

## Flow Regimes

Clean water flowing onto the Project Site is proposed to be diverted around the disturbance areas into existing drainage lines. The clean water runoff from the eastern catchment will be diverted either north into Driggle Draggle Creek or south into the central unnamed drainage line. This will result in a large area of clean catchment being diverted around the site and into the natural drainage system rather than being held in the site water management system. The clean runoff from the west of the site originating in the Vickery Sate Forest will also be either diverted north or south into the same drainage lines.

As a result of the diversions, only runoff that lands within the proposed water management system of the Project Site will be contained for pollution control. This equates to an area of approximately 380 hectares at full development. This should help maintain ephemeral flows and sediment movement patterns in the watercourses downstream of the Project Site. It must also be noted that water of suitable quality contained within the water management system can be discharged when required through the LDPs under the provisions of the site's EPL.

## Water Sources

The majority of water required within the Project Site will be for dust suppression activities, including in the crushing and screening process. A nominal amount of potable water and water for ablutions is required on-site and will continue to be sourced from rainfall capture from the roofs of on-site buildings and trucked in from an external source.

Water sources for operational activities will be used in the following order of preference:

- Mine Water (via the Mine Water Dam);
- Dirty water from the sediment basins, preferentially sourced from the basins with higher EC readings;
- Licensed bores (via the Bore Pump Dam);
- Clean water within Maximum Harvestable Right Dam Capacity (MHRDC) (via storage dams); and
- Water occasionally trucked in from off-site as required.

## TSS Mitigation Measures

In addition to standard sediment control measures and progressive rehabilitation, it is recommended that mitigation measures be employed to improve the TSS levels within on-site water. Initially, sediment basins SD3 and proposed Dam B (all dirty water within the Project Site reports to one of these dams before exiting the site) will be drawn down and emptied at all times to allow for maximum runoff storage volume when the next rainfall event occurs and minimise the chances of a discharge off-site. It is Whitehaven's preference to promptly use any water that reports to either of these dams for dust suppression or pumped into other sediment basins around the site. However this will be influenced to a large degree by the volume of pit water stored in the Mine Water Dam, which will be utilised prior to utilising the water within SD3 and proposed Dam B.

Chemical flocculation to help increase the settling times of the sediment in the water column will also be employed as required. Tests using floc blocs have already indicated that TSS levels can be effectively reduced via chemical flocculation.

There are various other methods and techniques available to remove solids from sediment-laden water and the most appropriate will be determined for use on a case by case basis in conjunction with specialists and relevant government agencies.

### 7.5.7 Licensing Requirements

#### Maximum Harvestable Right Dam Capacity

The MHRDC for the Project Site has been calculated by GSSE (2010c) to be approximately 32 ML. All existing clean water storage dams that will be used for water supply are within this volume, hence no licences are required for these existing dams.

#### Dirty Water Dams

All the existing and proposed dirty water dams (sediment basins), as well as the Mine Water Dam, aimed at preventing the contamination of downstream waterways, are exempt from harvestable right calculations under the *NSW Farm Dams Policy 1999*.

The Bore Water Dam will be used as a ‘turkey’s nest’ dam to contain water pumped from the licensed groundwater bores. It will not capture water from the natural catchment and is therefore also exempt from licensing under the *NSW Farm Dams Policy 1999*.

#### Licensed Discharge Points

While LDP 11 will continue to be used at the southern end of the Project Site, LDP 12 will be superseded and require relocation due to the expanded Northern Emplacement Area. It is proposed that a new LDP to replace LDP 12 be positioned at the outlet of the proposed Dam ‘B’ located at the northern boundary of the Project Site to enable discharge into Driggle Draggle Creek. This will be undertaken in consultation with the DECCW.

### 7.5.8 Monitoring

The existing *Site Water Management Plan* (RCA Australia in conjunction with Soil Conservation Service 2009) comprises a *Surface Water Monitoring Program* that includes:

- Baseline data on surface water flows and quality in adjoining creeks and waterbodies that could be affected by the project;
- Surface water impact assessment criteria;
- A program to monitor the impact of the project on surface water flows and quality; and
- Procedures for reporting the results of this monitoring.

As outlined above, the Rocglen Extension Project will necessitate changes to the existing surface water management system. While many aspects of the current monitoring program will remain applicable to the expanded mine operation, it will be reviewed and updated to ensure changes to the surface water management system are accounted for. **Table 47** presents a summary of the intended surface water monitoring, as recommended by GSSE (2010c).

**Table 47 - Proposed Surface Water Monitoring**

Identification	Type of Monitoring Point	Pollutants	Frequency	Sampling Method
LDP 11	Wet Weather Discharge	Conductivity ( $\mu\text{S}/\text{cm}$ ) Oil and Grease (mg/L) Total Organic Carbon (mg/L) Total Suspended Solids (mg/L) pH	Special Frequency 1 (all)	In situ
LDP 12	Wet Weather Discharge		Special Frequency 1 (all)	
Driggle Draggle Creek to the north of the Project Site	Baseline Data and Wet Weather Discharge (downstream of site)		Special Frequency 2 (all)	Grab sample
Un-named drainage channel to the south of the Project Site	Baseline Data and Wet Weather Discharge (downstream of site)		Special Frequency 2 (all)	Grab sample
Dam SD7 (eastern side of Project Site)	Baseline Data (upstream of site)		Special Frequency 2 (all)	In situ
Mine Water Dam	Water Quality	Aluminium Arsenic Bicarbonate Chloride Conductivity Iron Manganese Oil and Grease Sodium Total Organic Carbon Total Suspended Solids pH	Yearly Yearly Yearly Yearly Quarterly Yearly Yearly Quarterly Yearly Quarterly Quarterly Quarterly	Grab sample Grab sample Grab sample Grab sample In situ Grab sample Grab sample Grab sample Grab sample Grab sample Grab sample In situ

Special Frequency 1 – collection of samples as soon as practicable after each discharge commences and in any case not more than 12 hours after each discharge commences.

Special Frequency 2 – collection of samples quarterly (in the event of flow during the quarter) at a time when there is flow and as soon as practicable after each wet weather discharge from LDP 11 and LDP 12 commences and in any case not more than 12 hours after each discharge commences.

In addition to the monitoring required under the site's EPL, surface water monitoring is proposed for internal dams within the Project Site. This additional monitoring will allow the performance of the surface water management system to be assessed and enable implementation of additional controls if required. It will also allow for the monitoring of salt and alkalinity in dams collecting water from subsoils.

Whilst the continuation of water quality monitoring is recommended for the site, the establishment of volumetric flow monitoring at the Driggle Draggle Creek monitoring point and the southern drainage channel monitoring point is not warranted. These drainage lines are ephemeral and do not flow regularly enough to warrant the establishment and maintenance of flow gauging stations within those drainage lines.

The results of water quality analysis will be reported in the AEMR. In the event that an exceedance in surface water quality criteria is identified, the exceedance will be reported to the relevant agency in accordance with the requirements of the EPL.

## 7.6 Groundwater

Douglas Partners (2010) was commissioned to address hydrogeological (groundwater) issues associated with the Rocglen Extension Project. Douglas Partners (2010) confirmed and updated the conceptual hydrogeological model derived by RCA Australia for Rocglen in 2002 and 2007, and subsequently constructed and calibrated a revised numerical groundwater flow model in order to assess impact on the surrounding groundwater system and assess the quantum of groundwater seepage that may occur into the pit.

A copy of the *Hydrogeological Assessment* is contained within **Appendix R**, with the key assessment findings and recommendations summarised below.

### 7.6.1 Existing Environment

#### Aquifers

From drilling of coal exploration bores within the area, it is noted that groundwater is mainly limited to the coal seams (particularly the Belmont Coal Seam), which is considered to be the main aquifer zone within the Maules Creek Formation sequence. The Belmont Coal Seam is generally consistent in thickness and groundwater occurs in fracture cleat within the seam.

The other major aquifer of the region is the sand/gravel accumulations within alluvium associated with the Namoi River and associated tributaries. Alluvium abuts the Maules Creek Formation to the north and to the southwest of Rocglen Mine.

Previous testing by RCA Australia (2002 and 2007, as cited in Douglas Partners 2010) show that the coal seams are generally at least two orders of magnitude more permeable than the interburden strata.

#### Groundwater Levels and Flow Directions

RCA Australia (2007, as cited in Douglas Partners 2010) recorded groundwater levels in a number of bores throughout the region and calculated approximate reduced levels to a common datum. The reduced levels were then contoured to assess groundwater levels and flow directions.

Whitehaven has installed piezometers and has also monitored groundwater levels and quality in 13 private bores, which are known as WB-01 to WB-12, Yarrari Bore and Wundurra Bore. Bore WB-04 is not monitored due to casing around the bore preventing access. The locations of the monitoring bores are shown on **Figure 24**, and **Appendix R** contains summary detail and hydrographs.

The RCA Australia monitoring in 2007 included bores screened in the coal seams as they were within the mine footprint. The current monitoring bores generally do not intersect the coal seams as they are located outside the mining footprint (to avoid disturbance by mining) and, due to the geology, the coal seams are generally not present outside of the mine footprint.

Contoured groundwater levels (approximate) across the area prior to the commencement of mining, based on the current monitoring wells, suggests that the groundwater table is a subdued reflection of topography, and that groundwater flows from elevated areas east of the mine westward towards the Namoi River. The contoured groundwater levels are similar to those contoured by RCA Australia (2007). Of particular note is that the bores within the mine footprint, which were measured in 2007 were no longer available in 2008 as a consequence of mining commencing were not able to be used to calculate the contours. Reference to Table 6 of Douglas Partners' report (2010) indicates that for these bores the heads were generally in the range RL 252 to RL 258 in 2007. The contoured groundwater levels indicates interpolated groundwater contours in the range RL 255 to RL 260, which is similar to the heads measured in 2007.

### Groundwater Recharge

Hydrographs of groundwater levels presented in **Appendix R** show that recharge of the groundwater system in the vicinity of Rocglen is poor. No significant groundwater level rises in response to rainfall events are apparent in any of the hydrographs presented.

During the monitoring period, there have been a number of significant rainfall events which would be expected to result in groundwater recharge. In particular, the periods September to November 2008 and December 2009 and January 2010 recorded above average rainfall, yet groundwater level rises did not follow.

Poor recharge of the strata in the vicinity of Rocglen is probably a function of low permeability, in addition to the general exceedance of evaporation over rainfall.

### Groundwater Quality

RCA Australia (2007, as cited in Douglas Partners 2010) assessed baseline groundwater quality based on the laboratory analysis of 13 groundwater samples. Samples were analysed for alkalinity, aluminium, arsenic, chloride, EC, iron, magnesium, manganese, nitrates, nitrites, pH, potassium, sodium and sulphates. Based on this analysis, it was concluded that groundwater in the vicinity of Rocglen could be characterised as follows:

- pH ranging from 6.3 to 7.7 (essentially neutral);
- EC values indicate that the groundwater is brackish; and
- The groundwater is generally of a sodium-bicarbonate/chloride type.

The range of chemical parameters analysed for by RCA Australia (2007, as cited in Douglas Partners 2010) is somewhat limited, and Douglas Partners (2010) state that the 2007 characterisation cannot be relied upon without additional testing.

Since mining began, Whitehaven has periodically collected groundwater samples from a number of monitoring bores and had them laboratory analysed for an extensive range of chemical parameters. A total of 35 groundwater samples from 13 monitoring bores have been analysed since October 2008. The results have been analysed to calculate Percentage Reacting Values (PRVs) of major ions and assess water type. Key findings include:

- Sodium is the dominant cation with an average PRV of about 60%;
- Calcium and magnesium are also prominent cations in groundwaters from a number of monitoring bores with PRVs in excess of 25%; and
- Chloride and bi-carbonate are the dominant anions with average PRVs of 52% and 43%, respectively.

While the waters can generally be described as either sodium chloride or sodium bi-carbonate in type, the prominence of calcium and magnesium indicates a wide range of chemical types.

A significant range in water quality is characteristic of groundwater systems with low permeability, minimal flow and structural complexity.

