Part 4B
Surface Facilities

This section describes the specific environmental features of the Surface Facilities and its surrounds that would or may be affected by the Narrabri Coal Project. Information on existing conditions, proposed safeguards and controls and potential impacts the project may have after implementation of these measures is presented on those issues identified in Section 3 as being of greatest significance.

Where appropriate, proposed monitoring programs are also described.

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4B.1 SURFACE WATER

The surface water assessment was undertaken by WRM Water and Environment Pty Ltd. The full assessment is presented as Part 1 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections.

4B.1.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential surface water impacts requiring assessment and their unmitigated risk rating are as follows.

- Erosion of natural drainage lines (high risk).
- Erosion of rehabilitated final landform (moderate risk).
- Discharge of sediment-laden or turbid water from the project site (high risk).
- Reduced flows to downstream agricultural land (low risk) and native vegetation (moderate risk).
- Temporary degradation of downstream water quality through minor discharge/spill of saline or contaminated water (high risk).
- Long term contamination of downstream water quality through major or repeated discharge/spill of saline or contaminated water (extreme risk).
- Altered flooding patterns and indirect impacts on native vegetation communities and ecosystems (high risk).

In addition, the Director-General's requirements issued by the DoP require that the assessment of surface water include a detailed water balance and refer to the *Guidelines for Fresh and Marine Water Quality* (ANZECC), and *Managing Urban Stormwater: Soils & Construction* (Landcom) documents.

The following sub-sections describe and assess the existing drainage and surface water environment, identify the surface water management issues, proposed surface water controls safeguards and mitigation measures and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4B.1.2 The Existing Environment

4B.1.2.1 Regional Drainage

The Project Site is located in the Namoi River catchment and within the catchments of its tributaries, namely Kurrajong Creek, Pine Creek and Tulla Mullen Creek. The Namoi River flows in a northwesterly direction approximately 3km to 5km to the east of the eastern boundary of the Project Site.

The Namoi River catchment has been used extensively for agricultural activities for over 100 years and is one of Australia's most developed irrigation areas, supporting significant cotton and broadacre cropping (mainly sorghum, sunflower and wheat) as well as other crops, and some sheep and cattle grazing.

There are a number of major storages in the Namoi River catchment, namely the Keepit, Chaffey and Split Rock Dams located on the Namoi, Peel and Manilla Rivers, to provide water for the licensed water users in the region.

Most of the Project Site is located within the catchments of Kurrajong and Pine Creeks. Pine Creek and its tributaries traverse the northern part of the Project Site, before entering the Namoi River, while Kurrajong Creek and its tributaries originate in the southwestern corner of the Project Site and traverse the southern part of the Project Site, draining to Tulla Mullen Creek, which in turn drains into the Namoi River. The remaining southeastern portion of the Project Site drains into Tulla Mullen Creek via an unnamed tributary. The local catchment boundaries and drainage paths draining the Project Site are shown in **Figure 4B.1**.

The total catchments areas of Pine and Kurrajong Creeks are 76 km^2 and 62 km^2 respectively. Tributary 2 of Tulla Mullen Creek that drains the southeastern corner of the Project Site has a total catchment area of approximately 16 km^2.

Pine and Kurrajong Creeks are ephemeral, generally flowing for short periods after significant rainfall events or protracted wet periods. Baseflows in these creeks are insignificant. Tulla Mullen Creek is also ephemeral and is fed by Kurrajong Creek and a number of smaller tributaries. Sections of the local creeks are quite 'active' and are susceptible to high levels of erosion. The drainage paths of the smaller tributaries are poorly defined along some reaches through the Project Site.

4B.1.2.2 Project Site Drainage

Figure 4B.1 depicts the Project Site, the location of the Pit Top Area and the local catchment boundaries. **Figure 4B.2** presents greater detail of the Pit Top Area and the local drainage paths and catchments within that area.

Table 4B.1 lists the proportions of the Project Site and Pit Top Area that currently drain to each of the local sub-catchments. **Table 4B.2** lists the existing cleared and forested areas within the Project Site in each of the local sub-catchments.

4B.1.2.3 Existing Local Water Storages

There are 47 farm dams within the Project Site, the locations of which are shown on **Figure 4B.1**. The total storage capacity of the Project Site farm dams is estimated at 1 157ML. The 12 farm dams within the Proponent's landholding (including the Pit Top Area) have a combined storage capacity of approximately 46.5ML. The individual storage capacities of these dams vary from approximately 0.5ML to 22.5ML.

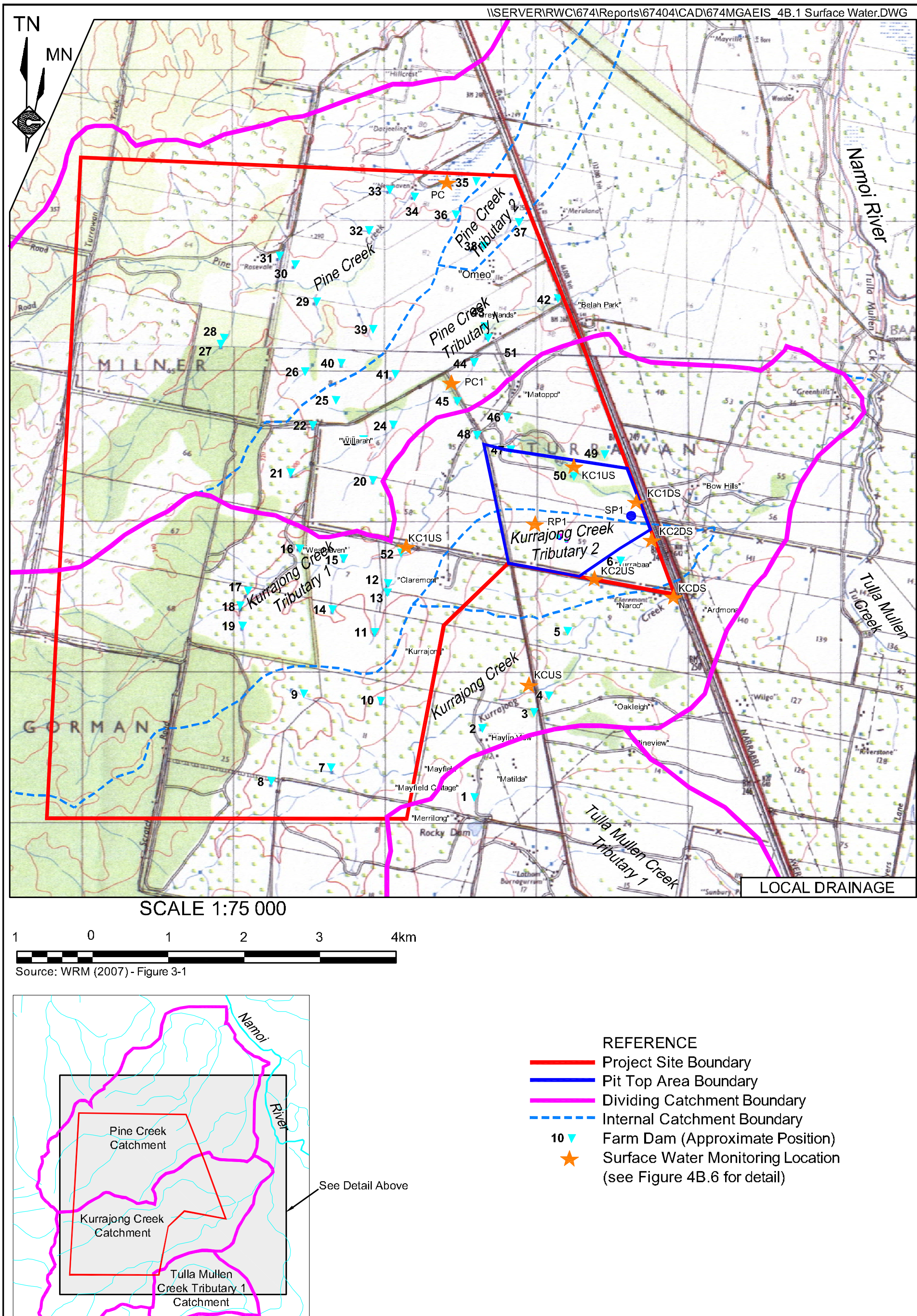

Figure 4B.1
REGIONAL / LOCAL DRAINAGE

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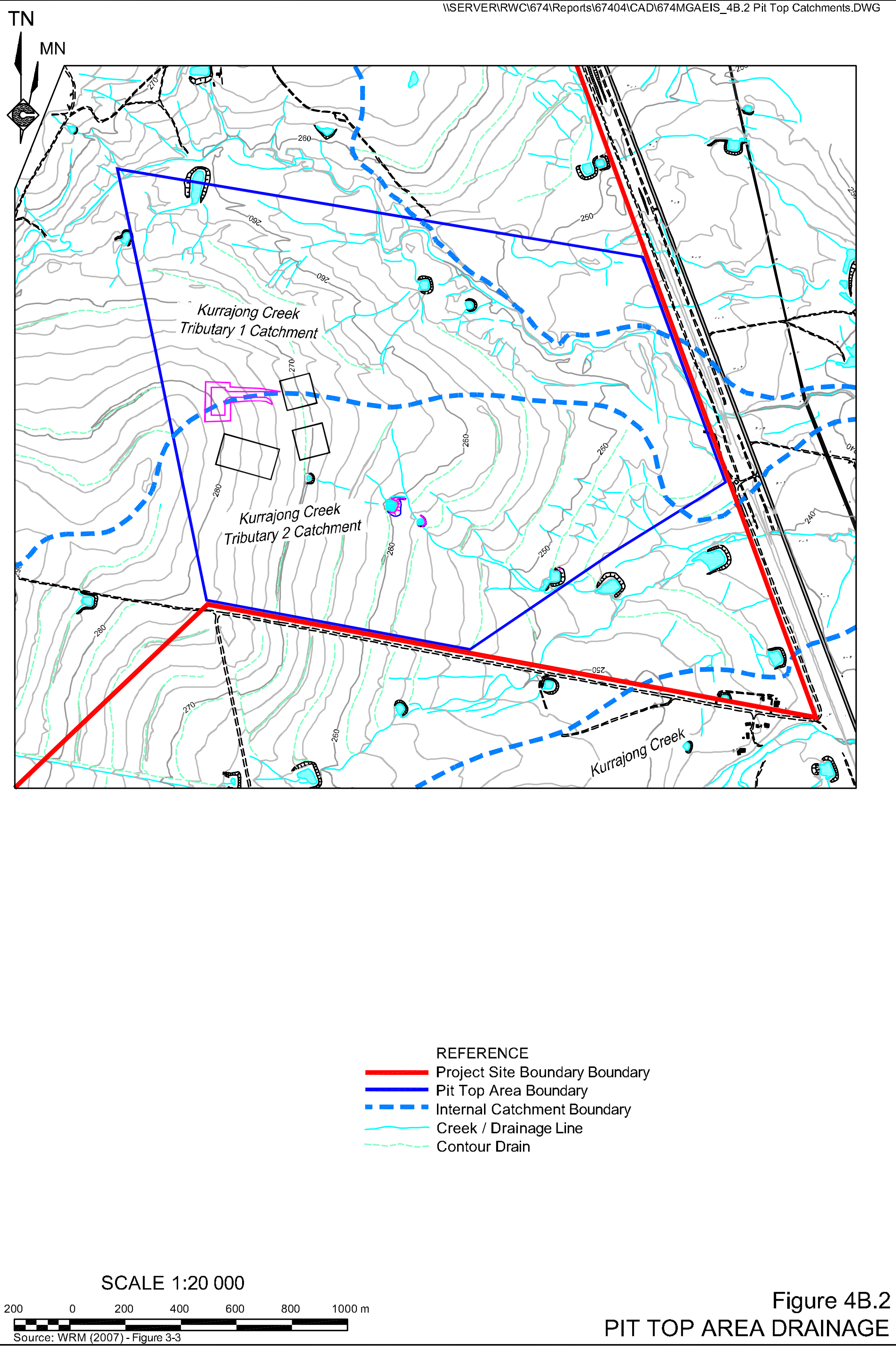

Source: WRM (2007) - Figure 3-3

Figure 4B.2
PIT TOP AREA DRAINAGE

Table 4B.1
Project Site and Pit Top Areas Draining to Local Sub-Catchments

Sub- Catchment	Project Site Area Within Sub-Catchment		Pit Top Area Within Sub-Catchment	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Pine Creek	1 714	29.0	-	-
Pine Creek Trib 1	716	12.1	-	-
Pine Creek Trib 2	103	1.7	-	-
Kurrajong Creek	1 167	19.8	3	1.13
Kurrajong Creek Trib 1	1 709	29.0	131	44.6
Kurrajong Creek Trib 2	317	5.4	159	54.2
Tulla Mullen Creek Trib 1	174	3.0	-	-
Total	**5 900**	**100**	**293**	**100**
Source: WRM (2007) – Table 2-2				

Table 4B.2
Cleared and Forested Areas within the Project Site in Each Local Sub-Catchment

Sub- Catchment	Cleared Area		Forested Area	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Pine Creek	592	16	1 122	52
Pine Creek Trib 1	693	18	23	1
Pine Creek Trib 2	103	3	0	0
Kurrajong Creek	907	24	260	12
Kurrajong Creek Trib 1	964	26	745	35
Kurrajong Creek Trib 2	317	8	0	0
Tulla Mullen Creek Trib 1	174	5	0	0
Total	**3 750**	**100**	**2 150**	**100**
Source: WRM (2007) – Table 2-3				

4B.1.2.4 Surface Water Quality

Limited water quality data has been obtained from locations upstream and downstream of the Pit Top Area on the tributaries of Kurrajong Creek. **Figure 4B.1** identifies the sites sampled in August 2006 (following sustained rainfall in the area at this time) and **Table 4B.3** presents the baseline water quality results.

Table 4B.3
Kurrajong Creek Water Quality

Site*	pH	Electrical Conductivity (µS/cm)	Total Suspended Sediment (mg/L)	Phosphorous (mg/L)	Nitrogen (mg/L)	Total Organic Carbon (mg/L)
KCUS	7.9	255	22	0.24	0.59	<10
KCDS	8.0	205	163	0.42	1.5	15
KC1US	8.2	1300	15	0.36	0.5	<10
KC1DS	6.9	430	39	0.22	1.0	<10
KC2US	6.7	75	84	0.58	2.2	18
KC2DS	6.7	85	21	0.32	1.0	12
Average	7.4	392	57	0.36	1.1	-
* see **Figure 4B.1**						
Source: Ecowise						

The results presented in **Table 4B.3** suggest that local surface water is of generally neutral pH, and fresh (with the exception of the KC1US sample). The water has a relatively high suspended sediment level reflecting the ephemeral nature of these drainage lines.

As the on-site water quality data represents only a single sampling period, additional water quality data collected at the nearby Turrawan gauging station (Station No. 419023) on the Namoi River for the period 15 October 1976 to 28 October 1986 was considered to provide an indication of regional water quality characteristics (although due to the difference in catchment conditions, this is more likely to be representative of water held in Project Site dams). **Table 4B.4** presents a summary of available flow and water quality data for the Namoi River at Turrawan gauging station.

Table 4B.4
Flow and Water Quality Data for the Namoi River at Turrawan Gauging Station

Parameter	Years of Data	Mean	Median	Min	Max	10th Percentile	90th Percentile
Water Level (m)	27	1.2	1.2	0.7	3.3	1.0	1.6
Flow (ML/day)	9	1311	678	19	12500	117	2380
Electrical Conductivity (μS/cm)	10	545	538	275	1720	330	716
pH	10	8	8	7	9	8	8
Temperature (°C)	10	19.6	20.5	10	30	11.0	26.5
Turbidity (NTU)	9	15.6	5.4	2	130	2.0	40.4
Source: Modified after WRM (2007) – Table 3-3							

4B.1.2.5 Flooding Potential

No flood data is available for the Project Site. Given the elevation of the Project Site at its lowest point is approximately 246m AHD, and the elevation of the Namoi River to the east is approximately 220m AHD, the Project Site is not susceptible to flooding from the Namoi River which has exhibited maximum flood levels of around 10m.

The Project Site does, however, contain several ephemeral water bodies, most notably Tributaries 1 and 2 of Kurrajong Creek which traverse parts of the Pit Top Area (see **Figure 4B.2**). WRM (2007) undertook a flood study assessing the 1 in 100 year Average Recurrence Interval (ARI) flood levels of Kurrajong Creek Tributary 1, in order to determine the susceptibility of this part of the Pit Top Area to localised flooding, and the potential impact on flooding characteristics of constructing the rail loop in close proximity to Kurrajong Creek, Tributary 1. The flood study included the water management structures identified in Section 4B.1.4 which would increase the catchment of Kurrajong Creek Tributary 1 by 19.6ha, and considered flood levels of the existing (without project-related surfaces changes) and developed (with the rail loop and other water management controls) situations.

Figure 4B.3 presents the location of cross sections assessed by the WRM (2007) flood study and the extent of localised flooding following a 1 in 100 ARI event. **Table 4B.5** presents the 1 in 100 flood levels at these cross sections. The results illustrate the construction of the rail loop and incorporation of Project Site water management structures would not affect the flooding characteristics of Kurrajong Creek Tributary 1 because the constriction of flow occurs within the backwater caused by the North Western Branch Railway.

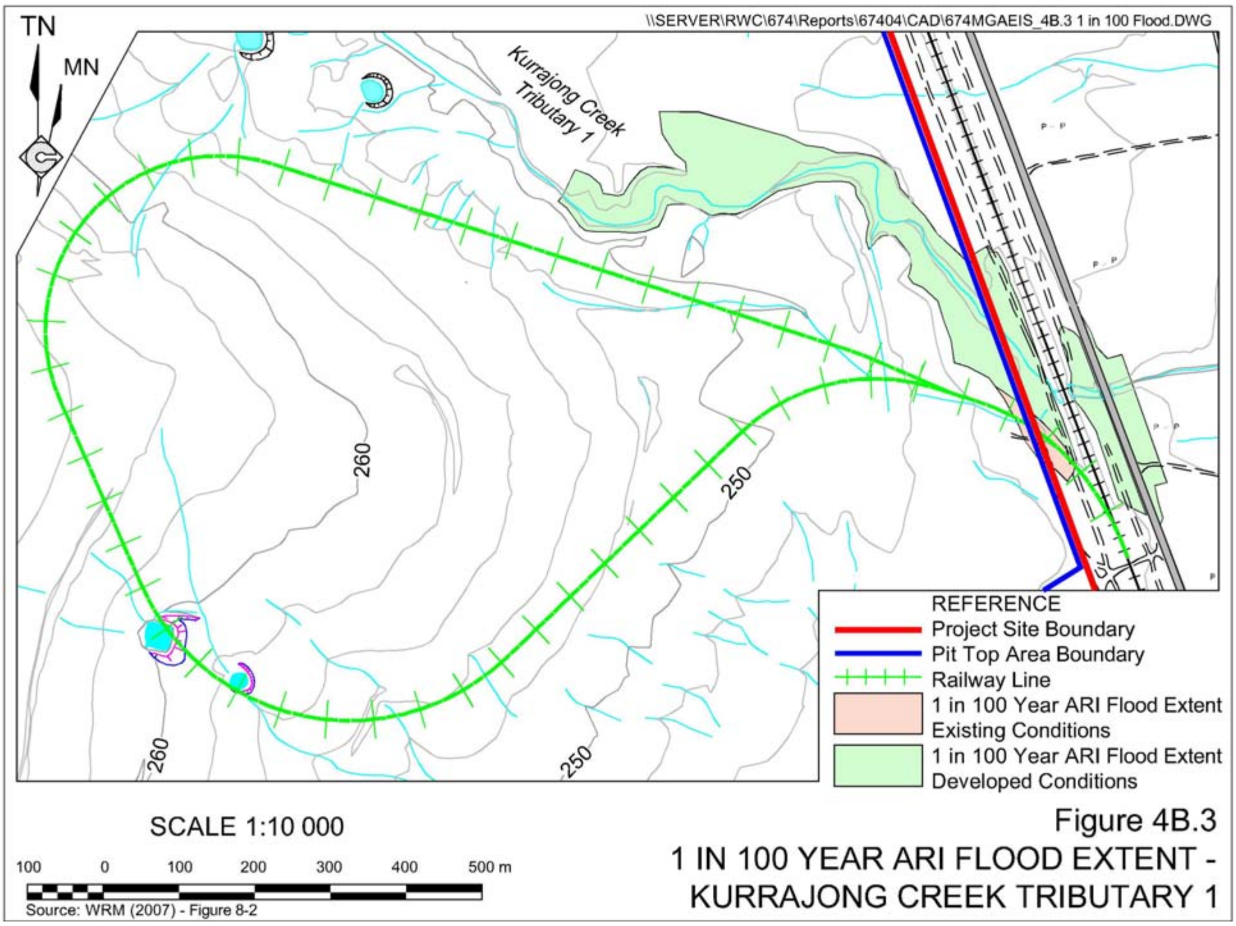

Figure 4B.3
1 IN 100 YEAR ARI FLOOD EXTENT - KURRAJONG CREEK TRIBUTARY 1

Table 4B.5
Design Flood Level of Kurrajong Creek Tributary 1 (m AHD)

Cross-Section ID*	Existing Conditions	Developed Conditions
XS3	242.55	242.55
XS4	243.71	243.71
XS5	244.63	244.63
XS6	245.37	245.37
XS7	246.42	246.42
XS8	247.83	247.83
XS9	248.63	248.63
* see **Figure 4B.3**		
Source: WRM (2007) – Table 7-2		

The results presented in **Table 4B.5** and **Figure 4B.3** do, however, indicate the rail loop would be located within an area affected by a 1 in 100 ARI flood event within the tributary. Section 4B.1.4.4 presents the proposed controls and safeguards to be incorporated into the design and construction of the rail loop to mitigate its location within this flood prone area.

4B.1.2.6 General Sensitivity of the Namoi River Catchment

The surface water flows on and around the Project Site provide a minimal contribution to the combined flows within the Namoi River catchment. This water is important to local landowners that use the water from local creeks for stock watering and/or crop irrigation purposes, with any changes in water availability potentially detrimental to the existing land uses. The impact on Namoi River catchment flows during periods of floods and low flows would be negligible given the level of regulation and the size of the upper catchment in relation to the Project Site.

The surface water flows are also important to the ecological health of the Namoi River, ie. the fauna and flora which rely on good quality water. A release of contaminated water from the Project Site could significantly impact on the health of flora and fauna, as well as downstream water users.

There are no public health sensitivities associated with the existing surface water catchment that would be affected by the project.

4B.1.3 Surface Water Management Issues

4B.1.3.1 Introduction

The project has the potential to impact upon both the quality and quantity of surface water flowing from the Project Site. The following sub-sections identify the potential impacts that have been considered in the design of surface water management controls principally within the Pit Top Area and to a lesser extent within the Ventilation Shaft Area. Section 4B.1.4 then addresses the controls to be implemented to avoid or maintain these impacts at an acceptable level.

4B.1.3.2 Potential Sources of Water Pollution

The potential sources of water pollution from the proposed activities within the Project Site are as follows.

(i) Runoff from areas disturbed during construction of the surface facilities.

(ii) Runoff from stockpiles of topsoil, subsoil and mined rock.

(iii) Surface runoff from ROM coal and coal product stockpiles.

(iv) Runoff from hardstand areas including roads, coal crushing/sizing area and surface buildings.

(v) Surface runoff from rehabilitated areas prior to full stabilisation.

(vi) Uncontrolled discharge of saline mine waters.

(vii) Leakage or spillage of hydrocarbons.

Based on the potential sources of pollution, suspended solids, ie. sand, silt, clay or coal particles in water, hydrocarbons and saline water are likely to be the major sources of surface water pollution.

4B.1.3.3 Potential changes to Surface Water Quantity

Development of the project would necessitate the clearing of some, mainly agricultural, vegetation and construction of hardstand areas which would potentially result in increased surface water run-off within the affected catchment and subsequently from the Project Site. It is more likely, however, that the volume of water leaving the Project Site would decrease marginally as a result of surface water being captured within water storages constructed on the Project Site to provide for operational water requirements.

4B.1.3.4 Erosion and Sedimentation

Uncontrolled run-off from the perimeter amenity bund, cut and fill activities of the rail loop construction, soil stockpiles or other cleared areas, including run-off as a result of localised flooding, may lead to sheet, rill and/or gully erosion over areas of the Pit Top Area. Recognising this potential, the surface water management controls have been designed to minimise the number and velocity of water flows within the Pit Top Area. Reference is also made to management controls that would reduce the erosion and sedimentation risk posed by localised flooding events.

4B.1.3.5 Dryland Salinity

Dryland salinity which is the accumulation of salts within the soil profile has been recognised as an issue of concern within the Namoi Valley for some time. The potential of the project to increase dryland salinity has been considered given the necessity to store in-flowing groundwater to the underground workings in evaporation /storage ponds within the Pit Top Area. The ponds would be constructed with sufficiently impermeable floors and walls, and recognising the bulk of the deep rooted vegetation of the Project Site is located outside of the proposed area of disturbance, the potential for dryland salinity is considered minimal.

4B.1.4 Water Management Measures and Operational Safeguards

4B.1.4.1 Introduction

For management purposes, the surface water within the proposed areas of disturbance has been divided into four categories, namely:

- **"Clean" -** surface runoff from rehabilitated catchments and catchments undisturbed or relatively undisturbed by construction, mining or related activities;
- **"Dirty" -** surface runoff from areas disturbed by construction or activities such as soil, overburden and coal stockpiling, and rehabilitation (until stabilised), all of which could contribute suspended solids to the surface water;

- **"Saline" -** water containing concentrations of total dissolved solids (TDS) above that considered fresh water by ANZECC (2000) criteria; or
- **"Contaminated" -** surface water containing hydrocarbons or any other contaminant other than suspended solids above DEC or ANZECC (2000) criteria.

The key principles in managing surface water within and around the Project Site would be to:

- divert clean water away from disturbed areas;
- capture dirty water and treat it so that it could be discharged in accordance with relevant DEC and ANZECC guidelines;
- store saline water dewatered from the underground workings and allow this to evaporate;
- capture and treat contaminated water prior to discharge from and/or re-use on the Project Site; and
- maintain as much vegetation cover (particularly grass) as possible.

The water management controls identified in Sections 4B.1.4.2, 4B.1.4.3 and 4B.1.4.4 are drawn from WRM (2007) (see Part 1 of the *Specialist Consultant Studies Compendium*) and have been developed on the assumption of worst-case scenarios, as they apply to each aspect of water management. Where appropriate, distinction is made between controls relevant to site establishment and/or operations.

It should be noted that, whilst comprehensive in its assessment of Project Site surface water flow and the design of water management structures for the project, the proposed water management is essentially conceptual in terms of the positioning and number of structures. As the development and operation of the Narrabri Coal Project progresses, some variation to the structures may be required. The design of any variations would reflect, however, the overall objectives and principles included in the Site Water Management Plan for the project.

4B.1.4.2 Water Quality

4B.1.4.2.1 Introduction

The primary considerations adopted in designing water management structures to control surface water quality are based upon the above key principles. **Figure 4B.4** presents the surface water controls that would be implemented during the site establishment phase of the project and maintained for the life of the project.

The Proponent has also developed a number of operational responses in the event that the quality of water discharged or with the potential to be discharged from the Project Site does not satisfy DEC surface water discharge limits.

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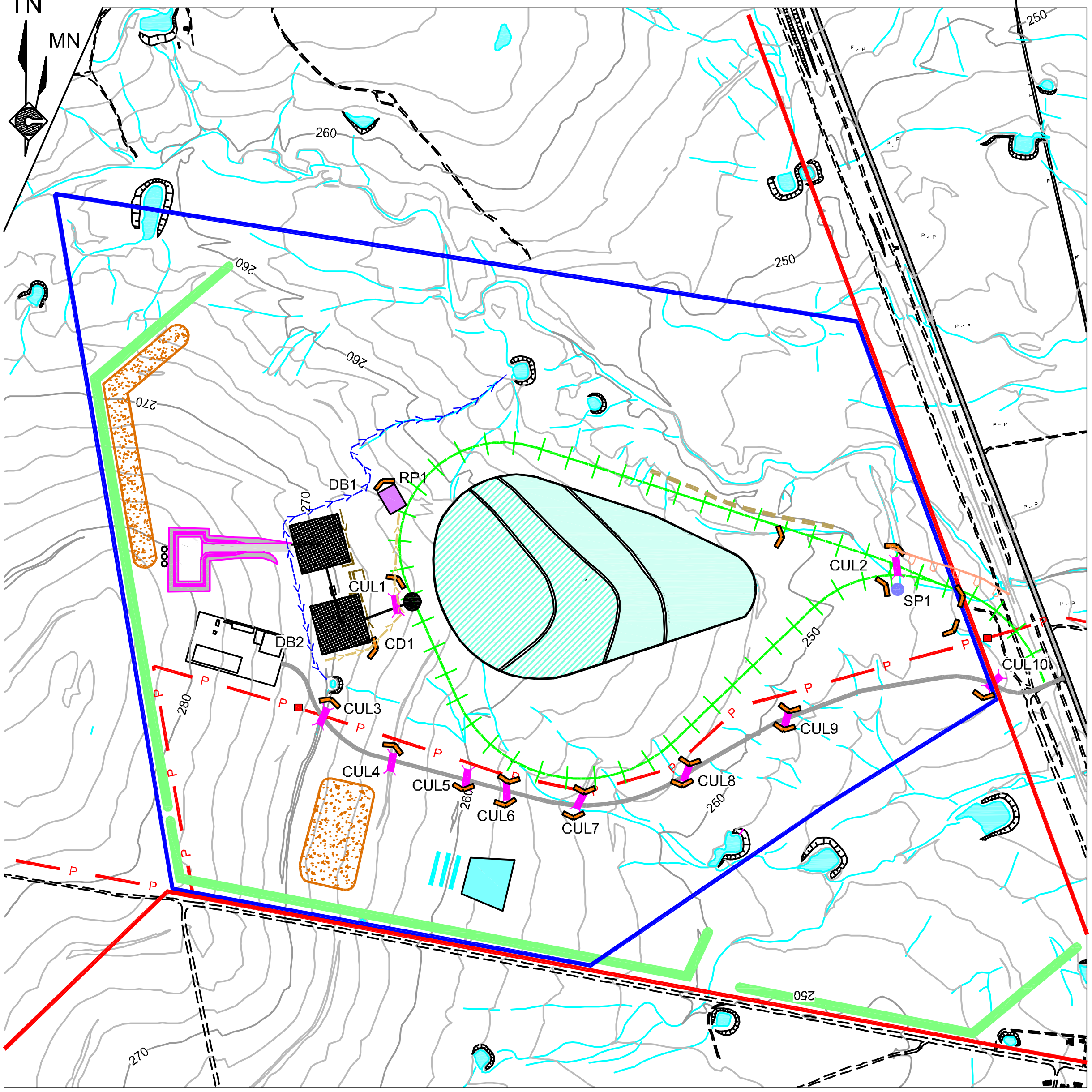


REFERENCE

Project Site Boundary	Pit Top Area Boundary
290 Contour (m AHD)(Interval = 2m)	Site Access Road
Creek / Drainage Line	Rail Loop
Dam / Water Storage	P Power Line
Sealed Road	Hay Bale Silt Trap / Sediment Fence
Unsealed Road / Track	CUL6 Proposed Culvert
Building	RP1 Proposed Retention Pond
Rail Loop Bund	SP1 Proposed Sediment Pond
Amouring	Proposed Evaporation / Storage Ponds
Perimeter Amenity Bund	
Diversion Bank	
Catchment Bank	

SCALE 1:15 000

250 0 250 500 750 m

Source: WRM (2007) - Figure 7-1

Figure 4B.4
SURFACE WATER CONTROLS

4B.1.4.2.2 Diversion of Clean Water

In order to ensure that all clean water not harvested for operational purposes is diverted away from active or disturbed areas of the Pit Top Area and Project Site, the following surface water management controls are proposed.

- Diversion drains (DB1 and DB2) would be used to direct clean runoff around the northern and southern sides respectively of the stockpiling and crushing/sizing area.
- New culverts (CUL3, 4, 5, 6, 7, 8, 9 & 10) would be constructed under the Site Access Road and CUL2 would be constructed under the rail loop. CUL 1 would be constructed under the rail load out road/conveyor.
- The soil stockpiles would be reshaped to be free-draining and grassed to provide long term stability. Hay bales or sediment fences would be placed downstream until the vegetation becomes established.

Diversion Drains 1 and 2 (DB1 and DB2)

As illustrated on **Figure 4B.4**, DB1 and DB2 are located along the upstream boundary of the ROM and product stockpile area. DB1 drains to the northeast of the Project Site, following existing drainage lines before discharging into an existing farm dam. DB2 runs southeast discharging into an existing farm dam located to the south of the product coal stockpile area.

Table 4B.6 provides the dimensions of diversion banks DB1 and DB2 proposed for the Project Site, designed for the 10 Year ARI design discharge.

Table 4B.6
Diversion Bank Specifications

Structure ID	Catchment Area (ha)	Channel Bottom Width (m)	Channel Depth (m)	Channel Grade (%)	Bank Height (m)
DB1	26.73	4	0.4	2	0.6
DB2	6.02	2	0.3	1.2	0.5
Source: Modified after WRM (2007) – Table 7-4					

It is noted that the safety bund planned to be constructed at ground level adjacent to the box cut would effectively act as a diversion bank. WRM (2007) provides specifications for this bund, referred to as DB3.

The following general guidelines, as provided by WRM (2007) for the construction of diversion banks (and catch drains) would be implemented.

- The channel of the drain is to be trapezoidal.
- The bank batters are to be between 1:3 to 1:6 (V:H).
- The channel batters are to be 1:3 (V:H).

Culverts (CUL1 to CUL10)

To allow for the continued flow of water through the Pit Top Area along natural drainage lines, the Proponent proposes to install 10 culverts as identified on **Figure 4B.4** and described as follows.

- CUL 1 would be constructed under the rail load out road/conveyor.

- CUL 2 would be located under the eastern end of the rail loop, to drain water from SP1 (see Section 4B.1.4.2.3) and the interior rail loop catchment into Kurrajong Creek Tributary 1 via an existing drainage path.
- CUL3, 4, 5, 6, 7, 8, 9 and 10 would be installed beneath the Site Access Road within existing drainage paths.

Table 4B.7 presents the design specifications for the culverts proposed for the Project Site which have been sized for both pipe and box culvert types.

