and Property 29. These properties are located between 100 and 3,000 m from the Stage 2 Project Area (see Plans 17 to 22 in Volume 2) and between 100 and 1500 m of the Stage 1 Project Area. Dust (and/or noise) criteria were predicted to be exceeded at each of these premises in Stage 1 and as a result these land owners all have acquisition rights under the Stage 1 Project Approval.

Table 5.1.4 Predicted air quality impacts at non-mine-owned premises

Property ID	Project-Specific				Cumulative			
	PM10 (µg/m3)		TSP (µg/m3)	Dust Deposition (g/m2/mth)	PM10 (µg/m3)		TSP (µg/m3)	Dust Deposition (g/m2/mth)
	24-hr	Annual	Annual	Annual	24-hr	Annual	Annual	Annual
	50	30	90	2	150	30	90	4
Year 2								
25# (Ulan–Mudgee Road)	**60**	7	13	0.7	NA	23	55	2.3
Year 7								
5# (Lagoons Road)	**66**	14	28	1.5	NA	**30**	69	3.1
Year 12								
5# (Lagoons Road)	**98**	13	23	1.2	NA	28	64	3.2
29A# (Moolarben Road)	**80**	6	13	0.9	NA	20	53	2.5
29B# (Moolarben Road)	**398**	29	69	**4.7**	NA	**43**	**108**	**6.3**
Year 16								
5# (Lagoons Road)	**62**	6	9	0.4	NA	23	53	2.1
29A# (Moolarben Road)	**269**	19	45	**3.2**	NA	**35**	88	**4.9**
29B# (Moolarben Road)	**993**	**78**	**187**	**11.9**	NA	**93**	**228**	**13.5**
29# (Moolarben Road)	**79**	7	14	0.9	NA	21	54	2.5
Year 19								
29A# (Moolarben Road)†	**57**	5	9	0.7	NA	21	52	2.4
29B# (Moolarben Road)†	**164**	13	30	2.0	NA	28	71	3.6
Year 24								
None	-	-	-	-	NA	-**	-**	-**

Private residences that have acquisition rights under the Stage 1 Project Approval.

Predicted exceedences in **bold**.

** There is no information available regarding other dust-generating activities in the area for Year 24 as operations at Ulan and Wilpinjong mines are not approved for this period. Therefore, cumulative predictions were not included.

† Property 29A and Property 29B are located within the footprint of OC3 and are likely to be removed by Year 19.

Dust criteria will not be exceeded at other non mine-owned premises, including the Ulan Public School. It is predicted that the operation of Stage 1 and Stage 2 using site-specific dust control measures (see Section 5.1.7) will not result in dust criteria being exceeded at any premises that was not predicted to be impacted by Stage 1 alone.

A number of mine-owned properties are predicted to experience dust impacts above DECC air quality criteria (Appendix 3A of Volume 1). Written information will be provided to occupants of these properties to ensure that they understand that it is not a requirement for MCM to meet the DECC air quality criteria at these properties.

The NSW Department of Health has published a fact sheet titled 'Mine Dust and You' (Department of Health, 2007). Moolarben Coal Mines in conjunction with the NSW Department of Health has also produced a dust fact sheet, which it has made available to the local community. This dust information sheet will be provided to tenants in mine-owned residences. A copy of this fact sheet is included as Appendix 2B and is also available for download from MCM's website (www.moolarbencoal.com.au/documents).

5.1.7 Environmental Management

Dust mitigation and management will be undertaken according to the following hierarchy:

1. Implement standard industry dust control measures and site-specific control measures, including the use of chemical dust suppressants on trafficked areas (as modelled for this assessment).
2. Implement short-term changes in site operations to reduce dust emissions based on real-time monitoring and reporting of meteorological conditions and dust parameters.
3. Review monitoring data to determine effectiveness of dust control measures. If short-term dust criteria are exceeded or long term dust criteria are predicted to be exceeded, change ongoing dust control measures or implement new measures to further reduce dust emissions.
4. Inform all residents potentially affected by fine particulates of the health implications.
5. Acquire properties that experience dust levels in excess of criteria following implementation of dust control measures, where this impact is shown to be the result of the mine.

5.1.7.1 Standard Industry and Site-specific Dust Control Measures

Long-term off-site dust impacts will be controlled through the application of operational procedures and routine environmental management practices that are standard practice at NSW coal mines. These measures include:

- The Stage 2 access road from Ulan-Wollar Road to the Stage 2 office and work shop will be sealed.
- All non-sealed roads and trafficked areas will be watered.
- All haul roads will have edges clearly defined with marker posts or equivalent to control their locations, especially when crossing large overburden emplacement areas.
- Obsolete roads and unused vehicle tracks will be ripped and revegetated.
- Long-term topsoil stockpiles will be revegetated, unless required within six months of stockpiling.
- Drill rigs will be equipped with dust extraction cyclones or water injection systems, and use of dust aprons will be mandatory.
- Water injection or dust-suppression sprays will be used when high levels of dust are being generated.
- All blasts will be stemmed appropriately.

- Blasting will be undertaken under favourable meteorological conditions, where practicable.

These control measures are assumed to achieve a 50% reduction in dust emissions (see Appendix 3A in Volume 1).

A series of site-specific dust control measures will be implemented to further reduce dust emissions.

While increasing the rate at which water is applied to dust prone areas provides better dust control, this increases water use. This additional water may not be available to the MCP in all years of its operation (see Section 5.6). Further, MCM has been advised by Holmes Air Sciences that increased water application is likely to only achieve a maximum of 75% reduction in dust emissions.

Chemical dust suppressants will be applied to trafficked areas to achieve better dust control than water alone. Application of chemical dust suppressants can result in an 85% reduction in dust emissions and will reduce dust impacts on off-site receivers. Chemical dust suppressants are used by several coal mines in NSW to control dust emissions. Several types of chemical dust suppressants are commercially available, including:

- Electrolytes, including reducing agents that bond chemically.
- Polyelectrolytes that hold dust particles together electrostatically.
- Surfactants (wetting agents).
- Polymeric films that form a surface crust.

The selected chemical dust suppressant will be customised for the site to optimise effectiveness, longevity, water savings and cost.

MCM will also investigate where the standard dust controls can be improved, including:

- Construction of haul roads from low-silt-content materials.
- Automatic water sprays on stockpiles, triggered by meteorological conditions, where practicable.
- Additional screens and sprays on infrastructure and material handling equipment.

5.1.7.2 Real-Time Monitoring and Short-term Changes in Site Operations

The air quality monitoring program for Stage 1 focuses on monitoring of dust and PM_{10} levels to the west and southwest of the Stage 1 Project Area. Dust emissions from the Stage 2 Project Area will pass over the Stage 1 Project Area before reaching non-mine-owned premises. Therefore, the Stage 1 air quality monitoring program will measure any off-site dust impacts from Stage 2.

The Stage 1 air quality monitoring program, as specified in Environment Protection Licence (EPL) 12932, is summarised in **Table 5.1.5**. Monitoring locations include WS1 in Ulan Village and WS2 at Property 36 on Moolarben Road, as shown in Plan 16 in Volume 2.

Table 5.1.5 Stage 1 air quality monitoring program

EPA Identification (EPL 12932)	Location	Units	Frequency
Dust Deposition			
6	Property No. 52	g/m^2/month	Monthly
7	Property No. 16	g/m^2/month	Monthly
8	Property No. 2	g/m^2/month	Monthly
9	Spring Street, Ulan Village	g/m^2/month	Monthly
10	Property No. 46	g/m^2/month	Monthly
11	Property No. 31	g/m^2/month	Monthly
12	Property No. 36	g/m^2/month	Monthly
13	Property No. 29A	g/m^2/month	Monthly
14	Property No. 37	g/m^2/month	Monthly
PM_{10}			
15 (TEOM 2)	Property No. 16	$\mu g/m^3$	Continuous
17 (TEOM 1)	Ulan Public School	$\mu g/m^3$	Continuous
PM_{10} (High Volume Air Sampler)			
17	Spring Street, Ulan Village	$\mu g/m^3$	Every 6 days

Stage 1 monitoring will be used to monitor the combined impacts of Stage 1 and Stage 2, as well as the cumulative impacts from other contributors to dust in the area.

A third mobile real-time PM_{10} monitor (i.e., in addition to the real-time monitors that are part of the Stage 1 monitoring program) will be used to determine dust levels as part of managing dust emissions on site, particularly during unfavourable weather conditions. One indicative location for the real-time PM_{10} monitor is marked as TEOM 3 in Plan 16 in Volume 2. The mobile monitor will also be used to monitor PM_{10} concentrations at a range of other sites including the Winchester Crescent and Ridge Road rural residential area southwest of the project area.

The real-time PM_{10} monitor, TEOM 2, is located on Property 16, which was privately owned at the time of the preparation of the 2006 Stage 1 EA. This property is now owned by MCM. The Stage 1 monitoring program (and EPL 12932) will be modified to locate this real-time PM_{10} monitor to another site more applicable to monitoring the dust impacts of the MCP on non-mine-owned properties.

A series of real-time PM_{10} concentration trigger levels will be developed as part of the Air Quality Monitoring Program to allow management actions to be taken to avoid exceedence of 24-hour PM_{10} criterion at privately-owned residences as outlined in **Table 5.1.6**.

The real-time dust monitors will provide computer and mobile phone text message alerts to the environmental and operational managers when trigger levels are reached at a real-time PM_{10} monitor. Management actions in response to these alerts are outlined in Table 5.1.6.

Table 5.1.6 Real-time air quality control response measures

Trigger Level	Management/Control Actions
Trigger level 1	Review weather data and trends. Review weather predictions. Review current dust generating activities. Review current dust controls. Ensure standard mitigation measures are in place. Monitor changes in PM_{10}.
Trigger level 2	Operational changes: e.g., restricting overburden dumping to areas protected from the wind on the lee side of overburden emplacements.
Trigger level 3	Reschedule dust generating activities.

Real-time trigger levels and subsequent management measures will be continuously reviewed and improved. This will be based on increasing understanding of local weather patterns, overburden composition, impact of rainfall on dust emissions, etc.

5.1.7.3 Long-term Monitoring and Continuous Improvement

Air quality and meteorology monitoring data will be reviewed monthly, quarterly and annually to determine whether dust criteria are achieved and assess the effectiveness of dust control measures. Dust control measures will be continually improved based on monitoring results. If, after the implementation of dust control measures, air quality criteria are exceeded, further measures will be adopted, which may include:

- Changing the mining schedule.
- Reducing production levels.
- Acquiring properties at the request of the land owner.

5.1.7.4 Property Acquisition

A privately-owned property shown to be impacted by dust from the MCP will be acquired by MCM when the annual PM_{10} concentration or the annual TSP dust criteria in Table 5.1.1 are exceeded or the short-term criteria in Table 5.1.2 are exceeded at the residence and a written request from the land owner for acquisition is received by MCM.

5.1.8 Spontaneous Combustion

Coal reacts with atmospheric oxygen even at ambient temperatures. This reaction produces heat (that is, it is an exothermic reaction). If heat generated from this reaction is allowed to accumulate, the temperature within the coal increases, increasing the reaction rate. This leads to an exponential increase in the temperature until the ignition temperature of coal is reached and the coal starts to burn. This process is known as spontaneous combustion.

Spontaneous combustion can occur when coal is still in the ground or after it has been extracted, either in stockpiles or in reject materials. Spontaneous combustion of in situ coal results in hazardous conditions for mining due to the production of noxious gases, odour and, in extreme cases, fire.

The coal from the Ulan Seam is susceptible to spontaneous combustion. A spontaneous combustion management plan (SCMP), will be prepared and implemented with the aim of minimising the risk of spontaneous combustion. The SCMP will apply to both underground and surface operations and will include the following control measures:

- An adequate number of intake and return main development roads will be provided to minimise ventilation pressures in the underground workings.
- No loose coal will be stored underground.
- Coal fracturing will be minimised to avoid leakage paths and heating sites.
- Goafs of worked-out longwall panels will be unventilated and when the individual panels are completed the walls will be sealed off and the pressure around the seals equalised.
- Longwall panels will initially be developed in discrete blocks that will allow monitoring by atmosphere analysis.
- Coal will not be left in stockpiles for periods longer than two weeks.
- Corrective actions will be implemented should spontaneous combustion occur.

Effective control of the spontaneous combustion hazard will ensure that release of odours from heated coal or from burning coal will not be emitted at levels that will impact air quality.

5.2 Greenhouse Gas

5.2.1 Objectives

The objectives of the greenhouse gas assessment are to determine the greenhouse gas emissions from Stage 2 and the MCP more generally, and to compare these to state, national and international emissions.

5.2.2 Assessment Method

Holmes Air Sciences undertook an assessment of the direct and indirect greenhouse gas emissions that will result from the MCP. The assessment considers the outcomes of the greenhouse gas assessment for Stage 1, and by comparing these to total MCP emissions the contribution from Stage 2 has been derived. The greenhouse gas assessment report is included as **Appendix 3B** in Volume 1.

The greenhouse gas emissions for the MCP have been estimated using the approach published by the Department of Climate Change (DCC) (Commonwealth) in its National Greenhouse Accounts (NGA) Factors publication, referred to as the DCC Workbook (DCC, 2008a).

The DCC Workbook defines three scopes of greenhouse gas emission:

- Scope 1 – direct emissions from sources within the boundary of an organisation such as fuel combustion and manufacturing processes.
- Scope 2 – indirect emissions from the consumption of purchased electricity produced by another organisation. Scope 2 emissions result from the combustion of fuel to generate the electricity, and do not include emissions associated with the production of fuel.
- Scope 3 – all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation.

Scopes 1 and 2 are carefully defined to ensure that two or more organisations do not report the same emissions in the same scope.

The DCC Workbook also includes emission factors for estimating carbon dioxide-equivalent (CO_2-e) emissions from the burning of diesel fuels and from fugitive sources associated with coal mining (Scope 1), uses of electricity (Scope 2), and transport and burning of coal (Scope 3).

The relevant emission factors are:

- 2.9 kg CO_2-e /litre for diesel usage – based on full fuel cycle analysis – made up of 2.7 kg CO_2-e for Scope 1 emissions and 0.2 kg CO_2-e for Scope 3 emissions.
- 1.068 kg CO_2-e /kWh of electrical energy used in NSW (estimated factor for NSW in 2007) – made up of 0.89 kg CO_2-e for Scope 2 emissions and 0.17 kg CO_2-e for Scope 3 emissions. Black coal in NSW has an energy content of 22.5 GJ/t and results in 89.3 kg CO_2-e/GJ when burnt.
- 45.5 kg CO_2-e/t of ROM coal for open cut mines and 8.4 kg CO_2-e/t of ROM coal from 'less gassy' underground mines in NSW, to account for CH_4 and CO_2 liberated as fugitive emissions.

It is assumed that all product coal is transported by rail to the Port of Newcastle, a distance of 274 km (one way), and that 83% of ROM coal yields 100% of product coal. An average value for rail transport of 12.3 CO_2-e g/net tonne-km has been used (QR Network Access, 2002).

Site-specific data based on testing of coal drill core samples from the Stage 1 UG4 mine indicate emissions for the Ulan Seam of 0.23 kg CO_2-e /t (on raw coal basis). This is substantially less than the default figures of 45.5 kg CO_2-e/t of ROM coal for open cut mines and 8.4 kg CO_2-e/t of ROM coal for underground mines, suggested in the DCC Workbook.

The low site-based fugitive emission value is consistent with measurements made at the Wilpinjong coal mine. It is assumed that the low depth at which the coal is buried has allowed the greenhouses gases to be lost over geological time. The value of 0.23 kg CO_2-e /t for the Ulan Seam has been used to calculate Scope 1 fugitive emissions for the MCP.

The resultant total Stage 2 greenhouse gas emissions have been compared to NSW, Australian and global cumulative emissions.

5.2.3 Issues

The following issues are addressed as a part of the greenhouse gas assessment:

- Total Scope 1, 2 and 3 emissions.
- Impact on global warming and climate change.

5.2.4 Impact Assessment

Coal mining and the subsequent burning of coal for electrical energy produces greenhouse gases. Greenhouse gases contribute to the greenhouse effect and thus global warming. However, the effects of global warming and associated climate change are the cumulative effect of many sources worldwide.

The current global demand for energy supply provides market pressure for coal resources. The 2008 Inquiry into Electricity Supply in NSW (the Owen Inquiry) (Owen, 2008) noted the need for coal-fired power to meet NSW base-load energy requirements beyond 2013. New coal mines are needed in Australia to meet domestic and international energy needs for at least the medium term (i.e., upcoming decades). If Stage 2 of the MCP is not permitted, there will be no consequential reduction of international coal demand, burning of coal, or greenhouse gas emissions. If coal demand is not met through the MCP, coal will continue to be extracted elsewhere, including at existing Australian mines. For this reason, it is problematic to attempt to address climate change on a mine-by-mine, or project-by-project basis.

5.2.4.1 Estimated MCP Emissions

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UN, 1998) nominates gases that contribute to enhancing the greenhouse effect. The most significant of these gases for the MCP are carbon dioxide (CO_2) and nitrous oxide (N_2O), which will be liberated when fuels are burnt in diesel-powered equipment and in the generation of electrical energy used by the project. The MCP will also give rise to emissions of methane (CH_4) and CO_2 released as fugitive emissions as the coal is mined. A summary of estimated total and annual average Scope 1, 2 and 3 emissions for the MCP (combined Stage 1 and Stage 2) is provided in **Table 5.2.1**.

Table 5.2.1 Total MCP greenhouse gas emissions (Scopes 1, 2 and 3)

	Scope 1 (Mt)	Scope 2 (Mt)	Total of Scopes 1 and 2 (Mt)	Scope 3 (Mt)	Total (Mt)
Total	3.285	3.014	6.299	703.738	710.037
Annual average	0.137	0.126	0.262	29.322	29.585

Source: Holmes Air Sciences (2008).

5.2.4.2 Scope 1 and 2 Emissions

On average, the annual Scope 1 and 2 emissions for the MCP will be 0.262 Mt of CO_2-e/year.

According to the National Greenhouse Gas Inventory 2006 (DCC, 2008b), under the accounting provisions applying to Australia's 108% Kyoto emissions target, in 2006 Australia's net greenhouse gas emissions totalled 576.0 Mt of CO_2-e across all sectors. Based on this baseline total, the estimated Scope 1 and 2 emissions for the MCP will cause an increase in national emissions of 0.045%.

Based on the national inventory, NSW accounts for 28% (or 160 Mt of CO_2-e) of total national emissions across all sectors. The MCP will cause an increase in NSW emissions of 0.16%.

Based on International Energy Agency and Inter-Governmental Panel on Climate Change estimates, in 2006 Australia's share of world emissions was around 1.5%. On this basis, it is estimated that MCP Scope 1 and 2 emissions will cause an increase in global emissions of 0.00067%. On a global scale this is negligible.

5.2.4.3 Scope 3 Emissions

Scope 3 emissions have been calculated for the MCP to address the judgement of her Honour Pain J in the matter of Gray v The Minister for Planning.

The emissions from burning coal are much larger than those associated with the mining of coal, comprising 99% of estimated emissions. Scope 3 emissions from the MCP are estimated at 29.322 Mt of CO_2-e/year, which includes emissions from the transport of the coal to the Port of Newcastle and emissions from the end users.

The adopted convention is that Scope 3 emissions are attributed to the user of the coal not the producer, in order to avoid double counting of the emissions for the MCP. The reporting of Scope 3 emissions (from export coal) is not included in the NSW or the Australian inventories, as these emissions will be accounted for in the inventory for the country in which the end user is located.

5.2.4.4 Total Emissions from Stage 2 and the MCP

The average annual greenhouse gas emissions for the MCP from Scope 1, 2 and 3 emissions are estimated to be 29.585 Mt of CO_2-e (see Table 5.2.1). The average annual greenhouse gas emissions for Stage 1 from Scope 1, 2 and 3 emissions (from the production of 10 Mtpa of product coals) was estimated to be 24.938 Mt of CO_2-e (Holmes Air Sciences, 2006). Therefore on average Stage 2 will result in an additional 4.647 Mt of CO_2-e/year.

Based on estimated global emissions for the 1990s as provided in the IPCC Climate Change 2001 report (IPCC, 2001), doubling of the CO_2-e concentration in the atmosphere would lead to an estimated 2.5°C increase in global average temperature, and the current global CO_2 load is 2,750 Gt. The annual emissions from mining and burning coal from the MCP are estimated to be less than 0.1% of global CO_2-e annual emissions.

Holmes Air Sciences has estimated the annual contribution of greenhouse gas emissions from the MCP to global warming and to human induced climate change. Based on total Scope 1, 2 and 3 emissions (mining, transporting and burning the coal) it is estimated the MCP will potentially lead to an increase in global temperature of 0.000027°C [(29.6 x 106/2,750 x 109) x 2.5°C]. Considering only the contributions from Scope 1 and 2, the MCP will potentially lead to an increase of 0.000000238°C [262 x 103 /2,750 x 109 x 2.5°C]. Both of these calculations assume that all the CO_2 liberated in a year stays in the atmosphere and that temperature increases associated with the enhanced greenhouse effect are linear. Based on these estimates, it is predicted that the additional contribution of greenhouse gas emissions from Stage 2 will be negligible.

5.2.5 Environmental Management

Energy consumption is a significant cost in mining operations and the incorporation of energy efficiency in design can have significant cost benefits. The MCP has been designed to achieve minimum fuel consumption compatible with efficient operation of the mine and efficient use of capital.

An Energy Savings Action Plan (ESAP) has been developed for Stage 1 and this will be updated where necessary and applied to Stage 2.

The following general actions will be undertaken to minimise energy consumption and minimise net greenhouse emissions during the construction and operation of the MCP:

- Regular maintenance of plant and equipment.
- Promotion of car pooling among mine employees.
- Monitoring of haul truck payloads to ensure maximum efficiency of haulage is consistently achieved.
- Training of mine employees on the importance of energy efficiency and the efficient use of energy-intensive equipment.
- Monitoring and accounting of fuel use.
- Use of energy-efficient equipment and the efficient use of equipment, such as ensuring pumps are sized correctly for the required throughput.
- Use of high-efficiency lights with photo-sensors and timers.
- Revegetation of cleared and disturbed areas on MCM owned land.

The potential for additional greenhouse gas emission reductions at the MCP will be investigated, including the potential for:

- Use of hybrid diesel/liquid natural gas (LNG) engines for mining fleet.
- Use of biodiesel blends as an alternate fuel.
- Increasing efficiencies of specified electrical transformers.

- Installation of heat pump hot water systems instead of standard electric hot water systems.
- Installation of heat pump air conditioning systems boosted by gas heaters instead of standard electric heaters with timers or other control systems.
- Use of LED lighting.

Felix, MCM's parent company, has entered into agreement with the Australian Greenhouse Office under the Greenhouse Challenge Plus Program Framework. Under this program, Felix has made commitments to put in place appropriate, practical and cost-effective actions to reduce its greenhouse gas emissions and to encourage its staff and other external stakeholders to implement similar measures.

Felix is also contributing to the Coal 21 Fund, which is a recently formed voluntary fund established by the coal industry to invest in various low-carbon-emission coal technologies. Through its fully owned subsidiary, UCC Energy, Felix is developing the Ultra Clean Coal Process. This has the potential to make significant improvements in the efficient use of coal in the production of electricity, and consequently, significant savings in greenhouse gas emissions associated with coal-fired electrical power generation. The NSW government is a sponsor of this low-carbon-emission coal development program.

5.3 Noise and Blasting

5.3.1 Objectives

The objective of the noise and blasting impact assessment is to determine whether changes to noise and vibration from Stage 2 and Stage 1 modifications will impact on sensitive receivers during construction and operations. Project-specific and cumulative impacts were assessed, and where required, recommended management measures developed.

5.3.2 Assessment Method

Spectrum Acoustics were engaged to undertake a noise and vibration study for Stage 2. A full copy of the noise and vibration report is contained in **Appendix 4** in Volume 1. The cumulative noise impacts of the MCP (Stages 1 and 2 combined) were modelled using RTA Technology's Environmental Noise Model (ENM), according to the requirements of the NSW Industrial Noise Policy (INP). The ENM is an industry and DECC-accepted modelling package and has been used to predict noise impacts from other coal mines in NSW.

The ENM incorporates consideration of varying terrain categories to account for the range of ground types present over space and time. The expected occurrence of disturbed, grassed and forested areas were taken into account for each of the years that were modelled. These categories were applied to the digital topographic model for the MCP Area.

All major noise-producing items and plant were modelled at their known or most exposed positions. Point data and noise contours were then generated based on sound levels and source heights for the different plant items (see **Table 5.3.1**).

Table 5.3.1 Operation noise sources and sound power levels modelled

Operational Noise Source	Sound Power Level dB(A)		Source Height (m)
	$L_{eq(15\ min)}$	L_{max}	
Loading empty coal wagons	101	121	3
4 x locomotives idling on loop	112	112	3
Trucks at receival dump hopper.	115	125	3
Primary crusher	114	118	5
Dozer at receival dump hopper	115	130	2
Overburden drill	114	116	1
Overburden excavator (996)**	116	125	5
Coal excavator (R9350).	115	122	5
Overburden dump (per pit)*	115	125	3
Overburden haul (on slope)*	115	120	3
Overburden haul (on flat)*	113	118	3
Coal haul (from pit to processing area)*	111	116	3
Transfer station	115	118	15
Sizing station	116	118	20
Receival dump hopper (OC4)	114	121	5
Coal washery	116	118	15

Table 5.3.1 Operation noise sources and sound power levels modelled (cont'd)

Operational Noise Source	Sound Power Level dB(A)		Source Height (m)
	$L_{eq(15\ min)}$	L_{max}	
Conveyors (per 100 m)	96	N/A	2-10
Ventilation fan (enclosed)	102	102	5
Personnel carrier	110	115	1
Stacker/reclaimers (each)	105	N/A	10

* All sources involving trucks assume 10 to 2 truck pass-bys per 15-minute period so that all haul trucks proposed for the various years of mining are included. Haulage sources area placed at approximately 500 m intervals on haul routes. The Komatsu 830E haul trucks will be fitted with upgraded mufflers and grid-box silencers.

** The modelling assumes that the Liebherr 996 excavators will be fitted with upgraded mufflers to reduce noise tones to below 500 Hz.

Modelling was conducted for the following atmospheric conditions:

- Daytime calm 'Neutral' – Air temperature 20°C, relative humidity (RH) 70%, no wind and a 1°/100 m vertical temperature gradient (i.e., dry adiabatic lapse rate).
- Inversion – Air temperature 5°C, RH 70% and a +3^{o}C/100 m vertical temperature gradient (this equates to an F Class inversion and is likely to occur in excess of 30% of winter nights; while G Class inversions have minimal occurrence).
- Prevailing wind (summer/autumn) 'ENE wind' – Air temperature 20°C, RH 70% and a 3 m/s wind from the east-northeast.
- Prevailing wind (winter/spring) 'SW Wind' – Air temperature 20°C, RH 70% and a 3 m/s wind from the southwest.

The prevailing wind directions represent worst-case (ENE wind) noise-propagating and best-case (SW wind) noise ameliorating wind directions for the MCP with respect to the location of private residences, and are not an accurate account of wind direction variation across all seasons. The full suite of wind roses for Ulan is included in the air quality specialist report (Appendix 3A in Volume 1).

Noise models were generated for each of the following operational scenarios, for each of the atmospheric conditions outlined above. These are considered to be representative of the worst cases in terms of noise generation and potential impacts:

- Year 2 OC1 (with bund) and OC4.
- Year 7 commence OC2, OC4 continuing and UG1.
- Year 12 commence OC3, OC4 continuing and UG2.
- Year 16 OC4 continuing and UG2.
- Year 19 OC4 continuing and UG4.
- Year 24 OC4 continuing and UG4.

The maximum number of noise sources per year of operation is summarised in **Table 5.3.2**, while the location of the sources for each operational scenario is contained in Appendix B of Appendix 4 in Volume 1. This includes use of existing equipment for Stage 1 and additional equipment for Stage 2 that will need to be used across the MCP to maximise efficient development of the open cut mines. This is a worst-case estimate and it is likely that fewer numbers of some mobile equipment will actually be used.

Table 5.3.2 Maximum number of noise sources in the years of operation of the various operational scenarios

Noise Source	Type	Year of Operation					
		2	7	12	16	19	24
Overburden excavator	996 Liebherr	2	4	5	7	6	6
Coal excavator	R9350 Liebherr	2	2	2	2	2	2
Overburden trucks	Komatsu 830E	13	17	17	17	17	17
Coal trucks	Komatsu 830E	12	12	12	12	12	12
Dozers – dump	Komatsu 375-5	2	4	5	7	6	6
Dozers - face	Komatsu 375-5	2	4	5	7	6	6
Graders	Komatsu 825	4	4	4	4	4	4
Overburden drills	Sandvik	2	2	2	2	2	2
Coal drills	Sandvik	1	2	2	2	2	2
Coal dozers	Komatsu 275-5	2	2	2	2	2	2

To reduce noise impacts from Stage 1 on surrounding receivers, the Stage 1 noise model (Wells Environmental Services, 2006) incorporated a number of specific mine design features aimed at reducing the noise output of Stage 1. This included an environmental bund around the western extent of OC1, acoustic barriers on the OC1 ROM coal dump hopper, and below ground level crushing stations. These measures have also been incorporated into the noise model.

Preliminary modelling incorporating initial Stage 2 mine plans indicated that noise levels to the west of the MCP Area would be elevated by 2 dB to 4 dB compared to the predictions for Stage 1 alone. As a result, MCM has incorporated a number of additional acoustically-sensitive design elements into the final Stage 2 mine plan. These include:

- Combining UG1 and UG2 mine access to one acoustically-shielded location on the floor of OC1, despite more economical underground access options in other locations.
- Changing the location of the approved UG4 access drift entry and surface facilities to a more acoustically-shielded location on the floor of OC1.
- Designing haul roads with minimum grades to reduce engine noise and braking, where possible.
- Using tonal reversing alarms on mobile equipment.
- Fitting upgraded mufflers on all excavators and haul trucks.
- Fitting grid-box silencers to haul trucks.

With the inclusion of these acoustic measures, the model predicts that cumulative MCP noise levels west of the MCP Area will be similar to those predicted for Stage 1 alone.

The use of grid-box silencers on haul trucks was included in the Stage 1 and Stage 2 noise model as a noise control device. These are relevant for trucks with electric wheel drives. The contract for the supply of trucks requires noise attenuation to meet specified sound power level criteria. In complying with these criteria, the manufacturer may fit different noise control devices; however, acceptance by MCM is based on achievement of the specified noise criteria.

5.3.3 Existing Environment

Noise has been monitored in numerous locations throughout the local area since 2005 to determine the ambient acoustic environment (see Plan 16 in Volume 2). Furthermore, during the period of 10 to 16 June 2008, further ambient noise monitoring was conducted at three residential receivers (R160, R26 and R36) in locations surrounding the MCP area. The locations of these premises are shown on Plan 2 in Volume 2. The purpose of this further monitoring was to determine whether noise from the Wilpinjong coal mine had changed the ambient acoustic environment at these locations since the Stage 1 studies. The monitoring showed there was no discernable difference from Stage 1 results and that the Rating Background Levels (RBLs) defined for Stage 1 are equally applicable to Stage 2 studies. The results of the Stage 2 ambient noise monitoring expressed as L_{Aeq} and L_{A90} RBLs are summarised in **Table 5.3.3**.

Table 5.3.3 Ambient noise background levels

Location	L_{Aeq} period dB(A)			L_{A90} period* dB(A)		
	Day	Evening	Night	Day	Evening	Night
R160 (Ulan Public School)	56	50	50	32	32	30
R26 (Ulan Road)	51	49	43	31	32	30
R36 (Moolarben Road)	54	40	32	30	30	30

* For the purposes of setting noise criteria relative to ambient noise levels, the NSW Industrial Noise Policy considers a RBL of 30 dB(A) if the measured L_{A90} level is less than 30 dB(A).

Based on these ambient noise monitoring results, the project-specific noise impact assessment criteria for Stage 1 have been adopted as the impact assessment criteria that apply to all MCP noise impacts (i.e., Stages 1 and 2 combined).

5.3.3.1 Noise Impact Assessment Criteria

Construction Noise Impact Assessment Criteria

Construction of the Stage 2 ROM coal facility will be conducted concurrently with Stage 1 construction activities. Noise criteria during the initial construction and site establishment period for Stage 1 (OC1 and Stage 1 Infrastructure Area) were determined in the Stage 1 noise assessment (Wells Environmental Services, 2006). Stage 2 and cumulative Stage 1 and Stage 2 construction noise has been assessed against these criteria.

Operations Noise Impact Assessment Criteria

The relevant operational noise impact assessment criteria for non-mine-owned properties are summarised in **Table 5.3.4**. These are generally consistent with the noise limits in EPL 12932 for Stage 1.

Table 5.3.4 Adopted operations noise impact assessment criteria for non-mine-owned properties

Receiver ID and General Location	Operational Noise Criteria dB(A)			
	Day	Evening	Night	
	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
R26 (Ulan Road)	38	38	38	45

Table 5.3.4 Adopted operations noise impact assessment criteria for non-mine-owned properties (cont'd).

Receiver ID and General Location	Operational Noise Criteria dB(A)			
	Day	Evening	Night	
	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
R22, R23, R41A (Ulan Road) R63, R64, R70, R170, R171, R172 (Ridge Road)	38	38	37	45
R169 (Cope Road)	37	37	37	45
All other non mine-owned residential receivers	35	35	35	45
R168 (Anglican Church) R160A (Ulan Public School) R151 (Catholic Church)	35 (internal) when in use and under all weather conditions (assumes 45 externally, measured at the external façade)			N/A
Goulburn River National Park Munghorn Gap Nature Reserve	50 (at the most noise affected point within 50 m of the boundary of the National Park or Nature Reserve)			N/A
R162 (Ulan Hotel) All other commercial premises	65 when in use and under all weather conditions			N/A

5.3.3.2 Land Acquisition and Cumulative Noise Impact Assessment Criteria

The Stage 1 Project Approval contains land acquisition criteria and cumulative noise criteria for Stage 1. These criteria are summarised in **Tables 5.3.5** and **5.3.6** respectively. It is assumed that these criteria will apply to Stage 2 and MCM have committed to this.

Table 5.3.5 Adopted land acquisition noise impact assessment criteria

Land Number	Day/Evening/Night $L_{Aeq\ (15\ min)}$
158*, 46A*, 29	43/43/43
22, 23, 41A, 64, 70#, 170, 172	43/43/42
All other private landowners	40/40/40

* Adopted from criteria at R26 and R49.

Adopted from criteria at R170 and R172.

Table 5.3.6 Adopted cumulative noise impact assessment criteria

Assessment Criteria	Acquisition Criteria
$L_{Aeq(11\ hour)}$ 50 dB(A) – Day	$L_{Aeq(11\ hour)}$ 53 dB(A) – Day
$L_{Aeq(4\ hour)}$ 43 dB(A) – Evening	$L_{Aeq(4\ hour)}$ 45 dB(A) – Evening
$L_{Aeq(9\ hour)}$ 40 dB(A) – Night	$L_{Aeq(9\ hour)}$ 43 dB(A) – Night

5.3.3.3 Blasting Impact Assessment Criteria

The airblast overpressure and ground vibration blasting criteria for Stage 1 are also applicable to Stage 2. These criteria are summarised in **Table 5.3.7** and **Table 5.3.8**, respectively. It is assumed that these criteria will apply to Stage 2 and MCM has committed to this.

Table 5.3.7 Adopted airblast overpressure impact assessment criteria (ANZECC criteria)

Airblast Overpressure Level (dB(Lin Peak))	Allowable Exceedence
115	5% of the total number of blasts over a period of 12 months
120	0%

Table 5.3.8 Adopted ground vibration impact assessment criteria

Receiver	Peak Particle Velocity (mm/s)	Allowable Exceedence
Residence on privately owned land (ANZECC criteria for human comfort)	5	5% of the total number of blasts over a period of 12 months
	10	0%
330kV transmission line	50	0%
Railway Culverts	20	0%
Aboriginal rock shelters	40	0%

5.3.3.4 Road Traffic Noise Impact Assessment Criteria

The road traffic noise criteria for Stage 1 are also applicable to Stage 2. These are summarised in **Table 5.3.9**.

Table 5.3.9 Adopted road traffic noise impact assessment criteria

Road	Day and Evening $L_{Aeq(1\ hour)}$	Night $L_{Aeq(1\ hour)}$
Ulan and Cope Road	60	55

5.3.4 Issues

The off-site noise and blasting issues for Stage 2 are:

- Construction noise impacts.
- Operations phase noise impacts.
- Blast overpressure and vibrations.
- Fly rock impacts.
- Transport (road and rail) impacts.
- Cumulative impacts, including noise at the Ulan Public School.

5.3.5 Impact Assessment

Predicted Stage 2 and combined Stage 1 and Stage 2 noise and blast emissions have been assessed against the above impact assessment criteria. These are the adopted noise and blast impact assessment criteria for Stage 2.

The government encourages mining companies to develop land buffers around their operations so that the general amenity of the community is protected from mining-related impacts (noise, vibration, dust, etc). Mining companies do this by acquiring properties neighbouring their mining tenements. Ulan and Wilpinjong coal mines and MCM have acquired numerous properties in and around their respective mining tenements (see Plans 2 and 2A in Volume 2). Where residents or premises outside this buffer experience impacts from a mining operation above established guideline criteria, the government provides those land owners with further protection, such as requiring the mining company to acquire the property if the owner so desires.

Spectrum Acoustics has assessed the predicted noise and vibration impacts of the MCP against the adopted impact assessment criteria at all residential and non-residential properties surrounding the MCP, including mine-owned properties but excluding the Ulan and Wilpinjong mines. The full results of predicted noise impacts from the MCP are included in the Spectrum Acoustics report in Appendix 4 in Volume 1. However, as the mine-owned land is generally considered to provide a buffer to the impacts of the mining operations, the following discussion focuses solely on predicted MCP noise and vibration impacts to non-mine-owned properties. There are some differences between the full list of considered properties (Appendix 4 in Volume 1) and the non-mine-owned properties considered below. This reflects MCM's ongoing commitment to property acquisition in the area. All properties within the Stage 2 ROM coal facility and OC4 are owned by MCM or the Ulan and Wilpinjong coal mines.

5.3.5.1 Construction Impacts

Stage 2 construction activities will occur south of Ulan-Wollar Road and will be carried out concurrent with Stage 1 construction activities. Combined construction worst-case noise emissions for both stages of the MCP have been modelled for the four meteorological conditions defined in Section 5.3.2. Modelled construction noise sources include general earth works (dozers, dump trucks, graders, etc.) and metal fabrication activities (hammering, drilling and grinding at heights to 25 m above ground). The results for the closest non-mine-owned properties are summarised in **Table 5.3.10**, which shows that additional construction works associated with Stage 2 will not contribute additional noise impacts to those predicted for Stage 1. Hence, no additional receivers will be impacted by construction noise from Stage 2.

Table 5.3.10 Predicted worst-case construction noise levels

Receiver	Stage 2 (dB)	Stage 1 (dB)	Total for MCP (dB)
R160A (Ulan Public School)	26	46	46
R26 (Robinson)	24	44	44

5.3.5.2 Operations Impacts on Residential Receivers

Predicted contoured noise levels for Years 2, 7, 12, 16, 19 and 24 for the $L_{Aeq(15\ min)}$ ENE wind meteorological scenario are shown in **Plans 23 to 28** in Volume 2. These are considered representative of worst case noise emissions. Predicted contoured noise levels and tabulated values for all receiver locations for all operational and meteorological scenarios are presented in the specialist noise assessment report in Appendix 4 in Volume 1.

Spectrum Acoustics predicts nine privately-owned properties will be impacted during operations by the addition of Stage 2, as shown in **Table 5.3.11**, five of which have acquisition rights under Stage 1. This does not include properties that have been acquired by MCM.

Table 5.3.11 Predicted privately-owned properties with exceedances above project-specific assessment noise impact criteria

Mine Context*	Privately-owned Receiver	Exceedance (dB)	Atmospheric Condition
Year 7	R5# (Lagoons Road)	greater than 10	Neutral, Inversion and ENE Wind
	R20# (Lagoons Road)	up to 10	Inversion and ENE Wind
	R22 (Ulan Road)	up to 3	Inversion and ENE Wind
	R23 (Ulan Road)	up to 2	Inversion and ENE Wind
	R41A (Ulan Road)	1	Inversion and ENE Wind
Year 12	R5# (Lagoons Road)	up to 2	Inversion and ENE Wind
	R30 (Moolarben Road)	1	ENE wind
	R36# (Moolarben Road)	up to 7	Inversion and ENE Wind
Year 16	R29A# (Moolarben Road)	3	Inversion
Year 12	R29B# (Moolarben Road)	5	Inversion

* No exceedances are predicted in Years 2, 16, 19 or 24.

Privately-owned proerties that have acquisition rights under the Stage 1 Project Approval.

In addition to the properties listed in Table 5.3.11, nine privately-owned receivers (R26, R31, R47 R58, R63, R64, R70, R169, R172) are predicted to experience noise levels at or within 2 dB below the project-specific noise impact assessment criteria at some time during the life of the mine. These include three receivers in Year 2 (R26, R169), six in Year 7 (R26, R58, R63, R64, R70, R172), one in Year 12 (R47) and two in Year 19 (R31, R47). Spectrum Acoustics has recommended that these receivers be included in an attended noise monitoring program for the relevant years.

Noise levels above the project-specific noise impact assessment criteria have been predicted at seven Ulan Coal Mine Ltd and Wilpinjong Coal Mine Ltd owned properties (R46B, R46C, R46G, R65B, R65C, R65D, R141), of which two (R46C, R46G) will be demolished to enable mining of OC4 in later years.

The Ulan Public School will not be impacted by noise from Stage 2, and the cumulative impact of the MCP on the school will not change as a result of Stage 2.

5.3.5.3 Sleep Disturbance

Spectrum Acoustics has assessed the potential for sleep disturbance at surrounding privately-owned properties. This assessment considers the DECC recommendation that further assessment for sleep disturbance is required if maximum noise levels (L_{Amax}) exceed the background level (L_{A90}) by more than 15 dB at a bedroom window.

Maximum noise levels at the nearest or potentially most impacted receiver were considered under worst-case operating conditions. The assessment predicts that no receiver will experience sleep disturbance as a result of noise from Stage 2. However, R26 may experience sleep disturbance under adverse meteorological conditions when overburden dumping in OC1 (Stage 1) is at its closest point to this residence. This can be controlled by careful management of night-time dumping activities, including avoiding night-time dumping in exposed positions in OC1 when operations are close to this residence.

5.3.5.4 National Estate

The predicted noise impacts of the MCP on the adjoining Goulburn River National Park and the Munghorn Gap Nature Reserve have been assessed against the NSW Industrial Noise Policy amenity noise criteria and the Stage 1 noise impact assessment criterion of 50 dB(A) ($L_{Aeq(15)}$). While no noise levels above this assessment criterion are predicted for the Goulburn River National Park, noise in excess of 50 dB(A) due to Stage 2 is predicted in the vicinity of the northern boundaries of the Munghorn Gap Nature Reserve. This area of the reserve is remote from parts readily accessible to recreational park users. Therefore, the predicted Stage 2 noise impacts are not expected to affect the amenity of park users.

5.3.5.5 Cumulative Mining Noise Impacts

The Wilpinjong Coal Project EA (Resource Strategies, 2005) reports that residences potentially affected by cumulative mine noise from both the Wilpinjong coal mine and the MCP are within the Murragamba Creek valley. All privately-owned properties within this area have since been acquired by MCM, as they will be directly affected by mining of OC4.

Noise complaints from residents south of Wilpinjong coal mine have led to targeted noise mitigation and management actions at that mine. It is therefore important that noise from the MCP does not also impact on these residents. The nearest residential receiver to the MCP and south of the Wilpinjong coal mine is Langshaw (Property 138) (see Plan 2 in Volume 2). This residential receiver is over 6 km from the nearest MCP component and is outside of the predicted 20 dB(A) contour for all modelled operational scenarios and meteorological conditions (see Plans 23 to 28 in Volume 2 and figures in Appendix 4 in Volume 1). Based on this modelling, Spectrum Acoustics predict the MCP will be inaudible at this receiver at all times.

5.3.5.6 Blast Overpressure, Vibration and Fly Rock

Mining in OC4 will employ blast technology to break up overburden and coal. This will require use of charges up to a maximum instantaneous charge (MIC) weight of 1,788 kg. Spectrum Acoustics has made predictions for overpressure and ground vibrations for MIC values between 450 kg and 1,788 kg. Blasts using the higher charge weights will be used for overburden, while blasts using the lower charge weights will be used for coal. The predictions are based on standard equations and analysis of monitoring results for a coal mine in the Hunter Valley.

Spectrum Acoustics report (see Appendix 4 in Volume 1) determined that one receiver (R44) in Eastern Creek valley will be impacted by airblast overpressure above the relevant criteria due to blasting in OC4. This property has since been acquired by MCM (see Plan 2 in Volume 2) and there are now no non mine-owned properties predicted to be impacted by blasting associated with Stage 2. The nearest privately-owned residence is more than 2 km beyond the boundary of OC4. Stage 1 blasting impacts were assessed in the Stage 1 EA report (Wells Environmental Services, 2006).

Blasting in OC4 will come within 50 m of the Ulan-Wollar Road, bridges over Murragamba Creek and Eastern Creek, within 100 m of the Gulgong-Sandy Hollow rail line and its associated culverts, and within 200 m of the 330-kV transmission line adjacent to Ulan-Wollar Road and the Gulgong-Sandy Hollow rail line.

A peak ground vibration level of 61 mm/s is predicted for a 1,788-kg MIC blast when blasting in OC4 comes within 200 m of the 330-kV transmission line adjacent to Ulan-Wollar Road and the Gulgong-Sandy Hollow rail line. This is above the adopted ground vibration impact assessment criteria (see Table 5.3.8). Spectrum Acoustics has recommended that ground vibration monitoring be undertaken at this structure when mining occurs within a distance of approximately 500 m. Subject to blast monitoring results, it may be necessary to reduce MIC values in OC4 for blasts within approximately 400 m of this structure.

Moolarben Creek Dam is a rock-filled structure with a reinforced concrete lining on the upstream face. Since completion of the Stage 1 assessment, the NSW Dams Safety Committee has indicated their preference that ground vibration at dam walls be assessed against an initial screening criterion of 10 mm/s peak particle velocity. As the blasts at OC4 are in excess of 3 km away from the dam wall, no impact is predicted.

An Aboriginal rock art site has been identified near the top of the ridgeline above UG2 (see Section 5.9). This site is 350 m west of the nearest point of OC4. The predicted peak ground vibration level at this site is 9 mm/s peak particle velocity from OC2 (Stage 1) and 34 mm/s peak particle velocity from OC4 using a MIC of 1,788 kg. These levels are below the adopted assessment criterion (Stage 1 approval conditions) of 40 mm/s peak particle velocity for this type of feature. However, to ensure peak ground vibration levels do not increase above the adopted assessment criterion, monitoring of ground vibration levels will commence when blasting is within 500 m of the rock art site.

Apart from the generation of airborne dust (see Section 5.1), blasting may also generate fly rock. Fly rock is material (rock and other debris) cast into the air as a result of blasting. The main risk of fly rock is its potential to cause damage to properties or structures and injury or death to people or livestock.

5.3.5.7 Off-site Transport Impacts

Road

A road traffic noise assessment has been carried out for the MCP considering cumulative traffic noise generation from both Stages 1 and 2. This assessment involved measuring passing vehicle noise in the Ulan village to determine roadside traffic noise levels. These measurements were then applied through scaling to the potential maximum hourly traffic load expected for the MCP. The maximum hourly traffic load is expected to occur at the early morning shift change over, between 6.00 a.m. and 7.00 a.m. This shift change is within the DECC-classified night-time period and, therefore, night-time road traffic noise criteria apply.

The assessment indicates that traffic noise levels associated with the early morning shift change over will not adversely impact any privately-owned receiver. As this is the predicted worst-case traffic scenario for the MCP, no other traffic noise impacts are expected.

The nearest residence to Cope Road is approximately 2.8 km west of Ulan village and at a distance of about 30 m from the road. It is predicted that the combined MCP-generated traffic noise at 30 m from the road will be about 51 dB(A), which is below the 55 dB(A) night-time assessment criteria (see Table 5.3.9).

However, it is expected that traffic from other sources, combined with that of the MCP, will increase the overall traffic noise level on Ulan and Cope roads. Spectrum Acoustics has recommended that attended traffic noise monitoring be undertaken at the identified residence on Cope Road as part of the general noise monitoring program for the mine.

As shift changes will occur outside of school hours, MCP traffic-related noise impacts on the Ulan Public School are expected to be negligible.

Rail

The Stage 1 rail traffic noise assessment (Wells Environmental Services, 2006) considered up to 10 Mtpa of product coal being transported by rail east to Muswellbrook. The addition of Stage 2 to the MCP will increase the amount of product coal to be transported by rail from the MCP to 13 Mtpa. This equates to an increase of one additional train comprising some 91 wagons and 3 or 4 locomotives per day on average. The Stage 1 assessment considered four trains per day on average.