**Appendix R** contains a comparison of average concentrations of all chemical parameters tested for from each of the monitoring bores with ANZECC (2000) guideline values for potable water quality and for livestock watering guideline values. Many of the groundwaters sampled exceed guideline values for potable water quality in terms of pH, salinity (EC and TDS), sodium, chloride, sulphate, ammonia, arsenic, iron, lead, manganese and nickel. In terms of stock watering guidelines, no guideline values are exceeded for the parameters analysed, with the exception of groundwater from Bore WB-5 which has an average salinity (TDS) value in excess of 5,000 mg/L.

### **Groundwater Utilisation**

Groundwater resources are used by landholders throughout the area for domestic use, stock watering and irrigation, with the major use being stock watering. Individual bore yields are generally low (less than 1 L/s).

Douglas Partners (2010) undertook a search of the NSW Government's Groundwater Database to identify groundwater users in the vicinity of Rocglen, with a total of 32 bores identified. Results of the database search show that bores in the region are on average 60 metres deep. Very few bores are greater than 100 metres depth or shallower than 30 metres. Bore yields average 0.5 L/s, ranging from 0.1 L/s to 1.3 L/s. The depth to the groundwater table is generally about 25 metres for most bores.

### **Groundwater-Dependent Ecosystems**

RWC (2007) reported no groundwater dependent ecosystems have been identified on or immediately surrounding the Project Site. As groundwater dependent ecosystems are typically associated with groundwater discharge zones, which are not present on or surrounding the Project Site, it is unlikely that the Project would impact on any (yet to be identified) groundwater dependent ecosystems.

RWC (2007) stated that the former NSW Department of Water and Energy (now part of the DECCW) advised that tree roots have been recorded within bores of the region to a depth of 30 metres, suggesting some degree of groundwater dependence. Geoff Cunningham Natural Resource Consultants (2007b) (as cited in RWC 2007) advised, however, that the vegetation communities found in and adjacent to the Project Site, most notably within the Vickery State Forest are highly unlikely to set roots at these depths and as such would not be dependent on groundwater. Douglas Partners (2010) reports that the depth to the groundwater table is generally about 25 metres for most bores.

### **7.6.2 Existing Groundwater Licences**

Rocglen currently has three groundwater extraction licences, the details of which are summarised in **Table 48**.

**Table 48 - Groundwater Extraction Licences**

<b>Licence Number</b>	<b>Date of Issue</b>	<b>Valid Until</b>	<b>Allocation (ML/year)</b>	<b>Conditions</b>
Aquifer Interference (90BL254684)	May 2009	May 2014	700	Metering and annual reporting, development of model, monitoring of groundwater levels and quality.
Linked Groundwater Licence (90BL254758)	Jan 2010	Jan 2015	120 (total combined as linked licence)	Metering and annual reporting, development of model, monitoring of groundwater levels and quality.
Linked Groundwater Licence (90BL255249)	Jan 2010	Jan 2015		Metering and annual reporting, monitoring of groundwater levels and quality (requirements outlined in detail below).

Environmental monitoring for 90BL255249 licence includes the following conditions:

- Desired outcome - monitor and record environmental impacts on the local environment;
- Monitor the surface water level (SWL) and saturated thickness and water quality of the following registered bores:
  - GW050395, GW050166, and GW011066 on the Glenroc Property;
  - GW045621 on the Yarrawonga Property;
  - GW044068 and GW044069 on the Yarrari Property;
  - GW022319 on the Roseberry Property; and
  - GW013369 on the Brolga Property.

Timing – SWL and saturated thickness quarterly, water quality annually (subject to review).

- Construct and monitor the SWL of the three piezometers on proponent owned land between the open cut and the nearest non-project related groundwater bores. Timing - continuously (data logger) with downloads monthly;
- Monitor water quality of the in-pit sump. Timing - 6 monthly; and
- Prepare and implement a groundwater monitoring program, in consultation with DECC (now DECCW), DWE (now NOW) and DoP. Timing - before commencement of mining.

The bores required to be monitored as part of the program are listed in **Table 49**.

**Table 49 - Bores to be Monitored as Condition for Licence 90BL255249**

Bore ID	Whitehaven Number	Property	Depth	Aquifer
GW050395	WB02	“Glenroc”	36.6	Unknown
GW050166	WB03	“Glenroc”	18.3	Well - unknown
GW011066	WB05	“Glenroc”	47.9	Maules Creek Formation
GW045621	WB04	“Yarrawonga”	10.0	Unknown
GW044068	WB06	“Yarrari”	43.6	Maules Creek Formation
GW044069 <sup>1</sup>	Not Monitored <sup>3</sup>	“Yarrari”	47.9	Maules Creek Formation
GW022319	WB07	“Roseberry”	52.4	Maules Creek Formation
GW013369 <sup>2</sup>	Not Monitored <sup>3</sup>	“Brolga”	22.3	Unknown

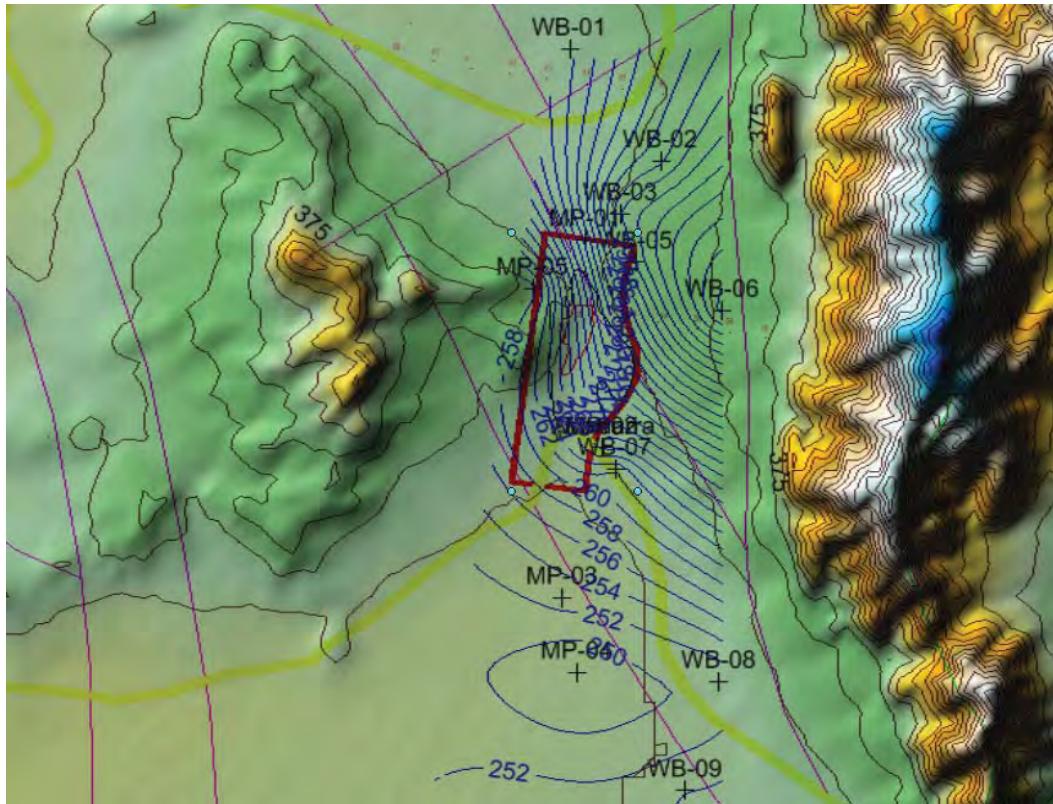
1 - closest monitored bore is WB06, ~0.48 km distant

2 - closest monitored bore is WB12, ~1.25 km distant

3 – bores are not serviceable and are not required to be monitored as part of Rocglen's *Site Water Management Plan*

### 7.6.3 Conceptual Modelling

The conceptual model for the groundwater flow at the site as presented by Douglas Partners (2010) is shown in **Figure 29**.



**Figure 29 – Site Terrain and Groundwater Head Contours (m AHD) in July 2008**

This conceptual model is described by Douglas Partners (2010) as follows:

- Rainfall recharge occurs across the model domain;
- Flow from recharge on the eastern valley sides flows in a generally westerly direction towards the site. Flow at the southern end of this range is diverted in a south-westerly direction discharging towards the southern alluvium. Flow from the northern end of the range is diverted in a north-westerly direction towards the northern alluvium;
- A similar flow regime is expected to occur on the western side of the valley, with flow in a generally easterly direction. There is little groundwater data on the western side of the valley to fully characterise this, however the groundwater divide is likely to be offset to the western side of the valley due to the reduced relief on this side;
- The head in the northern alluvium is expected to be about 20 metres higher than the southern alluvium and there will also be some recharge to the site from the northern alluvium and discharge of flow from the site to the southern alluvium. It is noted that although WB01 is not screened directly in the alluvium, it is screened below the alluvium in the shale. Only a slight variation in head would be expected due to some limited vertical flow, and therefore WB01 is expected to give a reasonable representation of the head in the alluvium. The hydraulic gradient in the alluvium is generally expected to be low due to its relatively high permeability with respect to the coal measures rocks. In the southern alluvium there are indications of localised drawdowns (near MP-004) which are probably related to groundwater extraction.

It is noted that groundwater monitoring was prevented at times in WB07 because of the presence of a pump in the well and during the site visit high volume extraction was noted from several bores to the south of the site;

- Within the mine site the Glenroc and Belmont coal seams are the primary water bearing zones, with estimated permeability of at least two orders of magnitude higher than the surrounding strata. The seams are only present between the Belmont and Roseberry Fault, and also subcrop in several locations around the proposed extent of mining. The full extent of the seams within the areas between the faults has not been established, in particular to the south of the site, however is likely to be less than the full extent between the faults;
- Recharge into the coal seams is expected to occur from the northern alluvium and eastern and western valley sides and is expected to be impeded by the presence of faulting as discussed further below. Some very limited direct rainfall recharge on the site may also recharge the coal seams.
- Preferential flow is expected to occur within the coal seams below the site towards the south which eventually discharges into the alluvium through limited hydraulic connection. The coal will in essence act as a drainage blanket.
- The Belmont and Glenroc Coal seams are truncated by faulting and do not continue significantly to the east, west or north of the immediate mine site. The role that the faults are expected to play in the interaction between the coal seams and the surrounding strata are discussed as follows:
  - The Belmont fault immediately to the east of the site has no direct connection to the southern alluvium, however it does connect with the Mooki Thrust, further to the east, which does intersect with the southern alluvium several kilometres south of the site. The region where the faults are present to the east of the site is characterised by relatively high groundwater heads compared with heads within the coal seams at the site. This indicates that flow occurs from the strata to the east into the coal seams towards the west, however the connection seems limited, as evidenced by the elevated head to the east of the fault, suggesting the fault is having a damming effect rather than a draining effect. There is also no indication of a significant connection between the eastern faults and the southern alluvium. If a significant connection was present the faults would be expected to act as drains, leading to drawdown of head in adjacent strata and possible flow from the west towards the eastern fault; however this is not evident.
  - The fault immediately east of the site also connects with a lineament to the north of the site which does intersect with the northern alluvium. However, the groundwater contours indicate there is no significant hydraulic connection between the alluvium and the coal seam. There is a minor hydraulic connection between the northern alluvium and the coal seams, however it doesn't necessarily occur through the faulting. If a significant hydraulic connection was present, the heads in the coal seams below the site would be closer to the head in the northern alluvium. However, the head in the coal seams below the site are closer to those in the southern alluvium, suggesting more connectivity to the southern alluvium than to the northern alluvium.
  - The fault to the west of the site continues directly below the alluvium to the south. There are limited monitoring data to the west of the site and it is possible that the hydraulic connection between coal seams below the site could be at least partly due to preferential flow throughout the fault, however it would also be due to vertical flow between the strata separating the alluvium and the coal seams.

Based on the conceptual model, the impacts of mine drainage would be expected to be subdued due to the presence of faulting to the east, west and north of the site, effectively limiting any hydraulic connection between the coal seams within the site and the surrounding strata. There is likely to be some hydraulic connection between the coal seams and the southern alluvium. The degree of connection has been further assessed by numerical modelling, as presented in the following sections.

### 7.6.4 Monitored Impact to Date

Using numerical modelling techniques, RCA Australia (2007, as cited in Douglas Partners 2010) in their original assessment predicted that over a seven year period of mining, inflows to the open pit would be as follows:

- During mine years 1 to 3 - average inflow of 1,643 m<sup>3</sup>/day (~19 L/s);
- During mine years 4 and 5 - average inflow of 2,235 m<sup>3</sup>/day (~26 L/s); and
- During mine years 6 and 7 - average inflow of 1,813 m<sup>3</sup>/day (~20 L/s).