Table 4B.7
Culvert Specifications

Structure ID	Catchment Area (ha)	Design Flow Rate (m^3/s)	Diameter for Pipes (m)	Number of Barrels	Height and Width for Box (m)	Number of Boxes
CUL 1	1.04	0.46	0.450	3	0.45 x 0.45	2
CUL 2	17.27	3.03	0.750	4	0.75 x 1.2	3
CUL 3	14.49	0.77	0.525	3	0.45 x 0.75	2
CUL 4	6.75	0.46	0.450	3	0.45 x 0.45	2
CUL 5	45.74	1.62	0.750	3	0.75 x 0.75	2
CUL 6	1.19	0.14	0.450	1	0.45 x 0.45	1
CUL 7	1.62	0.18	0.525	1	0.45 x 0.45	1
CUL 8	1.65	0.18	0.525	1	0.45 x 0.45	1
CUL 9	2.62	0.25	0.525	1	0.45 x 0.60	1
CUL 10	8.17	0.53	0.450	3	0.45 x 0.60	2

Source: Modified after WRM (2007) – Table 7-5

Box Cut for the Transport Drift and Conveyor Drift

The transport drift and conveyor drift portals would be constructed within a 50m x 100m box cut, which would be approximately 35m to 40m deep. Drainage within the box cut would be directed towards a small pump-out sump which would collect any water falling within the box cut.

4B.1.4.2.3 Capture of Dirty and Contaminated Water

In order to ensure that all potentially dirty or contaminated water is prevented from entering natural drainage lines off the Pit Top Area and Project Site, the following surface water management controls are proposed.

- A retention pond (RP 1) would be constructed to collect dirty and contaminated runoff from the stockpiling and crushing/sizing area. RP1 would be pumped to the evaporation / storage ponds if it is full.
- A sediment pond (SP 1) would be constructed to collect dirty water generated during the construction of the rail loop and evaporation / storage ponds.
- The existing farm dams would be used to treat dirty water generated from the surface facilities area.

- A catch drain (CD 1) would direct dirty and contaminated runoff from the stockpiling and crushing/sizing area to RP 1.
- Hay bale protection would be placed within natural and created drainage lines from the Pit Top Area to provide additional sediment protection.

Where possible, flows from diversion banks have been directed into existing storages to further reduce the likelihood of any sediment release. **Figure 4B.4** presents the location of these dirty water controls, greater detail of which is provided as follows.

Retention Pond 1 (RP1)

As illustrated on **Figure 4B.4,** RP1 is to be located to the north of the ROM and product coal stockpile areas adjacent to the rail loop. RP1 would collect and store potentially dirty runoff from the Stockpiling and Crushing/Sizing area. Runoff from this area may include suspended solids, sediment, hydrocarbons and coal fines (from the ROM and Product Stockpiles).

Table 4B.8 presents the proposed configuration of RP1 which has the following design criteria:

- The catchment draining to RP1 is 6.94ha.
- An emergency spillway would be constructed with a nominal width of 5 m should the proposed pump fail during a storm event.
- The crest width would be a minimum of 3m wide.
- The crest height would be a minimum 0.6m above spillway level (0.3m above the 100 Year ARI design flood level).
- The excavation and dam batters would be at least 1:3(V:H).
- The inlet and outlet channel batters would be 1:6(V:H).
- The outlet channel slope would be about 1:400 if the channel is bare. It could be lower if the outlet channel is to be grassed.

Table 4B.8
Approximate Retention Pond 1 Specifications

Structure ID	Storage Capacity (ML)	Storage Depth (m)	Base Length (m)	Base Width (m)	Outlet Width (m)	Sill Width (m)
RP1	8.8	3	45	45	5	5
Source: Modified after WRM (2007) – Table 7-2						

The water stored in RP1 would be pumped as required, to the evaporation / storage ponds to prevent it from overflowing via a 1ML/day pump. The pump would be operated when the stored water is greater than 1ML.

Sediment Pond 1

As illustrated on **Figure 4B.4,** SP1 would be constructed at the eastern end of the proposed rail loop. It would collect runoff from the catchment draining the rail loop during the construction of the evaporation / storage ponds. Once the project enters the operational phase, the catchment would be relatively clean and would not require a sediment pond. SP1 would be retained however, to provide additional water storage capacity within the Pit Top Area.

Table 4B.9 provides the proposed configuration of SP1 which has been designed for Type 'C' soils in accordance with Landcom (2004).

Table 4B.9
Minimum Sediment Pond Specifications

Structure ID	Catchment Area (ha)	Storage Capacity (ML)	Depth Below Spillway Level (m)	Base Length (m)	Base Width (m)	Outlet Width (m)	Sill Width (m)
SP1	39.91	0.7	1.5	41.9	14	12	18
Source: Modified after WRM (2007) – Table 7-3							

The following general guidelines were provided for the construction of the SP1 by WRM (2007).

- The crest width would be a minimum of 3m wide.
- The crest height would to be a minimum 0.75m above spillway level (0.3m above the 100 Year ARI design flood level).
- The excavation and dam batters would be at least 1:3(V:H).
- The inlet and outlet channel batters would be 1:6(V:H).
- A low flow outlet pipe and perforated riser would be installed. The riser would be wrapped in permeable geofabric, and would consist of a 525mm diameter RCP, with an open top 0.4m below the spillway level.
- The outlet channel slope would be about 1:400 if the channel is bare. It could be lower if the outlet channel is to be grassed.

Catch Drain 1

As illustrated on **Figure 4B.4**, CD1 would commence at the southwest corner of the product stockpile, and run parallel to the rail loop, passing under the rail load out conveyor and bin via a culvert CUL1 to RP1.

Table 4B.10 provides the dimensions of catch drain CD1 proposed for the Project Site, designed for the 100 Year ARI design discharge.

Table 4B.10
Catch Drain Specifications

Structure ID	Catchment Area (ha)	Channel Bottom Width (m)	Channel Depth (m)	Channel Grade (%)	Bank Height (m)
CD 1	6.99	3	0.4	1.2	0.7
Source: Modified after WRM (2007) – Table 7-4					

The same general guidelines, as provided by WRM (2007) for the construction of diversion banks, would be implemented for the catch drain.

Hay Bale Protection

A temporary barrier of hay bales laid end to end across the direction of flow, usually at the outlet of a drain or across a swale, diversion channel or waterway, would be used to intercept and filter run off before it enters a channel and/or to direct water in low flow situations. The proposed location of hay bale protection is provided on **Figure 4B.4**.

4B.1.4.2.4 Discharge of Water

While it is the intention of the Proponent to capture all saline, dirty and contaminated water flowing on the Project Site for preferential use in dust suppression activities, a discharge of water may occur from water storages on the Project Site during or following periods of high rainfall. Water flowing from SP1 or RP1 would be filtered through hay bales and allowed to flow via naturally grassed banks to reduce the total suspended sediment in water. **Figure 4B.4** presents the drainage lines on the margins of the Pit Top Area that would carry surface water flows from the site. Only those within the dirty water catchments are presented.

Discharged water would be sampled within 24 hours of a discharge event and assessed against DEC water quality criteria. Contingency measures in the event of exceedance of water quality criteria have been prepared and are discussed in Section 4B.1.5.

4B.1.4.2.5 Saline Water Management

Evaporation / Storage Ponds

In order to manage the mine in-flows dewatered from the Stage 1 underground workings, a significant proportion of which is anticipated to be saline (>10 000mg/L TDS – GHD, 2007), the Proponent has committed to the construction of up to four evaporation / storage ponds within the proposed rail loop as a depository for this water and potentially dirty storage runoff from the stockpiling and crushing/sizing area. **Table 4B.11** presents the designed surface area and storage volume of the proposed Evaporation Ponds A to D.

Table 4B.11
Approximate Evaporation / Storage Pond Specifications

Pond	Surface Area @ 3.5m (ha)	Storage Volume (ML)
A	5.87	191
B	5.36	174
C	4.23	136
D	5.90	192
Source: Modified after WRM (2007) – Table 7-1		

The following is of note with respect to the proposed evaporation / storage pond configuration.

- The ponds have been designed to not overflow assuming average long term mine in-flows do not exceed 880m^3/day.
- The ponds would vary in size from 4.2ha to 5.9ha.
- Each pond would be approximately 3.5m deep.
- The boundary and divider walls would consist of 1:2 (V:H) side slopes and 5m wide crests.
- The difference in bed level between adjoining ponds is approximately 2m.
- The base and walls would be covered with a low permeability liner to achieve a permeability of not less than 10^{-8} m/s.
- Spillways would be constructed across each dividing wall such that Pond A spills to Pond B, which spills to Pond C etc. An emergency spillway will be constructed on the outer wall of Pond A in the unlikely event that the evaporation basin is overtopped.

The evaporation / storage ponds would be operated to maximise the surface area for evaporation and to minimise the likelihood of spills occurring. The following operating rules would be used.

- Dewatered mine in-flows would be pumped directly to Pond A.
- The dust suppression water would be extracted from Pond A.
- The water level in the other ponds would be maintained at a level of 1m above the bed (if water is available) by pumping/syphoning from Pond A.
- Additional measures, such as spraying water into the air to increase evaporation and irrigating pastures will be undertaken if the available storage volume in the evaporation / storage ponds is less than 10% of its maximum capacity. This is equivalent to 69.3ML.
- The DEC would be notified if insufficient storage volume is available to contain the 90th percentile 5 day rainfall (150.6mm). This is equivalent to 32.2 ML.
- Gauge boards would be installed in each pond to monitor the water level.

To estimate the volume of groundwater that would be required to be dewatered and managed at surface, GHD (2007) prepared and ran a computer model using site specific information on geology, hydraulic conductivity of the geological strata impacted by the underground workings, inter-connectivity of the geological strata and a detailed mine plan which predicted the in-flow of groundwater to the mine over time. Further detail on the design and calibration of the model is provided by GHD (2007) and a more detailed analysis of the model outputs in Section 4B.2. The model predicted that groundwater in-flow to the mine would approximate 30ML in Year 1, increasing steadily over the initial 25 years of operation to a maximum of 818ML before levelling off to approximately 690ML per year from about Year 25 onwards.

Based on the predictions of GHD (2004), WRM (2007) prepared and ran a water balance model for the initial 10 years of mine development using representative dry, median and wet periods from the 116 year record for the Project Site. In all but the final year of the wet period, assuming maximum mine in-flow rates, sufficient capacity would be held in Evaporation / Storage Ponds A and B to avoid overflow of the dewatered mine in-flows. The results illustrate that there would be at least a 5 to 10 year period during which the groundwater modelling results can be validated (or otherwise) and implications on future water management considered. As noted in Section 2.5.4, depending on the results of the groundwater modelling validation study / exercise, surface water management may be upgraded to include additional evaporation / storage ponds and / or a water conditioning plant. **Figure 4B.5** reproduces the four surface water management scenarios that would be implemented, depending on actual mine dewatering requirements. Further detail on the water balance modelling completed by WRM (2007) is provided in Section 4B.1.4.3.3.

The water stored in the evaporation / storage ponds would be used for dust suppression underground and on the stockpiling and crushing/sizing area. The remainder would be allowed to evaporate. In the event a water conditioning plant is constructed, the improved quality water would be used for dust suppression and other operational activities in preference to saline and dirty water.

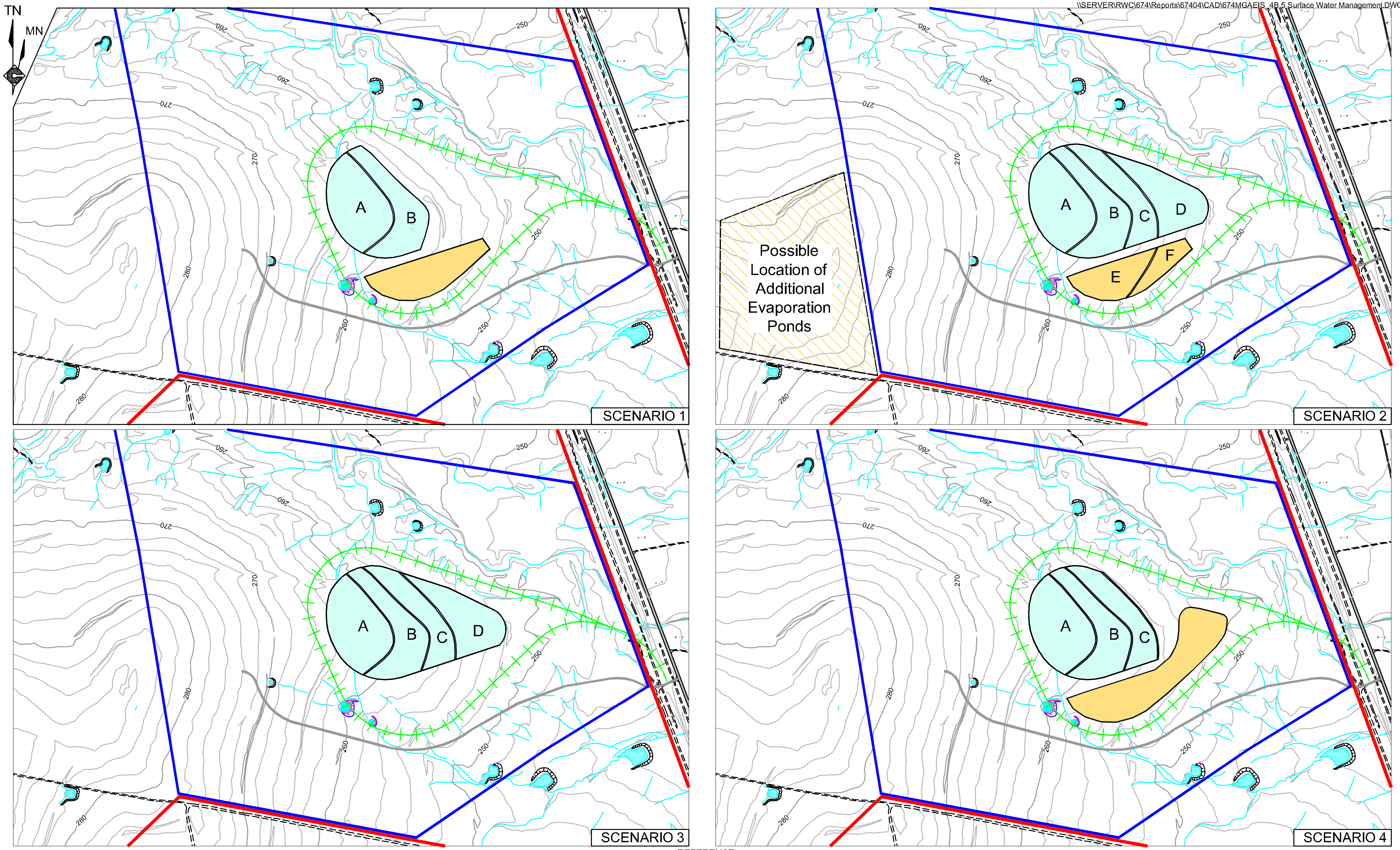
Irrigation Management Strategy

In the event a water conditioning plant is constructed within the rail loop to reduce the salinity of the water, or less saline water is encountered and dewatered, the Proponent would irrigate this water, subject to compliance with ANZECC and ARMCANZ (2000) water quality criteria, onto Proponent-owned land or land of neighbouring landholders (subject to negotiation of a suitable arrangement).

As described in Section 2.4.10.4, the water conditioning plant would improve the quality of water to a potable standard.

Less saline water encountered by the mine, and therefore not requiring treatment through the water conditioning plant, would only be irrigated if it had a measured pH of between 6 and 9 and an electrical conductivity lower than the following.

- Wheat and other grain crops - EC <3 100µS/cm.
- Beef cattle - EC <3 350µS/cm.
- Sheep - EC <6 700µS/cm.
- Horses - EC <4 000µS/cm.
- Poultry - EC <2 000µS/cm.



REFERENCE

- Project Site Boundary
- 290 Contour (m AHD)(Interval = 2m)
- Creek / Drainage Line
- Dam / Water Storage
- Sealed Road
- Unsealed Road / Track
- Pit Top Area Boundary
- Site Access Road
- Rail Loop
- Evaporation Pond
- Water Conditioning Plant and Ponds

SCALE 1:15 000

250 0 250 500 750 m

Figure 4B.5
WATER MANAGEMENT SCENARIOS

It is recognised that pH and EC, whilst generally considered the primary factors in consideration of water for agricultural use, are not the only parameters requiring consideration prior to irrigation or stock watering. The proportion of anions and exchangeable cations, dissolved metals and total dissolved solids (TDS), along with the chemical and physical characteristics of the receiving soils, eg. sodium absorption ratio, pH and dispersibility, are all factors which may influence the suitability of water for irrigation.

Given the sometimes complex nature of water quality, soils and irrigation, the Proponent would prepare an Irrigation Management Plan, for review by the DEC and other relevant government agencies, prior to commencement of irrigation. Notably, the possible requirement to irrigate is at least 15 years away, given the proposed storage capacity of Evaporation / Storage Ponds A to D. This would provide ample time for the Proponent to collect and analyse groundwater samples, as well as determine the annual volume of water that would be irrigated.

4B.1.4.2.6 Road Design

The Site Access Road from the Kamilaroi Highway has been positioned such that no crossing of Kurrajong or Pine Creek is required. Traversing the headwaters of Kurrajong Creek Tributary 2 and several contour banks draining to Kurrajong Creek Tributary 2 would be unavoidable (see **Figure 4B.2**). Either a concrete causeway or appropriately sized pipe culvert would be constructed at each of these points.

The Site Access Road would be crowned so that any water that falls onto the road would be shed into roadside drains either side of the road surface (see Detail A of **Figure 2.8**) and ultimately to the concrete causeways or pipe culverts within the minor drainage lines. The roadside drains would be immediately grassed to provide erosion and sediment control with sediment fencing installed within the minor drainage lines if required. The road would be sealed between the Kamilaroi Highway and Pit Top Area thereby reducing the potential for the generation of sediment-laden water in that area.

4B.1.4.2.7 Hydrocarbon Products

The following management practices would be adopted to ensure water flowing from areas on the Project Site with the potential to generate hydrocarbon-contaminated water, eg. washdown areas, workshops, hydrocarbon storage and refuelling areas, is not contaminated by hydrocarbons.

- All water from wash-down areas and workshops would be directed to oil/water separators and containment systems.
- All storage tanks would either be self-bunded tanks or bunded with an impermeable surface and a capacity to contain a minimum 110% of the largest storage tank capacity.
- All hydrocarbon products would be securely stored.
- All of the Proponents mining fleet would be refuelled within designated areas of the project surface facilities. With the exception of some maintenance activities on underground machinery and mobile equipment, all maintenance works requiring the use of oils, greases and lubricants would be undertaken within designated areas of the project surface facilities, ie. maintenance workshop.

4B.1.4.2.8 Maintenance of Vegetation

The maintenance of vegetation, particularly ground cover, would be an important factor in reducing the velocity of surface water flows and maintaining acceptable surface water quality. By reducing flow velocity, the potential for soil erosion is reduced as would be the potential for further sediment to be entrained by the runoff. The vegetation itself would also act to filter any suspended solids contained within the water. As a general rule, a ground cover would be maintained on the Project Site beyond the planned areas of disturbance. Importantly, the Proponent would undertake progressive revegetation of all completed landforms in order to maintain a ground cover of vegetation at 70% or better, although this value may fluctuate with seasonal conditions.

The areas where the retention and management of vegetation is of highest priority would be those subjected to large quantities of diverted water. This water is likely to be sediment-laden or potentially dirty.

Vegetation, particularly trees, also reduce the risk of dryland salinity by reducing the depth of the water table relative to the root zone of plants. By maintaining and/or enhancing as much vegetation on the Project Site as possible, particularly trees, the potential for dryland salinity would be reduced.

4B.1.4.3 Water Quantity

4B.1.4.3.1 Introduction

The primary goal in managing the quantity of water captured/discharged within the Project Site is to prevent discharges of poor quality water to the downstream environment whilst ensuring sufficient water is captured to meet the operational requirements of the project. Underground and within contained (bunded) areas of the surface facilities, the use of saline water generated underground and contaminated water generated from the Pit Top Area would be maximised. To meet the dust suppression requirements elsewhere on the Project Site, the capture of dirty water would be maximised such that clean water captured and used by the project remains within the maximum harvestable right of the Project Site. Section 4B.1.4.3.2 presents the calculated maximum harvestable right for the Project Site and Section 4B.1.4.3.3 presents a water balance for the Project Site to identify the quantities of water available during the life of the mine.

4B.1.4.3.2 Maximum Harvestable Right

The harvestable right for the Project Site is determined by the following equation.

Harvestable Right = Catchment Area of Proponent owned land x Multiplier Value
= 1 200 x 0.07
= 84ML

The above calculation is based on guidelines provided by the Department of Natural Resources (DNR) using the folder supplied by Department of Land and Water Conservation (DLWC) now DNR titled *Rural Production and Water Sharing Landholders Information Package* for the determination of the maximum harvestable right for each property. It is noted that the maximum harvestable right does not include storages that are used on a mine site for environmental management purposes, eg. capture of 'dirty' saline or sediment-laden water.

4B.1.4.3.3 Site Water Balance

To assess the performance of the various water management structures of the Project Site, WRM (2007) completed water balance modelling for the following scenarios.

- Long Term Simulation (1900 – 2004) to assess the behaviour of the Water Management System when the groundwater inflows are expected to be at their greatest (this is expected to occur after approximately 25 years of mine operations). This water balance modelling considered the performance of the evaporation / storage ponds and RP1 under best estimate in-flow rates (2 000m^3/day), maximum in-flow rates (2 500m^3/day) and was used to identify the trigger in-flow rate above which an overflow of the evaporation / storage ponds would be expected.
- Start-up Water Balance (10 Years) to assess the behaviour of the Water Management System during the first ten years of operation when groundwater inflows are expected to be at their lowest. This water balance modelling was completed to determine the ability of the evaporation / storage ponds to manage the expected and maximum in-flow rates during representative dry, median and wet rainfall periods from the local record. The results of the modelling would illustrate the period of time in which the groundwater modelling needs to be validated in order for alternative water management strategies to be implemented (if necessary).

An AWBM (Boughton, 2003) rainfall-runoff model was developed to determine the runoff volume draining the various catchments on the Project Site and a spreadsheet water balance model developed to determine the behaviour of the various water storages of the Project Site. The model was run over the 105 year period of rainfall data from 1900 to 2004 (inclusive). The use of such a long period of continual data provides a good indication of the behaviour of the various storages over extended dry and wet periods.

A spreadsheet water balance model was developed of the catchments draining to RP1 and the evaporation / storage ponds. Inflows to each pond would be direct rainfall and catchment runoff and also dewatered groundwater into the evaporation / storage ponds. Outflows from each storage would be evaporation, spills and project water use, ie. demand. The following assumptions were used.

- Inflows into RP1 occur as a result of direct rainfall and catchment runoff. It was assumed that 60% of the catchment would be stockpile/hardstand and 40% of the catchment would be natural.
- Water would be pumped out of RP1 at a rate of 0.864ML/day when the stored volume in RP1 exceeds 1ML.
- The evaporation ponds were modelled as a single storage.
- The underground and surface dust suppression and coal wetting demands would be taken directly from the evaporation ponds.

- A constant daily project water demand of 411m^3/day (120ML/year) was assumed (see Section 2.9.2).
- Dam seepage was ignored.

The long term simulation water balance modelling predicts that the likelihood of RP1 spilling is insignificant. However, the modelling predicts that under expected (2 000m^3/day) and worst case (2 500m^3/day) in-flow rates, the evaporation / storage ponds would eventually overflow with annual spill volumes of 412ML and 573ML respectively. This spill volume equates to 1.12ML/day and 1.62ML/day which would require alternative management, eg. through reverse osmosis water conditioning.

Table 4B.12 presents the results of the start-up water balance modelling and provides the reliability of supply and spill estimates from Evaporation / Storage Ponds A and B for representative dry, median and wet 10 year periods of the 116 year dataset.

Table 4B.12
Reliability of Supply and Spill Statistics of Evaporation / Storage Ponds A and B

Parameter	Best Estimate Mine Inflows			Maximum Mine Inflows		
	Dry Period	Median Period	Wet Period	Dry Period	Median Period	Wet Period
Year of initial pond overflow	N[1]	N[1]	N[1]	N[1]	N[1]	10
Years of operational demand shortfall[2]	1, 2, 4, 9	1, 9	3	1	1	-
Note 1: The evaporation / storage ponds would not overflow. Note 2: Based on operational water requirements of 120ML.						
Source: Modified after WRM (2007) – Tables 9-4 & 9-5						

Based on the results presented in **Table 4B.12**, the following assessment is made.

- With the exception of a combined wet period and maximum mine in-flow rate, demand shortfalls would be experienced in the first ten years of the project for all modelled best estimate and maximum mine in-flow scenarios.
- With the exception of a combined wet period and maximum mine in-flow rate, Evaporation / Storage Ponds A and B would retain capacity to store water falling during the initial 10 years of project operations. A spill of 69ML was predicted for Year 10 of the maximum mine in-flow model during the wet 10 year period.

The implementation of an alternative water management strategy may ultimately be required beyond 10 years, however, the water balance indicates that sufficient capacity is provided within Evaporation Ponds / Storages A and B, to enable actual mine inflows to be measured and informed decisions over future water management implemented.

4B.1.4.4 Flooding (Rail Loop Protection)

The rail loop has been located to minimise the potential for flood waters to overtop the rail line (see Section 4B.1.7.6) and therefore limit the Proponent's ability to despatch coal from the Pit Top Area.

In order to protect against the effects of flood-related erosion on the embankments of the rail loop, these would be armoured with ballast (larger diameter competent rock). Following periods of elevated water levels within Kurrajong Creek Tributary 1, the embankments of the rail loop would be inspected and any erosion damage remediated.

4B.1.4.5 Post-Mining Management

With the exception of the established perimeter bund wall, the rail loop and Site Access Road which are intended to be retained post project, the final landform would be constructed to effectively recreate the landform disturbed by the surface facilities activities. Contour banks would be reconstructed along appropriate contour lines to allow for erosion protection of the land.

Monitoring of the final landform and surface water flows on the Project Site would be included in post project monitoring until such time as a stable landform could be demonstrated.

4B.1.5 Management Measures and Contingency Planning

During the site establishment period for the project, areas of the Project Site would be cleared with only limited opportunity for the establishment of grass cover. During this period, should high rainfall occur, it is possible elevated levels of sediment could be entrained in surface water flows and ultimately discharged from the designed water storages. In the event that monitoring confirms elevated sediment levels in water discharged, one or more of the following measures would be adopted.

- The DEC would be advised. Salient preceding weather information would also be provided.
- Additional flocculants would be used to expedite settlement of sediments.
- The sediment basins would be enlarged or additional sediment basins constructed.
- An additional storage dam would be constructed downstream which would become the new site discharge point and monitoring location. DEC would be advised to enable amendment to any Environment Protection Licence.

In the event of a major hydrocarbon spill, one or a combination of the following measures would be implemented.

- Recovery of as much of the spilled material and contaminated soils as possible. These would be placed on an impermeable surface on the Project Site to be later remediated and/or transported to an approved waste depot.
- Excavate one or more holes within or around the spill site to create a hydraulic gradient so that water and the spilled material would accumulate within the holes thus enabling pumping out.
- Monitor downstream surface water and groundwater (if applicable) for any contamination and treat appropriately.

All personnel responsible for handling hydrocarbons on site would be trained to ensure all site specific procedures are followed.

In the event that one of the evaporation / storage ponds or other saline water transfer or storage structure are breached, one or a combination of the following measures would be implemented.

- Dewatering from the underground workings would be transferred to an intact evaporation / storage ponds along with any water remaining in the breached pond. In the event no suitable storage facility is available, the underground workings would be evacuated and dewatering ceased until a suitable storage area is identified.
- The breached pond or pipe would be repaired immediately and inspected by a suitably qualified person prior to re-integration into the saline water management system.
- The project water cart would be used to transfer non-saline water to the area of the spill to flush and dilute the water discharged. As far as practical, at least 4 times the volume of the spilled water would be used to flush the downstream environment.
- Monitor downstream vegetation for any impacts of increased salinity and treat appropriately.

4B.1.6 Impact Assessment Criteria

As noted in Section 4B.1.3, the project has the potential to impact on both the surface water quantity and quality in the absence of appropriate management or controls. The following assessment criteria would provide an indication of the impact of the project on surface water discharged from the Project Site.

Surface Water Quantity

The acceptability of any decrease in the quantity of clean water available downstream of the Project Site would be assessed against the maximum harvestable right for the Project Site of 68ML.

Surface Water Quality

The quality of surface water discharged from the Project Site would be assessed against NSW DEC guidelines for pH, suspended solids and grease and oil as identified in **Table 4B.13**. **Table 4B.13** also includes a criteria value for salinity (as TDS). This value is based on the ANZECC (2000) limit for irrigation.

Table 4B.13
Discharge Limits – Surface Water

Parameter	50^{th} Percentile Limit	70^{th} Percentile Limit	100^{th} Percentile Limit
pH	-	-	6.5 to 8.5
Total Suspended Solids (mg/L)	20	35	50
Turbidity (NTU)	-	-	50
Salinity (as EC) (µS/cm)	-	-	800
Grease and Oil (mg/L)	-	-	10
Source: Soil Services (2005) – Table 3			

4B.1.7 Assessment of Impacts

4B.1.7.1 Introduction

Following the adoption of the water management controls identified in Section 4B.1.4 and mitigation measures identified in Section 4B.1.5, the impacts on surface water within and beyond the Project Site have been assessed as follows.

4B.1.7.2 Surface Water Catchments

The final landform created following mining would be largely the same as the pre-project landform. The project would result in the catchment of Kurrajong Creek Tributary 1 being increased by 19.6ha while that of Kurrajong Creek Tributary 2 would be decreased by the same area. This marginal change would have a negligible impact on the two catchments and no impact on the total catchment of Kurrajong Creek.

No other catchment would be significantly effected by the project.

4B.1.7.3 Surface Water Quantity

The total capacity of the existing farm dams on the Proponent-owned land holding is 46.5ML, which is less than the maximum harvestable right of 68ML. The proposed evaporation / storage ponds and retention pond are not included in the maximum harvestable right calculation because they are used for environmental management purposes. The catchment area of these two storages is about 1% of the total Kurrajong Creek catchment, in which these dams are located, and would therefore have a negligible impact on water users and environmental flows downstream of the Project Site.

4B.1.7.4 Surface Water Quality

The Pit Top Area has been designed to capture all dirty water generated by project-related activities and direct it to SP1, RP1 or hay bale protection via catch drain CD1 or natural drainage lines. The design of SP1 would ensure that sufficient time is provided for any suspended sediment to settle out prior to discharge from the Project Site. The design of RP1 and its operating rules would ensure that the potentially dirty water collected is pumped to the evaporation / storage ponds before it overflows.

The construction of Evaporation Ponds A, B, C and D would cater for dewatered mine in-flows which may have an elevated salinity level. A proportion of this dewatered groundwater would be used for dust suppression, a proportion allowed to evaporate and that proportion measured to be of suitable quality for irrigation or stock watering on-sold or transferred to a local landholder in accordance with an Irrigation Management Plan to be developed. To further assist in maintaining adequate storage volume within the evaporation / storage ponds, jet sprays may be used which would increase evaporation by 5% to 7%.

The adoption of the mitigation measures presented in Section 4B.1.4.3 would ensure that a discharge of water from the Project Site that exceeds the water quality criteria would be limited to isolated occurrences. As a result, the likely impact of the project on surface water quality external to the Project Site would be negligible.

The Namoi Catchment Management Authority has established targets to be achieved within the Namoi River Catchment with reference to river salinity (NCMB, 2003). The project has therefore been assessed against the four following targets.

- *Target RS.1 - Water quality*
  By 2010 to have all land managers (including urban) using better management practices throughout the catchment to minimise the mobilisation of salt to rivers.

  Saline water not suitable for irrigation or stock watering purposes would be managed within the evaporation / storage ponds of the Pit Top Area or treated to reduce salt levels through a water conditioning plant. Groundwater measured to be of suitable quality for agricultural use (irrigation or stock watering) would either be discharged to storage Ponds C or D, farm dams of the Project Site or on-sold/transferred to local land holders in accordance with an Irrigation Management Plan to be developed by the Proponent.

  The salinity of any other water discharge from the Project Site should be comparable with existing water quality provided this water is segregated from dewatered groundwater.

- *Target RS.2 - Gully control*
  By 2010, halt existing gully erosion and bed lowering within priority salinity sub catchments by constructing 1000 gully control and bed lowering structures to reduce the mobilisation of salt to the river.

  The comprehensive surface water management controls presented within Section 4B.1.4 would ensure gully erosion is minimised on the Pit Top Area and therefore would ensure gully control structures are not required.

  Target RS.3 - New development
  From 2001, new investment requiring a Development Application or requiring approval under Part 5 of EP&A Act, to result in no net increase in the salt load to the river.

  The project is to be assessed under Part 3A of the EP&A Act. This notwithstanding, the Project Site water discharge should contribute to no net increase in the salt load of the Namoi River (based upon the observations relating to Target RS.1 above).

- *Target RS.4 - Point sources*
  By 2010 existing point sources of river salinity to have a reduction of 10% on current (2001) salt loads.

  There are no point sources of river salinity associated with the project.

4B.1.7.5 Erosion and Sedimentation

The construction of the water quality management controls identified in Section 4B.1.4 and implementation of mitigation measures identified in Section 4B.1.5, in conjunction with the commitment of the Proponent to enhance the vegetation (particularly grass) cover (see Section 4B.1.4.2.8), would reduce the potential for erosion and sedimentation on the Project Site.

4B.1.7.6 Flooding

Localised and short duration flooding may occur within the Pit Top Area during and following a 1 in 100 year ARI flood event. Based on modelling undertaken by WRM (2007), only the rail loop on the Pit Top Area would be impacted by 1 in 100 year ARI flood. The modelling found that the rail level would remain 1.32m above the 1 in 100 ARI flood. The ballast on the rail loop embankments would provide protection against the erosive forces of flood waters and the potential impact on the rail loop and/or rail loop function.

In addition, the modelling indicates that the rail loop does not impact on flood levels because constriction of flow already occurs within the backwater of the Kurrajong Creek Tributary 1 caused by the North Western Branch Railway (WRM, 2007).

4B.1.7.7 Dryland Salinity

In relation to the potential impacts of dryland salinity, the three targets established by the Namoi Catchment Management Authority to be achieved within the Namoi River Catchment (NCMB, 2003) have been referenced.

- *Target DS.1 - Use of best management practices*
  By 2010, to have 60% of land managers and an area of 18 600km² across the whole of the Namoi catchment managed to minimise the mobilisation of salt to a set of agreed best management practices and in identified hazard areas to increase the adoption rate to 80%.