The Stage 1 assessment identified 22 residences within 70 m of the rail line located between the MCP and Muswellbrook. The majority of these are within the town of Denman, with the remaining residences being within rural areas.

Once trains leave the Stage 1 rail loop and pass onto the Gulgong-Sandy Hollow rail line the train noise becomes the responsibility of the Australian Rail Track Corporation Ltd (ARTC) and other relevant rail authorities. In terms of the trains servicing the MCP, these trains are subject to conditions of the ARTC's environment protection licence (EPL 3124). The set back distance for meeting the ARTC's EPL noise criteria is approximately 70 m and is governed by predicted night-time L_{Aeq} levels.

Although the incremental impact of train noise and vibration due to the one additional train is not of concern, the cumulative impact suggests that further investigation may need to be undertaken by the coal transport service provider, and if required mitigation measures adopted.

5.3.6 Environmental Management

5.3.6.1 Noise Monitoring

Acoustical monitoring for the MCP will comprise a combination of continuous (near real-time) monitoring and logging of noise, and attended monitoring by an acoustical consultant.

The areas to the west and southwest of the MCP represent the main interface with sensitive noise receivers. In this regard, monitoring proposed for Stage 1 will also be effective to assess the additional contribution of noise from Stage 2 on these areas. Additional monitoring will also be required in the area to the southeast of OC4.

Monitoring will be implemented at the four privately-owned properties predicted to experience noise levels above the project-specific assessment criteria (see Table 5.3.11). Attended monitoring will also be implemented at the nine residences where MCP noise levels are predicted to be within 2 dB(A) of the assessment criteria and at other attended noise monitoring locations recommended by Spectrum Acoustics. A real-time noise monitor will be established at the school for the entire duration of the MCP, including the construction phase.

Table 5.3.12 lists the locations, types and timing of noise monitoring to be implemented for Stage 1 and Stage 2. This will be further developed in an integrated noise monitoring program for the MCP.

Table 5.3.12 Noise monitoring proposed for Stage 1 and Stage 2

Location	Timing	Instrument	Parameters and Purpose
Real-time noise monitoring sites: R160A Ulan Public School.	Start to finish.	Noise Monitor 1 (NL1)	Real-time noise monitoring to provide for continuous improvement and noise reducing operational changes.
Mobile noise monitoring sites: • R26 (Ulan Road). • R169 (Cope Road).	Year 2 / start of OC1.	Noise Monitor	Real-time noise monitoring to provide for continuous improvement and noise reducing operational changes.
• R22 (Ulan Road). • R23 (Ulan Road) or • R41A (Ulan Road).	Year 6 to 7 / start of OC2.		
• R30 (Moolarben Road). • R35 (Moolarben Road). • R47 (Mayberry Road).	Start of OC3.		
Attended noise monitoring sites.	Quarterly frequency or as required.	Attended Noise Monitor	Attended noise monitoring to determine compliance with noise criteria.
• R160A Ulan Primary School (external).	Start to Finish.		
• R26 (Ulan Road). • R169 (Cope Road) and others predicted to be 1-2 dB(A) below noise criteria.	During mining in OC1 and OC2 and as required.		
• R22 (Ulan Road). • R23 (Ulan Road) or • R41A (Ulan Road).	Year 6-7 / start of OC2.		
Representative site for Ridge Road residences nearest to MCP (e.g. R63, R70, or R172).	Year 6-7 / start of OC2.		
• R30 (Moolarben Road). • R35 (Moolarben Road). • R47 (Mayberry Road).	Start of OC3.		
• R138 (Wollar Road).	Start of OC4.		
Nearest non-mine-owned residences to Cope and Ulan roads.	Start to finish.		
Background control noise monitoring site: In vicinity of furthest Ridge Road residence to the MCP.	Start to finish.	Noise Logger	Continuous noise logging.

Real-time monitoring will enable near continuous review of the noise levels at the monitoring sites and, if necessary, provide response triggers for site activities to be reviewed and modified. Real-time monitoring data will be transmitted to a central computer and interpreted by software to provide onscreen and mobile phone text message alerts to environmental and operational staff when response triggers are reached. As the data requires transmission and interpretation, the triggers and appropriate responses will occur 5 to 15 minutes after the noise is first made.

The results collated from the real-time monitoring will be used as an operational tool to understand noise levels emanating from any one activity. The continuous units will provide an early warning tool to inform relevant on-site personnel that noise levels are approaching criteria. This will allow MCM to review its activities and respond proactively. Noise and meteorological triggers will be developed in conjunction with a specialist noise consultant and, where appropriate, with relevant government authorities.

To provide for a greater understanding of ambient noise levels typical of the rural residential areas west of the MCP, a background or control noise monitoring site will be established in the Ridge Road to Cooks Gap area. This monitoring site will record background noise levels to allow comparison with mine-related noise impacts.

5.3.6.2 Blast and Vibration Monitoring

Monitoring will be provided within a Blast Monitoring Program (BMP) that will be established and implemented for Stage 2 and integrated with the BMP for Stage 1. This will include the monitoring procedures specified below.

Blast overpressure and ground vibration monitoring will commence once blasting in OC4 is within 500 m of any sensitive infrastructure such as Ulan-Wollar Road, Gulgong-Sandy Hollow rail line or the 330-kV transmission line. Ground vibration monitoring will also be undertaken at the Aboriginal rock art site near the top of the ridgeline above UG2 once blasting of OC4 comes within 500m. Each blast will also be monitored for overpressure and ground vibration. Blast events will be visually monitored and videoed.

Sensitive infrastructure (e.g. the aforementioned Ulan-Wollar Road, Gulgong-Sandy Hollow rail line, the 330-kV transmission line, etc.) within 500 m of the blast will be inspected prior to and post blasting.

5.3.6.3 Response to Monitoring and Exceedances

Where noise monitoring indicates an exceedance, MCM will notify the land owner within 24 hours and offer a range of measures to mitigate the noise at these residences. These measures may include air conditioning of the dwelling, installation of insulation, or double glazing of windows. However, if an exceedance of 5 dB(A) or more above the project-specific noise impact assessment criteria occurs, then the land owner will have the right to request that MCM acquire their property. If acquisition is not desired by the land owner, MCM will offer acoustical mitigation measures or enter into a negotiated agreement with the land owner. Where an exceedance of 5 dB(A) or more above the project-specific assessment criteria is recorded, MCM will notify the land owner and report it to the DoP and the DECC.

Exceedances of airblast overpressure and vibration will be reported to the DG of the DoP and relevant government agencies within 24 hours of detection. Should any exceedances occur, blasting design, i.e., the positioning of explosives as well as MIC weight, and blasting practices will be modified in order to reduce levels of airblast overpressure and vibration to below the specified criteria (see Tables 5.3.7 and 5.3.8).

5.3.6.4 Noise Mitigation

As previously indicated, a suite of acoustically-sensitive design elements have been incorporated into the mine design. These elements will be supplemented with a range of standard operating procedures that will ensure the MCP is operated within the Stage 1 noise footprint. In addition to those elements assessed in Stage 1, Stage 2 will employ the following additional measures, all of which will be incorporated into Stage 1 wherever practicable:

- Upgraded mufflers fitted to excavators to reduce exhaust noise tones below 500 Hz.
- Upgraded mufflers fitted to haul trucks to reduce noise emissions in both uphill and downhill travel.
- Construction of low gradient haul roads, where feasible.
- Fitting of broadband reverse alarms to all mobile plant.
- Avoiding operational activities in exposed positions close to residents at night-time.
- Blasting only under favourable meteorological conditions, where practicable.

A range of other standard acoustical controls that will be implemented at the MCP are listed in **Table 5.3.13**.

Table 5.3.13 Standard noise control measures for the MCP

Timing	Management / Control Actions
As required/specified by manufacturer	Maintain equipment and machinery in good working order.
At all times	Maintain haul roads in good condition free of pot-holes or unnecessarily rough areas to reduce haulage related noise.
When people are entering site for first time	Provide awareness and understanding of construction noise issues through site inductions for all staff, contractors and visitors to MCP, including highlighting of noise reducing universal work practices including: • Avoiding shouting/yelling, unless required for safety. • Reducing or avoiding the use of stereos outdoors. • Avoiding of slamming vehicle doors. • Avoiding dropping materials from height.
As required	Use and operation of equipment such as: • Reduction of throttle settings and turning off of equipment when not being used. • Avoid metal to metal contact on equipment. • Where possible use quieter equipment (e.g., rubber-wheeled tractors instead of steel-tracked tractors), in situations where either piece of equipment will suit the purpose.
Within 1 week of machinery being used on-site	Sound-power level measurement of plant and equipment prior to working on-site.
During design and construction	Ensure design and construction of infrastructure employs appropriate noise suppression methods.
Daily during operations	Mine personnel to evaluated environmental risks and measures that may be used to reduce the risk level.

5.3.6.5 Blasting Mitigation

A 500-m exclusion zone will be established around blast events and blasting will be designed to ensure that fly rock is controlled within this zone. To minimise impacts, the 500-m exclusion zone will be cleared prior to blasting and pre-blast inspections will be carried out in order to make sure no persons, property or livestock are at risk from blasting. Sentries will be installed to limit access to the fly rock exclusion zone. Proposed blast areas will be inspected and prepared to ensure that all soft, loose or blast-damaged material is removed prior to blasting. All blasts will be undertaken during designated blasting times (currently 9:00 to 17:00 Monday to Saturday as approved for Stage 1).

Site conditions will be assessed prior to each blasting event. Misfires will be managed appropriately and in accordance with legislation. Any fly rock found to have been ejected beyond the 500-m exclusion zone will prompt an investigation to determine the cause. Blast practices and design will be modified in light of the results of the investigation.

If it is found that blasting has damaged sensitive natural features or infrastructure either through vibrational or physical impact, an investigation will be conducted to determine the extent of damage and repairs will be agreed with the relevant authority or owner responsible for that item.

5.4 Groundwater

5.4.1 Objectives

The objectives of the groundwater assessment are to:

- Develop a thorough understanding of the groundwater environment, groundwater users and groundwater uses in and around the Stage 2 Project Area.
- Assess the contribution of Stage 2 impacts on the groundwater environment and groundwater users, including regional changes in groundwater levels during and after mining.
- Assess the impacts of Stage 2 on groundwater dependent ecosystems (GDEs).
- Predict groundwater mine inflows and the groundwater component of mine water supply.
- Predict changes in surface water groundwater interactions, particularly changes in baseflow.

5.4.2 Assessment Method

Aquaterra (formerly Peter Dundon and Associates Pty Ltd) has assessed the groundwater environment of the MCP, and the impact of Stage 2 on this environment and on surrounding groundwater users. This assessment includes:

- A groundwater census.
- Baseline monitoring.
- Production bore testing.
- Hydraulic testing.
- Numerical groundwater flow modelling.

A copy of the groundwater report is included as **Appendix 5** in Volume 3. The assessment builds on and complements the groundwater investigations carried out for Stage 1.

5.4.2.1 Groundwater Census

The locations of all (licensed and unregistered) groundwater access points (bores, wells, springs, soaks, and groundwater-fed dams) in the Stage 2 Project Area were determined through field surveys and a search of the DWE bore database. Where possible, the census also determined groundwater use at each location. The MCP groundwater database now incorporates both Stage 1 and Stage 2 census data. The locations of all known groundwater access points are shown in **Plan 29** in Volume 2.

5.4.2.2 Baseline Monitoring

Baseline groundwater monitoring commenced in February 2005, with the initiation of groundwater investigations for Stage 1, and now encompasses all Stage 1 and Stage 2 monitoring locations. Groundwater levels are measured monthly with samples collected quarterly for laboratory analysis of water quality.

The baseline monitoring network comprises over 100 monitoring bores. These have been constructed as open (standpipe) bores or multi-level piezometers (including vibrating-wire piezometers). The monitoring network also includes selected registered bores and unregistered groundwater sites across MCM's exploration areas (see **Plan 29**, **Plan 30** and **Plan 31** in Volume 2).

Baseline monitoring for Stage 2 is focussed on the OC4 (Murragamba Creek and Eastern Creek valleys) and UG1 and UG2 areas. Monitoring bore depths range from less than 50 m in the open cut area to over 150 m in the underground mine area. Monitoring bores drilled into chain pillars (i.e., unmined pillars of coal that provide roof support to underground mine access roadways, etc.) or outside the extent of underground workings have been completed as multi-level vibrating-wire piezometers. This will enable any depressurisation in the overlying Permian and Triassic strata as a result of underground mining to be monitored. A further vibrating-wire piezometer was installed adjacent to test bore TB179 (see Plan 31 in Volume 2), which will enable the monitoring of groundwater levels within the Ulan Seam and overlying Permian and Triassic strata as a result of pumping from the borefield.

5.4.2.3 Production Bore Testing

The Stage 2 assessment includes pump testing on one bore (TB179) drilled in the area of the proposed Stage 1 borefield. This complements the pump testing of four bores (TB52A, TB52B, TB103 and TB105) completed in the Stage 1 assessment. It is expected that these and other bores will be developed further to form the production borefield (see Plan 31 in Volume 2). The borefield is required to supply make-up water for the MCP and will also serve to dewater the Ulan Seam prior to mining UG4. The impacts of the borefield and dewatering of UG4 on the local and regional groundwater environment were assessed in the Stage 1 EA report.

5.4.2.4 Hydraulic Testing

Hydraulic testing was carried out on each monitoring bore using standard constant rate or slug permeability tests to determine the values of hydraulic conductivity for each of the tested aquifer units. All aquifer hydraulic conductivity values are reported in Appendix 5 in Volume 3, and were used to inform development of the numerical groundwater flow model.

5.4.2.5 Numerical Groundwater Flow Modelling

A conceptual regional groundwater model was developed for the Stage 1 groundwater investigations. This conceptual model was used to construct a three-dimensional finite difference numerical groundwater flow model. The conceptual (see **Plan 32** in Volume 2) and numerical flow models have been updated to incorporate Stage 2. The model version used for the Stage 2 groundwater studies is referred to as MC2.1 and incorporates a number of improvements over the Stage 1 model, including:

- More advanced software.
- Extension of the model area 15 km north and 10 km west to enable simulation of known future extensions to the Ulan coal mine and sufficient distance to the model boundaries.
- Addition of a new Layer 1 to represent the regolith (weathered rock, colluvium, alluvium and Tertiary-age palaeochannel deposits).
- Updated parameter values.
- Transient (i.e., time varying) model calibrations.

The numerical flow model incorporates the MODFLOW and MODFLOW SURFACT software packages. This has enabled the modelling of both saturated and unsaturated groundwater flow conditions. The numerical model has been used to model the impacts of the MCP on the local and regional groundwater environment, and covers an area of about 2,750 km^2.

The model simulates the effect of aquifer depressurisation associated with the construction and operation of mine voids (both surface and underground), and the pumping of groundwater for mine dewatering and water supply purposes. This has enabled an assessment to be made of the impact of the MCP on the groundwater flow regime, including supply of baseflow to surface waters, to be made.

The model has been calibrated against publicly available mine dewatering records for the Ulan and Wilpinjong coal mines and long-term groundwater level monitoring data. Calibration runs were performed in both steady state and transient model modes. Good agreement was achieved between modelled and actual groundwater levels, which confirms the applicability of the calibrated model as a predictive tool to simulate the complex multi-layer Moolarben aquifer system.

An analysis of the sensitivity of the calibrated model to changes in various model input parameters has been carried out. This analysis has found that the most critical parameter to model reliability is the vertical permeability of areas above mined longwall panels (i.e., in goaf and subsidence zones). Further more, the analysis found that the model is insensitive to aquifer recharge, specific yield and storage coefficient.

An uncertainty analysis of predicted model outcomes has shown that prediction uncertainties in regard to changes in the critical parameters are not significant.

The numerical flow model assumes the MCP will operate for a period of 30 years. This is based on the indicative mine schedule for Stage 2 (approximately 24 years - see Section 4) and a revised indicative mining schedule for Stage 1 (mining of UG4 delayed until after completion of UG1 and UG2). The model also considers the cumulative impact of the MCP, Ulan and Wilpinjong coal mines operating concurrently, as the effect of each mine on the regional groundwater environment overlaps that of its neighbours. Indicative mining schedules, mine layouts, and water supply and dewatering requirements for Ulan and Wilpinjong coal mines were sourced from publicly available reports (i.e., environmental assessments, environmental impact statements and annual environmental monitoring reports). The cumulative impact of active mining at both Ulan and Wilpinjong coal mines has only been considered to the extent of their current development approvals. The model also simulates groundwater level recovery following the cessation of all mining in the area. This was achieved by including an additional stress period of 100 years, following the conclusion of modelled mining activities.

The conceptual and numerical flow models have been peer reviewed by Associate Professor Noel Merrick of the University of Technology, Sydney (formerly head of the National Centre for Groundwater Management). The final calibrated model has been evaluated against the Murray-Darling Basin Commission's Groundwater Flow Modelling Guideline (Aquaterra, 2001) and has been determined to be a suitable model for assessing the impacts of the MCP on the local and regional groundwater environment.

5.4.3 Existing Environment

5.4.3.1 Groundwater Occurrence

The geology and stratigraphy of the project area is briefly described in Section 4.2.1. Site investigations have determined the occurrence of groundwater within each of the following hydrogeological regimes:

- Localised aquifers within unconsolidated Quaternary-age (recent) alluvium associated with the present drainage system.
- Localised aquifers within unconsolidated Tertiary-age palaeodrainage channel fill deposits.
- Localised fracture aquifers within Triassic-age sediments (Narrabeen Group).
- Localised fracture aquifers within Permian-age coal measures, principally the Ulan Seam.
- Limited aquifer potential in older Shoalhaven Group sediments and basement rocks.
- Aquifers in weathered basement granites and volcanics.

The general outcrop expression of these hydrogeological units proximal to the MCP, Ulan and Wilpinjong coal mines is shown in plan view in Plan 30 in Volume 2.

The surficial aquifers (within unconsolidated Quaternary and Tertiary-age sediments) are mostly poorly developed and do not comprise sufficient water to constitute useful water supplies for the MCP. Quaternary-age alluvium is very poorly developed in the Murragamba Creek valley and does not constitute an aquifer of significance in this area. Tertiary-age palaeochannel aquifers are better developed and located within the central parts of the Murragamba Creek, Eastern Creek and Wilpinjong Creek valleys (see Plan 30 in Volume 2).

The Triassic Narrabeen Group sediments provide good groundwater resource potential. However, groundwater within these units has only been recorded in the northern most part of the EL area, over 6 km north of the Stage 2 mining areas. This was discussed in the Stage 1 assessment (PDA, 2006a and 2007a). Test drilling in the Triassic sandstones indicates these units exhibit negligible groundwater stores above the Stage 2 underground mines.

The Ulan Seam is the principal aquifer in the project area. This is a regionally extensive aquifer with groundwater storage developed in secondary permeability features (i.e., coal cleats, joints and fractures). The Ulan Seam is only partially saturated within most of the Murragamba Creek valley. Minor spring seepages have been observed from, or below, the floor level of the Ulan Seam where it outcrops in low-lying areas.

Weathered basement granite provides good groundwater resource potential. Localised occurrences of groundwater have also been identified within other basement rocks (e.g., Shoalhaven Group sediments).

5.4.3.2 Groundwater Access

The combined Stage 1 and Stage 2 groundwater census has identified in excess of 230 groundwater access points in and around the MCP area. These access points include bores, wells, waterholes, springs, soaks, scalds and farm dams fed in part by groundwater. Some of these features were either abandoned or dry at the time of the census. A further 130 registered bores and wells were identified within a 10 km radius of the MCP area from the DWE bore database, including water supply and dewatering bores for both Ulan and Wilpinjong coal mines. The census and bore database search results are summarised in Appendix 5 in Volume 3.

Based on work undertaken for Stage 1, the volume of individual spring and seep discharges within the Murragamba Creek and Eastern Creek catchments is relatively small. Many seeps are only visible as patches of dampness, wet grass or salt scalds. The flow rate of the largest spring flow observed during the Stage 1 groundwater studies was in the Moolarben Creek valley and this had an estimated rate of flow of less than 0.1 L/s.

5.4.3.3 Groundwater Levels and Flow Patterns

Quaternary-age Aquifers

The regolith comprises weathered bedrock and Quaternary-age alluvium and colluvium. These units are collectively referred to as the surficial aquifer system. They typically comprise local shallow watertable aquifers, which respond directly to recharge from rainfall infiltration. Groundwater levels mirror surface topography, with shallow watertable levels in elevated areas and zones of discharge, and lower watertable levels in the valleys. Groundwater flow also follows topography, with flow down gradient to lower valley floor areas. Discharge occurs locally through topographically controlled springs and seeps or as baseflow to local drainage channels. Some groundwater is lost from these shallow aquifers through vegetation uptake and evapotranspiration. The surficial aquifer system is not hydraulically connected to the deeper Permian rock aquifers.

Tertiary-age Aquifers

The extent of Tertiary-age palaeochannel deposits is shown in Plan 30 in Volume 2. These are thought to be part of a remnant drainage system that extends from between UG1 and UG4 eastward along the Wilpinjong Creek valley. Minor tributaries of this palaeochannel are found in the Murragamba Creek and Eastern Creek valleys. This aquifer system is not coincident with the present drainage and is thought to have only limited hydraulic connectivity with the creeks and associated alluvium. Where groundwater is observed in these channels, it is shallow, occurring at between 2 m and 13 m below the surface. However, investigative bores drilled into the channel between UG1 and UG4 and in parts of OC4 were either dry or only partially saturated. It is believed that these aquifers provide only limited baseflow contribution to the present creek system. Recharge is via direct rainfall infiltration.

Triassic-age Aquifers

Triassic-age sandstone units (Narrabeen Group) are present across a significant portion of the MCP Area. This aquifer is mostly unsaturated above UG1 and UG2 and in the OC4 area, and negligible inflow is expected from these rocks during Stage 2 mining. Groundwater is present in the lower Triassic-age sediments in the very northern end of UG4, but the saturated depth ranges between about 0 to 12 m. The upper Triassic-age sediments are unsaturated across the whole of the MCP area.

Permian-age Aquifers

The Permian-age coal measures comprise the most significant aquifers in the MCP area. Of these, the Ulan Seam is the most significant. Within the Stage 2 Project Area, the groundwater level in the Ulan Seam is more than 90 m below that of the upper parts of the Permian-age overburden and surficial aquifers, indicating limited hydraulic connection through the stratagraphic section. The

Permian rock aquifers are recharged in areas where the aquifer units outcrop, with regional groundwater flow down dip toward the northeast.

This flow pattern has been locally disrupted by dewatering at the Ulan coal mine, which has locally reduced groundwater levels within these aquifers. This effect extends into the MCP area where up to 40 m of drawdown has occurred in the Ulan Seam and lower Permian rock aquifers along the western margin of UG4.

5.4.3.4 Baseflow

Surface drainage within the Murragamba Creek and Eastern Creek valleys is ephemeral. This means there is insufficient baseflow from near surface aquifers to maintain permanent flow in these creek systems. However, groundwater is evidenced in seeps and small pools in locations along the main drainage lines indicating direct connectivity between the near-surface watertable and the creek systems. This is supported by similar water chemistry in both the near-surface groundwaters and surface waters within the creek systems.

5.4.3.5 Groundwater Dependent Ecosystems

Two significant GDEs have been identified in the Stage 2 Project Area. These GDEs both occur within the Eastern Creek valley, one at the head of the valley, the other at its confluence with Wilpinjong Creek. A number of other springs, soaks, seeps and some farm dams within the Stage 2 Project Area have also been identified as having potential to support GDEs, although none of these were assessed as being significant. Groundwater dependent ecosystems are discussed further in Section 5.7.

5.4.3.6 Groundwater Quality

Groundwater quality across the Stage 2 Project Area is variable, both in terms of key field parameters (salinity and pH) and hydrochemical constituents (anions and cations). As previously indicated, there is close similarity in water chemistry between near-surface groundwaters and surface water within the Murragamba Creek valley (based on baseline surface water samples, see Section 5.5.3.5).

Salinity – Total Dissolved Solids

Salinity concentrations range from less than 200 mg/L total dissolved solids (TDS) (fresh) to more than 11,000 mg/L TDS across the Stage 2 Project Area. Maximum TDS concentration for stock watering of cattle is 5,000 mg/L (ANZECC, 2000). Higher TDS concentrations tend to be more pronounced in the surficial aquifer system than in the underlying Permian-age aquifers, although variation in salinity in these latter aquifers does occur.

The most saline groundwater occurs near the downstream end of Murragamba Creek. It is believed that shallow watertable depths, evapotranspiration and surface water–groundwater interactions contribute to concentrating salt in these near-surface systems. Palaeochannel deposits in the Murragamba Creek valley comprise moderately saline to saline groundwaters (2,300 to 6,700 mg/L TDS). Groundwater within the Ulan Seam is low to moderately saline (220 to 2,100 mg/L TDS), although locally elevated values have been recorded.

pH

All Stage 2 Project Area groundwater is mildly acidic, with pH values ranging between 5 and 6.

Dissolved Metals

Laboratory analysis indicates moderately elevated dissolved metals concentrations in groundwater samples, with zinc concentrations above ANZECC (2000) trigger values for the protection of slightly to moderately disturbed ecosystems.

Nutrients – Ammonia and Nitrate

Ammonia and nitrate concentrations are generally below freshwater ecosystem protection guideline criteria (ANZECC, 2000), although minor elevated values were recorded in some bores.

5.4.4 Issues

The following issues were addressed as part of the groundwater assessment:

- Groundwater levels.
- Groundwater quality.
- Groundwater–surface water interactions – baseflow.
- Potential impacts on existing groundwater users.
- Potential impact on GDEs.
- Impacts of final mine voids.
- Groundwater availability for mine water supply.

5.4.5 Impact Assessment

5.4.5.1 Groundwater Levels

The most significant impacts on groundwater levels due to the MCP are predicted to occur within the Permian coal measures, particularly within the Ulan Seam. A cone of groundwater depression centred over UG4 is predicted to develop in the Ulan Seam and lower Permian rock aquifers as a result of dewatering of UG4 and borefield extractions. Drawdowns of up to 5 m or more are predicted to extend to about 18 km from the MCP in the Ulan Seam, and to about 15 km in the lower Permian rock aquifers (see **Plan 33** in Volume 2). A less pronounced cone of depression is predicted in the middle and upper Permian rock aquifers with drawdowns of up to 5 m or more predicted to extend in these units to about 12 km from the MCP.

Partial dewatering of the Triassic-age aquifers is predicted above UG4, with drawdowns of less than 5 m immediately outside the UG4 mine footprint. The impact of UG4 on Triassic-age aquifers was closely studied in the groundwater assessment for Stage 1. Inclusion of updated information from the Ulan coal mine in the Stage 2 assessment has led to the prediction that drawdowns in Triassic strata groundwater levels above Ulan coal mine will increase due to dewatering in UG4. Increased surface cracking due to mining of 450-m-wide longwall panels at Ulan coal mine is believed to increase the permeability of the overlying Triassic-age strata, which results in increased mine inflows and decreased groundwater levels in these units when groundwater is pumped from the Ulan Seam and lower Permian units at the MCP. Stage 2 is not predicted to increase the impact on the Triassic-age aquifers, as this unit is unsaturated in all areas of mining in Stage 2.

Drawdown in the surficial aquifer system is predicted to be of only limited and localised extent. Negligible impact on groundwater levels (less than 1 m) within the alluvium in the Goulburn River and Wilpinjong Creek areas beyond the immediate proximity of the MCP are predicted. Surfical and palaechannel aquifers within the footprint of OC4 will be completely removed by mining. The removal of these aquifers will cause a temporary impact on groundwater levels in the Wilpinjong Creek valley, where these water table aquifers are in connection with their downstream counterparts. However these are expected to fully recover, post-mining.

At the end of the 100-year recovery period, groundwater levels in all the main hydrogeological units are predicted to recover to at least existing baseline levels. In some instances, the recovered levels are predicted to be higher since existing levels include a significant component of prior dewatering from the Ulan coal mine.

5.4.5.2 Groundwater Quality

There is no adverse impact predicted on the existing quality of groundwater sources outside the Stage 2 Project Area as a result of Stage 2.

As open cut mining progresses through the Murragamba and Eastern Creek valleys, the quality of groundwater inflows into OC4 will vary in direct response to the quality of water in aquifers intersected by mining. More saline groundwater inflows are expected toward the northern part of the Murragamba Creek valley where saline surficial aquifers will be intersected. This will have the effect of removing saline groundwaters from parts of the landscape, which will ultimately improve the quality of surface water flows in Wilpinjong Creek downstream of MCM's mining operations.

5.4.5.3 Baseflow

Baseflow to Wilpinjong Creek above and below the confluences of Murragamba and Eastern creeks has been modelled for existing, during mining and post-mining conditions.

Groundwater modelling predicts that, prior to commencement of Stage 2, baseflow is 0 m^3/day in Murragamba Creek and Eastern Creek, 5 m^3/day in Wilpinjong Creek above the confluence with Murragamba Creek, and 47 m^3/day in Wilpinjong Creek above the confluence with Cumbo Creek, downstream from the Stage 2 Project Area.

Baseflow to both reaches of Wilpinjong Creek (i.e., above and below the confluences of Murragamba and Eastern creeks) is predicted to increase significantly as a result of mine scheduling at the Wilpinjong coal mine, but is then predicted to reduce to zero during the mining of UG4. Post-mining, baseflow to Wilpinjong Creek is predicted to recover to above existing levels, assuming all mining (i.e., the MCP, Ulan and Wilpinjong coal mines) has ceased.

Impacts on baseflow to all other surface drainages including the Goulburn River were addressed in the Stage 1 EA report (PDA, 2006a and 2007a). It is predicted that Stage 2 will not cause any additional baseflow impacts on these water bodies.

5.4.5.4 Existing Use

Apart from a small number of abandoned groundwater access points, all other groundwater features have been considered as potential water supply points, even though many are not used or are unlikely to be used for water supply. All bores, wells, waterholes, springs, soaks, scalds and groundwater-fed farm dams within the footprint of OC4 will eventually be lost through the course of mining. This includes up to 57 groundwater features, including three registered bores in the Murragamba Creek valley. All of these features are on mine-owned land.

No impact to existing users of groundwater from alluvial aquifers is predicted and there are no existing users of groundwater from the palaeochannel aquifers.

Six bores developed in Triassic-age Narrabeen Group sediments to the north of the MCP are predicted to be impacted to some extent by dewatering of UG4. Groundwater levels in these bores are predicted to be drawn down by up to 8 m, but will recover to within at least 0.8 m of existing levels. The Stage 1 assessment indicated only two of these bores would be impacted, but with drawdowns of less than 1 m. The predicted increase in the number of bore users affected by decreased water levels in the Narrabeen Group aquifers is believed to be due to increased permeability effects associated with wider longwall panel extraction at the Ulan coal mine (see Section 5.4.5.1), not the result of Stage 2 mining.

The model predicts that the MCP may decrease groundwater availability and flow at groundwater supply points in Permian rock aquifers at up to 6 km from the centre of OC4 and UG4, with complete loss of groundwater availability at some existing supply points. This includes up to 25 sites comprising bores, soaks and groundwater-fed farm dams that may dry out. Of these, 22 are on MCM-owned land, one is a farm dam on Ulan Coal Mine Ltd-owned land and the other two are soaks on privately-owned land. The latter two groundwater features were addressed in the Stage 1 investigations. Groundwater level and flow conditions within Permian rock aquifers are expected to return to existing conditions within 10 to 20 years after mining (i.e., at the MCP, Ulan and Wilpinjong coal mines) has ceased.

5.4.5.5 Groundwater Dependent Ecosystems

The assessment of potential impacts to GDEs was carried out in accordance with the NSW Groundwater Dependent Ecosystems Policy (DLWC, 2002) and is discussed further in Section 5.7.

Of the two significant GDEs identified in the Eastern Creek valley, one will be lost as a result of mining OC4. The other, at the head of the valley, is not predicted to be impacted. Other GDE sites that occur within the footprint of OC4 will be lost as a result of mining.

No GDEs have been identified as occurring above UG1 and UG2.

5.4.5.6 Final Void Impacts

An approximate 34-ha 80-m-deep void will be left in OC4 at its eastern margin, immediately adjoining Wilpinjong coal mine tenements (see Plan 10 in Volume 2) at the completion of mining. It is predicted that the salinity concentration of the void lake water compared to surrounding groundwater will increase due to evaporation from the open water surface. It is expected that the void lake will act as a local hydrologic sink (as it is predicted that evaporation will be greater than groundwater and rainfall inflows) and will not impact on the quality of surrounding groundwater or surface water bodies. The final post-mining water level of the void lake has not been predicted as it will also be influenced by the final configuration of mining at the Wilpinjong coal mine, which is unknown at this time. The impact of Stage 1 open cut voids was assessed in the Stage 1 EA report (Wells Environmental Services, 2006).

5.4.5.7 Mine Water Supply

Groundwater will be used as a source of water for the MCP (including Stage 2). This will be obtained from inflows into pit voids and from dewatering and groundwater supply bores. The water balance and components of mine water supply are described in more detail in Section 5.6.5.

Groundwater modelling was carried out to simulate groundwater inflows, dewatering and mine water supply requirements. As previously indicated, modelling assumed Stage 1 and Stage 2 will be operated concurrently over a 30 year time period. The cumulative impact of groundwater inflows and extractions from the Ulan and Wilpinjong coal mines were also included.

The first groundwater model run assumed that the only groundwater available was from inflows into mine areas (i.e., no extractions from water supply bores). When combined with the predicted quantities of surface water capture (see Section 5.6.4), estimated available water supplies were insufficient to meet the water demands for Stage 2 operations in all but the last year.

A second model run incorporated groundwater inflows to mine areas (open cut and underground voids) and pumping from the MCP borefield. Pumping was assumed to occur from the Ulan Seam and overlying lower Permian rock aquifers (groundwater model layers 7 and 6 respectively) (see Appendix 5 in Volume 3). However, even with optimal bore pumping and the addition of estimated surface water capture, shortfalls in water supply are predicted in 11 of the 24 years of Stage 2 operations.

The estimates of surface water capture used with predicted groundwater flows in these first two model runs assumed average rainfall conditions in all years. Further model runs were carried out to estimate combined groundwater and surface water availability in very low rainfall years (i.e., extremely dry years), low rainfall years and high rainfall years. However, in all scenarios the model predicts a water deficit in at least 11 of the 24 years of Stage 2 operations. This is discussed in more detail in Section 5.6.4.

Small water surpluses were predicted in some years when modelling included groundwater extractions from the water supply borefield. This is because the model requires pumping rates to be specified in advance. In reality, there would be no surplus as bores would only be pumped as required.

It is predicted that surplus water will be generated from about Year 17 onward. This coincides with the dewatering of UG4 in advance of mining. The impacts associated with dewatering UG4 and pumping from the borefield were considered in the 2006 Stage 1 EA report (PDA, 2006a and 2007a). Where excess groundwater requires discharge to the environment, it will be treated to an appropriate standard before discharging in accordance with any EPL requirements that may be imposed.

5.4.6 Environmental Management

5.4.6.1 Groundwater Monitoring

Groundwater management (see Section 5.4.6.3) will be based on the results of a groundwater monitoring program. This program will include monitoring of groundwater quality and quantity (i.e., groundwater levels) for Stage 1 and Stage 2, the details of which will include:

- Determining baseline conditions (quality, level and flow as applicable) for all groundwater access points identified in the groundwater census (see Section 5.4.2.1), including recording of the exact location of each point.
- Recording of the volume and quality of groundwater pumped from dewatering and water supply bores.

- Regular measurement (monthly or continuous from automated loggers) of groundwater levels from the network of pumping bores and monitoring bores and sites, including continuing the current baseline groundwater level monitoring program.
- Quarterly sampling and analysis of groundwater from all pumping bores, and annual sampling and analysis of groundwater quality from a representative set of monitoring bores, including continuing the current baseline groundwater quality monitoring program.

The groundwater monitoring program will also include monitoring of subsidence induced impacts on groundwater resources. Multi-level vibrating-wire piezometers have been installed to enable ongoing monitoring of the impacts of these underground mines, although the Permian-age, Triassic-age and surficial aquifers above UG1 and UG2 are at best only partially saturated. A comprehensive monitoring program will be developed for UG4 prior to mining in this area, as required by the Stage 1 Project Approval.

5.4.6.2 Management and Contingency Response

Groundwater inflows into Stage 2 mine voids (OC4, UG1 and UG2) will be collected in catch drains and transferred to a water sump in the void floor. The water will be pumped from the sump and either used directly for dust suppression or other mine use, or transferred to another water storage dam for reuse. Similarly, groundwater from dewatering bores will be transferred to a water storage dam for reuse. The Water Management Strategy for Stage 2 is described in Section 5.5.6.2.

A groundwater response plan, which will form part of the Surface Water and Groundwater Response Plan, will be prepared and implemented for Stage 2, and in conjunction with the Stage 1 plan will form an integrated plan for the whole of the MCP. This plan will detail management, mitigation and contingency measures that will be applied in the event that the MCP causes unforeseen adverse impacts on the groundwater environment. This plan will also consider measures to respond to surface water impacts, since there is an interconnection between groundwater and surface water sources both on and off the mine site. Specific management and contingency measures developed for Stage 2 will be included in the integrated MCP Surface Water and Groundwater Response Plan.

5.4.6.3 Response Monitoring Sites

Aquaterra has recommended a number of groundwater monitoring sites (see **Table 5.4.1** and Plan 30 in Volume 2) where groundwater trigger values will be adopted. These will be used to initiate a management response in case of impacts to the surrounding groundwater environment during construction and the first three years of Stage 2 operations. After this time, the number and location of monitoring sites for Stage 2 where trigger values will be adopted will be reviewed.

Table 5.4.1 Groundwater monitoring locations

Monitoring Bore ID	Aquifer	Screened Interval (m below ground level)	Date Monitoring Commenced	Notes
PZ158	Surficial alluvium	11.5 to 14.5	March 2008	-
PZ52	Tertiary-age Palaeochannel fill	24 to 30	August 2005	-
TB52B	Tertiary-age Palaeochannel fill	31 to 37	January 2006	-
PZ181	Tertiary-age Palaeochannel fill	21 to 24	March 2008	-

Table 5.4.1 Groundwater monitoring locations (cont'd)

Monitoring Bore ID	Aquifer	Screened Interval (m below ground level)	Date Monitoring Commenced	Notes
PZ184	Tertiary-age Palaeochannel fill	6 to 9	July 2008	-
PZ150	Regolith and Surficial alluvium	10 to 13	January 2008	-
PZ152	Ulan Seam	82.5 to 88.5	January 2008	Paired piezometer site
PZ179	Triassic-age sediments and Permian-age coal measures, including Ulan Seam	28, 33, 82, 145	July 2008	Multi-level vibrating-wire piezometer
PZ164	Upper and Middle Permian-age coal measures	20.5 to 26.5	March 2008	-
PZ165	Surficial alluvium	2.5 to 5.5	March 2008	Paired piezometer site
PZ172	Upper and Middle Permian-age coal measures	18 to 21	March 2008	-
PZ173	Regolith and Surficial alluvium	6 to 9	March 2008	Paired piezometer site
PZ176	Upper and Middle Permian-age	19 to 25	March 2008	-
PZ177	Regolith and Surfical alluvium	4 to 7	March 2008	Paired piezometer site
PZ39	Lower Permian-age coal measures	57 to 60	July 2005	-
PZ111	Ulan Seam	71 to 77	April 2006	-

5.4.6.4 Trigger Values and Response Measures

Aquaterra has recommended initial trigger values for Stage 2 (see **Table 5.4.2**) that will be applied at the groundwater monitoring sites in Table 5.4.1. These trigger values will be reviewed against the baseline groundwater data at the end of the first three years of mining.

5.4.6.5 Review and Reporting

The groundwater monitoring data will be subject to annual review by an experienced hydrogeologist. This will enable the impacts of the MCP on the groundwater environment to be assessed in detail, and to compare any observed impacts with those predicted from the numerical groundwater flow modelling.

Two years after coal production commences at the MCP, a modelling post-audit will be undertaken in accordance with industry best practice (Aquaterra, 2001). Further post-audits will be carried out at five-yearly intervals throughout the remaining mine life. This will enable the predictions of the pre-mining numerical groundwater flow model to be validated. Where required, the model will be re-calibrated and re-run to update model impact predictions. However, if this review or post-audits indicate significant variance between observed and predicted groundwater levels and quality, then the implications of this will be assessed and an appropriate response developed and implemented in consultation with the DWE, DPI and DECC, as required.

The Stage 1 Project Approval (condition 33 of schedule 3) requires MCM to undertake a Regional Water Supply and Monitoring Investigation in consultation with the DECC, DWE, DPI and Ulan and

Wilpinjong coal mines. The investigation is to consider the potential for developing a regional surface and groundwater monitoring program that broadly encompasses the Ulan, Wilpinjong and MCP (Stage 1) mines. MCM will extend this investigation to incorporate the whole of the MCP, with a view to form an integrated monitoring program through partnership and data-sharing with the nearby Ulan and Wilpinjong coal mines.

Table 5.4.2 Trigger values and response measures

Parameter	Trigger	Response
Groundwater level	20% or more increase in drawdown (i.e., decrease in groundwater level) over any consecutive three month period.	Monitoring data will be immediately referred to an appropriately qualified and experienced hydrogeologist for review. The reviewer will assess the data to establish the nature of the decreased groundwater levels and the reasons for it, and will be asked to recommend an appropriate response action plan for implementation, in consultation with relevant government authorities. It is expected that the recommended actions are likely to involve one or more of the following: • Reduction in pumping rate from a particular pumping bore or bores. • Cessation of pumping from a particular pumping bore or bores. • Modification to the mine plan. • Continuation of pumping and dewatering, with closer monitoring. • No change to the operations. In the event that an existing water supply is adversely affected by an increase in predicted drawdowns, and that impact is shown to be directly attributed to MCP activities, then an alternative or replacement water supply of similar or better supply rate and quality will be offered to the affected user.
Groundwater quality	50% or more increase in salinity compared to long-term baseline averages.	Monitoring data will be immediately referred to an appropriately qualified and experienced hydrogeologist for review. The reviewer will assess the impact on other users or the environment. If remedial action is recommended by the reviewer, then the recommended action will be implemented in consultation with relevant government authorities. It is expected that the recommended actions are likely to involve one or more of the following: • Re-location of dewatering pumping location(s). • Cessation of pumping from one or more bores. • Increase in rate of pumping from one or more bores. • Continuation of pumping and dewatering, with closer monitoring. • No change to the operations. In the event that an existing water supply is adversely affected by an increase in salinity, and that impact is shown to be directly attributed to MCP activities, then an alternative or replacement water supply of similar or better supply rate and quality will be offered to the affected user.

5.5 Surface Water

5.5.1 Objectives

The objectives of the surface water assessment are to:

- Establish the existing hydrologic characteristics of the Stage 2 Project Area.
- Describe the potential impacts that Stage 2 will have on the existing hydrologic regime.
- Examine and quantify the flooding characteristics of Murragamba and Eastern Creeks.
- Develop a conceptual design for the relocation and reinstatement of Murragamba and Eastern Creeks post-mining.
- Develop a site water management strategy.

5.5.2 Assessment Method

Worley Parsons (formerly Patterson Britton & Partners Pty Ltd) assessed the hydrologic characteristics of the Stage 2 Project Area, and the impact of Stage 2 on the existing hydrologic regime. The assessment builds on the surface water studies carried out for Stage 1. A copy of the surface water assessment report is included as **Appendix 6A** in Volume 4.

The surface water assessment includes:

- Baseline surface water monitoring.
- Surface flow analysis.
- Flood modelling.
- Water quality and ecosystem condition.
- Creek diversion and realignment.

The majority of Stage 2 surface water impacts will result from open cut mining in the Murragamba and Eastern Creek catchments, and it is these areas that form the focus of the following assessment.

5.5.2.1 Baseline Monitoring

Monthly sampling and testing of surface water has been carried out at nine monitoring sites (see Plan 16 in Volume 2), since February 2005. These sites were established for Stage 1 studies (Wells Environmental Services, 2006) and include:

- SW1 – Goulburn River downstream of the 'The Drip'.
- SW2 – Goulburn River at 'The Drip' Picnic Area.
- SW3 – Murragamba Creek at Murragamba Road crossing.
- SW4 – Murragamba Creek at Ulan-Wollar Road.
- SW5 – Goulburn River – Moolarben Creek confluence at the Ulan-Cassilis Road crossing.
- SW6 – Ryans Creek near Ulan Road.
- SW7 – Lagoon Creek within the 'swampy section' in its upper reaches.

- SW8 – Moolarben Creek midway between its confluence with Springs Creek and Lagoon Creek.
- SW9 – Moolarben Creek upstream from its confluence with Springs Creek.

Two of these monitoring sites are within the Stage 2 Project Area, namely SW3 and SW4. All other sites are within the Stage 1 Project Area and were described in detail in the Stage 1 EA. A further five monitoring sites SW10, SW11, SW12, SW13 and SW14 (see Plan 16 in Volume 2) will be installed prior to commencement of Stage 1 operations.

5.5.2.2 Surface Flow Analysis

A conceptual surface water catchment model was developed for the Murragamba and Eastern Creek valley catchments. This was used to construct a 'node and link' surface flow network based on physical catchment characteristics including catchment area, slope, roughness and percent impervious area. These parameters were obtained from 1:25,000 10-m topographic contour mapping, detailed photogrammetric 1-m contour generation, air photo interpretation and visual inspection. Each node represents the runoff contribution from smaller sub-catchments within the two main Stage 2 catchment areas (Murragamba and Eastern Creek catchments).

The conceptual node and link model forms the basis for numerical catchment runoff modelling, which was carried out using the RAFTS-XP software package. Spatial and temporal rainfall intensities were derived from the Institution of Engineers Australia Australian Rainfall and Runoff guidelines (IEAust, 1987). The model assumes an initial and continuing loss of rainfall due to infiltration, vegetation capture and evapotranspiration, with an initial loss of 10 mm and continuing loss of 5 mm/hr applied. The remaining rainfall constitutes the amount of runoff flowing through the catchments.

The model was calibrated using the approach outlined in the Australian Rainfall and Runoff guidelines, as there was insufficient continuous stream flow data available from the area to enable reliable calibration. Parameter values used to calibrate the model were obtained from the RAFTS User Manual and the Australian Rainfall and Runoff guidelines.

The calibrated model was used to assess the change in flow between pre and post-mining catchment conditions, with the predicted change determined from the difference in modelled catchment flows.

5.5.2.3 Flood Modelling

A HEC-RAS flood model was developed to define design flood behaviour along both Murragamba and Eastern Creeks. The model was used to simulate 5, 20 and 100-year recurrence flood and probable maximum flood (PMF) levels.

This required estimating the critical storm duration for each catchment. The critical storm duration is defined as the storm duration that produces the highest peak discharge at the downstream catchment boundary (i.e., Ulan-Wollar Road crossing). The model assumes a critical storm duration of 6 hours for both catchments.

5.5.2.5 Water Quality and Ecosystem Condition

Surface water quality has been assessed against Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). This included comparison of baseline data for pH, salinity, turbidity and nutrients against aquatic ecosystem trigger values for upland rivers (see **Table 5.5.1**).

In addition to water quality, these ANZECC guidelines define three levels of ecosystem condition for surface waters, namely high ecological value aquatic ecosystems, slightly to moderately disturbed aquatic ecosystems and highly disturbed aquatic ecosystems. The objective for these is to respectively conserve, maintain or improve the condition of the aquatic ecosystem. An assessment of creek condition has been made against these definitions.

Table 5.5.1 ANZECC water quality guideline trigger values for upland rivers

Parameter	Aquatic Ecosystem Physical and Chemical Stressors
Total Nitrogen (mg/L)	0.25
Total Phosphorus (mg/L)	0.02
pH	6.5 to 8.0
Turbidity (NTU)	2 to 25
Salinity (µS/cm)	350

5.5.3 Existing Environment

5.5.3.1 Site Hydrology

The Stage 2 Project Area is located across four small sub-catchments within the Goulburn River Catchment. These sub-catchments form part of the headwaters to the greater Hunter River Catchment.

The Stage 2 ROM coal facility is located within the small ephemeral catchment of Bora Creek. This drains directly into the Goulburn River diversion channel around the Ulan coal mine. Stage 1 infrastructure (offices, CHPP and rail loop) is also located in the Bora Creek catchment. Stage 2 underground mines (UG1 and UG2) are located beneath the ridgeline between Moolarben Creek and Murragamba Creek valleys. Stage 1 open cuts (OC1, OC2 and OC3) are located in the Moolarben Creek valley, which drains into the Goulburn River. The Stage 2 open cut (OC4) is located in the Murragamba and Eastern Creek valleys. These valleys form part of the headwaters of the Wollar Creek Catchment, a sub-catchment to the Goulburn River Catchment.

The Murragamba and Eastern Creek valleys are relatively wide, consisting of open grassland with low slope. Surface flows are provided by storm runoff from the steep upper slopes of the Munghorn Gap Nature Reserve and surrounding timbered ridgelines. Runoff from these steeper areas quickly becomes concentrated in numerous small intermittent drainage lines and gullies. Where these meet the lower cleared valley floor, they typically diminish and the runoff discharges as either overland sheet-flow or via ill-defined channels, draining ultimately into Murragamba and Eastern Creeks.