RCA Australia (2007, as cited in Douglas Partners 2010) further considered that these inflows would be balanced by evaporation in excess of rainfall, and that as a result, net seepage into the pit would be limited and not noticeable.

While evaporation does exceed rainfall markedly on an annual basis, there are periods during the year, notably the months of June and July, where rainfall almost balances evaporation. During such times, a baseline inflow of the order of 20 to 25 L/s would be apparent. During the period of mining from mid 2008 to present, there have been a few such occasions where an inflow of the order of 20 L/s should have presented.

Whitehaven reported that there have generally been no noticeable inflows from the inception of mining to date, with the exception of the eastern extent where the seams dip and are locally deeper. Therefore, based on site observations it seems that the predicted inflows were slightly overestimated, although such flows have probably occurred for the locally deeper parts of the excavation.

Apart from the groundwater levels recorded for monitoring bore WB-05, which is likely to be anomalous and affected by nearby pumping, it is apparent that the mine has had very little impact on surrounding groundwater levels over the period mid 2008 to present.

Based on the monitored groundwater levels to date, it is considered that the RCA Australia (2007, as cited in Douglas Partners 2010) model over-predicts the mine induced impact on the groundwater system. This is likely to be because the model assumed that the coal seam was continuous beyond the site, and did not take account of the faulting, which is present.

In comparison with the extent of the approved Rocglen Coal Mine, the proposed expansion comprises a reasonably uniform increase around the existing perimeter and therefore is not expected to have a significantly different impact on groundwater flow directions.

### 7.6.5 Numerical Modelling

In order to clarify the conceptual model outlined above in **Section 7.6.3**, a 3D numerical model was developed by Douglas Partners (2010) using the software Visual MODFLOW. The primary aim of the modelling was to assess potential impacts of the mine drainage on the aquifers, in particular the magnitude of interference to flow to the southern alluvium. The model domain was limited to the extent of groundwater monitoring data, as per the conceptual model.

#### Steady State Modelling

Steady state modelling was undertaken to replicate the groundwater heads measured in July/August 2008, prior to commencement of mining. Given it is possible to have differing sets of permeability/recharge data provide the same modelled outcomes, the model was run for a range of plausible parameters.

Two cases were modelled as follows:

- Case 1 - based on a best estimate of the permeability of the coal seams ( $1.0 \times 10^{-5}$  m/s / 0.86 m/day), from the well test data. The permeability of the overburden strata and recharge were then adjusted to match the observed head distribution; and
- Case 2 - permeability of the coal was set to a maximum credible value ( $4.6 \times 10^{-5}$  m/s / 4 m/day) and the permeability of the overburden and recharge were adjusted to fit the data.

A permeability of  $5.0 \times 10^{-5}$  m/s (4.3 m/day) was adopted as being typical of alluvial strata and to replicate the relatively low hydraulic gradients in the alluvium. The thickness of alluvium was based on bore logs from registered wells and typically ranged up to approximately 70 metres in the model domain. The extent of alluvium was based on the Namoi Alluvium mapping, however was extended slightly to the east as part of the calibration process.

For the above cases it was assumed that there was limited hydraulic conductivity across the faults, as per the conceptual model. In order to assess the possibility that the faults were in fact conduits for flow, a number of additional cases were modelled to assess the plausibility of the faults being conduits for flow:

- Case 1A – all faults high permeability;
- Case 1B – western and northern faults high permeability; and
- Case 1C – only western fault high permeability.

The faults were modelled with a hydraulic conductivity of  $1.0 \times 10^{-4}$  m/s.

For Case 1A, the presence of the faults resulted in heads to the east of the site being too low. If the recharge was then adjusted to increase the heads to the east, the heads in the coal seams below the site were too high. In essence, the high hydraulic gradient to the east of the mine could not be replicated.

For Case 1B the heads to the east of the site could be more closely replicated, however the heads in the coal seam were too high, and increasing the permeability of the fault lines actually made the heads higher rather than lower. This is because the strong hydraulic connection to the northern alluvium resulted in the heads in the coal seam being more an average of the heads in the north and south alluvium, which is not the case.

For Case 1C, it was possible to gain a calibration close to, though not quite as good a fit as Case 1. Case 1C did not require any restriction in flow between the coal seams and eastern strata as it was offset by the additional connection to the southern alluvium. Therefore Case 1C with a permeable fault to the west, connecting to the southern alluvium is considered a plausible alternative to Cases 1 and 2. The presence of permeable faults connecting to the alluvium to the east and/or north are considered implausible, based on an analysis of the data available

### **Transient Modelling**

The results of groundwater monitoring during the first year of operation of the pit indicated minimal impact on water levels and generally no observable or only slight inflows to the pit. The level of excavation during this period ranged down to about RL 200, however more generally in the range RL 220 to RL 240, and an average drainage RL of approximately RL 230 was modelled.

The model was run in transient mode, simulating a 12 month period, to allow calibration to the observed changes in head. Daily time steps were used.

The four cases were modelled as follows:

- Case 1 - upper bound permeability;
- Case 1C - upper bound permeability with permeable western fault;
- Case 2 - lower bound permeability; and
- Case 2C - lower bound permeability with permeable western fault.

The calibrated model flows into the pit are presented in **Table 50**. The model assumes an instant drawdown occurs, however, in reality the mining occurs over a period and the drawdown is more gradual. As the model simulates instant drainage, the initial flow rates are over-estimated. Therefore the first 50 days of calculations has been ignored for the purpose of the flow assessment.

**Table 50 – Calibrated Flow in Pit During First Year of Operation**

Flow into Pit	Case 1	Case 1C	Case 2	Case 2C
Initial (50 days)	2850 m <sup>3</sup> /day 33 L/s	2534 m <sup>3</sup> /day 29 L/s	1656 m <sup>3</sup> /day 19 L/s	1097 m <sup>3</sup> /day 13 L/s
Final (360 days)	1664 m <sup>3</sup> /day 19 L/s	1641 m <sup>3</sup> /day 19 L/s	607 m <sup>3</sup> /day 7 L/s	509 m <sup>3</sup> /day 6 L/s

Observations from the mine were that there was generally no seepage observed in the pit during this time, with some localised seepage on the eastern side where the excavation was deeper and in this instance the flow may have been in the order of about 20 L/s.

The model simulates an average drainage level, however due to the steep dip of the seams, the drainage level will vary and in cases where the mining is locally deeper, such as along the eastern side, the flow rates will be above the average and visa-versa. Therefore the Case 2/2C calculated flow rates are considered more consistent with site observations. Flows in the range 19 to 32 L/s, as calculated for Case 1 would be expected to have resulted in clearly evident flows much of the time.

Subsequent records from the mine indicate that 23 ML has been pumped from the pit for the period August 2009 to July 2010, which is equivalent to 63 m<sup>3</sup>/day (0.7 L/s). Much of this is likely to have been from rainfall, which further supports that Case 2 conditions are more likely.

### Predictive Modelling

The calibrated numerical models were used to simulate flow rates and drawdown in order to assess likely impacts of the Rocglen mine to the end of mine life. The mining sequence was split into two periods as follows:

1. Northern Mining Phase – to simulate mining in the northern parts of the pits anticipated to be from 2008 to Year 5 of the expanded operation, which is expected to be around 2015; and
2. Southern Mining Phase – to simulate mining in the southern parts of the pits anticipated to be from Year 5 to Year 10/11 of the expanded operation, which is expected to be around 2015 to 2020.

The pit was modelled as a material with a high permeability of  $1.0 \times 10^{-4}$  m/s (8.6 m/day), commensurate with mine spoil.

The predicted drawdown at each of the groundwater monitoring wells, from the start of mining, is presented in **Table 51**.

**Table 51 - Predicted Drawdown at Groundwater Monitoring Points**

Monitoring Well	Case 1 (Case 1C) (metres)		Case 2 (Case 2C) (metres)	
	End of Northern Mining Phase	End of Southern Mining Phase	End of Northern Mining Phase	End of Southern Mining Phase
MP01	2.2 (1.9)	3.0 (5.2)	0.5 (0.5)	0.6 (3.7)
MP02	7.4 (6.5)	27.8 (30.0)	4.0 (3.2)	24.3 (32.1)
MP03	0.5 (1.8)	0.65 (2.4)	0.1 (0.6)	0.2 (1.4)
MP04	0.2 (0.1)	0.3 (1.9)	0.1 (0.2)	0.1 (1.0)
MP05	13.4 (8.7)	21.2 (24.7)	6.2 (2.7)	22.9 (9.9)
WB01	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
WB02	0.7 (0.6)	1.0 (0.7)	0.5 (0.4)	0.8 (0.3)
WB03	0.9 (0.6)	1.1 (1.9)	0.3 (0.1)	0.5 (0.3)
WB05	2.5 (2.8)	3.2 (5.4)	0.5 (0.5)	0.7 (1.6)
WB06	0.6 (0.6)	0.7 (1.7)	0.1 (0.1)	0.2 (0.1)
WB07	2.9 (3.3)	12.9 (20.9)	3.3 (1.3)	13.2 (14.0)
WB08	0.7 (0.4)	0.9 (2.1)	0.1 (0.1)	0.1 (0.3)
WB09	0.3 (0.4)	0.4 (2.3)	0.1 (0.1)	0.1 (0.2)
WB10	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
WB12	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)

**Table 51** indicates high drawdowns in close proximity to the mine site, up to approximately 30 metres near MP02 and MP05, with relatively low impacts to the east of the faulting. The predicted impacts on the alluvium are also low, however are slightly higher in the alluvium immediately south of the pit in the case that a permeable fault was present to the west of the site. The extent of the impacts on groundwater head are expected to be less than previously predicted by RCA Australia (2007, as cited in Douglas Partners 2010) for areas outside of the area of faulting.

**Table 52** presents the predicted flow rates into the pit for current mine operation, end of the Northern Mining Phase (anticipated to be around Year 5 of the expanded operation or 2015) and end of Southern Mining Phase (anticipated to around Year 10/11 of the expanded operation or 2020). The table also includes the estimated interference that the mine drainage will have on base flows into the alluvium.

**Table 52 - Modelled Pit Inflows**

Time	Case 1 – Flow Components (m <sup>3</sup> /day) (Case 1C – Permeable Faulting)			Case 2 – Flow Components (m <sup>3</sup> /day) (Case 2C – Permeable Faulting)		
	Into Pit	Storage Loss from Alluvium	Reduction of Flow in Alluvium**	Into Pit	Storage Loss from Alluvium	Reduction of Flow in Alluvium**
Initial (50 days)*	2850 (2534)	189 (611)	1	1656 (1097)	66 (136)	<1
2009	1664 (1641)	419 (833)	4	607 (509)	70 (254)	<1
End of Northern Mining Phase	1105 (1326)	518 (809)	52 (30)	491 (516)	106 (243)	6 (2)
End of Southern Mining Phase	2614 (3381)	1206 (1932)	191 (187)	1057 (1504)	270 (751)	37 (25)

\* assumes instant excavation and over-estimates initial flow rates

\*\* measured at constant head boundaries

Flow rates are generally expected to decrease as mining continues in the northern end of the pit, however are expected to increase as the mining progresses to the south due to the increased area of the pit and because the flow is less restricted by the faulting to the north. The variations in flow between the various years will be less distinct than those predicted as the modelling assumed three distinct stages of mining, however in reality the sequencing will be gradual.

As the floor of the Belmont Seam ranges in elevation the flow rates into the pit will vary according to the depth of the seam. For areas where the seam floor is about RL 210, mostly on the central parts of the proposed mining extent, the flows can be expected to be less than the average predicted values and will probably generally not be visible in the pit due to evaporative effects. For deeper parts of the excavation the flow rates can be expected to be higher and free flow into the pit can be expected.