  The project would have very little impact on existing deep-rooted vegetation of the Project Site which are most important in the prevention of dryland salinity. By lining the evaporation / storage ponds with a suitably impermeable layer, the migration of salts from this saline water to the groundwater would be prevented. Considering these two factors, the project is considered to be managed to minimise the mobilisation of salt and therefore contribute to the achievement of this target.

- *Target DS.2 - Cap and pipe the bores*
  By 2010 Cap and Pipe all (25) high flow bores (>5L/s) in the Namoi portion of the Great Australian Basin.

  GHD (2007) has determined that the project would be unlikely to impact significantly on groundwater from the Great Australian (Artesian) Basin (see Section 4B.2).

- *Target DS.3 - Discharge areas*
  From 2001 retain all vegetation on saline discharging areas and establish an additional 1 000ha of ground cover to be managed at greater than 70% cover.

  The Proponent intends to contain all saline water (not suitable for other agricultural purposes) within the evaporations ponds and defined areas of the Pit Top Area for the life of the project and remediate and rehabilitate the evaporation / storage ponds once mining ceases.

4B.1.8 Monitoring Program

Table 4B.14 presents a conceptual water quality monitoring program to be implemented for the project. Monitoring has already commenced at a number of these locations as presented on **Figure 4B.1**. The program would be revised / modified in consultation with the NSW DEC, DoP and DNR on the basis of monitoring results.

The salinity (as electrical conductivity) of mine in-flows dewatered from the underground workings would be continuously monitored such that suitable quality water could be discharged from the Pit Top Area to farm dams of the Project Site or on-sold or transferred to local land holders for agricultural use (irrigation or stock watering). Any discharge or transfer of this water would be in accordance with an Irrigation Management Plan to be prepared for the project on approval.

Table 4B.14
Surface Water Monitoring Program

<table>
<tr><th>Location</th><th>Parameter</th><th>Frequency</th></tr>
<tr><td>Meteorology Station*</td><td>Rainfall, wind speed, wind direction</td><td>Continuous</td></tr>
<tr><td>Dewatered Mine In-flows</td><td>TDS (or EC)</td><td>Continuous</td></tr>
<tr><td>Retention Pond 1 (RP 1)</td><td>EC, TDS, pH, TSS, Total Organic Carbon</td><td>Following exceedance of design level or discharge</td></tr>
<tr><td>Sediment Pond 1 (SD 1)</td><td>EC, TDS, pH, TSS, Total Organic Carbon</td><td>Following discharge from SP1</td></tr>
<tr><td>Evaporation / Storage Ponds</td><td>Water level</td><td>Weekly</td></tr>
<tr><td>Kurrajong Creek Tributary 1 and 2 upstream* (KC1US, KC2US)</td><td rowspan="4">EC, TDS, pH, TSS, Total Organic Carbon, water level</td><td rowspan="4">Following a significant rain event leading to flow</td></tr>
<tr><td>Kurrajong Creek Tributary 1 and 2 downstream* (KC1DS, KC2DS)</td></tr>
<tr><td>Kurrajong Creek (upstream and downstream) (KCUS, KCDS)</td></tr>
<tr><td>Pine Creek (PC)
Pine Creek Tributary 1 (PC 1)</td></tr>
<tr><td colspan="3">Source: Modified after WRM (2007) – Section 11 * see Figure 4B.6</td></tr>
</table>

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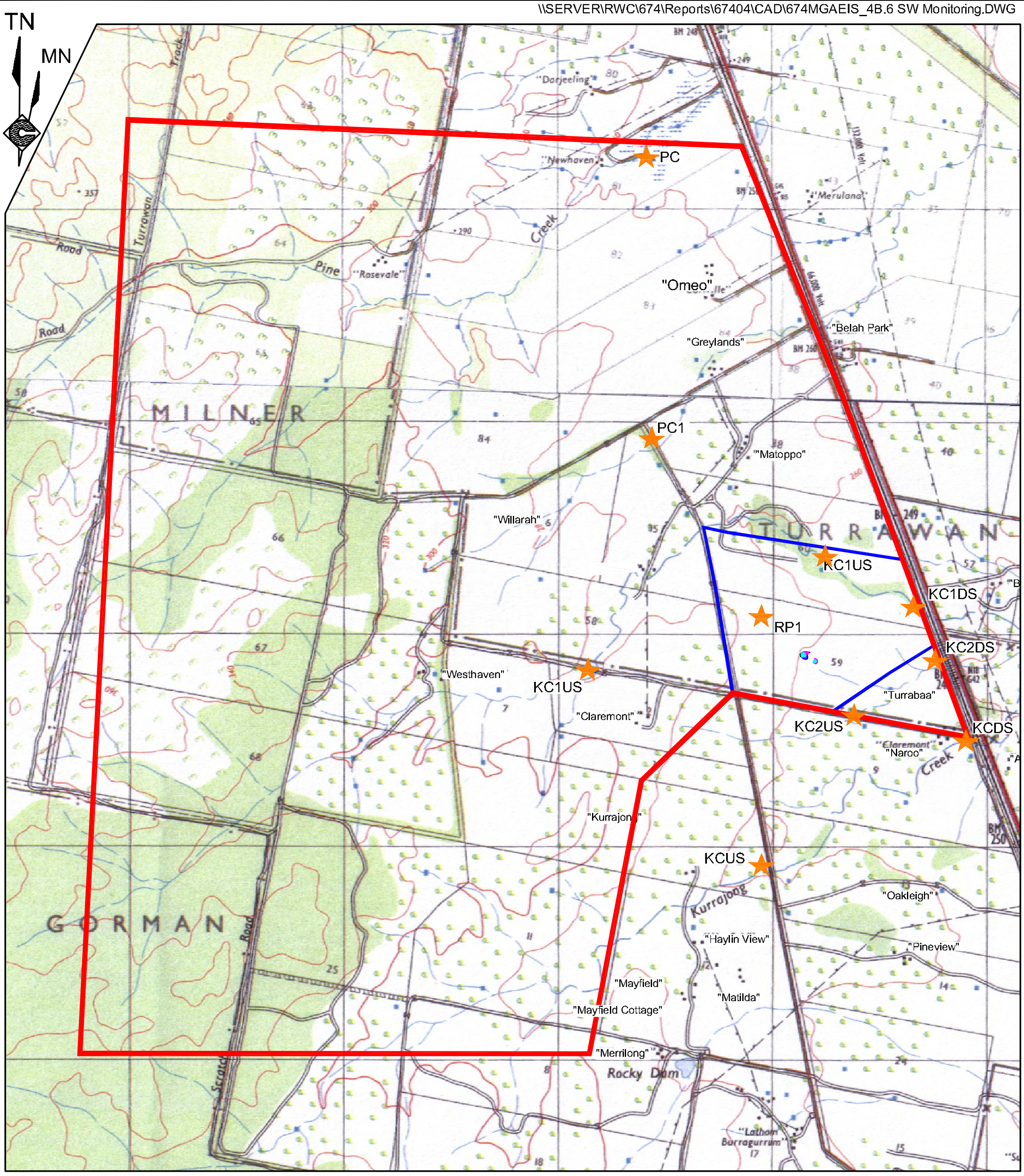


REFERENCE

- Project Site Boundary
- Pit Top Area Boundary
- ★ Surface Water Monitoring Location

KC	Kurrajong Creek
KC1	Kurrajong Creek Tributary 1
KC2	Kurrajong Creek Tributary 2
US	Upstream
DS	Downstream
PC	Pine Creek
PC1	Pine Creek Tributary 1
RP	Retention Pond

SCALE 1:60 000

1 0 1 2 3km

Source: WRM (2007) - Figure 11-1

Figure 4B.6
CONCEPTUAL WATER QUALITY MONITORING PROGRAM

Water levels in the evaporation / storage ponds and RP1 would be monitored on a weekly basis using a water level gauge (0 to 4.0m) which would be installed in each pond and a gauge board in RP1 signifying the 1ML storage volume. The water level gauge in Pond D would also contain two marks to identify when remaining storage capacity is less than 69.3ML (indicating that additional evaporation or irrigation measures should be undertaken) and 32.2ML (when the DEC would be informed that a spill is possible). When the water level in RP1 reaches the gauge board level, a pump would be switched on to transfer water to Evaporation Pond A.

Water quality samples would be collected in the evaporation / storage ponds whenever the water level exceeds the nominated values above. The water quality parameters to be tested include the following.

- Total Dissolved Solids (TDS).
- Total Suspended Solids (TSS)
- Electrical Conductivity.
- pH.

Water quality samples would be collected, and analysed for the above noted parameters, during or following discharge events from the Sediment Pond (SP1).

All monitoring would be undertaken in accordance with site-specific procedures manuals reflecting relevant industry best practices and guidelines such as the NWQMS Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC, 2000).

4B.2 GROUNDWATER

The groundwater assessment was undertaken by GHD Pty Ltd (GHD, 2007). The full assessment is presented as Part 2 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections.

4B.2.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential groundwater impacts requiring assessment and their unmitigated risk rating are as follows.

- Groundwater pollution as a result of leakage or spillage (moderate to high risk).
- Drawdown of:
  - aquifers below the Project Site (high risk);
  - aquifers beyond the Project Site within Gunnedah Groundwater Management Area (high risk); and
  - aquifers of the embargoed Great Artesian Basin and Upper Namoi River alluvium (high risk).
- Reduction in the yield / saturated thickness of groundwater bores:
  - on the Project Site or Proponent-owned land (high risk);
  - by <15% on non-project related properties (high risk); and
  - by >15% on non-project related properties (high risk).
- Impacts on groundwater-dependent ecosystems (moderate risk).

In addition, the Director-General's requirements issued by the DoP require that the assessment of soil and water include a detailed water balance, and refer to the *Guidelines for Fresh and Marine Water Quality* (ANZECC), and the various *State Groundwater Policy* documents.

This section commences with a review of the existing regional and local hydrogeology, local availability and use of groundwater resources and current statutory framework for the management of groundwater. Potential sources of groundwater contamination are then identified and the operational safeguards, controls and mitigation measures described. The section concludes with an assessment of the residual impacts following the implementation of these safeguards, controls and mitigation measures.

4B.2.2 The Existing Environment

4B.2.2.1 Regional and Local Hydrogeology

Regional Geology

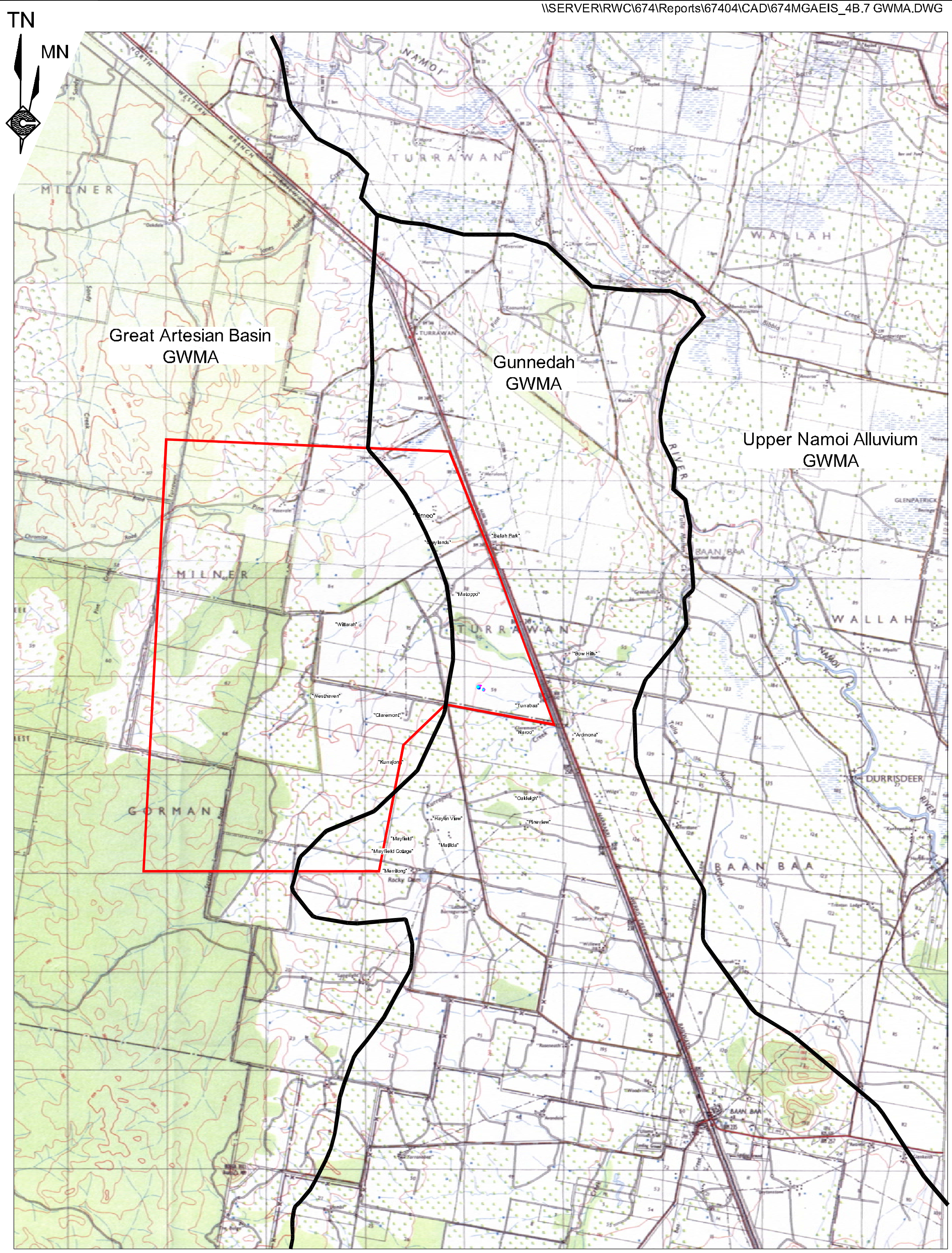
As mentioned in Section 2.2.1, the Project Site is located within the Mullaley Sub-basin, which is part of the Gunnedah Basin. In the western part of the Project Site, the Gunnedah Basin sequence is unconformably overlain by the Jurassic age Surat Basin sequence. The Jurassic and Triassic sequences are overlain in northern and western parts of the Project Site by Quaternary sand and talus material. These alluvial channel and overbank deposits of gravels, sand, silt and clay are associated with the Namoi River and can reach a thickness of up to 120m.

Regional Aquifers and Groundwater Management Areas (GWMA's)

The Triassic, Jurassic and Quaternary sequences contain differentiated aquifers which have been defined by the Department of Natural Resources as groundwater management areas (GWMAs). **Figure 4B.7** presents the mapped locations of the three GWMA's in relation to the Project Site. These are described as follows.

- Great Artesian Basin GWMA (601) which is defined by the easterly extent of the Surat Basin sequence. The Surat Basin is a large intra-cratonic basin covering approximately 270 000km^2 with the southern third of the basin occupying a large part of northern New South Wales. The Surat Basin sequence of the Project Site includes the following formations.
    - The Pilliga Sandstone: which is a Jurassic age braided stream deposit consisting of very well sorted medium to very coarse grained, quartzose sandstone with very minor interbeds of mudstone and siltstone. This formation constitutes the major intake beds and aquifers for the Great Artesian Basin groundwater system and occurs across the northwestern part of the Project Site. Notably, a piezometer constructed within this formation did not intercept any water indicating it is unsaturated on the Project Site.
    - The Purlawaugh Formation: which consists of thinly bedded, lithic, fine to medium grained sandstone interbedded with siltstone and mudstone. The argillaceous sediments weather readily and the sandstone is noted as having low porosity and permeability.

\\SERVER\RWC\674\Reports\67404\CAD\674MGAEIS_4B.7 GWMA.DWG



REFERENCE
Project Site Boundary
Groundwater Management Area Boundary

SCALE 1:120 000
2 0 2 4 6km

Source: GHD (2007) - Figure 3

Figure 4B.7
BARWON REGION GROUNDWATER MANAGEMENT AREAS

  - The Garrawilla Volcanics: which consists of flows of basalt and trachyte and interbedded pyroclastics. Individual flows range in thickness from 1m to 8m and range from extremely vesicular to non-vesicular. The volcanics are found sub-cropping under alluvium and represent the north-south trending boundary between the Surat Basin and Gunnedah Basin Sequence, roughly dividing the Project Site down the centre.

- Gunnedah GWMA (604) which is comprised of the Permo-Triassic Gunnedah Basin sequence and is found in the eastern part of the Project Site. The Gunnedah Basin sequence of the Project Site includes the following formations.
  - The Mid Triassic Napperby Formation which is a thick sequence of siltstone/sandstone laminate overlain by sandstone. This formation sub-crops under alluvium/talus material in the eastern part of the Project Site. A basalt sill of up to 26m in thickness splits the Napperby Formation through the central part of the Project Site.
  - The Early Triassic Digby Formation which is a poorly sorted lithic conglomerate alluvial fan deposit and is thought to sub-crop under alluvium near the mine drift portal and to the east of the Project Site.
  - The Late Permian Black Jack Group which includes the Hoskissons Coal Seam with subordinate layers of fine grained sandstone, carbonaceous siltstone and claystone. These layers have been classified as follows.
    - Arkarula Formation – Quartzose sandstone and siltstone, typically the upper 10m of the Black Jack Formation over the Project Site.
    - Brigalow Formation – Coarse sandstone and conglomerate interbedded within the coal seam and grades laterally into the Arkarula Formation, thickening to the west across the Project Site from 2m to 10m.
    - Pamboola Formation – Lithic sandstone, siltstone, claystone and coals. Continuous over the Project Site below the Arkarula Formation and Brigalow Formation with a thickness of between 55m to 75m.
  - The Late Permian Millie Group, Early Permian Bellata Group and Gunnedah Basin sequence basement lie beneath the Black Jack Group but would not be intersected by the proposed underground workings.
- The Upper Namoi GWMA (004) which is contained in the unconsolidated sediments of the Namoi River and its tributaries. The Upper Namoi GWMA is divided into 11 zones of which Zone 5 is found to the east of the Project Site.

Local Hydrogeology

Through a review of the available literature and mapping of the hydrogeological properties of the various formations below the Project Site, and site investigations which involved the construction and permeability testing of eight groundwater bores, GHD (2007) determined that groundwater at the Project Site is typically associated with fractures encountered in the consolidated sedimentary rocks and volcanics. In consolidated sandstones and shales, groundwater can occur both in the pore space in the rock matrix and within fractures and joints, whereas in the volcanics groundwater is generally only associated with fractures and joints. In the absence of fracturing, the inter-bedded and laminated nature of the Napperby and Purlawaugh Formations is likely to restrict vertical groundwater flow in these formations.

Shallow groundwater intersections at depths of 15m to 30m below surface are associated with the weathered and fractured strata of the Garrawilla Volcanics. Yields from this aquifer vary by an order of magnitude (0.4 L/s to 4 L/s) illustrating the Garrawilla Volcanics below the Project Site to be moderately to highly permeable. Between 35m and 75m below surface, groundwater intersections within a confined to semi-confined fractured rock aquifer occur within the Purlawaugh, Napperby and Garrawilla Volcanics formations. Yields are generally low (<0.6L/s) indicating low permeability. As noted in Section 4B.2.2.1, while the Pilliga Sandstone, which is identified as constituting major intake beds of the Great Artesian Basin, has been mapped over the western half of the Project Site, it was either not intercepted by any of the eight monitoring bores or was unsaturated (GHD, 2007).

Deeper groundwater intersections were encountered from 74m to 144m below surface and were typically associated with the fractures in the Basalt Sill and Napperby Formation below the sill. Given the observed fractured nature of the sill in some boreholes, this unit may provide localised preferential flow paths, however, as the sill is not continuous over the Project Site, the hydraulic properties of the overlying and underlying Napperby Formation are likely to be more important in influencing the regional hydraulic connection in the deeper fractured rock aquifer(s). The lack of groundwater intersections in the Digby Formation in the exploration drilling, very low yields indicated in the DNR data and low permeability results suggests this formation is likely to be acting as an aquitard under natural flow conditions.

The recent installation and pump testing of piezometers within the Hoskissons Coal Seam, Arkarula Formation and Pamboola Formation encountered groundwater, however, low permeability values and slow recharge rates suggest the three formations are unlikely to provide significant groundwater intersections.

Groundwater Flows

The direction of groundwater flows vary between shallow, localised flow systems which are influenced by topography and surface water features and regional flow systems which occur at depth and can be influenced by basin structure and stratigraphy.

Within the shallow aquifers of the Quaternary alluvium, a northeasterly flow direction towards the Namoi River is indicated by monitoring of the shallow groundwater bores on the Project Site.

The groundwater flow pattern in the deeper fractured rock aquifers are likely to be highly heterogeneous and depend more on the nature and continuity of the fracturing and jointing than the hydraulic properties of the aquifer. The discontinuous and infrequent nature of the groundwater intersections in the deeper aquifers would suggest that the fracturing does not provide extensive hydraulic connections over the area but may provide localised preferential flow paths.

Consistent with the low permeability of this unit, no clear flow direction has been determined for the Hoskissons Coal Seam. This would suggest poor hydraulic connection over the Project Site with fractures providing some localised flow paths.

4B.2.2.2 Surface Water – Groundwater Interaction

While groundwater has been recorded as high as 5m below surface in some bores (NC-098), suggesting there is potential for groundwater to discharge to the surface drainage lines (depending on the depths of the local creeks), the general groundwater levels of 20m to 50m below surface suggests the majority of the Project Site is located in groundwater recharge zones. This suggests recharge to the shallow local flow systems is in the elevated catchment areas to the west and discharge would be towards the lower regional drainage lines.

No evidence of natural springs was identified on or surrounding the Project Site.

4B.2.2.3 Groundwater Quality

Table 4B.15 presents the results for groundwater pH and TDS based on sampling and chemical analyses of groundwater from each groundwater monitoring bore installed. Salinity ranges from below 2 000mg/L to over 10 000mg/L TDS for the upper four formations tested while pH is in the neutral to slightly alkaline range. No groundwater observation bores monitor the Digby Formation, Hoskissons Coal Seam or Black Jack Formation and no groundwater intersections were encountered in these formations during the exploration drilling, hence no groundwater analyses are available.

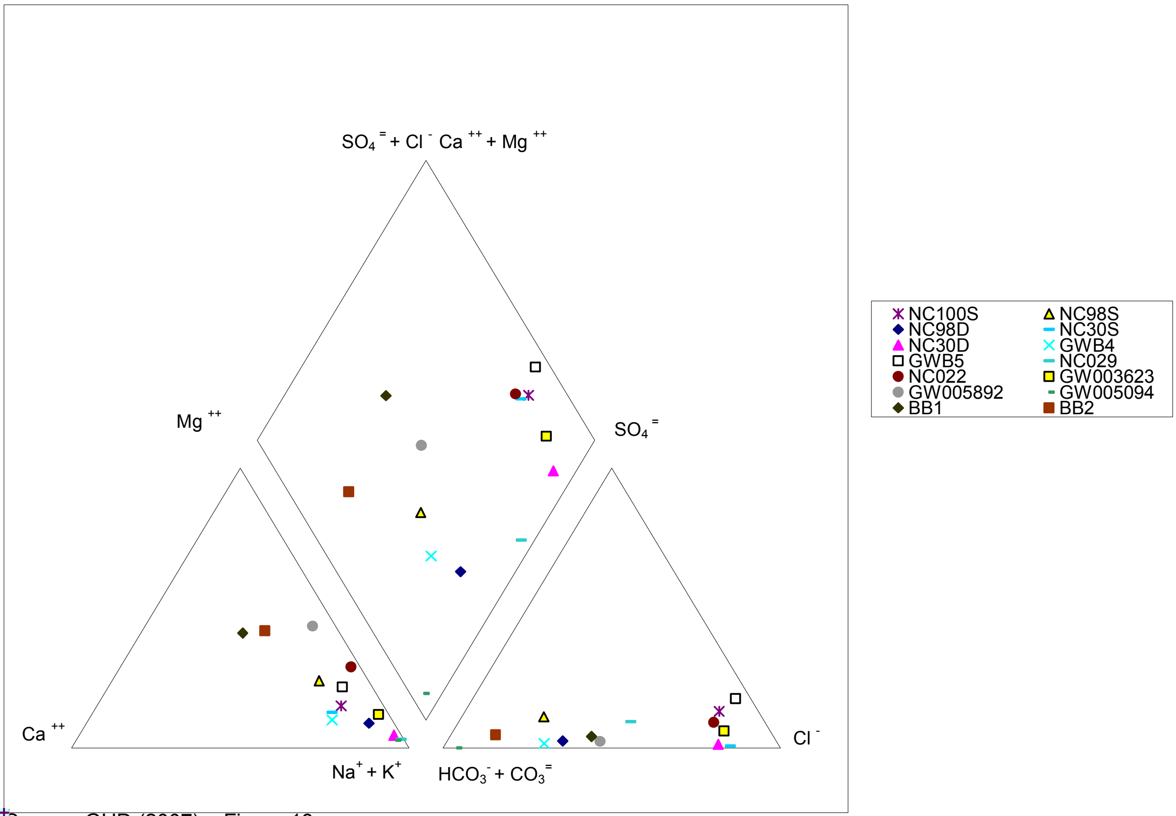
Table 4B.15
Groundwater Monitoring Bore pH and TDS Data

Formation	Number of Samples	Groundwater pH	Groundwater TDS (mg/L)
Purlawaugh Fm	4	6.25 – 8.0	1 140 – 16 250
Garrawilla Volcanics	5	6.27 – 8.1	684 – 11 400
Napperby Fm	6	6.65 – 7.9	708 – 10 200
Basalt Sill	3	7.4 – 8.7	1 860 – 16 250
Napperby Fm (below Sill)	1	7.8	8 310
Digby Fm	0	–	–
Hoskissons Coal Seam	1	8.5	1350
Arkarula Formation	1	7.1	7 740[1]
Pamboola Formation	1	6.0	7 140[1]

[1] TDS values were not measured but converted from measured EC values. Further analysis of groundwater chemistry results by Parsons Brinkerhoff as part of a technical memorandum on design features and a concept design for water conditioning indicates this converted value may underestimate TDS by between 50% and 70% (see PB, (2007) – Appendix 4).

Source: GHD (2007) – Table 9

All available major ion analyses within 5km of the Project Site were plotted on a Piper Trilinear plot (see **Figure 4B.8**) which identifies two dominant groundwater types (based on the predominant anion). 14 bores clearly show chloride as the predominant anion. The remaining 11 bores show bicarbonate and carbonate to be the predominant anions but also show a broader mix of anion percentages along the bicarbonate – chloride axis. Bicarbonate type groundwater was encountered at depths from 5m to 184m and the salinity ranged from 700mg/L to 9 990mg/L TDS with the shallower groundwater typically being fresher. The chloride type groundwater showed a greater range of salinity from 1 200mg/L to over 16 000mg/L TDS and was encountered at depths ranging from 12m to greater than 140m.



Source: GHD (2007) – Figure 13

Figure 4B.8
GROUNDWATER QUALITY

Variations in the groundwater chemistry from the three Black Jack Group bores sampled in the Project Site are evident. The Arkarula Formation sample was a strongly bicarbonate type groundwater whereas the Pamboola Formation sample, although it had a similar salinity at greater than 7 000mg/L TDS, showed chloride as the predominant anion. The relatively lower salinity of the Hoskissons Coal Seam is consistent with results from samples taken from the Hoskissons Coal Seam for the Sunnyside Coal Project (GHD, 2007) and may be due to the shallower location of the coal seam on the margin of the Boggabri Ridge, which is therefore closer to recharge zones from infiltrating surface water. The difference in groundwater chemistry would also indicate poor vertical hydraulic connection between the Black Jack Group formations under natural conditions.

In summary the groundwater chemistry data suggests that groundwater of the Project Site is generally saline in the 5 000mg/L to 15 000mg/L TDS range over most of the Project Site with a localised fresher groundwater zones present especially in the areas where the Garrawilla Volcanics subcrop.

These results are comparable with those contained within a DNR database of local groundwater bores which indicates the groundwater in those bores screened over the deeper Gunnedah Basin sediments to be saline (between 7 000mg/L and 10 000mg/L). Groundwater in the Jurassic sediments Surat Basin Jurassic sediments, however, is generally considered to be of good quality (non-saline).

4B.2.2.4 Water Use and Availability

Regional Groundwater Bores

Groundwater occurring regionally (ie. within 5km of the Project Site) is used predominantly for domestic or agricultural purposes, however, the extent of use is invariably dependent on the quality of water. A search of the DNR groundwater bore database for water availability / use and water quality was completed for a 5km distance from the Project Site boundary (see **Figure 4B.9**). The search revealed the following.

- Numerous bores are registered in the Quaternary alluvium of the Namoi River Valley (**Figure 4B.9**). These bores are typically shallow bores screened within the Quaternary alluvium and the pumped water used for domestic, stock and irrigation purposes. Some of the deeper irrigation bores are up to 80m deep and have yields of up to 90L/s.
- Of the bores registered for domestic, stock and general purposes, eleven are likely to screen the Pilliga Sandstone and possibly other deeper Jurassic sediments. The bore yields were reported between 0.1L/s and 0.8L/s and groundwater quality was consistently described as good. The standing water levels varied between 50m to 80m below surface level close to the Project Site to typically between 30m to 40m depth further to the northeast.
- Two of the stock and domestic use registered bores screen the Garrawilla volcanics produce a water quality described as good and a relatively high yield of 2.75L/s.
- A number of the groundwater bores within 5km of the Project Site are identified as screening the Napperby Formation of the Gunnedah GWMA. Water quality from these bores varies from "very good" to a TDS of up to 7 000mg/L with yields less than 2L/s.
- A small number of registered bores are identified as screening the Black Jack Formation. Water quality from these bores is generally of poorer quality (TDS >7 000mg/L).

Local Groundwater Bores

Figure 4B.10 displays the locations of local groundwater bores (ie. within approximately 1km of the Project Site) together with the geological mapping across the Project Site. The formation from which the bore is identified by GHD (2007) as drawing water is also identified.

The concentration of total dissolved solids (TDS) of the water sampled from the Project Site (a reflection of salinity levels) generally exceeds 3 000mg/L, considered the maximum for potential drinking water supply (DEC 2004), and as such the possible beneficial uses of this water are considered to be as follows.

- Agricultural Use. The groundwater TDS generally exceeds the recommended limits for irrigation application but falls within some of the livestock watering tolerances and therefore this beneficial use is considered relevant.