Both Murragamba and Eastern Creeks flow northward, discharging into Wilpinjong Creek north of the Ulan-Wollar Road. Water then flows eastward across Wilpinjong mine's tenement frontage into Wollar Creek, about 12 km downstream from Stage 2. Wollar Creek flows in a northeasterly direction through the Goulburn River National Park where it eventually joins the Goulburn River.

The Goulburn River joins the Hunter River downstream of Denman, about 80 km from the Stage 2 Project Area. The existing catchment hydrology is shown in **Plan 34** in Volume 2.

A number of springs and seeps discharge groundwater to the surface throughout the Murragamba and Eastern Creek catchments. However, the majority of this spring water is captured in farm dams.

Aquaterra has determined that baseflows to Murragamba and Eastern Creeks do not sustain permanent water flow in either of these creeks (see Section 5.4.3.4).

5.5.3.2 Rainfall, Sunshine and Evaporation Characteristics

Rainfall in the area is variable, with an average of 610 mm per annum at Ulan. Rainfall occurs throughout the year with a slightly higher seasonal distribution in summer. Intense showers, particularly in summer, characterise much of the rainfall and account for falls of up to 130 mm in 24 hours.

The average number of hours of bright sunshine per day in summer months is 9 hours and in winter months is 6 hours.

The average annual evaporation of the Ulan area is about 1,730 mm. The relatively low rainfall and high evaporation means the area typically exhibits the characteristics of a semi-arid climate.

5.5.3.3 Catchment Characteristics

The Stage 2 Project Area comprises considerable topographic relief, with elevations varying from 400 m to over 500 m AHD. The area of Murragamba Creek catchment is 2,220 ha and that of Eastern Creek catchment is about 930 ha, with a combined total of about 3,150 ha.

In the upper valley floor areas the creeks are ill-defined, consisting more of a depression in the floodplain rather than a creek channel. The creeks become more defined with distance downstream and there is an increase in the density of vegetation along the banks of the lower reaches of both creeks.

Vegetation coverage across the two catchments varies considerably. The steeper sections are typically densely vegetated and uncleared. The lower valley floor areas comprise wide, relatively flat floodplains, which have been cleared for grazing, which is the predominant land use in the valleys (see Section 5.17).

As reported by JAMMEL (see Section 5.11), the majority of the Murragamba and Eastern Creek catchments comprise soils of the Ulan soil landscape. These soils have imperfect to poor drainage and pose a moderate to high erosion hazard.

5.5.3.4 Stream Characteristics

Murragamba Creek

As indicated, the upper reaches of Murragamba Creek are ill-defined, existing more as a vegetated depression. Channel definition increases with distance downstream.

The upper section of the creek (approximately 2 km in length) conveys drainage from the Munghorn Gap Nature Reserve through to a geomorphologically sound section of creek. From this point the creek comprises an approximate 1-km long section of well defined channel with areas of exposed bedrock. The creek banks along this section are densely vegetated with both small and large -sized trees. This section of the creek is considered to be hydraulically and geomorphologically stable, being able to withstand the erosive forces of high flows and floodwaters. It is also considered to have high ecological and archaeological values (see Sections 5.7 and 5.9). Beyond this point, the creek comprises sections of disturbed channel morphology typical of that found in most cleared valley agricultural landscapes.

The longitudinal grade of Murragamba Creek is typically about 1 vertical in 100 horizontal (i.e.,1%), although some sections approach grades of 1 in 50 (i.e., 2%), which is considered to be hydraulically steep.

Worley Parsons has defined Murragamba Creek as a slightly to moderately disturbed ecosystem.

Eastern Creek

Eastern Creek has similar channel characteristics to Murragamba Creek. The grade of the valley in the upper reaches is about 2%, and that of the lower reaches about 1%.

Worley Parsons has defined Eastern Creek as a slightly to moderately disturbed ecosystem.

5.5.3.5 Surface Water Quality

Monitoring results for all baseline monitoring sites is included in Appendix 6A in Volume 4. The results for monitoring sites in the Murragamba Valley (sites SW3 and SW4) are briefly described below.

Salinity – Electrical Conductivity and Total Dissolved Solids

Average salinity measured as electrical conductivity (EC) at sites SW3 and SW4 is 689 μS/cm and 866 μS/cm, respectively.

Average salinity measured as total dissolved solids (TDS) is 413 mg/L at SW3 and 520 mg/L at SW4. This is above the ANZECC (2000) trigger value for NSW upland rivers. The maximum TDS concentration for stock watering of beef cattle is 5,000 mg/L (ANZECC, 2000).

Elevated salinity in Murragamba Creek is attributed to saline soils in the upper sections of the catchment and to moderately saline to saline groundwaters in the lower reaches (see Section 5.4).

pH

The average pH of surface water at sites SW3 and SW4 is 6.35 and 6.39 respectively, with a range of 5.10 to 7.50 across both sites. This is consistent with the values measured in groundwater in the Murragamba Creek valley. The average values are slightly more acidic than the aquatic ecosystem guideline trigger values (pH 6.5 to 8.0).

Turbidity

High average turbidity levels of 78.3 NTU and 120.7 NTU were recorded for sites SW3 and SW4, respectively. These are above aquatic ecosystem guideline trigger values (2 to 25 NTU).

Soils mapping (see Section 5.11) indicates the presence of Yellow Podzolic, Red Podzolic and Alluvial soils across the upper sections of Murragamba Creek catchment. These include fine sandy soils and dispersive clays. Considerable gulling and erosion is evident in Murragamba Creek (see **Figure 5.1**) and along many of its feeder channels. There is a direct correlation with elevated turbidity and high rainfall events.

Figure 5.1 View looking downstream along the lower reaches of Murragamba Creek showing the extent of bank undercutting and erosion

Nutrients – Nitrogen and Phosphorous

The average total nitrogen concentration for sites SW3 and SW4 is 0.96 mg/L and 1.01 mg/L, and the average total phosphorous concentration is 0.08 mg/L and 0.09 mg/L, respectively. These are both in excess of the aquatic ecosystem guideline trigger values (see Table 5.5.1). The elevated values indicate in-stream nutrient concentrations are linked to agricultural land use (past and present) throughout the valley.

5.5.4 Issues

The following issues were addressed as part of the surface water assessment:

- Water quality and quantity impacts.
- Creek diversions and realignment.
- Altered flood regime.

5.5.5 Impact Assessment

5.5.5.1 Water Quality and Quantity

Stage 2 ROM Coal Facility Area

The Stage 2 ROM coal facility is described in Section 4. Hardstand areas, workshops, coal ROM pads and other infrastructure will lead to increased impervious surface area and introduce various potential contaminants to the Stage 2 Project Area, such as hydrocarbons, acids, salts, sewage and sediment. If unmanaged, this will lead to decreased water quality in Bora Creek and ultimately the Goulburn River.

Hardstand areas (building roofs, car parks, road surfaces) will lead to more rapid throughput of rainfall into Bora Creek, and ultimately the Goulburn River.

Increased sediment load, if uncontrolled, could partially or completely block culverts that drain runoff along Bora Creek beneath Ulan-Cassilis Road. This was investigated in the Stage 1 flood studies, which concluded that partial blockage of these road culverts would have a significant impact on flood behaviour in the lower reaches of Bora Creek.

These impacts will be greatly reduced with the implementation of appropriate management measures.

Area Above Underground Mines

The potential for surface cracking due to subsidence from longwall mining in UG1 and UG2 is discussed in Section 5.8. Up to 1,980 mm of surface subsidence and surface fracturing along some drainage lines above the longwalls is predicted. These effects will be superimposed on the generally steep surface topography overlying the longwalls.

Drainage lines above the underground mines are ephemeral and high in the catchment headwaters with flows occurring for only short periods during and after rainfall events. Some natural ponding already exists in these drainages, generally lasting for only short periods after major rainfall. Surface subsidence due to longwall extraction is expected to lead to additional ponding. However, it is expected that the gradients of the drainage lines following subsidence will be similar to that existing before mining. Sections of beds downstream from ponded areas may erode, especially during times of high flow. Hence, the extent of additional ponding along drainage lines is expected to decrease with time. As this is a net evaporative region the residence time of potentially ponded water is expected to be low and seasonally dependent. Additional ponding may also provide some benefit to local fauna.

Cracking of the beds of drainage lines above the underground mines will occur, particularly in areas where the depth of cover is less than 100 m. Connective cracking is also predicted between the surface and the underground workings in areas of shallow cover (see Section 5.8.5).

Some infiltration of surface water into cracks is expected, particularly during low flow events, although the generally steep terrain, small subcatchments and intermittent flow (being directly related to rainfall runoff) are not expected to be conducive to persistent low flow conditions. In times of heavy rainfall, the majority of runoff will be expected to flow over these surface cracks. However, some loss of surface flows may occur where connective cracking develops in the drainage lines. This may be exacerbated in low gradient drainage areas where ponding due to subsidence develops above zones of bedrock cracking and fracturing. The quantity of water potentially entering the mine through connective cracks will depend on a number of factors. This includes the number of cracks and fractures that develop in the beds of the drainage lines, the quantity of water flowing over the cracks, the time this water is available for infiltration into the cracks and the hydraulic conductivity of the cracks and fractures (see Section 5.8.5.1).

While it is expected that surface fractures will naturally fill with sediments, some remediation of the beds of the drainage lines is expected to be required. This will be done through the manual infilling of cracks with clay materials or other inert sealing compounds. In areas where sufficient sealing cannot be achieved to reduce the risk of mine inflows temporary drainage diversions may need to be established.

The overall impact on the quality and quantity of surface water draining from the ridges above UG1 and UG2 is expected to be minor, as only minor changes in drainage are predicted from surface subsidence from longwall mining.

Open Cut Mining Area

As OC4 proceeds, a sequence of clearing, mining, backfilling and rehabilitation will occur. The catchment will change compositionally from vegetated land to bare soils and earth with occasional areas of impervious hardstand (such as haul roads), and then back to vegetated lands.

Open cut mining will alter natural runoff regimes. The process of disturbing the land; exposing saline and highly erodible saline soils, dispersive clays (see Section 5.11) and incompetent weathered materials; and creating out-of-pit overburden emplacements will increase the potential for surface runoff to collect sediment, salt and other potential contaminants. Without the use of appropriate control measures, this will increase sediment and salt loads in catchment out flows and impact on downstream users.

The open cut operation will remove near-surface aquifers, which will reduce the amount of potential baseflow available to support surface flows. Aquaterra has determined that there is minimal baseflow to Murragamba and Eastern Creeks from the near surface aquifers in these valleys (see Section 5.4). Hence this impact is expected to be minor. As mining progresses through the valleys, the dewatering of near surface aquifers may improve offsite surface water quality as the potential for interaction between surface flows and saline groundwaters is diminished.

Mining of OC4 will also remove sections of Murragamba and Eastern Creeks. These will be diverted during mining and reinstated in the post-mining landform (see Section 5.5.6.3). The open cut mine plan avoids the geomorphologically stable section of Murragamba Creek. This will reduce the potential for impact on the ecological value in this area of the valley.

5.5.5.2 Creek Diversion and Realignment

To maximise open cut coal recovery, OC4 will mine through sections of both Murragamba and Eastern Creeks. This will require the temporary diversion of surface flows around the open cut operations and the reinstatement of the creeks in the final post-mining landform. Approximately 7 km of Murragamba Creek and 5 km of Eastern Creek will be relocated as result of mining OC4.

The new creek alignments will be constructed in areas of unmined ground and backfilled overburden. The realigned sections will be constructed to fit in with retained creek sections. Once mining is complete, both creeks will comprise a mix of natural and reconstructed alignments. The sequence and location of creek realignments is shown schematically in Plans 5 to 10 in Volume 2 and in Appendix 6A in Volume 4 and discussed further in Section 5.5.6.3.

The realigned sections will increase overall stream length and channel sinuosity, and decrease bed slope, compared to existing creek conditions. Despite this, the new alignments will be susceptible to stream bed and bank erosion, particularly under high velocity flow conditions. If unmitigated, this will lead to erosion and the development of degraded unstable drainage channels in the post-mining landscape, which will lead to increased sediment load in Wilpinjong Creek.

It is expected there will be little opportunity for groundwater baseflow to develop in the post-mining landscape, and it is anticipated that the reconstructed creeks will remain disconnected from the developing water table within the backfilled void.

Open cut mining will permanently alter the characteristics of the Murragamba and Eastern Creek catchments. The net impact will be to alter the flow regime of both creeks, which will ultimately alter environmental flows draining into Wilpinjong Creek. However, MCM has committed to maintain environmental flows in these creeks for the duration of the project (see Section 5.6).

5.5.5.4 Flooding

The realignment of both Murragamba and Eastern Creeks will lead to a change in creek hydraulics during and after mining. This has the potential to change the extent of possible flood inundation in the catchments.

The Stage 2 Project Area is located outside the predicted 100-year recurrence flood event. Hence, development of Stage 2 will not impact on existing flood behaviour. For floods in excess of this, Worley Parsons predicts that a small section of OC4 adjacent to the geomorphologically sound section of Murragamba Creek will be prone to flood inundation. To avoid this, Worley Parsons has recommended that a small levee be constructed as a precautionary measure between the edge of OC4 and the creek in this section.

Flood modelling predicts that the peak 100-year recurrence flood for the realigned creeks in the post-mining landscape will be contained within the reconstructed creek corridors, for both Murragamba and Eastern Creeks.

5.5.6 Environmental Management

5.5.6.1 Water Management Strategy

A conceptual Water Management Strategy for the MCP (inclusive of Stage 2) has been prepared taking into consideration the guidelines documented in the Hunter-Central Rivers Catchment Action Plan (HCRMA, 2007). The aim of these guidelines is to achieve best practice in natural resource management and to reduce the impacts of mining on the environment.

The conceptual Water Management Strategy for the MCP is shown in Plan 15 in Volume 2 and is based on the following broad strategic objectives:

- Clean surface water runoff is diverted around the site and used to maintain environmental flows.
- Groundwater inflows to open cut mining areas are used for mining purposes.

- Groundwater from dewatering bores or production bores is used for mining purposes.
- Runoff from disturbed or operational areas is captured and stored in strategically located sedimentation ponds and used for dust suppression and for the irrigation of rehabilitated disturbed areas.
- Re-use of mine water is maximised.
- Water sharing with neighbouring coal mines is undertaken, where possible.
- Surplus dirty water is treated and discharged according to the requirements of Environment Protection Licence conditions, unless required for on-site use or at adjacent coal mines.
- Development and implementation of a Surface Water Monitoring Program and a Surface Water and Groundwater Response Plan for the MCP incorporating measures and requirements specific for Stage 2.
- Development and implementation of a detailed Creek Rehabilitation Plan for Murragamba and Eastern Creeks.

This strategy promotes the use of good quality water to be diverted away from mining areas to be used for maintaining environmental flows, re-use of the increasing volumes of dirty water generated as open cut mining progresses and water sharing with adjacent mines to reduce demand on the production borefield.

5.5.6.2 Surface Water Management

Erosion and Sediment Control

Erosion and sediment control measures will be implemented to protect downstream surface water quality during both the construction and operational phases of Stage 2. These will be consistent with relevant government and industry guidelines for the control and management of sediment and erosion, including the Blue Book (Managing Urban Stormwater Soils and Construction, Landcom, 2004). This is discussed further in Sections 5.11 and 5.18.

Construction Phase

During construction, MCM will implement erosion and sediment control measures at strategic locations to control the quality of runoff from construction areas. This will include:

- Constructing and regularly maintaining catch drains, silt fences and sedimentation ponds downslope of all construction activities and disturbance areas.
- Revegetating disturbed areas as soon as practicable.
- Establishing oil collection and separation systems downslope of high trafficked hardstand and storage areas (this will avoid contamination of offsite surface runoff from these areas).
- Developing and implementing a sediment and erosion control program that includes frequent inspection and repair and maintenance of control structures.

Operational Phase

Erosion and sediment control will be implemented for the life of Stage 2, continuing until a stable post-mining landform is achieved. This will include:

- Clearly identifying and delineating areas to be disturbed so that only the minimal amount of ground is disturbed.
- Clearing and disturbing areas to permit the progress of mining only when required.
- Limiting the number of roads and tracks to be established.
- Constructing catch drains and sediment dams to capture and contain runoff from disturbed areas.
- Constructing temporary diversion drains and sedimentation ponds above disturbed areas to convey clean runoff around and away these areas.
- Constructing road, cut and fill and other earthworks batters with angles of 1 to 3 (vertical to horizontal) or less, where possible, to maximise long term slope stability.
- Reshaping, topsoiling and vegetating road, cut and fill and other earthworks batters as soon as practicable.
- Vegetating earthen bunds.
- Reshaping, rehabilitating and revegetating disturbed areas as soon as practicable.
- Constructing and regularly maintaining catch drains, silt fences and sedimentation ponds downslope of all disturbance areas.
- Developing and implementing a sediment and erosion control program that includes frequent inspection and repair and maintenance of control structures.

Clean Water Control

Surface runoff upstream of the open cut pit will be diverted and temporarily contained upstream of the mine pit and overburden areas to prevent water contamination. Diverted water will be used as a clean water source for maintaining environmental flows to both Murragamba and Eastern Creeks, and ultimately Wilpinjong Creek (see Section 5.6).

In other undisturbed areas, water will be diverted around mining operations through water swales and trench drains and either discharged directly to the existing creek channels or transferred to one of the clean water storage dams. Water in these storage dams will be piped to a suitable location for discharging into Murragamba or Eastern Creeks. Each dam has been designed to contain the runoff from a 100-year recurrence event from its upstream catchment.

The general location of the clean water storage dams (including indicative capacity), water swales, trench drains and diversion channels for the Stage 2 ROM coal facility and for successive mining years of OC4 is shown in **Plan 35, Plan 36, Plan 37, Plan 38 and Plan 39** in Volume 2. The indicative storage capacities of these dams is summarised in **Table 5.5.2**.

The clean water storage dams will generally be decommissioned as mining and rehabilitation progresses through the Murragamba and Eastern Creek valleys. Some of the dams may be retained in the final post-mining landscape and converted to artificial wetlands to improve habitat and biodiversity potential.

Table 5.5.2 Clean water dam storage capacity

Dam ID	Clean Water Dam Location	Indicative Capacity (ML)
Stage 2 ROM coal facility		
1	West and upstream of Stage 2 ROM coal facilities (see Plan 35 in Volume 2)	19.0
2	Central and upstream of Stage 2 ROM coal facilities, east of dam 1 (see Plan 35 in Volume 2)	35.0
OC4		
1	Head of Murragamba Valley upstream of Southern Out-of-Pit Emplacement (see Plan 36 in Volume 2)	152.8
2	Head of Murragamba Valley upstream of South-Western Out-of-Pit Emplacement (see Plan 36 in Volume 2)	3.1
3	West of OC4, north of dam 2 (see Plan 37 in Volume 2)	17.9
4	West of OC4, north of dam 3 (see Plan 37 in Volume 2)	22.7
5	West of OC4, north of dam 4 (see Plan 37 in Volume 2)	8.6
6	West of OC4, north of dam 5 (see Plan 37 in Volume 2)	26.5
7	Temporary dam prior to mining in Eastern Creek valley (see Plan 38 in Volume 2)	362.0
8	Head of Eastern Creek valley, south of dam 7 (see Plan 39 in Volume 2)	138.0
9	Downslope of eastern ridgeline, east of Eastern Creek valley (see Plan 39 in Volume 2)	17.5
10	Southern end of eastern limits of OC4, south of dam 9 (see Plan 39 in Volume 2)	35.0

Dirty Water Control

Rain that falls on each mine operational area will be intercepted by drainage swales and catch drains and distributed across the site. Swales and catch drains will be located strategically throughout the Stage 2 ROM coal facility, at the downslope side of each mine operation area, along the top of the OC4 pit wall and at the base of out-of-pit emplacement areas.

Runoff collected by in these features will be gravity fed (where possible) or pumped to sedimentation ponds. The sedimentation ponds will serve as local dirty water storage ponds, with the water being re-used for dust suppression and the irrigation of rehabilitated open cut areas as mine development progresses. The drainage swales, catch drains and sedimentation ponds will be designed to convey peak discharges based on a design 20 year recurrence storm event.

Further controls will be implemented for hard stand, workshop, office, chemical and fuel storage and refuelling areas. This will include dedicated storage areas, appropriately sized containment bunding and oil and water collection areas and separating apparatus, each designed for predicted high rainfall storm events.

As mining in OC4 progresses, the area of disturbance will increase. This will also increase the total volume of dirty water captured. This will require additional temporary sedimentation ponds to be progressively constructed at locations throughout the OC4 footprint. Runoff and groundwater that accumulates in the open cut pit will be collected and either pumped or diverted to these sedimentation ponds for storage. This water will then be available for dust suppression within the operating areas of the open cut and on the haul roads.

The capacity of each sedimentation pond has been sized to the predicted maximum volume of surface runoff from the disturbed area in which it is located, based on the required number of service years. The sizing of ponds assumes a maximum depth of 3.0 m and sufficient freeboard for a 20-year recurrence storm event. The size and approximate disturbance area each sedimentation pond services is summarised in **Table 5.5.3**. The location of these is shown in Figure 21 in Appendix 6A of Volume 4.

Runoff from rehabilitated areas will be collected, conveyed and or pumped to the sedimentation ponds and extracted for use in dust suppression, irrigation of rehabilitated areas and other mine purposes. Selected sedimentation ponds will continue to operate following the completion of mining and during the rehabilitation phase until a stage where high quality water is being captured from the rehabilitated areas. These will then either be progressively decommissioned or retained in the final landscape to enhance post-mining aquatic and terrestrial ecosystem development (see Section 5.18).

Table 5.5.3 Sedimentation pond storage capacities and indicative area of disturbance

Location	Indicative Area of Disturbance (ha)	Indicative Total Capacity (ML)
Stage 2 ROM coal facility		
MI3	45.8	12.0
OC4		
OC4A	350	30.0
OC4B	80	15.0
OC4C	80	8.0
OC4D	208	20.8
OC4E	165	16.5
OC4F	111	11.1
OC4G	158	15.8

5.5.6.3 Post-Mining Creek Realignments

The process of constructing creek realignments within overburden requires the mining of coal, emplacement of overburden, shaping of the new landform and construction of the new creek alignment with sufficient time to allow the constructed creek alignment to stabilise before water from the original creek is introduced into the new creek alignment. Environmental flows will be maintained where possible through the construction of temporary diversions and dams, and the pumping of water around disturbed areas into the creeks.

The conceptual design of the creek realignments is based on consideration of geomorphic features, stream ecology, riparian habitat and flood design, but recognises constraints such as the extent and sequence of open cut mining and the surrounding topography. The conceptual design generally follows the empirical design guidelines outlined in the Cooperative Research Centre for Catchment Hydrology's A Rehabilitation Manual for Australian Streams (Rutherford, 2000).

The realigned creeks will have a trapezoidal shaped low flow channel. The realigned channels will have a base ranging in width from between 2 and 4.5 m, a depth ranging from between 0.65 and 1.45 m and will carry peak discharges equivalent to the one year recurrence flood. The side-slopes of the channel will have a grade of 1 in 4 (vertical to horizontal) which will rise to an in-channel terrace. The in-channel terrace will range in width depending on the location in each of the creek alignments, with the side-slopes of the remaining section rising to the natural surface of the proposed post-mining floodplain.

The conceptual design also seeks to maximise the opportunity to incorporate meanders, replicating the characteristics of the existing creek channels. The meanders are designed with curve radii of approximately 50 m.

The creek base for the realigned sections will be constructed from compacted overburden material. This will then be seeded with native grasses to provide erosion protection in the bed of the channel. As both existing creeks are ephemeral it is expected that the establishment of native grasses within the reconstructed creek channel will provide sufficient protection from storm flows.

Additional structural measures will be included to control bed and bank scour channel erosion. This includes the use of rip-rap to a depth (approximately 0.5 m) below the anticipated bed scour depth at the interface between the stream bed and the lower bank slopes. Longitudinal grade control will be achieved by construction of artificial riffles or drop structures at frequent intervals along the realigned channels. Pools will be created by lining the base of the channel with clay in the areas upstream of riffle structures (see below for further detail). On shallower runs a mix of rock, gravel and river sand will be used to anchor the bed sediments.

This conceptual design will achieve hydraulically and geomorphologically stable realigned creek channels which, when finally rehabilitated, will be ecologically diverse with improved water quality compared to pre-mining conditions, and aquatic and terrestrial habitat.

The progression and final location of the realigned creeks is shown in Plans 5 to 10 in Volume 2. Conceptual creek cross sections at various points along the length of the creek realignments are shown in **Plans 40** and **Plan 41** in Volume 2, the locations of which are marked on Plans 5 to 10 in Volume 2.

Further detail on the conceptual design of the permanent creek diversions and detailed plans of the realigned creek sections are provided in Appendix 6A in Volume 4.

Murragamba Creek

The realigned Murragamba Creek will be approximately 7.5 to 8.0 km long, the final length being dependant on the detailed design and conditions encountered during the reinstatement and rehabilitation stage. This is about 1,000 m longer than the existing creek alignment. The additional length will reduce the bed slope from about 0.0106 to 0.0095 m/m (i.e., a reduction in grade of about 10%).

The realignment incorporates numerous meanders between the headwaters of the creek and the Gulgong–Sandy Hollow rail line crossing to replicate the meander characteristics of the existing channel. Downstream from the rail crossing the existing creek will be retained and rehabilitated to enhance the existing natural features of the creek. The realignment will occur on a progressive basis commencing in the first year of mining at the southern end of the valley and will continue until about Year 15, with ongoing rehabilitation and monitoring.

In the first years, the upper 2 km section of creek between the head of the valley and the geomorphologically sound section will be realigned and constructed within virgin ground to the east of the existing creek alignment (see Plans 5 and 6 in Volume 2). The geomorphologically sound section of creek will be protected from mining and will not be disturbed. The realigned section will constructed so as to fit in with the retained geomorphologically sound section. A farm dam (Dam 1) will be constructed at the head of the valley to collect runoff from the Murragamba Creek headwaters and divert flow into a temporary diversion around the southern out-of-pit emplacement and disturbed mining areas. This will also enable the environmental flows to Murragamba Creek to be maintained.

By around Year 5, it is anticipated that the new creek alignment will be hydraulically stable with sufficient vegetation cover to control erosion scour. Dam 1 (OC4 dam 1, see Table 5.5.2) will most likely be retained as a source for maintaining environmental flows via a permanent diversion around the rehabilitated southern out-of-pit emplacement into the realigned upper creek section.

From the northern end of the geomorphologically sound section of creek, the creek will be realigned for a further distance of approximately 5 km to the beyond the northern limit of OC4. This section of creek will be shifted about 300 m to 400 m west of its original alignment and will be constructed within backfilled overburden. The existing section will be retained to enable flows to pass down the length of the creek from the realigned upper sections until the new alignment is complete (see Plans 7 and 8 in Volume 2). This will be undertaken in Years 12 to 15, after which the existing creek will be mined through. The realigned section will be keyed into the existing creek section beyond the limit of the OC4 boundary. During these years, a number of dams (dam 3 and 4, see Table 5.5.2) and conveyances will be constructed to collect and divert clean runoff around the open cut operations. This will also enable water to be pumped to lower sections of the creek to maintain environmental flows.

Rehabilitation works will also be undertaken north of the OC4 boundary to improve channel stability and enhance riparian vegetation.

Eastern Creek

The relocation works for Eastern Creek will commence in about Year 15. The relocation will require a temporary diversion of the lower reaches of the creek, before constructing the permanent alignment 300 m east of its original position. The reconstructed alignment will be completely within backfilled overburden (see Plan 10 in Volume 2). A temporary dam will be built prior to mining to collect and control the flow of clean water from the upper reaches of the catchment and will be moved up stream as mining progresses up the valley. This dam and associated temporary diversion works will enable environmental flows to be maintained to the lower reaches of the creek. At the completion of mining, this dam will be decommissioned. By the end of Year 24 the permanent realigned creek will be rehabilitated.

When complete the total length of the reconstructed creek alignment will be approximately 600 m longer than the original, and will reduce the bed slope from about 0.0130 m/m to about 0.0119 m/m, (i.e., a reduction in grade of about 10%).

Pool and Riffle Sequences

The conceptual design for the reconstructed creek channels incorporates pool and riffle sequences to reduce the average channel bed slope, reduce peak flood velocities and to mimic a more ‘natural’ creek regime. The conceptual design of the pool and rifle structures is shown in Plan 41 in Volume 2.

Artificial riffles, or drop-structures, will be constructed in the low flow channel at 200 m to 300 m intervals over the length of the realigned creek sections. They are designed to provide an effective channel bed drop of up to 0.5 m and will be formed by a rock weir extending across the low flow channel, with loosely placed rock extending downstream from the weir at an average grade of 1 in 2 (horizontal to vertical). The toe of the riffle will comprise connected 1 m by 1 m rock filled gabions that extend across the width of the channel. The gabion toe will be “keyed” into the side-slopes of the low flow channel to provide stability, and to resist bank erosion through the process of outflanking. As an alternative to gabions, imported large armour stone could be used to provide a robust toe. The gabions or armour stone will dissipate flow energy, thereby preventing the formation of head cuts and bed scour.

Large sized rip-rap will be placed at the ridge to provide roughness, increase pool diversity and habitat and prevent excessive erosion. The rip-rap will consist of angular rock of various sizes packed tightly to reduce the porosity of the structure. Large oversized rocks will be included in the riffles and will protrude from the surface creating a more complex but natural surface condition, thereby increasing habitat potential. The design effectively creates a channel bed drop that will not impede the passage of fish.

The ability of the bed to maintain pools will be created by lining the base of the channel with clay and compacting this to achieve low permeability. This will reduce the infiltration rate of the ponded waters into the overburden material. The pool sequences will be constructed upstream and adjacent to riffle structures. The exact design of the pond areas will be determined in the detailed design stage with input from terrestrial and aquatic ecologists.

Where ever possible, large woody debris will be incorporated into the design of the pool and rifle structure. This will enable the development of a more natural design that will use materials that may be produced during the clearing of areas to be mined in OC4.

Channel Scour and Erosion Protection

In addition to the pool and riffle structures, stream bed and bank erosion will be controlled using a range of additional structural measures and planting techniques. The design of these measures will provide control of the three main types of erosion: sub-aerial erosion; fluvial scour; and mass gravity failure.

Sub-aerial erosion caused by processes unrelated to channel flow (e.g., rain splash, surface run-off, and rill erosion) will be more common on the upper and mid banks. This will be controlled through the planting of native perennial grasses to increase soil cover and cohesion properties, and through planting of overhanging trees to decrease the potential for erosion from rain-splash.

Fluvial scour of bed sediments due to high velocity flow and shear stress will be controlled by the pool and rifle structures and through creek bed grade control. This will reduce flow velocities and provide bed stability at the toe of the rifles. Planting of vegetation on the lower bank will decrease flow velocities close to the bank and will assist in strengthening bank material, making it harder to remove. Establishment of vegetation, particularly macrophytes, close to the toe of the bank and in the main channel will also aid in controlling channel scour.

Deep rooted local riparian tree species will be planted to reduce the potential for mass slumping of the channel banks. It is known that dense tree coverage increases the thickness of the boundary layer over the bank, substantially reducing shear stresses acting on the bank surface and increasing resistance to mass bank failure. In addition, the soil binding characteristics of these species will reinforce the failure plane and further increase bank stability.

Other erosion control measures that are incorporated in the conceptual design of the reconstructed creeks, particularly during the establishment phase include:

- Use of rip-rap and rock armouring on the outside bends of the channel and in other high flow areas, and as temporary reinforcement to bank stability.
- Oversizing of the low flow path to allow some sedimentation and to limit potential scour.
- Incorporation of temporary retardation storages upstream of the inlet of the reconstructed creek sections to reduce high flows.

5.5.6.4 Surface Water Monitoring

Surface water in and surrounding the Stage 2 Project Area will be monitored closely throughout the life of Stage 2, the details of which will be developed in an integrated Surface Water Monitoring Program for the whole of the MCP.

In its assessment of the surface water environment for Stage 2, Worley Parsons has made a number of recommendations for surface water monitoring. These will be implemented by MCM and included in the integrated Surface Water Monitoring Program for the MCP and include:

- Preparation of a surface water management plan (as part of a Surface Water and Groundwater Response Plan) including a comprehensive and auditable monitoring program.
- Installation of a gauging station at the downstream end of Murragamba and Eastern Creeks to monitor for low flows and changes in EC (i.e., salinity).
- Continuation of the baseline monitoring program and addition of the following monitoring sites within the Stage 2 Project Area:
  - In the downstream reaches of Eastern Creek before discharging into Wilpinjong Creek.
  - Downstream of Splitters Hollow Dam before its confluence with Wilpinjong Creek.
  - A site located on Wilpinjong Creek as the creek flows out of the Stage 2 (and EL 6288) Area.
  - A site located on Wilpinjong Creek upstream of its confluence with Murragamba Creek.
  - A site located on Wilpinjong Creek upstream of its confluence with Eastern Creek.
  - A site located on Bora Creek upstream of mine infrastructure areas (monitoring site SW10 see Section 5.5.2.1 and Plan 16 in Volume 2).

Sampling will be conducted during representative flow events and tested for pH, turbidity, salinity and total suspended solids as a minimum.

- Water quality monitoring of significant runoff events (i.e., greater than 20 mm in 24 hours) in all major water storages and sedimentation ponds. This will also include a visual inspection of the integrity of these structures.
- Records will be kept of water levels and volumes within all Stage 2 water storages on a quarterly basis.

- The site water balance (see Section 5.6.4) will be used to monitor the performance of water management for Stage 2 and the MCP, more generally, and to inform upgrades or changes to water storages and other water management provisions that may be required from time to time.

The monitoring program will enable MCM to establish and continually assess the impacts of the MCP on the surface water environment, including on downstream users. It will also enable the site water balance (see Section 5.6.4) to be validated.

5.5.6.5 Management and Contingency Response

A Surface Water and Groundwater Response Plan will be prepared and implemented for the whole of the MCP. This will consider a range of management, mitigation and contingency measures that will be applied in the event that the MCP causes unforeseen adverse impacts on the surface water environment. This plan will also consider measures to respond to groundwater impacts (see Section 5.4), since there is an interconnection between groundwater and surface water sources within and outside the MCP area. Specific management and contingency measures developed for Stage 2 will be included in the integrated MCP Surface Water and Groundwater Response Plan, and will include such measures as:

- Provision of flocculation equipment on sedimentation ponds to improve the rate of sedimentation.
- Augmenting the sedimentation ponds to create greater retention volume and residence time to increase the capacity for suspended sediment to settle out.
- Increasing pumping capacity at each sedimentation pond to minimise the potential for sediment laden discharges.
- Regular inspection and maintenance of sediment ponds and control structures to maintain suitable integrity and adequate freeboard.
- Using captured and stored dirty water for irrigating rehabilitated areas immediately surrounding the structures to improve stability and erosion control.
- Supplementing environmental flows to Wilpinjong Creek from the Splitters Hollow Dam.
- Developing completion criteria for the rehabilitated and realigned creeks.

5.6 Water Demand and Supply

5.6.1 Objectives

The objectives of the water demand and supply investigations are to:

- Estimate the volume of water required for the MCP (including Stage 2).
- Determine an operational site water balance.
- Determine a water balance for maintaining environmental flows.
- Investigate the availability of existing on-site water sources to meet these demands.
- Investigate other water supply alternatives.

5.6.2 Assessment Method

Worley Parsons has determined the water balance for Stage 2 and the MCP for a range of rainfall scenarios. The water balance modelling is based on the anticipated Stage 2 and MCP water demands, which has been supplied by MCM. The water balance and water supply determinations also draw on information provided by Aquaterra in its assessment of the groundwater environment (Appendix 5 in Volume 3). The water balance modelling is reported in the surface water assessment included in Appendix 6A and **Appendix 6B** in Volume 4.

5.6.3 Water Demand

5.6.3.1 Operations Water Demand

Water will be required for dust suppression on trafficked areas, haul roads, stockpiles and other disturbed areas and for irrigation where rehabilitation and revegetation is planned. Water will also be required to supplement Stage 1 supplies to account for increased throughput of coal at the CHPP due to Stage 2. Potable water will also be required for administration and bathhouse facilities.

An initial estimate of the likely water demand for Stage 2 was made on the same basis as that used to estimate the likely water demand for Stage 1. The water demand estimates for Stage 1 assumed that all ROM coal would be washed to produce saleable coals. On this basis MCM estimated that approximately 208 ML of water per million tonnes of ROM coal would be required for Stage 2, and the MCP more generally. Utilising this water demand estimate, the maximum amount of water required for the MCP in years of peak production (i.e., for 17 Mtpa ROM coal) would be 3,536 ML/annum. This is summarised in **Table 5.6.1**.

Table 5.6.1 Distribution of initial MCP water demand

Area of use	Maximum water demand (ML/year)
Coal handling and preparation plant	1,414
Dust suppression across open cut and mine infrastructure areas	849
Potable (Bath-house)	50
Use in underground area	601
Evaporation	622
Total maximum demand	3,536

However, since this initial calculation for water demand at the MCP was made, MCM has re-evaluated its operational water requirements and has now updated its water demand estimates for Stage 2 and the MCP. The re-evaluation of operational water requirements for the MCP was prompted by the need to ensure that years of potential water supply deficits are minimised, and on site water efficiencies maximised, thus ensuring the risk of securing a suitable water supply for the mine is minimised. The revised water demand estimates for the MCP rely on not washing underground coal, use of chemical dust suppressants with reduced application of water for dust suppression, and additional recovery and recycling of water through the CHPP.

Tests on coal from UG1 and UG2 indicate that this coal is a low ash coal and will not require washing prior to export. In addition, MCM has determined that 15 ML of water will be recovered from rejects and tailings for every million tonnes of coal that is passed through the wash plant. This water will be recycled back through the CHPP. Based on the outcomes of dust modelling for Stage 2, MCM has now committed to using chemical dust suppressants on trafficked areas (see Section 5.1.7). According to one chemical dust suppressant supplier (Reynolds Soil Technologies, 2009), use of chemical dust suppressants at other Australian mining operations has achieved at least a 40% saving in water used in dust suppression of trafficked areas. Based on these water savings, MCM now estimates that the water demand for the MCP will be 157 ML of water per million tonnes of ROM coal. This is 51 ML less per million tonnes of ROM coal than was originally proposed and represents a substantial reduction in the amount of water that will be required at the MCP. At maximum production (i.e., for 13 Mtpa ROM coal) the yearly water demand for the MCP based on this updated water demand estimate is 2,668 ML. This is summarised in **Table 5.6.2**.

Table 5.6.2 Distribution of updated MCP water demand

Area of use	Maximum water demand (ML/year)
Coal handling and preparation plant	886#
Dust suppression across open cut and mine infrastructure areas	509
Potable (Bath-house)	50
Use in underground area	601
Evaporation	622
Total maximum demand	2,668

#This includes the recovery and recycling of 195 ML/year from rejects and tailings

5.6.3.1 Environmental Flow Water Demand

In addition to the demand for operations water, a supply of clean water will be required to maintain environmental flows in Murragamba and Eastern Creeks. Environmental flow estimates for the Murragamba and Eastern Creek catchments were determined from an analysis of continuous stream flow data and catchment area. The closest stream gauge is Station 210082, located on Wollar Creek upstream of its confluence with Wilpinjong Creek and is more than 10 km downstream from the Stage 2 Project Area. The relative average flow from each catchment was determined from an analysis of the 50th percentile flow recorded between 1969 and 1997.

Worley Parsons has estimated the average annual 50th percentile flow for the Murragamba and Eastern Creek catchments to be 0.95 ML/day and 0.4 ML/day, respectively (see Appendix 6A in Volume 4). Based on these estimates the anticipated annual water demand required to maintain environmental flows in these creeks is about 237 ML/year for Murragamba Creek and about 146 ML/year for Eastern Creek.

5.6.4 Water Balance Modelling

5.6.4.1 Operations Water Balance

Worley Parsons has determined the site water balance for both the initial and updated water demand estimates. The former is reported in the surface water assessment included as Appendix 6A in Volume 4. The water balance model using the updated water demand estimate has only recently (March 2009) been calculated. This is because MCM has only recently (February-March 2009) updated its water demand estimates for the MCP. The updated water balance model is included in Appendix 6B in Volume 4.

The water balance model uses a bucket water budgeting approach. This is based on a conceptual surface flow model which uses annual rainfall, infiltration, evaporation and runoff as model inputs, and site water storages required to meet expected mine water demand as outputs. As indicated the initial water balance modelling was based on the assumption that the water demand for Stage 2, and the MCP more generally, is 208 ML per million tonnes of ROM coal. The updated water balance model assumes the water demand for Stage 2, and the MCP more generally, is 157 ML per million tonnes of ROM coal. Both water balance models also assume:

- All rain falling on disturbed areas (mining and infrastructure) is considered dirty.
- The open cut mine intercepts rainfall.
- Rehabilitated areas are graded to allow gravity drainage to collection swales.
- During each open cut mining stage dirty water storage is maximised through utilising smaller dams in various locations.
- Seepage losses from sedimentation ponds and swales are assumed to be negligible.
- Mining and production rates are as per the indicated schedules (see Section 4.5.2.14).
- Groundwater inflows are as determined in the groundwater assessment (see Section 5.4.5.7 and Appendix 5 in Volume 3).
- Groundwater bore extraction rates will be adjusted so that only the required volume of water for mine operations is extracted. The extraction rates have been limited to the predicted borefield capacity.

The site water balance for mine water supply has been modelled under worst case (358 mm), below average (519 mm), average (645 mm) and above average (849 mm) annual rainfall conditions. Stage 2 has been modelled in isolation and combined with Stage 1 (the MCP). For Stage 2, 24 years of mining were modelled, and for the MCP, 30 years. This is because mining in UG4 has now been delayed compared to the previous assessment. This is consistent with the period considered in the groundwater model. Any extension of mining beyond these limits will require further assessment and approval in the future.

The modelled water balance for the initial estimated water demand (i.e., 208 ML of water per million tonne of ROM coal) under all modelled rainfall scenarios indicated that Stage 2 in isolation would experience a water deficit in Years 9 to 16, and the MCP a water deficit in at least Years 6 to 16. The volume of this deficit in individual years ranges from about 310 to 960 ML for Stage 2 and from 10 to over 1,000 ML for the MCP, depending on rainfall conditions. These results are presented in detail in Tables 17 through 23 in Appendix 6A in Volume 4.

The potential for such a large water deficit was viewed as a significant operational constraint, hence MCM's re-evaluation of the estimated likely water demands for the mine. The modelled water balance for the revised water demand estimate (i.e., 157 ML of water per million tonne of ROM coal) indicates that Stage 2 in isolation will experience a water deficit in Year 10 for average and above average rainfall years; in Years 10, 11 and 13 for below average rainfall years; and in Years 9 to 13 for worst case rainfall years. Under this scenario the MCP will experience a water deficit in Year 11 for below average rainfall years and in Years 8 to 12 for worst case rainfall years. For Stage 2 in isolation the volume of this deficit in individual years ranges from 9 to 200 ML and for the MCP from 49 to 216 ML, depending on the modelled rainfall scenario.

Table 5.6.3 and **Table 5.6.4** show the predicted water balance for Stage 2 in isolation for worst case rainfall years and average rainfall years, only deficit years are shown for the modelled worst case rainfall years. **Table 5.6.5** and **Table 5.6.6** shows the predicted water balance for the MCP for worst case rainfall years (deficit years only) and average rainfall years (first 24 years only). The complete results for the revised water balance for Stage 2 and the MCP for all modelled rainfall conditions is included in Appendix 6B in Volume 4.

Table 5.6.3 Water balance model for Stage 2 – worst case rainfall years (deficit years)

Mine year	Total mined ROM coal (Mtpa)	Total demand (ML/yr)	Mine inflows (ML/yr)	Required borefield inflows (ML/yr)	Surface water inflows (ML/yr)	Total available water (ML/yr)	Surplus / deficit (ML)
9	16.3	2292	450	1713	77	2240	-52
10	16.4	2416	429	1709	77	2216	-200
11	15.8	2324	547	1659	57	2264	-60
12	16.3	2409	502	1661	81	2244	-165
13	16.2	2389	536	1611	127	2274	-115

Table 5.6.4 Water balance model for Stage 2 – average rainfall years

Mine year	Total mined ROM coal (Mtpa)	Total demand (ML/yr)	Mine inflows (ML/yr)	Required borefield inflows (ML/yr)	Surface water inflows (ML/yr)	Total available water (ML/yr)	Surplus / deficit (ML)
1	7.0	0	162	0	338	500	500
2	11.0	628	221	218	189	628	0
3	11.5	707	165	376	166	707	0
4	12.0	707	177	363	166	707	0
5	12.3	682	221	294	166	682	0
6	14.4	1393	246	955	192	1393	0
7	15.4	1158	578	388	192	1158	0
8	16.2	1136	448	496	192	1136	0
9	16.3	2292	450	1668	174	2292	0
10	16.4	2416	429	1709	136	2275	-141

Table 5.6.4 Water balance model for Stage 2 – average rainfall years (cont'd)

Mine year	Total mined ROM coal (Mtpa)	Total demand (ML/yr)	Mine inflows (ML/yr)	Required borefield inflows (ML/yr)	Surface water inflows (ML/yr)	Total available water (ML/yr)	Surplus / deficit (ML)
11	15.8	2324	547	1601	175	2324	0
12	16.3	2409	502	1659	248	2409	0
13	16.2	2389	536	1590	263	2389	0
14	15.4	2253	579	1394	280	2253	0
15	16.0	2359	630	1452	277	2359	0
16	15.3	2238	580	1259	399	2238	0
17	15.3	2199	1124	666	409	2199	0
18	15.7	1884	735	741	409	1884	0
19	16.8	1884	1343	92	449	1884	0
20	16.9	1884	794	632	458	1884	0
21	16.6	1884	899	528	457	1884	0
22	16.0	1806	1380	0	478	1858	53
23	14.7	1570	1974	0	568	2542	972
24	14.2	1473	1016	279	178	1473	0

Table 5.6.5 Water balance model for the MCP – average rainfall years

Mine year	Total mined ROM coal (Mtpa)	Total demand (ML/yr)	Mine inflows (ML/yr)	Required borefield inflows (ML/yr)	Surface water inflows (ML/yr)	Total available water (ML/yr)	Surplus / deficit (ML)
1	7.0	1099	162	591	347	1099	0
2	11.0	1727	221	1143	362	1727	0
3	11.5	1806	165	1278	362	1806	0
4	12.0	1884	177	1344	362	1884	0
5	12.3	1938	221	1354	362	1938	0
6	14.4	2257	246	1489	521	2257	0
7	15.4	2414	578	1295	541	2414	0
8	16.2	2549	448	1574	527	2549	0
9	16.3	2562	450	1588	524	2562	0
10	16.4	2573	429	1622	521	2573	0
11	15.8	2481	547	1403	531	2481	0
12	16.3	2566	502	1322	742	2566	0
13	16.2	2546	536	1251	759	2546	0
14	15.4	2410	579	1060	771	2410	0
15	16.0	2516	630	1118	768	2516	0
16	15.3	2395	580	913	901	2395	0
17	15.3	2408	1124	358	925	2408	0

Table 5.6.5 Water balance model for the MCP – average rainfall years (cont'd)

Mine year	Total mined ROM coal (Mtpa)	Total demand (ML/yr)	Mine inflows (ML/yr)	Required borefield inflows (ML/yr)	Surface water inflows (ML/yr)	Total available water (ML/yr)	Surplus / deficit (ML)
18	15.7	2467	735	818	915	2467	0
19	16.8	2642	1343	351	948	2642	0
20	16.9	2648	794	894	960	2648	0
21	16.6	2606	899	747	960	2606	0
22	16.0	2514	1380	145	988	2514	0
23	14.7	2313	1974	0	1239	3213	900
24	14.2	2230	1016	532	683	2230	0

Table 5.6.6 Water balance model for the MCP – worst case rainfall years (deficit years)

Mine year	Total mined ROM coal (Mtpa)	Total demand (ML/yr)	Mine inflows (ML/yr)	Required borefield inflows (ML/yr)	Surface water inflows (ML/yr)	Total available water (ML/yr)	Surplus / deficit (ML)
8	16.2	2549	448	1758	168	2375	-174
9	16.3	2562	450	1713	184	2346	-216
10	16.4	2573	429	1709	321	2459	-113
11	15.8	2481	547	1659	217	2424	-58
12	16.3	2566	502	1661	287	2450	-116

5.6.3.1 Environmental Flow Water Balance

A water balance for environmental flow water for Murragamba and Eastern creeks has been modelled separately, as the source of this water will be segregated from the source and supply of water for mining operations. The modelled available clean water for maintaining environmental flows from areas up stream from the proposed mining areas is between 500 and 4,300 ML/year. The water balance modelling indicates this is more than enough clean water available to maintain environmental flows in Murragamba and Eastern creeks for the duration of Stage 2 (see Figure 31 in Appendix 6A in Volume 4).