The predicted impact on flows to the alluvium is minor as most of the flow comes from storage, however as the life of the mine increases the influence of storage reduces and the impact of flows to the alluvium increases slightly. Impacts on storage in the alluvium occur in close proximity to the mine and the percentage contribution to the inflow to the mine from storage depends on the presence of permeable faulting to the west of the site. For possible permeable faulting to the west of the site or for the higher ranges of permeability with no faulting, the component of flow from alluvial storage is initially low and then ranges up to about 50 percent. For the more likely Case 2, with lower permeability and limited permeability faulting to the west of the site, the component ranges up to about 25 percent. The impact on flows/storage in the alluvium is primarily to the southern alluvium (at least 90 percent) as the northern alluvium is up gradient and essentially hydraulically separated.

The range of possible inflows to the pit, based on the credible range of parameters, ranges from 1,057 to 3,381 m<sup>3</sup>/day. Overall, the predictions for Case 1 are similar to the predictions of the previous modelling by RCA Australia (2007), however based on site observations to date it is considered that the Case 2 flows are more likely to occur. Therefore it is unlikely that the annual flow rates into the pit will exceed the existing groundwater interference licence of 700 ML/year (1,918 m<sup>3</sup>/day). It is noted however that there is some uncertainty in the site conditions, in particular to the south west of the site, and flows greater than 700 ML/year may be possible if adverse conditions occur. Therefore a robust ongoing monitoring program and updating of the predictive model are recommended as mining continues.

### 7.6.6 Mine Closure

It is understood that the majority of the pit will be backfilled to an elevation above 250 metres AHD, with the exception of an area of about 38 hectares in the southern side of the pit where the surface levels will be in the range RL 220 to RL 250. It is expected that once mining is complete, recharge of groundwater and rainfall infiltration into the pit will result in the formation of a water table within the backfill. It is likely that this will eventually lead to the formation of surface water in the southern part of the pit with the locally deeper final surface level.

The inflow to the pit will be offset by evaporation from the area of surface water and therefore it is unlikely that the groundwater levels within the pit will ever fully recover to pre-development levels. It is estimated that the final equilibrium water levels will range between RL 220 and RL 245, however this may take 20 to 50 years to occur and would also be subject to variations according to climatic conditions.

The existing groundwater in the Maules Creek Formation is generally brackish with total dissolved solids in the range 1000 to 5130 mg/L. In general, the pore water in the backfilled mine spoil is expected to become less saline over time due to the percolation of rainfall through the spoil pile. The exception to this will be in the area of surface water in the non-backfilled portion of the pit. In this location, the salinity is expected to increase over time as the evaporation leads to a reduction in water volume and leaves the dissolved salt behind. The increase in concentration is expected to be generally isolated to the surface water in the locally deep area, with some minor mixing with the adjacent pore water in the mine spoil.

Consideration was given to raising the backfill levels such that surface water is never formed within the pit, thereby reducing evaporation and the associated increase in salinity over time. Calculations indicate that a final fill level of about RL 275 metres AHD is required to prevent surface water ever occurring. This level is above the pre-development groundwater level because the mine spoil will be relatively permeable and porous, and recharge rates into the mine spoil will be substantially higher than for the surrounding undisturbed ground. Such a high final ground level, well above pre-development groundwater levels, is understood to be impractical from a mine spoil management perspective.

It is considered that, although the proposed final void form will, over time, lead to increasing salt concentrations in the localised area of surface water within the final void, this will be of minimal impact outside the final void for the following reasons:

- The final void will behave as a groundwater sink. Therefore any increases in salinity within the sink will not affect the surrounding groundwater quality as the flow will be towards the area of higher salinity and not away from it;
- The surface water level at equilibrium will be below surrounding groundwater levels; and
- The surface water will be located within a small final void with relatively steep sloping sides. This small area will be unsuitable for alternative land uses which would be sensitive to the potential saline surface water

### 7.6.7 Management and Monitoring

The existing groundwater management strategies, mitigation measures and monitoring activities employed at Rocglen will continue to be implemented for the Rocglen Extension Project. In summary:

- All hydrocarbon products will be securely stored.
- All of the mining fleet will be refuelled within designated areas of the Project Site
- All water from wash-down areas and workshops would be directed to oil/water separators and containment systems.

- With the exception of some maintenance activities on mobile equipment, all maintenance works requiring the use of oils, greases and lubricants would be undertaken within designated areas of the Project Site.
- All storage tanks will be either self-bunded tanks or banded with an impermeable surface and a capacity to contain a minimum of 110% of the largest storage tank capacity.

A revised groundwater monitoring program will be implemented to verify the predicted impacts on groundwater availability and develop, if required, mitigation measures to ensure that any reduction in available groundwater is replaced by a comparable water source or otherwise compensated. Replacement and/or compensatory measures would be developed in consultation with the relevant government agencies and effected landholder.

Groundwater monitoring undertaken since 2008 has been based on available existing bores in proximity to the mine site and several established bores for monitoring purposes. As recommended by Douglas Partners (2010), the following actions will be implemented to improve monitoring outcomes:

- The aquifer interval monitored by each of the bores is not known with certainty. Bores will be cleaned out (air-lift developed) and depth checked with a weighted tape. Bores will then be geophysically wireline logged (SP/SPR and Gamma) to confirm slotted intervals and the nature of the strata over slotted intervals;
- All monitoring bores will be surveyed for location and level (both ground level and the level of the Reference Point (RP) from which groundwater levels are measured);
- Monitoring of groundwater levels will initially be undertaken on a monthly basis for the first year of the expansion, after which the interval could potentially be relaxed subject to review of the results. In the longer term a monitoring interval of three months is anticipated. The current frequency of groundwater sampling and laboratory analysis of water samples will remain. Water samples will be analysed for all major ions, including carbonate; and
- Pressure transducers/dataloggers will be installed in monitoring bores MP-01 to MP-05 for the continual recording of groundwater levels. These instruments will be downloaded every 2 months. In the case of MP-04 and MP-05, these wells only just intersected the water table when installed and have been observed to run dry. On this basis, these bores will be deepened to at least 10 metres below the water table.

In order to address the concerns of the NOW in regard to the potential for impact on alluvial aquifers of the Namoi River and associated tributaries, and as recommended by Douglas Partners (2010), the following program of investigations will be undertaken:

- Bores MP-04 and WB-01 are nominally located within the alluvium south and north of the mine, respectively. Once this is confirmed through the activity recommended above, a second bore will be drilled adjacent to each of them, to a depth at which the base of the alluvium is intersected. This adjacent bore will be completed as a monitoring bore in the Maules Creek Formation and have a pressure transducer/datalogger installed for continuous water level monitoring. Such actions will need to be agreed to by the relevant landowners; and
- There is some uncertainty regarding the nature of the interface between the southern alluvium and the weathered conglomerate profile of the Maules Creek Formation at the southern end of the proposed pit. On this basis, a pair of piezometers will be installed immediately to the south of the proposed pit, one in the Belmont Seam and one in the alluvium/weathered conglomerate. Also, hydraulic testing will be undertaken on the bore in the alluvium/weathered conglomerate to allow refinement of the groundwater model in this regard.

Regular monitoring of both MP-04 and WB-01, the new piezometers immediately to the south of the pit, and their adjacent bores will assist in assessing the degree of hydraulic connection between the Maules Creek Formation and the alluvial aquifer.

## 7.7 Flora and Fauna

RPS (2010a) was engaged to undertake a flora and fauna assessment of the Rocglen Extension Project. The purpose of the assessment is to:

- Ensure planning, management and development decisions are based on sound scientific information and advice by documenting the presence of any biodiversity components or potential significant impacts that may exist on the site; and
- Provide information to enable compliance with applicable assessment requirements contained within the *Threatened Species Conservation Act 1995* (TSC Act), EP&A Act, the EPBC Act, and any other relevant state, regional and local environmental planning instruments.

In addition to a review of existing literature and available vegetation mapping, RPS employed a variety of field survey techniques while on site between the 8 and 12 February 2010 to record a representative sample of flora and fauna species across the site. The methodology was designed on previous ecological works undertaken on site, and to satisfy the *Threatened Species Survey and Assessment Guidelines* (DEC 2004, as cited in RPS 2010a). The surveys included a site inspection, flora surveys and various fauna survey methods including trapping, spotlighting and habitat assessments. Targeted searches for threatened flora and fauna species were also undertaken.

The key findings and recommendations of the *Flora and Fauna Assessment* (RPS 2010a) are summarised below. The full report within **Appendix K** should be referred to for full detail.

### 7.7.1 Existing Flora

The previous flora survey undertaken by Geoff Cunningham Natural Resource Consultants (2007b) described and mapped five vegetation communities within the Rocglen study area. These being:

- Narrow-leaf Ironbark – Pilliga Grey Box Community;
- Pilliga Grey Box – White Cypress Pine Community;
- Pilliga Grey Box – White Box - Yellow Box – White Cypress Pine Community;
- Brigalow Community;
- Cleared Lands – used for grazing and / or cultivation.

Ground truthing of the vegetation within the Project Site, and within the adjacent “Yarrawonga” and nearby “Greenwood” properties, identified the following five vegetation communities:

1. Narrow-leaved Ironbark (*E. crebra*), White Cypress (*Callitris glaucophylla*) Open Forest;
2. Narrow-leaved Grey Box (*E. pilligaensis*), White Cypress (*Callitris glaucophylla*), Narrow-leaved Ironbark (*E. crebra*) Forest;
3. Bimble Box (*E. populnea*), Yellow Box (*E. melliodora*) Inland Grey Box (*E. microcarpa*), Grassy Woodland (Endangered Ecological Community);
4. Brigalow (Endangered Ecological Community); and
5. Cleared land with scattered trees.

Following discussions with the DECCW during the development of the revised *Biodiversity Offset Strategy* (ELA 2010), the DECCW requested that vegetation communities 3 and 5 (above) be further investigated. Such investigations were undertaken during the development of the revised *Biodiversity Offset Strategy* by ELA (2010), with the two communities defined as follows:

3. Bimble Box (*E. populnea*), Yellow Box (*E. melliodora*) Inland Grey Box (*E. microcarpa*), Grassy Woodland -
  - i Poplar Box grassy woodland on alluvial heavy clay soils in the Brigalow Belt South Bioregion (Benson 101); and
  - ii White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions.
5. Cleared land with scattered trees -
  - i Poplar Box grassy woodland on alluvial heavy clay soils in the Brigalow Belt South Bioregion (Benson 101) – Derived native grassland; and
  - ii White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions – Derived native grassland.