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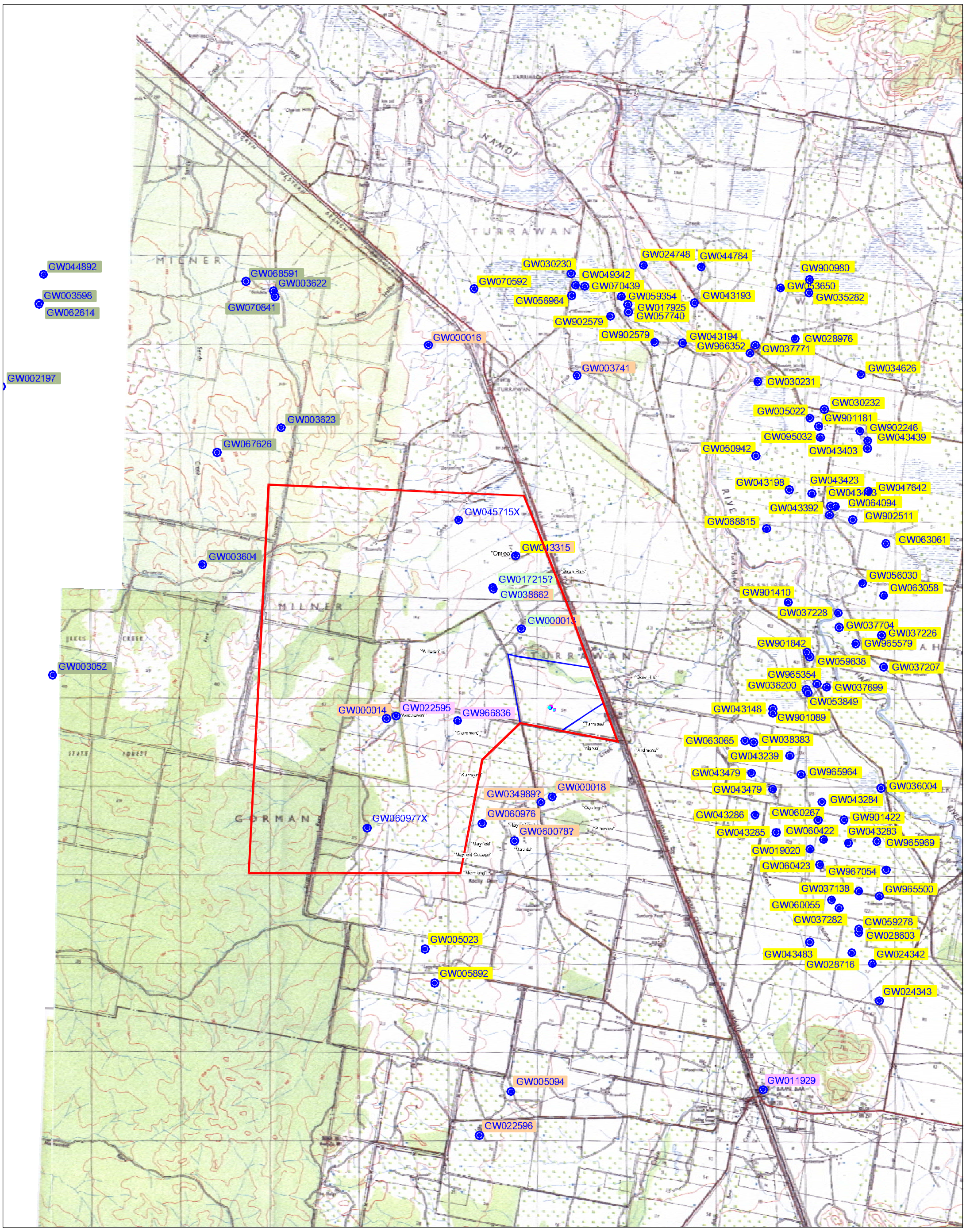
TN
MN



REFERENCE
- Project Site Boundary
- Pit Top Area Boundary
- Registered Groundwater Bore

GROUNDWATER BORES

Aquifer / Formation

(yellow)	Alluvial
(green)	Pilliga / Purlawaugh
(pink)	Garrawilla Volcanics
(orange)	Napperby
(blue)	Black Jack / Coal
X	Backfilled
?	Assumed

SCALE 1:150 000

2.5 0 2.5 5.0 7.5 km

Groundwater Bore Source: DNR Groundwater Database (as provided by GHD (2007)

Figure 4B.9
REGIONAL GROUNDWATER BORES

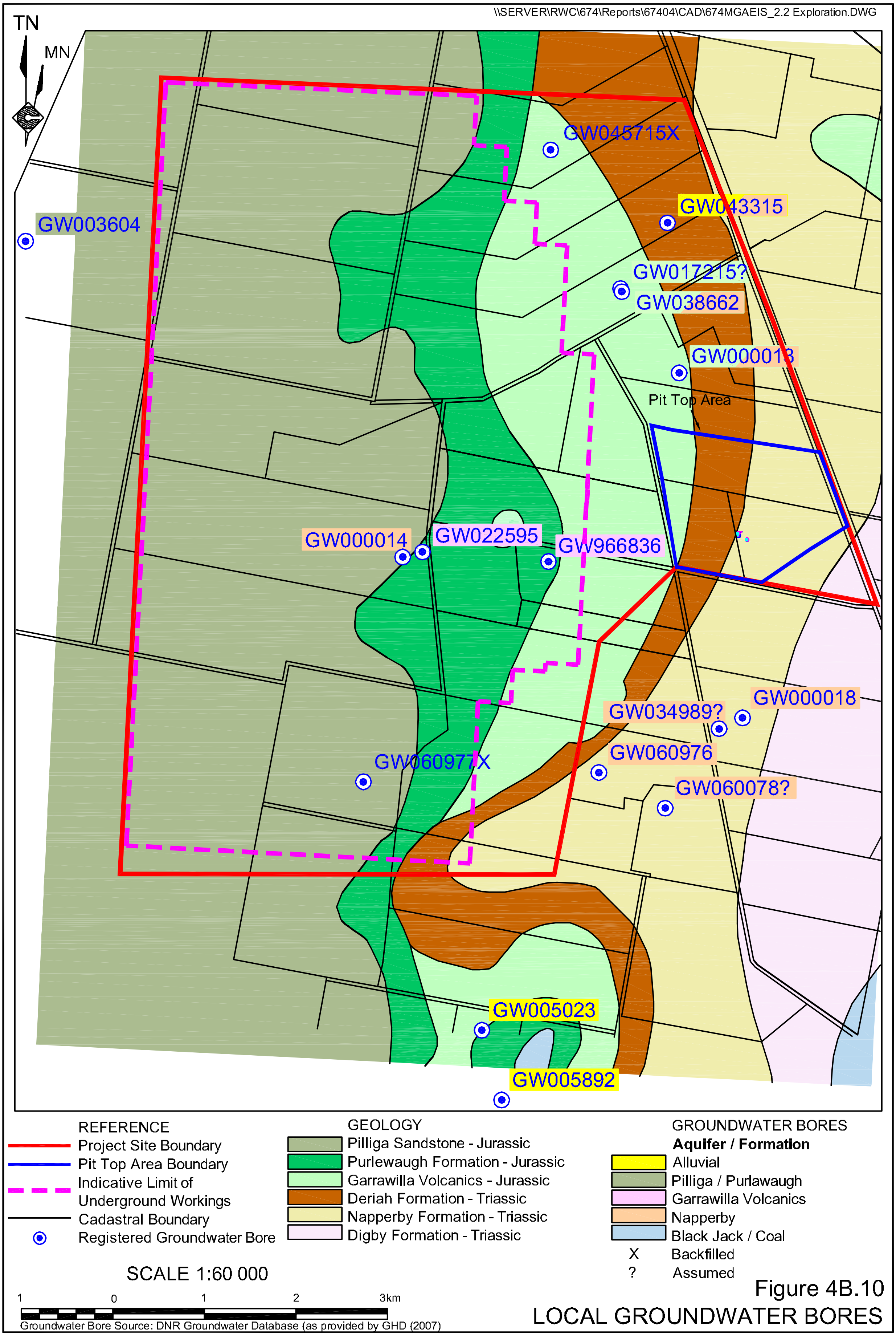


Figure 4B.10
LOCAL GROUNDWATER BORES

- Recreational Purposes. As it cannot be demonstrated with the available data that no groundwater discharge to surface water is occurring, this beneficial use is currently assumed to apply.
- Ecosystem Protection. Although no groundwater dependent ecosystems have been identified by DNR to date in the Gunnedah GWMA, this beneficial use is included as the western part of the Project Site is located in the recharge area for the GAB GWMA where groundwater dependant ecosystem have been identified.

Within the Project Site itself, thirteen groundwater bores are registered, primarily for stock and domestic purposes. Consistent with the data obtained by GHD (2007), with the exception of two bores screened within the Garrawilla Volcanics, water is considered saline and therefore generally only useful for some stock watering purposes.

4B.2.2.5 Regulatory Framework

Water sharing plans, ie. statutory instruments under the *Water Management Act 2000*, are being developed for the GWMAs that occur on the Project Site. These plans are designed to provide long term environmental protection and achieve a level of sustainability of the groundwater resources as well as directing how water would be allocated and shared among the different water users and apply the goals and principles of the State Groundwater Policy at the regional and local level.

The NSW EPA 2003 State of the Environment Report identified groundwater use in the Great Artesian Basin (GAB) GWMA exceeded 100% of the sustainable yield. In the Gunnedah GWMA, groundwater use is less than 30% of sustainable yield whereas in the Upper Namoi GWMA, groundwater use is 70% to 100% of sustainable yield. As a consequence, the Upper Namoi GWMA and GAB GWMA have been identified by Department of Natural Resources (DNR) as high risk aquifers (DLWC 1998a).

4B.2.3 Potential Impacts on Groundwater Quality and Availability

4B.2.3.1 Potential Sources of Groundwater Contamination

The potential sources of groundwater contamination include:

- fuel, oil or other hydrocarbon spills or leaks;
- recharge of saline water to fresh water aquifers; and
- explosives residues.

Based on experience elsewhere, explosives residues would be unlikely to have any measurable effect on the chemistry of the groundwater. In any event, negligible quantities of explosives would be used throughout the life of the mine. Potential contamination by fuel, oil or other hydrocarbons, and/or localised increases in the salinity of currently non-saline aquifers, are therefore the main issue that needs to be managed across the Project Site.

4B.2.3.2 Potential Impacts on Groundwater Availability

Underground workings would intercept up to nine geological formations of varying thicknesses and permeability. The dewatering of the in-flowing groundwater ("mine in-flow") would also maintain the pressure gradient between the aquifer (high pressure) and void (low pressure) resulting in the continuance of these mine in-flows. Ultimately, the dewatering required may lead to a lowering of the water levels within the intercepted aquifers, which may subsequently impact on the yield of the groundwater bores on landholdings surrounding the Project Site.

The potential lowering of shallow and non-saline aquifers which recharge the GAB and Upper Namoi GWMA's also has the potential to affect any groundwater dependent ecosystems which may be dependent to varying degrees on this water supply.

4B.2.4 Management Measures and Mitigation Measures

4B.2.4.1 Groundwater Contamination

Although it is not anticipated that the project would have a significant or long-term impact on the level or quality of groundwater beneath landholdings surrounding the Project Site, specific controls and mitigation measures have been proposed by the Proponent for hydrocarbon and saline water management. These controls equally apply to the protection of surface water and are described in Section 4B.1.4.

4B.2.4.2 Groundwater Availability

In order to limit the quantities of in-flowing groundwater to the underground workings, the drifts and ventilation shaft would be progressively grouted.

Given the bulk of the groundwater in-flows would originate from the Gunnedah Basin rock units which are saline and, with the possible exception of fractured zones, low in permeability, the likely impact on groundwater levels, bore yields and groundwater availability generally is predicted not to be significant. As such, emphasis in the management of groundwater availability (and groundwater quality) would be placed on the implementation of a groundwater monitoring program, as recommended by GHD (2007). Section 4B.2.6.1 presents further detail on the preparation of the groundwater monitoring program while Section 5.7 presents the details of commitments made in relation to this groundwater monitoring program.

4B.2.5 Assessment of Impacts

4B.2.5.1 Impact Assessment Criteria

Table 4B.16 presents the National Environment Protection Measure (NEPM) groundwater quality criteria (NEPC, 1999). Groundwater quality would be assessed predominantly against the NEPM livestock guideline levels, given this is the predominant use of groundwater in the vicinity of the Project Site.

Table 4B.16
Groundwater Quality Criteria

Analyte	Agricultural Irrigation (mg/L)	Livestock (mg/L)
Arsenic (total)	0.1	0.5
Cadmium	0.01	0.01
Chromium (Total)	1.0	-
Chromium (VI)	0.1	1.0
Copper	0.2	0.5
Lead	0.2	0.1
Manganese	2.0	-
Mercury (total)	0.002	0.002
Nickel	0.02	1.0
Zinc	2.0	20.0
Calcium	-	1 000
- No published values		
Source: Modified after NEPC (1999)		

Impacts on the water quality parameters of pH, TDS, other anions and heavy metals (not considered by the NEPM criteria) would be based on comparisons to baseline monitoring of groundwater quality taken from all groundwater bores within the Project Site.

Groundwater levels and the saturated thickness within bores on neighbouring landholdings would be monitored with any variations over 15% considered a significant impact given the these levels would be expected to naturally vary by this much. The criteria for groundwater level and saturated thickness has therefore been determined to be a >15% decrease in water level or saturated thickness.

4B.2.5.2 Assessment Methodology

The extent of mine in-flows into the underground workings and the effect the project would have on groundwater levels, borehole yields, groundwater level re-establishment and availability of groundwater from existing surrounding bores has been predicted using the United States Geological Survey (USGS) finite-difference groundwater flow modelling code MODFLOW 2000 (Harbaugh et al., 2000 – cited in GHD, 2007). The model was run to estimate the steady state and transient mine in-flows into the underground working for Stage 1 of the project. The steady state represents the final impact on groundwater levels once equilibrium has been reached and therefore provides for long term impacts on the availability of groundwater following completion of the project. The transient modelling provides for ‘instantaneous’ predictions of mine in-flows and is therefore more useful for assessing the anticipated volume of water requiring dewatering and storage over the life of the project.

The hydrostratigraphy of the model is summarised in **Table 4B.17** and differentiates between the Gunnedah Basin sequence and Jurassic formations which comprise the Great Artesian Basin GWMA.

Table 4B.17
Conceptual Model Structure

Model Layer	Formation	GWMA
1	Alluvium	Great Artesian Basin
2	Pilliga Sandstone	
3	Purlawaugh Formation	
4	Garrawilla Volcanics	
5	Napperby (above Sill)	Gunnedah Basin
6	Basalt Sill	
7	Napperby (below Sill)	
8	Digby	
9	Hoskissons Coal Seam	
10	Arkarula	
	Brigalow	
11	Pamboola	
Source: Modified after GHD (2007) – Table 11		

Values for the input parameters of the model were generated based on on-site testing, with relevant and appropriate comparison made to the historic literature and mapping available for the region and local area. GHD (2007) provides a detailed description of the on-site testing completed and historic literature reviewed.

Through sensitivity analysis of the model to variation of the input parameters, GHD (2007) identified that alteration of the conductivity of the Hoskissons Coal Seam and Arkarula Formation had greatest influence on the predicted mine in-flow. The groundwater model was subsequently run with the permeability of each of these layers on order of magnitude greater than the mean value.

Table 4B.18 summarises the hydraulic conductivity values used for the steady state and transient modelling undertaken.

Table 4B.18
Modelled Hydraulic Conductivity (Kh)

Model Layer	Formation	Mean Hydraulic Conductivity (Kh^2) (m/d)	Sensitivity Testing[1] Hydraulic Conductivity (Kh^2) (m/d)
1	Alluvium	1	
2	Pilliga Sand	0.5	
3	Purlawaugh Formation	2×10^{-2}	
4	Garrawilla Volcanics	0.3	
5	Napperby Formation (above Sill)	1×10^{-3}	
6	Basalt Sill	1×10^{-2}	
7	Napperby Formation (below Sill)	8×10^{-5}	
8	Digby Formation	1×10^{-4}	
9	Hoskissons Coal Seam	2×10^{-3}	2×10^{-2}
10	Arkarula Formation	3×10^{-3}	3×10^{-2}
10	Brigalow Formation	5×10^{-2}	
11	Pamboola Formation	1×10^{-3}	

Note 1: Sensitivity testing was completed on the Kh values of the other layers for previous version of the groundwater model. These analyses indicated the Kh of the Hoskissons Coal Seam and Arkarula Formation to be of greatest significance to model output. Consequently, the sensitivity analyses for the final groundwater model considered these layers only.
Note 2: Kh = Hydraulic Conductivity
Source: Modified after GHD (2007) – Table 13

Further detail on the design, calibration and running of the model is provided in GHD (2007).

4B.2.5.3 Groundwater Levels / Drawdown

Based on an assessment of drawdown in the equilibrated steady state model of GHD (2007), it was found that for most of the layers considered, the predicted drawdown extend far further to the west due to the sub-cropping of the formations on the Boggabri Ridge to the east. The following is a summary of the predicted impact of the project on groundwater levels within the alluvium, Surat Basin sediments of the Great Artesian Basin sequence and the Gunnedah Basin sequence. **Figure 4B.11** illustrates the predicted drawdown in representative layers of these strata.

Quaternary Alluvium

The alluvium was modelled as unsaturated over the Project Site and so direct impact on the drawdown within this layer was not predicted. However, when considering the drawdown in the uppermost saturated model layer (Surat basin sediments), this was not predicted to extend to the Upper Namoi River GWMA. Therefore groundwater levels in the Namoi River alluvium was not predicted to be affected by the project.

Surat Basin Sediments of the Great Artesian Basin

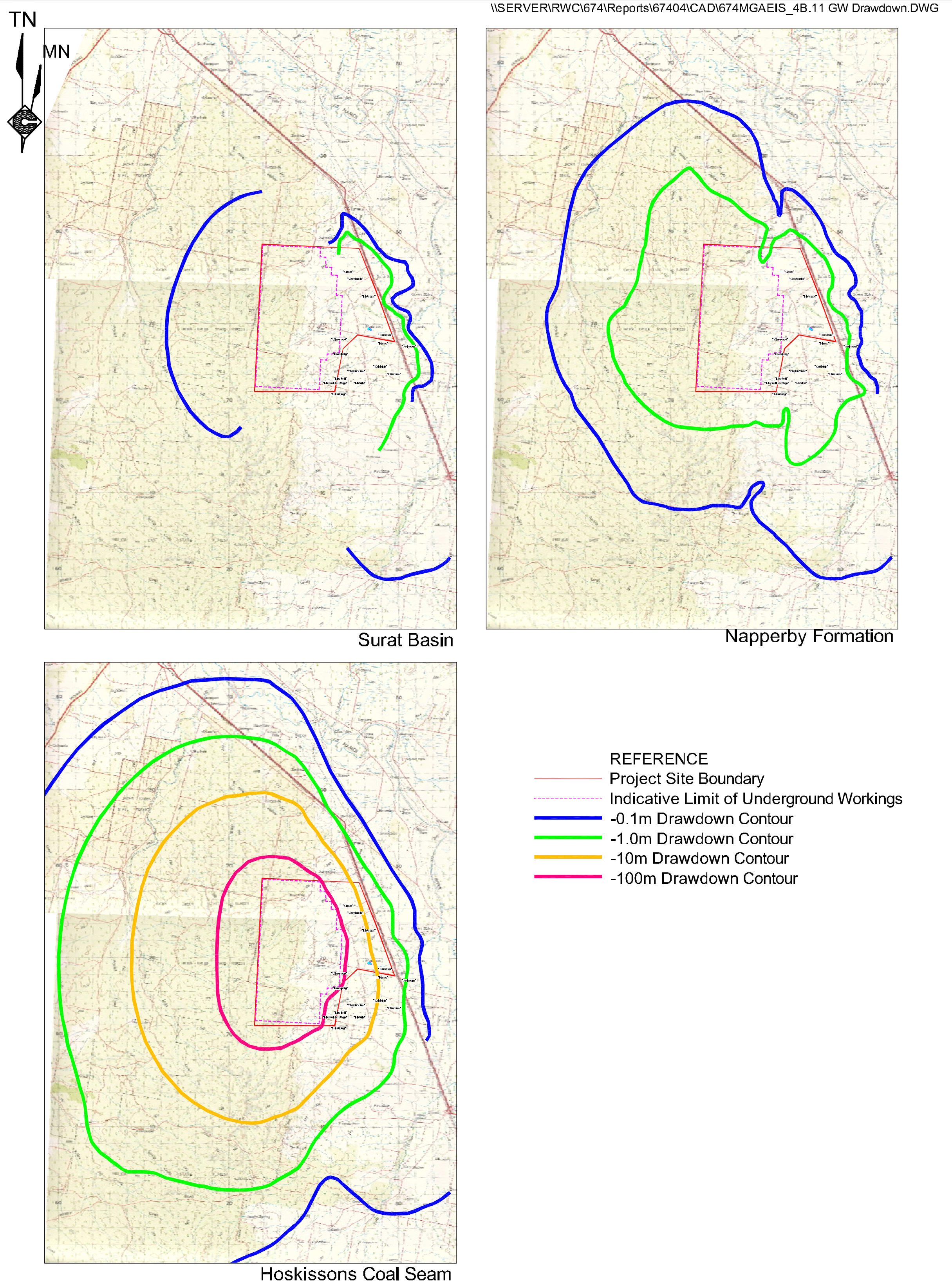
Drawdown in the uppermost saturated layer of the model, considered to be the Pilliga and Purlawaugh Formations from roughly midway on the Project Site to the west and the Garrawilla Volcanics to the east, was predicted through the modelling of GHD (2007) (see **Figure 4B.11**). To the west in the Pilliga and Purlawaugh Formations, drawdown was predicted to be less than 1m and extend less than 5km to the west. To the east in the Garrawilla Volcanics, drawdown was predicted to be between 10m and 1 m with the deeper formations having a greater impact due to greater the hydraulic connection with the Hoskissons Coal Seam.

Based on these drawdown levels, the long term impact of the project is predicted to be minimal in the areas where the regional aquifer is saturated and northwesterly groundwater flow occurs towards the central GAB.

Gunnedah Basin

Drawdown in the Gunnedah Basin Sequence was considered for both the Hoskissons Coal Seam and the Napperby Formation (above the sill), ie. the layers in the sequence with the highest hydraulic conductivities.

Drawdown within the Hoskissons Coal Seam, representing impacts in the lower layers of the Gunnedah Basin sequence, of 10m or greater is predicted to extend around 6km to 7km to the west, north and south of the underground workings (see **Figure 4B.11**). The drawdown extent to the east is significantly less and is limited by the subcrop of the coal seam. The area of greater than 1m drawdown in the Hoskissons Coal Seam extends approximately 10km to the west and south and 8 km to the north.



SCALE 1:350 000

5 0 5 10 1.5km

Source: GHD (2007) - Figures 20,21 & 22

Figure 4B.11
PREDICTED GROUNDWATER DRAWDOWN AFTER 50 YEARS

The predicted drawdown in the Napperby Formation (above the sill) illustrates the impacts of the project at the top of the Gunnedah Basin sequence. Drawdown of greater than 10m is largely limited to above the Project Site while drawdown greater than 1m extends 5km to the west and south and between 2km to 4km to the north and east of underground workings. The impact between 0.1m and 1.0m extends another 1km to 4 km beyond this (see **Figure 4B.11**).

Previous sensitivity analyses performed by GHD on the hydraulic conductivity values of each layer determined that while these did not have a major impact on the predicted maximum drawdown within each layer there was some impact on the extent of groundwater drawdown.

4B.2.5.4 Mine In-flows

The groundwater model predicted mine in-flows are summarised in **Table 4B.19** and illustrated in **Figure 4B.12**.

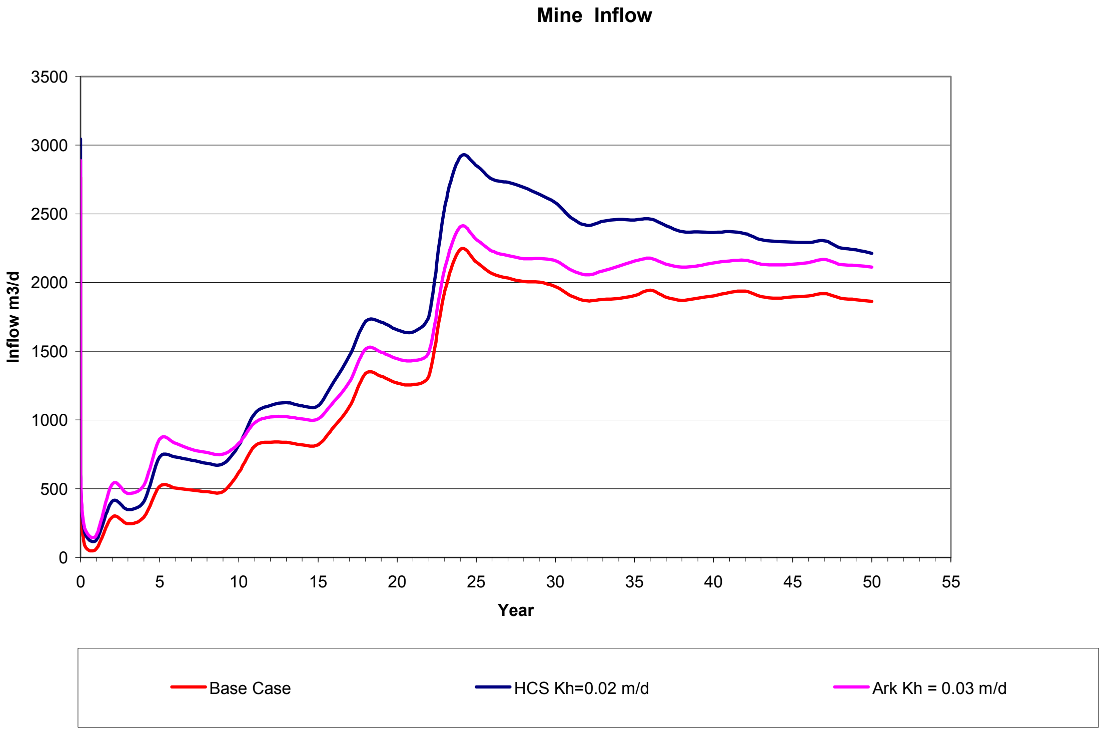
Table 4B.19
Mine In-Flow Over Time

Year	Mean Conductivity (kh)[1]		Increased Conductivity (HCS kh = 0.02)		Increased Conductivity (Ark kh = 0.02)	
	m^3/day	ML/year[2]	m^3/day	ML/year[2]	m^3/day	ML/year[2]
1	61.0	22.3	124.2	45.3	124.2	45.3
2	294.0	107.3	408.1	149.0	408.1	149.0
3	245.9	89.8	348.6	127.2	348.6	127.2
4	294.2	107.4	407.1	148.6	407.1	148.6
5	517.1	188.7	730.8	266.7	730.8	266.7
10	618.1	225.6	816.0	297.8	829.8	302.9
15	820.0	299.3	1102.8	402.5	1006.9	367.5
20	1269.6	463.4	1656.9	604.8	1445.6	527.6
25	2149.2	784.5	2851.4	1040.8	2313.2	844.3
30	1971.4	719.6	2580.0	941.7	2159.6	788.3
35	1905.4	695.5	2456.0	896.4	2156.0	786.9
40	1903.0	694.6	2365.4	863.4	2142.5	782.0
45	1896.8	692.3	2293.5	837.1	2133.8	778.8
50	1862.2	679.7	2213.9	808.1	2112.2	771.0

Note 1: Hoskissons Coal Seam (HCS) kh = 0.002, Arkarula Formation (Ark) kh = 0.003
Note 2: Yearly volume is estimated based on daily in-flow rate on last day of relevant year, ie. ML/year = m^3/day x 365/1000
Source: Modified after GHD (2007) – Figure 26

These results are summarised as follows.

- Using the mean hydraulic conductivity values, groundwater inflows gradually increase to 475ML/year over the first 22 years, reach a maximum of 818ML/year prior to Year 25 and then decline and stabilise around 690ML/year for the remaining life of the project.
- An increase in the hydraulic conductivity of the Hoskissons Coal Seam by an order of magnitude to 2 x 10^{-2}m/d results in total inflows increasing by approximately 30% over the life of the project.
- An increase in the hydraulic conductivity of the Arkarula Formation by an order of magnitude to 3 x 10^{-2}m/d results in total inflows 7% over the life of the project.



Source: GHD (2007) – Figure 26

Figure 4B.12
PREDICTED MINE IN-FLOWS

It is noted that the groundwater model assumes the following, which could influence the in-flow of water to the underground workings.

- If groundwater intersections are encountered in the drifts and ventilation shaft, they are assumed to be grouted and not contribute to mine inflow estimates.
- The model does not address inflow through localised, naturally occurring fractured areas which may be orders of magnitude higher over the short-term.

The modelling results indicate that there would be sufficient storage within the evaporation / storage ponds to contain the dewatered mine in-flows for at least 15 years, even when considering the 30% increased flows resultant from the higher hydraulic conductivity parameter used for the Hoskissons Coal Seam. Should actual dewatering rates approximate or exceed those predicted by GHD (2007), additional water management strategies would need to be implemented as outlined in Section 2.5.4.

4B.2.5.5 Groundwater Quality

Assuming the implementation of appropriate safeguards to avoid contamination by hydrocarbons or saline water (see Section 4B.1.4), it is unlikely that the project would impact on the water quality of the groundwater within the geological layers intercepted by the underground workings. In any event, the Proponent has committed to a program of water quality monitoring to ensure there is no impact on the quality of the groundwater resources of these layers (see Section 4B.2.5.6).

It is considered unlikely that Stage 1 mining activities would result in enhanced connection of aquifers, which may impact on the groundwater quality of the non-saline aquifers, as mining induced fracturing would be restricted to the immediate roof of the worked section, ie. between aquifers of comparable water quality.

4B.2.5.6 Water Resource Use and Availability

The predicted steady state model drawdown using the average hydraulic conductivity model at the registered bores within the Project Site compared to the recorded saturated thickness and presented in **Table 4B.20**. The average hydraulic conductivity model steady state model results are considered to represent a worst case scenario given the higher hydraulic conductivity results compared to the geometric means.

The groundwater model results using the mean hydraulic conductivity indicate that of those bores located on and immediately surrounding the Project Site, five would suffer decreases in saturated thickness of greater than 15% (see **Table 4B. 20**). Of these, one is located on the "Claremont" property and a second on the "Matoppo" property, both owned by the Proponent and therefore project related. Of the three bores predicted to suffer a drawdown of greater than 15%, the most significant impact would be on GW000014 (on the "Westhaven" property) as the 15% criteria level would be exceeded within 6 years. Mitigation or compensatory measures would be required to ensure the owners of these bores retain access to groundwater resources.

Table 4B.20
Predicted Drawdown in the Registered Bores within the Project Site

Bore[1] (Property Name)	Bore Use	Model Layer	Saturated Thickness (m)	Estimated Drawdown (m)	% Decline in Saturated thickness
GW060976 ("Haylin View")	Stock & Domestic	Alluvium	12.1	Negligible	Negligible
GW000014 ("Westhaven")	Stock & Domestic	Napperby (Above Sill)	46.2	17.1	37% (6 years to exceed 15%)
GW000018 ("Oakleigh")	Unknown (assumed Stock & Domestic)	Napperby (above sill)	80.2	13.9	17% (33 years to exceed 15%)
GW022595 * ("Westhaven")	Stock & Domestic	Garrawilla Volcanics	NA (24) [2]	6.1	25% (26 years to exceed 15%)
GW966836 [3*] ("Claremont")	Stock & Domestic	Garrawilla Volcanics	24.5	NA (22.3)	NA
GW000013 * ("Matoppo")	Stock & Domestic	Napperby (Below Sill)	102.4	25	25% (47 years to exceed 15%)
GW017215 ("Greylands")	Stock	Napperby (Above Sill)	41.6	13.7	33% (41 years to exceed 15%)
GW043315 [3] ("Omeo")	Stock & Domestic	Alluvium	4.2	NA (6.9m)	NA

[1] see **Figure 4B.10** for location of bores
[2] based on nearby GW966836 SWL.
[3] modelled as dry for this layer.
* Bore is located on a Proponent owned property.
Source: Modified after GHD (2007) – Table 4

None of the bores located off the Project Site and not included in **Table 4B.20** were predicted to incur a decrease in saturated thickness of greater than 15% (GHD, 2007 – Table 15). In all cases, the predicted drawdown was <0.6m.

Considering the observed heterogeneity of the fractured rock aquifers below the Project Site and throughout the local area, the actual impact on the groundwater level, bore yields and water availability on and surrounding the Project Site would be largely controlled by the extent and depth of the fractures intersected by these bores and localised recharge rates. Therefore, while the model predicts minimal impacts on groundwater availability, the Proponent would adopt the monitoring and contingency planning recommended by GHD (2007) and further recorded on **Table 5.1**.

4B.2.5.7 Groundwater Dependent Ecosystems

No groundwater dependant ecosystems have been identified on the Project Site. GHD (2007) note that the groundwater monitoring data indicates there is an existing potential for downwards groundwater flow indicating recharge to the deeper formations rather than groundwater discharge to the surface. As groundwater dependent ecosystems are typically associated with groundwater discharge zones, it is unlikely that the project would impact on any, as yet unidentified, groundwater dependent ecosystems.

4B.2.5.8 Regulatory Compliance

The groundwater modelling conducted by GHD predicts the mine in-flows during and on completion of Stage 1 of the project to be primarily associated with the Gunnedah Basin sequence and therefore have little influence on the groundwater of the GAB and Upper Namoi GWMA's which have been quoted as being currently above 100% and between 70% and 100% of sustainable yield respectively. Minimal impact upon the Purlawaugh Formation, which forms part of the recharge zone for the intake beds of the GAB GWMA, is predicted.

The project would have little influence on the existing beneficial uses of groundwater below the Project Site and surrounding areas and as stated in Section 4B.2.5.7 would not impact on any groundwater dependent ecosystems.

4B.2.6 Groundwater Monitoring and Contingency Plans

4B.2.6.1 Groundwater Monitoring

Should the project be approved, a groundwater monitoring program would be prepared focussing on establishing baseline levels for standing water level, saturated thickness and water quality and monitoring changes to these which could be attributable to the mining activities. The program would be finalised by the Proponent's hydrogeological consultant and in consultation with the Department of Natural Resources and potentially impacted property owners. Based upon the current knowledge of the groundwater occurrences beneath and surrounding the Project Site the following groundwater monitoring program is proposed.

Monitoring Locations

In order to obtain data on existing groundwater levels, water quality, groundwater flows and aquifer hydraulic conductivity for the groundwater assessment of GHD (2007), a total of seven groundwater monitoring bores were installed. Of these, the use of one (NC-100D) has been compromised through contamination by grout used in the installation process. The remaining six monitoring bores would be retained and used to monitor water level and quality as follows.

- NC-100S - Garrawilla Volcanics.
- NC-098D - Napperby Formation above the Basalt Sill.
- NC-098S - Garrawilla Volcanics / Napperby Formation above the Basalt Sill.
- NC-030S - Napperby Formation.
- GWB 4S - Purlawaugh Formation.
- GWB 5S - Purlawaugh Formation.

The following registered groundwater bores, predicted to be potentially impacted by the long term drawdown predicted by GHD (2007), would be included in the Proponent's groundwater monitoring program.

- GW000013.
- GW000014.
- GW017215.
- GW000018.
- GW022595.
- GW005023.

The locations of these monitoring bores are presented on **Figure 4B.13**.

Monitoring Parameters and Frequency

Standing water level (SWL) would be monitored at each of the proposed locations on a monthly basis for at least 12 months prior to the commencement of mining. After 12 months, this would reduce to quarterly monitoring.

The water quality of the 11 monitoring bores would be monitored at 6 monthly intervals for at least the first year of the project, reverting to annual monitoring once seasonal variation has been established. The bores would be purged until field chemistry parameters have been stabilised and then sampled and analysed for pH, TDS, EC, major ions and heavy metals.

Reporting

The results of groundwater monitoring would be reported to the relevant government agencies on an annual basis in an Annual Environmental Management Report or similar document.

4B.2.6.2 Contingency Plans

As noted in Section 4B.2.5.6, the heterogeneity of the fractured rock aquifers below the Project Site and the local area means that while the modelling provides a very good indication of the likely impacts on groundwater levels, bore yields and water availability, impacts may be greater

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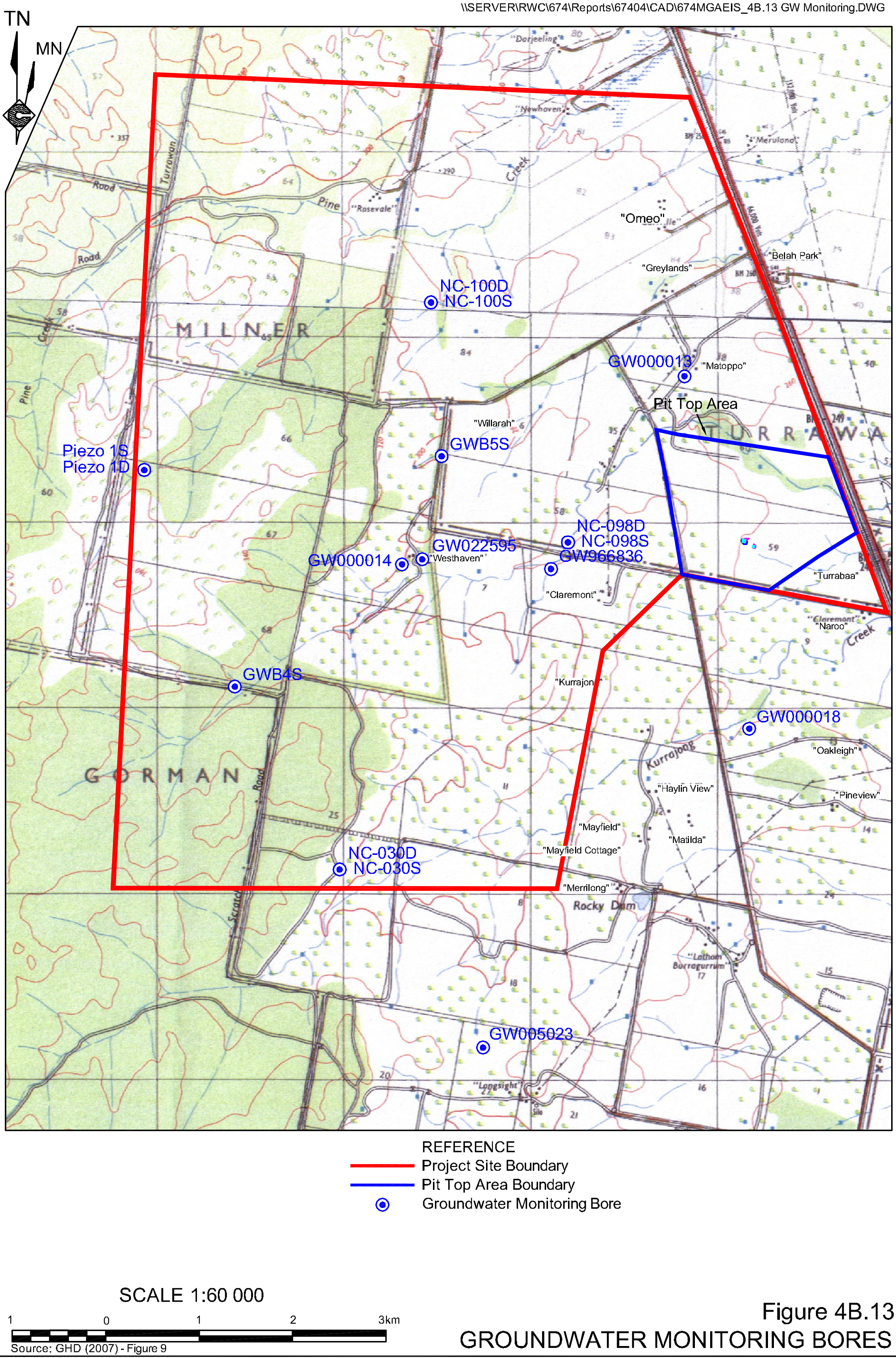

Figure 4B.13
GROUNDWATER MONITORING BORES

(or less) than predicted in the various layers and subsequently different bores. To accommodate for this possibility, the Proponent would prepare a contingency strategy to ensure that any reduction in groundwater availability to local users would be remediated or replaced. The remedial actions that may be appropriate for the deeper bores includes lowering of the pump sets, installation of pumps with higher lift if casing diameter allow or possibly replacement of bores to accommodate deeper, high lift pumps. For the shallower alluvium bores, deepening of the bores to provide a greater saturated thickness may be required. It is considered unlikely that sourcing an alternate groundwater supply would be required as the Stage 1 development is not expected to impact on the groundwater quality in the registered bores and the drawdown impact is not predicted to exceed 25m after 50 years. However, if the proposed remedial actions did not provide the required supply, this option would need to be adopted.