The impact of the post-mining landscape on environmental flows to Wilpinjong Creek down stream of its confluence with Murragamba and Eastern creeks has also been modelled. It is predicted that surface water runoff from Murragamba and Eastern Creek catchments will reduce by up to 7% compared with pre-mining levels. However, environmental flows are expected to increase once backfilled rehabilitated areas consolidate and the post-mining landscape reaches a stable hydrologic condition.

5.6.5 Water Supply

5.6.5.1 Potable Water

Potable water for all facilities at the CHPP, UG1, UG2 and OC4 will be sourced from a combination of rainwater captured from the roofs of facilities, suitably treated bore water or imported from external sources. Potable water demand for the MCP is estimated at 50 ML/annum and is included in the estimate for mine water demand (see Table 5.6.2).

5.6.5.2 Operations Water

Water for operational purposes will be first sourced from all groundwater mine inflows, runoff from disturbed mine areas and the recycling of water from the CHPP and tailings. Make-up water will then be sourced from the borefield (this was assessed as part of Stage 1) and if required from Splitters Hollow Dam on the Red Hills property (Property 14, see Plans 2 and 4 in Volume 2), although this will require the existing licence for the dam to be amended. This dam is located in the northern part of the Stage 2 Project Area, adjacent to Wilpinjong Creek, upstream from its confluence with Murragamba Creek. Splitters Hollow Dam has a licensed capacity of 78 ML for stock and domestic use. However, for water from this dam to be used as a supplementary source to the CHPP for coal beneficiation, or other mining related purpose, an appropriate licence will be required. The borefield will have the dual purpose of providing water for supplying mine water needs as well as concurrently providing advanced dewatering of UG4. The location of the borefield is shown in Plan 31 in Volume 2.

Table 5.6.7 and **Table 5.6.8** summarise the modelled available water supply from each of the available water sources for Stage 2 and the MCP.

Table 5.6.7 Available water sources for Stage 2 operations

Groundwater inflows into mine voids (ML)	Rainfall runoff capture from disturbed areas (ML)				MCP production bores (ML)
	Worst case	Below average	Average	Above average	
162 - 1974	39 - 307	59 - 568	136 - 568	164 - 568	218 - 1713

Table 5.6.8 Available water sources for MCP operations

Groundwater inflows into mine voids (ML)	Rainfall runoff capture from disturbed areas (ML)				MCP production bores (ML)
	Worst case	Below average	Average	Above average	
33 - 720	184 - 597	125 - 1234	347 - 1239	326 - 1180	123 - 1784

It is anticipated that any remaining water shortfall will be obtained from surplus water generated by the nearby Ulan or Wilpinjong coal mines. It is understood that the Ulan coal mine has a net water make of up to 1,360 ML/year (Umwelt (Australia) Pty Ltd, 2008), which, if accessed by MCM, would enable it to reduce the pumping of groundwater from its borefield.

Since the approval of Stage 1, Wilpinjong coal mine has applied to develop a water pipeline, dam and supporting infrastructure, linking it with the Ulan coal mine. This pipeline is proposed to run across the Stage 2 Project Area within the 66-kV electricity supply easement adjacent to Ulan-Wollar Road. While MCM currently has no formal agreement to integrate with this water sharing network, it has commenced negotiations with Ulan and Wilpinjong coal mines to participate in a joint water sharing arrangement and will seek to source water from either mine as soon as possible.

The operation of the MCP as a single mining complex will provide MCM with the flexibility to generally match production scheduling to available water resources. The revised water balance modelling indicates that the water demand requirements for the MCP can be met from available water sources. In the unlikely event that insufficient water is available from any of the above sources, mining operations will be adjusted to meet the available water supplies. This will be achieved either by reducing the rate of coal beneficiation, adjusting the mine schedule, or by temporarily increasing on site water storage prior to predicted deficit years under worst case rainfall conditions. Alternatively, MCM will seek to supplement its water supply with local groundwater from other licensed sources. No other changes to mine operations would be required and it is not expected that potential water shortfalls under worst case rainfall conditions will constrain operation of the MCP.

5.6.5.2 Environmental Flow Water

Water for environmental flow purposes will be made available through the diversion, capture and re-release of clean water draining from areas upstream from disturbed mining areas. This water will be diverted around the mining operations and discharged into the undisturbed reaches of the creeks. The volumes and locations of clean water storage dams are described in section 5.5.6.1 and in Plans 35 to 39 in Volume 2.

However, in the event the water balance predictions for environmental flows are not met, MCM has an emergency water supply available in the Splitters Hollow Dam and would use part of this water to supplement environmental flows into the creeks.

5.7 Ecology

5.7.1 Objectives

The objectives of the ecology assessment are to:

- Quantify the terrestrial and aquatic biodiversity values of the Stage 2 Project Area.
- Assess the potential impacts of Stage 2 on existing biodiversity.
- Ascertain the extent of impact management and biodiversity offsets required to achieve a 'maintain or improve' outcome.

5.7.2 Assessment Method

An ecological impact assessment was undertaken for Stage 2. This involved a terrestrial ecological assessment undertaken by Ecovision Consulting (Ecovision) and an aquatic ecological assessment undertaken by Marine Pollution Research. A copy of the combined assessment report is included as **Appendix 7** in Volume 4.

The ecological assessment considered a 3,382 ha area within the Stage 2 Project Area, bounded by Stage 1 in the west, the Munghorn Gap Nature Reserve in the south, the Wilpinjong coal mine lease area in the east and the Gulgong-Sandy Hollow rail line in the north, with an extension to encompass the Splitters Hollow Dam and proposed water supply pipeline (see **Plan 42** in Volume 2). This area was considered within a regional biodiversity context defined by a 50 km radial arc.

The assessment involved literature reviews, database searches, detailed field studies, results interpretation and classification of the terrestrial and aquatic biodiversity values of the study area, followed by an impact analysis. Ecological surveys were designed and conducted in accordance with the following standards and guidelines:

- Draft Guidelines for Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC, 2004a).
- Draft Guidelines for Threatened Species Assessment (DEC and DPI, 2005).
- State Groundwater Dependent Ecosystem Policy (DLWC, 2002).
- NSW DPI Guidelines for the assessment of aquatic habitat (NSW Fisheries, 1999).
- Management of stream-aquifer systems in coal mining developments, Hunter Region (DIPNR, 2005).

Threatened biodiversity listings relevant to this assessment include those identified by the *Threatened Species Conservation Act 1995* (TSC Act) and FM Act for State matters and the EPBC Act for Commonwealth matters.

5.7.2.1 Terrestrial

The study area was initially characterised using literature reviews, database searches (i.e., DECC's Wildlife Atlas database, Birds Australia and National Herbarium) and analysis of soil landscapes, geology, vegetation and land zoning. Ecological stratification units were then defined to strategically focus and maximise field survey efforts.

Terrestrial surveys of flora and fauna were conducted between September 2004 and July 2008, involving several seasons of sampling. Surveys were undertaken using standard, replicated techniques. Random survey locations were also used to sample ecotones, areas of existing disturbance or future impacts from mining.

Flora surveys involved systematic (quadrat) and non-systematic (targeted) techniques to sample the study area's floristic diversity. Fauna surveys involved diurnal and nocturnal sampling regimes such as owl broadcast, pitfall trapping, hair tubes, spotlighting, Anabat II echolocation recordings, Elliot trapping and timed and targeted searches. Most of the fauna surveys were of a systematic nature, and were located in close proximity to systematic flora survey locations.

Data interpretations involved both spatial and statistical analysis to classify and quantify biodiversity values primarily at a landscape scale. Impacts were then assessed on this basis.

5.7.2.2 Aquatic

The aquatic impact assessment began with an aquatic scoping study. This study involved field surveys, a literature review, and threatened species database searches, and provided a basis for the design of a systematic survey approach. The scoping study provided some broad indications of potential aquatic ecological impacts, and assisted in the provision of constraints and opportunity advice regarding ecological impacts for preliminary mine planning.

Aquatic field surveys were undertaken at 36 sites in spring 2004, autumn and spring 2005, summer 2006, spring 2007 and autumn 2008. Survey intensity varied between 4 and 10 sites per season. Of the 36 visited sites, 24 sites had sufficient water available for macroinvertebrate sampling, and 15 sites had sufficient water available for sampling at least once over the surveying period.

The sites were assessed for overall aquatic habitat condition using a standardised Riparian-Channel-Environment (RCE) ranking scheme. At each site, the main stream health assessment method targeted aquatic macroinvertebrates, based on the AusRivAS protocol. The overall stream health of the macroinvertebrate assemblages at each site was assessed by comparing Site Stream Invertebrate Grade Number Average Level (SIGNAL) pollution tolerance scores within and between sample periods.

AusRivAS surveys were supplemented with aquatic plant observations, physical water quality measurements (temperature, conductivity, dissolved oxygen, pH and turbidity) and fish trapping using baited traps. Searches plus habitat assessments were also made for Platypus and Native Water Rat.

5.7.3 Existing Environment

Stage 2 is located within the headwaters of the Hunter Central Rivers catchment management area (CMA), more specifically in the Wollar Creek sub-catchment headwaters of the Goulburn River. The area falls within the northern extremity of the Sydney Basin bioregion in a transitional zone between the western slopes of the Great Dividing Range and coastal NSW. Therefore many plants, animals and/or communities representative of these regions intergrade at this locality and are at their range limits.

5.7.3.1 Vegetation Communities

It is estimated that approximately 2,750 km^2 of native vegetation cover occurs within a 50 km radius of the study area, representing 35% of the total area within this arc. Approximately a third of this native vegetation cover is contained within conservation reserves (Goulburn River National Park, Munghorn Gap Nature Reserve, Wollemi National Park, Avisford Nature Reserve) and state forests.

Of the 3,382 ha within the Stage 2 Project Area studied, approximately 2,354 ha is intact native vegetation. This represents approximately 39% of the intact native vegetation throughout EL 6288, excluding land currently approved for mine development (EL 6288 is approximately 11,000 ha or 110 km^2 in extent). The remaining 1,028 ha of the study area is cleared lands.

Two broad vegetation formations feature prominently within the study area, and are considered similar to regional vegetation classes (Keith, 2004), these being:

- Western Slopes Dry Sclerophyll Forest (e.g., Ironbark; Scribbly Gum and Box Ironbark communities).
- Western Slopes Grassy Woodlands (e.g., Box Redgum communities).

Valley floor vegetation is predominantly cleared of tree canopy cover, with agriculture the prevailing land use. Fragmented, partially connected or fringing vegetation patches and remnants exist. Riparian woodlands containing Box and Redgum species occur along Murragamba, Eastern and Wilpinjong creeks as fragmented linear vegetation tracts. Grassy Box Woodlands occur as highly fragmented remnants in the adjacent lower slopes. The vegetation changes upslope into shrubby Box Ironbark communities. Ironbark and/or Native Pine Forests dominate the ridgelines and upper slopes, with isolated Grassy Box Woodlands and open woodlands found on scattered basalt outcrops. Broad vegetation communities are shown on **Plan 43** in Volume 2.

5.7.3.2 Flora

A search of the DECC's Wildlife Atlas database and a literature review identified 514 species within a 50 km radius of the study area, consisting of 467 natives and 47 exotics. The detailed flora survey conducted in the study area identified 513 plant species, consisting of 452 natives and 61 exotics.

A total of 30 threatened plant species or endangered populations (EPs) were identified from database searches and literature reviews as being likely to occur within the study area. Of these, two threatened flora species are known to occur within the study area, Scant Pomaderris (*Pomaderris queenslandica*) and Wallangarra White Gum (*Eucalyptus scoparia*). Of the remaining 28 threatened plant species or EPs, five were assessed as having moderate to high potential habitat values within the study area. However, targeted field surveys failed to locate known habitat for any of these species or EPs within the study area.

A single plant of the endangered *Pomaderris queenslandica*, listed in the TSC Act, was observed within a sheltered open depression near the boundary between the Permian – Triassic geological formations (see **Plan 44** in Volume 2). This observed occurrence within the study area is consistent with known habitat values observed in the Sandy Hollow district east of the Stage 2 Project Area.

The threatened *Eucalyptus scoparia*, listed as endangered on the TSC Act and vulnerable on the EPBC Act, was identified within a highly modified landscape in the central Murragamba Creek valley. Its location is associated with historically intense human landuses including a school and a regional road. The NSW Herbarium identified a sample of the specimen, and indicated the plant was a cultivated specimen. This is supported by the historical use of this species as a roadside landscape tree, and the distance of the site from known natural habitat (the species commonly grows on elevated granitic soils near the NSW/ Queensland border).

Tracts of White Box Yellow Box Blakely's Redgum Woodland (WBYBBRW) Endangered Ecological Community (EEC) (listed under Schedule 1 of the TSC Act), and its EPBC Act listed Critically Endangered Ecological Community (CEEC) equivalent, were also observed across the study area. The distribution of EECs/CEECs in the study area is shown in Plan 42 in Volume 2.

Table 5.7.1 lists the 30 species of threatened flora that may occur in the Stage 2 ecological study area, whilst Plan 44 in Volume 2 illustrates the locations of the two species of threatened flora identified in and surrounding the study area during field surveys.

Table 5.7.1 Summary of threatened flora species

Common Name	Scientific Name	TSC Act	EPBC Act	Database Records†			
				30 km	Mitchell	Geology	Total
	*Cynanchum elegans**	E	E	0	2	3	32
Hoary Sunray	*Leucochrysum albicans var tricolor***		E	1	1	0	1
	*Ozothamnus tessellates**	V	V	8	8	9	9
Ausfield's Wattle	*Acacia ausfieldii*	V	–	2	1	0	2
Flockton Wattle	*Acacia flocktoniae*	V	–	1	1	1	1
Weeping Myall of the Hunter Catchment	*Acacia pendula*	E2	E	1	1	1	16
	*Kennedia retrorsa**	V	V	0	17	17	17
	*Swainsona recta**	E	–	0	0	0	0
Cannons Stringybark	*Eucalyptus cannonii****	V	–	3	3	3	3
River Redgum of the Hunter Catchment	*Eucalyptus camaldulensis*	E2	–	2	0	0	68
	Eucalyptus scoparia	E1	V	1	0	0	1
	Eucalyptus pumila	V	V	0	1	9	12
	*Homoranthus darwinioides**	V	–	4	4	4	4
Tiger Orchid of the Hunter Catchment	*Cymbidium canaliculatum*	E2	–	0	14	0	17
Painted Diuris	*Diuris tricolor (syn D. sheiffiana)**	V	V	3	5	4	23
	Diuris pedunculata	E1	E	0	2	0	4
	*Digitaria porrecta**	V	V	0	0	0	0
Silky Pomaderris	*Pomaderris sericea**	V	–	1	0	1	1
Scant Pomaderris	*Pomaderris queenslandica*	E1	–	0	18	18	21

Table 5.7.1 Summary of threatened flora species (cont'd)

Common Name	Scientific Name	TSC Act	EPBC Act	Database Records†			
				30 km	Mitchell	Geology	Total
Denman Pomaderris	*Pomaderris reperta*	E1	CE	0	17	17	17
	*Prostanthera discolor**	V	V	8	6	7	8
	Prostanthera cineolifera	V	V	0	1	1	1
	*Prostanthera cryptandroides**	V	V	0	8	10	15
	Prostanthera stricta	V	V	0	8	8	8
	*Philotheca ericifolia**	V	V	0	0	0	1
	Commersonia rosea	E1	–	0	5	5	5
	Lasiopetalum longistamineum	V	V	0	13	13	13
	Rulingia procumbens	V	V	0	2	2	2
Austral Toadflax	*Thesium australe**	V	V	0	0	0	3
Wollemi Pine	*Wollemia nobilis**	E1	E	n/a	n/a	n/a	n/a

* Identified by EPBC Act Protected Matters Search
** Known to occur locally
*** Total for Hunter Central Rivers CMA
† DECC (2008a)

5.7.3.3 Terrestrial Fauna

A search of the DECC's Wildlife Atlas database (DECC, 2008a) for the western half of Hunter Central Rivers CMA identified 497 fauna species consisting of 474 native and 23 exotic species. The baseline fauna survey conducted for Stage 2 identified 256 fauna species within EL 6288 comprising 170 birds, 37 mammals, 32 reptiles and 7 amphibians. The only threatened amphibian species recorded in the broader catchment area with a known dependence on permanent water regimes is the Giant Barred Frog. This species was not recorded within the study area during the baseline surveys nor was its habitat detected.

Areas of Western Slopes Grassy Woodlands were observed to have higher fauna species richness, with the majority being woodland birds. Western Slopes Dry Sclerophyll Forest was observed to provide habitat for many microchiropteran bat species and reptiles due to the locally elevated abundance of trees with hollows and surface rock. Transition areas between these two vegetation classes appeared to be locally important for honeyeaters and other regionally migratory species, particularly within vegetated protected gullies with diverse habitat resources. Ground mammals were rarely encountered during all seasonal studies, a result consistent with other local and regional studies.

At least 36 threatened fauna species or their habitats were identified as potentially occurring within the study area (DECC, 2008a; Birds Australia, 2008; DEWHA, 2008). These results are largely consistent with other local ecological assessments conducted for the Ulan and Wilpinjong coal mines.

Table 5.7.2 lists threatened fauna species which may occur within the study area, while **Plan 45** in Volume 2 illustrates the locations of threatened fauna identified within and adjacent to the study area during field surveying.

Table 5.7.2 Summary of threatened fauna species

Common Name	Scientific Name	TSC Act	EPBC Act	Database Records†			
				30 km	Mitchell	Geology	Total
Booroolong Frog*	*Litoria booroolongensis*	E1	E	0	0	0	6
Giant Barred Frog	*Mixophyes iteratus*	E1	E	1	0	15	24
Worm Skink	*Aprasia parapulchella*	V	V	1	0	1	1
Collared Whip Snake	*Suta flagellum*	V	–	1	0	0	1
Sydney Broad-headed Snake*	*Hoplocephalus bungarioides*	E1	V	0	0	0	0
Mallee Fowl*	*Leipoa ocellata*	E1	E	1	1	0	1
Square-tailed Kite	*Lophoictinia isura*	V	–	10	2	2	15
Bush Stone-curlew	*Burhinus grallarius*	E1	–	1	1	13	141
Australian Painted Snipe*	*Rostratula australis*	V	V	0	0	0	2
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	–	19	10	113	178
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	–	60	104	255	609
Swift Parrot*	*Lathamus discolor*	E1	E	2	0	8	50
Superb Parrot*	*Polytelis swainsonii*	V	V	0	0	0	0
Turquoise Parrot	*Neophema pulchella*	V	–	55	16	47	102
Barking Owl	*Ninox connivens*	V	–	1	2	18	63
Powerful Owl	*Ninox strenua*	V	–	32	9	132	414
Masked Owl	*Tyto novaehollandiae*	V	–	1	0	0	0
Gilberts Whistler	*Pachycephala inornata*	V	–	1	0	0	0
Brown Treecreeper	*Climacteris picumnus*	V	–	147	164	60	323
Speckled Warbler	*Pyrrholaemus sagittatus*	V	–	79	86	86	240
Painted Honeyeater	*Grantiella picta*	V	–	15	9	4	17
Black-chinned Honeyeater	*Melithreptus gularis gularis*	V	–	37	13	39	120
Regent Honeyeater*	*Anthochaera phrygia*	E1	E	86	20	23	77
Hooded Robin	*Melanodryas cucullata*	V	–	33	39	13	45
Grey-crowned Babbler	*Pomatostomus temporalis*	V	–	9	34	25	319
Diamond Firetail	*Stagonopleura guttata*	V	–	54	59	23	91
Spotted-tailed Quoll*	*Dasyurus maculata*	E1	E	0	2	35	992
Koala	*Phascolarctos cinereus*	V	–	8	6	43	693
Squirrel Glider	*Petaurus norfolkensis*	V	–	1	6	150	460
Brush-tailed Rock-wallaby*	*Petrogale penicillata*	E1	V	1	12	80	139
Large-eared Pied Bat*	*Chalinolobus dwyeri*	V	V	8	18	66	109
Little Pied Bat	*Chalinolobus picatus*	V	–	1	4	4	4

Table 5.7.2 Summary of threatened fauna species (cont'd)

Common Name	Scientific Name	TSC Act	EPBC Act	Database Records†			
				30 km	Mitchell	Geology	Total
Eastern Bentwing Bat	*Miniopterus schreibersii*	V	–	2	9	103	359
Eastern Long-eared Bat*	*Nyctophilus timoriensis*	V	–	6	8	25	30
Large-footed Myotis	*Myotis adversus*	V	V	1	0	0	0
Yellow-bellied Sheath-tailed Bat**	*Saccolaimus flaviventris*	V	–	0	2	4	26

* Identified by EPBC Act Protected Matters Search

** Known to occur locally from local studies (i.e., no databased records).

† Birds Australia (2008) and DECC (2008a) for the Hunter Central Rivers CMA west of Cessnock (i.e., eastern extent of Narrabeen geology)

5.7.3.4 Aquatic Fauna

Most of the creeks and drainages in the study area are ephemeral or intermittent, and few creeks have permanent natural ponds or riffle areas. There are numerous shallow springs located near drainage swales, with many small in-line farm dams scattered throughout the study area. Good aquatic habitat was located within a section of Murragamba Creek and Eastern Creek and several sections along Wilpinjong Creek. Better aquatic habitat was generally associated with in-line creek or groundwater interception dams.

The Stage 2 aquatic field surveys recorded 53 aquatic macroinvertebrate taxa, with 48 common to the Stage 1 study. The diversity of the individual sites over the 10 days of sampling ranged from 4 taxa to 25 taxa. Seasonal diversity varied from 7 taxa in Autumn 2006 to 41 taxa in Spring 2005 and Spring 2007. The pollution tolerance of the taxa ranged from very pollutant tolerant (SIGNAL score of 1) to very intolerant (SIGNAL score of 8), with an average for all taxa of 4.04, indicating that there was a relatively even spread of pollution tolerant taxa over the total study area.

No threatened aquatic fauna listed under the FM Act were found during surveys, or are expected to occur in the study area. Only two fish were caught or sighted during surveys, Plague Minnow and Long-finned Eel, in the lower sections of the three main creeks. No aquatic mammals (Platypus or Native Water Rat) were found during the study and although they are known to occur downstream of the study area, none are expected in the study area.

5.7.3.5 Groundwater Dependant Ecosystems

The potential of groundwater dependant ecosystems (GDEs) occurring within the study area was investigated by mapping biological values against groundwater resources. The significance of GDEs was assessed using the eight-step rapid assessment process contained within the NSW Groundwater Dependant Ecosystem Policy (DLWC, 2002). The assessment found:

- One terrestrial GDE (sedge herbfield) with numerous mapped occurrences in the study area. This vegetation exhibits highly localised spatial extent, and is generally linked to permanent surface seepage expressions of groundwater.
- A number of groundwater seepages intercepted with constructed dams downstream, which provide suitable habitat for emergent riparian sedges, aquatic plants and aquatic fauna. These can be considered constructed aquatic GDEs.

- Parts of the vegetation cover classified as 'Murragamba Sands Woodlands' near the central northern parts of the study area may be linked with the local aquifers contained within the associated deep sand deposit and could also be classified as a GDE.
- Shallow alluvial groundwaters in the lower portion of Murragamba Creek.

The assessment of riparian vegetation did not indicate any specific riparian plant communities that could be considered GDEs. The groundwater assessment has indicated that there is negligible baseflow to Murragamba and Eastern creeks. However, there are pools and soaks along the creeks that indicate the existence of a shallow water table that supports the tree cover of the Murragamba, Eastern and Wilpinjong creeks.

5.7.4 Issues

Ecological impacts of Stage 2 include:

- Loss of indigenous flora due primarily to the footprint impact of the OC4, surface infrastructure and out-of-pit waste rock emplacements.
- Loss of rare or endangered flora or populations.
- Impact on EECs/CEECs.
- Impact on fauna, in particular threatened species, due primarily to the removal of native vegetation.
- Impact on aquatic ecosystems, primarily the creeks.
- Impact on GDEs.

5.7.5 Impact Assessment

Stage 2 will result in a suite of impacts on the ecology of the study area and in certain instances will impact on the wider area. The development will modify much of the study area and in so doing will result in the loss or modification of native vegetation cover, aquatic ecosystems and associated fauna.

5.7.5.1 Vegetation

The total potential Stage 2 disturbance area is 2,463 ha, comprising open cut and underground mine areas, infrastructure areas and out-of-pit waste rock emplacements (see **Table 5.7.3**). Of this, approximately 1,756 ha is currently intact native vegetation and the remainder comprises other landcover classifications.

The establishment and operation of OC4 and Stage 2 infrastructure and facilities (ROM coal facility and office and workshop facility) will directly result in the clearing of 851 ha of native vegetation and 654 ha of grassland and disturbed land. More subtle indirect impacts on vegetation and hence possibly on fauna will result from surface subsidence associated with the two underground mines, UG1 and UG2. Table 5.7.3 identifies these impacts in terms of direct (e.g., open cut operations) and indirect (e.g., underground operations) actions on intact native vegetation cover.

Table 5.7.3 Summary of mining impacts on intact native vegetation cover

Operation	Total area of disturbance (ha)*	Area of intact native vegetation disturbed (ha) *	
		Direct (e.g., clearing)	Indirect (e.g., subsidence)**
Open Cut 4	1,274	707	0
Underground No. 1	686	0	633
Underground No. 2	279	0	272
Infrastructure	105	51	0
Out-of-Pit Waste† Rock Emplacements	118	94	0
Total	2,463	851	905

* Rounded to nearest whole number

** These are maximum areas at risk from subsidence – the actual area anticipated to be lost is considered to be negligible.

† This has been revised down from the values presented in the Ecology Assessment Report based on updated mine plans.

The direct plus indirect impact areas for each vegetation formation are summarised in **Table 5.7.4**. Of the intact native vegetation cover that is to be cleared, approximately 157 ha comprises WBYBBRW EEC/CEEC. This represents a loss of some 53% of this vegetation type within the Stage 2 Project Area (total 295 ha) and is considered a significant impact.

Indirect impacts such as surface cracking, surface ponding, potential damage to root systems and changes in water availability as a result of underground mining could potentially impact further areas of this EEC/CEEC.

Much of the EEC/CEEC that is located above underground mines has been identified as having a close association to basalt occurrences. The subsidence report (see Appendix 8 in Volume 5) states that basaltic areas are predicted to be capable of resisting surface cracking and deformation. It also notes that where the depth of material above the longwall panels exceeds 100 m, only minor surface cracking is expected. As much of the EEC/CEEC occurs in these basaltic areas and are generally situated in areas of 100 m or more cover, only minor impacts on EEC/CEEC due to underground mining is anticipated.

Table 5.7.4 Summary of direct/indirect impacts of Stage 2 – intact native vegetation

Vegetation Formation	Direct (ha)	Indirect (ha)**
*Blakely's Redgum - Rough-barked Apple Woodland	53.21	2.18
*Blakely's Redgum - Yellow Box - Apple Woodland	40.82	6.6
Broad-leaved Ironbark Grey Gum Forest	61.81	453.75
Cyperoid Herbland	0.57	
Footslope Ironbark - Gum – Box Forest	125.24	70.19
*Grassy White Box Woodland	2.95	79.15
Grey Box - Narrow-leaved Ironbark Forest	84.37	
Hardcap Scribbly Gum - Ironbark Woodland	67.44	
*Lowland Box - Redgum Woodland	59.78	

Table 5.7.4 Summary of direct/indirect impacts of Stage 2 – intact native vegetation (cont'd)

Vegetation Formation	Direct (ha)	Indirect (ha)**
Lowland Ironbark Forest	73.28	11.95
Ridgetop Broad-leaved Ironbark - Black Cypress Pine on shallow sands	1.74	248.79
Rough-barked Apple - Banksia Woodland	264.44	
Scribbly Gum Narrow-leaved Ironbark Woodland		22.16
Shrubby White Box Forest	15.52	9.66
Total	851.17	904.43

* Note: Denotes EEC/CEEC.
** These values refer to the total areas vulnerable to some impact due to subsidence. It is anticipated that the actual loss of vegetation is likely to be insignificant.

5.7.5.2 Threatened Biodiversity

In terms of threatened plants, only one flora species occurring as a natural population was located within the study area, this being the endangered State listed *Pomaderris queenslandica*. The single specimen was located adjacent to the western margin of OC4 and UG2 (see Figure 6 in Appendix 7, Volume 4) and will not be affected by Stage 2. Possible indirect impacts are manageable, particularly given the predicted retention of the plant, its associated habitat and the presence of additional unaffected known habitat as part of the Redhill Property offset associated with the Stage 1 Project Approval. The single specimen of *Eucalyptus scoparia* is a cultivated specimen and its destruction is not considered significant. No other threatened flora species are known to occur within the study area. Targeted searches for locally occurring threatened species such as Cannon's Stringybark (*Eucalyptus cannonii*), Ausfeld's Wattle (*Acacia ausfeildii)*, Hoary Sunray (*Leucochrysum albicans var tricolor*), Painted Diuris (*Diuris tricolor*) and potential species such as *Homoranthus darwinioides*, *Swainsona recta*, the Tiger orchid (*Cymbidium canaliculatum*), *Ozothamnus tessellatus* and Australe toadflax (*Thesium australe*) failed to detect any individual population or occurences within the Stage 2 disturbance area. The flora species most likely to be impacted by the project are listed in **Table 5.7.5**, along with their status under the TSC and EPBC Act. This table also identifies the nature of the predicted impact and includes a consideration of the level of impact based on the proposed mine plan and progressive rehabilitation and the findings of the other specialist studies (subsidence, groundwater, etc.).

It is likely that open cut mining will impact on threatened biodiversity that are known to or may occur within the study area, particularly species that occupy the valley floor such as woodland birds and microchiropteran bats (e.g., Painted Honeyeater, Hooded Robin, Diamond Firetail and Long-eared Pied Bat). Indirect impacts from underground mining will be largely restricted to ridge tops and associated midslopes, predominantly characterised by Western Dry Sclerophyll Forests. Species such as the Glossy Black-cockatoo and Brown Treecreeper rely on habitats like those contained in this landscape. **Table 5.7.6** provides a summary of the fauna species most likely to be impacted upon by Stage 2, including a consideration of the nature of the predicted impacts similar to Table 5.7.5.

Table 5.7.5 Threatened flora species most likely to be impacted

Common Name	Scientific Name	TSC Act	EPBC Act	Predicted Impact	Explanation	Implications of Stage 2
–	*Ozothamnus tesselatus*	V	V	Impact of concern on potential habitat	Although the study failed to detect the species, this was influenced by steep terrain. If present, it would be impacted by subsidence on the western face of the Murragamba Creek valley.	Given the minimal predicted effect of subsidence on the western face, it is unlikely that any specimens that may be present would be significantly affected.
Scant Pomaderris	*Pomaderris queenslandica*	E1	–	Impact of concern on known habitat	This species has been recorded adjacent to the proposed OC4 and UG1 and thus would be impacted by mining in those areas.	The area in which the specimen has been found will not be directly impacted by OC4, while the impact of subsidence is considered to be insignificant.

Table 5.7.6 Threatened fauna species most likely to be impacted

Common Name	Scientific Name	TSC Act	EPBC Act	Predicted Impact	Explanation	Implications of Stage 2
Glossy Black-cockatoo	*Calyptorhynchus lathami*	V	–	Impact of concern on known habitat	The impact on viable habitat of this species is high given that foraging material and likely onsite breeding will coincide with development activities.	This species was observed in the woodlands/forests above UG1 and UG2 operations where foraging resources are concentrated. This habitat is unlikely to be significantly affected and hence the any impact is likely to be negligible.
Powerful Owl	*Ninox strenua*	V	–	Impact of concern on known habitat	The impact on viable habitat will be high since it is known to forage forested ridge tops to be affected by underground mining.	The impact of subsidence caused by underground mining on foraging resources on the upper midslopes and ridgetops is likely to be negligible.
Speckled Warbler	*Pyrrholaemus sagittatus*	V	–	Impact of concern on known habitat	The majority of habitat important to this species is present along the outcropping Triassic sandstones, with extensions into the midslopes of the valley particularly where Ironbark dominated woodlands occur.	The population is unlikely to experience any lasting detrimental impacts from progressive open cut mining activities, as their dependence on the valley floor is limited.

Table 5.7.6 Threatened fauna species most likely to be impacted (cont'd)

Common Name	Scientific Name	TSC Act	EPBC Act	Predicted Impact	Explanation	Implications of Stage 2
Square-tailed Kite	*Lophoictinia isura*	V	–	Impact of concern on known habitat	This species relies on areas along cleared-wooded interfaces such as the outcropping Triassic and Tertiary basalts for foraging and breeding.	Stage 2 will result in a sequenced loss of foraging areas and breeding habitat. Short-term losses of foraging resources and breeding areas would be offset over time through the recovery of rehabilitated landscapes.
Brown Tree Creeper	*Climacteris picumnus*	V	–	Impact of concern on known habitat	This species will be impacted by the removal of trees with hollows along the Triassic outcrop and grassy and shrubby woodlands. The impact is considered high.	Although the Brown Treecreeper would not have relied on grassy woodlands prior to European disturbance, frequent records imply a reliance on these habitats at some stage in the lifecycle. Open cut mining will have an ongoing sequential impact throughout the mine life, which may force individuals into the Dry Sclerophyll Forests.
Painted Honeyeater	*Grantiella picta*	V	–	Impact of concern on known habitat	Direct impacts of mining are expected to be on foraging and breeding habitat, particularly in the footslope Box Gum Ironbark Forest.	The lifecycle of the species would be interrupted by open cut mining in the short term, although preserved habitat and revegetated landscapes will become more important in satisfying the local requirements of the species.
Black-chinned Honeyeater	*Melithreptus gularis gularis*	V	–	Impact of concern on known habitat	The impacts of mining activities on foraging habitat will be largely indirect, with the potential for direct impacts throughout riparian corridors dominated by Yellow Box.	The loss of habitat will be progressive, impacting over the short to medium term, with long term vegetation re-establishment and conservation outcomes likely to reverse the impacts.
Hooded Robin	*Melanodrya cucullata*	V	–	Impact of concern on known habitat	This species will be impacted by disturbance of the valley floor near/within grassy woodland remnants connected with upslope Tertiary basalt caps and semi-permanent water resources.	The sensitivity of this species to habitat alterations such as open cut mining is high. In the short to medium term, it is predicted that the local population would significantly contract due to local distribution to residual landscapes.

Table 5.7.6 Fauna species most likely to be impacted (cont'd)

Common Name	Scientific Name	TSC Act	EPBC Act	Predicted Impact	Explanation	Implications of Stage 2
Grey-crowned Babbler	*Pomatostomus temporalis*	V	–	Impact of concern on known habitat	Although few records of this species have been collected, there is a high likelihood for a direct impact as a consequence of open cut mining.	The study area and broader locality is not supportive of life-cycles of this species, and hence no significant impact is predicted.
Diamond Firetail	*Stagonopleura guttata*	V	–	Impact of concern on known habitat	This species will be impacted by the disturbance of the valley floor with loss of foraging resources and permanent water.	Given the preference of lower grassier slopes and creek lines, it is likely that this species will be affected.
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	Impact of concern on known habitat	This species will be impacted by disturbance to the Triassic sandstones, which it uses to roost, and disturbance of the lowland areas, which it uses to forage.	Although subsidence is unlikely to have a substantial affect on Triassic sandstones, some collapse on to roosts may occur. Lowland foraging areas will be disturbed due to progressive open cut mining.
Little Pied Bat	*Chalinobus picatus*	V	–	Impact of concern on known habitat	As above, this species will be impacted by disturbance to the Triassic sandstones and lowland areas.	Although the impacts of mining would result in the removal of potential roost sites and foraging habitat, the rehabilitation outcome is considered beneficial for this species in the medium to long term.
Eastern Bentwing Bat	*Miniopterus schreibersii*	V	–	Impact of concern on known habitat	As above, this species will be impacted by disturbance to the Triassic sandstones and lowland areas.	Subsidence is unlikely to have a substantial affect on roosts. The removal of primarily disturbed agricultural land may not have a severe impact on foraging due to its preference for hunting in forested areas.
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	–	Impact of concern on potential habitat	This species will be impacted by disturbance to they valley floor and midslopes.	Since mining will progress gradually, giving time for the tailing land to recover, the total impact on available foraging habitat at any one time is unlikely to be severe.

5.7.5.3 Aquatic systems and Groundwater Dependent Ecosystems

Mining of OC4 will result in the progressive loss of about 7.5 km of Murragamba Creek and some 4.2 km of Eastern Creek, plus the almost complete removal of associated feeder drainages plus springs, swales, dams and GDEs on the eastern slopes up to the wooded ridgelines in both subcatchments. Mining to the east of the Eastern Creek subcatchment will also impact on several minor drainages flowing directly to Wilpinjong Creek or to Planters Creek. These seasonal aquatic systems are currently relatively degraded and do not support any species of conservation interest. However, mining will result in the loss of most aquatic habitat within the footprint of the open cut operation which will have consequential implications for terrestrial fauna dependant on them. The aquatic systems (and GDEs) within the study area are potentially important to threatened fauna species such as the Hooded Robin and Diamond Firetail, with permanent reliable water resources also important to the wider woodland bird cohort that includes an array of declining species.

The (Goodenia) GDE located on Property 44 (Powers) at the head of Eastern Creek valley will be retained and consequently embellished by revegetation works planned for this area.

No endangered aquatic populations or their habitats would be knowingly impacted by the proposed development.

5.7.5.4 Effects on the National Estate

No mining will take place within 1 km of the Goulburn River National Park. Furthermore, the reserve is separated from the mine by Wilpinjong Creek and its associated riparian vegetation, the Ulan-Wollar Road and the Gulgong-Sandy Hollow rail line. The Stage 2 Project Area is not hydraulically connected with the national park and therefore impacts on the park ecosystems are unlikely. Operational phase impacts expected include noise, light and dust when the open cut mining progresses closest to the northern boundary.

Munghorn Gap Nature Reserve borders the mining area to the south. Setbacks will range from 20 to 350 m, with the average being between 200 and 250 m, and some noise impacts are predicted (see Section 5.3). Underground mining is located sufficiently distant to ensure no direct subsidence impacts. Moolarben Coal Mines will implement appropriate management measures to ensure that Stage 2 will not lead to inappropriate fire regimes, road kills, introduction of weeds, pathogens or feral animals at either reserve. The loss of habitat due to mining may have subtle indirect impacts on the conservation resources due to the loss of ecological function currently contained within the Murragamba Creek valley.

5.7.5.5 Evaluation of Impacts Against the Draft Guidelines for Threatened Species Assessment

The Stage 2 ecological assessment has considered the key threshold parameters identified within the Draft Guidelines for Threatened Species Assessment (DECC and DPI, 2005). A summary evaluation of Stage 2 against each key threshold is provided below.

Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

In the short term, biodiversity values will be detrimentally affected. However, the proposed environmental management measures described in the following section are expected to deliver a maintain outcome in the medium to long term at the locality, and improved long term conservation security of native vegetation.

Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

Mining will not affect any known naturally occurring threatened flora species. The loss of vegetation cover and habitat will represent a short term loss particularly for threatened woodland birds, but would benefit fauna populations in the longer term as the extent of native vegetation increases and habitat complexity is reestablished.

Whether or not the proposal is likely to accelerate the extinction of species, population or ecological community or place it at risk of extinction.

Stage 2 is unlikely to result in the acceleration of local flora or fauna extinctions. The proposal will result in a short term impact on WBYBBRW EEC/CEEC. However this will be offset through dedication of this EEC/CEEC to the National Estate at a ratio of at least 2:1. Through the rehabilitation and revegetation of the site with box woodland species a localised improvement outcome for the WBYBBRW EEC/CEEC will be achieved.

Whether or not the proposal will adversely affect critical habitat.

Stage 2 will not directly impact any areas declared as critical habitat as listed under the TSC Act, FM Act or EPBC Act.

5.7.6 Environmental Management

The objective of the impact management approach is to achieve a “maintain or improve” outcome for significant biodiversity values contained within the area impacted by Stage 2, in line with the requirements of the NSW TSC Act.

Ecovision has recommended a range of measures that it believes will adequately offset and mitigate the impacts of the project on the long-term biodiversity values of the Stage 2 Project Area. The intent of these recommendations has been adopted by MCM in its commitment to offset project impacts on local biodiversity values, and over the life of the project will continue to investigate opportunities for improving biodiversity values on MCM owned land.

Some of the more specific actions in Ecovision’s recommendations have been modified to better align with MCM’s capabilities and overall environmental management strategy for Stage 2, and the MCP more generally. The two most significant modifications entail providing surface water features (such as sedimentation ponds) within the post mine landscape to provide additional aquatic and terrestrial habitat, rather than attempting to create near surface perched aquifers within the backfilled and rehabilitated OC4 mine void, and providing financial assistance towards biodiversity mapping of regional roadside corridors rather than undertaking the work as it is not of specific benefit to MCM’s ecological management strategy.

5.7.6.1 Approach

Impact management is principally focused at the landscape level with the purpose being the restoration and/or conservation of sustainable habitat over the long term. The approach proposed in response to the mine’s impact is broadly defined as follows:

- Avoidance of areas of ecologically important values where possible.
- Establish, restore and reinstate functional aquatic (creek), terrestrial and riparian corridors.
- Increase the net native vegetation cover within the locality.
- Enhance the ecological values of retained aquatic ecological resources and of native vegetation cover and associated habitats.
- Conserve fauna habitats through managed salvage and compensatory works (including retention of large woody debris for use in creek diversion and rehabilitation activities).
- Establish and enhance wildlife connectivity between conservation reserves and adjoining unreserved native vegetation cover.
- Incorporate specific rehabilitation techniques for use in an integrated rehabilitation strategy designed to restore key ecological function (e.g., grassy woodlands mosaic).
- Offset areas of significant ecological values, and dedicate to the National Estate.
- Ensure that the development is consistent with the DECC's Guidelines on Developments adjoining DECC Land (2008b), especially with respect to ecological connectivity, erosion, sedimentation, runoff, pests, weeds, edge effects, fire management, boundary encroachments and indirect impacts.

5.7.6.2 Actions

Key actions to satisfy the impact management approach incorporate 'Priority Action Statements' as defined by the DECC for key threatened biodiversity. Management actions include:

- Maintaining at least a 20 m buffer between any open cut mining operations/ infrastructure and the adjacent Munghorn Gap Nature Reserve.
- Ensuring UG2 will not encroach within 140 m of the Munghorn Gap Nature Reserve, and a barrier of unmined coal will be maintained to minimize the risk of subsidence related impacts on the nature reserve.
- Undertaking extensive progressive terrestrial and aquatic fauna habitat salvage works throughout the directly impacted areas and restoration works throughout retained landscapes.
- Monitoring and managing fauna populations throughout the duration of mining and in the reinstated post mining landscape to ascertain the balance between common and sensitive species.
- Establishing movement corridors of sufficient width and ecological condition between Munghorn Gap Nature Reserve and Goulburn River National Park to facilitate regional movements including the removal of stock and fences.
- Undertaking progressive mine rehabilitation works that integrate key environmental gradients supportive of baseline ecological function to embellish and link retained vegetated and revegetated landscapes.
- Reestablishing ecological function conducive to the development of Box Gum Woodland species in the rehabilitated open cut mining area. This, as well as the rehabilitation of degraded and agricultural lands within the mine footprint, and the revegetation of cleared lands within MCM-ownership outside of the mine footprint will result in an estimated 1,700 ha of native

vegetation, thus achieving a long-term net increase of more than 800 ha of native vegetation (see Section 5.18).

- Undertaking progressive creek diversion and restoration works to maintain and embellish core creek aquatic and riparian ecological function and connectivity.
- Developing an Aquatic Habitat Rehabilitation Plan to guide the establishment of compensatory habitat areas and to provide targets against which the improvement of aquatic habitat can be measured. This plan will be cognisant of the DoP's Guidelines for Wetland Restoration Plans *(*1999) and the Cooperative Research Centre for Catchment Hydrology's A Rehabilitation Manual for Australian Streams (Rutherford, 2000).
- Integrating important ecological values such as those that occur within grassy woodland in an improved condition within the final landscape to 'seed' the future restoration works including revegetation and rehabilitation initiatives. This will be achieved through avoiding selected parts of the study area such as creek lines and existing vegetation cover.
- Taking all necessary steps to prevent, control and eradicate listed environmental and noxious weeds from the Stage 2 area, particularly known troublesome species of rehabilitated landscapes such as Galena (*Galena pubscens*), Rhodes Grass (*Chloris gayana*) and Coolati Grass *(Hyparrhenia hirta*).
- Establishing offsite conservation outcomes for native vegetation communities and EEC/ CEEC lost due to direct impacts.
- Developing and implementing a Rehabilitation and Offset Management Plan which aims to rehabilitate areas disturbed by mining including sections of disturbed creek lines, revegetate all cleared lands owned by MCM and improve local biodiversity values. The Aquatic Habitat Rehabilitation Plan will form part of the Rehabilitation and Offset Management Plan.
- Supporting ecological research that will have a direct benefit for the rehabilitation of the Stage 2 Project Area.

The planned rehabilitation for Stage 2 is detailed further in Section 5.18.

5.7.6.3 Outcomes

Maintain and improve outcomes arising from the above management actions include, but are not restricted to the following:

- Increased certainty of conservation outcomes for threatened biodiversity at the landscape level, particularly for ecological communities that are under represented in the National Estate through impact offsets and dedications to the National Estate.
- Increased native vegetation cover through a combined revegetation and rehabilitation program for MCM-owned lands.
- Increased understanding of biodiversity responses to revegetation and rehabilitation works, thus improving the success of future revegetation and rehabilitation programs designed to establish biodiversity outcomes.

5.7.7 Biodiversity Offsets

Moolarben Coal Mines has identified lands to offset, dedicate and rehabilitate or revegetate as part of the 'improve or maintain' requirements of the NSW TSC Act, as described in the DECC's Principles for the use of biodiversity offsets in NSW (DECC, 2008c), as described below and summarised in **Table 5.7.7**. A Rehabilitation and Offset Management Plan will be prepared for Stage 2, and will be integrated with a similar plan for Stage 1 (see Section 5.18.4.1).

To offset the ecological impacts of Stage 2 and increase native vegetation cover and biodiversity values, MCM is proposing to provide connectivity and continuity between existing vegetated areas and wildlife corridors, and improve the ecological value of the post-mining landscape. Biodiversity offsets for Stage 2 will be integrated with the offsets for Stage 1 to further improve the ecological value of the surrounding region in the medium to long term. Biodiversity offsets will include conversion of existing cleared grazing land within the Stage 2 Project Area to land with native vegetation cover, through rehabilitation or revegetation, post-mining. Rehabilitation is discussed further in Section 5.18.

5.7.7.1 Proposed Offsets

Moolarben Coal Mines commits to offset biodiversity directly cleared by mining as follows:

- Provide like-for-like offsite offsets for EEC/CEEC actually destroyed in the construction and operation of Stage 2 at a ratio of 2:1.
- Provide for the long-term security of these EEC/CEEC offsets by offering the land on which they occur to the DECC for inclusion in the National Estate.
- Provide generally like-for-like offsets for native vegetation actually destroyed by the construction and operation of the MCP on a basis of at least 1:1.
- Provide additional offsets for native vegetation by rehabilitating and revegetating (with endemic species) cleared, part cleared or degraded lands under the control of MCM that are not within the mine disturbance footprint and will not be impacted by mining.
- Provide for the security of these native vegetation offsets by a VCA (or the like) for the duration of the MCP. Post closure, the native vegetation offsets would be protected under the Native Vegetation Act and other like legislation.
- All offset areas will be located on MCM-owned land and will not be disturbed by future mining.
- Offsets will be provided progressively based on the forward planning of clearing and mining activities. These will be calculated annually based on the following year's planned mining activities.

5.7.7.2 Land Proposed for Offsets

Within MCM-owned land, 460 ha of intact native vegetation is currently available and proposed for offset, 162 ha of this land is WBYBBRW EEC/CEEC. This land is not within the Stage 2 disturbance footprint, is outside of the lease area for Stage 1, and is separate to the offsets provided in the Stage 1 Project Approval. The following MCM-owned lands will constitute part of this offset:

- Part Property 43 (adjacent to Munghorn Gap Nature Reserve).
- Property 51 (adjacent to Munghorn Gap Nature Reserve).

- Part Properties 13, 14 and 15 (adjacent to Goulburn River National Park) (parts not included in Stage 1 offset and rehabilitation requirements).
- Properties 6 and 21.

Moolarben Coal Mines is in negotiations to purchase a number of other land holdings identified by the DECC as preferred lands for addition to the National Estate. Once acquired, this land will also be used to offset EEC and native vegetation disturbed by Stage 2.

In addition, all revegetated and rehabilitated areas within MCM's ownership will provide long term offsets to those areas of native vegetation cleared by Stage 2. Once rehabilitated, this will amount to over 1,700 ha, and will comprise:

- 175 ha of revegetated and improved land outside the mine footprint, including Properties 24, 49 and 173, and parts of Properties 12 to 19 and Property 28.
- 46 ha recovered Grassy White Box Woodlands EEC/CEEC site outside the mine footprint.
- 851 ha of cleared native vegetation, rehabilitated with native vegetation.
- 655 ha of cleared degraded and agricultural lands, rehabilitated with native vegetation.