**Figures 30 and 31** illustrate the extent of these vegetation communities.

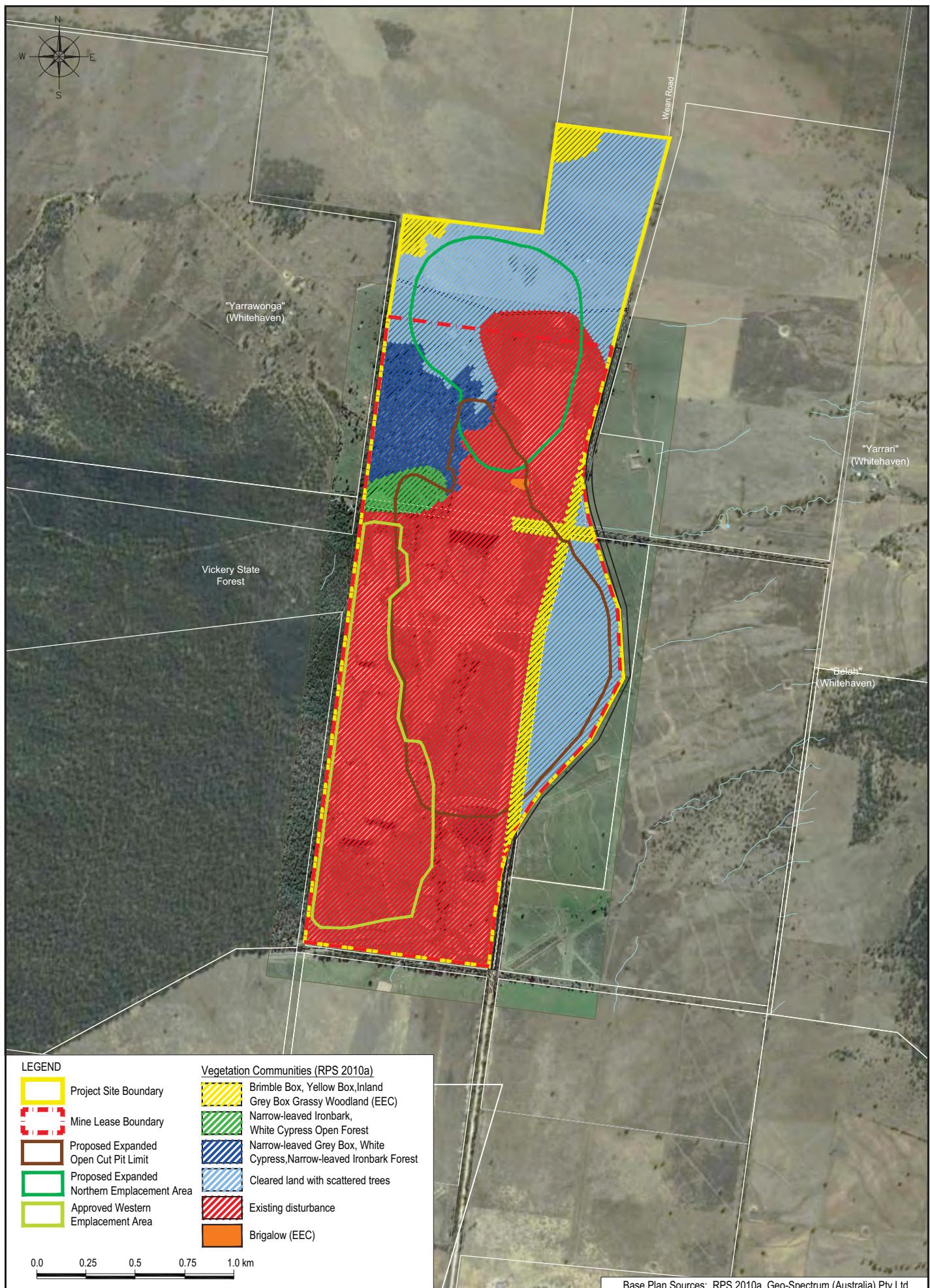
The Bimble Box (*E. populnea*), Yellow Box (*E. melliodora*) Inland Grey Box (*E. microcarpa*), Grassy Woodland, as described and mapped by RPS (2010a) corresponds to the Endangered Ecological Community (EEC) known as White Box Yellow Box Blakely's Red Gum Woodland, which is listed within the TSC Act. This community also corresponds to the federally listed threatened community known as "White Box – Yellow Box – Blakely's Red Gum Grassly Woodland and Derived Native Grassland", which is listed as critically endangered within the EPBC Act.

The highly disturbed small patch of Brigalow, as described and mapped by RPS (2010a), corresponds to the EEC listed within the TSC Act known as Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions. This community also corresponds to the federally listed EEC (EPBC Act) known as "Brigalow (Acacia harpophylla dominant and co-dominant)". The Brigalow EEC is comprised of a stand of 38 old age Brigalow trees in a 0.14 hectare area. No other tree species were recorded and only a single species (Slender Bamboo Grass, *Austrostipa verticillata*) was recorded in the understorey. Given the depauperate state of the Brigalow patch, it is not considered as a viable ecological community into the future.

Suitable habitat for two cryptic threatened flora species, Finger Panic Grass (*Digitaria porrecta*) and Tricolour Diuris (*Diuris sheaffiana*), may occur in the local area. RPS (2010a) undertook the field surveys during the January to February flowering period for Finger Panic Grass (when it is most likely to be detected). Surveys for Tricolour Diuris during the flowering period of September to November were not possible, however the proposed removal of a relatively small area of 'moderate' potential habitat relative to the availability of nearby similar habitat areas would be unlikely to significantly impact the species.

All other species of threatened flora known or likely to occur in the local area are non-cryptic or were surveyed within their recommended survey period.

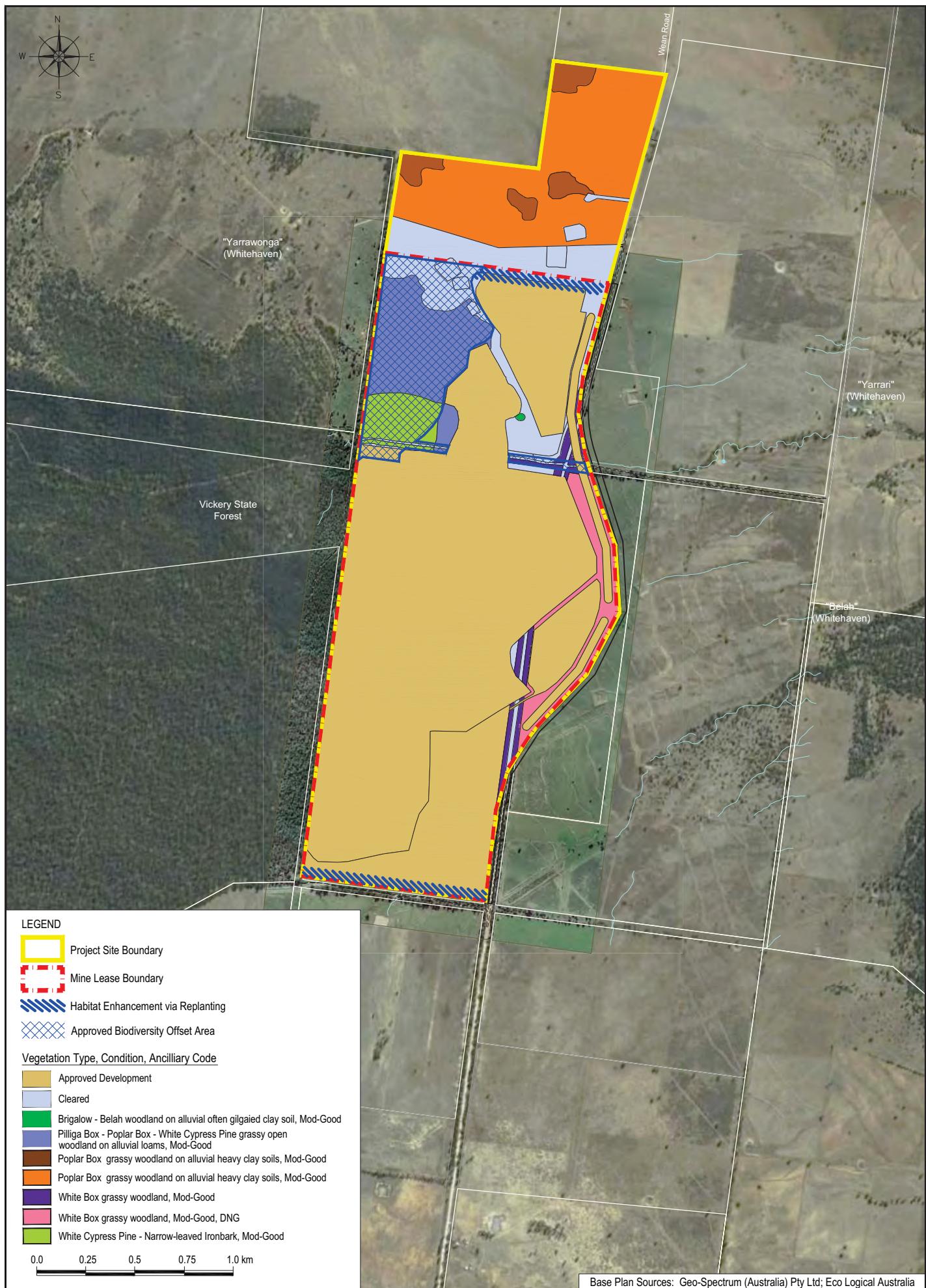
No threatened flora species were observed during previous flora surveys by Geoff Cunningham Natural Resource Consultants (2007b) or by the recent flora surveys by RPS (2010a).



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Rocglen Coal Mine Extension Project  
Vegetation Mapping (RPS 2010a)

**FIGURE 30**



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Rocglen Coal Mine Extension Project  
Biometric Vegetation Mapping (ELA 2010)

**FIGURE 31**

## 7.7.2 Existing Fauna

The previous fauna survey within the Rocglen study area undertaken by Countrywide Ecological Service (2007) found or detected the following threatened species on-site:

- Grey Falcon (*Falco hypoleucus*);
- Gilbert's Whistler (*Pachycephala inornata*);
- Grey-crowned Babbler (*Pomatostomus temporalis*);
- Turquoise Parrot (*Neophema pulchella*);
- Hooded Robin (*Melanodryas cucullata*);
- Beccari's Mastiff-bat (*Mormopterus beccarii*); and
- Yellow-bellied Sheathtail-bat (*Saccopteryx flaviventris*).

The assessment for these species found that there was no significant impact likely to occur as a result of the proposed mine (Countrywide Ecological Services 2007).

A total of 100 fauna species were recorded by RPS (2010a) during field surveys in February 2010, comprising nine frogs, nine reptiles, 64 birds and 18 mammals. While no species listed on the EPBC Act were recorded, as listed in **Table 53**, five threatened fauna species listed on the TSC Act were recorded.

**Table 53 – Identified Threatened Fauna Species**

Scientific Name	Common Name	Property Recorded Within
<b>Vulnerable Species – TSC Act</b>		
<i>Pyrrholaemus sagittatus</i>	Speckled Warbler	Project Site
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	Project Site
<i>Daphoenositta chrysopetra</i>	Varied Sittella	Neighbouring Land
<i>Stagonopleura guttata</i>	Diamond Firetail	Neighbouring Land
<i>Saccopteryx flaviventris</i>	Yellow-bellied Sheathtail-bat	Project Site

Potential habitat exists for a further 13 threatened fauna species listed on the TSC Act. Of the 14 threatened species and 10 migratory species listed on the EPBC Act protected matter database search results, none were identified in the Project Site. However potential habitat exists for two of the threatened species and seven of the migratory species.

## 7.7.3 Potential Flora Impacts

No threatened flora species were observed within the Project Site, and it is therefore considered that the Rocglen Extension Project will not have any significant effect on locally occurring threatened flora species.

### White Box Yellow Box Blakely's Red Gum Woodland EEC

It is expected that the Project will result in the removal of 5.9 hectares of the White Box Yellow Box Blakely's Red Gum Woodland EEC along Wean Road (note that a large portion of Wean Road occurs within areas covered by the original mine approval) and Jaeger Lane, and 10.9 hectares of derived native grassland of the EEC from the within the Project Site.

Habitat critical to the survival of this EEC has not been gazetted within the TSC Act or EPBC Act. Therefore the Project is not likely to impact any habitat critical to this community.

The importance of the patch of White Box Yellow Box Blakely's Red Gum Woodland EEC to be removed is considered to be 'medium' due to a number of factors:

- Disturbances such as invasion by some common exotic pasture species;
- Trampling and grazing by livestock;
- Suppression of the shrub layer via grazing and other land management practices;
- Suppression of tree recruitment, also by grazing and other land management practices; and
- The area of EEC proposed for removal comprises the eastern most portion of a larger contiguous patch of woodland vegetation extending into Vickery State Forest.

The Project is not expected to extensively modify abiotic factors such as ground or surface water levels such that it affects other areas of White Box Yellow Box Blakely's Red Gum Woodland EEC.

The revised *Biodiversity Offset Strategy* (ELA 2010) contained within **Appendix L** and outlined in **Section 5.8** provides a 'maintain or improve' outcome for the removal of this vegetation community.

#### **Brigalow EEC**

A small stand (approximately 0.14 hectares) of Brigalow trees (*Acacia harpophylla*) is present within the proposed mine expansion area. The presence of this EEC is not definitive, due to its modified condition, but is indicative of the EEC "Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions EEC" listed under the TSC Act.

Two factors need to be considered where a highly cleared landscape is concerned, if that area is less than or equal to 4 hectares (DECC 2009, as cited in RPS 2010a). These are the contribution of the stand to regional biodiversity values and the viability of the stand. If both of the above factors are considered to be 'low', then the DG may consider that 'Red Flag' areas may not be impacted by a development if the overall impact can be regarded as improving or maintaining biodiversity values.

#### ***Contribution to Regional Biodiversity***

While no other stands of this EEC exist at the development site, the actual extent of this community in the Gunnedah region is not known, although Benson et al. (2006, as cited in RPS 2010a) describes this EEC as occupying up to 18,000 hectares in the bioregion (which includes the Liverpool and Moree Plains). The removal of 0.14 hectares of this community is an extremely small reduction in the overall extent in the region/bioregion. In this case, its contribution to regional biodiversity values is likely to be low.