Commitments made by the Proponent in relation to the preparation of a groundwater contingency strategy are provided in **Table 5.1**.

4B.3 ECOLOGY

The ecological assessment was undertaken by Ecotone Pty Ltd. The full assessment is presented as Part 3 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following sub-sections.

4B.3.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential ecological impacts requiring assessment and their unmitigated risk rating are as follows.

- Disturbance to native vegetation / habitat within nominated areas (high risk).
- Disturbance to native vegetation / habitat outside nominated areas (moderate risk).
- Disturbance to threatened flora / fauna and endangered ecological communities (high risk).
- Disturbance leading to local population reduction (high risk).
- Disturbance leading to local extinction(s) (extreme risk).
- Local biodiversity (moderate risk).
- Regional biodiversity (high risk).

The Director-General's requirements issued by the DoP require that the assessment of threatened species and their habitat include a field survey of the site which would be conducted and documented in accordance with the draft *Guidelines for Threatened Species Assessment* (DEC).

The following sub-sections describe and assess the existing Threatened species and their habitat, identify the ecological management issues, proposed controls, safeguards and mitigation measures for the Threatened species and their habitat.

4B.3.2 Study Methodology and Outcomes

4B.3.2.1 Desktop Assessment

The desktop component of the ecological assessment involved a review of flora and fauna surveys and assessments that have previously been conducted in the vicinity of the Project Site and a web-based search of the documented records held on the Department of Environment and Conservation, Atlas of NSW Wildlife Database. In particular, Threatened flora and fauna species recorded within the Baan Baa, Narrabri, Boggabri and Horton 1: 100 000 map sheets were identified.

Subsequently, the assessment also considered a reduced area within a 10km radius from the centre of the Project Site. The survey identified 24 threatened flora species, all of which are also listed under the national ROTAP database.

4B.3.2.2 Field Survey

The field survey covered the entire Project Site but concentrated most intensely on the area in the vicinity of Kurrajong Creek Tributary 1 within the Pit Top Area and Ventilation Shaft Area near where surface disturbance is planned to occur. In reality, most disturbance would occur in areas already cleared and used for cropping and/or grazing. Field survey methods employed during the surveys were as follows.

Flora

- Foot traverses within the Pit Top Area, Ventilation Shaft Area and nearby to assess the range of floristic variation, vegetation structure, extent of modification, disturbance, weed invasion, species diversity, condition of the vegetation and presence of any rare or threatened flora species.
- A drive around the remainder of the Project Site noting the broad ecological characteristics within the larger area.

Fauna

- Habitat assessment based largely upon the flora field survey, ultrasonic bat call detection, spotlighting, nocturnal call playback, two diurnal bird censuses and an amphibian and reptile search. Any opportunistic sightings of any fauna species during the field surveys were recorded. The locations of the fauna survey sites within the Pit Top Area and adjacent areas are shown in **Figure 4B.14**.

4B.3.3 Flora

4B.3.3.1 Regional Threatened Flora

The results of the desktop assessment indicate that only one threatened flora species has been previously recorded within 2.5km of the Project Site, *Cobar Coolabah, Bertya sp*. When increasing the search to the four 1:100 000 map sheets noted in Section 4B.3.2.1, the number of threatened species known to occur increases to 24. One of these species (*Hakea pulvinifera*) is

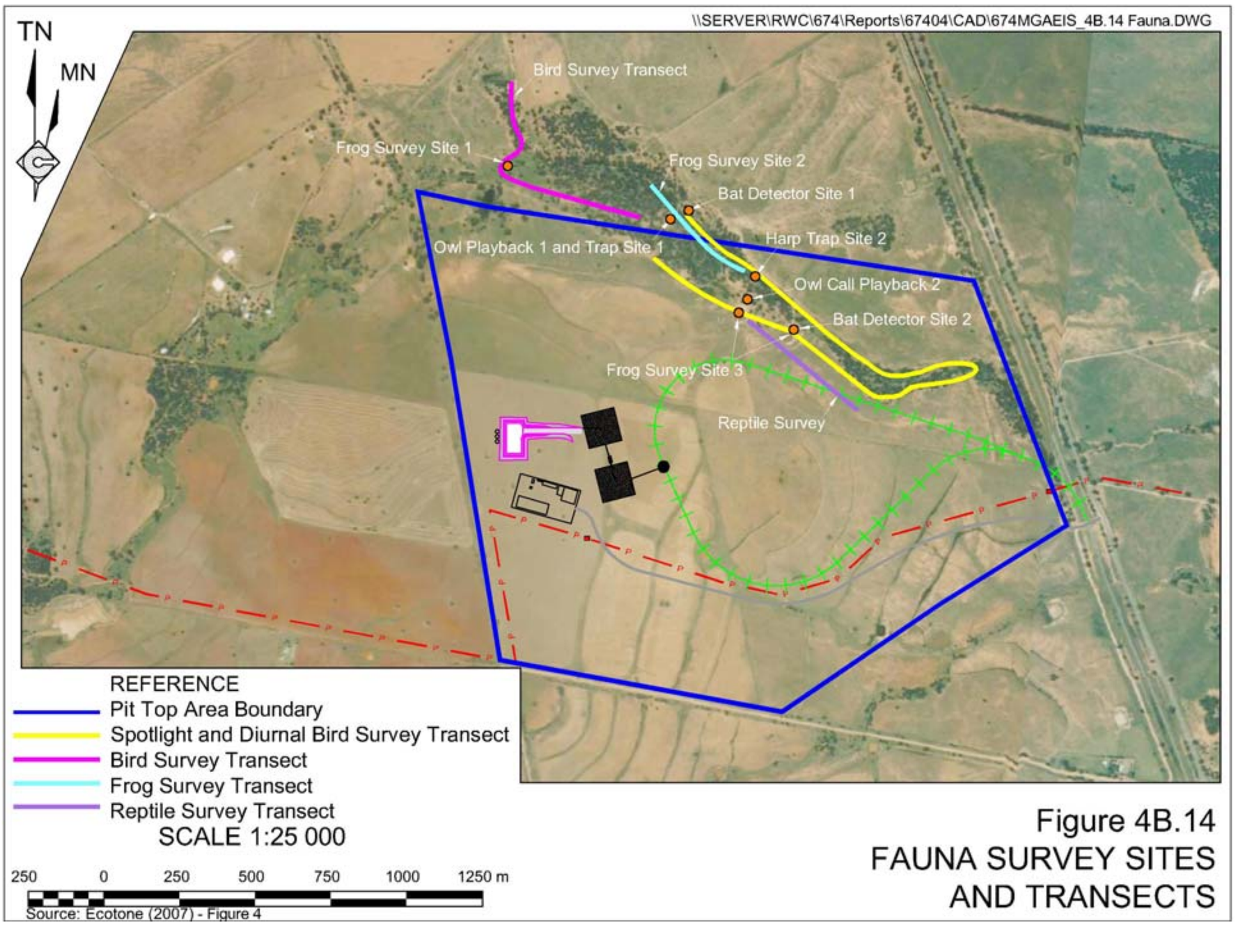

Figure 4B.14
FAUNA SURVEY SITES AND TRANSECTS

classified as Endangered on Schedule 1, Part 1 and nine species are classified as Vulnerable on Schedule 2 of the NSW *Threatened Species Conservation Act 1995*. One species (*Hakea pulvinifera*) is listed as Endangered and ten of the species are listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* within the search area. One of the ten species (*Bertya* sp. Cobar-Coolabah) has been recorded within 2.5km of the centre of the Project Site. No threatened species were identified during the field surveys of Ecotone (2007).

No endangered flora populations (Schedule 1, Part 2 of the *TSC Act 1995*) are recorded within 10km of the centre of the Project Site or within the wider area covered by the four local 1:100 000 map sheets. None were identified during the field surveys of Ecotone (2007).

Ecotone (2007) determined that none of the vegetation within the Project Site conforms to any endangered ecological communities.

4B.3.3.2 Existing Vegetation

Three broad natural or predominantly native vegetation community types occur within the Project Site (**Figure 4B.15**). These communities also reflect types of faunal habitat, with both listed as follows.

- Community 1 - Bimble Box / Grey Box Woodland.

  This community is dominated by Bimble Box, Western Grey Box, Blakely's Red Gum, Belah, White Cypress Pine, Yellow Berry Bush over sparse to moderate shrub cover with denser thickets and moderate ground cover. The associated fauna habitat is described as Lowland and Floodplain Woodland.

- Community 2 – Riparian Forest.

  This community is dominated by River Oak, Belah, Blakely's Red Gum, Spiny Mat Rush over very dense shrub cover and sparse ground cover. The associated fauna habitat is described as Riparian Open Forest.

- Community 3 - Brown Bloodwood / Red Ironbark / Mallee Woodland.

  This community is dominated by Brown Bloodwood, Red Ironbark, Dwyer's Mallee Gum, *Micromyrtus, Phebalium*, Fringe-Myrtle over very sparse to absent shrub cover and moderate to dense ground cover. The associated fauna habitat is described as Sandstone Slopes and Ridgetop Woodland.

Two artificial (cleared/semi-cleared or cultivated) communities make up the balance of the surface facilities, namely:

- Community 4 - Cleared open pasture with or without scattered native trees (mostly on the floodplain of Kurrajong Creek Tributary 1.

  This community is dominated by native and introduced pasture grasses with some scattered remnants of Vegetation Community 1, no shrub cover and dense ground cover. The associated fauna habitat is described as Open Pasture.

- Community 5 - Cultivated cropland with no native vegetation.

  This community is dominated by wheat with little or no shrub cover and dense ground. The associated fauna habitat is described as Cropland.

The native vegetation in the agricultural areas is generally remnant and in a highly modified condition.

The flora species diversity across the entire Project Site was observed to be high with 133 flora species from 48 families identified were introduced. Approximately 27% of all identified species. The vegetation adjacent to and within the floodplain of Kurrajong Creek Tributary 1 was particularly diverse.

There was also a high level of heterogeneity identified between the western vegetated part of the Project Site and the eastern agricultural part, with only two species common to both areas.

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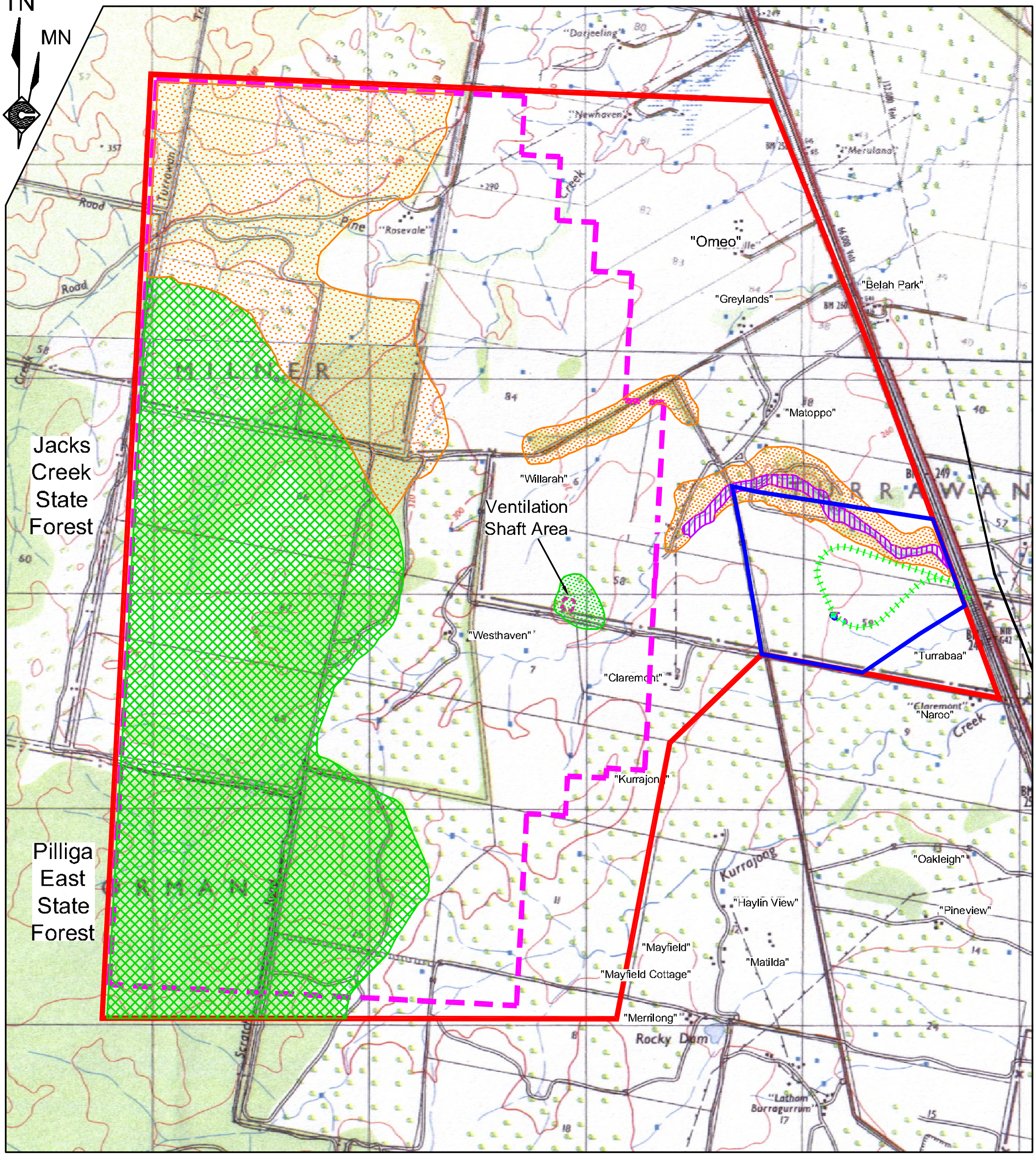

REFERENCE
- Project Site Boundary
- Pit Top Area Boundary
- Indicative Limit of Underground Workings
- Ventilation Shaft Area Boundary

Vegetation Communities
- Bimblebox / Grey Box Woodland
- Riparian Forest
- Brown Bloodwood / Ironbark / Mallee Woodland

SCALE 1:60 000

1 0 1 2 3km

Source: Ecotone (2007) - Figure 3a

Figure 4B.15
VEGETATION COMMUNITIES - PROJECT SITE

4B.3.3.3 Noxious Weeds

Four of the 36 introduced species recorded within the Project Site are declared noxious weeds in the Narrabri LGA, namely:

- African Boxthorn (*Lycium ferocissimum*) – W3 (must be prevented from spreading and its numbers and distribution reduced);
- Galvanized Burr (*Sclerolaena birchii*) – W3;
- Mother-of-Millions (*Bryophyllum delagoense*) – W3; and
- Prickly Pear (*Opuntia* spp.) – W4f (must not be sold, propagated or knowingly distributed. Any biological control or other control program directed by the local control authority must be implemented).

The most widespread and abundant noxious weed was Mother-of-Millions (*Bryophyllum delagoense*). This was particularly common along the floodplain of the Kurrajong Creek Tributary 1, presumably spread by floodwaters. African Boxthorn (*Lycium ferocissimum*) was also moderately common along the floodplain. Galvanized Burr (*Sclerolaena birchii*) was also common in much of the floodplain and low-lying areas, but Prickly Pear was relatively sparse, appearing to have succumbed to significant dieback due to infection by *Cactoblastis*.

4B.3.3.4 Flora Conservation Significance

The vegetation of the Project Site has little significance with respect to threatened species legislation, as none of the vegetation communities constitute any of the listed endangered ecological communities, and only one flora species is regarded as having potential to occur (Ecotone, 2007). The various vegetation communities within the Project Site do have broader significance at different levels, however, as follows.

- Vegetation Community 3 surrounding the Ventilation Shaft Area is a high quality, large remnant of natural vegetation in good condition. It has high species diversity, and is a sharply contrasting vegetation type to the surrounding communities on the low-lying flats and floodplains.
- Vegetation Communities 1 and 2 in the area of Kurrajong Creek Tributary 1 are significantly more disturbed, but nevertheless retain high native species diversity, particularly in the ground layer and a species composition is almost totally different to that of Community 3.
- One species of tree (*Eucalyptus populnea* – Bimble Box) in Vegetation Communities 1 and 2 is a listed habitat tree for Koalas.

All the remnant natural vegetation within the site has ecological value in that it facilitates movement of fauna and exchange of genetic material between native flora species locally.

4B.3.4 Fauna

4B.3.4.1 Regional Threatened Fauna

Fauna Species

A search of the DEC (NPWS) NSW Wildlife Atlas identified a total of 53 threatened species as having been previously recorded within the area of the four 1:100 000 map sheets listed in Section 4B.3.2.1. This includes 25 bird species, 22 mammal species, one amphibian and three reptile species. Of these, seven species are considered to be extinct, nine species are listed as Endangered on Schedule 1, Part 1 of the *TSC Act 1995* and the remainder as Vulnerable on Schedule 2 of the Act. With respect to the National listing, the Spotted-tailed Quoll and Bridled Nail-tailed Wallaby (extinct in NSW) are listed as Endangered, the Regent Honeyeater as Endangered and Migratory and eleven additional species are listed as vulnerable by the Commonwealth *EPBC Act 1999*. The species listed as extinct in NSW have been excluded from further assessment.

Only six of the 53 threatened fauna species have previously been recorded within a 10km radius of the Project Site, namely the Black-breasted Buzzard, Barking Owl, Turquoise Parrot, Masked Owl and the Koala, all of which have been recorded only once and the Glassy Black Cockatoo which has been recorded on four occasions.

No records of threatened fauna species were found within 2km of the Project Site.

An assessment of the relative likelihood of the threatened fauna species (previously recorded in the relevant map sheets) occurring within the Project Site is provided in the *Specialist Consultant Studies Compendium* - Part 3, Table 7. This was undertaken based on the existing habitat described in Section 4B.3.3.2. Following this assessment, only 20 species were determined as having the potential to occur within the Project Site and the remainder of the species were not assessed further. These 20 species are listed in **Table 4B.21**.

Table 4B.21
Local Threatened Fauna Species with Potential to Occur within the Project Site

Glossy Black Cockatoo	Diamond Firetail
Painted Honeyeater	Masked Owl
Swift Parrot	Barking Owl
Regent Honeyeater	Little Pied Bat
Black-chinned Honeyeater	Greater Long-eared Bat
Brown Treecreeper	Yellow-bellied Sheathtail Bat
Speckled Warbler	Black Striped Wallaby
Hooded Robin	Squirrel Glider
Grey-crowned Babbler	Koala
Turquoise Parrot	Pilliga Mouse
Source: Modified after Ecotone (2007) – Section 2.3.2	

Only two threatened fauna species were recorded in, or in the vicinity of, the Project Site during the field survey. The Yellow-bellied Sheathtail-bat was recorded within the Pit Top Area and is expected to occur over much of the overall study area. The Grey-crowned Babbler was recorded beyond the Project Site on Jacks Creek Road toward Narrabri. Potential habitat occurs within the Project Site for this species, particularly along road reserves and creekline vegetation. Both species are listed as Vulnerable.

Small terrestrial mammals were not targeted during these surveys, however, the habitat assessment of the area between Kurrajong Creek Tributary 1 and the grain crops of the Pit Top Area, identified open floodplain with some cracking soils. This indicates that small mammals, such as the Fat-tailed Dunnart *Sminthopsis crassicaudata* and Narrow-nosed Planigale *Planigale tenuirostris* could occur. Although not listed as threatened, both these species have been recorded from the Narrabri area and their presence within the Pit Top Area would be considered locally significant.

Endangered Populations

Two endangered fauna populations (Schedule 1, Part 2 of the *TSC Act 1995*) are listed for the bioregions within 10km of the Project Site (Nandewar and Brigalow Belt South), namely:

- the Tusked Frog population in the Nandewar and New England Tablelands Bioregions; and
- an Australian Bush Turkey population in the Nandewar and Brigalow Belt South Bioregions.

Project Site Fauna Habitat

A habitat assessment of the various components of the Project Site was undertaken by Ecotone (2007), noting floral and faunal habitat types and features of each area. The habitat assessment determined the primary faunal habitats summarised below. These are aligned to the vegetation communities outlined in Section 4B.3.3.2 and have been used to determine the potential for threatened species to occur within the Project Site.

- Lowland and Floodplain Woodland (Community 1 – Bimble Box / Grey Box Woodland).
- Riparian Open Forest (Community 2 – Riparian Forest).
- Sandstone Slopes and Ridgetop Woodland (Community 3 – Brown Bloodwood / Red Ironbark / Mallee Woodland).
- Open Pasture (Community 4 – Cleared open pasture).
- Cropland (Community 5 – Cultivated cropland).

The following additional habitat features, other than vegetation communities, are present within the Project Site.

- Large mature trees, dead and hollow-bearing trees were common along Kurrajong Creek Tributary 1 and scattered throughout the surrounding landscape.

- Waterbodies/wet areas existing as pools in creeks or farm dams, occur within the Pit Top Area and Ventilation Shaft Area .
- The only fauna movement corridors present in the eastern part of the Project Site are along some of the drainage lines, providing minor connectivity with the forested areas in the west.

4B.3.4.2 Project Site Fauna

A total of 86 fauna species were identified within the Project Site and surrounds, including 21 mammal, 8 frog, 5 reptile and 52 bird species. Seven of these species were introduced species, including farm animals (Ecotone, 2007).

Two State-listed vulnerable species, the Yellow-bellied Sheathtail Bat and the Grey-crowned Babbler were identified on, or in the vicinity of, the Project Site.

4B.3.4.3 Fauna Conservation Significance

Most of the fauna species recorded within the Project Site are considered to be common and widespread. Only two threatened species were identified on or in the vicinity of the Project Site, the Yellow-bellied Sheathtail-bat and the Grey-crowned Babbler.

Based on the results of the current and previous surveys conducted in the wider locality, other threatened species listed as vulnerable in the *TSC Act 1995* that were not recorded but may occur are a number of species of woodland birds (Diamond Firetail, Turquoise Parrot, Hooded Robin, Speckled Warbler and Brown Treecreeper), and two species of bat (the Greater Long-eared Bat and the Little Pied Bat).

Habitat for the Koala occurs along the road reserves and creek lines, however, these areas may be too isolated from known core habitat in the Pilliga Scrub located in the State Forests to the west and south of the Project Site. Given that the Koala survives in roadside reserves through agricultural land near Gunnedah, however, it cannot be discounted as occurring.

The additional threatened fauna species are considered less likely to occur within the Project Site, but cannot be completely discounted.

4B.3.5 Ecological Management

4B.3.5.1 General Management Measures

The following ecological management measures relate to both flora and fauna within the Pit Top Area and the Ventilation Shaft Area.

- The Project Site layout has been designed to minimise the clearing of native vegetation, particularly with the Pit Top Area located on agricultural land with only scattered trees. The ventilation shaft would be constructed in an area already largely disturbed by previous quarry activities surrounded by remnant vegetation. Additionally, Kurrajong Creek Tributary 1, which supports native riparian vegetation along its banks, would not be disturbed by the project.

- The boundaries of construction areas would be clearly marked for the machinery operators to minimise the extent of clearing. No clearing would occur outside these boundaries.
- A pre-clearance survey would be undertaken by a qualified ecologist to identify and relocate any fauna species residing in any of the individual trees to be cleared. In particular, the survey would target Threatened species known or potentially occurring in the area and identify habitat within the clearing areas.
- A survey of any individual trees to be cleared would be undertaken by a qualified ecologist. Should any of the trees to be cleared be identified as hollow-bearing, the ecologist would install replacement hollows in the form of an equivalent number of nest boxes on suitable trees to be retained within the Pit Top Area.
- All hollow-bearing trees removed are to be re-sited and re-erected where practicable to avoid any net loss of hollow resources, with the re-erection of hollow-bearing trees undertaken as soon as practical after felling.
- Regular programs would be conducted to control noxious weeds, particularly for the most widespread and problematic noxious weed, Mother-of-Millions (*Brypohyllum delagoense*). A co-ordinated weed control program developed in association with the local Rural Lands Protection officer and the Narrabri Shire Council weeds officer would give greater effect to such a weed control program in the area.
- Any cleared native vegetation would be dispersed whole or mechanically reduced and spread outside the perimeter bund around the ventilation shaft to provide habitat, increase the seed bank and to provide a mulch material for nutrient cycling and water retention purposes.
- A feral animal management program would be implemented to lower the predator impact upon small terrestrial native species, and would be reviewed on an annual basis throughout the life of the project.
- During operations, the sediment dams and evaporation / storage ponds would be regularly inspected for fauna during the course of regular maintenance and operational inspections.
- The facilities within the Pit Top Area and Ventilation Shaft Area would be decommissioned and the area rehabilitated on completion of the project to re-instate a final land use of agriculture and native vegetation in accordance with that detailed in Section 2.15.

4B.3.6 Assessment of Ecological Impacts

4B.3.6.1 Assessment of Threatened Species and Endangered Populations

4B.3.6.1.1 Introduction

Under the *Environmental Planning and Assessment Act 1979* and the *Threatened Species Conservation Act 1995*, a Section 5A assessment (“seven-part test”) was carried out to assess impacts and losses at the local rather than the regional level. This is used as a tool to assist in determining whether further assessment might need to be undertaken. Since the project is being assessed in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* no Species Impact Statement (SIS) is required.

There are no recorded endangered flora or fauna populations within the Project Site. Hence, these are not considered further.

The threatened species recorded under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) are consistent with those listed within the schedules of the *Threatened Species Conservation Act 1995* (*TSC Act 1995*). Consequently, no further discussion is included in this sub-section although reference can be made to Part 3 of the *Specialist Consultant Studies Compendium*.

4B.3.6.1.2 Threatened Species

Flora

Only one species, *Bertya* sp. Cobar-Coolabah, has potential to occur within the Project Site on the basis of suitable habitat and proximity of recent records. It is highly unlikely that this species would be present in the proposed areas of disturbance within the Pit Top Area and Ventilation Shaft Area.

Fauna

Although only one threatened fauna species was detected within the area of surface facilities (Yellow-bellied Freetail-bat), other species are likely to occur, at least on a seasonal basis. It has been estimated that the twenty (20) species listed in **Table 4B.21** could potentially occur, although some of the birds and bats are highly mobile and likely to also forage on land outside of the Project Site. All these species were assessed by a seven-part test (refer to *Specialist Consultant Studies Compendium* – Part 3 – Section 4.2.3). Some species with similar habitat requirements (for instance tree roosting bats, woodland birds and owls are assessed as a group). The conclusion of the seven-part tests completed by Ecotone (2007) was that the project would not have a significant impact on the threatened fauna species known or having some potential to occur within the Pit Top Area and Ventilation Shaft Area for the following reasons.

- Habitat loss would be restricted to a few isolated trees.
- A large expanse of potential habitat for the subject species occurs along the western boundary of the Project Site and beyond to the Newell Highway, (Jacks Creek and Pilliga East State Forests) to the west and the Pilliga Nature Reserve further to the south.
- There would not be a significant increase to the incidence of key threatening processes, as listed in Schedule 3 of the *TSC Act 1995*.

4B.3.6.1.3 SEPP 44 – Koala Habitat Protection

Although large Koala populations are known from Narrabri to the north, Gunnedah to the south and Pilliga Scrub to the west of the Project Site, the field assessment did not identify any Koala faecal pellets, potential scratches or actual Koalas on the Project Site. As no resident Koala population occurs in the Project Site, the area does not constitute ‘core Koala habitat’ as defined by SEPP 44.

Only one of the tree species on the Project Site is listed as a Koala feed tree under SEPP 44, the Bimble Box (*Eucalyptus populnea*). This tree is common within the creek side vegetation along Kurrajong Creek Tributary 1 and along the road verges. The species represents greater than 15% of the tree cover in these areas, hence the forest/woodland within parts of the Project Site can be considered "potential Koala habitat" under SEPP 44. The areas where this species was identified are not part of the surface facilities, and as such, further consideration of SEPP 44 is not required.

4B.4 ABORIGINAL HERITAGE

The Aboriginal heritage assessment was undertaken by Australian Archaeological Survey Consultants Pty Ltd. The full assessment is presented in Part 4 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections.

4B.4.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential environmental impacts related to Aboriginal heritage requiring assessment and their unmitigated risk rating are as follows.

- Disturbance or destruction of identified sites and/or artefacts of Aboriginal cultural heritage without the permission of LALC or DEC (extreme risk).
- Disturbance or destruction of currently unidentified sites and/or artefacts of Aboriginal cultural heritage without the permission of LALC or DEC (high risk).

In addition, the Director-General's requirements issued by DoP require that the assessment of Aboriginal heritage refer to the draft *Guidelines of Aboriginal Cultural Heritage Assessment and Community Consultation* (Department of Environment and Conservation).

The following sub-sections present the method of assessment, review the results of an Aboriginal heritage survey undertaken, provide the proposed management of identified sites and assess the significance of any impact on these. The assessment was undertaken in consultation with the Narrabri Local Aboriginal Land Council (LALC).

4B.4.2 Method of Investigation

The Aboriginal heritage assessment comprised the following components.

1. A review of previous archaeological investigations on and surrounding the Project Site.
2. Consultation with the Narrabri Local Aboriginal Land Council (LALC), including on-site discussions with a group representative. As no Aboriginal heritage sites would be disturbed by the project, further consultation in accordance with DEC (2004) was not warranted.
3. An assessment of the archaeological potential of the Project Site based on the presence or absence of resources such as vegetation, water and stone.

4. A review of the Aboriginal Sites Register (Aboriginal Heritage Information Management System – AHIMS) covering the Project Site, EL 6243 and surrounding local area.
5. The development of a predictive model for archaeological material that might realistically be expected to be present.
6. A comprehensive field survey of the Pit Top Area and Ventilation Shaft Area. Additionally, observations of 12 geotechnical pits along the northern section of the rail loop were undertaken to determine the potential for sub-surface deposits in this area along with a sample survey of an area at the western end of Mining Area A ("the Western Survey Area"). **Figure 4B.16** presents the areas covered by the field surveys.
7. An assessment of the cultural significance of the identified sites of Aboriginal heritage.
8. Development of recommendations for the management of identified sites of Aboriginal significance.
9. An assessment of the impact on Aboriginal heritage as a result of Stage 1 of the project[1], including consideration of potential cumulative impacts on the regional archaeological record.

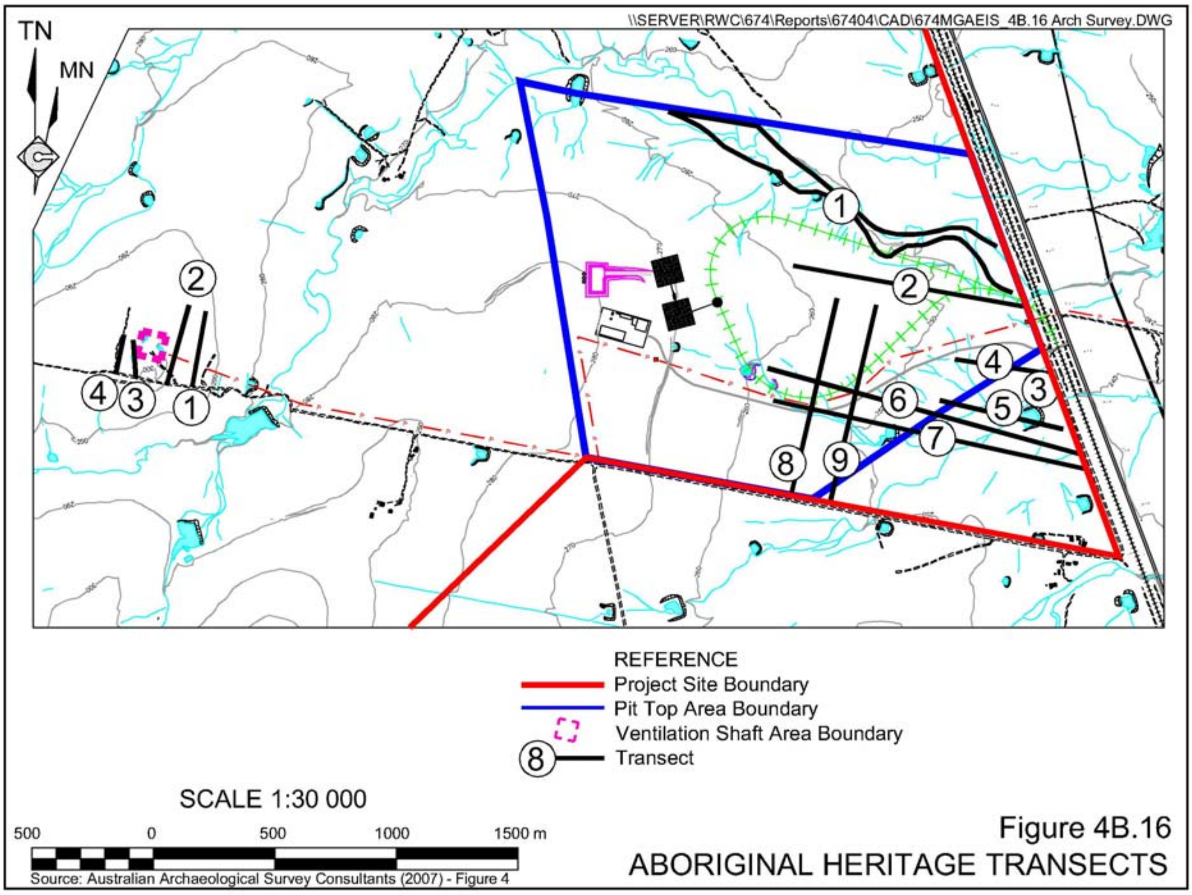

Figure 4B.16
ABORIGINAL HERITAGE TRANSECTS

[1] An assessment of the possible impacts associated with Stage 2 Longwall Mining is presented in Section 4C.6.3.