The revegetated and rehabilitated areas will achieve a long-term net increase of approximately 800 ha of native vegetation, comprising EEC/CEEC species and communities, compared to the existing status of native vegetation within the Stage 2 Project Area.

The post-mining landscape will have a higher proportion of native vegetation and improved ecological value. The proposed offsets will improve connectivity both on a local and regional scale. Local connectivity will be improved between the Munghorn Gap Nature Reserve and Goulburn River National Park and the Munghorn Gap Nature Reserve as illustrated in **Plan 55** in Volume 2. Regionally, this connectivity will be consistent with the Great Eastern Ranges Initiative, improving ecological connectivity along the east coast of Australia.

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Table 5.7.7 Proposed biodiversity offsets

Aspect	Proposed Offset	Timing
Biodiversity offsets	Offsets for EEC at a 2:1 ratio consistent with Stage 1 Project Approval, up to a maximum of 157 ha. Offset native vegetation generally on a 'like for like' basis. Within MCM-owned land, 460 ha of native vegetation is proposed for offset, 162 ha of this land is WBYBBRW EEC/CEEC. The following MCM-owned lands which adjoin the National Estate will constitute part of this offset: • Part Property 43 (adjacent to Munghorn Gap Nature Reserve). • Property 51 (adjacent to Munghorn Gap Nature Reserve). • Part Properties 13, 14 and 15 (adjacent to Goulburn River National Park) (parts not included in Stage 1 offset and rehabilitation requirements). • Properties 6 and 21 contain existing native vegetation and will also be offered as offsets. Additional lands will be purchased, including land preferred by DECC for inclusion in the National Estate, to make up the complement of required offsets.	Offsets will be provided progressively based on the forward planning of clearing and mining activities. These will be calculated annually based on the following year's planned mining activities. VCAs will be entered into for the duration of the MCP, to secure the offsets for future protection under the NV Act.
Revegetation of cleared and disturbed lands outside of the Stage 2 mine footprint	Revegetation and improvement of all cleared lands in MCM ownership. This includes 175 ha of grasslands and degraded lands outside the mine footprint, including properties: • Properties 24, 49 and 173. • Part Properties 12, 13, 14, 15, 16, 17, 18, 19, and 28.	Rehabilitation and Offset Management Plan to be developed within 12 months of Project Approval. Revegetation to occur over a five-year period following Stage 2 Project Approval. VCAs will be entered into for the duration of the MCP, following successful revegetation, to secure the offsets for future protection under the NV Act.
Rehabilitation of mined lands	Lands disturbed by mining will be progressively rehabilitated in accordance with the principles and mitigation measures proposed within this EA report and Appendix 7. The 851 ha of permanent native vegetation and 655 ha of grasslands and disturbed lands cleared by Stage 2 will be rehabilitated with native open woodland, grassland and shrubland.	Progressively following mining. VCAs will be entered into for the duration of the MCP, following successful rehabilitation, to secure the offsets for future protection under the NV Act.

5.8 Subsidence

5.8.1 Objectives

The objectives of the subsidence assessment are to determine the effect that subsidence from longwall mining of UG1 and UG2 may have on the natural, heritage and built environments, and to present management interventions to address the impacts.

5.8.2 Assessment Method

Subsidence describes ground movement as a result of underground mining. Subsidence usually refers to the vertical movement of a point, but subsidence of the ground actually includes both vertical and horizontal movement. In some cases, especially where subsidence is small, the horizontal movements can be greater than the vertical subsidence. Ground strains, tilt and curvature are the more important parameters when assessing the impact that subsidence might have on the ground surface and on improvements (e.g., fences, railway lines, buildings).

The natural surface and improvements can tolerate low levels of tilt and strain with no impact. High levels of tilt and strain can cause damage to surface features and improvements. Ground strains and curvature associated with substantial subsidence can have significant effects on large or continuous structures. However, many improvements can remain unaffected by subsidence.

Mining Subsidence Engineering Consultants (MSEC) undertook a mine subsidence impact assessment to determine the implications of subsidence for Stage 2. A copy of the full report is included as **Appendix 8** in Volume 4. Experience of longwall coal mining in NSW on rural and natural environments has shown that the impact of subsidence can be assessed with a high level of certainty.

The area considered by MSEC in its subsidence assessment includes the surface area enclosed by a 26.5 degree angle from the limit of mining (the angle of draw) and the predicted 20 mm subsidence contour resulting from the extraction of Longwalls 1 to 13 (LW1 to LW13). Mining Subsidence Engineering Consultants has also considered the potential for far-field horizontal movements and valley related (upsidence and closure) effects.

The predicted systematic subsidence parameters for the Stage 2 longwalls have been made using the Incremental Profile Method, developed by MSEC. This method is an empirical model based on a large database of observed monitoring data from previous mining within the Southern, Newcastle, Hunter and Western Coalfields of NSW. The model was calibrated to local conditions using observed monitoring data from mines in the upper Hunter Valley, the nearby Ulan coal mine and other collieries with similar longwall panel widths and cover geometries. The predicted profiles obtained using the calibrated model show good correlation to the observed profiles from monitoring at the Ulan coal mine.

The level of significance of ground cracking, tilting and related disturbances from the Stage 2 underground mines has been predicted using the calibrated model. The location of these disturbance effects have been determined by overlaying the subsidence predictions on the mine plan.

5.8.3 Existing Environment

A range of natural features and surface improvements that could be influenced by subsidence associated with the Stage 2 underground mines have been identified. This includes drainage lines; cliffs and overhangs; archeological and heritage sites, occurrences of EECs (as defined by the TSC Act), CEECs (as defined by the EPBC Act); several vehicular tracks; power lines; rural buildings and structures; and farm dams. These features and improvements are shown in **Plan 46** and **Plan 47** in Volume 2. For the purposes of brevity, reference to CEECs in the following discussion includes both EECs and CEECs as defined by their respective Acts.

The Stage 2 underground mine layout is divided into two areas, with thirteen longwalls in total. Longwall 1 to LW9 will be extracted from UG1 with LW10 to LW13 extracted from UG2. Longwall 1 to LW5 will be developed and extracted north to south and each panel mined in a south westerly direction. Longwall 6 to LW9 will be developed and extracted south to north and each panel mined in a northeast direction. Longwall 10 to LW13 will be developed and extracted west to east and each panel mined in a northeast direction. The longwall panels vary in width from about 270 to 305 m and vary in length from about 1,685 to 2,870 m. The longwalls have pillar widths of 30 m. Coal will be extracted from the DWS of the Ulan Seam (see Section 4.2.3), with the extracted seam thickness varying from about 2.2 to 3.2 m. The depth of cover above the DWS varies from about 35 to 165 m. However, the majority of the longwall panels (LW1 to LW4, LW7, LW8, LW11 and LW12) will be developed under cover depths greater than 100 m. This is shown in Plan 46 in Volume 2.

The design of the UG1 and UG2 mines has been influenced by the proximity of a number of natural features and surface improvements. Barriers of in-situ coal have been provided to protect some of these natural features and surface improvements from the effects of mine subsidence. A barrier has been proposed against the Gulgong-Sandy Hollow rail line, which is located north east of the limit of UG1. Another barrier has been provided south and east of the limit of UG2 to protect the Munghorn Gap Nature Reserve. A substantial block of in-situ coal has also been provided to protect an Aboriginal rock art shelter and archaeological objects above UG2 from subsidence impacts (see Plans 11 and 47 in Volume 2).

5.8.4 Issues

The potential issues addressed in this section include the impacts of subsidence on:

- Drainage lines.
- Cliffs, overhangs, rock ledges and steep slopes.
- Archaeological and heritage sites.
- Threatened or protected species and communities.
- Roads and rail lines.
- Powerlines and communication cables.
- Residential and rural buildings.
- Mining infrastructure.
- Fences and farm dams.
- Survey references.

5.8.5 Impact Assessment

The predicted subsidence levels for UG1 and UG2 are shown in **Plan 48** in Volume 2. These predictions do not include valley related upsidence and closure movements, or the effects of faults and other geological structures.

The maximum predicted total systematic subsidence due to extraction of the longwalls is 1,980 mm. This is expected over the middle of LW3 after the extraction of LW4. At this location the depth of cover is 143 m and the proposed extracted seam thickness is 3.2 m. The predicted total subsidence of 1,980 mm represents 62% of the extracted seam thickness.

The maximum predicted total systematic tilt due to the longwalls is 95 mm/m (i.e., 9.5%) or a change in grade of 1 in 10, and is expected near the maingate of LW9 after the extraction of LW9. The maximum predicted total systematic tensile and compressive strains resulting from the extraction of the longwalls are both greater than 50 mm/m, and the associated minimum radii of curvatures are both less than 0.3 km. The maximum predicted total systematic tensile and compressive strain is predicted to occur near the maingate of LW9, after the extraction of LW9. These subsidence effects will result in soil erosion on the steep slopes or in the drainage channels.

The proposed longwalls have width-to-depth ratios between 2 and 3. For panel width-to-depth ratios greater than 2, and with depths of cover shallower than 100 m, MSEC predicts that the height of fracturing will extend up to the existing ground surface. There are some basalt intrusions above the proposed longwalls which may be of sufficient strength to prevent fracturing from reaching the surface in these locations. Coal exploration borehole WMLB48 adjacent to CEEC01 encountered a 20 m thick, low to medium strength basalt approximately 15 m below the ground surface. Coal exploration borehole WMLB113 adjacent to CEEC03 encountered a 15 m thick, very high to extremely high strength basalt from 3 m below the ground surface. The location of the mapped CEECs is shown in Plan 46 in Volume 2. These thick basalt layers, if of sufficiently high strength and extent, could prevent fracturing associated with mine subsidence from reaching the surface.

Fracturing and dilation of bedrock is expected to occur at the surface. This is expected to be more prevalent in areas of maximum strain, especially in areas of natural bedrock jointing, geological weakness (e.g., faults and discontinuities) and where existing natural grades are relatively shallow. It is also expected that where depths of cover are shallowest the height of the fractured zone will extend from the underground workings to the surface. This will increase the connectivity between the surface and the mine workings.

The cover sequence above the underground mines is largely unsaturated (see Section 5.4). Hence, fracturing and surface cracking above longwalls will have minimal impact on existing groundwater resources. Open cut mining in OC1, OC2 and OC4 adjacent to the UG1 and UG2 is expected to dewater the Ulan Seam and only minor groundwater inflows into the Stage 2 underground mines are expected.

Surface cracking will be more visible where the depth of cover is less than 100 m and MSEC predicts cracks as large as 500 mm could occur where depth of cover is shallowest. However, this is a conservative prediction. Based on the relationship between depth of cover and surface crack width, surface cracks in the order of 150 to 200 mm wide are more likely. The extent of shallow (less than 100 m) covered areas above the proposed longwall panels is shown in Plans 46 and 47 in Volume 2. It is evident from these plans that small sections of LW9 and LW10 will be developed in areas where the depth of cover is less than 50 m, a large portion of which will be above the chain pillars. More substantial areas of longwall panels LW5, LW6, LW9, LW10, LW12 and LW13 will be developed in areas where the depth of cover is between 50 and 100 m.

The development of surface cracks and connected fracturing in areas of shallow cover will present a conduit for surface runoff to infiltrate the underground workings. Unexpected or uncontrolled mine inflows, if of significant quantity, poses a risk to mine safety. It may also potentially disrupt mining operations. Hence, further detailed geotechnical and hydrological assessment will be carried out prior to the development of these longwall panels to quantify mine safety and operational risks. In addition, detailed monitoring, management and remediation measures will be developed and implemented to reduce the potential for surface water inflows to impact on mine safety and operations. According to the proposed indicative underground mine schedule mining of LW5 will commence in Year 6 of underground mine development or Year 9 following project approval (see Plan 11 in Volume 2 and Section 4.5.3.11). This will provide adequate time for further detailed investigations to be carried out, and appropriate monitoring and management measures to be developed.

Where surface cracks develop above areas of thicker cover, these are expected to close and heal naturally, otherwise they can be remediated by manual infilling with clay materials or other inert sealing compounds, or by locally regrading and compacting the surface.

5.8.5.1 Drainage Lines

The ridges above the underground mines comprise a number of small low order ephemeral drainage lines. These serve to transfer runoff from steeper ground to the lower slopes and valley floor areas where open cut mines will be developed (OC1, OC2 to the west and OC4 to the east).

Drainage lines above the underground mines will be subjected to travelling tilts and strains where the extraction faces of the proposed longwalls pass beneath them. Predicted movements have been determined along seven of these drainage lines, DL1 to DL7 (see Plan 46 in Volume 2). It is expected that these drainage lines could be subjected to travelling tilts up to 60 mm/m (i.e., 6 %), or changes in grade up to 1 in 17, and could be subjected to travelling strains up to 40 mm/m. The maximum predicted systematic tilts along the alignments of the drainage lines vary between 35 mm/m (i.e., 4 %) and 70 mm/m (i.e., > 7 %), or changes in grade between 1 in 30 and greater than 1 in 14. The maximum predicted systematic subsidence along drainage lines resulting from the extraction of the proposed longwalls ranges from 1,390 mm at DL3 to 1,890 mm at DL5.

The predicted changes in grade are generally less than the natural grades of the drainage lines which vary from about 20 mm/m to 500 mm/m, the shallower grades occurring along the lower parts of DL5, DL6 and DL7 closer to the valley floor. Longitudinal profiles of initial and subsided surface levels for each of the seven drainage lines are presented in Figures C.05 to C.11 in Appendix C to MSEC's report (see Appendix 7 in Volume 4). Surface subsidence and the resultant change in grade of drainage lines is expected to alter surface water ponding and the rate and amount of erosion that occurs downstream following a rainfall event.

The depth of cover between the underground workings and the modelled drainage lines is generally greater than 70 m; the shallowest areas occur above LW4, LW5, LW6 LW13 and LW12 below the break in slope between the ridgeline and the valley floor (see Figures C.05 to C.11 in Appendix C to MSEC's report). As previously discussed, connective cracking between the surface and the underground workings is expected to develop in areas of shallow cover.

In times of heavy rainfall, the majority of runoff will be expected to flow over these surface cracks. During low flow conditions more runoff could be diverted into the strata below, although the generally steep terrain and small subcatchment drainages are not expected to be conducive to persistent low flow conditions. As these drainage lines are high in the catchment headwaters and the underlying strata is predominantly unsaturated, very little impact on the overall quality and quantity of water flowing out of the drainage lines is expected.

However, some loss of surface flows may occur where connective cracking develops in the drainage lines, particularly in areas of shallow cover. This may be exacerbated in low gradient drainage areas where ponding due to subsidence develops above zones of bedrock cracking and fracturing, particularly in areas of tensile strain. As previously indicated, unexpected and increased mine inflows pose a risk to mine safety and may result in unscheduled operational downtime. The quantity of water potentially entering the mine through connective cracks will depend on a number of factors. This includes the number of cracks and fractures that develop in the beds of the drainage lines, the quantity of water flowing over the cracks, the time this water is available for infiltration into the cracks and the hydraulic conductivity of the cracks and fractures.

In its assessment of flood inundation levels for OC4, Worley Parsons modelled peak surface water flows for each subcatchment above the underground mines (see Appendix 6A in Volume 4). Based on a 100 year ARI storm event for each subcatchment, Worley Parsons estimated the volume of surface water available to be between 14 and 27 m^3 (i.e., between 0.014 and 0.027 ML), maximum flows to be less than or equal to 5 m^3/s (i.e., 0.005 ML/s) and the time to reach maximum flow conditions to be about 16 minutes. This indicates there is very little lag between the commencement of the storm event and the time it takes for substantial runoff to reach the drainage lines. It is also expected that under these surface flow response conditions runoff and surface flow in the drainage lines would diminish in a similarly rapid manner. Under average rainfall conditions the quantity, peak flow and duration of surface flows in each drainage line would be expected to be much less than that predicted for the modelled 100-year flood scenario. This means that for most rainfall events the potential for significant mine inflows from surface runoff through connected surface cracking will be small. Further, it is expected that detailed assessment of the ground conditions and development and implementation of appropriate monitoring and management measures based on these outcomes will provide adequate opportunity for MCM to control and prevent significant mine inflows from surface runoff from occurring.

While it is expected that the surface fractures will naturally fill with sediments, some remediation of the beds of the drainage lines is expected to be required. This will be done through the manual infilling of cracks with clay materials or other inert sealing compounds. In areas where sufficient sealing cannot be achieved drainage diversion works may be required.

5.8.5.2 Cliffs, Overhangs, Rock Ledges and Steep Slopes

Ten cliffs have been identified in the area above the underground mines, which when combined yield a total length of 570 m. Most of the cliffs are between 10 and 15 m high, and approximately 20 m in length. There are two large cliffs with heights of about 20 m that extend in length for 50 m and 100 m respectively. These cliffs also have overhangs of between 5 and 7 m.

Cliff sites will experience a range of mine subsidence ground movements and rock falls may occur at some sites. Considering the shallow depths of cover, the magnitude of the predicted subsidence movements and the shape and position of these cliff sites, MSEC predict that up to 30% of the total length of cliffs and overhangs may experience rockfalls as a result of longwall mining.

Cliff 7 contains a rock overhang with Aboriginal art and non-Aboriginal graffiti (Cliff site C7 and Archaeological site S2MC236) (see Section 5.9). This site is located above LW12 and LW13 and will be protected by retaining a block of coal below the site, between the two longwalls (see Plans 11 and 47 in Volume 2).

Steep slopes located within the study area are subject to the full range of predicted systematic subsidence movements. Where these movements occur on steep slopes, MSEC predicts there is a higher likelihood of surface tension cracking occurring near the tops of the slopes. MSEC also assert that it is unlikely that mine subsidence will result in any large scale slope failure, since such failures have not been observed in similar settings at other coal mines in NSW as the result of longwall mining.

5.8.5.3 Archaeological and Heritage Sites

In addition to the rock art site in cliff 7, there are 26 other archaeological sites located above the underground mines in the defined area of surface subsidence (see Appendix 9 in Volume 5). Open sites containing artefact scatters and isolated finds are unlikely to be impacted by surface cracking. Care will be taken to prevent impact to the open sites through any surface remediation activities that may be required for aspects other than heritage. These measures will be incorporated into the Aboriginal Heritage Management Plan for the MCP.

Sites located in overhangs will be subject to similar impacts as described for the cliffs and overhangs, and artefact scatters and isolated finds can potentially be affected by rock falls. Any artefacts that require protection from potential impacts will either be removed from the overhangs or will be protected by minimising the risks of rock falls at the relevant overhang.

There is one non-Aboriginal heritage item of moderate local significance located near the finishing end of LW6. The item is a dry stone wall that formed part of the Mudgee-Wollar Road that ran via Moolarben. The dry stone wall is unlikely to be subjected to any significant impact resulting from the extraction of the longwalls. A detailed photographic record of the pre-mining condition of the dry stone wall will be prepared so that if any stones become dislodged, they can be identified and replaced in the correct positions following the completion of mining. This is further discussed in Section 5.10.

5.8.5.4 Threatened or Protected Species and Vegetation Communities

There are records of threatened bat species occurring within the study area, one of which, the Large-eared Pied Bat resides predominantly in caves and rock overhangs (see Section 5.7). Those caves and rock overhangs are likely to be impacted by the extraction of the longwalls, as described above. It is expected that the impacts, particularly if rock falls should occur, could cause damage to the habitats and affect some bats. However, cracking of strata may also introduce additional habitat.

Mining Subsidence Engineering Consultants predicts that systematic tilts are likely to result in some reduced and also some increased grades in areas where the CEECs occur. As previously described, these changes may cause some ponding of surface runoff and fracturing and dilation of the bedrock and soils in areas containing CEECs.

In its ecological assessment for Stage 2, Ecovision has mapped a general association between the occurrence of some of the CEECs above the underground mines with soils derived from underlying tertiary basalt deposits (see Section 5.7.5.1 and Appendix 7 in Volume 4). As previously indicated, basalt is a competent strata that may resist surface cracking. Where the basalt spans the longwall panels it may also resist subsiding. The weathered basalt soil horizon is also expected to be high in clay content and will therefore exhibit greater plasticity in the event that surface cracking and subsidence occurs. This will provide a readily available source of natural sealing materials where surface cracking does develop. With the exception of CEEC03 and CEEC05 the location of the CEECs above the underground mines also coincides with depths of cover greater than 100 m (see Plan 46 in Volume 2). Further, substantial parts of the mapped CEECs above the underground mines comprise cleared areas of native grasses (see for example Plans 4, 42, 43 and 46 in Volume 2). In consideration of the contribution of all these factors, the direct impact of mine subsidence on CEECs is expected to be minor.

Notwithstanding, if monitoring of mine subsidence effects on CEECs indicates that surface cracking and surface water ponding develops and adversely impacts on CEECs, then remediation works will be undertaken to mitigate against these effects in the long term. Depending on the location and extent of required remediation works, the mobilisation of equipment and the undertaking of the works could in themselves result in further impacts to the CEECs. In such instances, and where practicable, the required remediation works will be carried out by hand.

5.8.5.5 Rail Line and Roads

The Gulgong-Sandy Hollow rail line is approximately 330 m from the nearest edge of LW5 and is therefore outside the area predicted to be affected by surface subsidence effects. At this location the rail line will not be subjected to measurable systematic mine subsidence ground movements. Mining Subsidence Engineering Consultants has also considered the potential for far-field horizontal movements and upsidence and closure effects at this location. However, it predicts these effects will be small and unlikely to adversely impact on the rail line.

There are no sealed roads within the area that will be impacted by surface subsidence. Murragamba Road is located over the northeast part of LW4 and LW5 and Carrs Gap Road crosses directly over LW6 (see Plan 46 in Volume 2). Moolarben Coal Mines have requested that both roads be closed. Most of Murragmaba Road will be mined out as a result of OC4, however that part located over LW4 and LW5 will be retained and developed for use as the OC4 haul road.

It is expected that increased levels of ponding could occur along the roads and that cracking and rippling of the road surface will occur as a result of longwall extraction. Both roads are unsealed and will be amenable to regrading and repair using standard road maintenance techniques.

5.8.5.6 Powerlines and Communication Cables

There is one low voltage electricity power line within the study area, passing over Carrs Gap at the commencing end of LW6 and LW7. This powerline will be terminated in the Moolarben Creek valley on the western side of Carrs Gap and therefore will not be impacted. A telecommunications cable follows the alignment of Murragamba Road and this will be removed in consultation with Telstra as part of OC4. Hence, neither of these improvements will be impacted upon by subsidence.

There is an optical fibre cable located along the northern side of the Ulan-Wollar Road. The closest point of the cable to the longwalls is approximately 240 m from the northeast end of LW5. At this location, the optical fibre cable will not be subjected to measurable systematic mine subsidence ground movements. However, it may experience minor far-field horizontal movements and possibly upsidence and closure movements. These effects will be small and are unlikely to adversely impact on the optical fibre cable.

5.8.5.7 Residential and Rural Building Structures

There are two houses with water tanks and on-site waste water systems located within the area of influence of surface subsidence. These structures are owned by MCM and will be demolished prior to underground mining. There are no other buildings or rural structures that will be impacted by surface subsidence effects.

5.8.5.8 Fences and Farm Dams

There are a number of fences within the area of predicted surface subsidence. These could be affected by tilting of the fence posts and changes of tension in fence wires due to strain as mining occurs. Mining Subsidence Engineering Consultants predicts that some sections of fence will require repair or replacement. These will be repaired or replaced by MCM, where necessary.

Thirteen small farm dams have been identified within the area of predicted surface subsidence. These water retaining structures are no longer required for farming and hence the predicted change in freeboard, although only minor, is of no consequence. It is expected that cracking and leakage of water could occur in the farm dams which are subjected to greater strains, although any loss of water would merely flow into the drainage line in which the dam was formed.

5.8.5.9 Mining Infrastructure

The south western out-of-pit emplacement associated with OC4 will be located above LW10 to LW12. It is expected that additional settlement will occur at the top of the emplacement, as the longwalls mine beneath it. The additional settlement at the top of the emplacement is predicted to be about 25 mm/m. This area will be monitored to ensure the emplacement area remains stable, post settlement.

5.8.5.10 Survey Control Marks

One survey control mark, known as the Murragamba Trig Station (see Plan 47 in Volume 2), is located above LW6 and will be subjected to mine subsidence movements. When the ground has stabilised it will be necessary to re-establish this mark in consultation with the NSW Department of Lands.

5.8.6 Environmental Management

The most effective means of controlling and managing the surface effects and impacts of mine subsidence are applied during the mine design stage. This includes the design parameters for longwall extraction, specifically panel width, length and height, and locating main drives, gate roads and longwall panels relative to the location of sensitive surface features and improvements. These mine design considerations need to be balanced against the economics of underground mining and efficient recovery of the coal resource.

The proposed layout of the Stage 2 underground mines (UG1 and UG2) has been designed in accordance with these subsidence management principles, which MSEC predict will provide adequate protection to the Munghorn Nature Reserve, the Gulgong-Sandy Hollow rail line and then overlying Aboriginal rock art site.

Prior to commencement of underground mining, MCM will prepare a Subsidence Management Plan (SMP). When this is prepared it will include both subsidence monitoring and mitigation strategies. The objective of these strategies will be to ensure that safety and serviceability are maintained during mining, and that adequate and timely remediation is carried out where impacts have occurred. The SMP will be assessed by an inter-agency subsidence management review committee. No underground mining will be undertaken prior to approval of the SMP by this committee. It is also likely that more than one SMP will be required to be prepared to enable mining of the Stage 2 underground coal resource. Typically an initial SMP will be prepared for the first series of longwall panels (e.g., LW1 to LW5), with subsequent longwall panel extraction being the subject of further SMPs. This will enable further refinement and implementation of subsidence management and mitigation measures for later longwall panel extraction, based on the experience gained during extraction of the initial longwall panels.

5.8.6.1 Mitigation Measures

Based on its extensive experience in mine subsidence assessment and control, MSEC has recommended a range of mitigation measures to protect natural features and surface infrastructure, and to minimise the impacts of subsidence on these and other surface improvements in the areas above the underground mines. MCM has committed to implement these for Stage 2 and has proposed additional mitigation measures. These are summarised in **Table 5.8.1**, and will be developed in detail in consultation with government agencies during the preparation of the SMPs for Stage 2.

Table 5.8.1 Summary of mitigation measures for natural features and surface infrastructure

Feature	Mitigation Measure
Drainage lines	If significant unpredicted loss of flow occurs, identified cracking in drainage lines will be remediated by infilling the surface cracks with materials comprising a high clay content, or by locally regrading and recompacting the surface. Where connected cracking in drainage lines poses a significant safety risk to mine workers and infilling and sealing is insufficient to prevent significant ingress of surface water into the underground workings, then surface drainage diversion works will be designed and implemented.
Cliffs, overhangs and rock ledges	The likelihood of cliff collapse or damage at some of the identified cliffs has been minimised by the design of the longwall starting and finishing positions. Management strategies include further restriction of access and if required, making site areas safe should any cliff face appear to become unstable. The existing condition of cliffs within the study area will be documented and photographed prior to mining.
Steep slopes and vegetation communities	If unpredicted significant surface cracking occurs, it will be remediated by infilling with soil or other suitable materials or by locally regrading and compacting the surface. Surface water ponds that develop and adversely impact on existing native vegetation will be remediated. Remediation works and erosion control measures will be implemented to arrest potential slumping and erosion of soils on steep slopes.
Rail line and roads	If Carrs Gap Road is not closed, management strategies will be developed in consultation with MWRC to maintain the road in a safe and serviceable condition throughout the mining period.
Survey control marks	Survey control marks will be re-established in consultation with the Department of Lands, following the completion of mining.

Table 5.8.1 Summary of mitigation measures for natural features and surface infrastructure (cont'd)

Feature	Mitigation Measure
Powerlines and communication cables	A monitoring, management and response plan will be established for the optical fibre cable prior to mining LW1 to LW5, to the satisfaction of the owners of the cable. Management strategies will be developed, in consultation with the owners, for the implementation of suitable remediation measures should any impacts on the fibre optics cable occur.
Mining infrastructure	Management strategies will be developed for the safe placement of spoil and the management of the steep slopes as the longwalls are mined beneath and in the vicinity of the out-of-pit emplacement areas. Management strategies will be developed to maintain stability of open cut highwalls during the underground mining period.
Archaeological and Heritage sites	Overhang site at Cliff C7 will be protected by leaving a block of unmined coal below the site. Any artefacts below overhangs that require protection from potential impacts will either be removed from the overhangs or will be protected by minimising the risk of rock falls at the relevant overhang. Care will be taken during any ground surface remediation to avoid disturbance of any of the archaeological sites. Approvals will be obtained from the appropriate authorities for remediation of the surface, if necessary, in the location of archaeological sites. If any stones from the dry stone wall become dislodged during mining, they will be replaced in the correct positions following the completion of mining, based on a pre-mining photographic recording of this feature.

5.8.6.2 Subsidence Monitoring

A detailed monitoring program will be developed and implemented for the underground mines and this will form part of the SMPs. This will include monitoring of:

- Surface subsidence above the longwall panels.
- Soil slumping and erosion on steep slopes.
- Rock falls and cliff stability.
- Surface water ponding.
- Surface cracking of bedrock (particularly in areas of shallow cover).
- The height of fracturing above the goaf of the longwall panels.
- The impact of surface subsidence on sensitive natural surface features, including the Aboriginal rock art site, drainage lines (particularly in areas of shallow cover) and CEECs.
- The impact of underground mining and mine subsidence on overlying aquifers and on surface water quality and quantity draining off the area of underground mining.

The monitoring program and results will be used to guide remediation works to mitigate post-mining surface subsidence impacts. A summary of the proposed monitoring measures is presented in **Table 5.8.2**.

Two survey lines will be established across the two groups of longwalls in UG1 (i.e., LW1 to LW5 and LW6 to LW9) and two survey lines will be established across the two groups of longwalls in UG2 (i.e., LW10 to LW12 and LW13). The monitoring lines will be established prior to extraction of the longwalls and these monitoring lines will be monitored on completion of mining or until results show that further subsidence has ceased.

Visual monitoring and photographic records of the important natural features and items of surface infrastructure will be undertaken during the mining period. A baseline inspection will be carried out to establish the condition of the natural features and items of surface infrastructure prior to extraction of the longwalls. Inspections will then be carried out on a regular basis during the mining period and approximately 6 months after the completion of mining.

Detailed monitoring will also be implemented in areas of shallow cover, in drainage lines where connective cracking could develop and pose a conduit to mine inflows, and at other selected sensitive surface features. The monitoring of ground movements will be undertaken at these locations as subsidence occurs. This will enable immediate remediation works to be implemented to mitigate against adverse impacts. It will also enable observed ground movements to be compared with predicted movements. This will provide detailed information to inform regular (annual) review of the subsidence predictions and to develop site-specific mitigation and management measures and implementation time frames.

5.8.6.2 Review of Subsidence Impacts, Monitoring and Mitigation

Prior to the mining of each successive longwall panel and prior to the development of each successive SMP, surface subsidence impacts, monitoring results and the success (or not) of mitigation and remediation measures for previously mined longwall panels will be reviewed. A suitably qualified and experienced subsidence consultant will carry out this review in consultation with DPI - Minerals. The review will evaluate subsidence predictions and enable predictions in subsequent SMPs to be calibrated to specific site conditions. The outcomes of the review will also inform the development of monitoring and mitigation measures, which if amended will be implemented in subsequent years of underground mining.

Where this review indicates that subsidence impacts have been under predicted, then depending on the nature and extent of these impacts and the success of applied mitigation strategies, the underground mine plan for future years will be reviewed. However, any change in mine design will need to be balanced against the need to maximise the efficient and economic recovery of the coal resource.

Table 5.8.2: Summary of monitoring measures for natural features and surface infrastructure

Feature	Monitoring Measure
Drainage lines	Visual monitoring as the longwalls mine beneath the drainage lines.
Cliffs, overhands and rock ledges, and steep slopes	Visual monitoring during the mining period from a remote and safe location until such time as the mine subsidence movements have ceased. Visual monitoring will be complimented by surveyed movements for Cliffs C7 to C10. Visual monitoring of steep slopes above the longwalls as they are mined.
Groundwater occurrence	Establishment of piezometers to regularly monitor the effects of underground mining on overlying aquifers (see Section 5.4).
Vegetation communities	Visual monitoring of the vegetation communities as the longwalls mine beneath them.

Table 5.8.2: Summary of monitoring measures for natural features and surface infrastructure

Feature	Monitoring Measure
Railway and roads	Surveyed ground monitoring of the rail line during extraction of LW1 to LW5.
Powerlines and communication cables	Monitoring during the extraction of LW1 to LW5 using optical fibre sensing techniques, such as Optical Time Domain Reflector monitoring.
Mining infrastructure	Monitor settlement of the out-of-pit emplacements as longwalls mine beneath them. It may be necessary to monitor from a remote location using reflectors placed on the out of pit emplacement, or using aerial laser scan techniques. Establish survey lines along the top and bottom of the highwalls to monitor movements as the longwalls are mined. Regular visual inspection of the faces of the highwalls and the tops of the highwalls, as mining occurs.
Archaeological and Heritage sites	Monitor overhang sites as required in accordance with cliff line monitoring. Visual monitoring of open archaeological sites. Photographic record of the pre mining condition and visual monitoring of the dry stone wall during extraction of LW6 and LW7.
Survey control marks	Murragamba Trig Station should not be used during mining unless correction has been made for any movements of the trig station.

5.9 Aboriginal Heritage

5.9.1 Objectives

The objectives of this assessment are to describe the Aboriginal archaeological or cultural heritage objects and sites in the locality, assess their significance and the effect of Stage 2 on these objects and sites. Management measures are identified according to the predicted impact and significance of the objects and sites.

5.9.2 Assessment Method

Archaeological Risk Assessment Services Pty Ltd (ARAS) undertook an Aboriginal cultural heritage impact assessment of the Stage 2 Project Area, which involved the following:

- A review of the DECC Aboriginal Heritage Information Management System (AHIMS) to determine if there were any known Aboriginal sites registered in the area, their landform association and rarity.
- Field surveys, which had regard to previous archaeological surveys conducted in the district.
- Consultation with Aboriginal groups and individuals.

The archaeological and cultural heritage study area included the Stage 2 Project Area and some areas to the west within the EL6288 boundary (see **Plan 49** in Volume 2). Field surveys were conducted by foot by a team of archaeologists and up to 8 local Aboriginal community members for a 40 day period during October to November 2006, January to February 2007 and June to July 2008. A total of 49 foot transects were completed with approximately 7.65 km^2 or 20.6% of the study area assessed on foot by the team. Constraints to the field surveys included access limitations to properties/landscapes, weather conditions, steepness of the terrain and surfaces with less than 20% surface visibility.

A copy of the report is contained in **Appendix 9** of Volume 5.

5.9.2.1 Consultation with Aboriginal Groups and Individuals

The Aboriginal heritage assessment process was undertaken having regard to the DECC (formerly known as Department of Environment and Conservation (DEC)) guidelines: Interim Community Consultation Requirements for Applicants (DEC, 2004b). Aboriginal stakeholders consulted include Murong Gialinga Aboriginal and Torres Strait Islander Corporation, Warrabinga Native Title Claimants Aboriginal Corporation, North-East Wiradjuri Native Title Claimants and Mudgee Local Aboriginal Land Council.

An overview of the consultation process is provided below:

- Public notices were placed in the Mudgee Weekly and Mudgee Guardian newspapers on 9 and 11 August 2006, respectively, seeking expressions of interest from Aboriginal community groups or individuals with respect to the project. In addition, letters of invitation were sent to the local Aboriginal stakeholder groups (as stated above) seeking input into Stage 2. The North-East Wiradjuri Native Title Claimants and two local individuals responded to the public notices and invitations.

- Meetings were held in Mudgee on 12 and 17 September 2006 to introduce the project, explain and seek input into survey methodologies and assessment process from Aboriginal groups and individuals.
- Discussions were held during the conduct of field work between the Aboriginal representatives and project archaeologist.
- Each Aboriginal stakeholder community group provided written comment on the proposal and the final reports' recommendations after the completion of the assessments undertaken during October to November 2006, January to February 2007 and June to July 2008.
- An Aboriginal stakeholder meeting was held at Ulan village on 30 July 2008 in order to discuss and explain the results of the cultural assessment report and impacts upon Aboriginal sites. The meeting was attended by representatives of the local Aboriginal stakeholders (as stated previously). Following the briefing session, a field inspection of the Stage 2 Project Area was undertaken.
- An additional Aboriginal stakeholder meeting was held on 5 November 2008 at Mudgee in order to engage the Aboriginal community and provide a broad overview of the assessment report and its findings. The audience was asked to provide written feedback on the findings and recommendations of the assessment, which was distributed in hard copy as a final draft during the meeting. Additional site-specific management information was also explained to the stakeholders.
- A site inspection of the Stage 2 Project Area was conducted on 5 December 2008 with 16 members of the local Aboriginal community to show them existing and newly recorded Aboriginal sites and discuss their likely management status. Attendees were encouraged to submit comments on the project and report findings.

As part of the 12 and 17 September 2006 consultation, it was agreed with the Aboriginal stakeholder groups that the Aboriginal assessment would include two components: an archaeological assessment and an Aboriginal cultural assessment. The archaeological assessment was undertaken with four local Mudgee Aboriginal groups during October to November 2006, January to February 2007 and June to July 2008. The cultural assessment was carried out in November 2006 with two representatives from the Aboriginal stakeholder groups and involved a site inspection and the recording of any places or sites of cultural significance. It was also agreed that the Aboriginal participants would be able to comment on the draft final report and forward any comments or cultural knowledge regarding Aboriginal sites and objects of significance to MCM within two weeks of receiving the reports. Submissions received are included in Appendix 9 of Volume 5.

5.9.3 Existing Environment

5.9.3.1 Landscape

The culture of the Aborigines is tied to the landscape, therefore, impacts on the landscape may affect Aboriginal cultural heritage.

The most dominant natural landform features, which formed part of the survey investigation areas, were Murragamba Creek and the surrounding sandstone ridgelines.

5.9.3.2 Registered Aboriginal Heritage Sites

The AHIMS search identified 19 registered Aboriginal sites (of which two had been recorded twice and have separate DECC numbers) within the general region of the Stage 2 Project Area. A review of previous archaeological surveys identified a range of site types having been recorded in the district. Site types include open camp sites (made up of stone artefacts some containing hearth material), scarred trees, carved trees, burial sites, bora rings, art sites, axe grinding grooves and waterholes/wells. Likely stone raw material supplies (quartz, tuffs, slate and siltstones) used in the manufacture of tools were likely to have been sourced from the creek beds in the area.

5.9.3.3 Survey Results

The field survey conducted by ARAS located a total of 4,825 stone artefacts from 258 Aboriginal sites. The sites comprised 150 open stone artefact scatter sites of varying densities, 102 individual stone artefact isolate finds, five rock shelter sites and one grinding groove site. A total of 33 potential archaeological deposits (PADs) were also identified.

Site types recorded for the different development areas (OC4, UG1, UG2 and infrastructure areas) for Stage 2 are summarised below. A full list of Aboriginal items discovered during the field survey is contained within Table 9 in Appendix 9. The distribution of Aboriginal heritage sites is shown in Plan 49 in Volume 2.

Open Cut 4

A total of 175 Aboriginal sites were recorded for the OC4 area comprising 102 artefact scatters and 73 isolated finds. Within the OC4 area, the survey identified 20 PADs. Spatially, the sites were concentrated within a 1.75 km linear section of Murragamba Creek opposite the Munghorn Gap Nature Reserve. Approximately 1 km of this section of Murragamba Creek will be protected from the impacts of mining OC4.

A second narrow linear area associated with Eastern Creek was also recorded. These sites were typically within 100 m of the creek.

Archaeological Risk Assessment Services Pty Ltd concluded that these sites displayed a pattern of intensive short term occupation, dominated by quartz stone tool technology.

Underground 1

A total of eight Aboriginal sites were recorded for the UG1 area. These consisted of five isolated finds, one artefact scatter and two rock shelter sites. No PADs were located in this area. The area principally consists of elevated sandstone ridge crests or mid slopes with steep gullies and is dominated by open woodland and forest with mainly poor ground visibility.

Archaeological Risk Assessment Services Pty Ltd concluded that the sites displayed short term occupation with quartz stone tool technology.

Underground 2

A total of four Aboriginal sites were recorded for the UG2 area comprising two artefact scatters, one isolated find, and one rock shelter with art. One PAD was also identified in the area. The area is dominated by a sandstone ridgeline (south of the Carrs Gap Trig Station) and associated gullies.

It largely comprises open woodland and steep mid-sloping ground with mainly poor ground visibility.

Archaeological Risk Assessment Services Pty Ltd concluded that the ridgeline would have been used for the movement of Aboriginal people between the Moolarben and Murragamba creek valleys. Occupation of this area is demonstrated by sites S2MC 236 and S2MC 238.

Site S2MC 236 contains a single large sandstone tor feature which contains DECC registered rock art site 36-3-0134. This is an elongated sandstone shelter facing east containing rock art images and European graffiti dating back to the early 1900s. The Aboriginal art work is considered to be regionally significant and is situated between the Moolarben and Murragamba Creek valleys.

Site S2MC 238 is located approximately 500 m south of S2MC 236, and contains an artefact scatter with a PAD. The site lies at the head of a gully and overlooks an expanse of sandstone escarpment. The site comprises mainly quartz artefacts and may contain sub-surface evidence for occupation of the site.

The ROM coal facility and office and workshop areas

A total of 28 Aboriginal sites have been recorded in areas proposed for infrastructure. This comprises 16 isolated finds and 12 artefact scatters. Four PADs have also been identified in this area.

The areas comprise mainly revegetated shrubs and trees with open pasture for grazing. There is generally poor ground visibility. The dominant environmental features of these areas, which may have influenced local Aboriginal occupation pattern, are the ephemeral drainages associated with the northern part of Wilpinjong Creek and the sandy ridge located north of Bora Creek, which provides dry and soft campsite locations.

The artefacts were mainly of quartz technology but had a low density of utilised implements and cores.

Conservation Areas

Property 14 (known as Red Hills) and the southern part of Property 44 (known as the Powers Property) outside OC4 footprint (see Plans 2 and 4 in Volume 2) will be set aside as heritage conservation areas for the life of the MCP. The field survey identified 43 Aboriginal sites within these two properties as well as in the adjacent portion of the Munghorn Gap Nature Reserve. These Aboriginal sites comprise 33 artefact finds, seven isolated finds, two rock shelters with artefacts and one grinding groove and artefact scatter. Eight PADs have been identified in this area.

The area comprises mainly narrow drainage channels running through cleared open woodlands and pasture. There is generally variable ground visibility. Environmental features located either within or near both Properties 14 and 44, which may have influenced Aboriginal occupation patterns, are the Wilpinjong Creek valley and the freshwater seepages along the upper sections of Eastern Creek.

Archaeological Risk Assessment Services Pty Ltd concluded that the greatest evidence of Aboriginal occupation within the conservation areas is within the Wilpinjong Creek valley located on Property 14. This section of Wilpinjong Creek contains a cluster of 33 open sites with 4 sites containing over 100 artefacts and 7 sites containing PADs distributed over a 1.5 km length of creek and within a 100 m corridor. The sites within Property 14 display a pattern of short-term occupation dominated by quartz stone tool technology with some tuff and silcrete.

Potential Archaeological Deposits

The majority of the 33 PADs recorded in the field survey are associated with alluvial deposits situated adjacent to either Murragamba Creek, Wilpinjong Creek or Eastern Creek. No rock shelter sites within the Stage 2 Project Area were found to contain PADs.

Site Condition

Only 5 Aboriginal sites (two open artefact scatters sites in Murragamba Creek and two in Wilpinjong Creek, and one grinding groove site within Property 44) of the 258 recorded are considered to be in fair condition. The rest of the sites are in poor condition. Only parts of registered DECC site 36-3-0134 (S2MC 236) (rock art site) are considered to be in fair condition. A high proportion of art located on its vertical walls has been damaged by weathering, wasp nests and dust. The condition of a heritage site has a direct bearing on the amount of information that can be obtained from the site.

5.9.3.4 Significance of Aboriginal Sites

Approximately 85% of the sites are located within a valley floor, alluvial floodplain or drainage channel context. Approximately 15% of sites were located on elevated knolls, saddles, spurs or ridgelines and were the most rarely occupied land units. Within the ridge system, formerly occupied shelters were located within 500 m of water sources and access corridors.

Of the locally existing landform types, the most dominant natural features which formed part of the survey investigation areas were Murragamba Creek and the surrounding sandstone ridgelines. Murragamba Creek was the most surveyed drainage line in the study area and it was also assessed as being the most disturbed. Murragamba Creek contained the highest concentration of sites with the richest and most diverse surface stone artefact assemblages.

Most identified sites (80%) were within 50 m to 100 m of a water body, including soaks and springs. Work by Aquaterra indicates that Murragamba Creek has the highest concentration of natural springs and soaks compared to other local catchments within the MCP area, but is insufficient to maintain baseflow to the creek.

Archaeological Risk Assessment Services Pty Ltd reported that individually the majority of the sites recorded within the study area are not unique or rare, but commonly represented. It was found that the main area of Aboriginal occupation within the Stage 2 Project Area was located within the Murragamba Creek valley and the surrounding low ridges above historic flood levels.

Archaeological Risk Assessment Services Pty Ltd argues that settlement within the Murragamba Creek valley offered strategic access to long-term resources and places to undertake ceremonies and make art. The Murragamba Creek valley is so shaped that it naturally concentrates water resources and creates habitable nodes in the broader landscape.

The combination of the above factors makes the Murragamba Creek valley a more significant site or cultural landscape compared to other areas assessed within the Stage 2 Project Area. Sites in the Murragamba Creek valley provide more evidence of transport corridors or patterns of seasonal movement across a broader region.

Table 5.9.1 summarises the ARAS assigned significance rating for each site.

Table 5.9.1 Significance of Aboriginal sites/objects within Stage 2

	Low	Medium	High
S2MC No	S2MC: 1-5, 7-13, 16-17, 19-29, 31-42, 44, 47-49, 52-53, 55, 59-60, 65-75, 78-80, 82-88, 90-122, 126-149, 152-153, 155-199, 202-206, 210-215, 217, 219-221, 223-225, 228-234, 237, 239-249, 252-257, 259-260, 36-3-0690 – 36-3-0699.	S2MC: 6, 14-15, 18, 30, 45-46, 50-51, 56-58, 61, 76, 81, 89, 125, 150, 154, 201, 208-209, 216, 218, 222, 226-227, 250, 251, 258, 36-3-0237, 36-3-0238, 36-3-0239, 36-3-0240, 36-3-0241, 36-3-0287, 36-3-0337	S2MC: 43, 54, 62-64, 123-124, 151, 200, 207, 236 (36-3-0134) and 238
No. of New Sites	215	30	12*
No. of DECC Sites	10	7	(included in above figure)
Total	225	37	12

* Includes one DECC site (36-3-0134 otherwise known as S2MC 236)

5.9.3.5 Aboriginal Social and Cultural Values

The Aboriginal representatives participating in the assessment process did not identify any places of cultural significance within the Stage 2 Project Area. However, generally all archaeological and cultural sites seem to be important to Aborigines.

The most sensitive Aboriginal cultural landscapes have been identified as the Murragamba Creek valley and Moolarben Ridgeline south of Carrs Gap.

5.9.4 Issues

The following issues were addressed as a part of the Aboriginal cultural heritage assessment:

- Potential impacts on Aboriginal heritage.
- Potential impacts on cultural landscape value.

5.9.5 Impact Assessment

5.9.5.1 General Impacts upon Heritage

The main potential mining impacts on cultural heritage include:

- Physical disturbance, destruction or removal of heritage items/sites due to soil stripping, excavation, stockpiling, dumping, damming, haulage and construction of buildings and infrastructure.

- Vibratory impacts on heritage sites from mine blasting.

- Subsidence impacts such as geological cracking, fracturing, faulting, water seepage, erosion and rock falls affecting heritage items.

As stated in Section 5.8, open archaeological sites containing artefact scatters and isolated finds are unlikely to be affected by surface cracking due to mining. However, it is possible that remediation and rehabilitation works to surface areas could potentially affect archaeological sites.

All heritage objects and sites within the OC4 boundary will be removed by the mining process. Those on the boundaries of the mining area may also be affected. Specific impacts on identified Aboriginal heritage are discussed below.

5.9.5.2 Impacts upon Aboriginal Heritage

Archaeological Risk Assessment Services Pty Ltd has found that 173 Aboriginal sites will be directly affected by Stage 2 while 85 sites will be conserved (see **Table 5.9.2**).

Table 5.9.2 Aboriginal sites which will be impacted and conserved

Type of Mining Impact	Sites to be Impacted	Sites to be Conserved	Total
Open Cut 4	139	36	175
Underground No. 1	6	2	8
Underground No. 2	3	1	4
Infrastructure impacts	25	2	27
Conservation offsets	-	44	44
Total	173	85	258

All Aboriginal objects identified in this assessment which will be impacted by Stage 2 will be salvaged, recorded and managed as per the measures identified in the environmental management section (Section 5.9.6) described below.