While the Brigalow stand groundcover is disturbed by exotic species invasion, and the native mid and groundcover species normally associated with this community are almost completely absent the over-storey is relatively intact, and so according to the criteria of the bio-banking assessment tool (DECC 2009, as cited in RPS 2010a) the vegetation must be considered to be in 'moderate to good' condition.

Analysis of local vegetation mapping failed to identify any areas of similar vegetation in the local area. Due to the small size and significant isolation of the Brigalow stand it is considered regionally unviable and thus regionally insignificant.

### **Stand Viability**

Given the past use of the area by cattle (causing ground compaction), the in-situ seedbank for this species is unlikely to be viable. Grazing has also ensured that regeneration of this community has not occurred. The absence of any signs of regrowth during a recent site inspection would confirm the above. The old age of the trees would also suggest that the end of their natural lifespan is close. In addition the native shrub and ground layer species associated with this EEC are completely absent within the subject site patch, in other words the community is represented wholly by the occurrence of only one species (*Acacia harpophylla*).

Given the location of the Project Site it is considered that this patch of Brigalow EEC is not at the limit of the known distribution for Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions. This EEC is known to occur within scattered locations over a wide range. The removal of this very small and floristically depauperate patch is not likely to have an adverse effect on the extent of the ecological community given that the stand is not considered to be ecologically viable.

Given the very poor biodiversity of the Brigalow patch and notwithstanding the possible rehabilitation of this community within offset areas, it is considered that the Project is not likely to further substantially and adversely modify the composition of the ecological community as it is already depauperate with regard to species composition. The Brigalow patch is already fragmented or isolated from other areas of similar vegetation and is unlikely to provide an adequate stepping-stone patch for any flora or fauna species specialising in this vegetation type.

The Critical Habitat Registers within the TSC Act and the EPBC Act do not list any critical habitat pertaining to the Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions EEC. Therefore, the Project is not likely to have any direct or indirect adverse effect on critical habitat for this EEC.

In summary, it is considered that the existing stand of Brigalow is not viable due to its small size, lack of recruitment, depauperate condition, isolation and lack of an adequately sized gene pool for continued survival.

There are currently no draft or final recovery plans for the Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions. The proposed removal of the small (0.14 hectare) patch of Brigalow would not be consistent with the general aims to protect, conserve and manage Brigalow within the state of NSW. However, the revised *Biodiversity Offset Strategy* (ELA 2010) contained within **Appendix L** and outlined in **Section 5.8** provides a 'maintain or improve' outcome for the removal of this vegetation community.

#### **7.7.4 Potential Fauna Impacts**

While the removal of forest and woodland vegetation from the Project Site would displace a group of Grey-crowned Babblers and reduce the foraging area for one or more groups (pairs and trios) of Speckled Warblers, suitable areas of similar habitat occur within the adjacent "Yarrawonga" property. Both the Grey-crowned Babblers and Speckled Warblers were also recorded on "Yarrawonga".

The Varied Sittella and Diamond Firetail were recorded on "Yarrawonga" and likely also utilise the Project Site forest and woodland vegetation. Both species would be unlikely to be significantly affected by the Project due to the large amount of similar vegetation occurring on "Yarrawonga" and in Vickery State Forest.

The Yellow-bellied Sheathtail-bat was identified on the Project Site from Anabat analysis. Due to a mechanical/programming failure no Anabat data was collected from "Yarrawonga" however, it is likely that the Yellow-bellied Sheathtail-bat also occurs on "Yarrawonga" and across the Vickery State Forest. Due to the large areas of suitable habitat on "Yarrawonga" and in Vickery State Forest the Yellow-bellied Sheathtail-bat would be unlikely to be affected by the Project.

The Project would be unlikely to significantly affect any threatened, migratory or protected fauna species occurring within the subject site.

### 7.7.5 Key Threshold Assessment

As required by the *Draft Guidelines for Threatened Species Assessment for Part 3A Applications* (DEC/DPI 2005, as cited in RPS 2010a), RPS (2010a) has provided the following assessment of Key Thresholds for the Project.

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

It is considered that the information presented within the *Flora and Fauna Assessment* (RPS 2010a), combined with the revised *Biodiversity Offset Strategy* (ELA 2010), is likely to result in a maintained, if not an improved, long term outcome for biodiversity within the region.

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

The threatened species, populations and ecological communities within the Project Site are, or are likely, well represented in the surrounding habitat areas of Vickery State Forest and Kelvin Aboriginal Area. The removal of the relatively small area of habitat for the Project is considered unlikely to reduce the long-term viability of any species, population or EEC.

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

The threatened species, populations and ecological communities within the Project Site are, or are likely, well represented in the surrounding habitat areas of Vickery State Forest and Kelvin Aboriginal Area as well as the wider region. The removal of the relatively small area of habitat for the Project is considered unlikely to accelerate the extinction or place at risk of extinction any species, population or ecological community.

**4. Whether or not the Proposal will adversely affect critical habitat.**

There is no declared “Critical Habitat” within the Rocglen Coal Mine locality, and as such the Project will not adversely affect any such habitat.

### 7.7.6 Other Legislative Considerations

Considerations under the EPBC Act and SEPP No. 44 – Koala Habitat Protection have been made and are outlined in **Section 6.1.1** and **6.3.2**, respectively, and summarised below:

#### EPBC Act

An assessment of the applicability of the EPBC Act to the Rocglen Extension Project was included in the *Flora and Fauna Assessment* (RPS 2010a). RPS (2010a) undertook an on-line search of the EPBC Act Protected Matters Search database (3 January 2010) to generate a list of those matters of NES within 40 km of the Project Site. This data, combined with other local knowledge and records, was utilised to assess whether the type of activity proposed will have, or is likely to have, a significant impact upon a matter of NES, or on the environment of Commonwealth land.

A summary of RPS’s (2010a) assessment of the eight matters of NES prescribed under the EPBC Act is provided in **Section 6.1.1**. Of particular importance is:

### **Nationally Listed Threatened Species and Ecological Communities**

A total of 27 threatened species or ecological communities listed under the EPBC Act have been recorded or have suitable habitat within a 40 km radius of the subject site.... The potential for the Proposal to significantly impact on threatened species and ecological communities has been assessed in Section 6.0 (of RPS 2010a).

The Proposal will require the removal of approximately 5.9 hectares of the White Box, Yellow Box, Blakeley's Red Gum Grassy Woodland in the form of intact remnants along Wean Road and Jaegar Lane and 10.9 hectares of the community as derived native grasslands, and 0.14 hectares of the Brigalow (*Acacia harpophylla* dominant and co-dominant). ELA (2010) provides a detailed Biodiversity Offset Strategy to provide a 'maintain or improve' outcome for the removal of the above vegetation communities.

None of the 14 threatened fauna species listed on the EPBC Act were recorded during field surveys. Only two species were assessed as having a moderate likelihood of occurrence on the subject site (Large-eared Pied Bat and Greater Long-eared Bat). Given the relatively small area of potentially suitable woodland and forest habitat for the 14 threatened fauna species in comparison to the much larger provision of woodland and forest habitat in Vickery State Forest and surrounding rural properties, it is unlikely that the Proposal would significantly affect any of the 14 threatened fauna species. Additionally ELA (2010) provides a detailed Biodiversity Offset Strategy to provide a 'maintain or improve' outcome for the removal of potential habitat areas for threatened fauna species.

### **Nationally Listed Migratory Species**

A total of 10 migratory species listed under the EPBC Act have been recorded or have suitable habitat within a 40 km radius of the site. The Proposal is unlikely to substantially modify, destroy or isolate an area of important habitat, result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat or seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

Following submission of a referral in late May 2010, the Rocglen Extension project was found to be considered a 'controlled action' under the EPBC Act. In summary, the then DEWHA advised the following:

*The proposed action is a controlled action. The project will require assessment and approval under the EPBC Act before it can proceed.*

*The project will be assessed through an accreditation of Part 3A of the New South Wales Environmental Planning and Assessment Act 1979.*

A copy of the letter and decision notice issued by the then DEWHA is contained within Appendix N.

### **SEPP No. 44 – Koala Habitat Protection**

As outlined in **Section 6.3.2**, an assessment of the applicability of the SEPP No. 44 – Koala Habitat Protection to the Rocglen Extension Project was included in the Flora and Fauna Assessment (RPS 2010a). In summary, RPS (2010a) determined that due to the relatively small area of forest and woodland vegetation within the Project Site in comparison to the area of also suitable forest and woodland vegetation in the adjacent Vickery State Forest, it is unlikely that the koala would be significantly affected by the Project.

### **7.7.7 Management and Monitoring**

All efforts will be made by Whitehaven to avoid disturbance of the vegetation communities within the Project Site and to maintain and enhance as much of the existing remnant vegetation on-site as possible.

Whitehaven already employs a range of complementary flora and fauna management strategies and mitigation measures and these will continue to be implemented for the Rocglen Extension Project.

As specifically recommended by RPS (2010a), the following mitigation measures will be implemented, in addition to the revised *Biodiversity Offset Strategy* (see **Sections 5.8** and **7.7.8**) and *Rehabilitation and Decommissioning Strategy* (see **Section 5.7**), to minimise the potential impacts of the Project on flora and fauna:

- A high level of hygiene will be adopted in respect to vehicle and machinery to help prevent soil-borne disease transmission and weed seed dispersal;
- Strict erosion and sediment control measures will be installed, monitored and maintained to prevent the erosion and sedimentation impact on adjacent areas;
- Dust control measures will be implemented to protect adjacent retained vegetation communities;
- The minimal practicable amount of clearing will be undertaken as a general objective, particularly within those areas that currently contain identified threatened species or ecological communities;
- Where possible disturbance areas will be fenced to protect adjoining vegetation prior to disturbance activities in order to reduce potential damage from uncontrolled or accidental access;
- Stockpiling of materials will occur within already disturbed areas;
- Weed management, monitoring and control practices will be implemented to minimise the spread of exotic species into natural areas within the site;
- A tree felling protocol will be developed to minimise harm to fauna species during clearing activities. The tree felling protocol will be developed by a suitably qualified and licensed ecologist with previous experience supervising the felling of trees. It is anticipated that the protocol will comprise the following key steps:
  - Establishment of the best time of the year for felling;
  - Pre-felling mapping of habitat trees;
  - Inspections of trees on the day of felling;
  - Procedures for the safe removal of fauna species from trees prior to and post felling;
  - A relocation/release protocol;
  - Leaving the tree overnight where it fell; and
  - A protocol for the salvaging of tree hollows for rehabilitation works where necessary.

Where possible, tree felling will be supervised by the ecologist that developed the tree felling protocol or by another suitably qualified and licensed ecologist;

- Where trees are to be removed an assessment of the surrounding level of tree hollow provision will be undertaken by a suitably qualified ecologist in order to determine the need for local supplementing of tree hollows (using salvaged tree hollows or nest boxes);
- Mature and hollow-bearing trees will be retained wherever feasible within the site;
- Vegetation to be removed will be clearly marked in the field using temporary fencing (flagging tape or similar) so that the boundaries are clearly established and to minimise the potential for equipment to accidentally enter areas to be retained;
- Where possible, the timing of clearing activities will be undertaken at such times to avoid removal of hollow-bearing trees during breeding season of threatened species; and
- Regular monitoring of the vegetation within the Project Site and offset areas will be undertaken in order to enable effective management with regards to rehabilitation (planting), regeneration, watering, fencing and weed control.

Many of the above mitigation measures are part of Whitehaven's pre-clearance procedures adopted at Rocglen.

### 7.7.8 Revised Biodiversity Offset Strategy

The direct and indirect impacts to threatened species, populations and ecological communities and their habitats as a result of the Rocglen Extension Project are documented in the *Flora and Fauna Assessment* (RPS 2010a), as outlined in the above sections.

To address and offset these impacts, and as outlined in **Section 5.8**, ELA was engaged to prepare a revised *Biodiversity Offset Strategy* that meets the offset requirements for an approval under the EP&A Act and the EPBC Act. ELA conducted a quantitative assessment of vegetation condition at the Project Site and adjoining properties ("Yarrawonga" and "Greenwood") utilising the BioBanking Assessment Methodology (DECC 2009) ('the BioBanking Methodology') from 20 to 22 October 2010. As recommended by DECCW, the BioBanking Methodology was used to 'inform' the 'improve or maintain' assessment and provide an indicative 'quantum' of area required to offset the impacts of the Project.