4B.4.3 Summary of Results

The search of the AHIMS database did not identify any sites within the Project Site, EL 6243 or surrounding local area.

A predictive model, based on knowledge of site patterning and site types across the landscape, was compiled to identify the archaeological sensitivity of the Project Site. The model divided the Project Site into the following three Zones (**Figure 4B.17**).

Zone 1: Watercourses: *Archaeological Potential – High*. This zone comprises about 15% of the Project Site. Sites are likely to be found close to sources of water. While the watercourses in the Project Site have been disturbed by agricultural activities, some of the larger creeks and gullies have retained some of their original riparian woodland. Where this is the case the fluvial soil deposition may be deep enough to have sub-surface archaeological deposits.

Zone 2: Agricultural Areas: *Archaeological Potential – Low.* This zone comprises about 50% of the Project Site. This zone, which is largely flat, featureless and devoid of water, is unlikely to contain many traces of archaeology. It has the potential to contain isolated finds and small artefact scatters in localised areas. Agricultural activity, especially cereal cropping, has likely damaged any sites that are present.

Zone 3: Native Vegetation Zone: *Archaeological Potential – Low.* This Zone comprises about 35% of the Project Site. It is an area of dense woodland with low, sandy soil hills and some outcropping rocky surfaces. Shallow ephemeral watercourses drain the forest out into the agricultural areas to the east. There is a reasonable potential for scarred trees to be present where remnant stands of vegetation survive. A low level density of artefacts may also be present, in a similar pattern to Zone 2. Rocky outcrops may have been utilised for artefact manufacture where conditions present suitable stone types on the surface.

A total of seven Aboriginal archaeological sites were identified during the surface archaeological survey (Sites 1-7, **Figure 4B.18**). Sites 1 to 6 were identified within or close to the boundary of the Pit Top Area and are discussed in this section. Site 7 was identified approximately 500m northeast of the Western Survey Area.

The seven sites consist of one resource site, two isolated finds, two artefact scatters and two scarred trees. **Table 4B.22** lists the salient features of the sites.

4B.4.4 Significance Assessment

The Narrabri LALC has indicated that, due to the fact that remnant sites are an ever diminishing resource as a result of development and continued rural activities, all archaeological sites are of significance to its members. The archaeological sites therefore serve as cultural reminders of the Aboriginal peoples' prior existence and relationship to this region and are important to the custodians in ensuring their cultural identity through connection with their land and knowledge of past practices is kept alive. However, as no sites would be damaged as a consequence of the project, no further advice was provided by Narrabri LALC.

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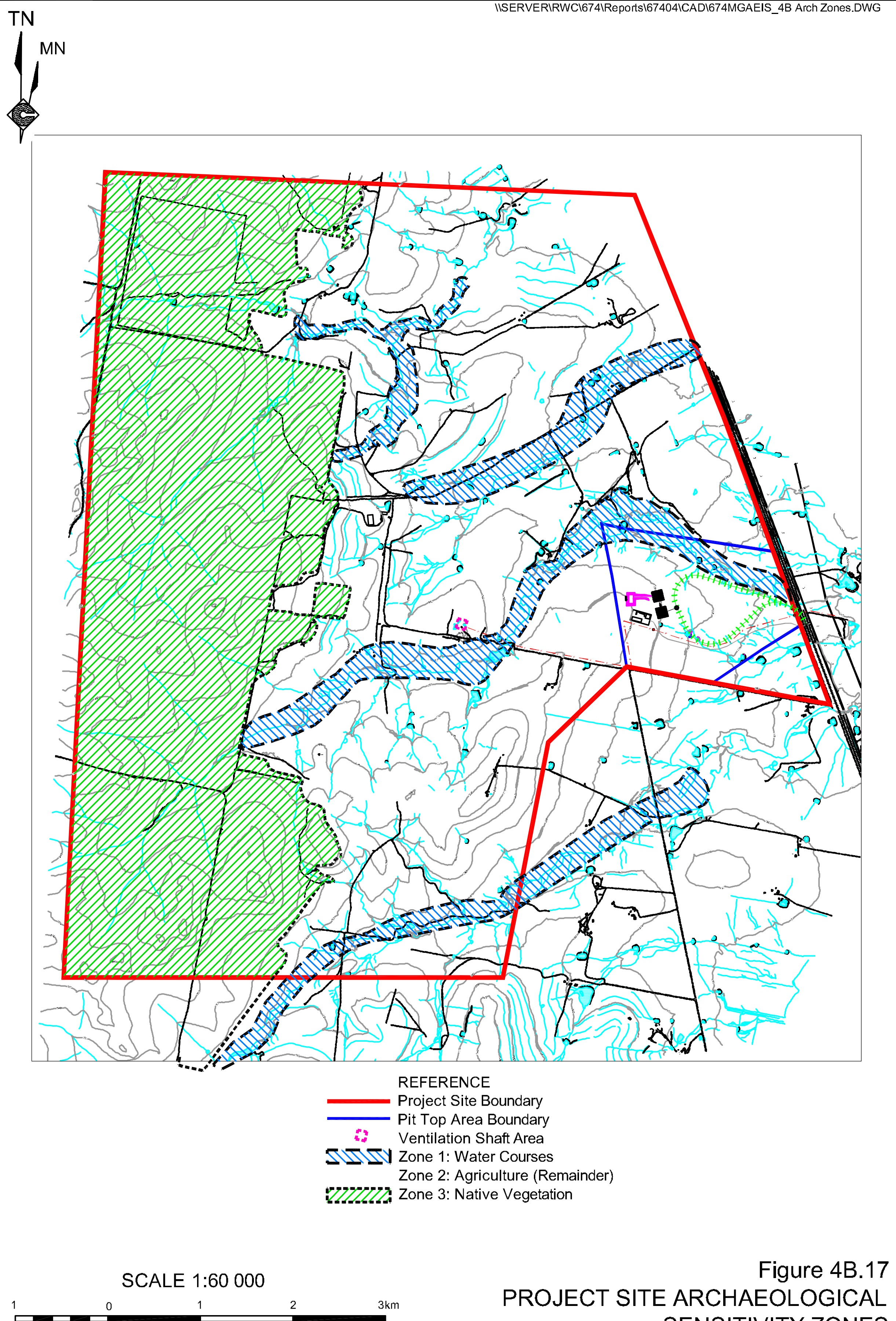

Source: Australian Archaeological Survey Consultants Pty Ltd (2007) - Figure 3

Figure 4B.17
PROJECT SITE ARCHAEOLOGICAL SENSITIVITY ZONES

Figure 4B.18
Aboriginal Heritage Sites

A4/B&W

Table 4B.22
Identified Aboriginal Heritage Sites of the Pit Top Area

Site No.	Easting	Northing	Type	Comments
1	778770	6620785	Resource Site	Wild Orange trees, a native food resource.
2	778351	6621156	Artefact Scatter	Low density scatter located on the edge of the creek terrace. 12 flakes were identified within a 10m radius.
3	778098	6621242	Scarred Tree	Dead tree, with upper half broken off and lying on the ground. The cultural scar is located on the standing section. 104cm x 30cm.
4	778338	6620931	Artefact Scatter	Also a low density scatter exposed by the erosion of the creek terrace. >10 artefacts within a 20m radius, including flakes and cores.
5	778859	6620615	Isolated Find	3 Chert flakes exposed by a small gully erosion joining the creek.
6	779673	6619677	Isolated Find	1 Silcrete Flake located in agricultural paddock.
7	7727759	6621273	Scarred Tree	A cultural scar on a fallen tree.

Source: Modified After AASC (2007) – Table 1

On the basis of the results of previous archaeological investigations within the region reviewed previously, and information held by the NSW DEC, AASC (2007) has determined that the isolated finds and artefact scatter located during this investigation (Sites 2, 4, 5, 6) are widespread in the general region. Overall, based on the Burra Charter significance assessment criteria, the campsites would rate low, from a scientific point of view and the isolated finds, very low. The scarred trees (Sites 3 and 7) which are in poor condition, would similarly rate low.

4B.4.5 Management Measures

The following general and area specific management measures would be implemented to minimise the impact on any Aboriginal heritage sites and values in the Project Site.

General

(i) Aboriginal monitors would be invited to site for all soil stripping and ground disturbance activities during the site establishment phase. Any sites detected during monitoring would be managed in accordance with the relevant Acts.

(ii) If any further Aboriginal objects are uncovered at any time during the course of the project, work at the area would cease and Proponent must contact the NSW DEC for advice.

(iii) The Proponent would conduct a Cultural Heritage Awareness Induction Course for its staff, contractors and any heritage monitors working on the Project Site. This would help raise awareness and ameliorate any impact on heritage sites during site establishment and subsequent mining activities. This induction would include making all staff and contractors aware of their responsibilities with respect to Aboriginal heritage under the *National Parks and Wildlife Act 1974*.

Pit Top Area

(i) The open artefact scatters located during this investigation, would be preserved *in situ*, and protected from the activities that would be conducted within the Pit Top Area. In the case of known sites on the western side of Kurrajong Creek Tributary 1 (Sites 3, 4 and 5) and in the nearby paddock (Site 6) this would involve temporary, visible fencing.

(ii) With the exception of a minor section of the rail loop, all Pit Top Area activities would be conducted outside Zone 1 (watercourses). In the event disturbance is required within Zone 1, it would not proceed until further detailed survey work and possibly test pitting is undertaken and advice received from the consulting archaeologist and Narrabri LALC.

(iii) As no Aboriginal heritage sites or artefacts were identified in the area of the proposed evaporation / storage ponds, the general management measures would suffice for this area and no specific management measures would be required.

Ventilation Shaft Area

(i) During the construction activities within the Ventilation Shaft Area involving the removal and/or reshaping of the top 40cm to 50cm of soils and felling of individual large trees, a representative of the Narrabri Local Aboriginal Land Council would be invited to monitor activities. Any sites detected during monitoring would be managed in accordance with the relevant Acts. Particular attention would be paid to any trees that are to be felled of the Eucalypt species as these are more likely to have cultural scars on them then other species.

(ii) In the event that a tree is identified as having culturally made scars, it would be retained *in situ* and protected from the proposed development. If this is not possible, any scarred trees would be cut, to preserve the scar, and relocated into a designated protected area. Salvage of any sites would occur prior to disturbance of this area. This work would be undertaken by a qualified archaeologist and members of the Land Council under Part 3A of the *Environmental Planning and Assessment Act 1979.* In the interim, all site personnel would be made aware of the presence of the site and their obligations under the relevant Acts.

Stage 1 Mining Areas

There is to be no surface disturbance of the Stage 1 mining Areas A, B and C and no appreciable surface subsidence, hence no specific management procedures are proposed for this area. However, to ensure the continued conservation of Site 7, staff and contractors should be made aware of its location and their obligations.

4B.4.6 Assessment of Impacts

4B.4.6.1 Identified Aboriginal Heritage Sites and Artefacts

The potential disturbance or destruction of the identified Aboriginal heritage sites within or close to the Pit Top Area would be minimal as they would be marked and protected, and employees and contractors informed of their responsibilities under the *NPW Act 1974*.

4B.4.6.2 Unidentified Aboriginal Heritage Sites and Artefacts

The majority of project-related disturbance would be undertaken within the cleared paddocks within Zone 2. AASC (2007) notes that while Aboriginal cultural heritage sites remain on this land unit, they do so at a very low level, exemplified by the fact that despite the survey effort over this zone, only one Aboriginal heritage site was identified (Site 6). As such, the probability of identifying additional sites or artefacts during construction activities would be low. By inviting Aboriginal monitors to the Project Site to observe sub-surface disturbance works, however, the Proponent would maximise the probability of identifying such sites allowing for appropriate management measures to be developed in consultation with the Narrabri LALC and DEC.

Subsidence is unlikely to impact on any sites or artefacts as this would be less than 20mm and therefore unlikely to result in significant movement of land, vegetation or artefacts.

It is therefore assessed, that the potential impact on unidentified Aboriginal heritage sites and artefacts that may be present on the Project Site is minor given these are unlikely to be present within the areas to be disturbed but if present would be identified by monitors and managed appropriately.

4B.4.6.3 Assessment of Cumulative Impact

As the project would have no impact on Aboriginal heritage, there would be no cumulative impact on the archaeology of the wider region. Should this change in the future, the individual assessment of sites to be affected would consider the impact on the regional archaeological record as a whole, as part of the normal process of site disturbance/destruction. It should be noted, however, that the landscape within the Project Site and its immediate surrounds does not appear to be unique and is unlikely to contain archaeological deposits not found elsewhere in the region.

4B.5 SOILS, LAND CAPABILITY AND AGRICULTURAL SUITABILITY

The soils and land capability assessment was undertaken by Geoff Cunningham Natural Resource Consultants. The full assessment is presented in Part 5 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections.

4B.5.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential soil impacts and changes to land capability and agricultural land suitability requiring assessment and their unmitigated risk ratings are as follows.

- Insufficient soil quantities for rehabilitation (high risk).
- Temporary disturbance to soil quality (moderate risk).
- Degradation of soil quality (moderate risk).
- Elevated erosion or erosion potential (moderate risk).
- Decreased land and agricultural capability of the final landform (high risk).

The Director-General’s requirements issued by the DoP require that the assessment of soils and land capability / agricultural land capability would refer to *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

The following sub-sections describe the soils within the areas proposed to be disturbed, identify the soil and land management issues and the proposed soil-related controls, safeguards and mitigation measures. Additionally, an assessment of the residual impacts upon the soil resources following the implementation of these safeguards and mitigation measures is also described.

4B.5.2 Soil Occurrences

4B.5.2.1 Regional Setting

The Narrabri Soil Conservation Service Technical Manual (Anon, 1978) depicts the Project Site located on the boundary of Red Brown Earth soils and the Pilliga Scrub soils.

Red Brown Earth soils are generally associated with gently undulating slopes. The soils are typically hardsetting with a sandy loam to sandy clay loam A horizon overlying a sandy clay loam to light clay B horizon. The soils are predominantly red brown in colour and have a weak to moderate degree of structure.

The Pilliga Scrub soils are mainly sandy solodised soils and sandy solodic soils. The soils possess a surface horizon of light texture that is sharply differentiated from the subsoil, which has a well developed columnar structure with a sandy texture. There is usually a strongly bleached zone above the subsoil. Other soils within this complex include deep siliceous sands, earthy sands, lithosols and red and yellow earths.

4B.5.2.2 Project Site Soils

4B.5.2.2.1 Site Investigations

The site investigations undertaken by GCNRC (2007) concentrated on those areas within the proposed areas of surface disturbance within the Pit Top Area and Ventilation Shaft Area. The soil investigation involved the complete description of nine representative profiles exposed in eight test pits, each dug to a depth of 2.5m or the depth of backhoe refusal. The locations of the soil sampling sites within the soil investigation Study Area are shown in **Figure 4B.19**.

A number of soil characteristics were recorded for each test pit during the field work. Additionally, samples from all profiles within Test Pits 1 and 6 were analysed in the Department of Lands' NATA - registered soil testing laboratory for more detailed analysis to determine the range of particle size, dispersion percentage, coherence (Emerson aggregate test) and electrical conductivity. As noted in Section 2.4.10.3, samples from three of the test pits were also analysed by the Department of Lands Scone Laboratory for saturated hydraulic conductivity (permeability).

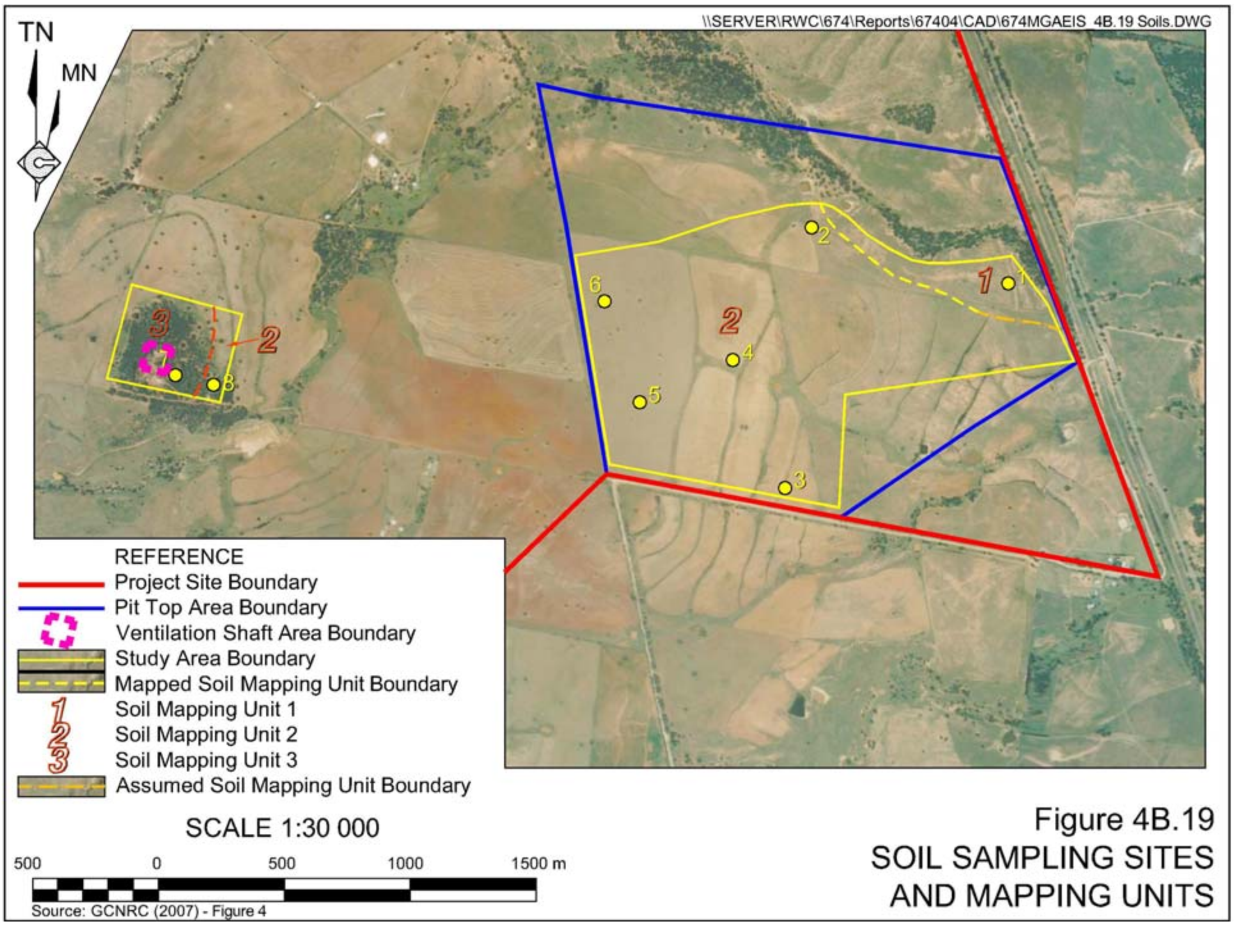

Figure 4B.19
SOIL SAMPLING SITES AND MAPPING UNITS

4B.5.2.2.2 Soil Distribution and Characteristics

Soil Mapping Units

From the information gained from the detailed soil profile descriptions, three Soil Mapping Units (SMUs) were identified (**Figure 4B.19**).

SMU 1 occurs in the floodplain area near Kurrajong Creek Tributary 1. SMU 2 occurs on the slopes and crests in the Pit Top Area and SMU 3 is associated with the ridge beneath the Ventilation Shaft Area. The soils of the mid- and lower slopes within the Ventilation Shaft Area are SMU 2 soils.

Table 4B.23 presents a summary of the soil profiles and characteristics of the identified SMUs.

Table 4B.23
Summary of Soil Mapping Units within the Pit Top Area and Ventilation Shaft Area

Soil Mapping Unit (SMU)*	Topsoil	Subsoil
1 Brown Chromosol	**Topsoil to 12cm -** sandy loam; many roots; pH 6.0; stones and gravel absent; brown	**Subsoil of four layers,** medium clay or medium-heavy clay in upper layers, sandy light clay at base of excavation; pH 8.0 to 9.5; stones and gravel generally absent; brown or yellowish brown coloured sometimes mottled in colours of brown, yellow and grey
2 Brown (mainly) and Red Vertosols	**Topsoil** sandy clay, sandy light clay, light clay, medium clay, medium to heavy clay, heavy clay; pH 5.5 to 7.0; some to much rounded angular gravel to 0.5-4cm present; not mottled; not bleached; brown coloured	**Subsoil** consisting of two to four horizons; medium clay or medium to heavy clay to heavy clay textured; stones and gravel absent or containing some to much grave and larger stones in the lower horizons; variously coloured brown, reddish brown, dusky red, yellowish red; sometimes mottled in colours of grey, brown, red and yellow
3 Red Rudosol	**Topsoil to 15cm deep,** sandy clay loam; pH 4.5-5.0; some gravel to 2cm; not mottled; not bleached; reddish brown [5YR4/4] dry, dark reddish brown [5YR3/3] moist	**Subsoil** consisting of a single layer**,** sandy clay textured; pH 4.5-5.0; containing mainly flat and angular gravel 1-2cm and some angular sandstone to 10cm; not mottled; not bleached; red coloured
* See **Figure 4B.19** for locations		
Source: GCNRC (2007) – Section 5.1		

4B.5.2.3 Soil Physical Attributes

Ten soil samples from two representative test pits were analysed to further characterise the physical properties of each SMU. Three tests, namely particle size analysis (PSA), dispersion percentage (D%) and Emerson Aggregate Test (EAT) were undertaken and results are presented in **Tables 4B.24** and **4B.25**.

Particle Size Analysis

The Particle Size Analysis (PSA) test shows the amounts of gravel, clay, silt, fine sand and coarse sand contained within each sample. The results shown in **Table 4B.24** indicate that the topsoils and subsoils in both profiles generally contain relatively low levels of gravel and consequently the material is suitable for use in rehabilitation works.

Table 4B.24
Particle Size Analysis Results of Selected Samples

SMU / PIT NO.	LAYER	TEXTURE [fine earth]#	DEPTH [cm]	PSA % CLAY	PSA % SILT	PSA % FINE SAND	PSA% COARSE SAND	PSA % TOTAL SAND	PSA % GRAVEL
SMU 1 PIT 1	1	Loamy sand	0-12	7	7	39	47	86	<1
	2	Sandy clay loam	12-39	29	4	32	35	67	<1
	3	Clay / clay loam	39-73	32	7	29	32	61	<1
	4	Clay / clay loam	73-172	34	9	27	29	56	1
	5	Sandy clay	172-250	31	4	31	34	65	<1
SMU 2 PIT 6	1	Clay	0-15	51	11	25	12	37	1
	2	Clay	15-82	54	12	22	11	33	1
	3	Clay	82-126	57	9	21	12	33	1
	4	Clay loam	126-173	25	17	23	23	46	12
	5	Silty loam	173-218	13	26	42	18	60	1
Source: GCNRC (2007) – Table 1									

Table 4B.25
Dispersion Percentage and Emerson Aggregate Test Results of Selected Samples

SMU / PIT NO.	LAYER	TEXTURE [fine earth]#	DEPTH [cm]	D %	D% level of dispersion	EAT	EAT level of dispersion
SMU 1 PIT 1	1	Loamy sand	0-12	60	High	2[1]	High to moderate
	2	Sandy clay loam	12-39	93	Very high	2[3]	Very high
	3	Clay / clay loam	39-73	71	Very high	2[3]	Very high
	4	Clay / clay loam	73-172	83	Very high	2[3]	Very high
	5	Sandy clay	172-250	93	Very high	2[3]	Very high
SMU 2 PIT 6	1	Clay	0-15	12	Slight	5	Slight
	2	Clay	15-82	12	Slight	4	Negligible
	3	Clay	82-126	12	Slight	4	Negligible
	4	Clay loam	126-173	19	Slight	4	Negligible
	5	Silty loam	173-218	27	Slight	4	Negligible
Source: GCNRC (2007) – Table 1							

Dispersion Percentage

The Dispersion Percentage (D%) test indicates the proportion of the soil material less than 0.005 mm in size that would disperse on wetting.

The D% values shown in **Table 4B.25** indicate the following.

- The topsoil of SMU 1 has high dispersibility.
- The topsoil of SMU 2 showed only slight dispersibility.
- The subsoil of SMU 1 indicated very high dispersibility values.
- The subsoil horizons of SMU 2 showed only slight dispersibility values.

Based on these results, the erosion potential for SMU 1 soils (including stockpiled subsoils) would be high, and as such appropriate measures would need to be taken to protect the stockpiles of stripped SMU 1 soils. This would also apply to any embankments or the like constructed with or excavated within this material. The same material, when respread, would need to be rapidly stabilised with pasture cover.

Emerson Aggregate Test (EAT)

This test provides a measure of the coherence of soil aggregates when they are immersed in water. The degree of soil aggregate stability increases from Class 1 through to Class 8, with aggregates in Emerson Classes 1 and 2 being generally regarded as being unstable while those in Classes 4 to 8 are considered to be stable. Classes 2 and 3 have a number of subclasses based on the degree of dispersion.

Results of this analysis indicate that:

- the topsoil of SMU1 have a moderate to high dispersibility rating;
- the topsoil of SMU2 have a slight dispersibility rating;
- the subsoils of SMU1 exhibited a very high dispersibility rating; and
- the subsoils of SMU2 again showed negligible dispersibility.

These results reinforce the previously noted requirement for appropriate measures regarding SMU 1, such as immediate erosion protection, to be conducted for exposed SMU 1 subsoils.

Saturated Hydraulic Conductivity

This test provides an estimate of the permeability of selected soils under saturated conditions, eg. when used to line a dam wall. Three representative soil samples from Pits 3, 5 and a composite sample of Pit 5 and 6 were analysed and **Tables 4B.26** and **4B.27**present the physical characteristics of these.

Table 4B.26
Physical Characteristics of Saturated Hydraulic Conductivity Samples

Sample No.	Material Description	Profile Detail	Field Texture
1 (Pit 3)	Clay	135cm to 260cm	Medium to Heavy Clay
2 (Pit 5)	Gritty Clay	191cm to 255cm	Sandy Light Clay
3 (Pit 5) (Pit 6)	Clay	71cm to 115cm 82cm to 126cm	Medium to Heavy Clay Heavy Clay
Source: GCNRC (2007) – Appendix 6 – Table 1			

The results of the laboratory test for Saturated Hydraulic Conductivity are presented in **Table 4B.27** and compared against the South Australian EPA benchmark requirement for Waste Water and Evaporation Lagoon Construction of $1x10^{-9}$ m/sec.

Table 4B.27
Saturated Hydraulic Conductivity Results

Sample No.	Saturated Hydraulic Conductivity (m/sec)	Bulk Density (t/m^3)	Moisture Content (%) of Compacted Soil
1	$0.55x10^{-9}$	1.60	19.6
2	$16x10^{-9}$	1.59	23.1
3	$3.7x10^{-9}$	1.35	26.3
Source: GCNRC (2007) – Appendix 6 – Table 2			

Of the three samples tested, on (Sample 1) has a hydraulic conductivity below the benchmark requirement of $1x10^{-9}$, one (Sample 3) is almost 4 times the benchmark and the third (Sample 2), 16 times the benchmark requirement.

4B.5.2.4 Soil Chemical Attributes

The representative samples used for physical characterisation were also subject to laboratory chemical analyses to evaluate the likely salinity hazard. **Table 4B.28** presents the results of the chemical analyses of the Project Site.

Soil pH

The results presented in **Table 4B.28** indicate that for most soils, the pH is within the acceptable range for agronomic purposes (pH 4.0 to pH 8.5). The topsoils of SMU 1 showed pH levels not only within the acceptable 4.0 to 8.5 range, but also within the pH range of 6.0 to 6.5, usually regarded as optimal for most plant growth.

The subsoils of SMU 1 were generally within the acceptable range of pH 4.0 to 8.5, and those from SMU 2 were all within this range. Within SMU 1, high pH material occurs about 40cm below the surface in moderately saline horizons and so this material would not be stripped.

For SMU 3, both topsoil and subsoil pH values were in the 4.5 to 5.0 range and thus are at the lower end of the acceptable range.

Table 4B.28
Chemical Attribute Results of Selected Samples

SMU / PIT NO.	LAYER	TEXTURE [fine earth]#	DEPTH [cm]	pH *	EC [dS/m]#	SOIL SALINITY STATUS
SMU 1 PIT 1	**1**	Loamy sand	0-12	6.0	0.01	Non-saline
	2	Sandy clay loam	12-39	8.0	0.27	Slightly saline
	3	Clay / clay loam	39-73	9.0	0.67	Moderately saline
	4	Clay / clay loam	73-172	9.5	0.78	Moderately saline
	5	Sandy clay	172-250	8.0	0.64	Moderately saline
SMU 2 PIT 6	**1**	Clay	0-15	6.0	0.04	Non-saline
	2	Clay	15-82	8.5	0.10	Non-saline
	3	Clay	82-126	8.5	0.09	Non-saline
	4	Clay loam	126-173	8.5	0.10	Non-saline
	5	Silty loam	173-218	8.5	0.10	Non-saline
Source: GCNRC (2007) – Table 2 and 3						

Electrical Conductivity

Soil salinity is a measure of the presence of water-soluble salts, mainly of sodium, calcium and magnesium in the soil solution. These salts may be chlorides, sulphates or carbonates and can have a major impact on plant growth if they occur in sufficiently large quantities. The level of salinity in a soil sample is determined by measuring the electrical conductivity [EC] of a 1:5 soil / water suspension.

The electrical conductivity data (see **Table 4B.28**) from the analysis of the representative soil samples indicates that:

- the topsoils of SMU1 are non-saline;
- the topsoils of SMU2 are non-saline;
- the subsoils of SMU1 is slightly saline in the upper horizon and then moderately saline for the remaining horizons;
- the subsoils of SMU2 are non-saline.

The results indicate that soils >40cm deep in SMU 1 would preferably not be stripped as the saline properties combined with the soil dispersibility would make the soils difficult to manage.

Erosion Potential

The soils within the proposed disturbance areas are currently generally stable except for some minor areas of sheet erosion on the slopes and some minor gully erosion in the main drainage lines and tracks. Data from the representative soil samples for SMU 1 and SMU 2 were analysed using the SOILOSS computer program to determine erosion hazard.

The results indicate that:

- the SMU1 topsoils and subsoils exhibit a moderate erodibility rating; and
- the SMU2 topsoils and subsoils show a low erodibility rating.

The low erodibility for SMU 2 soils may be understated given the extensive soil conservation bank and waterway system across these soils.

Due to the moderate erodibility rating of the SMU 1 soils, they need to be carefully managed when disturbed. Additionally, the combination of high pH for subsoils, relatively high dispersibility for topsoil and subsoils and salinity in some SMU 1 subsoils requires careful management during the stripping and rehabilitation stages to ensure that soil structure damage is minimal and that they are suitably protected by vegetation or some other medium at all times.

Analysis of the chemical and physical attributes of the soils led to the determination of soil stripping suitability and the identification of required soil management measures, as detailed in Section 2.4.3.

4B.5.2.5 Soil Management

The following soil management procedures for both topsoils and subsoils have been developed from an interpretation of the results of the soil survey within the Pit Top Area and Ventilation Shaft Area and the associated field and laboratory analysis data. The procedures would be adopted, principally throughout the site establishment phase.

- Subsoils in SMU 1 below 40cm in depth would preferentially not be stripped.
- All soils would be handled as little as possible by ensuring the area to be stripped and the area of stockpiling is clearly identified.
- Soils would preferentially not be stripped or replaced when under wet conditions.
- Driving of machinery on the topsoil and subsoil stockpiles would be prohibited once the stockpiles are created, to minimise compaction and further degradation of soil structure.
- Topsoil stockpiles would not exceed 2m in height, while the subsoil stockpiles would not exceed 3m in height.
- Upslope water diversion banks and the perimeter amenity bund would direct overland surface water flow away from the soil stockpiles.

- Downslope sedimentation controls would be implemented as required, until such time as the surface of the soil stockpiles is appropriately stabilised using groundcover species.
- Within the evaporation / storage ponds area, it is proposed that subsoil recovered from the floor of each cell would be used to construct the perimeter walls suitably impermeable clay would be used to line the floor and inside walls with the topsoil used to stabilise the outer slopes of the dam walls created. The sampling and testing of selected soil samples from the location of the evaporation / storage ponds suggests that soil types of suitably impermeable qualities ($<1x10^{-9}$) are available to line the constructed pond walls although more targeted sampling and laboratory testing would be undertaken prior to construction to confirm this. Surplus topsoil would be stored in dedicated stockpiles near the perimeter of the evaporation / storage ponds or in Surplus Soil Stockpile Areas 1 and 2.
- The formed soil stockpile surfaces would have a generally uneven surface that is as 'rough' as possible, in a micro-sense, to assist in runoff control and seed retention and germination.
- Soil stockpiles would be sown with stabilising groundcover species as soon as possible after placement and watered if necessary to speed up establishment. The vegetation would help stabilise the surface and minimise erosion and sedimentation.
- Stabilisation measures would be taken to minimise loss of soil materials from the stockpiles prior to the establishment of stabilising ground cover. Stabilisation measures would include the use geotextile “silt fences” or lines of straw bales.