Table 5.9.3 identifies the magnitude of impact that will affect the Aboriginal heritage sites within the study area.

Table 5.9.3 Impact assessment of Aboriginal sites

Cultural/Archaeological/ Heritage Significance	Predicted Impact				Total
	Unknown*	None	Low	High	
Low	10	67 (30)	4	138	219 (30)
Medium	1	19 (10)	7	16	43 (10)
High	-	5 (3)	2	5	12 (3)
Total	11	91 (43)	13	159	274 (43)

* The location of these DECC registered sites are unknown, therefore the impact of Stage 2 on these sites is unknown.

Numbers in brackets represent the number of Aboriginal sites that will be within a conservation area that is a subset of the larger number.

Of the 274 sites identified (which includes both sites uncovered during the surveys as well as DECC-registered sites), 12 are considered to be of high significance. Of these 12, only 5 will be permanently removed (high impact). All five sites are located within the proposed OC4 area and comprise artefact scatters and PADs. The sites include S2MC 43, 62, 64, 123 and 124 and will be completely removed by mining of OC4.

Two high significance sites are predicted to be somewhat affected/disturbed (low impact) by Stage 2 (two sites). The sites include S2MC 236 and 238. Five sites of high significance are not expected to be affected at all, while three sites will be within the proposed heritage conservation area. These are artefact scatter and PAD sites S2MC 200 and S2MC 207 and grinding grooves/ artefact scatter site S2MC 151 located within Properties 14 and 44 respectively. Stage 2 has been designed to minimise damage to S2MC 236; this is discussed in more detail in Section 5.9.6 below.

The rest of the Aboriginal sites within the Stage 2 Project Area are considered to be of low or medium significance. Of these, it is predicted that 16 medium significance sites will be highly impacted, 7 will receive a low impact, while the rest of the medium significance sites (i.e., 19) will not be affected. Ten of the sites that will not be affected are located within the proposed heritage conservation areas. The medium significance sites that will be highly impacted include S2MC 6, 18, 45, 46, 51, and 251, which are all artefact scatters and PADs; S2MC 30, 61, 76, 81, and 125, each of which is an artefact scatter; and DECC sites 36-3-0237 to 36-3-0240, which are registered as artefacts.

Some 138 low significance sites will be permanently removed with two low significance sites receiving a low impact. The remaining 67 low significance sites will not being affected at all and of these, 30 are situated in the proposed heritage conservation areas. Of the sites of low significance, three were recorded by ARAS as being in the Munghorn Gap Nature Reserve. Due to their location, these sites will not be affected by Stage 2.

Archaeological Risk Assessment Services Pty Ltd identified 11 additional DECC sites with unknown locations. None of these were determined by ARAS to be of high cultural/archaeological significance while one was determined to be of medium significance with the rest being of low significance.

5.9.5.3 Aboriginal Views of Sites and Cultural Landscape Value

As part of the assessment process, each Aboriginal group participating in the survey was asked what cultural landscape values the project area may contain. A number of issues were raised and are summarised below:

- The effect of mining on sites located within the Munghorn Gap Nature Reserve associated with rock art and contemporary ceremonial practice.
- Access to sites and cultural landscape by all Aboriginal people in the community without restrictions in order to undertake cultural practices and teachings to preserve ongoing cultural awareness.
- The removal of cultural objects and identification of Aboriginal burials.
- The broader impact of mining on Aboriginal heritage within the Ulan and Moolarben areas.
- The establishment of a ‘Keeping Place’ within close vicinity of the sites or on mine-owned land for Aboriginal people in the community.
- Consultations with Aborigines on Aboriginal heritage should be done as a group.
- Impacts to the Murragamba Creek valley should be avoided.
- Mitigation of impacts on heritage items such as the erection of fences around specific sites.

Although ARAS states that none of the community members interviewed objected to the mining proposal, one member of the Wiradjuri people did object by letter. Another member of the Wiradjuri people asked in writing for several mitigation measures to be undertaken as well as the provision of community benefits including a community building for such uses as a cultural centre for example and 'Land for Cultural Experiences including Employment Training [sic]'. These letters formed Appendix 4 of the Aboriginal cultural heritage impact assessment (Appendix 9 in Volume 5), and have been submitted to the Department of Planning along with this EA report for assessment. For the purposes of confidentiality, this section of Appendix 9 in Volume 5 has been removed from the publicly available EA report.

5.9.6 Environmental Management

5.9.6.1 General Management

In order to protect as much Aboriginal heritage as possible, MCM will implement the following general mitigation and conservation measures prior to mining within the Stage 2 Project Area:

- Salvage and recording of sites.
- Conservation and preservation of sites outside the disturbance area from likely mine impacts.
- Archaeological salvage and test excavations including a suitable lithic analysis of all material collected as part of the salvage operations.
- Surface collection of Aboriginal objects.
- Identification, management and monitoring of Aboriginal rock art sites.
- Monitoring of earthworks in locations with the potential for Aboriginal burials.
- Intensive in situ recording.
- Ongoing monitoring and assessment of subsidence impacts including protection, analysis and recording of sites at risk of subsidence.
- Provision of expert subsidence advice to the Aboriginal community via a presentation by MCM to discuss the Stage 2 subsidence assessment.

All necessary approvals will be obtained prior to construction, mining and rehabilitation activities of the surface in locations where Aboriginal heritage items have been identified.

5.9.6.2 Specific Measures

The following archaeological mitigation measures will be implemented for Stage 2:

- Controlled gridded surface collection of isolated finds and low density artefact scatters (133 sites in total).
- Test excavation and salvage by means of mechanical (grader scrapes, back hoe trenching), shovel testing and hand excavations for 34 sites within the cleared valley floor areas within the OC4 footprint. These sites will undergo intensive surface recording.
- Intensive surface recording including fine scale mapping and photography for six sites including rock art site 36-3-0134. The six sites are S2MC 229, 231, and 236 to 239.

- Leaving a block of coal beneath the rock art site (36-3-0134/S2MC 236) between the longwalls (see Section 5.8), and ensuring that blasting associated with open cut mining operations does not exceed the DECC ground vibration criteria of 40 mm/s at this site. Monitoring of ground vibration levels will commence when mining is within 400 m of the rock shelter. These measures will protect both the rock art site and the associated cliff.
- Items above UG1 and UG2 that require protection from potential rock falls (i.e., sites within overhangs, near cliffs or steep rock faces) will be removed from the overhangs or protected by minimising the risk of rock fall at the relevant overhang.

5.9.6.3 Creek Sites and Landscapes

The Murragamba Creek landscape will receive the highest impact within the Stage 2 Project Area due to the mining of OC4. However, not all of the creek will be mined. The mine plan avoids a 1 km section of creek that has been identified as having high archaeological and ecological value (see Sections 5.5 and 5.7). MCM will preserve as much as of this landscape feature as practically possible.

Other sites of significance identified within creek landscapes such as Eastern Creek, Wilpinjong Creek (Property 14) and freshwater soaks with Aboriginal sites (Property 44), will be protected through conservation arrangements for the duration of the MCP.

5.9.6.4 Keeping Place

A Keeping Place has been provided for the purpose of housing and curating all salvaged Aboriginal objects and archaeological material during the life of the MCP. This Keeping Place will hold items from both the Stage 1 and Stage 2 Project Areas.

The Keeping Place will be managed jointly by MCM and Aboriginal community stakeholder groups. Its location, curatorial purpose, educational function and design will be subject to consultation with Aboriginal community stakeholder groups and the DECC. The location and management of the Keeping Place will ensure open access for all interested Aboriginal people as well as relevant scientific researchers.

Applications will be made to the DECC for a Care and Control permit to transfer any Aboriginal objects to local Aboriginal communities prior to storage of the items in the Keeping Place in accordance with section 85a of the National Parks and Wildlife Act.

5.9.6.5 Aboriginal Heritage Management Plan

An Aboriginal Heritage Management Plan for Stage 2 will be prepared and implemented, and will be integrated with the Stage 1 Aboriginal Heritage Management Plan. The plan will be developed from an Aboriginal heritage planning workshop with input and advice from local Aboriginal community stakeholders and DECC prior to Stage 2 works being carried out. As part of this plan, MCM will have continued involvement with the Aboriginal community in the management of Aboriginal cultural heritage issues identified throughout the life of the project.

The plan will include the specific and general management measures as described previously as well as:

- A program to assess and record Aboriginal heritage values of the area.

- Contingency measures to ensure the recording, protection and mitigation of significant Aboriginal objects of a nature not expected, including any Aboriginal skeletal remains.
- Procedures for the ongoing consultation and involvement of the Aboriginal community in the conservation and management of Aboriginal heritage within the Stage 2 Project Area.
- Establishing the process to fully notify the DECC of all currently known and future Aboriginal sites discovered, removed or salvaged during the operational life of Stage 2.
- Procedures for the full reporting of mitigation actions for all identified Aboriginal objects including as a minimum, the type, number and raw material attributes of each object and the involvement of the Aboriginal community with regards to these mitigation actions.
- All necessary applications for care and control of Aboriginal objects to the community will be made where such care and control is sought by the Aboriginal community.

5.9.6.6 Conservation Areas

As indicated previously, MCM will set aside two areas, Properties 14 and 44 (that part not affected by mining OC4), for the conservation of Aboriginal heritage during Stage 2. These properties contain a total of 85 Aboriginal heritage sites. These are in addition to the 78 sites (440 Aboriginal objects) that will be conserved as part of the Stage 1 Project Approval.

All archaeological sites on other MCM-owned land outside the Stage 1 and Stage 2 disturbance footprints will be conserved as these areas will not be disturbed by MCM construction or mining activities.

5.10 Non-Aboriginal Heritage

5.10.1 Objectives

The objectives of this assessment are to describe any non-Aboriginal archaeological or cultural heritage objects or sites in the locality, their significance and the effect of Stage 2 on these objects and sites. Management measures are outlined depending on the predicted impact and significance of the objects and sites.

5.10.2 Assessment Method

Heritas Architecture (Heritas) undertook a non-Aboriginal heritage assessment of the Stage 2 Project Area. A copy of this report is contained in **Appendix 10** in Volume 5.

A site inspection was undertaken in June and July 2008. The assessment method is based on the analysis of cultural heritage value under six criteria: historical, social, aesthetic, research significance, rarity and representativeness. The assessment was undertaken in accordance with the requirements of the Australia ICOMOS (International Council on Monuments and Sites) Burra Charter (ICOMOS, 1999).

A previous study by Veritas Archaeology and History Service (Veritas) was reviewed as part of the assessment.

5.10.3 Existing Environment

5.10.3.1 Non-Aboriginal Registered Heritage Sites

There are currently no non-Aboriginal heritage sites registered with the NSW Heritage Office and MWRC within the Stage 2 Project Area. Two items bordering the Stage 2 Project Area are however listed in the Register of the National Estate (Commonwealth):

- Goulburn River National Park.
- Munghorn Gap Nature Reserve.

Terrain, fauna, flora and indigenous values are identified as reasons for the listing of Goulburn River National Park in the register. Flora, fauna and possible indigenous and non-indigenous culture values are identified as reasons for listing Munghorn Gap Nature Reserve on the register.

5.10.3.2 Survey Results

A total of 11 non-Aboriginal heritage sites were identified within the Stage 2 Project Area. These are shown in **Plan 50** in Volume 2. Table 5.10.1 identifies the significance of these heritage sites. All the sites within Stage 2 are considered to be of only local significance.

Table 5.10.1 Significance of non-Aboriginal heritage sites identified within Stage 2

	Intrusive (Low)	Moderate	High
Item No.	35	8, 11, 18, 37, 57	9, 36a, 36b, 55, 56
Total No. of Sites	1	5	4

5.10.4 Issues

The non-Aboriginal heritage assessment addressed the issues of direct and potential disturbance on non-Aboriginal heritage objects and sites from Stage 2 activities.

5.10.5 Impact Assessment

The main potential mining impacts on cultural heritage include:

- Physical disturbance, destruction or removal of heritage items/sites due to soil stripping, excavation, stockpiling, dumping, damming, haulage and construction of buildings and infrastructure.
- Vibratory impacts on heritage sites from mine blasting.
- Subsidence impacts such as geological cracking, fracturing, faulting, water seepage, erosion and rock falls affecting heritage items.

Open archaeological sites containing artefact scatters and isolated finds are unlikely to be affected by surface cracking due to underground mining. Furthermore, the subsidence report (Section 5.8) concluded that impacts on the Carrs Gap Road dry stone wall are predicted to be minor. However, it is possible that remediation and rehabilitation works to surface areas could potentially affect archaeological sites.

Heritage sites identified within the Stage 2 Project Area and their assessed significance and potential impact are summarised in **Table 5.10.2**. The three identified heritage objects and sites within the footprint of OC4 will need to be removed to enable mining of OC4.

Table 5.10.2 Summary of non-Aboriginal heritage items impacted by Stage 2

Item No.	Item Name	Significance	Impact Status
8	Murragamba School Site	Local – moderate	High – within OC4
9	Farm Site	Local – high	High – within OC4
11	Farm Site	Local – moderate	High – on boundary of OC4
18	Carrs Gap Road Stone Wall	Local – moderate	High* – on boundary of UG1
35	House Site	Local – intrusive (does not meet the criteria for listing at local level due to various alterations and additions)	High – on boundary of OC4
36a	House Site	Local – high	High – on boundary of OC4 and UG1
36b	Grave and/or Burial Site	Local – high.	High – on boundary of OC4 and UG1
37	House Site	Local – moderate	High – within OC4
55	Water Trough and Spring Fed Well	Local – high	Low/nil – outside area of perceived impact – possible indirect impact by draining of water
56	Water Trough and Spring Fed Well	Local – high	Low/nil – outside area of perceived impact – possible indirect impact by draining of water
57	Feed Trough	Local – moderate	High – adjacent to proposed road re-alignments

* The subsidence report for Stage 2 (see Appendix 8 in Volume 5) indicates that only a minor impact will occur.

5.10.6 Environmental Management

5.10.6.1 General Management

The following management measures will be undertaken by MCM to lessen the negative impacts on non-Aboriginal heritage sites:

- No heritage site of any kind will be destroyed unless it will be affected by construction or mining activities. All sites will be considered an archaeological resource for the future.
- Heritage sites within the Stage 2 Project Area that will not be disturbed by construction or mining activities and are in locations that may be visited by mine employees will be fenced off to prevent accidental damage, for the duration of the MCP.
- Heritage sites within the Stage 2 Project Area that will not be directly impacted or disturbed by construction or mining activities, but will continue to deteriorate, will be considered for archival recording in accordance with NSW Heritage Office standards.

5.10.6.2 Specific Measures

Heritas has recommended specific measures for the recording and management of the identified non-Aboriginal heritage sites within the Stage 2 Project Area. **Table 5.10.3** identifies the recommended management measures for each of the heritage sites. The archival recoding of these objects and sites will be implemented by MCM in consultation with the Mudgee Historical Society and MWRC. This will ensure a record of these features is preserved within the local historical archives.

Table 5.10.3 Summary of non-Aboriginal heritage items affected by Stage 2

Item No.	Item Name	Management Measures	Justification of Management Measures
8	Murragamba School Site	Archival recording^{PS} Archaeological assessment	‘Small bush schools were the focal point of an isolated rural community…. This was the only public building in the valley.‘ ’The site has the potential to yield archaeological information and evidence of the culture that would not be available from other sites in this valley.’
9	Farm Site	Historical research Archival recording^{PSMI}	This construction method for this building is no longer practiced. The building was constructed on a limited budget using local materials and is reasonably intact, the latter being unusual for homestead sites. ’There is high potential to gain understanding of construction methods and the development of the farm on this site.’
11	Farm Site	Historical research Archival recording^{PS} Archaeological assessment	The construction method of using vertical slabs is no longer practiced but has been used in this building. The building was constructed on a limited budget using local materials. ’The site has potential to yield archaeological and social information on selection at a lower economic scale than for example, Murrugamba homestead.’

Table 5.10.3 Summary of non-Aboriginal heritage items affected by Stage 2 (cont'd)

Item No.	Item Name	Management Measures	Justification of Management Measures
18	Carrs Gap Road Stone Wall	Historical research Archival recording[PW]	'This section of road provides evidence of the technical skills of the early road builder and the method used to retain the road base. Evidence of this type of road construction is rare in this locality. Most evidence of this type is destroyed during road upgrades.'
35	House Site	No further action	N/A
36a	House Site	Historical research Archival recording[PSI] Archaeological assessment	'The house site has potential to yield new archaeological information on construction and lifestyle that has not been obtained from other parts of this district hence it is of high local importance.'
36b	Grave and/or Burial Site	Historical research Archival recording[PSI] Archaeological assessment	'It is considered to be of high local importance due to its strong and special association to a particular group in the community further enhanced by the presence of squaring posts, mortising rails and planted bulbs on the site.'
37	House Site	Historical research Archival recording[PSI]	'The building sites have potential to yield new archaeological information on construction methods, date of construction and possible use of the building. This will provide information on the dynamics of the site and identify the group who occupied the site in a local context.'
55	Water Trough and Spring Fed Well	Archival recording[P] To be fenced off	This site 'has the potential to yield information that will contribute to an understanding of the area's cultural or natural history.'
56	Water Trough and Spring Fed Well	Archival recording[P] To be fenced off	See above.
57	Feed Trough	Historical research Archival recording[P] To be fenced off if not impacted	See above.
8	Murragamba School Site	Archival recording[PS] Archaeological assessment	"Small bush schools were the focal point of an isolated rural community…. This was the only public building in the valley." "The site has the potential to yield archaeological information and evidence of the culture that would not be available from other sites in this valley."
9	Farm Site	Historical research Archival recording[PSMI]	This construction method for this building is no longer practiced. The building was constructed on a limited budget using local materials and is reasonably intact, the latter being unusual for homestead sites. "There is high potential to gain understanding of construction methods and the development of the farm on this site."

Table 5.10.3 Summary of non-Aboriginal heritage items affected by Stage 2 (cont'd)

Item No.	Item Name	Management Measures	Justification of Management Measures
11	Farm Site	Historical research Archival recording[PS] Archaeological assessment	The construction method of using vertical slabs is no longer practiced but has been used in this building. The building was constructed on a limited budget using local materials. "The site has potential to yield archaeological and social information on selection at a lower economic scale than for example, Murrugamba homestead."
18	Carrs Gap Road Stone Wall	Historical research Archival recording[PW]	"This section of road provides evidence of the technical skills of the early road builder and the method used to retain the road base. Evidence of this type of road construction is rare in this locality. Most evidence of this type is destroyed during road upgrades."
35	House Site	No further action	N/A
36a	House Site	Historical research Archival recording[PSI] Archaeological assessment	"The house site has potential to yield new archaeological information on construction and lifestyle that has not been obtained from other parts of this district hence it is of high local importance."
36b	Grave and/or Burial Site	Historical research Archival recording[PSI] Archaeological assessment	"It is considered to be of high local importance due to its strong and special association to a particular group in the community further enhanced by the presence of squaring posts, mortising rails and planted bulbs on the site."
37	House Site	Historical research Archival recording[PSI]	"The building sites have potential to yield new archaeological information on construction methods, date of construction and possible use of the building. This will provide information on the dynamics of the site and identify the group who occupied the site in a local context."
55	Water Trough and Spring Fed Well	Archival recording[P] In situ conservation	This site "has the potential to yield information that will contribute to an understanding of the area's cultural or natural history."
56	Water Trough and Spring Fed Well	Archival recording[P] In situ conservation	See above.
57	Feed Trough	Historical research Archival recording[P] Ex situ conservation (if not impacted, in situ conservation)	See above.

[P] Photographic

[S] Site plan to scale based on survey.

[I] Identification and recording of landscape elements.

[W] Site plan showing extent of wall.

[M] Measured drawing.

Note: The above item numbers correspond to those used in Stage 1, with the exception of additional items identified within Stage 2 (nos. 55 to 57).

Where indicated in Table 5.10.3, the following management measures will be implemented by MCM:

- Support for historical research to be carried out by the Mudgee Historical Society (or similar local group) or professional historian.
- Archival recording comprising photographic record and measured technical drawings, where appropriate, in accordance with the NSW Heritage Office guidelines (NSW, 2002). Recordings will be provided to the Mudgee Historical Society and MWRC.
- Archaeological assessment in order to confirm suspected inclusions (such as grave or burial sites), or to provide more definite information on known past uses of the place prior to impact, where appropriate.
- Fencing off heritage objects and sites that may be accessible to mine employees or public visitors and will not be impacted by construction or mining activities, for the duration of the MCP.

5.10.6.3 Heritage Management Plan

A Heritage Management Plan will be prepared and implemented by MCM for Stage 2 non-Aboriginal heritage in consultation with MWRC, prior to carrying out any construction or mining activities that may directly impact the integrity of identified non-Aboriginal heritage items.

The plan will include a program for archival recording of the identified heritage sites and will be integrated with the Stage 1 (non-Aboriginal) Heritage Management Plan.

5.11 Soils

5.11.1 Objectives

The objectives of the soil assessment are to:

- Determine the type, quality and quantity of soils within the Stage 2 Project Area.
- Identify their use for rehabilitating the site.
- Determine control measures for mitigating impacts to the soil resources.

5.11.2 Assessment Method

JAMMEL Environmental & Planning Services Pty Ltd (JAMMEL) was engaged to undertake a soil assessment for the Stage 2 Project Area. The assessment is based upon information obtained from interpretation of aerial photography, field surveys and laboratory analysis of soil samples. A copy of the report is included in **Appendix 11** in Volume 6, which also includes an assessment of the rural land capability and agricultural suitability of the Stage 2 Project Area.

Field surveys were carried out between August and September 2005, with follow up soil pit testing within the OC4 footprint in November 2005. This enabled the physical properties of the soil profile for the dominant soil types to be identified and determined through onsite testing and laboratory analysis.

The identified soil landscapes are based on those delineated in the Soil Landscapes of the Dubbo 1:250,000 Sheet (DLWC, 1998).

5.11.3 Existing Environment

5.11.3.1 Soil types and landscapes

The Stage 2 Project Area comprises four main soil landscapes, these are summarised in **Table 5.11.1**.

Table 5.11.1 Soil landscapes of the Stage 2 Project Area

Landscape	Landform	Lithology	Typical soils	Limitations
Ulan	Low undulating rises and creek flats. Elevations between 360-570 m. Slopes between 2-10%. Local relief varies between 10-40 m.	Undifferentiated and Illawarra Coal Measures: shale, sandstone, conglomerate, chert, coal and torbanite.	Yellow podzolic, Yellow Solodic /solonetz, yellow and brown earths, and earthy sands.	Moderate to high erosion hazard and susceptible to soil structure degradation. Imperfectly drained on the lower slopes and depressions. High soil salinity levels and low soil fertility.
Lees Pinch	Sandstone plateau and hill slopes with boulder debris. Elevations between 400 to 680 m. Slopes between 15 to 40%. Local relief from 60 to 240 m.	Narrabeen Group and Illawarra Coal Measures: sandstone, Wollar sandstone, conglomeratic sandstone, chert, shale coal, torbanite.	Shallow siliceous sands, shallow acid soils, yellow earths, yellow podzolic soils.	Steep slopes are high erosion hazard when cover is low. Very low fertility, acidic surface soils. Low to very low water holding capacity and high permeability.

Table 5.11.1 Soil landscapes of the Stage 2 Project Area (cont'd)

Landscape	Landform	Lithology	Typical soils	Limitations
Munghorn Plateau	Low undulating hills form plateaux from 600 to 700 m. Slopes from 3 to 10% and local relief varies from 20 to 60 m.	Narrabeen Group and Illawarra Coal Measures: sandstone, Wollar sandstone, conglomeratic sandstone, chert, shale coal, torbanite	Shallow siliceous sands, shallow acid soils, yellow earths, yellow podzolic soils.	High to very high erosion hazard when ground cover is low. Low soil fertility and low water holding capacity.
Bald Hill	Low hillocks with elevations from 460 to 600 m. Slopes 10 to 35%. Local relief from 60 to 120 m. Drainage lines are 300 to 500 m apart	Tertiary Basalt: olivine basalt, dolerite, teschenite.	Euchrozems – chocolate soils Intergrades, Chocolate soils.	Steep Slopes with rock outcrops; stoniness; moderate to high fertility and water holding capacity.

The Ulan soil landscape is largely found on the valley floor, the Lees Pinch and Munghorn Plateau soil landscapes are located on the slopes and ridgelines of the surrounding hills and plateaus, while the Bald Hill soil landscape is restricted to isolated tertiary basalt flow remnants.

In the Stage 2 Project Area these landscapes comprise six major soil types: Yellow Solodic, Yellow Podzolic, Earthy Sands, Red Podzolic, Red Earth, and Lithosol soils. Other minor soil types in the Stage 2 Project Area include Colluvial and Euchrozem soils (see **Plan 51** in Volume 2). The Yellow Solodic and Earthy Sand soils form the dominant soil types found in OC4. Patches of Lithosol are also found dispersed throughout OC4 and on the higher plateaus and sandstone escarpments.

5.11.3.2 Soil Characteristics

Field and laboratory tests indicate these soils are mainly acid in nature, have low organic matter content and are deficient in all major nutrients such as phosphorus, sulfur and nitrogen. They are generally non-saline (EC_{se} < 2 dS/m) but may be prone to dryland salinity outbreak. There is some occurrence of saline discharge from soils within OC4, however when tested, these showed only low to moderate salinity levels. The soils have also been identified to be highly erodible and will require special management to prevent erosion and land degradation and offsite sediment transport.

5.11.3.3 Rehabilitation Suitability

The surveys have identified that some of the soils will be suitable for rehabilitation purposes, provided that appropriate handling, storage and management practices are implemented. This includes three soil types dominant within OC4 that have significant quantities of topsoil suitable for site rehabilitation use. These are the topsoil components to the Yellow Solodic, Yellow Podzolic and Earthy Sands soils. The Alluvial, Red Earths and Red Podzolic topsoils are also suitable for rehabilitation use, but have limited resource potential due to their sporadic and limited distribution. However, they can be blended with the other major soil resources to increase the total topsoil resource volume.

The suitability of Stage 2 soils for rehabilitation is summarised in **Table 5.11.2**, the comments reflect the results of the chemical and physical soil tests, which are included as appendices to Appendix 11 in Volume 6.

Table 5.11.2 Topsoil suitability within the Stage 2 Project Area

Soil Type	Soil Horizon	Rehabilitation Suitability	Comment
Yellow Solodic	A1	Suitable if ameliorated.	Acid pH with severe dispersive qualities, excessive Mg levels (low Ca:Mg ratio), poor fertility, low Ca.
	A2	Suitable if ameliorated.	Acid pH with severe dispersive qualities, excessive Mg levels (low Ca:Mg ratio), poor fertility, low Ca.
	B	Not suitable.	Dispersive clay, excessive Mg and Na levels.
Yellow Podzolic	A1	Suitable if ameliorated.	Acid pH with severe dispersive qualities, excessive Mg levels (low Ca:Mg ratio), poor fertility.
	A2	Suitable if ameliorated.	Acid pH with severe dispersive qualities, excessive Mg levels (low Ca:Mg ratio), poor fertility.
	B	Not suitable.	Dispersive clay.
Earthy Sands	A1	Suitable for blending only.	Acid pH, elevated Al levels, high sand content.
	A2	Suitable for blending only.	Acid pH, elevated Al levels, high sand content with moderate dispersive qualities.
	A3	Suitable for blending only.	Acid pH, elevated Al levels, high sand content with severe dispersive qualities.
Alluvial	A1	Suitable if blended and ameliorated.	Acid pH with moderate dispersive qualities elevated Mg levels, poor fertility.
	A2	Suitable if blended and ameliorated.	Acid pH with moderate dispersive qualities, excessive Mg levels (low Ca:Mg ratio), poor fertility, sand gravel content levels are high.
	A3	Not suitable.	Dispersive clay, high Na and Mg levels.
Red Podzolic	A1	Suitable if ameliorated.	Acid pH with severe dispersive qualities, elevated Al levels, poor fertility.
	A2	Suitable if ameliorated and blended.	Acid pH with severe dispersive qualities, excessive Mg levels (low Ca:Mg ratio), poor fertility, sand gravel content exceeds 60%.
	B	Not suitable.	Dispersive clay, high Na and Mg levels.
Red Earth	A1	Suitable for blending only.	Acid pH, elevated Al levels, high sand gravel content.
	A2	Suitable for blending only.	Acid pH, elevated Al levels, high sand gravel content.
	B	Suitable for blending only.	Acid pH, elevated Al levels, high sand gravel content.

Table 5.11.2 Topsoil suitability within the Stage 2 Project Area (cont'd)

Soil Type	Soil Horizon	Rehabilitation Suitability	Comment
Euchrozem	A1-B	Highly suitable.	Neutral to alkaline pH, low erosion hazard, moderate to high fertility, potentially elevated Mn at depth.
Lithosol	–	Not suitable.	No soil resource available.

5.11.3.4 Available Resource

The disturbance area for OC4 is approximately 1,270 ha. All soils for rehabilitation purposes will be derived from this area. Topsoil stripping and stockpiling of the resource will be undertaken prior to further surface disturbance activities associated with overburden removal and mining. This will be done in a progressive manner as mining advances across Murragamba Creek and Eastern Creek valleys.

JAMMEL has estimated the quantities of topsoil available for rehabilitation in the OC4 and Stage 2 surface development areas. The stripping depth, areal extent and approximate volume available for rehabilitation purposes of each of these soil types are listed in **Table 5.11.3**.

Table 5.11.3 Topsoil resource availability within the Stage 2 Project Area

Type	Recommended Stripping Depth	Open Cut and Infrastructure Stripping area (ha)	Volume (m^3)
Yellow Solodic	0.3*	543.8	1,631,400
Yellow Podzolic	0.3*	187.6	562,800
Earthy Sand	1	526.1	5,261,000
Red Podzolic	0.25*	43.7	109,250
Red Earth	1	35.5	355,000
Alluvial	0.45	9.3	41,850
Euchrozems	1#	8.1	81,000
Lithosol	0	265	-
Total	N/A	1619.1	8,042,300

* Stripping depth has incorporated the blending of the top 0.1 to 0.2 m of the A2 horizon to increase topsoil volume.
# Subject to investigation prior to disturbance.
These calculations are inclusive of open cut, out-of-pit emplacements and infrastructure disturbance; approximately 240 ha will be made up of infrastructure areas where topsoil stripping may not occur across the full area.

Preliminary material balance calculations based on these recommended stripping depths indicate that the Stage 2 Project Area comprises a topsoil volume of about 8,000,000 m^3 which will be available for the progressive rehabilitation of disturbed areas.

5.11.4 Issues

The main soil related issues include the effect of development and operation of Stage 2 on erosion, salt and sediment release into surface drainages, and the handling and management of the topsoil resource for rehabilitation purposes.

5.11.5 Impact Assessment

The potential impacts that Stage 2 poses to soils include:

- Exposure of soils to increased erosion and offsite sediment transport through vegetation stripping and general site disturbance activities.
- Physical disturbance of soils leading to increased erosion during mining activities.
- Removal and disposal of bulk soils leading to loss of topsoil resources during general earth works, excavation or mining.
- Physical, chemical and biological alteration due to poor handling, stockpiling and management.
- Contamination from hydrocarbon or other chemical spills during general earth works and mining activities, and exposure and release of existing soil contaminants from unknown past agricultural practices (such as sheep dips).
- Poor landscape reconstruction and rehabilitation leading to erosion and offsite sediment transport during site rehabilitation and over the long term post closure.

Open cut mining will involve the stripping and removal of soils. Land cleared of vegetation will be at greater risk from erosion than vegetated land. If unmanaged, erosion will result in soil loss and lead to adverse impacts on water quality in surface drainages. The highly erodible soils in the Stage 2 Project Area will require special attention to avoid these impacts.

The physical properties of the soils may also be altered by vehicles driving over them, degrading their structure. This is more relevant for soils that will not be removed through mining OC4 or other site related construction activities. Mixing of different soil types and profile horizons during stockpiling may also alter the physical and chemical characteristics of the soil. This can have either positive or negative impacts depending on whether the mixing is planned and managed or random.

The chemical and biological properties of the soil may be altered through the clearing of land and subsequent handling, stockpiling and management. This includes the potential for nutrient loss or changes in chemical composition through the stockpiling of soils, if not suitably aerated. Increased soil salinity may also result from improper handling storage and management.

5.11.6 Environmental Management

An Erosion and Sediment Control Plan (ESCP) will be prepared to manage erosion and soils in all open cut mining and infrastructure disturbance areas. The ESCP will form part of the Water Monitoring and Management Plan for the MCP. The ESCP will be prepared in accordance with the requirements of Managing Urban Stormwater: Soils and Construction (The Blue Book) (Landcom, 2004). All erosion control and drainage works will be appropriately designed in accordance with Urban and Sediment Control Guidelines (DLWC, 1992).

5.11.6.1 Soil Resource Management

Preservation and appropriate management of all topsoil material within Stage 2 surface development areas will be a priority to assist in future land rehabilitation activities. The stripping and stockpiling of soil resources prior to any mine related disturbance will be carefully planned and managed, and appropriate controls implemented to avoid erosion and loss of viable rehabilitation topsoils. All disturbed areas not actively used will be rehabilitated and revegetated with local species as soon as practicable. Topsoil recovery will allow stripped soil from mining activities to be reused for rehabilitation. A soil management strategy will be developed for Stage 2 which will include the following key elements:

- Identification and quantification of topsoil and subsoil resources.
- Stripping and stockpiling in accordance with government and industry best practice guidelines.
- Management of topsoil and subsoil to preserve the health and viability of the stockpiled resource for rehabilitation purposes.
- Establishment of effective methods for utilising stockpiled soil resources in future rehabilitation work.

Further detail is described in **Table 5.11.4**.

Table 5.11.4 Soil management strategies

Prior to Commencement of Stripping Activities	During Stripping and Stockpiling Activities	During Rehabilitation Activities
• Quantification of soil resources. • Characterisation of the suitability of material for rehabilitation purposes. • Formulation of stripping and stockpiling guidelines including the nomination of appropriate depths, scheduling, and location of areas to be stripped and stockpile locations.	• Minimise over-clearing. • Selective stockpiling of soil according to type (i.e. soil group, topsoil, subsoil) and salinity. • Storage of soil in a manner that does not compromise the long term viability of the resource. • Implementation of amelioration measures to ensure the long term viability of the soil.	• Management of soil suitability for rehabilitation. • Use of stockpiled soils for progressive rehabilitation of disturbed areas as soon as practicable.

5.11.6.2 Land Degradation

Land degradation will be avoided. Where land degradation exists, it will be managed through the application of soil conservation practices. This will be an integral component of site management. JAMMEL has recommended a range of management practices that can be applied to arrest and improve land degradation. The following principles will be implemented by MCM to prevent or arrest land degradation from occurring:

- There will be continual monitoring and reporting on all mining areas for occurrences of soil erosion and landform irregularities.
- Disturbance areas to all essential mining activities and infrastructure developments will be minimised.
- Where underground mining activities cause surface irregularities, appropriate soil conservation measures will be immediately implemented.
- Runoff will be prevented from flowing across areas without adequate stable disposal areas.
- Temporary revegetation of degraded land areas proposed for mining in future years, and progressive rehabilitation of all disturbed areas, using appropriate local species.

- All access roads and haul roads will be constructed with appropriate pavement surfaces and storm water drainage systems.
- Activities with the potential to cause contamination (e.g., refuelling of equipment and vehicles, storage of chemicals, etc.) will be segregated from areas containing stockpiled soils and soils with the potential for rehabilitation. Potential contaminants will be stored in appropriate containers over hard surfaces. Spill kits will be located near to areas where potentially contaminative activities are undertaken and training will be provided to staff on how to manage spills and leaks.

The adoption of these principles along with broader land management activities to maintain the land within the Stage 2 Project Area will be incorporated into a Rehabilitation and Offset Plan. This is discussed further in Section 5.18.

5.11.6.3 Soil Salinity

JAMMEL has identified that low class agricultural land (Class IV and V lands) within the Stage 2 Project Area may be prone to dryland salinity outbreaks. Soils identified as being saline may be used for rehabilitation purposes and JAMMEL has recommended a range of management practices that can be applied to make use of the soil resource during rehabilitation of the site, including:

- Saline soil types will be stripped and stockpiled separately over an aggregated substrate to allow leaching of salt concentrations over time.
- Species selected for rehabilitation purposes will be tolerant of saline environments. Additionally, salinity occurrence is usually associated with water logging, so the species chosen will also need to withstand water logged environments.
- The application of saline water through irrigation or damping down (water use) will be minimised.

MCM will adopt these practices to avoid the release of salt into water draining from the Stage 2 Project Area and the build up of salt in soils in the post mining landscape.

The final landform and post mining land use will dictate the composition and structure of species proposed to be established for the rehabilitation phase. Species selection will not only take into consideration climatic and soil nutritional issues but the occurrence of water logging and salinity levels within the soils. This is discussed further in Section 5.18.

5.11.6.4 Soil Health for Plant Growth

As previously indicated, all Stage 2 soils are slightly acidic and have low organic matter content. These factors reduce the availability of nutrients and create an unfavourable microclimate for the germination of plant seeds. JAMMEL has recommended a range of management practices that MCM will implement to improve soil health and increase soil fertility, including:

- Application of appropriate soil ameliorants (e.g., superfine lime and gypsum) and fertilizer.
- Establishment of a cover crop for soil protection purposes and improvement in organic matter levels, such as native grasses.
- Use of imported organic materials such as biosolids.

The application and use of biosolids is readily becoming accepted as a rehabilitation practice. Biosolid products have been used successfully on mine sites and degraded agricultural lands providing organic matter inputs, soil amelioration and soil nutrients. If a local source of biosolids is found to be available, then MCM will trial the use of these products in consultation with MWRC and DECC.

5.11.6.5 Long-term Viability of Soil Resources

JAMMEL has recommended the following management practices that MCM will implement to improve the long-term viability of the soil resource. This includes:

- Soil stockpiles will be located outside of proposed mining areas.
- Vehicular traffic will be kept to a minimum on the soils to be stripped and soils sensitive to structural degradation.
- Loaders and trucks will be used rather than scrapers to minimise structural degradation.
- Stockpiles with a ‘rough’ surface condition will be constructed to reduce erosion hazard, improve drainage and promote revegetation.
- Soil stockpiles will be no more than 60 cm high to maintain the soil microflora and macroflora biology. Where site constraints do not permit this, stockpiles will be no deeper than 3 m in order to minimise problems with anaerobic conditions.
- Stockpiles which will be inactive for extended periods (i.e., over six months) will be fertilized and seeded to maintain soil structure, organic matter content and microbial activity.
- Silt fences will be installed around stockpiles to prevent loss of stockpiled soil through erosion prior to vegetative stabilisation.
- Prior to the reapplication of stockpiled soil for rehabilitation, stockpiles will be deep-ripped to establish aerobic conditions.
- If soil stockpiles become dispersive, soil ameliorants will be applied as required.
- Weed control strategies will be implemented particularly for noxious weeds.
- Revegetate all disturbed areas after mining activities have ceased.
- Immediate revegetation of stockpiles and cleared areas will provide vegetative competition to assist in the control of undesirable plant species.

These measures will minimise soil erosion and structural soil degradation, help to establish vegetation, minimise undesired vegetation growth, and prevent degradation in soil health which will all minimise negative impacts on the soil.

5.12 Transport

5.12.1 Objectives

The objectives of the transport assessment are to:

- Identify existing road and rail transport infrastructure that will be used or will potentially be impacted by Stage 2.
- Assess the capacity of this infrastructure to accommodate Stage 2.
- Assess the existing level of safety performance of this infrastructure and assess the impact of Stage 2 on this level of performance.
- Recommend environmental management measures to mitigate any adverse Stage 2 impacts.

5.12.2 Assessment Method

Sinclair Knight Merz Pty Ltd (SKM) undertook a road and rail transport assessment for Stage 2.

5.12.2.1 Road Assessment

An assessment of road condition, baseline traffic counts and vehicle crash and injury frequency rates has been made for roads servicing the Stage 2 Project Area. This assessment was based on Roads and Traffic Authority (RTA) data, traffic assessments undertaken for Stage 1 (Wells Environmental Services, 2006) and the Wilpinjong Coal Project (Resource Strategies Pty Ltd, 2007), and physical inspection of relevant roads. Road capacity and intersection sight distances were assessed against relevant Austroads guidelines. A full copy of the road assessment report is included as **Appendix 12** in Volume 6.

5.12.2.2 Rail Assessment

An assessment of rail condition and capacity and the performance of level crossings has been made. This assessment was based on baseline and forecast data from the Australian Rail Track Corporation (ARTC) Network Control Centre North (NCCN), and physical inspection of the rail lines and level crossings. A full copy of the rail assessment report is included as **Appendix 13** in Volume 6.

5.12.3 Existing Environment

5.12.3.1 Road Network

The Stage 2 Project Area is located east of Main Road (MR) 214 (Ulan-Cassilis Road) and south of Ulan-Wollar Road (see Plan 1 in Volume 2). Ulan-Cassilis Road is a regional road linking Mudgee with Cassilis, via Ulan. Ulan-Wollar Road is a local road connecting Ulan-Cassilis Road with the village of Wollar. A further regional road, MR258 (Cope Road) connects the town of Gulgong with Ulan-Cassilis Road at Ulan. Both regional roads (MR214 and MR258) provide access to the Ulan coal mine and all three roads provide access to the Wilpinjong coal mine and to Stage 1. Access to Stage 2 will also be via these three roads.

Two state highways (SH), the Castlereagh Highway (SH18) and Golden Highway (SH27), provide interregional road links between the major towns of the region. These roads are located to the west and north of the project area respectively (see Plan 1 in Volume 2).

In addition to Ulan-Wollar Road, there are two other local roads that run through the Stage 2 Project Area. Carrs Gap Road runs west to east across the ridgeline (Carrs Gap) under which UG1 and UG2 will be developed and connects MR214 with Ulan-Wollar Road via Lagoon Road and Murragamba Road. Murragamba Road runs north to south along the length of the Murragamba Creek valley and connects with Ulan-Wollar Road in the north (see Plan 2 in Volume 2).

5.12.3.2 Traffic Counts, Speed Limits and Road Conditions

The Ulan-Cassilis Road is a two-lane road with a speed limit of 100 km/hr. In 2005, the average annual daily traffic (AADT) was approximately 1,300 axle pairs (one axle pair is equivalent to one passenger car), as shown in **Table 5.12.1**. This data was acquired north of Budgee Budgee (see Plan 1 in Volume 2) and reflects the number of vehicles travelling to and from the Ulan area along Ulan-Cassilis Road. North of Ulan this drops to about 600 axle pairs per day. Long term AADT data indicates traffic growth between Mudgee and Ulan is about 2.3% per year.

Table 5.12.1 MR214 actual and forecasted baseline traffic volume growth

RTA Count Station	Location	AADT (Axle pairs)	1984	1988	1992	1996	1999	2002	2005	2009	2019
99.221	North of Budgee Budgee	Actual	920	1,078	1,401	1,281	1,490	1,321	1,306	N/A	N/A
		Trend	904	1,019	1,134	1,249	1,335	1,421	1,507	1,622	1,909

Cope Road is a two-lane road with a speed limit of 100 km/hour. In 2005, the AADT count was approximately 1,670 axle pairs (see **Table 5.12.2**). This data was acquired at the level crossing east of Gulgong and reflects the number of vehicles travelling to and from the Ulan area along this road. Traffic growth on this road is about 1.9% per year.

Table 5.12.2 MR598 actual and forecasted baseline traffic volume growth

RTA Count Station	Location	AADT (Axle pairs)	1984	1988	1992	1996	1999	2002	2005	2009	2019
99.510	East of Gulgong	Actual	1,060	1,350	1,285	1,029	1,119	1,685	1,677	N/A	N/A
		Trend	1,024	1,125	1,226	1,328	1,404	1,480	1,556	1,657	1,910

Ulan-Wollar Road is a local road with a speed limit of mostly 100 km/hr and at its western end is sealed for the first 4 km east of the junction with Ulan-Cassilis Road. The Minister's approval for the Wilpinjong coal mine requires Wilpinjong to complete the seal of Ulan-Wollar Road from the intersection with Ulan-Cassilis Road to its mine entrance some 7.3 km further on.

According to a 2007 road and traffic assessment for the Wilpinjong mine, there were on average 48 non-mine related daily vehicle movements on Ulan-Wollar Road between its junction with Ulan-Cassilis Road and the Wilpinjong mine entrance. A further 236 daily vehicle movements are expected to travel between the junction of Ulan-Cassilis Road and the Wilpinjong mine entrance when this mine reaches peak production (Resource Strategies, 2007). Stage 1 will add a further 120 daily vehicle movements on this road when the open cut mines reach peak production. However, these movements will only use the first 250 m of Ulan-Wollar Road to the Stage 1 open cut mine access intersection.

5.12.3.3 Road Safety

Road safety audits for MR214 and MR258 conducted for the Stage 1 EA report identified that road delineation, road edge formation and shoulder provision were areas of particular safety concern for both these roads. The MWRC has plans to progressively upgrade Ulan-Cassilis Road between Mudgee and Ulan, to an 8 m seal on a 10 m formation, with shoulders provided throughout.

According to RTA records, in the five years from September 2003 to August 2008 there were 32 crashes on MR214, including 19 injury crashes and 2 fatal crashes. The most common type of crash involved the vehicle leaving the carriageway, and accounted for 49% of all crashes. Over the same period, there were 10 crashes on MR598, including 7 injury crashes. Nine of these involved the vehicles leaving the carriageway. No fatalities were recorded for MR258 during this time.

Using this data, the crash rate for MR214 is about 41 crashes per 100 million vehicle kilometres travelled (MVKT), and for MR258 about 28 crashes per 100 MVKT. These rates are both below the NSW state average of approximately 75 crashes per 100 MVKT.

5.12.3.4 Public Transport

Apart from local school bus services, there are no other public transport services in the area. The school bus services operate along several routes to and from Mudgee, Ulan and Gulgong, including along MR214 and MR598. The school bus routes in the vicinity of the MCP include:

- Cooks Gap to Mudgee (Ulan-Cassilis Road).
- Ulan to Mudgee (Ulan-Cassilis Road).
- Turil to Gulgong (Cope Road).
- Yarrawanga to Gulgong (Yarrawanga Road).
- Winchester Crescent and Ridge Road to Ulan (Ulan-Cassilis Road).

School buses generally travel along these routes between 7.30 a.m. and 9.00 a.m. in the morning and 3.00 p.m. and 5.00 p.m. in the afternoon. These services only operate Monday to Friday during school terms.

5.12.3.5 Rail Network

The Gulgong-Sandy Hollow rail line runs in a generally east to west direction north of Ulan-Wollar Road through the Stage 2 Project Area (see Plan 2 in Volume 2). This line continues to Muswellbrook where it joins the main Northern rail line, about 146 km east of the MCP. The Australian Rail Track Corporation (ARTC) manages this line under lease from the government.

The rail line is currently used by the Ulan and Wilpinjong coal mines to transport coal to market. It is also used to transport other freight between western areas of NSW and the eastern sea board, although less frequently. There are no regular passenger services in operation on this line. The rail line can generally accommodate all train types, except that locomotives and rolling stock with a 30 tonne axle load cannot travel west beyond the Ulan coal mine rail loop junction.

According to the ARTC's NCCN, on average there are 22 train movements per day on the Ulan to Muswellbrook rail line. A train movement is defined as a one directional run. Existing regular train movements are shown in **Table 5.12.3**.

Table 5.12.3 Existing regular daily train movements between Ulan and Muswellbrook

Name of Mine	Train Movements per Day
Ulan Coal Mine	6
Wilpinjong Coal Mine	6
Bengalla Coal Mine	8
Elura Copper Ore Mine	2
Total	22

ARTC expect these figures will change in the short to medium term due to:

- New (approved) coal mining operations at Mt Pleasant and Anvil Hill near the existing Bengalla Coal Mine.
- New rail capacity improving works along the Gulgong to Muswellbrook rail corridor, including a number of new crossing loops and the implementation of a centralised traffic control safeworking.
- Implementation of a new standard working timetable to optimise train operations in accordance with the capital works programs for the corridor.

The ARTC has indicated the rail line between Ulan and Muswellbrook has sufficient existing capacity to accommodate a total of 32 train movements a day (i.e., over each 24 hour period).

5.12.4 Issues

The following issues were addressed as part of the road and rail transport assessment:

- Site access.
- Road traffic generation and network capacity.
- Intersection performance.
- Road safety.
- School bus services.
- Road closures, diversions and public access.
- Rail traffic generation and network capacity.
- Level crossing performance.

5.12.5 Impact Assessment

5.12.5.1 Site Access

Two access points have been approved for Stage 1. One of these will provide access to the main MCP office facilities and the CHPP, and is located on Ulan-Cassilis Road, north of the Ulan-Wollar Road junction, and about 400 m north of the railway bridge crossing. A second access point will provide access to the open cut areas south of Ulan-Wollar Road, and will be off this road about 250 m to the east of the Ulan-Cassilis Road junction. These mine access points were described and assessed in the Stage 1 EA report (Wells Environmental Services, 2006).