While not all vegetation within the Project Site is likely to be cleared, the *Flora and Fauna Assessment* (RPS 2010a) and revised *Biodiversity Offset Strategy* (ELA 2010) have been prepared on the assumption that all remaining vegetation will be cleared with the exception of approximately 30 hectares in the north-eastern corner of the Project Site encompassing a small area of Poplar Box Grassy Woodland. This approach has been adopted, regardless of whether the clearing/disturbance occurs, in order to allow more flexibility, if required, to site associated infrastructure and undertake site management in peripheral areas (for example, vehicle access and manoeuvring, surface water management and stockpiles). This approach will also provide flexibility if future geological exploration and economic modelling determine recoverable coal reserves within these peripheral areas, which, if approval was granted for extraction, would enable Whitehaven to further maximise coal recovery using existing infrastructure at an approved operation and also maintain the on-going socio-economic benefits of the mine for a longer period of time.

The *Biodiversity Offset Strategy* proposed for the Rocglen Extension Project, including replacement of original offset areas, is to retire the full 4,859 credit requirement as calculated by ELA (2010) from the Whitehaven Regional BioBank Site, which is in the final stages of registration by the DECCW as a BioBank Site under Part 7A of the TSC Act. It will be actively managed via a BioBanking Management Plan with in-perpetuity management funding, and will have the highest level of conservation status outside of National Parks via a BioBanking Agreement registered on the land title in-perpetuity.

In summary, the proposed *Biodiversity Offset Strategy* compensates for the direct loss of 95.44 hectares of vegetation in various condition states (intact and DNG) and replacement offsets for impacts to 47.9 hectares of the 131.74 hectares of approved offsets on a 'like for like' basis with over 525 hectares of vegetation in the Whitehaven Regional Biobank Site. The *Biodiversity Offset Strategy* provides an offset (525 hectares) to impact (110.44 hectares comprising 95.44 hectares of impacts for mine extension and the equivalent of 15 hectares of original impacts which now needs a replacement offset) ratio of 4.75:1.

The improvements in conservation values at the Whitehaven Regional Biobank Site (through the cessation of current grazing and implementation of conservation management practices, including enhancement tree and shrub planting and weed control) will lead to an 'improve and maintain' conservation outcome.

The retirement of the 4,859 credits brings the total number of credits proposed to be retired within the Regional BioBank Site to 10,154 out of the total 13,754 generated (ELA 2010) or 73.83%.

For further details, refer to the *Biodiversity Offset Strategy* contained within **Appendix L** and the detailed summary contained within **Section 5.8**.

## 7.8 Aboriginal Heritage

An assessment of Aboriginal cultural heritage issues associated with the Rocglen Extension Project has been undertaken by RPS (2010b). A copy of the *Cultural Heritage Survey and Assessment* is contained within **Appendix O**, with significant findings and recommendations summarised below.

The report has incorporated an environmental and archaeological regional context assessment, detailed literature review of previous archaeological and historical studies relevant to the Project Site, a search of the DECCW Aboriginal Heritage Information Management System (AHIMS) database, mapping and a field survey. RPS (2010b) states that the assessment report has been written in accordance with the NP&W Act and meets all of the requirements of the NPWS (1997 survey and assessment writing guidelines).

Whitehaven prepared an *Aboriginal and Cultural Heritage Management Plan* (ACHMP) in 2008 in accordance with PA 06\_0198. This ACHMP covers the entire mining lease and the majority of the Project Site. Since that time, the sites identified as B1, B2 and B3 have been salvaged under PA 06\_0198.

### 7.8.1 Aboriginal Community Consultation

RPS (2010b) followed the schedule for Aboriginal community consultation and archaeological survey methodology outlined in the ACHMP (Whitehaven 2008c). As outlined in **Section 2.3.4**, consultation with Aboriginal stakeholders was in accordance with the DECCW's 2004 *Interim Community Consultation Requirements* (ICCRs).

As listed in **Section 2.3.4**, there were 12 Aboriginal stakeholder groups that registered an interest in consultation for the Project following the advertisement and notification process commenced in January 2010 under Stage 1 of the ICCRs. Letters in accordance with Stage 2 of the ICCRs were sent to the registered stakeholders advising of the survey and detailing the proposed survey methodology. The Red Chief Local Aboriginal Land Council (RCLALC), Bigundi Biame Gunnedarr Traditional People (BBGTP), Gunida Gunya Aboriginal Corporation (GGAC) and Min Min Aboriginal Corporation (MMAC) participated in the field survey that was undertaken on the 2 March 2010.

RPS provided a copy of the draft *Cultural Heritage Survey and Assessment* to the RCLALC, BBGTP, GGAC and MMAC for review and comment, in accordance with Stage 3 of the ICCRs, on the 6 May 2010. Three written responses were received by the 4 June 2010, with the fourth response received by the 10 June 2010. The Consultation Log and received Aboriginal community responses are contained within the *Cultural Heritage Survey and Assessment* (RPS 2010b) in **Appendix O**.

### 7.8.2 Existing Environment

Regionally, the Project Site is incorporated in the Barwon Basin region, which is formed by the Bogan, Macquarie and Castlereagh Rivers flowing north and the southwest Namoi and Barwon Rivers. Aboriginal occupation along these river systems and its tributaries was geared towards the river channels and lakes and their aquatic resources.

The archaeological reports reviewed by RPS (2010b) and the AHIMS search (see below) found that the most commonly occurring site type associated with the Rocglen Coal Mine region is artefact scatters. Scarred trees were the second most commonly occurring site type, with some scar tree sites also incorporating artefact scatters. The implication for the Project Site is that there is a high probability that artefact scatters will occur given the proximity of local creek lines and tributaries. Scar trees have also been identified in the region close to permanent water supplies.

### Aboriginal Heritage Information Management System

A search of the DECCW's AHIMS was conducted over a 10 km radius encompassing the Project Site and immediate surrounds. The AHIMS results support the suitability of the regional area for the occurrence of artefact scatters, with a total of 12 sites recorded on the AHIMS database. Also recorded in the area were a number of scarred tree sites ( $n=9$ ) and scarred trees sites incorporating artefact scatters ( $n=4$ ). A grinding groove site was also identified which incorporated an artefact scatter ( $n=1$ ).

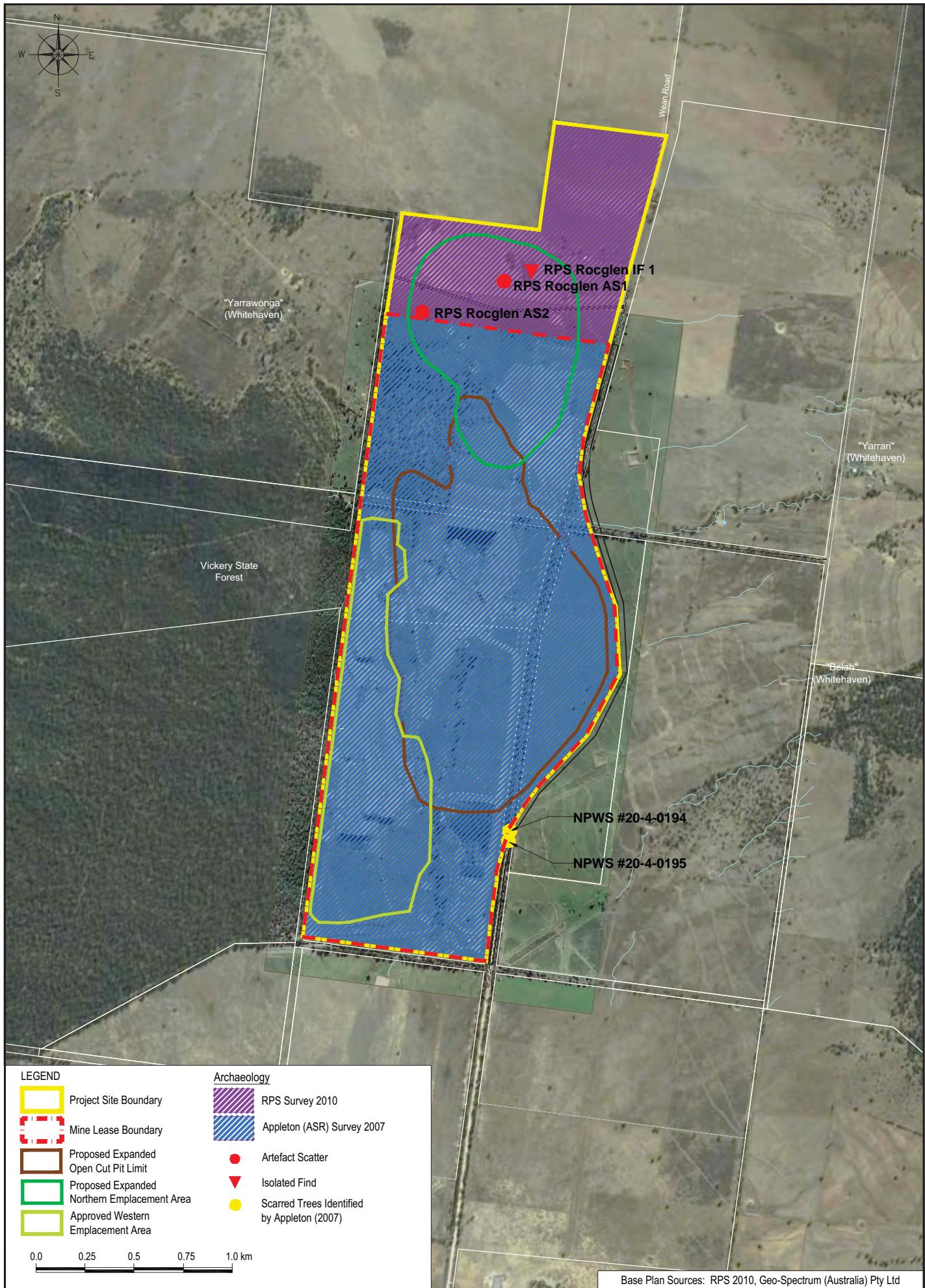
The results of the AHIMS search show that it is unlikely that shelter sites will occur in the Project Site due to the localised low lying landscape and the lack of rock outcrops where such sites may have been possible. In contrast, the State forests to the east and west have the potential for shelters because of the mountainous topography and potential availability of suitable outcropping rock. Midden sites have potential in the area as long as there is fresh water shell fish accessible in local rivers and creek systems. Exposed sandstone along these river and creek systems and other tributary drainage lines are potential areas for grinding groove sites in the locality. Scar trees in the area that may have been utilised for making canoes are likely to be in close proximity to water, whereas trees that were used for making shields or coolamons may have been some distance from water on a variety of landforms (DEC 2005, as cited in RPS 2010b).

### Field Survey

In August 2007 Whitehaven engaged Archaeological Surveys and Reports (ASR) to conduct an assessment of the potential impact of the original Rocglen Coal Mine development proposal on Aboriginal heritage. The extensive archaeological field survey undertaken with members of the Red Chief Local Aboriginal Land Council covered predominantly common ground to the recent survey by RPS (2010b) except for some of the area proposed to be disturbed by the expanded Northern Emplacement Area. Archaeological surveys are considered as being current for up to five years by the DECCW. As such, the RPS methodology for archaeological ground survey focussed on those areas not already covered by ASR two and a half years earlier.

RPS (2010b) undertook an archaeological survey of the area shown on **Figure 32** on the 2 March 2010. Survey team members included site officers of RCLALC, BBGTP, GGAC and MMAC, together with RPS Archaeologists. The strategy for field survey was to comprehensively cover all ground surface areas by means of a pedestrian survey and vehicular survey. The field survey equally targeted areas offering good ground surface visibility as well as more vegetated locations. Exposure included unformed livestock and vehicle tracks, areas absent of grass cover under trees, along fence lines and dam walls.

In summary, and as identified on **Figure 32**, three stone artefacts sites were located during the survey, comprising one isolated find and two artefact scatters.