Additionally, the Pit Top Area is currently actively cultivated and a significant amount of soil conservation works have been constructed in this area. Where the proposed surface disturbance does not impact these structures, they would be retained. In areas where surface disturbance would impact these structures, wherever possible, the alignment of these structures would be retained and they would be integrated into the areas surface water and soil management strategies.

4B.5.2.6 Assessment of Impacts

Analyses of the physical and chemical attributes of the soil to be stripped, stockpiled and ultimately respread indicate these soils have low to moderate erosion potential, pH levels suitable for plant growth and are highly unlikely to result in increased salinity levels. As a result, the adoption of the soil management controls summarised in Section 4B.5.3 would ensure that there would be minimal impacts as a consequence of physical or chemical alteration and/or loss of biological activity. Erosion from soil stockpiles or revegetated surfaces would also be unlikely given the erosion potential of the soils and proposed protection measures.

The results also suggest that the proposed evaporation / storage ponds could be successfully constructed using in-situ soil and subsoil materials such that saline water would not seep through the constructed floors or walls. This would be further tested and assessed prior to construction with additional low permeability clays or plastic liners imported to the Pit Top Area as required to supplement available in-situ low permeability clays.

Once the soils are replaced on the final landform, they would provide a suitable substrate for revegetation. As such, the impact to the soils within the disturbance area is considered temporary and manageable.

4B.5.3 Land Capability and Agricultural Land Suitability

4B.5.3.1 Existing Land Capability

"Land capability" was defined by Houghton and Charman (1986) as "*the ability of land to accept a type and intensity of use permanently, or for specified periods under specific management, without permanent damage*". Land that is used beyond its capability ultimately loses its production value through exhaustion of soil nutrient levels or land degradation of some description.

The 1: 100 000 scale Land Capability map of the Baan Baa map sheet area prepared by the former Soil Conservation Service of NSW (now DNR) indicates that the land within the Pit Top Area is mapped mainly as Class III land with a small area of Class IV land near the Ventilation Shaft Area as well as along the Kurrajong Creek Tributary 1.

The field component of the soil investigation indicated that the Pit Top Area, as well as the lower slopes around the proposed ventilation shaft, is Class III land while the upper slopes at the Ventilation Shaft Area are more correctly classed as Class VII land.

Figure 4B.20 displays the land capability within the Pit Top Area and the Ventilation Shaft Area whilst **Table 4B.29** presents relevant land capability class descriptions drawn from Houghton and Charman (1986).

Table 4B.29
Land Capability Class Descriptions

Land Capability Class	Description
Class III	Sloping land suitable for cropping on a rotational basis. Structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotations are required.
Class IV	Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation and requiring soil conservation practices such as pasture improvement, application of fertilizer and minimal cultivation for the establishment or re-establishment of permanent pasture.
Class VII	Land best protected by green timber. It generally comprises areas of steep slopes, shallow soils and/or rock outcrop. Adequate ground protection must be maintained by limiting grazing and minimising damage by fire.
Source: Modified after GCNRC (2007) - Section 9	

Based upon the proposed extent of surface disturbance shown on **Figure 2.5**, it is envisaged that 47.1ha of Class III land and 1.6ha of Class VII land would be disturbed within the Pit Top Area and Ventilation Shaft Area. **Table 4B.30** lists the land capability of the land within each component area within the Pit Top Area and Ventilation Shaft Area.

Table 4B.30
Land Capability and Agricultural Land Suitability of Land to be Disturbed

Component	Total Area (ha)	Land Capability Area to be Disturbed		Agricultural Land Suitability Area to be Disturbed		
		Class III	Class VII	Class 2	Class 3	Class 5
Box Cut and Drift Portals	1.0	1.0	0	1.0	0	0
Perimeter Amenity Bund	6.8	6.8	0	1.6	5.2	0
ROM Coal Stockpile Area	1.2	1.2	0	0	1.2	0
Crushing / Sizing Plant	0.2	0.2	0	0	0.2	0
Product Stockpile Area	1.2	1.2	0	0	1.2	0
Surface Buildings	2.3	2.3	0	1.0	1.3	0
On-site Tracks	0.6	0.6	0	0.6	0	0
Site Access Road	2.7	2.7	0	2.7	0	0
Rail Loop	4.7	4.6	0.1	0	4.6	0.1
Evaporation / Storage Ponds	26.5	26.5	0	0	26.5	0
Ventilation Shaft Area	1.5	0	1.5	0	0	1.5
TOTAL	**48.7**	**47.1**	**1.6**	**6.9**	**40.2**	**1.6**

4B.5.3.2 Existing Agricultural Land Suitability

"Agricultural land suitability" is based on land capability, but with the incorporation of other factors, such as closeness to markets and availability of water or processing facilities, in order to provide an indication of its suitability with respect to agriculture (Cunningham *et al.,* undated).

The Department of Primary Industries (Agriculture) has classified the lands in the vicinity of the Pit Top Area and Ventilation Shaft Area using its agricultural land suitability classification system. The classification indicates that these areas comprise mainly Class 3 land with minor areas of Classes 2 and 4.

GCNRC (2007) confirmed that the DPI (Agriculture) assessment of the agricultural land suitability is generally correct, although the slopes within the Ventilation Shaft Area would be more appropriately classed as Class 5 land as shown in **Figure 4B.21**.

The descriptions of the agricultural land suitability classes are presented in **Table 4B.31**.

Based upon the extent of surface disturbance shown on **Figure 2.5**, it is proposed that 6.9ha of Class 2 land, 35.7ha of Class 3 land and 1.6ha of Class 5 land would be disturbed across the Pit Top Area and Ventilation Shaft Area. **Table 4B.32** lists the existing agricultural land suitability of the land within each component area in the Pit Top Area and Ventilation Shaft Area.

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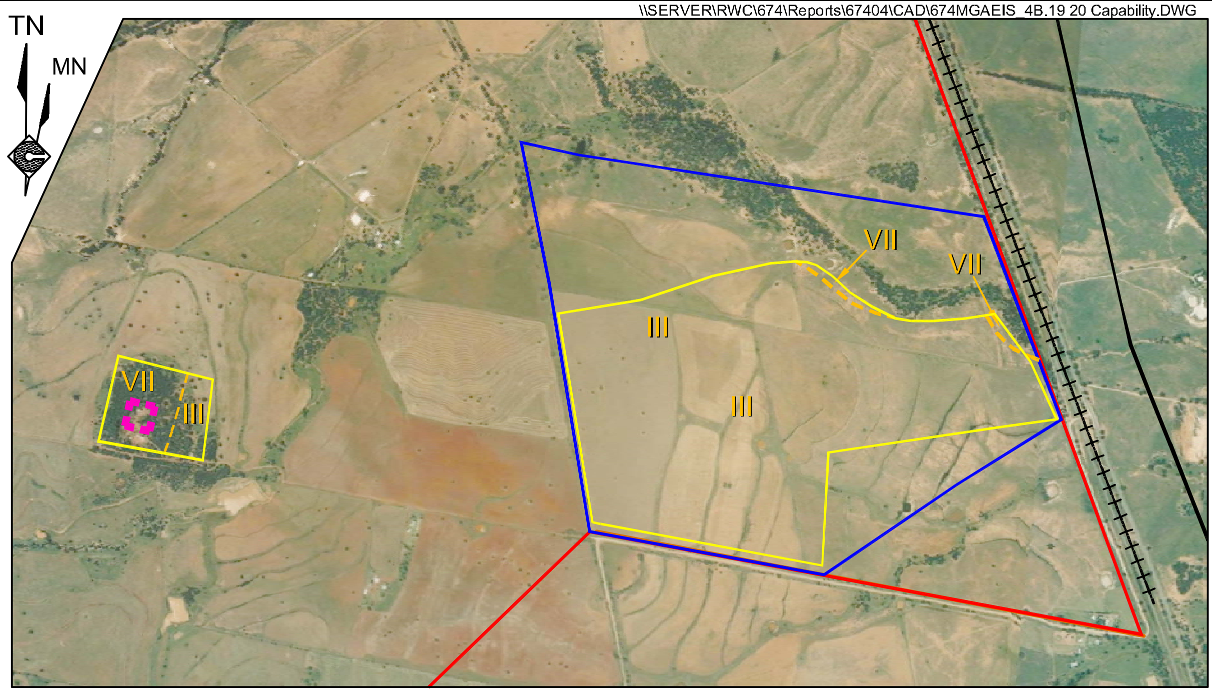
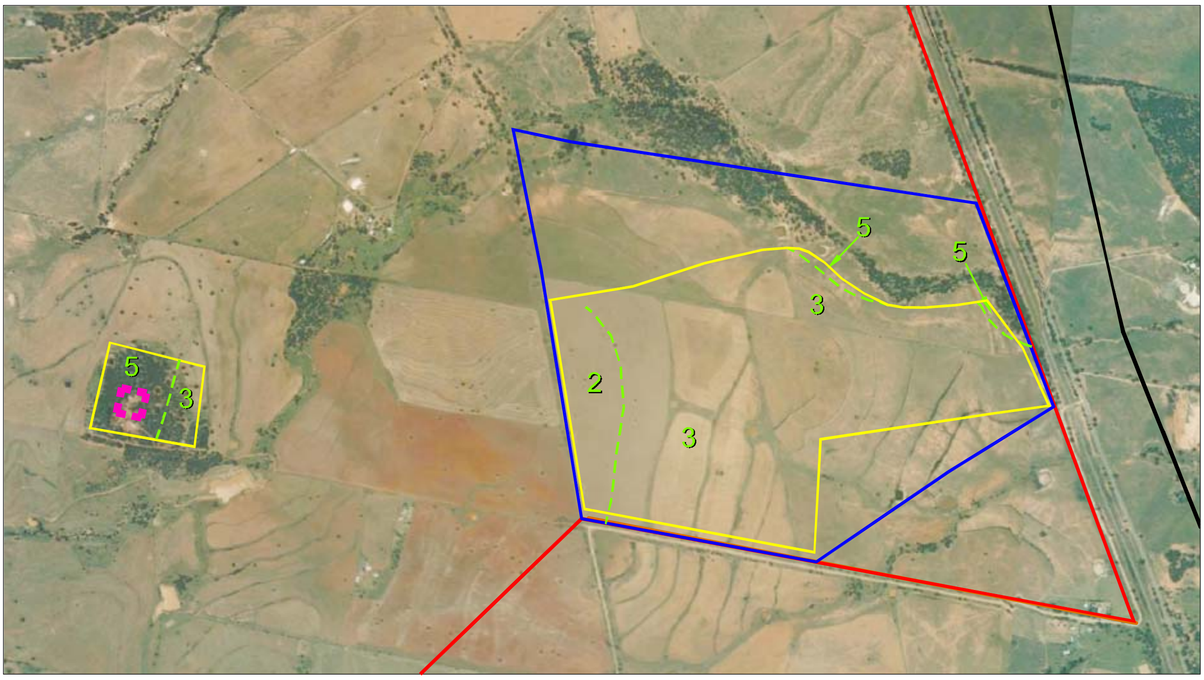


REFERENCE
Project Site Boundary
Pit Top Area Boundary
Ventilation Shaft
Study Area Boundary
Land Capability Boundary
VII Land Capability Reference

Figure 4B.20
LAND CAPABILITY



REFERENCE
Project Site Boundary
Pit Top Area Boundary
Ventilation Shaft Area Boundary
Study Area Boundary
Agricultural Land Suitability Boundary
2 Agricultural Land Suitability Reference

SCALE 1:30 000

500 0 500 1000 1500 m

Source: GCNRC (2007) - Figures 5 & 6

Figure 4B.21
AGRICULTURAL LAND SUITABILITY

Table 4B.31
Agricultural Land Suitability Class Descriptions

Agricultural Land Suitability Class	Description
Class 2	"Arable land suitable for regular cultivation for crops but not suitable for continuous cultivation. It has a moderate to high suitability for agriculture though soil or other environmental factors reduce the overall level of production and may limit the cropping phase to a rotation within sown pastures".
Class 3	"Grazing land or land well suited to pasture improvement that may be cultivated and cropped in rotation with pasture. Erosion hazard or soil structural breakdown limit the frequency of ground disturbance, and conservation works may be required".
Class 4	"Land suitable for grazing but not for cultivation. Agriculture is based on native pastures on improved pastures established using minimal tillage techniques".
Class 5	"Land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low or zero due to severe constraints which preclude improvement".
Source: Modified after GCNRC (2007) - Section 9	

Table 4B.32
Existing Agricultural Land Suitability

Component	Area (ha)	Existing		
		Class 2	Class 3	Class 5
Box Cut and Drift Portals	1.0	1.0	0	0
Perimeter Amenity Bund	6.8	1.6	5.2	0
ROM Coal Stockpile Area	1.2	0	1.2	0
Crushing / Sizing Plant	0.2	0	0.2	0
Product Stockpile Area	1.2	0	1.2	0
Surface Buildings	2.3	1.0	1.3	0
On-site Tracks	0.6	0.6	0	0
Site Access Road	2.7	2.7	0	0
Rail Loop	4.7	0	4.6	0.1
Evaporation / Storage Ponds	26.5	0	26.5	0
Ventilation Shaft Area	1.5	0	0	1.5
TOTAL	**48.7**	**6.9**	**40.2**	**1.6**

4B.5.3.3 Land Management Practices

The Proponent would adopt the following land management practices throughout the life of the project and at the end of the operational life of the project that would maximise the return of land to its former capability and agricultural suitability.

(i) All topsoil and subsoil resources would be properly managed (see Section 4B.5.3).

(ii) All surface water management controls nominated in Section 4B.1.4 would limit erosion of both natural and disturbed areas.

(iii) A substantial vegetative cover would be maintained on all areas within the Pit Top Area and Ventilation Shaft Area to minimise localised scouring during above-average rainfall events.

(iv) All topsoil and subsoil would be replaced appropriately to maximise the return of vegetation following landform reconstruction.

4B.5.3.4 Assessment of Impacts

Land Capability

Table 4B.33 lists the existing and proposed land capability of the component areas within the Pit Top Area and Ventilation Shaft Area.

The rehabilitation of the component areas at the end of the mine life would result in approximately 35.7ha of the 47.1ha of the Class III land being returned. Given this high proportion of returned land capability, the impacts are considered to be acceptable. The two component areas not returned to Class III land, namely the rail loop and the perimeter amenity bund would be retained as functional areas. That is, the rail loop is likely to serve some other form of industry and the vegetated perimeter amenity bund would serve as fauna habitat and would by that time be a recognisable feature of the local landscape.

Table 4B.33
Existing and Proposed Land Capability

Component	Area (ha)	Existing		Proposed	
		Class III	Class VII	Class III	Class VII
Box Cut and Drift Portals	1.0	1.0	0	1.0	0
Perimeter Amenity Bund	6.8	6.8	0	0	0
ROM Coal Stockpile Area	1.2	1.2	0	1.2	0
Crushing / Sizing Plant	0.2	0.2	0	0.2	0
Product Stockpile Area	1.2	1.2	0	1.2	0
Surface Buildings	2.3	2.3	0	2.3	0
On-site Tracks	0.6	0.6	0	0.6	0
Site Access Road	2.7	2.7	0	2.7	0
Rail Loop	4.7	4.6	0.1	0	0
Evaporation / Storage Ponds	26.5	26.5	0	26.5	0
Ventilation Shaft Area	1.5	0	1.5	0	1.5
TOTAL	**48.7**	**47.1**	**1.6**	**35.7**	**1.5**

Agricultural Land Suitability

Table 4B.34 lists the existing and proposed agricultural land suitability of the component areas within the Pit Top Area and Ventilation Shaft Area.

The rehabilitation of the component areas disturbed at the end of the mine life would result in approximately 75% of the Class 3 land being returned. Most of the Class 2 and Class 5 land would be returned to former suitability.

Table 4B.34
Existing and Proposed Agricultural Land Suitability

Component	Area (ha)	Existing			Proposed		
		Class 2	Class 3	Class 5	Class 2	Class 3	Class 5
Box Cut and Drift Portals	1.0	1.0	0	0	1.0	0	0
Perimeter Amenity Bund	6.8	1.6	5.2	0	0	0	0
ROM Coal Stockpile Area	1.2	0	1.2	0	0	1.2	0
Crushing / Sizing Plant	0.2	0	0.2	0	0	0.2	0
Product Stockpile Area	1.2	0	1.2	0	0	1.2	0
Surface Buildings	2.3	1.0	1.3	0	1.0	1.3	0
On-site Tracks	0.6	0.6	0	0	0.6	0	0
Site Access Road	2.7	2.7	0	0	2.7	0	0
Rail Loop	4.7	0	4.6	0.1	0	0	0
Evaporation / Storage Ponds	26.5	0	26.5	0	0	26.5	0
Ventilation Shaft Area	1.5	0	0	1.5	0	0	1.5
TOTAL	**48.7**	**6.9**	**40.2**	**1.6**	**5.3**	**30.4**	**1.5**

Given this status of agricultural land suitability following rehabilitation, the overall impact on agricultural land is assessed to be acceptable.

4B.6 VISIBILITY

4B.6.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential environmental impacts on visual amenity requiring assessment and there unmitigated risk rating are as follows.

- Reduced amenity of the altered Project Site landform as a result of:
  - temporary disturbance to the landform (high risk);
  - marginally identifiable changes to landscape (high risk); and
  - highly identifiable changes to the landscape (high risk).
- Reduced effectiveness of the Siding Springs Observatory as a result of night time lighting (low risk).

The following sub-sections assess the existing visual amenity of the local setting, identify operational safeguards and mitigation measures and provide an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4B.6.2 Existing Visual Amenity

Existing visual amenity is considered in relation to views of the Project Site component areas, namely, the Pit Top Area and the Ventilation Shaft Area. Various views are currently possible from the following non-project related residences or parts of the properties, particularly of cleared paddocks, isolated clumps of native woodland and scattered tree within the Pit Top Area and Ventilation Shaft Area.

- “Westhaven”
- “Kurrajong”
- “Ardmona”
- “Bow Hills”

- "Pineview"
- "Naroo"
- "Greylands"
- "Omeo"

Views of the component areas within the Pit Top Area or Ventilation Shaft Area are described as either local (within 1km) or distant (>1km), direct (without significant obstruction from topography or vegetation) or obscured (with significant obstruction from topography or vegetation). **Figure 4B.22** presents the non-project related residences with an assessment of the view afforded to each provided in **Table 4B.35**.

Local views of the Project Site are also possible from sections of Kurrajong Creek Road and the Kamilaroi Highway.

4B.6.3 Visual Control Measures

The principal visual control measures to be adopted within the Pit Top Area include the following.

(i) The 3m high perimeter amenity bund (**Figure 2.5**) would provide a barrier for views to the facilities within the Pit Top Area, particularly from Kurrajong Creek Road and the closest residences ("Naroo", "Ardmona", Bow Hills" and "Greylands"). The bund itself would be initially grassed to limit its visual contrast, however, it would be planted with a range of trees and shrubs to create a long term screen and fauna movement corridor.

(ii) All areas not required for site operations, particularly following site establishment, would be revegetated to ensure the maximum area of grassed paddock is present.

(iii) The load-out bin above the rail load-out area and site buildings would be painted in a grey/green hue to limit their overall visibility.

(iv) A high standard of housekeeping would be adopted to maintain a tidy site.

The Ventilation Shaft Area has been selected in an area already shielded by existing vegetation. The construction of the perimeter bund around the shaft itself would further reduce visual access to this area.

4B.6.4 Assessment of Impacts

The development and operation of the project would be noticeable in the local area, particularly through the construction of the perimeter bund, haul roads, increased road and rail traffic and the load-out bin, located up to 24m above the existing natural ground level.

However, the various control measures adopted would limit the visual intrusiveness of the various changes within the Pit Top Area.

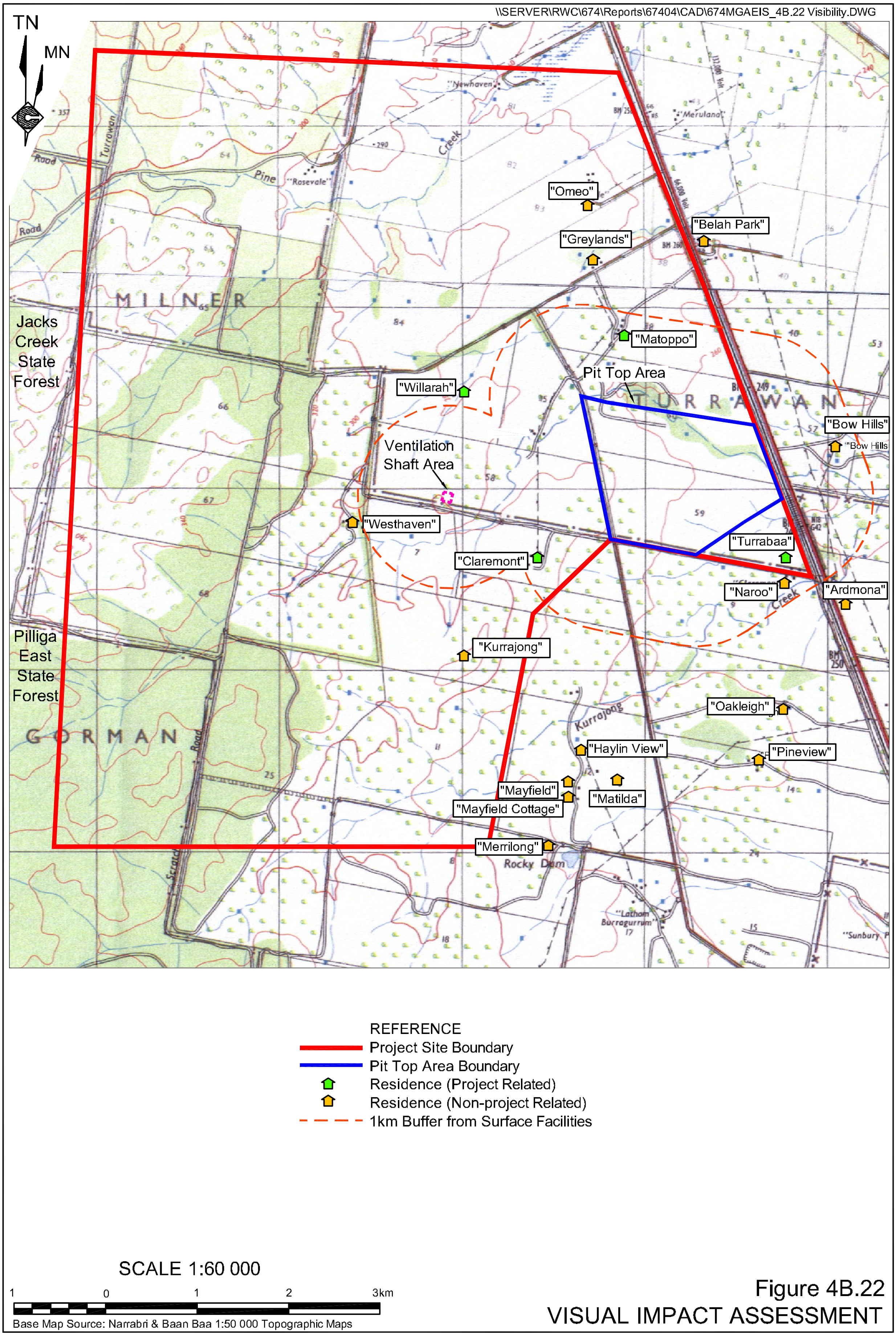


Figure 4B.22
VISUAL IMPACT ASSESSMENT

Table 4B.35
Local Views Afforded to Non-Project Related Residences

Residence	Pit Top Area		Ventilation Shaft Area	
	Distance (m)	Description	Distance (m)	Description
"Omeo"	2 070	Distant view obscured by vegetation	3 520	Distant view obscured by vegetation
"Greylands"	1 490	Distant view obscured by vegetation	3 000	Distant view obscured by vegetation
"Westhaven"	2 720	Distant view obscured by topography	1 010	Distant view obscured by vegetation
"Kurrajong"	2 070	Distant view obscured by topography and vegetation	1 710	Distant view obscured by remnant vegetation and constructed bund wall
"Haylin View"	2 310	Distant view obscured by topography and vegetation	3 060	Distant view obscured by topography and vegetation
"Pine View"	2 340	Distant view obscured by vegetation	4 390	Distant view obscured by topography and vegetation
"Oakleigh"	1 960	Distant view obscured by vegetation	4 300	Distant view obscured by topography and vegetation
"Naroo"	800	Local view obscured by vegetation	3 760	Distant view obscured by topography and vegetation
"Ardmona"	1 360	Distant view obscured by road and roadside vegetation	4 470	Distant view obscured by topography and vegetation
"Bow Hills"	740	Local view obscured by roadside vegetation	4 230	Distant view obscured by roadside vegetation and topography

4B.7 AIR QUALITY

The air quality assessment was undertaken by Heggies Pty Ltd. The full assessment is presented in Part 6 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections.

4B.7.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential air quality impacts requiring assessment and their unmitigated risk rating are as follows.

- Deposited dust levels attributable to the project occasionally (for one or two months every year) above DEC guideline, affects only adjacent landholders (moderate risk).
- Deposited dust levels attributable to the project regularly (>5 months per year) above approved limit, affects landholders some distance from the Project Site (high risk).

- PM_{10} levels attributable to the project occasionally (once every 1 to 2 years) above the project goal, affects only adjacent landholders (moderate risk).
- PM_{10} levels attributable to the project occasionally (>5 times per year) above the project goal affects landholders some distance from Project Site (high risk).
- Restricted to predominantly non-native vegetation within immediate vicinity of ventilation shaft (moderate risk).
- Impacts on native vegetation or extending beyond immediate vicinity of ventilation shaft (high risk).
- Impacts extend beyond the Project Site or impact on extensive areas of native vegetation (high risk).
- Greenhouse gas emissions (moderate risk).

The Director-General's requirements issued by the DoP require that the assessment of air quality refer to *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005).

Dust generation would be one of the main air quality issues relevant to the project. Depending upon the size and concentration of particles in the air and their composition, airborne dust has the potential to affect human health as well as contribute to the general degradation of the environment. The term *"particulate matter"* refers to a category of airborne particles typically less than 50µm in aerodynamic diameter and ranging down to 0.1µm in size. Particles less than 10µm and 2.5µm are referred to in this document as PM_{10} and $PM_{2.5}$ particles respectively. The human respiratory system has a built-in defensive system that prevents particles PM_{10} from reaching sensitive areas of the respiratory system. As particles larger than 10µm can also contribute to environmental degradation, the air quality assessment also considers the total mass of particles suspended in the air, ie. Total Suspended Particulate matter (TSP). Particles that have an aerodynamic sufficiently large so as not to be suspended in air (typically >35µm) are referred to as deposited dust.

The amount of fuel used each year for project-related activities would be comparatively low due to the use of rail for coal products. The fuel use associated with transporting coal by rail would be significantly less than for the road transport of a comparable quantity of coal. As a result, the emission of greenhouse gases attributable to the proposal would be significantly less.

Nitrogen dioxide (NO_2), sodium dioxide (SO_2) and greenhouse gases are emitted as a result of fuel use and, where present in substantial concentrations, can have detrimental environmental effects such as damaging leaf surfaces, limiting plant growth and in worst case scenarios, may lead to acid rain formation and acidification of soils. High concentrations of NO_2 and SO_2 have also been shown to impact on human health through decreasing lung function, lung inflammation and general exacerbation of symptoms in individuals with respiratory conditions such as asthma (DEC, 2000).

The effects of greenhouse gas emissions on global temperatures, most notably the Greenhouse Effect, are well documented. Carbon dioxide is produced during fuel combustion as a result of the oxidation of the fuel carbon content. Because the project will transport coal by rail, the emission of carbon dioxide generated directly by the project, referred to as Scope 1 and 2 emissions by the Greenhouse Gas Protocol Initiative, will be significantly less than if road transport were used for this purpose.

Greenhouse gases such as carbon dioxide and methane would also be emitted from coal seams during underground mining and, as a result, would contribute to the greenhouse gas inventory for the Narrabri Coal Mine. These are also considered Scope 1 and 2 emissions. Finally, greenhouse gases are emitted through the end use of the coal produced by the project. These Scope 3 emissions would also impact on the environment and are considered in this assessment of impacts on air quality.

The following sub-sections describe and assess the existing air quality environment, identify the air quality management issues and the proposed air quality controls, safeguards and mitigation measures. Additionally, the assessment of the residual impacts upon the air quality following the implementation of these safeguards and mitigation measures is also presented.

4B.7.2 Existing Air Quality

4B.7.2.1 Introduction

Air quality guidelines and goals refer to levels of "pollutants" in air which include both operational and existing sources. In order to fully assess impacts against all the relevant air quality guidelines and goals, it is therefore necessary to compile information or estimates on existing dust deposition levels and the existing concentrations of airborne particulates and gases such as SO_2 and NO_2.

In the absence of site-specific air quality data, existing background levels are described through reference to monitoring undertaken at nearby locations.

4B.7.2.2 Dust Deposition

Since late December 2005, five dust deposition gauges (Sites ND-1 to ND-5) have been positioned within the vicinity of the Pit Top Area to obtain site-specific dust deposition data (see **Figure 4B.23**). Three additional gauges were installed in April 2006 (Sites ND-6 to ND-8). A summary of the dust deposition results obtained to date is presented in **Table 4B.36**.

The background dust deposition rate attributable to rural activities within and surrounding the Project Site is considered to be in the order of 1.5g/m^2/month.

The concentrations of deposited dust recorded to date are consistent with the longer term measurements recorded at seven monitoring sites surrounding, but distant from the Whitehaven Coal Mine, located 37km southeast of the Project Site. Details of the monitoring at that site is presented in Heggies (2007).

4B.7.2.3 Particulate Matter

The term Particulate Matter refers to a category of airborne particles typically <50um in aerodynamic diameter and ranging down to 0.1um in size. Particles <10um and <2.5um are generally referred to as PM_{10} and $PM_{2.5}$ respectively.

Table 4B.36
Project Site Dust Deposition Monitoring Data

Site Location*	Monitoring Period	Number of Samples	Total Insoluble Solids (Non Filtrable Residue) g/m^2/month	Non Combustible Material (Ash) g/m^2/month
Site 1	Dec 05 - Dec 06	12	1.7	1.3
Site 2	Dec 05 - Dec 06	12	2.3	1.6
Site 3	Dec 05 - Dec 06	12	1.0	0.6
Site 4	Dec 05 - Dec 06	11	1.6	1.3
Site 5	Dec 05 - Dec 06	10	1.4	1.0
Site 6	June 06 - Dec 06	5	1.3	0.9
Site 7	June 06 - Dec 06	5	0.8	0.4
Site 8	June 06 - Dec 06	4	0.8	0.4
Weighted Average			**1.5**	**1.0**
Source: Heggies (2007) – Table 2				* See **Figure 4B.23**

The closest site monitoring Particulate Matter (PM_{10}) is maintained by the NSW Department of Environment and Conservation (DEC) in Tamworth, approximately 110km to the southeast of the Project Site. Data from 2005 has been selected as the most recent validated data set available from the DEC and an annual average of 16.5µg/m^3 considered representative of the local area and Project Site.

In order to estimate a background concentration of annual total Suspended Particulates (TSP), which is the combined total of all particulate matter, this report has taken the annual average PM_{10} records at Tamworth for 2004 (16.5µg/m^3), and uses the multiplier of two, for ambient air where road traffic is not the dominant particulate source, to derive the annual average background TSP concentration of 33µg/m^3.

4B.7.2.4 Nitrogen Dioxide and Sulphur Dioxide

Existing background NO_2 and SO_2 concentrations are assumed to be negligible given the rural nature of the site although small concentrations would be emitted by vehicles travelling along the Kamilaroi Highway and diesel-powered trains travelling along the North Western Branch Railway.

4B.7.2.5 Carbon Dioxide and Methane

Existing background concentrations of carbon dioxide and methane are recognised to be negligible and typical of a rural area.

4B.7.2.6 Summary of Existing Air Quality

For the purposes of assessing the potential air quality impacts of the project, **Table 4B.37** records the background levels adopted.

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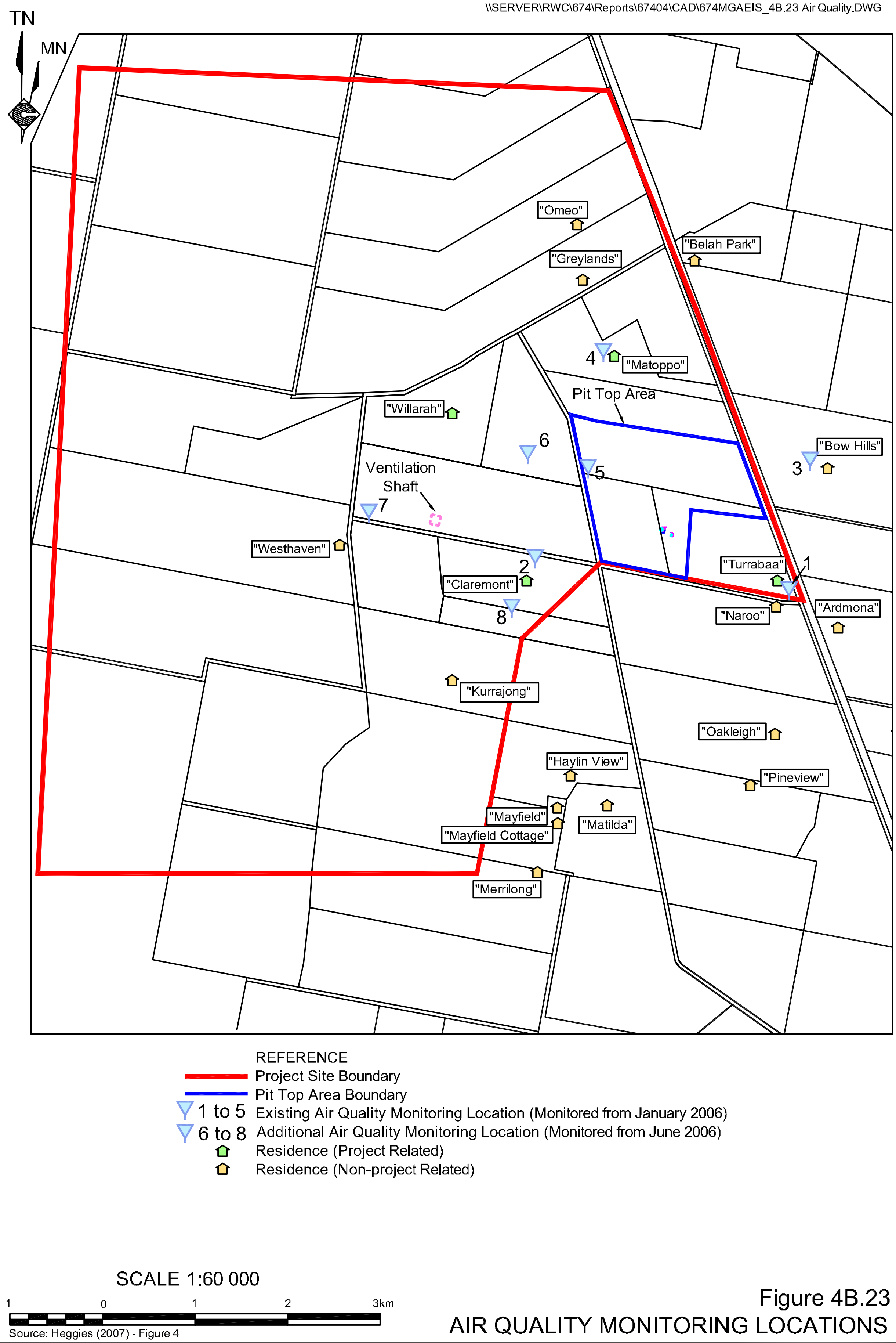

Source: Heggies (2007) - Figure 4

Figure 4B.23
AIR QUALITY MONITORING LOCATIONS

Table 4B.37
Background Air Quality Environment for Assessment Purposes

Air Quality Parameter	Averaging Period	Assumed Background Level
TSP	Annual	34μg/m^3
PM_{10}	24-Hour	Daily Varying
	Annual	16.5μg/m^3
Dust	Annual	1.5g/m^2/month
NO_2/SO_2/Odour	All Periods	Negligible

Source: Heggies (2007) – Table 4

4B.7.3 Potential Sources of Air Contaminants

4B.7.3.1 Particulate Emissions

Specific project activities would contribute to the particulate emissions inventory of the Narrabri Coal Project. The following activities are related to the site establishment, operational and transportation components of the project.