A new intersection will be constructed on Ulan-Wollar Road to provide access to the Stage 2 Project Area. This will be located on a relatively straight and flat section of road about 3 km east of the Ulan-Cassilis Road junction (see Plans 4 and 12 in Volume 2). The available sight distances at this location meet the Austroads guideline requirement of safe intersection sight distance for a design speed of 70 km/hr. As previously indicated, the Ulan-Wollar Road has a general speed limit of 100 km/hr. Hence SKM have recommended that the speed limit in the vicinity of the Stage 2 access point be reduced to 70 km/hr, in line with the Austroads guidelines. Further improvement to site distance and intersection performance is expected to be achieved through the realignment of this section of Ulan-Wollar Road. This is discussed further in Section 5.12.5.7.

The Stage 2 site access intersection will be constructed to the requisite level of safety and operational performance, to the satisfaction of the RTA and MWRC.

5.12.5.2 Construction Traffic Generation

The impact of Stage 2 construction related traffic has been assessed by SKM. However, since this assessment was undertaken, MCM has indicated that Stage 2 construction will be carried out by the same construction workforce employed for Stage 1. Further, that Stage 2 construction is expected to be completed within the same time frame as that for Stage 1. The impacts of construction workforce traffic on the local and regional road network were assessed in the Stage 1 EA report (Wells Environmental Services, 2006). There will be some (100 predicted in total) additional wide loads associated with Stage 2. These will be subject to the granting of permits from the RTA and travel to and from the Stage 2 Project Area under escort. Aside from the wide loads, it is expected there will be up to 6 delivery trucks a day and up to 20 concrete trucks a day during major pours. While these trucks may cause some temporary annoyance to local road users they are not expected to have a significant impact on local traffic flows or road intersection performance. Hence, only minor construction traffic impacts are expected from Stage 2.

5.12.5.3 Operations Traffic Generation

At peak production, Stage 2 will require an additional 122 workers to that required for Stage 1, and the entire MCP (Stage 1 and Stage 2) will have an operational workforce of up to 439 people.

The Stage 2 traffic impact assessment assumes a worst case scenario, in that each worker will drive their own car to the site. It also assumes that 80% of the workforce will reside in Mudgee and 20% in Gulgong, and that the number of employee vehicles travelling on Ulan-Cassilis Road and Cope Road (MR214 and MR598 respectively) will be split according to these proportions. All Stage 2 employees will use Ulan-Wollar Road.

The peak number of MCP vehicle movements will occur on a weekday between 6.00 a.m. and 7.00 a.m., when 207 people will arrive at the site for day shifts. In the following hour, there will be 104 staff leaving after night shift. Stage 2 accounts for 82 people arriving at the site for day shift and 40 leaving after night shift. The maximum hourly load during this time from the MCP alone could be as high as 311 vehicles, although this is more likely to be spread over close to 2 hours (as workers arrive before and depart after shift change over). Due to the staggered finishing times of the day shifts (see Section 4.5.2.13), the evening peak hour will be between 5.00 p.m. and 6.00 p.m., when 75 staff arrive for night shift and 96 leave after finishing day shifts. Stage 2 accounts for 40 arriving for night shift and 41 leaving after day shift. On weekends, the peak traffic generation would be 48 vehicles arriving and 46 vehicles leaving between 6:00 a.m. and 8:00 a.m., and the same number between 6.00 p.m. and 8.00 p.m.

An assessment of hourly traffic rates has been made, as it is expected that road traffic impacts will occur as a result of increased peak hour traffic loads when most other road users are travelling to and from work. In 2019, when both the MCP and Wilpinjong mine are expected to be operating under peak production (i.e, worst case traffic generation) SKM predicts that peak hour traffic movements on Ulan-Cassilis Road and Cope Road will be well within RTA's theoretical carrying capacity for roads of this type (820 vehicles per hour for regional roads).

A summary of the predicted total traffic volume increase due to Stage 2 is presented in **Table 5.12.4**. The data in this table has been compiled from relevant RTA AADT baseline data and from information presented in the traffic studies for Stage 1 (Wells Environmental Services, 2006) and the Wilpinjong coal mine (Resource Strategies, 2007). Projected two-way daily traffic numbers on Ulan-Cassilis Road north of Ulan was reported in both traffic studies to be about 1,500 axle pairs, predominantly comprised of light vehicles travelling to and from the MCP, Ulan and Wilpinjong coal mines. This includes predicted vehicle numbers for Stage 1 and the Wilpinjong coal mine. This is an over estimate of existing baseline data as Stage 1 is not yet operational, and predicted numbers are for Stage 1 and the Wilpinjong coal mine operating with a full employee complement. The tabulated data assumes daily total vehicle movements are split between Ulan-Cassilis Road and Cope Road, according to the previously described proportions. Stage 2 traffic will increase daily vehicle numbers on these roads by only a marginal amount, with negligible impacts expected.

Table 5.12.4 Predicted traffic volume increase due to Stage 2

Road	Location	Predicted Daily Baseline Traffic Flows[1]	Predicted Daily Traffic Flows with Stage 2 Operations Traffic[1]	Percent Daily Increase
Ulan-Cassilis Road (MR214)	North of Ulan	1,556	1,654	8%
Cope Road (MR598)	East of Gulgong	1,913	1,937	6%
Ulan-Wollar Road	East of Ulan-Cassilis Road	534	656	23%

[1] Includes predicted traffic from Wilpinjong coal mine and Stage 1.

The increase in traffic numbers on Ulan-Wollar Road due to Stage 2 is more substantial (i.e., 23%). It is expected that the majority of traffic on this road will be mine related and that the majority of these vehicle movements will occur at morning and evening shift change over times. As there is only a small number of non-mine related road users, the impact of Stage 2 traffic will be on other (Wilpinjong) mine workers. Moolarben Coal Mines has also since acquired a number of properties in the Stage 2 Project Area. There are now no non mine-owned properties with road access to Ulan-Wollar Road between the junction with Ulan-Cassilis Road and the Wilpinjong mine access point. Moolarben Coal Mines will also stagger its shift changes with the shift changes at Wilpinjong coal mine, which will reduce the potential cumulative maximum peak hour load. Hence it is expected that the impact to local traffic users from Stage 2 traffic will be minor.

5.12.5.4 Intersection Performance

The capacity and performance of the intersection of Ulan-Cassilis Road and Ulan-Wollar Road was assessed in the Stage 1 EA report (Wells Environmental Services, 2006). This intersection has now been upgraded to comply with standard RTA design criteria, and will safely accommodate additional traffic associated with Stage 2.

The intersection of Ulan-Cassilis Road with Cope Road has been assessed against the RTA's level of service (LoS) criteria, assuming both the MCP and Wilpinjong mine are operating at peak production (i.e., at maximum workforce numbers). Under this scenario the intersection is predicted to function at a satisfactory level of performance in accordance with the LoS criteria.

5.12.5.5 Road Safety

As previously indicated MWRC has plans to progressively upgrade Ulan-Cassilis Road between Mudgee and Ulan. This work is partly being funded by contributions made to council from MCM. The planned road improvements will address, amongst others, delineation and pavement condition. This will greatly improve the safety of this road for all users. Despite a predicted marginal increase in vehicle numbers using Ulan-Cassilis Road as a result of Stage 2, the road improvements to be carried out by council are also expected to reduce the rate of crashes on this road.

5.12.5.6 School Bus Services

The majority of all MCP staff will travel to and from the Ulan area outside of school bus service times. Hence, it is expected that Stage 2 traffic will have minimal impact on the operation and safety of the school bus services.

5.12.5.7 Road Closures, Diversions and Public Access

Carrs Gap Road, Murragamba Road and other local unformed ("paper") roads (see Plan 2 in Volume 2) will be affected by Stage 2 mining operations. There are no private land holdings within Murragamba Creek valley and the only private traffic expected to travel around the Stage 2 Project Area will be local farmers using the western part of Carrs Gap Road. Application was made to MWRC to close Carrs Gap Road west of Carrs Gap following approval of Stage 1. Since then, MCM has made further applications to MWRC for the closure of Murragamba Road and all other unformed roads in the Stage 2 Project Area. If these applications are unsuccessful these roads will diverted around the mining operations to avoid conflict between public and mine vehicle traffic.

Stage 2 will require two sections of the Ulan-Wollar Road to be realigned, both sections are shown on Plan 4 in Volume 2. The first of these commences at about 2.75 km west of the intersection with Ulan-Cassilis Road and extends east to the Murragamba Creek crossing for about 2 km. This section will shift to the east of its existing alignment and will improve sight distances at the Stage 2 access point. A further section of road will be diverted around the northeastern limit of OC4. This second section commences at about 13 km west of the intersection with Ulan-Cassilis Road and extends east for about 1 km. The associated road works will be constructed with minimal impact to existing road users, and where possible full road access will be maintained to users throughout the period of the required road works.

5.12.5.8 Rail

Coal from Stage 2 will be combined with coal from Stage 1. All product coal will be transported east by rail. As stated in Section 4, product coal will be loaded onto trains on a dedicated rail loop and rail load out facility, and railed to market (Newcastle) on the Ulan to Muswellbrook (Gulgong-Sandy Hollow) rail line in up to five trains a day (four during the day and one at night). Trains used will either be 3 x '90' class locomotives and 91 x '120' tonne hopper wagons or 4 x Pacific National

‘3,000’ horsepower ‘82’ class locomotives. This will deliver 8,827 tonnes of product coals and will be 1,542 m in length or extend to 1,564 m in length if the ‘82’ trains are used instead.

Construction and operation of the rail loader and rail loop were assessed in the Stage 1 EA report (Wells Environmental Services, 2006). However the impacts (dust and noise) associated with loading and transport of increased product coal from the site has been included in the Stage 2 and Stage 1 modifications impact assessments (see Sections 5.1 and 5.3).

At peak production the addition of Stage 2 coal to the total product output of the MCP will generate one additional laden coal train per day. The total number of trains required for the MCP will be five fully laden trains or 10 return paths per day, based on the capacity of existing rolling stock. When combined with other existing train movements, there will be a total of 32 train movements per day on this line (see Table 5.12.3).

As previously indicated, the capacity on the Ulan to Muswellbrook route is for a total of 32 train movements per day. Including MCP trains the capacity of this line will be at its maximum. However, ARTC has indicated it has a program of progressive future capital works for the Ulan to Muswellbrook route. This will provide higher track capacities and permit a higher number of daily train movements. Rail scheduling is beyond the control of MCM and other mine operators and it is expected that ARTC will allocate sufficient rail time for MCM to transport its product coal to market. Further, MCM has indicated that Ulan mine is now using larger capacity rolling stock which reduces the total number of required train movements. If MCM uses similarly larger capacity rolling stock, then it is expected that only four fully laden trains per day will be required to transport MCP product coal to market.

The only alternative to rail is road transport, and MCM has rejected this alternative on the basis of environmental, economic, social and road safety considerations.

5.12.5.9 Road Traffic Delays from Coal Trains

Increased train movements associated with increased coal production from the MCP is not expected to increase the incidental average waiting time for motorists at level crossings. Predicted delays are within industry accepted tolerances of 180 seconds per train movements. The overall waiting time at public level crossings is predicted to increase by 121 seconds per train movement, or 16 minutes per day.

5.12.5.10 Level Crossing Performance

The condition of public level crossings between Ulan and Muswellbrook has been assessed by SKM (Appendix 13 in Volume 6). This assessment has determined that all level crossings along this route are generally in a fair state of repair, with most crossings being well signposted in accordance with accepted industry standards.

The assessment also found that a number of level crossings require some form of remedial maintenance work, such as correction to damaged, missing or incorrectly mounted signs; and upgrading of crossings to improve sight distance, and compliance with current industry level crossing operation standards. These works are not the responsibility of MCM and would have to be undertaken by the relevant local government authority and the ARTC.

5.12.6 Environmental Management

The following management measures will be implemented during construction and operation of Stage 2:

- Access along all public roads will be maintained at all times, with the exception of the local farm roads proposed to be closed.
- Where temporary road closures are required, detours will be constructed around the worksite. Where it is not possible to provide a two-way detour, portable traffic signals will be used to regulate traffic flow in each direction.
- The movement of heavy vehicles, and in particular over-sized loads, will be arranged so as to minimise disruption to traffic during, before, and after school periods.
- A Traffic Management Plan will be established for the management of vehicles within and on roads heading to and from the Stage 2 Project Area, including managing the movement of over-sized vehicles, road diversions and closures, parking, pedestrians, and refuelling areas.
- Vegetation will be cleared to the west of the proposed access point on Ulan-Wollar Road to improve sight distances.
- Application will be made to MWRC to reduce the speed limit on Ulan-Wollar Road in the vicinity of the proposed access point to 70 km/hr with regulatory and advisory signs as appropriate.
- Appropriate bunding will be implemented to reduce the impact of headlight glare from mine vehicles on passing motorists on Ulan-Wollar Road (see Section 5.13).
- Early morning and evening shift changes will be outside school bus service times, and where feasible will be offset from existing Ulan and Wilpinjong mine shift change over times to minimize peak traffic loads on the road network.
- Fuel, stores and explosives will be delivered outside of school bus service hours and peak traffic times, where possible.
- A total financial contribution of $2.25 million will be made by MCM to MWRC for local road upgrades and maintenance as part of its commitments for Stage 1. This contribution is to help partly fund local road safety improvements. An additional road maintenance contribution will be made for Stage 2 based on the proportional increase in additional employees required for Stage 2 (see Section 5.14).
- Moolarben Coal Mines will work with MRWC and Ulan and Wilpinjong coal mines to generally improve road safety and traffic management on the local road network.

It is expected that these traffic management measures will improve the general road safety on local roads and minimise any potential traffic impacts that may arise from Stage 2.

5.13 Visual Amenity and Landscape

5.13.1 Objectives

The objectives of the visual amenity and landscape assessment are to determine the visual character of the regional and local landscape within which Stage 2 is located, and to assess the visual effect of Stage 2 on this visual landscape.

5.13.2 Assessment Method

O'Hanlon Design Pty Ltd undertook a visual and landscape assessment of Stage 2. A copy of the report is contained in **Appendix 14** in Volume 6.

A systematic visual impact assessment was made using quantitative measures, which assessed the influence of landform, vegetation, water and other landscape factors on scenic quality. The quantitative measures were determined in consideration of the sensitivity level of viewers from various viewpoints within the visual catchment.

Eight viewpoints were selected which reflected the major publicly accessible views of the various open cut areas and where the emplacement areas will be prominent. These locations were considered representative of a general location or group of locations (see **Figure 5.2**). Of the viewpoints analysed in the assessment, viewpoint six (VP6) is no longer considered representative, as access to the Murragamba Creek valley will be closed to the public. An assessment of the visual impact of Stage 2 on this viewpoint is not considered in the following discussion. An assessment of the views from this point are contained with the report in Appendix 14 in Volume 6.

The degree of visual impact of OC4, the emplacement areas and infrastructure was based on the perceived severity of the works and facilities within the landscape from selected viewpoints and the number and type of viewers expected to experience the visual changes.

The nightscape was assessed from local travel routes and locations around the Stage 2 Project Area. Background light levels, glare and brightness were compared to colour and background when the source was viewed from varying distances. Night lighting impacts of Stage 2 were assessed in relation to the overall character of these locations in the study area.

5.13.3 Existing Environment

5.13.3.1 Regional Landscape

The regional landscape is dominated by the ridges of the Great Dividing Range, which is dissected into a series of enclosed valleys surrounded by high escarpments. Ridges and slopes are generally dense with native vegetation. Existing cultural modifications in the region include:

- The town centres of Mudgee and Gulgong.
- Smaller villages including Ulan and Wollar (although Ulan is predominantly mine-owned).
- The existing Ulan coal mine north of Ulan.
- The Wilpinjong coal mine to the east of Stage 1 and west of Wollar.
- A number of rail lines (active and disused) and road infrastructure.
- High voltage power lines and attachments including the Wollar to Wellington 330-kv line.

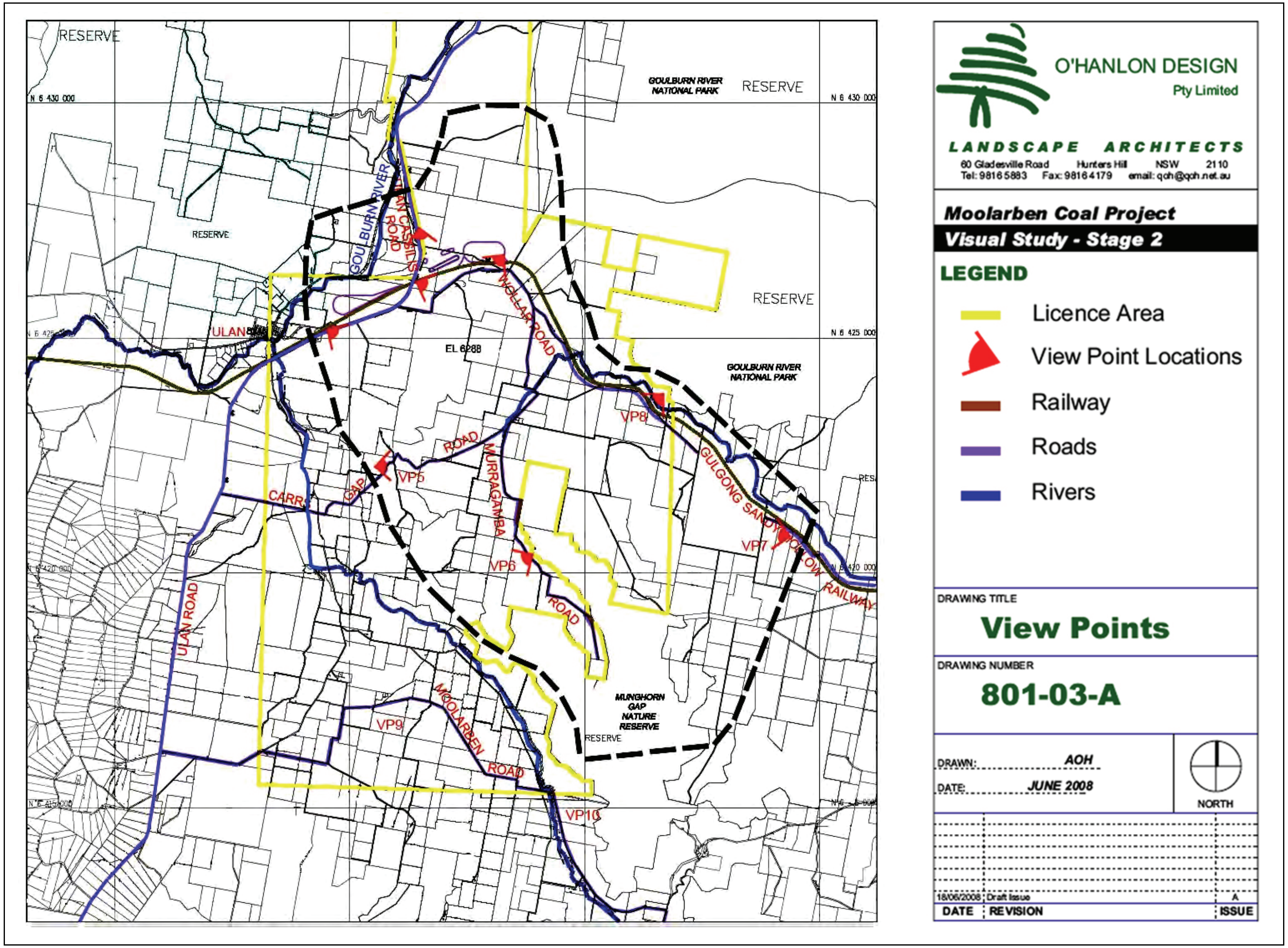

Figure 5.2 Study area and viewpoints

- The diversion of the Goulburn River at Ulan.

5.13.3.2 District Landscape

As with the regional character, the local landscape varies from east to west. Beyond the Great Dividing Range to the east, the topography is rugged with many steep sided enclosed valleys. The topography to the west comprises more gentle hills and has more cultural modification than the east.

Several key geographical features dominate the district landscape. These include the ridges of the Munghorn Gap Nature Reserve to the east and south, the ridges of the Goulburn River National Park to the north and east, Dexter Mountain and the main ridges of the Great Dividing Range to the west, and the hilly, visually enclosed area to the south between the Great Dividing Range and the Munghorn Gap Nature Reserve. The ridges of these features form natural boundaries to the view scape of Stage 2, with the predominant publicly accessible viewing areas restricted to the Ulan-Cassilis and Ulan-Wollar roads.

5.13.3.3 Stage 2 Landscape

The visual assessment study area can be loosely defined as the visual catchment north and northeast of Munghorn Gap Nature Reserve toward Wilpinjong Creek and the Goulburn River National Park. This area is defined by the black dashed outline in Figure 5.2. Within this area the predominant features are Murragamba, Eastern and Wilpinjong creeks. To the east, the viewshed extends along the valley of Wilpinjong Creek, into the area covered by the Wilpinjong coal mine. Visually the Stage 2 landscape has a strong sense of enclosure.

5.13.3.4 Nightscape

The nightscape of the area is perceived as being highly rural in character, with scattered residences and with very small concentrations of light at individual homesteads. The lighting of the existing Ulan and the Wilpinjong coal mine infrastructure and working areas stands out in the existing nightscape.

5.13.4 Issues

Cultural modifications such as mining can often detract from the scenic value if the modifications are discordant with the surroundings. As Stage 2 will be constructed in an area heavily modified by mining, the presence of the project will not be discordant. The main visual impacts are the introduction of surface infrastructure, the presence of the open cut mine and emplacement areas, and the impacts of night lighting that will result from Stage 2. There are no privately owned residences within the Stage 2 Project Area. Hence the visual impacts of Stage 2 will be predominantly witnessed by people driving through the area, many of who will be mine workers.

5.13.5 Impact Assessment

5.13.5.1 Visible Elements

Various visible elements of Stage 2 will affect the visual quality of the locality and visibility of Stage 2. These include the construction and operation of the following:

- OC4, UG1 and UG2 (see Plan 4 in Volume 2).
- Associated overburden placement areas (see Plan 4 in Volume 2).

- Coal stockpiles (additional to Stage 1, see Plans 4 and 12 in Volume 2).
- Proposed Stage 2 surface infrastructure and facilities (These are shown in plan and cross-section views in Plans 12, 13 and 14 in Volume 2).
- Lighting (additional to Stage 1).

Impacts from Mining Operations

OC4 will be spatially dominant in the local landscape. Views to OC4 will be prominent from locations along the Ulan-Wollar Road, although the road is generally lower than the pit edge so elevated views will be restricted. OC4 is relatively isolated and the bulk of the works will be remote from viewers. Viewers will predominantly be mine workers and will have low sensitivity to the works. Some local farmers will have access from Carrs Gap prior to development of the underground mines and will have views into OC4 from this viewpoint (VP5).

Two out-of-pit emplacement areas will be developed at the head of the Murragamba Creek valley (see Plan 4). Sections of the emplacement areas will exceed the 520 m AHD contour specified in clause 71 the Mid-Western Regional Interim LEP, however visual impacts will be minimal due to their location at the remote end of the valley, which is the furthest point from any publicly accessible areas (i.e., Ulan-Wollar Road). The emplacements will become significant permanent elements in the landscape, but their visual intrusiveness will be reduced through progressive rehabilitation. These features are not expected to be visible from publicly accessible areas outside the Murragamba Creek valley.

Impacts from Infrastructure and Facilities

Whilst Stage 2 has significant underground and open cut areas, its use of Stage 1 infrastructure will significantly reduce the degree of change to the visual environment. Stage 2 infrastructure and facilities are described in Section 4.

The net effect of Stage 2 on the visual environment will be an increase in infrastructure directly south Ulan-Wollar Road, about 2 km east of its junction with Ulan-Cassilis Road. The visual intrusion from Stage 2 will be confined to the south of Ulan-Wollar Road over a distance of approximately 2.5 km and will contribute to the overall visual impact of the Stage 1 infrastructure area (see Plans 4, 12, 13 and 14 in Volume 2).

Impacts from Road Diversions

Two road diversions are proposed. A 2 km section of the Ulan-Wollar Road will be realigned starting approximately 2.75 km east of the Ulan-Cassilis intersection, and a 1 km section will be realigned starting approximately 7.5 km east of the Ulan-Cassilis intersection (see Section 5.12.5.7). These realignments will require road works and will result in loss of roadside tree plantings. A bund of 1 to 2 m in height is proposed along the boundary of OC4 and adjacent to Ulan-Wollar Road. This will prevent potential accidental vehicle ingress into OC4 and will provide some visual screening for drivers travelling past the mine area.

5.13.5.2 Viewpoint Impact Assessment

The visual elements of the project that will be viewed by drivers passing through the district were assessed from various publicly accessible viewpoints (See **Table 5.13.1** and Figure 5.2).

Table 5.13.1 Viewpoint assessment

Viewpoint Number	Location	Height (AHD)	Visible Project Features
VP1	Ulan-Cassilis Road (1 km north of rail bridge).	430 m	• No views of OC4. • Stage 2 infrastructure will be visible at distances of 2.2 to 2.5 km, but will be largely masked by Stage 1 structures. Viewers will find it difficult to identify the various elements of each stage. • Stage 1 Raw Coal Reclaim Transfer Station and conveyors visible.
VP2	Ulan-Cassilis Road (at rail bridge).	430 m	• No views of OC4. • The Stage 2 office and workshop facilities will be visible 2 km to the east. Maintenance of vegetation would significantly screen the Stage 2 receival dump hopper and office and workshop facilities. • Stage 1 Raw Coal Reclaim Transfer Station and conveyors visible.
VP3	Ulan-Cassilis Road (adjacent to Ulan Stockpiles).	425 m	• No views of OC4. • Viewers travelling east along Ulan-Cassilis Road will have views of the Stage 1 product stockpiles at distances beyond 3 km. • Filtered views of the Stage 2 receival dump hopper, reject conveyor and bin and raw coal stockpile will be possible at distances varying from 3 to 4 km, for 1 to 1.5 minutes of driving.
VP4	Ulan-Wollar Road (adjacent to infrastructure).	430 m	• Stage 1 infrastructure will be visible. • The Stage 2 office and workshop facilities will be visible south of Ulan-Wollar Road at a distance of less than 100 m. Screening will reduce this impact. • The Stage 2 raw coal stockpile and overhead tripper and the raw coal reclaim conveyor and tunnels are within 100 m of the road, and will have a high visual impact in an area previously assessed as natural in Stage 1. This is of low concern due to the type and low number of probable viewers. (Stage 1 visual impacts were assessed in the Stage 1 EA report). • As mining progresses, views into OC4 will become possible for viewers travelling east around the bend and further along Ulan-Wollar Road. These impacts will increase toward the end of the project.
VP5	Carrs Gap Road (at “Murragamba”).	437 m	• Loss of vegetation, the open cut itself and gradual mine rehabilitation will be visible. • Reconstruction of the northern end of Murragamba Creek will be visible. • Prior to the mid point of extraction of OC4, works will pass within 300 m prior to mid-point of extraction and will be visible for several years.

Table 5.13.1 Viewpoint assessment (cont'd)

Viewpoint Number	Location	Height (AHD)	Visible Project Features
VP7	Ulan-Wollar Road (250 m north of Planters Creek).	390 m	• No views of the Stage 2 Infrastructure Area. • Views of OC4 around Year 8 to 10. • Surface of back-filled pit emplacement visible in final years of OC4. • Upper edges of final void visible on completion of extraction.
VP8	Ulan-Wollar Road (adjacent to Council waste transfer station).	415 m	• Impacts similar to VP7. • Elements of the workshop and CHPP may be visible at distances of 5 to 8 km (Stage 1 visual impacts). • Impacts of OC4 moderate around Year 8 to10, rising to high at completion of extraction. The proposed road safety bund would provide significant screening of the emplacement areas following behind OC4.

Whilst elements of Stage 2 (and Stage 1) infrastructure and facilities, OC4 excavation and emplacement activities and related mining operations will be visible from various viewpoints around the visual catchment, these elements will only be witnessed by drivers passing through the area and will be temporary in nature. There are no sensitive residential receivers as all properties in the vicinity of the project are mine-owned. The nearest village (Ulan) is mine-owned, and the majority of traffic in the area is mine related or through-traffic. The surrounding area is modified by the existing Ulan and Wilpinjong coal mines, and Stage 2 will not be discordant with existing land uses.

5.13.5.3 National Parks and Nature Reserves

Stage 2 will not have any impacts on views from the National Park and Nature Reserve in the local area, as areas within the park and reserve that would provide views of Stage 2 are not easily accessible by the public.

Goulburn River National Park is located north and east of Stage 2. Views from publicly accessible areas are not possible from the Goulburn River National Park over Stage 2. The proposed mine infrastructure and facilities will not be visible from any of the main lookouts, picnic areas or camping grounds within the Goulburn River National Park.

The Munghorn Gap Nature Reserve is located to the south and southwest of OC4. From the northern edge of the escarpment, extensive views of OC4 would be possible, however, there is no road or public access to this area. No views of the open cut area or infrastructure are possible from the main visitor facilities, the main walking track or the main access road (Wollar Road, see Plans 1 and 2 in Volume 2).

5.13.5.4 Night Lighting Impacts

Direct Lighting Effects

Night lighting impacts will be primarily concentrated on the Stage 2 ROM coal facility, the OC4 working area and access roads. Headlights and warning lights associated with truck movements at night will be noticeable as the light source will be flashing or moving.

Lighting impacts will be visible from a range of viewing points in the visual catchment, along travel routes and from the Ulan village. As indicated, there are no privately-owned residences in the village. Lighting impacts from OC4 will vary with time, progressing with the mine face. Impacts will be intermittent, and the degree of impact will vary depending on screening, elevation and distance from each potential viewer.

Sky Glow

Sky glow is most noticeable when there is a solid low cloud cover, as light reflects off the clouds. On a cloudy night the sky above the infrastructure area and working areas of OC4 will glow with a soft reflected light.

The lighting impacts from Stage 2 were assessed as being relatively minor. It was however noted that Stage 2 would extend and spread the overall lighting changes over a wider area and increase the cumulative effect of the MCP lighting on the rural landscape. The overall effect will be that viewers will drive through a highly visible industrial landscape for several kilometres.

5.13.6 Environmental Management

5.13.6.1 Management of Visual Impacts

MCM will implement the following measures to reduce the visibility of the open cut mining areas, the out-of-pit emplacement areas and the infrastructure elements from the various publicly accessible viewpoints:

- Rehabilitation will be progressively undertaken to replace the existing native vegetation that will be removed as part of the mining process, and other cleared and degraded areas within MCM owned land will be revegetated to create a post-mining landscape with a greater proportion of native vegetation (see Section 5.18). A Rehabilitation and Offset Management Plan will be prepared to guide rehabilitation and revegetation efforts, and a Final Void Management Plan will be prepared to guide the final landform of the OC4 void. These plans will form part of the Landscape Management Plan for the MCP.
- Existing vegetation will be retained around the new infrastructure areas and on road fringes of OC4 where possible.
- Bunding and planting along the edge of Ulan-Wollar Road where it abuts OC4.

5.13.6.2 Management of Night Lighting Impacts

Moolarben Coal Mines will implement the following measures to mitigate adverse night lighting impacts:

- Light columns and low brightness floodlights will be installed at a height of less than 15 m within the infrastructure areas. These will have horizontal floodlight bodies with floodlight reflectors designed to provide sharp light cut-off and restrict stray light.
- Horizontal wall mounted lights with low brightness will be used to light areas around the workshop to 50 lux, and adjacent hardstand areas to 10 lux.
- All floodlights will be shielded in the open cut area to the maximum extent practicable.
- Lighting will be screened to viewers where possible but will always be selected to initially meet safe working practices.

5.14 Social and Economic

5.14.1 Objectives

The objectives of this section are to assess the impact of Stage 2 on the social and economic aspects of the area.

5.14.2 Assessment Method

The Hunter Valley Research Foundation (HVRF) has prepared an estimate of regional economic impacts resulting from the construction and operation of Stage 1 and Stage 2 of the MCP. The combined economic impacts of both stages have been assessed together as the MCP will be operated as an integrated mining complex. An assessment for Stage 1 was previously carried out for the Stage 1 EA studies. The HVRF has compared the economic impacts of the previous study with the outcomes of the current assessment to estimate the economic impacts of Stage 2. A copy of the HVRF report is included as **Appendix 15** in Volume 6.

The economic impacts of the MCP have been determined using input-output analysis and through use of professional judgement. Input-output analysis identifies and evaluates linkages between sectors in the economy. It uses expenditures by a firm on its final product as a starting point and tracks backward through the various sectors in the economy to identify the contribution each sector makes to the final product. As the connections are traced backwards, the analysis is made in terms of the direct (or initial) impacts of the final expenditure and the induced (or flow on) impacts as all sectors provide inputs to enable the final production. The analysis is based on estimates of tax revenue generation and production-related royalty payments that will be derived from the MCP.

The long term economic forecasts made by the HVRF in its assessment of the MCP are based on a 30 year mine life. However, MCM is only seeking approval for Stage 2 for 24 years, up to the end of 2033. It is also seeking to modify the Stage 1 Project Approval to enable Stage 1 infrastructure to operate for the length of the Stage 2 Project Approval, as this will be used to process and export Stage 2 coal from site.

All currency values are in terms of 2008 Australian dollars, the values of the impacts are estimates and should be considered in terms of whole numbers, and a job is defined as a full-time position which lasts for one year.

The HVRF assessment of economic impacts is supplemented with a brief review of demographic and socio-economic data for the Mid-Western Regional local government area (MWRLGA), based on the 2006 Australian Bureau of Statistics (ABS) Census.

5.14.3 Existing Environment

5.14.3.1 Mid-Western Regional Local Government Area

The Stage 2 Project Area is located within the MWRLGA. This LGA was formed in 2004 following the amalgamation or part amalgamation of the former Mudgee, Rylstone and Merriwa Shires.

Stage 2 will be located between the Ulan and Wilpinjong coal mines and Stage 1. Therefore its construction and operation will not be discordant with much of the surrounding land uses. These mines and MCM own a substantial amount of freehold land in the area (see Plans 2 and 2A). This land has been acquired to reduce the impacts of the mines on the surrounding community. As a result of this land acquisition, MCM has significantly reduced the potential for Stage 2 to impact on local residences as well as on the social amenity of the area.

Government has already approved three coal mines in the area (Wilpinjong and Ulan coal mines and Stage 1). This has been interpreted by MCM to mean that there is a preference from government for coal mining to be developed within this locality (within the constraints imposed by environmental and planning legislation and community expectations), rather than other potential greenfields locations.

5.14.3.2 Population

At the time of the 2006 Census, the population of the LGA was 21,086 persons, of which 50.1% were males and 49.9% were females. Children aged between 0 to 14 years comprised 21% of the population whilst the age group 25 to 54 years comprised 37.7% of the population. The 2006 population age profile is shown in **Table 5.14.1**.

Table 5.14.1 Population age profile for the MWRLGA in 2006

Age Group	Population	% of Total Persons
0-4 Years	1,284	6.1
5-14 Years	3,142	14.9
15-24 Years	2,265	10.7
25-54 Years	7,944	37.7
55-64 Years	2,983	14.1
65 Years and over	3,468	16.4

According to the 2006 data, the LGA comprised 10,041 private dwellings, of which 8,461 were privately occupied. Of these, 7,623 (90.1%) were separate houses, 286 (3.4%) were semi-detached, terrace or town houses, 305 (3.6%) were flats, units or apartments and 247 (2.9%) were assessed as ‘other dwellings’.

5.14.3.3 Employment

In 2006, 8,550 persons were employed across approximately 20 industry sectors within the MWRCLGA. The mining sector employs approximately 596 (or 7.0%) of those employed. A further 671 (or 7.3%) were unemployed. The 2006 employment breakdown is shown in **Table 5.14.2**.

Table 5.14.2 Employment by industry sector in the MWRLGA in 2006

Industry Sector	Persons Employed
Agriculture, forestry & fishing	1,123
Mining	596
Manufacturing	727
Electricity, gas, water & waste services	91
Construction	618

Table 5.14.2 Employment by industry sector in the MWRLGA in 2006 (cont'd)

Industry Sector	Persons Employed
Wholesale trade	245
Retail trade	1,146
Accommodation & food services	715
Transport, postal & warehousing	281
Information media & telecommunications	69
Financial & insurance services	101
Rental, hiring & real estate services	101
Professional, scientific & technical services	334
Administrative & support services	150
Public administration & safety	367
Education & training	616
Health care & social assistance	720
Arts & recreation services	71
Other Services	269
Inadequately described/not stated	211
Total	**8,550**

5.14.4 Issues

The following issues were addressed as part of the socio-economic assessment:

- Employment.
- Government revenue from tax and mining royalties.
- The local economy.
- Housing.

5.14.5 Impact Assessment

The local council (MWRC) has identified mining as a key 'driver' in growing the population and economy of the LGA. In a report to council on land use in the LGA, Parsons Brinckerhoff (2008) concluded that the construction and operation of the MCP would have a significant impact on the local population, employment and housing.

The MCP will act as a catalyst for generating opportunities and employment in associated industries that service the coal mining sector. The development of the MCP will have a strong positive impact upon the local economy, whilst contributing directly and indirectly to both state and federal economies.

The HVRF estimates that economic impacts will result from both the construction and operation of the MCP. Economic impacts will first result from initial construction of mining facilities over a planned two year period, measured as the capital expenditure on facilities. The direct (annual output) of the operation is measured by the value of the coal output. The estimates provided by

HVRF are based on both Stage 1 and Stage 2 combined. This will deliver both operational and economic benefits for MCM.

It is expected that the Mudgee and Gulgong townships and to a lesser extent the Rylstone and Kandos townships, will experience an increase in population as a result of experienced mine workers and their respective families moving into the area and taking up permanent residency in the LGA.

5.14.5.1 Construction Phase Benefits

Construction of the Stage 2 infrastructure will occur concurrently with that of Stage 1 using the same workforce. This will be the most capital and labour intensive phase of construction, with further construction taking place over the next four years or more, on an as-needed basis and generally at a much reduced rate of expenditure and activity. The initial intensive two-year phase is required to construct all major MCP infrastructure components. The construction of other facilities in ensuing years will be contingent on the MCP achieving its planned mining and production targets. This second phase of construction will include OC4 and UG1 and UG2 facilities, the latter first requiring partial mining of OC1.

It is estimated that MCM will invest $525 million over six years for construction of the mining facilities. Of this, $242 million will be spent on mining equipment ($200 million for Stage 1 and $42 million for Stage 2) and $283 million on construction costs ($205 million for Stage 1 and $78 million for Stage 2). The total investment in Stage 2 construction is estimated to be $120 million. A breakdown of estimated construction costs is summarised in **Table 5.14.3**.

Table 5.14.3 Stage 1 and Stage 2 total construction costs

Component	Value
Construction	
Stage 1	$205 million
Stage 2	$78 million
Total construction	$283 million
Equipment	
Stage 1 (open cut and underground)	$200 million
Stage 2 (open cut)	$42 million
Total	$242 million
Total cost	
Stage 1 and Stage 2	$525 million

The HVRF estimate that of the total investment in construction, approximately $324 million will be made within the region. This is expected to:

- Stimulate additional production in the region valued at approximately $158 million and additional consumption worth $102 million, creating a total flow on benefit of $260 million, providing a total benefit to the region valued at $584 million. This is 2.2 times greater than the 2006 estimated regional benefit from Stage 1 construction.
- Yield taxation revenue to the Federal Government of almost $46 million, $29 million from income tax, $9 million from indirect taxes and $8 million from company tax. Payroll taxation

revenue to the State Government is estimated at more than $8 million, providing a total public sector benefit of close to $54 million. This is 2.8 times greater than the 2006 estimated benefit of Stage 1 alone.

- Create 87 jobs from additional production and a further 98 jobs from additional consumption in the region, leading to an induced benefit of 185 jobs, additional to the 220 direct construction jobs, in each year (first two years only) of the construction period.

The greatest impacts will be generated in the first and second years when construction expenditure is at its highest.

5.14.5.2 Operations Phase Economic Benefits

Production of the MCP is expected to commence in early 2010, with output from OC1. Production will be expanded progressively until 2016 to 2017 (Year 8) when open cut and underground mining will be at full production. Maximum production is expected to be maintained for a further 14 years, until 2030 to 2031. Consequently, the regional economic benefits specified for 2016 to 2017 will be expected to be maintained in each year of maximum production. This will decline thereafter in proportion to the reduction in output, and will be extinguished with the end of the economic life of the mine. Regional economic benefits accruing from the MCP are shown in **Table 5.14.4**.

When production revenue is maximised at $780 million per annum in Year 8 of operation, the coal mining activities of the MCP will:

- Stimulate further output in the region valued at approximately $731 million, comprised of $523 million from additional production and $208 million from additional consumption. The total output impact in each year of maximum production is expected to be valued at more than $1.5 billion.
- Directly create around 439 full-time equivalent positions in the mining operations. Additional production and consumption in the region will generate a further 847 and 585 jobs respectively creating a total flow on employment benefit of 1,432 jobs. In total, approximately 1,875 full-time equivalent positions will be created in the region in each year of maximum production.
- Yield Federal Government taxation receipts of approximately $98 million, comprised of $60 million from income tax, $19 million from indirect taxes, and $20 million from company tax. Payroll taxation revenue to the State Government is estimated at close to $17 million, yielding a total public sector benefit of almost $115 million in each financial year of maximum production.
- Generate around $47 million per annum in production royalties to the State Government (based on 6% of the value of production).
- Over the life of the mine, Stage 2 will increase the expected total tax revenue by 55% compared to Stage 1 alone and will provide an approximate three-fold increase in royalty revenues.

Table 5.14.4 Regional economic benefits from the MCP

Mining Year	Calendar Year	Value ($ million)	Employment (full-time equivalent)	Royalty payments ($ million) *6% value production*
Year 1	2009-10	$315	130	$18.90
Year 2	2010-11	$495	200	$29.70

Table 5.14.4 Regional economic benefits from the MCP (cont'd)

Mining Year	Calendar Year	Value ($ million)	Employment (full-time equivalent)	Royalty payments ($ million)
Year 3	2011-12	$517	250	$31.03
Year 4	2012-13	$540	250	$32.40
Year 5	2013-14	$570	300	$34.20
Year 6	2014-15	$756	400	$45.36
Year 7	2015-16	$756	439	$45.36
Year 8 to Year 23	2016-17 to 2030-31	$780	439	$46.80
Year 23	2031-32	$711	439	$42.66
Year 24	2032-33	$683	439	$41.00

Note:

(i) The value of output is assumed to average $60 per tonne in each year of the production period.

(ii) Saleable production (shown above) is estimated at approximately 75 per cent of gross (rate of mine) production from open cut mines and 90 per cent of gross production from underground mines.

5.14.5.3 Construction Phase Housing Impacts

Wherever possible, MCM will source its construction workforce from the local district. However, based on experience at other mines in New South Wales and Queensland, Felix anticipates that a number of construction workers will move into the area temporarily during the construction phase of the project. These workers will be housed in motels, hotels, tourist accommodation, caravan parks and units and other dwellings, with increased occupancy rates expected within the townships of Mudgee, Gulgong, Rylstone and Kandos. While it is expected that temporary long term occupancy will benefit the owners of these facilities and provide local economic stimulus, it will also impact on the availability of accommodation for casual visitors and tourists to the area.

5.14.5.4 Operations Phase Housing Impacts

As with the construction workforce, MCM will seek to engage local employees to work at the mine during the operations phase. As indicated in Section 4, Stage 2 will require 122 additional full time employees, a small number of which will be required for administration and management roles.

Mine workers and their families relocating to the area to work at the MCP will require accommodation and it is expected that a mix of housing types will be needed to meet this demand. It is likely the majority of these will seek residence in Mudgee or Gulgong townships, as these provide a range of established community, social, recreational, commercial, educational and religious facilities and services.

As previously indicated, the MWRC has identified mining as a key driver for population and economic growth in the LGA. The land development and housing construction industries and allied trades will be expected to benefit from the influx of people moving into the MWRLGA and taking up employment, as will local shops and services.

This could place pressure on the availability and affordability of housing, which could disadvantage people from lower socio-economic groups. It could also put pressure on the demand for social services such as medical facilities and schools.

However, assuming each of the 122 Stage 2 jobs is taken up by workers from outside the region and each full-time position equals a family of four, then based on 2006 population data, the increase in population to the LGA as a result of Stage 2 will be less than 0.06%.

5.14.6 Environmental Management

It is expected that Stage 2 will have a positive impact on the social and economic environment of the LGA, and more broadly the state and nationally.

In addition to the economic benefits described above, MCM will provide financial support to the MWRC through the payment of contributions in accordance with a voluntary planning agreement (VPA) for Stage 2 to be made between MCM and MWRC. The VPA for Stage 2 will be in addition to the $4,550,000 being voluntarily contributed to MWRC as part of Stage 1, and will compliment the commitments MCM has with MWRC under its Stage 1 VPA.

Moolarben Coal Mines will make additional (to Stage 1) payments to MWRC based on increased output of product coals when Stage 2 is operational. The Stage 2 contributions will comprise staged payments for each 0.5 Mtpa incremental increase above the Stage 1 approved product output (i.e., when the MCP output is greater than 10 Mtpa) up to a total value of $1,365,000. The company expects that MWRC will use this money to finance road maintenance, community infrastructure and other needs in the local area and throughout the LGA.

Other social and economic measures that MCM will seek to implement include:

- Employing workers in the local area, wherever possible.
- An unbiased employment program which includes job and training opportunities that:
  - Encourages women to become part of the Stage 2 workforce, similar to other mine sites operated and managed by Felix.
  - Encourages indigenous Australians to become part of the Stage 2 workforce.
  - Provides traineeships for young persons residing within the MWRC area.
- Supporting local businesses through the sourcing and use of materials, equipment and services from the local area, wherever possible.
- Providing information, guidance and support for workers relocating from other areas in relation to finding accommodation and essential services.

5.15 Hazards and Risks

5.15.1 Objectives

The objective of this section is to ascertain whether Stage 2 will result in any off-site hazards or risks to people or the environment. Furthermore, this section also addresses bushfires and waste as two specific types of risks.

5.15.2 Assessment Method

A detailed hazard analysis for Stage 2 was conducted by Sinclair Knight Merz (SKM), and incidents with the potential to result in off-site impact were identified. A copy of the hazard analysis report is contained in **Appendix 16** in Volume 6.

Available literature was reviewed to understand bushfire risk and existing fire management plans and fire management resources.

5.15.3 Existing Environment

5.15.3.1 Hazards

As no mining has commenced, no mine-related hazards currently exist.

5.15.3.2 Bushfires

The native vegetation of the locality is largely restricted to the adjoining National Estate (Goulburn River National Park and Munghorn Gap Nature Reserve) and elevated ridgelines of low agricultural suitability. Vegetation is mostly of open forest structure with a woody herbaceous/shrubby understorey that is classified as Group 1 vegetation under the Planning for Bush Fire Protection Guidelines (RFS, 2006). This vegetation cover represents the highest bushfire prone land category prescribed within the guidelines.

Weather conditions during the winter period are typically cold and dry, which contributes to the onset of an early fire season (i.e., September), particularly given the reduced fuel moisture levels (i.e., low rainfall) and fuel accumulation (including dry dead material). Westerly winds during the winter-spring period contribute to an increased likelihood of fire events. Average monthly relative humidity and temperature data for the September to January period are also conducive to increased fire intensity, with the weather conditions during the months of November and December being particularly suited to fire activity.

The adjoining conservation reserves are principally managed for the conservation of biodiversity, meaning that the use of fire within these areas is governed by biological thresholds rather than asset protection. Relatively few human-made assets exist along the boundary of the reserves, thereby minimising the risk of bushfire impacts on life and property. Many off-park assets are located within extensively cleared lands throughout the surrounding valleys, thereby increasing the separation of bushfire prone lands from areas of human habitation.

Local fire suppression resources include the Cooks Gap and Wollar Rural Fire Brigades, which form part of a wider resource base contained within the MWRC local government area. The Ulan Rural Fire Service facilities have been decommissioned. The local National Parks and Wildlife

Service at Mudgee also maintain fire management resources for use in local conservation reserves. The National Parks and Wildlife Service implement prescribed hazard management activities in accordance with specific management plans for Goulburn River National Park and Munghorn Gap Nature Reserve. Both the Rural Fire Service and National Parks and Wildlife Service have a defined working relationship that allows co-operative operations to suppress bushfires throughout the locality.

5.15.4 Issues

5.15.4.1 Hazards

Those incidents identified in the hazard analysis and carried forward for detailed consequence analysis were:

- Mix truck roll-over, fuel leak and fire.
- Explosion on the shotfirer's vehicle.
- Premature explosion of the ammonium nitrate and fuel oil (ANFO) mix on the mix truck.
- Diesel fuel storage fire.
- Lubricating oil storage fire.
- Magazine (for the storage of detonators and primer) explosion.