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Base Plan Sources: RPS 2010, Geo-Spectrum (Australia) Pty Ltd

## Rocglen Coal Mine Extension Project Archaeological Survey and Aboriginal Sites

**FIGURE 32**

The isolated find identified as **RPS Rocglen IF1** was located in the western section of Survey Unit 3 within a large cluster of eucalypt trees. The artefact is a chalcedony flake with a banded quartz vein.



Plate 1 - RPS Rocglen IF1 identified in Survey Unit 3

The artefact scatter identified as **RPS Rocglen AS1** was located in Survey Unit 4 on the western side of the north to south fence line in an area of exposed B Horizon soils. AS1 contained flake pieces comprising mudstone, chert and grey silcrete.



Plate 2 - RPS Rocglen AS1 identified in Survey Unit 4

The artefact scatter **RPS Rocglen AS2** was located in the western extent of Survey Unit 5 in exposed soils adjacent to an inundated area. The scatter contained flaked pieces of greenstone and chert.



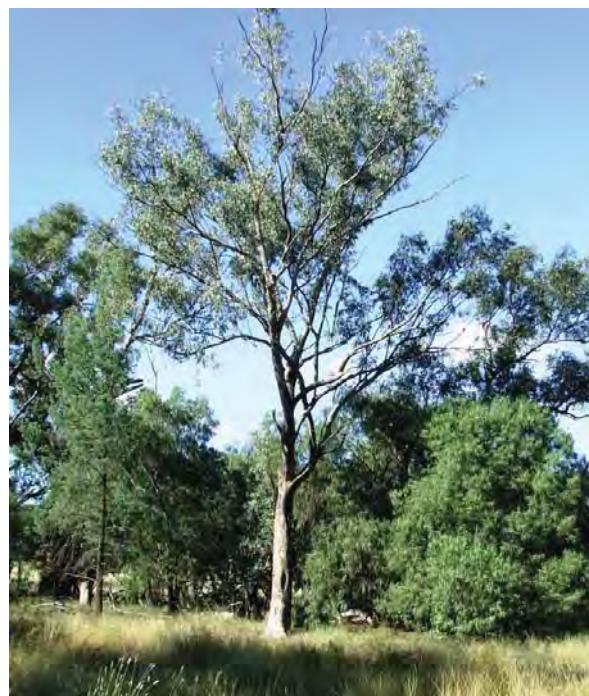
Plate 3 -RPS Rocglen AS2 identified in Survey Unit 5

Results of the field survey showed that there are no permanently flowing rivers or creeks in the Project Site. An ephemeral first order stream of Driggle Draggle Creek flows from the north west out of the Project Site. The three Aboriginal sites recorded on the field survey may have been associated with the fresh water reserves of this first order stream, but the consequence of seasonal weather conditions and agricultural activity in the area may result in the context of the sites being altered.

Further to the above finding, two scarred trees identified on the AHIMS as NPWS #20-4-0195 and NPWS #20-4-0194, recorded by Appleton (2007), are located on the eastern side of Wean Road reserve. The location of these scarred trees is shown on **Figure 32**.



**Plate 4 – Scarred Tree - AHIMS NPWS #20-4-0195**



**Plate 5 – Scarred Tree - AHIMS NPWS #20-4-0194**

### 7.8.3 Significance Assessment

The archaeological significance given to a site or area in the absence of identified sites is based on several criteria detailed below. This criterion has been used to ascertain the archaeological significance of the isolated find and two artefact scatters as identified for the Rocglen Extension Project.

**Rarity:** The isolated finds and two artefact scatters were located on a level plain landform associated with a first order stream of Driggle Draggle Creek which drains the north western section of the Project Site. All three sites would be considered to be of low rarity.

**Representativeness:** Artefact scatters are representative of the most common site found across the local and regional area. Isolated finds are very few in the local and regional area. In this instance, the artefact scatter sites (RPS Rocglen AS1 and RPS Rocglen AS2) have the potential to be classified as low to moderate for representativeness of the site type and raw material identified present.

**Integrity:** The area surrounding RPS Rocglen IF1 has been subject to disturbances by grazing cattle and possibly water. Cattle movement in the paddock may have contributed to alteration in the site's location. RPS Rocglen AS1 and RPS Rocglen AS2 have been subject to water flow after heavy rain when the tributary would have been present and abundant. All three sites are considered to have low to moderate integrity.

**Connectedness:** The area and location of the new recorded sites on the survey are considered to have moderate significance for connectedness.

**Complexity:** The complexity of the artefact scatter sites can only be determined by the surface material. As there is no evidence of subsurface material in either of the artefact scatter locations, it is considered that the complexity of the artefact scatter sites be assigned as low. The isolated find (RPS Rocglen IF1) was identified in a heavily vegetated area amongst grass, leaf and bark litter. Evidence of subsurface material was not determined and no other surface artefacts were identified in the close locality. It is considered that the complexity of the isolated find site be assigned as low.

**Contribute to Knowledge:** The artefact scatters (RPS Rocglen AS1 and RPS Rocglen AS2) and isolated find (RPS Rocglen IF1) are all located in areas of moderate to high disturbance. The two artefact scatter sites have the highest degree of disturbance as they are located in eroded soil context in areas that are at risk of inundation in heavy rain periods. The isolated find would be classified as moderate disturbance as it is not at risk of inundation and is situated at the base of a cluster of trees. As these sites are located in a disturbed context, they have low potential to contribute to the archaeological record.

### 7.8.4 Management

The comments received on the *Cultural Heritage Survey and Assessment* (RPS 2010b) from MMAC, GGAC and BBTP do not raise any significant issues. BBTP did recommend that the three sites found undergo archaeological excavation. RPS (2010b) does not recommend for excavation to be carried out at Aboriginal archaeological sites RPS Rocglen AS1 and RPS Rocglen AS2 due to the highly disturbed context and no evidence of in-situ archaeological items. However, in the case of RPS Rocglen IF1, the DECCW may consider subsurface investigation to be limited in this area.

All efforts will be made by Whitehaven to minimise disturbance within the Project Site. Rocglen already operates under an ACHMP (Whitehaven 2008c) and a range of management strategies and mitigation measures are employed. These will continue to be implemented for the Rocglen Extension Project.

The management requirements that stem from RPS's (2010b) archaeological assessment are based on the legislation designed to address the impact of development upon sites of cultural significance. As recommended by RPS (2010b), Whitehaven will implement the following management actions:

**Recommendation 1 – Aboriginal Community Consultation**

Liaison established with the registered Aboriginal stakeholders and other interested parties during the assessment will be maintained until all issues in relation to the management of Aboriginal cultural heritage have been resolved.

**Recommendation 2 – Aboriginal Archaeological Management**

Subject to the works associated with the expanded Northern Emplacement Area, if impact to RPS Rocglen IF1, RPS Rocglen AS1 and RPS Rocglen AS2 is unavoidable, a surface salvage will be undertaken in accordance with Section 3 of the ACHMP (Whitehaven 2008c). Artefacts salvaged will be transferred to relevant Aboriginal groups under a Care and Control Permit under Section 85A of the NP&W Act.

**Recommendation 3 – Aboriginal Archaeological Management of Wean Road Scar Trees**

Protective measures designed to prevent damage to the scarred trees (NPWS #20-4-0194 and NPWS #20-4-0195) will be enacted upon as per recommendations in Appleton (2007) and the ACHMP (Whitehaven 2008c). Whitehaven has restricted the proposed mine extension in this area and has committed to ensuring that no disturbance to the scarred trees or immediate surrounds will occur as a result of the Project. In short, the trees are not to be disturbed in any way and appropriate fencing and signage will be undertaken in consultation with the Aboriginal Community and the DECCW.

**Recommendation 4 – Drainage line in far north of Project Site**

In areas where surface excavation might occur in the future within 25 metres of the east-west oriented drainage line, Whitehaven will follow protocols in Section 4.1(iii) of the ACHMP (Whitehaven 2008c).

**Recommendation 5 - General**

In general during the course of the Project, if it is suspected Aboriginal cultural heritage material has been encountered, work will cease immediately in that locale. The DECCW, along with the RCLALC, BBGTP, GGAC and MMAC, will be notified. Works will only recommence when an appropriate and approved management strategy has been agreed to by all of the relevant stakeholders.

**Recommendation 6 - General**

In the event that skeletal remains are uncovered during operations, work will stop in the vicinity immediately and the NSW Coroner's Office and NSW Police contacted. If skeletal remains are deemed to be of Aboriginal origin, a representative of the local Aboriginal Community and the DECCW will be consulted.

## 7.9 European Heritage

An assessment of European heritage issues associated with the Rocglen Extension Project has been undertaken by RPS (2010b) as part of the *Cultural Heritage Survey and Assessment*. The full assessment report is contained within **Appendix O**, with significant findings and recommendations summarised below.

### 7.9.1 Existing Environment

The area has a history of pastoral use based on sheep and cattle grazing. There is potential for cultural remains from early or significant dwellings and farming structures such as sheds, fences and stockyards.

The unoccupied residence of the “Glenroc” property is in the northern sector of the Project Site. The residence, associated outbuildings, fences and structures were inspected by RPS (2010b) to determine if they were of heritage significance.



**Plate 6 – Unoccupied “Glenroc” Residence (view from south)**



**Plate 7 – “Glenroc” Outbuildings**

There are no known potential historic or archaeological elements in proximity of the Project Site. RPS (2010b) reports:

- There are no items on the State Heritage Register, which lists those places of State Significance recorded by the NSW Heritage Branch under the *Heritage Act 1977*;
- No items on the State Heritage Inventory, which contains items considered by local Councils to be of heritage value at the local level; and
- No items listed in the State Heritage database maintained by the NSW Heritage Branch, which lists all items that have been identified as of heritage value on LEPs throughout NSW.

### **7.9.2 Significance Assessment**

As outlined in **Section 5.9.4**, the Rocglen Extension Project proposes the removal of the “Glenroc” outbuildings within the northern extent of the Project Site in order to cater for the expanded Northern Emplacement Area. It is also likely that the unoccupied “Glenroc” residence further to the north, while outside of the proposed disturbance areas, will also be removed.

RPS (2010b) considers that the “Glenroc” residence was most likely constructed in the early to mid twentieth century together with associated outbuildings and fences. There was no evidence of an earlier house or buildings.

RPS (2010b) concludes that the “Glenroc” residence and associated outbuildings are not considered to have any historic significance. No other items of heritage significance were observed by RPS (2010b).

### 7.9.3 Management

While no European cultural heritage sites were located during the survey of the Project Site, as recommended by RPS (2010b), if significant European cultural heritage material is uncovered during site works, work will cease in that area immediately. An archaeologist will be contacted to assess the significance of the remains and works will only recommence when an appropriate and approved management strategy is instigated.

## 7.10 Visual Amenity

GSSE has undertaken a visual amenity assessment considering the post-mining outlooks from five residences (both privately owned and project-related) in close proximity to the mine. The purpose is to assess the visual amenity of the local setting, particularly that of privately owned residences, with the addition of the key elements associated with the Rocglen Extension Project and residual impacts following implementation of mitigation measures and site rehabilitation.

The following figures have been prepared to aid this visual assessment:

**Figures 33 and 34** – plans showing conceptual post-mining visual profiles from surrounding residences and the realigned Wean Road; and

**Figures 35 and 36** – plans showing conceptual photographic viewpoints from surrounding residences, comparing February 2010 outlooks to post-mining outlooks. The finished landform surfaces shown on **Figure 36** in a beige/tan (for identification purposes) will be rehabilitated and revegetated with woodland or pasture.

### 7.10.1 Existing Environment

The Project Site lies on the floor of a small north-south tending valley between the isolated elevated areas of Vickery State Forest to the west and the CCA Zone 2 Kelvin to the east. The elevated and vegetated slopes of the adjacent Vickery State Forest offer a level of natural screening to the west of the Project Site. The remaining areas around the site are dominated by cleared agricultural land with scattered trees. There are a number of public and private roads within the surrounding area that maintain narrow corridors of remnant vegetation.

The Project Site is located in an area that is removed from any urban areas and has a relatively low density of surrounding residences. In accordance with **Table 3** in **Section 3.6**, “Retreat” and “Penrynn” appear to be the closest privately owned residences to the north at approximately 4 km from the expanded Northern Emplacement Area, and “Surrey” appears to be the closest residence to the south at approximately 3.2 km from the approved Western Emplacement Area.