5.15.4.2 Bushfires

The presence of bushfire prone lands on MCM-owned land as well as in the adjoining areas represents a potential risk to the operation of Stage 2, while the mine creates a potential fire risk to the surrounding areas. The following issues are of concern:

- The safety of mine personnel (i.e., contact with smoke and flame).
- The safety of residents and visitors in the surrounding agricultural areas and reserves.
- Damage to mine plant and buildings (i.e., vehicles, machinery and administration centre).
- Damage to non mine-owned plant and dwellings.
- Ignition of coal stockpiles and flammable materials such as fuel and lube storages.
- Interruption of mining activities.
- Interruption of agricultural operations and recreation and conservation activities.
- Loss of biodiversity, rehabilitation and revegetation works.

5.15.5 Impact Assessment

5.15.5.1 Hazards

The hazard and consequence analysis concluded that all hazardous incidents underground (e.g., fires, explosions, etc,.) will be confined within the underground workings and will not result in an off-site impact. Further, the impact of the consequences of all identified hazards in the surface mine and pit top facilities do not have the potential to impact off-site due to the application of buffer zones around the open cut workings, and the location of the site explosives magazine well clear of the site boundary.

5.15.5.2 Bushfires

The impact of bushfires that start on non-MCM land but affects MCM land requires management, as detailed below.

However, of more concern is the potential increase in ignition sources due to Stage 2 as a result of undertaking routine construction and operational activities such as the use of machinery in vegetated lands or the undertaking of hot works under inappropriate conditions. The increase in incidence of accidental or deliberate human-related ignition sources may result in significant social, economic and ecological impacts to the mine and adjoining areas.

5.15.6 Environmental Management

5.15.6.1 Hazards

A number of risk reduction management and hazard mitigation strategies and site emergency responses have been prepared. These are detailed below:

- The potential incidents listed in the Hazard Analysis will be included in the Site Emergency Response Plan, along with other incidents identified to have on-site impact to mine equipment and personnel.
- During the regular emergency response drills, conducted as part of the Mine Rescue Team (MRT) exercises, the hazards will be included in the drill exercises to ensure MRT readiness.
- Fire in vehicles would be a potential hazard on-site, and fire growth has the potential to result in serious damage to occupants and vehicles. All vehicles on-site will be fitted with at least one dry powder type extinguisher. Larger vehicles will carry at least one 9 kg dry powder extinguisher and smaller vehicles at least one 4.5 kg dry powder extinguisher.
- All staff, contractors and visitors will be required to comply with relevant legislation to ensure that the MCP is a safe place to work and visit.

5.15.6.2 Bushfires

The MCP is divided into construction and operational phases, with both phases requiring prescribed management strategies to minimise bushfire risk to activities, processes, infrastructure and other assets located in close proximity to bushfire prone lands.

An integrated bushfire management strategy will be developed and implemented for both construction and operational stages. This will include the establishment of fire management zones and perimeter roads or management tracks. The availability of fire suppression assets such as water carts, dozers and static water storages will be defined in relation to the needs of local fire management organisations (i.e., National Parks and Wildlife Service and Rural Fire Service) to maximise the control of unplanned bushfire events.

Both these management plans will consider the management regimes prescribed for Goulburn River National Park and Munghorn Gap Nature Reserve to ensure maximum consistency with the conservation objectives for these areas.

5.16 Waste

5.16.1 Objectives

The objective of the waste assessment is to determine the quantity and nature of potential waste streams generated by Stage 2 and the modification of Stage 1, and to describe measures to minimise, reuse, recycle and dispose of any wastes produced.

This waste assessment considers both non-mineral wastes (i.e. construction waste, effluent, putrescibles and operational waste) and other mining wastes (i.e. overburden, reject and tailings).

5.16.2 Assessment Method

Estimates of the potential quantities of non-mineral construction wastes (e.g., plastic, food, sewage, hydrocarbons, tyres, etc) for Stage 2 are based on the estimates of predicted non-mineral construction wastes for Stage 1. Estimates of the potential quantities of non-mineral operations wastes are either based on reported quantities of non-mineral wastes for other Australian coal mines (scaled to the equivalent production capacity of Stage 2), or as a proportion per employee of estimated non-mineral construction wastes.

Environmental Geochemistry International Pty Ltd undertook a geochemical assessment for Stage 1 (Environmental Geochemistry International Pty Ltd, 2006) and Stage 2 (**Appendix 17** in Volume 6), which considered the acid rock drainage (ARD) and salinity hazard potential of the overburden, reject and tailings.

Following the completion of the Stage 1 EA, leach column tests were undertaken on Stage 1 mineral waste samples. Leach column tests simulate the long-term leaching of overburden materials to determine if acid-generating materials (e.g., pyrites) will be adequately neutralised by the dissolution of acid-neutralising materials (e.g., carbonates and silicates). Leach column testing was undertaken on blended and non-acid-forming (NAF) materials to confirm whether operational blending is a valid approach for managing potentially acid-forming (PAF) low capacity overburden and coarse reject materials. Leach column tests were undertaken on two blended Stage 1 overburden samples: a PAF low-capacity composite sample and a blend of the PAF low-capacity composite with a NAF overburden composite. Column leachates were analysed for pH, electrical conductivity (EC), acid/alkalinity and a suite of 32 elements.

Stage 2 samples were collected for geochemical characterisation from three chip holes drilled for groundwater investigations. A total of 107 samples were analysed from drill chips derived from three groundwater investigation boreholes: PZ130 (close to the intersection of UG1 and UG2), PZ133 (close to the centre of OC4) and PZ150 (on the east side of OC4) (see Plan 30 in Volume 2). Each of these boreholes were drilled to the base of the Ulan Seam, and were selected to best represent the full stratigraphic section that may be encountered in both the open cut and underground mining operations. The following tests were conducted on all samples: pH1:2 and EC1:2 on deionised water extracts, Leco total sulfur, acid neutralising capacity (ANC), and net acid producing potential (NAPP). In addition, the following net acid generation (NAG) tests were undertaken on 31 of the 107 samples: single addition NAG test, extended boil NAG and calculated NAG testing for samples with high organic carbon contents, and kinetic NAG.

5.16.3 Issues

5.16.3.1 Non-mineral Waste

Management issues for non-mineral wastes of potential concern include:

- Solid waste may contaminate the site and surrounding area.
- Sewage sludge or effluent may pollute surface water or groundwater.
- Hydrocarbons may pollute soils, surface water or groundwater.
- Hazardous materials may result in harm to the environment and pose a risk to people.
- Land contaminated by previous land uses may result in a risk to people and the environment.
- Resources may be wasted through inefficient recycling or over-ordering of stock.
- Odours may be generated from waste storage areas.

Non-mineral waste issues can be readily addressed by the implementation of suitable design and operational controls and hence do not constitute a measurable risk to the environment.

5.16.4.2 Overburden, Reject and Tailings Waste

The management issues for overburden, reject and tailings waste of potential concern include:

- Acid rock drainage potential.
- Salinity hazard potential.

These issues could result in long-term impacts on soils, surface water or groundwater, which in turn could impact on the rehabilitation of the area, other water users and the natural environment within and down gradient of the MCP.

5.16.4 Impact Assessment

5.16.4.1 Non-mineral Waste

Construction and operation of Stage 2 and its integration with Stage 1 will generate a variety of non-mineral material waste streams. This includes paper, cardboard, printer toner cartridges, plastic packaging, food and beverage containers, putrescible waste, sewage from bathhouse and offices, timber (including pallets), metal, drums, hydrocarbons, paints, batteries, tyres, concrete, chemicals, rubber from conveyor belts, demolition wastes and green waste.

All wastes will be segregated, and reused or recycled wherever possible, according to an approved waste management plan.

Construction Waste

Major construction non-mineral material waste types, their sources and an indicative estimate of the quantities that will be potentially generated per year of construction of Stage 2 are listed in **Table 5.16.1**.

Table 5.16.1 Indicative estimates of non-mineral waste streams potentially generated during Stage 2 construction

Waste Type	Source(s)	Approximate Quantity/Year
Cardboard	Used as packaging for various items.	10 m^3
Plastic packaging	Used for shrink-wrap over large good deliveries and general packaging.	100 m^3
Recyclables	Generated by personnel.	20 m^3
Putrescible waste	Food waste from employees and contractors.	100 m^3
Sewage	From bathhouse and office areas (approximately 66 L of wastewater will be generated per person per day).	200 m^3
Timber pallets and wooden boxing	From suppliers, post delivery of equipment, etc.	30 m^3
Batteries	Expended batteries from vehicle fleet.	1 m^3
Tyres	Expended tyres from vehicle fleet.	50 m^3
Hydrocarbons (oil and grease)	Rags used in workshop and servicing areas. Liquid oil and oil filters from vehicle maintenance. Grease from vehicle maintenance and from other machinery.	5 m^3 2 m^3 0.5 m^3
Chemicals	Excess chemicals or out of specification chemicals.	0.2 m^3
Metal	Excess materials from construction (e.g., electrical wire), parts of machinery unable to be reused, and fencing wire and metal gates.	30 m^3
Timber	Offcuts during construction. Formwork from concrete construction. Timber fencing from removed fences.	30 m^3 100 m^3 200 m^3
Concrete	From footings and other site preparation activities.	10 m^3
Demolition waste	From demolition of existing buildings.	10 m^3
Green waste	From clearing activities and preparation of site.	0 m^3 (Green waste will be used onsite for rehabilitation).

Operations Waste

During operations, waste streams will be reduced to general rubbish, sewage from offices, workshops and bathhouses, scrap timber from pallets and boxing, waste batteries and tyres, waste oil and filters, empty drums, and scrap metals, some of which will be recyclable. **Table 5.16.2** lists an estimate of the potential quantities of the wastes that will be produced per year of operations.

Table 5.16.2 Indicative estimates of non-mineral waste streams potentially generated during Stage 2 operations

Waste Type	Source(s)	Approximate Quantity/Year
General wastes including putrescible and organic (food waste), some plastics and paper not suitable for recycling	Generated by personnel.	1900 m^3 (190 tonnes)
Recyclables including paper and cardboard, plastics and glass	Generated by personnel.	12 m^3
Sewage	From bathhouse and office areas (approximately 66 L of wastewater will be generated per person per day).	122 m^3 (88 tonnes or 2.9 ML)
Timber pallets and wooden boxing	From suppliers, post delivery of equipment, etc.	32 m^3 (5 tonnes)
Batteries	Expended batteries from vehicle fleet.	5 m^3 (5 tonnes)
Tyres	Expended tyres from vehicle fleet.	1,000 m^3 (200 tonnes)
Oily sludge, oily rags, oil, grease, degreaser, solvents, etc	Liquid oil from vehicle maintenance. Rags used in workshop and servicing areas. Grease from vehicle maintenance and from other machinery.	13 m^3 (12 tonnes) 5 m^3 0.5 m^3
Oil filters	Workshop area.	4 tonnes
Empty drums	200-L drums. 20-L drums.	118 178
Metal	Mine infrastructure.	42 m^3 (5 tonnes)
Green waste	From clearing activities and preparation of site.	0 m^3 (Green waste will be used onsite for rehabilitation).

5.16.4.2 Overburden, Reject and Tailings Waste

Stage 2 mining operations will lead to the generation of overburden waste rock, and the processing of Stage 2 coals will lead to the generation of coarse rejects and tailings from the CHPP. These waste materials will need to be managed and disposed of on site.

Excavation of overburden to expose the coal resource in OC4 will generate between 8.4 and 50.1 Mbcm of waste rock per year (see Table 4.6 in Section 4). This will be disposed of in two out-of-pit waste rock emplacements and in the OC4 mine void (see Section 4.5.2.6). It should be noted that the majority of overburden is a valuable resource for rehabilitation of the mine, with only a very small portion of overburden having potential to generate acidic drainage.

The processing of Stage 2 coal at the Stage 1 CHPP will generate an additional 2 Mtpa of coarse rejects and tailings. In total, 4 Mtpa of coarse rejects and tailings will be generated from the processing of coal from the MCP. These waste materials will be transferred from the CHPP to two rejects bins, one of which will be adjacent to the Stage 2 ROM coal facility. The other rejects bin will be located at the OC1 ROM coal facility. The coarse rejects and tailings transferred to the Stage 2 rejects bin will be backhauled to OC4 for co-disposal with overburden in the open cut mine void (see Section 4.5.5).

Leach column tests conducted on Stage 1 waste rock indicated that overburden materials are unlikely to produce acid, salinity or leach metals/metaloids of environmental significance. Further, that the blending of coarse rejects and tailings with overburden and co-disposal in the open cut mine voids (OC1, OC2 or OC3) will be sufficient to control potential ARD from Stage 1 mineral wastes (Wells Environmental Services, 2006).

The results of Stage 2 geochemical analyses indicated that the bulk of the overburden and floor material from Stage 2 is likely to be NAF, with PAF overburden materials mainly associated with the Moolarben Seam, and roof and floor of the Ulan Seam. The Ulan Seam appears to have a greater proportion of PAF than overburden or floor, indicating possible ARD issues associated with rejects, tailings and coal stockpiles. The geochemical assessment of overburden and coarse reject material samples for Stage 2 found that:

- Only a small proportion of overburden is PAF, and depending on the overall distribution of PAF materials and their acid generating potential blending of this material with NAF overburden will be sufficient to control potential ARD. Alternatively, the PAF overburden materials may need to be selectively handled.
- There is the potential for runoff and leachate from coal stockpiles and underground operations to be saline and acidic.
- Coarse reject materials appear to have a higher ARD potential than other mine materials, and are likely to require specific management to control ARD.

There were uncertainties in ARD classification due to the combined effects of varying forms of sulfur and organic acid effects on characterisation test work, and further investigation would be required to fully assess the relative distribution of PAF and NAF materials, and the overall acid potential.

5.16.5 Environmental Management

5.16.5.1 Non-mineral Waste

A hierarchical waste management approach will be implemented at the MCP, with waste management decisions made in the following order:

- Avoidance.
- Reduction.
- Reuse.
- Recycling or reclamation.
- Waste treatment.
- Disposal.

An integrated Construction Waste Management Plan (CWMP) and Operations Waste Management Plan (WMP) will be developed for the MCP. This will enable the implementation of an integrated approach to waste management across the whole complex. The CWMP that was prepared for Stage 1 will be extended to include the management of construction wastes from Stage 2.

As part of general waste management practices, all personnel working on site will attend a compulsory induction program that will include waste management. An ongoing waste monitoring program will occur through the use of weekly waste assessments and feedback to personnel. A register of waste removed from the site will be maintained, including the type, quantity and destination of waste materials. Documentation on waste transported and disposed of offsite will be maintained, including a record of transport certificates, permits and licences.

Adherence to the following legislation, guidelines and policies will be used throughout the project to ensure responsible waste management:

- *Waste Avoidance and Resource Recovery Act 2001.*
- *Protection of the Environment Operations Act 1997.*
- *Protection of the Environment Operations (Waste) Regulation 1996*.
- Waste Classification Guidelines (DECC, 2008d).
- Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Waste Projects (DECC, 2006).
- Green Waste Action Plan (EPA, 1997).
- NSW Government's Waste Reduction and Purchasing Policy (DEC, 1997).
- NSW Government's Waste Reduction and Purchasing Policy guidelines for 2007 (DEC, 2006).

Construction Waste

Where possible, materials will be fabricated off-site to minimise the wastage of fit-out materials. Other resources will be ordered based on accurate calculations so as to minimise wastage. There is also economic savings to be made from ensuring correct quantities of materials are ordered for construction.

The MCP site will be kept free of litter. Bins will be placed in all office and workshop areas, and wherever food is consumed. Waste types will be segregated, and sufficient clearly identifiable containers will be located on site to ensure correct segregation of all recyclable and non-recyclable materials with no contamination. Clear written instructions will be provided at appropriate locations detailing recycling and waste segregation principles.

All non-toxic waste (including putrescible and inert) will be securely stored in appropriate receptacles. There will be no long-term storage of any waste materials on site. All waste will be removed from site and disposed of by an approved waste contractor. Wastes will be sent to either the Mudgee Waste Facility (landfill) or the MWRC Putta Bucca (waste water pumping station) for disposal and/or treatment. Recyclable materials (such as aluminium cans, paper, glass and plastics) will be transferred to a licensed facility for recycling, by an approved waste contractor.

Operations Waste

Operations waste (other then sewage or mineral wastes) is likely to include metal, oils and fuels, batteries, and general domestic rubbish. The waste management measures described above for construction will be adapted to manage operations wastes. All waste will be segregated to allow responsible waste management with recycling or disposal to a local licensed waste facility via an approved waste contractor.

Hazardous Waste

Operation of the mining fleet will generate waste hydrocarbons such as oils, greases and hydraulic fluids. These waste hydrocarbons will be placed in suitable containers and removed from the site for disposal at either an EPA-approved hydrocarbon waste site or a recycling depot. Hazardous waste will be stored in an environmentally-safe manner and will not come into contact with any incompatible waste. Runoff water from mobile equipment service areas will be directed to an interceptor trap to extract hydrocarbons, prior to it being discharged into the mine water management system. The trap will be routinely emptied of hydrocarbons by an approved waste contractor.

Sewage

All sewage will be disposed of in accordance with NSW Department of Health and DECC requirements for on-site sewage disposal. Typically, this will be via approved on-site sewage management systems located adjacent to each bathhouse. Stage 2 sewage will be treated to the appropriate standard and used in site rehabilitation and landscaping or will be collected in a pump-out system and disposed of at a licensed facility offsite.

5.16.4.2 Overburden, Reject and Tailings Waste

The following environmental management measures will be employed:

- As mining of OC4 progresses through the Murragamba Creek and Eastern Creek valleys, overburden will be geochemically characterised to determine the occurrence of PAF materials prior to mining. Characterisation test work will include pH1:2, EC1:2, Leco total sulfur, ANC, sulfur speciation and NAG tests. Further leach column testing will be undertaken of Stage 2 PAF materials to determine lag times and acid release rates. This characterisation will be used to determine the amount of PAF materials requiring specific management. The mining schedule for specific areas will be updated to include details of selective mining, segregation and co-disposal of PAF mineral wastes with NAF materials. The objective of blending PAF and NAF mineral wastes will be to form a composite that is NAF for on site disposal.
- Coarse rejects and tailings will be routinely tested to determine whether they are PAF. Batches of coarse rejects or tailings that are PAF will be managed by a combination of approaches to ensure that PAF material is appropriately contained and will not result in offsite impacts. This includes:
  - Blending and co-disposal of PAF materials with NAF materials that are self neutralising.
  - Placement of PAF materials in areas of the open cut void that will be permanently below the water table.
  - Treatment of PAF material with lime or limestone prior to blending and co-disposal in the open cut void.
  - Capping of disposed PAF material to isolate it from infiltration and prevent leachate generation.

- Runoff and seepage from open cuts, underground operations, coal stockpiles and overburden emplacements will be routinely monitored for the following parameters:
  - pH, EC and acidity/alkalinity.
  - Sulfate.
  - Metals, specifically aluminium, arsenic, cobalt, copper, iron, manganese, nickel and zinc.
- Runoff and leachate from PAF or moderately saline materials will be contained and used as part of the mine supply water. Leachate water quality will be monitored to ensure that it does not change the quality of the mine supply water to the extent that mine supply water cannot be used on site. If required, leachate will be treated using a mobile lime dosing plant (or similar) to maintain appropriate mine supply water quality.
- If acidic water is generated and requires discharge from site, it will be treated to ensure that it meets the discharge limits (including pH 6.5 to 8.5) specified in the environmental protection license for the mine.
- Broadcast application of agricultural lime or the addition of crushed limestone to exposed surfaces will be used to mitigate minor occurrences of ARD, if required.
- Materials with sodic and dispersion potential will be treated as required with gypsum or lime if exposed on dump surfaces, or will be placed in engineered structures.
- Reduction of salt in the post-mining landscape will be undertaken through managed overburden placement and rehabilitation, including planting of endemic salt-tolerant species where required.

5.17 Land Use

5.17.1 Objectives

The objectives of the land use assessment were to identify the current land uses of the Stage 2 Project Area and the effect Stage 2 will have on these.

5.17.2 Assessment Method

JAMMEL undertook a rural land capability and agricultural suitability assessment of the Stage 2 Project Area. This included aerial photography interpretation, field surveys and consideration of the soil assessment (see Section 5.11). A copy of the land use assessment is included in Appendix 11 of Volume 6.

Land capability was evaluated against the NSW eight class land capability system (Cunningham et. al., 1988). Agricultural suitability was assessed against agricultural land classifications mapped by the DPI (Agriculture) for the former Mudgee Shire (DPI, undated).

An assessment was made of how the existing land use would change during Stage 2 operations and in the post-mining environment.

5.17.3 Existing Environment

Stage 2 open cut mining (OC4) will be developed in the Murragamba Creek and Eastern Creek valleys on predominantly cleared land. Less than 40% of the area is vegetated, with woodlands and forest the major vegetation formations. Cleared areas have been used historically for the grazing of livestock (sheep and cattle), with some occasional fodder cropping near the creeks.

There is no prime agricultural land within the Stage 2 Project Area. The valley floors and surrounding slopes and ridgelines have been classified as Class IV, V, VI, VII and VIII lands against land capability criteria and Class 3, 4 and 5 lands against agricultural suitability criteria. That is, the Stage 2 Project Area ranges from land which at best is capable of supporting grazing and occasional cultivation provided that appropriate soil conservation and erosion control practices are employed, through to land that is best left in its naturally timbered state. The extent of land capability and agricultural suitability class areas are shown in **Plan 52** and **Plan 53** of Volume 2 respectively. Descriptions of the capability and suitability classes used to describe the lands are included in JAMMEL's report in Appendix 11 of Volume 6.

The Murragamba Creek and Eastern Creek valley floor areas comprise a mix of soil types including large areas of shallow sandy and dispersive soils, with high potential for soil structure breakdown and moderate to high potential for erosion (see Section 5.11). There is evidence of salt scalding and existing cleared paddock areas are heavily infested with Sifton Bush. The surface water quality has generally been degraded as a result of past agricultural practices and soil erosion, but is suitable for the watering of livestock (see Section 5.5).

The other parts of the Stage 2 Project Area are dominated by steep slopes and sandstone ridgeline country. It is under these areas that the underground mines will be developed. The land above UG1 and UG2 is predominantly timbered (see Plan 4 in Volume 2, for example). A small proportion of land above the underground mines is currently used by private land owners for farm purposes, mainly grazing.

There are a small number of farm properties and dwellings within the Murragamba and Eastern Creek valleys which are now owned by either Ulan coal mine or MCM. Some grazing is still carried out on the mine-owned land on lease back arrangements, however this will cease once mining commences.

There is evidence of some small scale quarrying with a number of borrow pits scattered around the valley margins. The largest of these is now used by MWRC as a general waste transfer area. Other land uses of the Stage 2 Project Area include road, rail, electricity and telecommunication corridors. As previously indicated, the Munghorn Gap Nature Reserve, Goulburn River National Park, Wilpinjong coal mine, Ulan coal mine and Stage 1 surround the Stage 2 Project Area.

Existing land uses are consistent with the Mid-Western Regional Interim LEP land use planning zone objectives.

5.17.4 Issues

The following issues were considered as part of the land use assessment:

- Permanent loss of agricultural land due to mining and post-mining conservation land use objectives.
- Loss of native vegetation due to mining.
- Opportunities for land improvement through rehabilitation and revegetation.

5.17.5 Impact Assessment

The predominant land use impacts associated with Stage 2 will be the progressive loss of agriculture due to the mining and subsequent rehabilitation of OC4, and the progressive loss of areas of native vegetation due to mining.

It is estimated there are about 670 ha of Class 3 agricultural suitability lands in the Murragamba and Eastern Creek valleys, and mining OC4 will impact the majority of these lands. A similar amount of lower class agricultural lands (Class 4 and 5) will also be impacted by mining. Land not immediately affected by mining will continue to be used for livestock grazing purposes on a lease back arrangement. However, areas available for grazing are expected to diminish as mining progresses through the valleys.

The total disturbance area of Stage 2 is about 2,463 ha (see Table 5.7.3 in Section 5.7.5). Construction and operation of OC4 and Stage 2 infrastructure and facilities will directly clear 851 ha of existing native vegetation, including 157 ha of EEC. These areas will be progressively rehabilitated with native vegetation following mining. There will be a small void left at the end of mining OC4 at its eastern boundary. This will provide access to future underground coal resources, and underground mining in the vicinity of the pit void is a potential future land use.

Land use above UG1 and UG2 will not change as a result of longwall mining and will continue to be predominantly naturally timbered. Stage 2 underground mining is not expected to impact on a small amount of existing privately-owned agricultural land within the area of predicted surface subsidence.

All currently cleared areas within the Murragamba and Eastern Creek valleys, including areas within and outside the OC4 disturbance area, will be revegetated. The objective for the post-mining land use is to create a landscape of natural woodlands and grasslands. Hence Stage 2 will result in the permanent loss of low class agricultural lands in these valley floor areas. However, the rehabilitation and revegetation initiatives that will be implemented in these areas will improve the quality of the land compared to its current condition, and increase the ecological and biodiversity values of the land.

5.17.6 Environmental Management

While mining activities are temporary, they will have an impact on the land, and progressive rehabilitation of disturbed areas is required to achieve a sustainable end land use. Planned rehabilitation for Stage 2 will not restore the land to its pre-mining state, but rather will rehabilitate the site with native vegetation, improving the ecological and biodiversity values of the site in the long term. Other cleared lands owned by MCM will also be revegetated with native vegetation to create a more continuous final landscape. These will link with the adjoining conservation reserves and other vegetated areas in the surrounding landscape, creating enhanced greenspaces and wildlife corridors. Rehabilitation is detailed in Section 5.18, and the post-mining landscape vision is described in Section 5.19.

5.18 Rehabilitation

Rehabilitation for Stage 2 does not aim to restore the land to its pre-mining state, but to rehabilitate the site with native vegetation, improving the ecological value of the site in the long term. Within the footprint of the Stage 2 Project Area, 851 ha of permanent native vegetation and 655 ha of grassland and disturbed lands which will be cleared for open cut mining will be rehabilitated with a mosaic of native open woodland, grassland and shrubland. In addition to rehabilitating mine impacted areas, MCM commit to revegetating all cleared land within their ownership, as well as improving existing vegetated areas on its lands. This will enhance the biodiversity values of the area in the long term and provide connectivity between greenspaces and wildlife corridors. Assuming revegetated areas establish successfully, the post mining landscape will achieve a long-term net increase of approximately 800 ha of native vegetation, comprising EEC species and communities, compared to existing conditions.

Rehabilitation for Stage 2 will be integrated with the rehabilitation for Stage 1, and will consider the rehabilitation objectives of the neighbouring Wilpinjong coal mine. This will enable a contiguous, complementary rehabilitated post-mining landscape to be created. Consultation and collaboration between MCM and Wilpinjong coal mine will enable rehabilitation goals and the best environmental outcomes for the post-mining landscape to be achieved.

Throughout the life of the mine, MCM will maintain consultation with relevant stakeholders to identify environmental and social objectives for the rehabilitation of the site. This will inform the development of detailed rehabilitation and landscape management objectives to achieve suitable mine closure (see Section 5.19).

5.18.1 Rehabilitation Concepts

The rehabilitation of the open cut area will require the design of specific rehabilitation methods. These methods will incorporate the following principles:

- Depletion of nitrogen in topsoils through the revegetation and management of cleared lands prior to mining with perennial native grasses.
- Use of salvaged habitat.
- Control of Sifton Bush prior to topsoil recovery, to reduce dominance in rehabilitated landscapes.
- Exclusion of frequent fires in the landscape to reduce stimulation of exotic perennials.
- Integration of sediment ponds to form ‘chain of ponds’ features in the final landform to increase water availability.
- Rehabilitation with a native open woodland/shrubland/grassland mosaic throughout the rehabilitated landscape.

Where practicable, areas of high ecological value will not be disturbed, and areas of terrestrial and aquatic fauna habitat directly impacted will be salvaged to ‘seed’ restoration and revegetation efforts. Permanent revegetation activities will include seeding cleared areas, and introducing clumped tree and shrub plantings to enhance the landscape and ecological values (e.g., woodland bird habitats). Increased shrub density will improve habitat for sensitive native fauna (e.g., Hooded Robbins and Grey Crowned Babblers) and control dominance of competitive native and exotic species (e.g., Pied Currawong and Noisy Minor). Rehabilitation efforts will include prevention, control and eradication of listed environmental and noxious weeds, particularly troublesome species for rehabilitated landscapes such as Galena, Rhodes Grass and Coolati Grass.

Existing cleared, disturbed and degraded areas proposed for mining in future years will be temporarily improved through rehabilitation and revegetation. Temporary revegetation will occur in cycles approximately seven years prior to mining. This will include the removal of weeds and the seeding of these cleared and degraded areas with native grasses. This will assist in short term erosion control, improve the condition of the soil and increase the native vegetation seed bank prior to the stripping and stockpiling of the soil in preparation for open cut mining. Revegetation and land management will involve the seeding of Kangaroo grass (*Themeda australis*), and the control of exotic species using a range of techniques including herbicides, pulse grazing and slashing. The benefits of this revegetation include:

- Improved competition of Kangaroo grass over exotic or disturbance tolerant native species.
- Increased soil organic matter, and reduced macro nutrients to inhibit exotic annual species.
- Improved seed banks and conditions for native vegetation growth in rehabilitated landscapes.
- Harvestable seed resource for collection and use in the rehabilitated landscape.
- The temporary improvement of corridors between existing stands of timbered vegetation.

Throughout the life of the project, stockpiled soil will be managed so as to improve soil health and fertility, and to improve the long-term viability of the soil in preparation for use in rehabilitation. Inactive stockpiles will be fertilised and seeded to maintain soil fertility. Soil ameliorants and imported organic materials such as biosolids may be applied, pending appropriate approval. Prior to the reapplication of stockpiled soil for rehabilitation, stockpiles will be deep-ripped to establish aerobic conditions.

Runoff from rehabilitated areas will be collected, conveyed to sedimentation ponds for settlement and extracted for use in ongoing irrigation for rehabilitation of the site or for use in dust suppression. These ponds will continue to operate until the water being captured off the rehabilitated areas is of a suitable quality for irrigation. Once the rehabilitated areas are satisfactorily established some of the ponds will be retained to enhance the post-mining aquatic and terrestrial ecosystems, others will be decommissioned.

Rehabilitation of the majority of the surface disturbance areas would be progressive, and will follow behind the active mine front. Revegetation of cleared areas outside of the mine footprint will occur over the first five-year period.

The final landform and post-mining land use will dictate the composition and structure of species to be established for the rehabilitation phase. Species selection will take into consideration climate and soil nutrition as well as the occurrence of water logging and salinity levels within the soils.

5.18.2 Rehabilitation of Surface Disturbance Areas

Rehabilitation of surface disturbance areas will be focussed on:

- Progressive rehabilitation of OC4.
- Realignment and rehabilitation of Murragamba and Eastern creeks.
- Rehabilitation of surface infrastructure and facilities remaining at the cessation of the project.

- Rehabilitation of land above UG1 and UG2, in the case of greater than expected impacts on native vegetation.

5.18.2.1 Rehabilitation of Land Above UG1 and UG2

The land above the underground mines will naturally and progressively subside as a result of longwall mining. Some surface cracking will develop as a result of mine subsidence, being most visible where the depth of cover is less than 100 m (see Section 5.8). Cracks are expected to close and heal naturally especially during rainfall events. Surface water ponding and changes in the grade of drainages may develop as a result of longwall extraction, and may locally impact on the rate and amount of erosion that occurs downstream following a rain event. If it is determined that surface cracks or water ponding pose a threat to EECs, the cracks or ponds will be remediated by infilling with soil or other suitable materials, or where it is practicable, by locally regrading and compacting the surface.

Concerns related to public safety and access to the underground mines after closure will be addressed in the Mine Closure Plan (see Section 5.19). Specific management measures will include sealing the entry points to UG1 and UG2, fencing to prevent public access, and signposting the area to warn of the safety risks.

5.18.2.2 Rehabilitation of OC4

The OC4 void will be progressively filled with the overburden excavated during the mining process, reshaped to create a final landform, and rehabilitated by planting local native species. Progressive mining and rehabilitation is illustrated in Plans 5 to 10. The 851 ha of existing native vegetation that will be cleared by open cut mining will be replaced in the final rehabilitated landscape with native vegetation. Stage 2 will also clear or disturb 655 ha of non-native grasslands and other disturbed lands. These lands will also be rehabilitated with native vegetation, creating a post mining landscape with a higher ecological value than pre-mining, and providing increased opportunities for improved soil condition and reduced soil salinity.

The rehabilitated final landscape will be a mosaic of native open woodland, grassland and shrubland (see Plan 54). Patches of native grassy woodland 5 to 10 ha in area will be planted no greater than 300 m apart. Small farm dams will be constructed to create ‘chain of ponds’ structures. This will increase water availability where possible. Patches of native shrubby woodlands 5 to10 ha in area will be planted to connect the grassy woodland patches. The open woodland, shrubland and grassland mosaic will be continued throughout the remainder of the landscape, with existing cleared lands vegetated to tie in with the rehabilitated areas. Salvaged habitat will be used wherever possible. A key feature of the rehabilitation of OC4 is the reestablishment of ecological function conducive to the development of Box Gum Woodland species. Rehabilitation is expected to achieve a long-term net increase in vegetated areas and an increase in the ecological value of the land.

When all of the overburden has been used for filling, a small void will be left in OC4 at its eastern margin, immediately adjoining the Wilpinjong mining area (see Plan 10). This void will allow access to underground coal resources that may be developed as part of future mining proposals. If this does not eventuate, the void will be left to form a small lake. Evaporation from the open water surface will exceed inflows, which is expected to elevate the salinity of the lake. Due to the ratio of evaporation to inflows, it is predicted that this void will be a hydrologic sink, and therefore no impacts to groundwater and surface water sources are expected to occur. It is also expected that the final post mining void shape and water level will be influenced by the final configuration of the

Wilpinjong mining area, which is unknown to MCM at this time. A Final Void Management Plan will be prepared and implemented prior to mine closure.

5.18.2.3 Creek Rehabilitation

Sections of Murragamba Creek and Eastern Creek will be disturbed during mining operations and will be realigned in the final rehabilitated landscape. Creek diversion and restoration works will be undertaken progressively to maintain environmental flows and to maintain and improve the aquatic habitat, where possible. Fauna habitat will be salvaged from impacted areas and restored in retained areas. An Aquatic Habitat Rehabilitation Plan will be developed to guide the creek rehabilitation and restoration process. Restoration will be undertaken with attention to the DoP's Guidelines for Wetland Restoration Plans (DoP, 1999) and the Cooperative Research Centre for Catchment Hydrology's A Rehabilitation Manual for Australian Streams (Rutherford, 2000). Reconstruction and rehabilitation of the creeks is discussed in Section 5.5.6.3.

Measures will be incorporated into the post-mining creek design to allow the reconstructed creeks to mimic a natural creek, to increase habitat and diversity, and minimise erosion.

5.18.2.4 Surface Facilities and Infrastructure

Surface facilities and infrastructure will be decommissioned, removed for use in other mining activities, or dismantled. The land will be revegetated with native species. Some facilities such as offices and crib rooms, water tanks, hardstand areas and amenities blocks may be left to cater for other land uses following mine closure (see Section 5.19).

5.18.3 Revegetation and Improvement of MCM-owned land

Moolarben Coal Mines commit to revegetating and improving all cleared lands within their ownership. This includes 175 ha of grasslands and cleared lands which lie outside of the mine footprint, including Properties 24, 49 and 173, and parts of Properties 12 to 19 (remaining parts of these properties will be revegetated under the Stage 1 Project Approval) and 28 (see Plan 2 in Volume 2). Revegetation is planned to occur over a five-year period following approval of Stage 2.

Within MCM's ownership, properties adjoining the National Estate will be embellished and enhanced to improve the quality of the native vegetation already present. This includes Property 51 and part of Property 43, both adjacent to the Munghorn Gap Nature Reserve. This is in addition to parts of Properties 13 to 15, adjacent to the Goulburn River National Park. Properties 6 and 21 contain additional intact native vegetation that will be embellished and improved (see Plan 2 in Volume 2). Moolarben Coal Mines also commit to the assisted recovery of a 46 ha Grassy White Box Woodlands EEC site identified during the field surveys undertaken as part of the ecological impact assessment (Appendix 7 in Volume 4).

The ecological values of these sites will be protected through Voluntary Conservation Agreements (VCAs) or the like for the duration of the MCP. It is proposed that following mine closure, the VCAs will be surrendered and the lands will be protected in the long term under the Native Vegetation Act and other nature conservation legislation.

5.18.4 Rehabilitation Outcomes

As discussed in Section 5.7, revegetated and rehabilitated areas within MCM's ownership will amount to over 1,700 ha, and will comprise:

- 175 ha of revegetated and improved land outside the mine footprint, including Properties 24, 49 and 173, and parts of Properties 12 to 19 and Property 28.
- 46 ha recovered Grassy White Box Woodlands EEC site outside the mine footprint.
- 851 ha of cleared native vegetation, rehabilitated with native vegetation.
- 655 ha of cleared degraded and agricultural lands, rehabilitated with native vegetation.

The revegetated and rehabilitated areas will achieve a long-term net increase of approximately 800 ha of native vegetation, comprising EEC species and communities, compared to the existing status of native vegetation within the Stage 2 Project Area.

The post-mining landscape will have a higher proportion of native vegetation and improved ecological value. Rehabilitated and revegetated areas will provide long-term offsets to those areas of native vegetation cleared by Stage 2, and together with the proposed offsets (Section 5.7.7) will improve local and regional connectivity.

5.18.5 Rehabilitation and Offset Management Plan

A Rehabilitation and Offset Management Plan will be developed for Stage 2 to guide the rehabilitation or revegetation of cleared lands under the control of MCM, both within and outside the mine footprint. This will be integrated into a similar plan for Stage 1, which will consider the rehabilitation and offset objectives for the entire MCP (offsets proposed for Stage 2 are discussed in Section 5.7). The Aquatic Habitat Rehabilitation Plan will form part of this integrated Rehabilitation and Offset Management Plan. The Rehabilitation and Offset Management Plan will enhance overall environmental management outcomes by incorporating non-mined areas with rehabilitated areas, as well as increasing the net native vegetation cover within the project area. Retained vegetation and habitats will be managed to enhance their ecological value. Moolarben Coal Mines has committed to revegetating all cleared lands within its ownership in order to achieve this goal.

The Rehabilitation and Offset Management Plan will take into consideration relevant strategic land use planning or resource management plans or policies, including:

- Mid-Western Regional Interim LEP (MWRC, 2008).
- Commonwealth of Australia Leading Practice Development Program for the Mining Industry booklets, Mine Rehabilitation and Mine Closure and Completion (Commonwealth of Australia, 2006a and 2006b).
- The DPI's Guidelines to the Mining, Rehabilitation and Environmental Management Process (DPI, 2006).
- The DoP's Guidelines for Wetland Restoration Plans (DoP, 1999).
- The Cooperative Research Centre for Catchment Hydrology's A Rehabilitation Manual for Australian Streams (Rutherford, 2000).
- The NSW Minerals Council's Rehabilitation Policy (NSWMC, 2006b).
- The DECC's Guidelines on Developments adjoining DECC land (DECC, 2008b) especially with respect to ecological connectivity, erosion, sedimentation, runoff, pests, weeds, edge effects, fire management, boundary encroachments and indirect impacts.

- The 'Great Eastern Ranges Initiative' conservation program.

The Rehabilitation and Offset Management Plan will be prepared within two years of the granting of approval for Stage 2. The plan will be periodically updated as part of the Mine Operations Plan (MOP) and the Landscape Management Plan. This will include the preparation and revision of goals and corresponding budgets to meet those goals, the development of implementation schedules to guide the execution of the rehabilitation works, and annual reporting of rehabilitated land areas.

5.18.6 Monitoring and Maintenance

A monitoring program will be developed and carried out for Stage 2 to determine early rehabilitation success, determine the need for any remedial actions and assess whether the rehabilitation efforts will meet the long-term post-closure land use objectives. Monitoring will include:

- Runoff water quality.
- Surface and slope stability.
- Effectiveness of erosion and sediment control measures.
- Soil and root zone properties.
- Structural attributes of plant communities.
- Composition of plant communities.
- Comparison of revegetated and rehabilitated sites with control sites.
- Abundance of fauna.
- Presence of weeds and pest species.
- Indicators of ecosystem functioning.

The results this monitoring will assist in demonstrating that the rehabilitated areas are consistent with lease relinquishment criteria (see Section 5.19).

5.19 Mine Closure

Rehabilitation is a progressive process, which aims to restore the environmental conditions of the disturbed mine site to a sustainable and stable end land use. Progressive rehabilitation of areas disturbed by Stage 2 will be guided by the conceptual post-mining landscape vision. **Plan 54** provides the conceptual post-mining landscape vision whilst **Figure 5.3** shows conceptual sections of the post-mining landscape.

5.19.1 Conceptual Post-Mining Landscape

The Murragamba Creek and Eastern Creek valleys will be rehabilitated and revegetated so as to improve ecological function and wildlife connectivity. The realignment of the Murragamba and Eastern creeks (see Section 5.5) will enable the creation of stable ecologically diverse elements that will improve water quality, and aquatic and terrestrial habitats. This will also help link the Munghorn Gap Nature Reserve to the Goulburn River National Park. It is envisaged this area will be used for conservation, passive recreation, and environmental education purposes. The final landform will be self-sustaining, and no ongoing maintenance will be required.

The OC4 mine footprint will be progressively rehabilitated with a mosaic of native open woodland, grassland and shrubland including EEC species. It is proposed that the OC4 post-mining landscape will include public self-guided nature walks and trails. The walking trails will incorporate viewing platforms, bird hides, raised creek crossings, rest stations with interpretive displays that will describe the landscape and topographical features of the area, vegetation communities, wildlife common to the area and historical (Aboriginal and non-Aboriginal) themes.

The surface area of the UG1 and UG2 mines, that is, the ridgelines, will generally be left intact. These areas will be linked to the network of trails and nature walks, and will provide access to a scenic lookout. Entry points to UG1 and UG2 will be sealed and fenced to prevent public access.

At the end of Stage 2, infrastructure will be dismantled. However, some infrastructure components may be retained and used to support mining of remaining coal reserves within MCM exploration lease areas (i.e., EL 6288, EL 7073 and EL 7074). Infrastructure may also be used for non-mining purposes such as tourism and education.

There is the potential for the establishment of low-key eco-friendly tourism ventures within the rehabilitated Stage 2 Project Area. Tourism ventures will focus on walking trails linking to the district's local landmarks, such as 'The Drip', and 'The Munghorn'. The long-term land use will be consistent with the provisions of the Mid-Western Regional Interim LEP (MWRC, 2008), relevant SEPPs, and input from relevant stakeholders and the Mine Closure Plan.

Land immediately adjacent to the National Estate that is not required for mining purposes will be rehabilitated and embellished with WBYBBBRW EEC species as part of the overall biodiversity offset strategy (see Section 5.18). Should this land not be accepted for dedication to the National Estate, all rehabilitated land will be included within a VCA in order to ensure that ecological values are maintained. At mine closure, MCM will seek to surrender the VCA and have these lands protected under the Native Vegetation Act and other similar legislation.

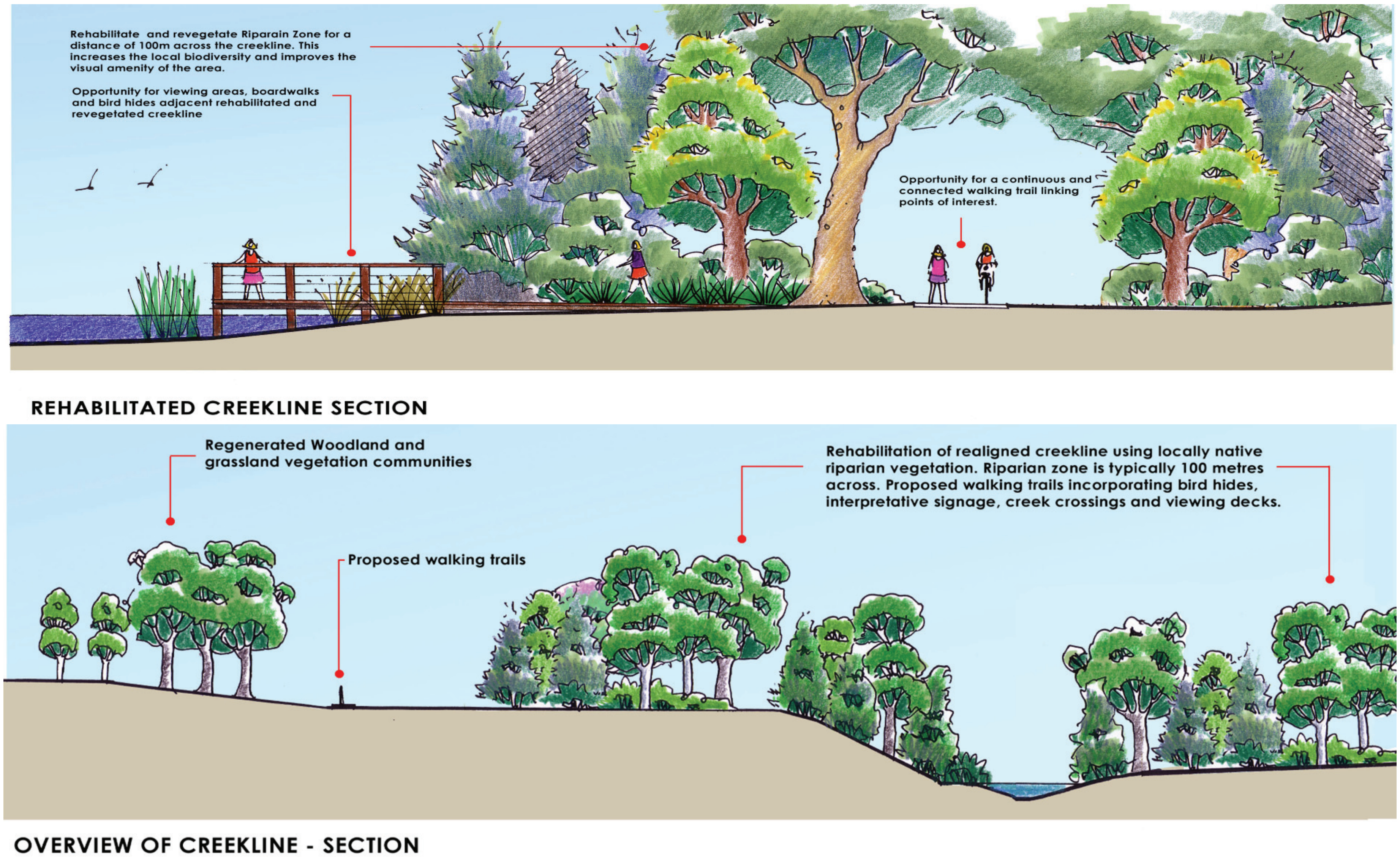

Figure 5.3 Indicative schematic representation of the rehabilitated creek line and surrounds

5.19.2 Mine Closure Plan

The objective for mine closure is to leave sites in a condition that is safe, stable and limits further environmental impacts so that mining tenements can be relinquished for alternative land uses.

Prior to the completion of Stage 2 mining operations, an integrated Mine Closure Plan will be developed for the MCP in consultation with the relevant authorities and stakeholders. This will address the key issues of safety, environmental issues, financial expectations and future land uses.

The Mine Closure Plan will be developed in consideration of relevant strategic land use, planning and resource management plans and policies. Consideration will also be given to mine closure guidelines including the Commonwealth of Australia Mine Closure and Completion document (Commonwealth of Australia, 2006b), and the Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia Strategic Framework for Mine Closure (ANZMEC and MCA, 2000).

The Mine Closure Plan will describe the conceptual closure and decommissioning process, final rehabilitation including final voids, post-closure maintenance, environmental monitoring, land tenure and future land use. A human resources plan will be developed as part of the Mine Closure Plan to manage the gradual release of mine staff and employees.

Following completion of Stage 2 mining (that is, at the end of the 24-year mining operations period), it is expected that MCM will retain tenure of the mining and coal leases until the lease relinquishment criteria are satisfied. Lease relinquishment criteria will be decided in consultation with relevant authorities and stakeholders and will be detailed in the Mine Closure Plan. Success criteria for rehabilitation will be grounded on ecological principles, and will address landscape level and specific ecosystem level properties. It is expected that criteria will include:

- Removal of infrastructure where appropriate or required.
- Safe, stable and adequately drained landforms consistent with the surrounding landscape.
- Surface water inflows to the final void have been minimised.
- The void has been profiled for long-term stability.
- Maintenance of downstream water quality.
- Area of native vegetation post-mining is greater than the pre-mining extent.
- Establishment of self-sustaining vegetation.
- Revegetated assemblages are characterised by the desired native vegetation communities.
- No significant weed infestations or proportion of weeds in any revegetated area.
- Revegetated areas provide habitat for fauna species.
- No loss of native flora or fauna species diversity in undisturbed areas.
- Ecological corridors are successfully established.
- Public safety and access is adequately controlled.
- Fulfilment of mining and coal lease and other statutory approval conditions.

The results of the long-term monitoring of rehabilitated efforts (see Section 5.18) will assist in demonstrating that the rehabilitated areas are consistent with lease relinquishment criteria. At this stage, any VCA over MCM-owned land will be surrendered for ultimate protection under the Native Vegetation Act and other similar legislation.