- Site establishment activities involving earthmoving equipment in hardstand area construction, road construction and delivery of road construction materials and construction of flat pads (through cut and fill methods) for various site components.
- Construction activities including vegetation clearing, soil stripping and excavation of the box cuts for the portal entries.
- Conveying of coal:
  - from the conveyor drift portal to the ROM stockpile;
  - from the ROM stockpile to the double roll crusher/sizing plant;
  - from the double roll crusher/sizing plant to the coal product stockpile; and
  - from the coal product stockpile to the rail load-out bin.
- Coal processing activities (operation of the double roll crusher/sizing plant, front-end loader).
- Rail load-out activities.
- General movement of heavy vehicles on unsealed roads within the Pit Top Area (truck wheel dust).
- Wind erosion of the ROM and product stockpiles and open areas around the Pit Top Area.

4B.7.3.2 Greenhouse Gas and Other Gas Emissions

The Project has the potential to generate greenhouse and other polluting gas emissions from a number of sources during both site establishment and operations.

Site Establishment

- The combustion of fuel by diesel-powered equipment and vehicles, including front-end loaders, excavators, bulldozers, scrapers, graders, drill rigs, explosives trucks and haul trucks.
- Combustion of diesel fuel for on-site power generation until mains power is connected.
- The use of explosives during blasting.

Operations

- The combustion of fuel by diesel-powered equipment, particularly the bulldozer on the coal stockpile area, site vehicles, vehicles delivering consumables and trains.
- The release of coal bed methane.

The product coal sold to predominantly export markets would ultimately be burnt to create energy. This process also produces significant volumes of greenhouse gases which are therefore attributable to the Project.

- Although carbon dioxide (CO_2) would be the principal gas produced, greenhouse gases emitted as a result of the Project would also include carbon monoxide (CO), methane (CH_4), oxides of nitrogen (NO_X), SO_2 and non-methane volatile organic compounds (NMVOCs).

4B.7.4 Air Quality Guidelines

4B.7.4.1 Particulate Matter and Dust Deposition

Goals Applicable to PM_{10}

Emissions of PM_{10} and $PM_{2.5}$ particles are considered important pollutants in terms of impact due to their ability to penetrate into the respiratory system.

The NSW DEC PM_{10} assessment goals as expressed in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005) are:

- a 24-hour maximum of 50µg/m^3; and
- an annual average of 30µg/m^3.

The 24-hour PM_{10} reporting standard of 50µg/m^3 is numerically identical to the equivalent National Environment Protection Measure (NEPM) reporting standard except that the NEPM reporting standard allows for five exceedances per year.

Goal Applicable to Total Suspended Particulates

The annual goal for Total Suspended Particulates (or TSP) is given as 90µg/m^3, as recommended by the National Health and Medical Research Council (NHMRC). This goal was developed before the more recent results of epidemiological studies suggested a relationship between health impacts and exposure to PM_{10} concentrations.

In rural areas, the PM_{10} particle size fraction is typically of the order of 50% of the TSP mass, and as such, this goal is consistent with an annual PM_{10} goal of approximately 45µg/m^3. Thus, the historical NHMRC goal may be regarded as less stringent than the newer DEC PM_{10} goal of 30µg/m^3 expressed as an annual average. Therefore, as the annual TSP goal is seen to be achieved if the annual PM_{10} goal is satisfied, TSP has not been considered further in this assessment.

Goals Applicable to $PM_{2.5}$

The ambient Air Quality NEPM was amended in 2003 to extend its coverage to $PM_{2.5.}$ This document references the following goals for $PM_{2.5}$.

- A 24-hour maximum of 25µg/m^3.
- An annual average of 8µg/m^3.

Historical quantitative assessments of air quality impacts of coal mining projects undertaken by Heggies have indicated that providing maximum predicted PM_{10} concentrations satisfy project air quality goals, goals applicable to $PM_{2.5}$ are similarly met. In view of the foregoing, it is assumed that providing adequate mitigation of PM_{10} is achieved, goals applicable to $PM_{2.5}$ would be satisfied. Potential impacts of $PM_{2.5}$ have thus not been considered further in this assessment.

Deposited Dust

In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4g/m^2/month.

In order to avoid dust nuisance the DEC (EPA) has developed assessment goals for dust fallout. **Table 4B.38** presents the allowable increase in dust deposition relative to the ambient levels.

Table 4B.38
DEC Goals for Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2g/m^2/month	4g/m^2/month
Source: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005)		

Based upon the maximum levels in **Table 4B.36** and the initial site-based and longer term regional dust deposition data, a site-specific goal for all dust sources attributable to site activities would be in the order of 3.5g/m^2/month.

4B.7.4.2 Gas Emissions

Greenhouse Gas Emissions

While no specific guidelines are provided for maximum emissions of greenhouse gases, the *National Greenhouse Gas Inventory* (Australian Greenhouse Office, 2006) estimates of the carbon dioxide emissions allow for an assessment as to the relative level of impact the proposal would have on Australian greenhouse gas emissions. The estimates for Australian and International emissions are as follows.

- 1990 Total Australian Emissions: 503 299 kilotonnes carbon dioxide equivalent.
- 2000 Total International Emissions: 33 666 million tonnes carbon dioxide equivalent (WRI, 2005).

Goals Applicable to Nitrogen Dioxide and Sulphur Dioxide

Table 4B.39 lists the DEC (EPA) goals for nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), as outlined in the AMMAAP.

Table 4B.39
DEC (EPA) Air Quality Goals - NO_2 and SO_2

Pollutant	Averaging Time	Maximum Concentration
Nitrogen dioxide (NO_2)	1 hour Annual	246µg/m^3 62µg/m^3
Sulphur Dioxide (SO_2)	10 Minutes 1 hour 24 hours Annual	712µg/m^3 570µg/m^3 228µg/m^3 60µg/m^3
Source: Heggies (2007) – Table 6		

4B.7.4.3 Goals Applicable to Odour Emissions

Impacts from odorous air contaminants are often nuisance-related rather than health-related and as such, odour performance criteria are not specifically intended to achieve "no odour". The methane released during mining of coal could potentially be odourous. The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit per cubic metre (OU/m^3).

In practice, the character of a particular odour can only be judged by the receiver's reaction to it, however, based on the literature available, the level at which an odour is perceived to be a nuisance can range from 2OU/m^3 to 10OU/m^3.

Odour performance criteria need to be designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours, using a statistical approach which depends on the size of the affected population. A summary of odour performance criteria for various population densities is shown in **Table 4B.40**.

Table 4B.40
DEC Odour Performance Criteria vs. Population Density

Population of Affected Community	Odour Performance Criteria OU/m^3
Urban area (≥ 2 000)	2.0
500 – 2 000	3.0
125 - 500	4.0
30 - 125	5.0
10 - 30	6.0
Single residence (≤ 2)	7.0
Note: These should be regarded as interim criteria to be refined over time through experience and case studies.	
Source: "Technical Notes: Draft Policy, Assessment and Management of Odours from Stationary Sources in New South Wales", DEC 2001	

The area surrounding the Project Site is primarily rural, hence it is assumed that the population that may potentially be affected by odour emissions associated with coal seam gases is of the order of 10 and 30 people. Consequently, the project odour performance goal adopted for this assessment is a maximum of 6.0 odour units per cubic metre (OU/m^3) expressed as a nose response average (1-second) value.

4B.7.4.4 Project Air Quality Goals

In summary, the DEC (EPA) project specific air quality goals are as follows.

PM_{10}: A 24-hour maximum of 50µg/m³
An annual average of 30µg/m³

$PM_{2.5}$: A 24-hour maximum of 25µg/m³
An annual average of 8µg/m³

Dust: Nuisance expected to impact on surrounding residences when incremental annual average dust deposition levels exceed 2g/m²/month

NO_2: A 1 hour maximum of 246µg/m³
An annual average of 62µg/m³

SO_2: A 10-minute maximum of 712µg/m³
A 1-hour maximum of 570µg/m³
A 24-hour maximum of 228µg/m³
An annual average of 60µg/m³

Odour: A maximum of 6.0OU/m³ expressed as a nose response average (1-second) value.

4B.7.5 Operational Air Quality Controls

4B.7.5.1 Introduction

The Proponent would apply a wide range of air pollution control measures to ensure air quality standards are not compromised by its activities. These operational controls have been categorised as either dust control measures or controls for other air contaminants.

4B.7.5.2 Dust Control Measures

The individual sources of dust and the proposed controls are listed in **Table 4B.41**.

4B.7.5.3 Control Measures for Other Potential Air Contaminants

Nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and greenhouse gases would be emitted as a result of vehicle exhausts and any blasting fumes. The following operational controls would be implemented to reduce the emission of these gases.

Exhausts

Earthmoving equipment and on-site vehicles would be fitted with exhaust controls which satisfy the NSW DEC emission requirements. The Proponent would ensure that all equipment is properly maintained to ensure no unacceptable exhaust emissions occur and commit to the removal of any vehicle or item of mobile equipment from on-site activities which is observed not to comply with NSW DEC guidelines. The exhausts of all equipment would be directed upwards or to the side so as not to impinge on the ground and cause dust lift-off.

4B.7.5.4 Greenhouse Gas Reduction

The major greenhouse gas reduction initiative of the proposal involves the use of rail over road transportation of coal products. The fuel use associated with transporting 2.5Mtpa of coal by rail would be significantly less than for the road transport of a comparable quantity of coal. As a result, the emission of greenhouse gases attributable to the proposal would be significantly less.

4B.7.6 Assessment of Impacts

4B.7.6.1 Introduction

The assessment of impacts of the proposed Narrabri Coal Project was primarily undertaken through computer modelling to establish likely concentrations of PM_{10}, deposited dust, emissions of SO_2, NO_2, odour and greenhouse gases around the Project Site. The modelling undertaken by Heggies (2007) at five of the closest non-project related residences ("assessment locations") assumes the adoption of operational controls as set out in Section 4B.7.5.

In order to assess the level of impact, the predicted concentrations are compared against the air quality goals established in Section 4B.7.4.

Table 4B.41
Dust Control Measures

Dust Emission Source	Operational Controls
Vegetation Clearing	• Cleared trees and branches would be retained for use in stabilising slopes identified for rehabilitation around the Ventilation Shaft Area.
Soil Stripping	• Where practicable, soil stripping would be undertaken at a time when there is sufficient soil moisture to prevent significant lift-off of dust. • The Proponent would avoid stripping soil in periods of high winds • Dust suppression by water application would be used to increase soil moisture, if required.
Continuous Miner	• Strategically located water sprays would be operational on the continuous miner and the breaker feeder to minimise dust creation underground.
Coal Transfer, Crushing and Screening	• Notwithstanding the moist nature of the ROM coal, water would be applied to the coal at the feed hopper, crusher and at all conveyor transfer and discharge points. • All conveyors would be fitted with appropriate cleaning and collection devices to minimise the amount of material falling from the return conveyor belts. • The crusher would be located in a building. • All surface conveyors would be partly enclosed to minimise dust lift off. • Some flexibility would exist to temporarily cease operation in the event of protracted dry periods, high winds, and significant dust generation and dispersal towards the surrounding residences.
Wind Erosion from Exposed Surfaces and Stockpiles	• Minimising the extent of clearing/site preparation during site establishment. • Clear definition of all site roads and the restriction of vehicles and equipment to those roads. • Progressive rehabilitation of areas of disturbance including topsoil and subsoil stockpiles. • Routine application of water sprayed onto stockpiles and hardstand areas. • Construction of the perimeter amenity bund and windbreaks.
Coal Loading to Rail Wagons	• The coal loaded to the conveyor of the rail load-out facility would be watered as required to maintain a sufficient moisture content in the stockpile to prevent dust lift-off.

4B.7.6.2 Air Quality Modelling

Computer predictions of fugitive emissions from the Project Site were undertaken using the Ausplume Gaussian Plume Dispersion Model software (Ausplume) developed by EPA (Victoria). Ausplume combines the particulate emission factors for the various Project Site activities, meteorological data and local topography to predict the dispersion of dust and other particulate matter.

Particulate Emission Factors

The inputs to the Ausplume model have been taken primarily from the default emission factors identified in the *Emission Estimation Technique Manual for Mining* (DEH, 2001). Where the moisture content of materials on the Project Site was not adequately reflected within the defaults emission factors, the equations presented within DEH (2001) were used.

Meteorological Data

The Air Pollution Model (TAPM) software, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), was used to simulate the meteorology of the area. Data was obtained from the Bureau of Meteorology's (BoM) Narrabri Bowling Club Automatic Weather Station (AWS) (Station Number 054120) was used to generate the TAPM simulation. Additional information on the input data, TAPM output data and validation of TAPM generated data is provided by Heggies (2007).

Local Topography

There are no significant topographic features which would impede atmospheric dispersion between the Project Site and adjacent residences. Considering such uncomplicated near field topography, topography has not been considered in the Ausplume dispersion model.

Modelled Scenarios

Two scenarios were modelled to reflect different stages of the proposed mine development. The scenarios chosen take into consideration the movement of mobile equipment across the Project Site along with all fixed plant emissions. The scenarios aim to be representative of worst case conditions during the site establishment and operational phases of the project.

The two scenarios modelled by Heggies (2007) are as follows.

(i) Site Establishment: incorporating all establishment and construction components of the project. These include soil stripping, surface excavations, and haulage and stockpiling of materials.

(ii) Site Operations: incorporating all production activities such as coal conveying, crushing / sizing and stockpiling, stockpile management and train loading.

4B.7.6.3 Dust Deposition

Ausplume predictions for dust deposition at the assessment locations, including the assumed background level of dust deposition of 1.5g/m^2/month, are displayed in **Table 4B.42**. Total mean monthly dust deposition (background plus increment) rates associated with the proposal are predicted to be less than 1.7g/m^2/month at all assessment locations for the scenarios modelled and readily satisfy the dust deposition criterion of 3.5g/m^2/month.

Table 4B.42
Dust Deposition at Nearest Assessment Locations

Assessment Location	Dust - Annual Average (g/m²/month)			
	Background	Increment attributable to the Project	Background + Increment	Project Goal
Scenario 1 – Site Establishment				
R1 - "Bow Hills"	1.5	0.1	1.6	3.5
R2 – "Ardmona"	1.5	0.1	1.6	3.5
R3 – "Naroo"	1.5	0.1	1.6	3.5
R4 – "Kurrajong"	1.5	0.1	1.6	3.5
R5 – "Westhaven"	1.5	<0.1	1.5	3.5
Scenario 2 – Site Operations				
R1 - "Bow Hills"	1.5	<0.1	1.5	3.5
R2 – "Ardmona"	1.5	<0.1	1.5	3.5
R3 – "Naroo"	1.5	<0.1	1.5	3.5
R4 – "Kurrajong"	1.5	<0.1	1.5	3.5
R5 – "Westhaven"	1.5	<0.1	1.5	3.5
Source: Heggies (2007) – Table 9				

4B.7.6.4 PM_{10}

The maximum 24-hour average PM_{10} concentration at the nearest assessment locations was predicted using Ausplume over a one-year time frame (see **Table 4B.43**). It has been assumed that background levels of PM_{10} vary on a daily basis with these background levels incorporated into the model. Appendix 2 of Heggies (2007) provides an explanation regarding the use of varying background PM_{10} levels.

Table 4B.43
24-hour Average PM_{10} Concentrations at the Nearest Assessment Locations

Residence	PM_{10} – 24-hour Average (µg/m³)			
	Background	Increment attributable to the Project	Background + Increment	Project Goal
Scenario 1 – Site Establishment				
R1 - "Bow Hills"	39.5	0.6	40.1	50
R2 – "Ardmona"	39.5	0.4	39.9	50
R3 – "Naroo"	39.5	0.9	40.4	50
R4 – "Kurrajong"	39.5	1.1	40.6	50
R5 – "Westhaven"	39.5	0.1	39.6	50
Scenario 2 – Site Operations				
R1 - "Bow Hills"	39.5	0.6	40.1	50
R2 – "Ardmona"	39.5	0.4	39.9	50
R3 – "Naroo"	39.5	0.9	40.4	50
R4 – "Kurrajong"	39.5	1.1	40.6	50
R5 – "Westhaven"	39.5	0.1	39.6	50
Source: Heggies (2007) – Table 10				

No exceedance of maximum 24-hour average PM_{10} concentrations are predicted with the highest concentration of 40.6µg/m^3 predicted to be received at the "Kurrajong" residences.

Table 4B.44 presents the predicted annual average PM_{10} concentrations assuming a background annual PM_{10} concentration of 16.5µg/m^3 at the assessment locations. **Table 4B.44** shows that for the scenarios modelled, annual average PM_{10} concentrations as a consequence of the project would be less than 17µg/m^3 and satisfy the project goal of 30µg/m^3.

Table 4B.44
Annual PM_{10} Concentrations at the Nearest Assessment Locations

Residence	PM_{10} - Annual Average (µg/m^3)			
	Background	Increment attributable to the Project	Background + Increment	Project Goal
Scenario 1 - Year 2 Site Operations				
R1 - "Bow Hills"	16.5	0.2	16.7	30
R2 – "Ardmona"	16.5	0.1	16.6	30
R3 – "Naroo"	16.5	0.3	16.8	30
R4 – "Kurrajong"	16.5	0.2	16.7	30
R5 – "Westhaven"	16.5	0.1	16.6	30
Scenario 2 – Year 7 Site Operations				
R1 - "Bow Hills"	16.5	0.1	16.6	30
R2 – "Ardmona"	16.5	0.1	16.6	30
R3 – "Naroo"	16.5	0.2	16.7	30
R4 – "Kurrajong"	16.5	0.3	16.8	30
R5 – "Westhaven"	16.5	0.3	16.8	30
Source: Heggies (2007) – Table 11				

4B.7.6.5 $PM_{2.5}$

Generalised particulate size distributions for activities likely to contribute to the air quality surrounding the Project Site have been used to derive a relationship between concentrations of the $PM_{2.5}$ and the PM_{10} particle size fractions. Heggies (2007) notes that based on this relationship (ie. approximately 30% of the PM_{10} particle size fraction would constitute $PM_{2.5}$), when the annual 24-hour average PM_{10} concentration goal of 50µg/m^3 is achieved, the 24-hour average $PM_{2.5}$ concentration goal of 25µg/m^3 would be satisfied. Heggies (2007) predicts the annual average $PM_{2.5}$ to be between 13µg/m^3 and 15µg/m^3, thereby satisfying the project goal of 25µg/m^3.

4B.7.6.6 Sulphur Dioxide and Nitrogen Dioxide

Atmospheric emissions of SO_2 and NO_2 have been modelled by Heggies (2007) based on the diesel consumption presented in Section 2.9.6. Combustion emissions were modelled as a point source emission from the coal processing area assuming:

- 3m release height – this is considered a low height of release. By selecting such a low height, pollutant dispersion potential is reduced, creating the potential for higher concentrations near the source; and

- 5m/s exit velocity – this is considered a relatively low velocity. By selecting a low velocity, plume rise would be reduced, reducing pollutant dispersion and therefore creating the potential for higher concentrations near the source.

Accordingly, emissions of NO_2 and SO_2 from all combustion sources have been modelled in a conservative manner both from the point of view of initial concentration and subsequent dispersion processes.

Modelling of SO_2 and NO_2 indicated negligible emissions as a consequence of fuel consumption, and satisfaction of all project goals (Tables 13 and 14 of Heggies, 2007).

4B.7.6.7 Results

The results of odour modelling predictions for maximum concentration over a one year time period are presented in **Table 4B.45**. The results predict concentrations well below the nominated project goal at all residences.

Table 4B.45
Predicted Maximum Odour Concentration

Residence	Maximum (100th percentile) (OU/m^3)	Project Goal
R1 - "Bow Hills"	0.2	6
R2 – "Ardmona"	0.2	6
R3 – "Naroo"	0.3	6
R4 – "Kurrajong"	0.5	6
R5 – "Westhaven"	0.9	6
Source: Heggies (2007) – Table 15		

4B.7.6.8 Greenhouse Gases

Project mining and related activities have the potential to generate greenhouse gas emissions from a number of sources. These sources include the following.

(i) The combustion of fuel by diesel-powered equipment and vehicles.

(ii) The release of coal bed methane during mining and post-mining activities.

(iii) Distribution of coal product.

(iv) The use of purchased electricity in Project Site buildings and activities.

(v) End use of coal products.

Greenhouse gas emitting sources are classified according to accepted greenhouse gas protocol as either Scope 1, 2 or 3 emissions, as follows.

Scope 1 Emissions

Those emissions resultant from activities under the Proponent's control or from sources which they own. Emission sources (i), (ii) and (iii) are considered Scope 1 emissions.

Scope 2 Emissions

Those emissions result which relate to the generation of purchased electricity consumed in its owned or controlled equipment or operations. Emission source (iv) is considered a Scope 2 emission, however, this is likely to be a relatively minor source of greenhouse gas emissions.

Scope 3 Emissions

These emissions are defined as those which do not result from the activities of the Proponent although arise from sources not owned or controlled by the Proponent. In the case of the Project, this includes the transportation of sold coal and the use of this coal, either domestically or overseas, ie. emission source (v).

A full life cycle assessment of both the projects annual and total (50 years) greenhouse gas emissions from the above sources was conducted by Heggies (2007). The results of this assessment indicate that the total annual emissions of CO_2-equivalent as a result of the operations at the project are predicted to be of the order of 7.4Mt of CO_2-equivalent per annum. This figure is inclusive of both transportation emissions and emissions associated with the burning of the coal at its end use.

A comparison of the predicted annual average and potential maximum (worst case) annual emissions from the project for combined Scope 1 and 2, Scope 3 and Total CO_2-equivalent emissions are presented in **Table 4B.46**. Additionally, greenhouse gas emissions for each Scope breakdown are compared against total Australian and International emissions of CO_2-equivalent, where relevant. It is noted that total Australian emissions for 1990 and International emissions for 2000, estimated to be 551.9Mt CO_2-equivalent (AGO, 2006) and 33 666Mt CO_2-equivalent (WRI, 2005) respectively, have been used in this comparison.

Table 4B.46
Comparison of Project Emissions of Greenhouse Gases with Australian and International Emissions

Emissions Estimation Period	Scope 1 & 2 Emissions CO_2-equivalent (%-age Comparison with Australian 1990 emissions[1])	Scope 3 Emissions CO_2-equivalent (%-age Comparison with Australian 1990 emissions[1])	Total Project Emissions CO_2-e (%-age Comparison with International 2000 emissions[2])
Annual Average	119kt (0.022%)	7.3Mt (0.022%)	7.4Mt (0.022%)
Worst Case Year	123kt (0.022%)	7.8Mt (0.023%)	7.9Mt (0.023%)

Note 1: From AGO (2006), National Greenhouse Inventory 2004
Note 2: From WRI (2005), *Navigating the Numbers – Greenhouse Gas Data and International Climate Policy*
Source: Heggies (2007) – Table 16

A comparison of the predicted maximum emissions from the Project with the 1990 estimate demonstrates that worst-case Scope 1 and 2 emissions would represent an increase of approximately 0.022% on the total baseline Australian emissions. Worst case Scope 1, 2 and 3 emissions that would be generated by the project would represent a similar increase in total baseline international emissions (0.018%).

4B.7.6.9 Impacts on Livestock

Livestock are exposed to dust from many natural sources, including airborne dust as a result of dust storms, yarding or general stock movements. This dust tends to accumulate on the coat or fleece of the animals and generally falls out or is washed out in heavy rain (Hunt, 1999). Increases to dust deposition associated with the proposed mine would be considerably less than the DEC goal for allowable dust deposition of $2g/m^2$/month for all potential grazing land outside the Project Site. It is therefore unlikely there would be any noticeable dust-related impact on livestock.

4B.7.6.10 Impacts on Pasture

Dust accumulation on pasture at the projected rate of deposition would have no effect on pasture palatability or stock production. In grazing trials with dairy cattle, coal dust added to pasture at a rate equivalent to $8g/m^2$/day, or 1 200 times the maximum incremental increase to dust deposition predicted at the assessment locations surrounding the Project Site, has been shown to have no effect on palatability or production by the cattle (Hunt, 1999).

4B.7.7 Monitoring

The above assessment indicates that both deposited dust levels and PM_{10} concentrations are likely to be acceptable for both the site establishment and operational phases of the project and as such air quality is not anticipated to be adversely affected at the surrounding residences.

However, in order to demonstrate compliance with the project air quality goals (refer Section 4B.7.4) the Proponent would undertake an air quality monitoring program to demonstrate compliance with project air quality goals. The program would involve monitoring of:

(i) 24 hour PM_{10} concentrations at a minimum of one location, namely any of the closest non-project related residences, that is “Naroo”, “Ardmona”, “Bow Hills” and “Kurrajong”;

(ii) deposited dust at up to eight locations (ie. ND-1 to ND-8); and

(iii) continuous wind speed and direction.

It is proposed that the monitoring program is conducted during the site establishment phase and the first two years of operations after which the locations and frequency of monitoring would be re-assessed in consultation with the DEC (EPA).

Monitoring would be undertaken according to the DEC document *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* 2001. Specifically, monitoring should be conducted in accordance with the following Australian Standards.

- AS 2922-1987 Ambient Air - Guide for the Siting of Sampling Units (NSW DEC Method AM-1).
- AS 3580.9.6-2003 *Particulate Matter - PM_{10} - high volume sampler with size-selective inlet*.
- AS 3580.10.1-2003 Methods for Sampling and Analysis of Ambient Air - Determination of Particulates - Deposited Matter - Gravimetric Method (NSW DEC Method AM-19).

4B.8 TRANSPORTATION ASPECTS

4B.8.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential environmental impacts related to traffic and transport requiring assessment and their unmitigated risk rating are as follows.

- Increased traffic congestion (moderate risk).
- Road pavement deterioration (high risk).
- Elevated risk of accident/incident on local roads (moderate to high risk).
- Elevated risk of rail related accident/incident (low to high risk).

In addition, the Director-General's requirements issued by the DoP require that this assessment refer to the Guide to Traffic Generating Development and Road Design Guide (Roads & Traffic Authority), or relevant Austroads standards.

The following sub-sections assess the existing road, rail and traffic environments, the proposed changes generated by the project, relevant design features, operational safeguards and ongoing management to mitigate the risks posed and an assessment of residual impacts.

4B.8.2 Existing Transport Network and Traffic Levels

4B.8.2.1 Introduction

The Project Site is serviced by a network of local roads, a State highway and railway line. **Figure 4B.24** displays these roads and railway line all of which are described in the following sub-sections.

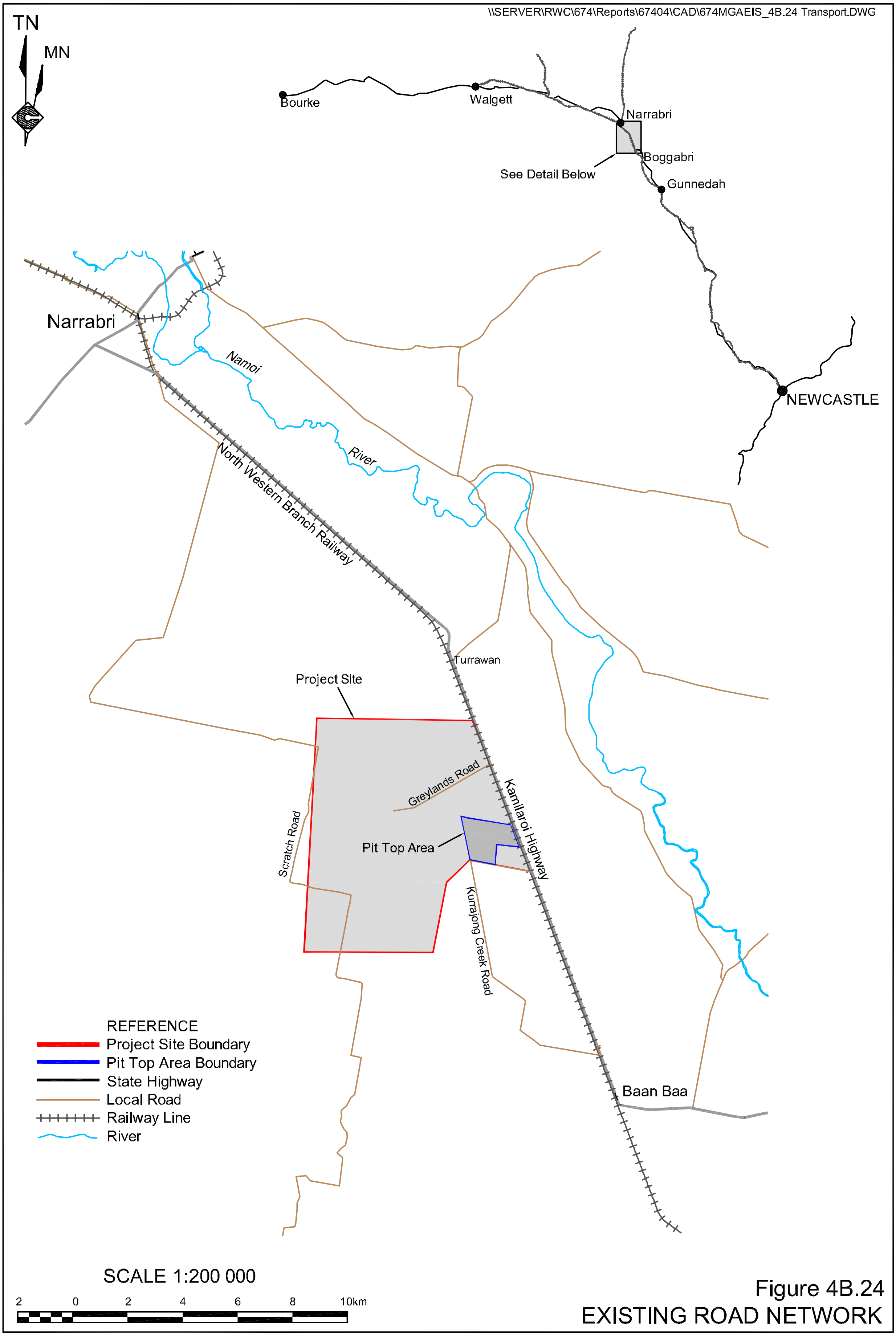

Figure 4B.24
EXISTING ROAD NETWORK

4B.8.2.2 Road Network

Kamilaroi Highway

The Project Site is accessed via the Kamilaroi Highway (SH 29), a RTA highway starting at Willow Creek and passing through Gunnedah, Boggabri, Baan Baa and Narrabri before terminating at Bourke. The Kamilaroi Highway is sealed along its entire length and is part of the network of State highways that provide the basis for heavy vehicle haulage across NSW. Pavement conditions of the Kamilaroi Highway are considered good at the intersection with Kurrajong Creek Road and both north and south of the intersection.

Table 4B.47 provides the Annual Average Daily Traffic (AADT) and traffic types on the Kamilaroi Highway (2002 data), 8km south of the Newell Highway junction in Narrabri (Station No. 92.289), ie. approximately 17km north of the Project Site.

Table 4B.47
AADT and Traffic Types – Kamilaroi Highway

7 day /24 hr average daily traffic	Total Vehicle Breakdown				Heavy Vehicle Breakdown					
	Avg. daily cars		Avg. daily heavy vehicles		Avg. daily rigids[1]		Avg daily semis[2]		Avg. daily mutli-artics[3]	
	No.	%	No.	%	No.	%	No.	%	No.	%
1466	1084	73.9%	382	26.1%	88	6%	214	14.6%	80	5.5%
1: Austroads classification 3,4,5: two to five axle trucks 2. Austroads classification 6 to 9: three to six axle articulated trucks 3: Austroads classification 10, 11, 12: B-doubles, double and triple road trains										
Source: Traffic Volume Data 2002 – Western Region (RTA, 2002).										

Table 4B.47 indicates that the Kamilaroi Highway is already subject to a relatively high proportion of heavy vehicles (26.1%) although the overall level of daily traffic is comparatively low and well within the capacity of the highway. The proportion of rigid, semi-trailer and multi-articulated heavy vehicles, provides an average of 5.0 axles per heavy vehicle.

Based on traffic data collected at Station No. 92.289 at approximately four yearly intervals, and using an RTA traffic projection spreadsheet, a projection of the yearly traffic levels for the life of the project was predicted. **Figure 4B.25** presents a chart illustrating the predicted increase in traffic volumes at five yearly intervals.

It is noted that **Figure 4B.25** presents the projection for the number of axle pairs and therefore in order to project future vehicle numbers, the same proportions of light and heavy vehicles was assumed as provided by the RTA (2002) data (see **Table 4B.47**). **Table 4B.48** presents this projection of future traffic numbers for the life of the project.

Kurrajong Creek Road

Kurrajong Creek Road is an unsealed road approximately 13km in length that provides access between the Project Site and Baan Baa on the western side of the Kamilaroi Highway. Kurrajong Creek Road provides access to up to 20 rural properties and is only used by the land owners and land users of these properties.

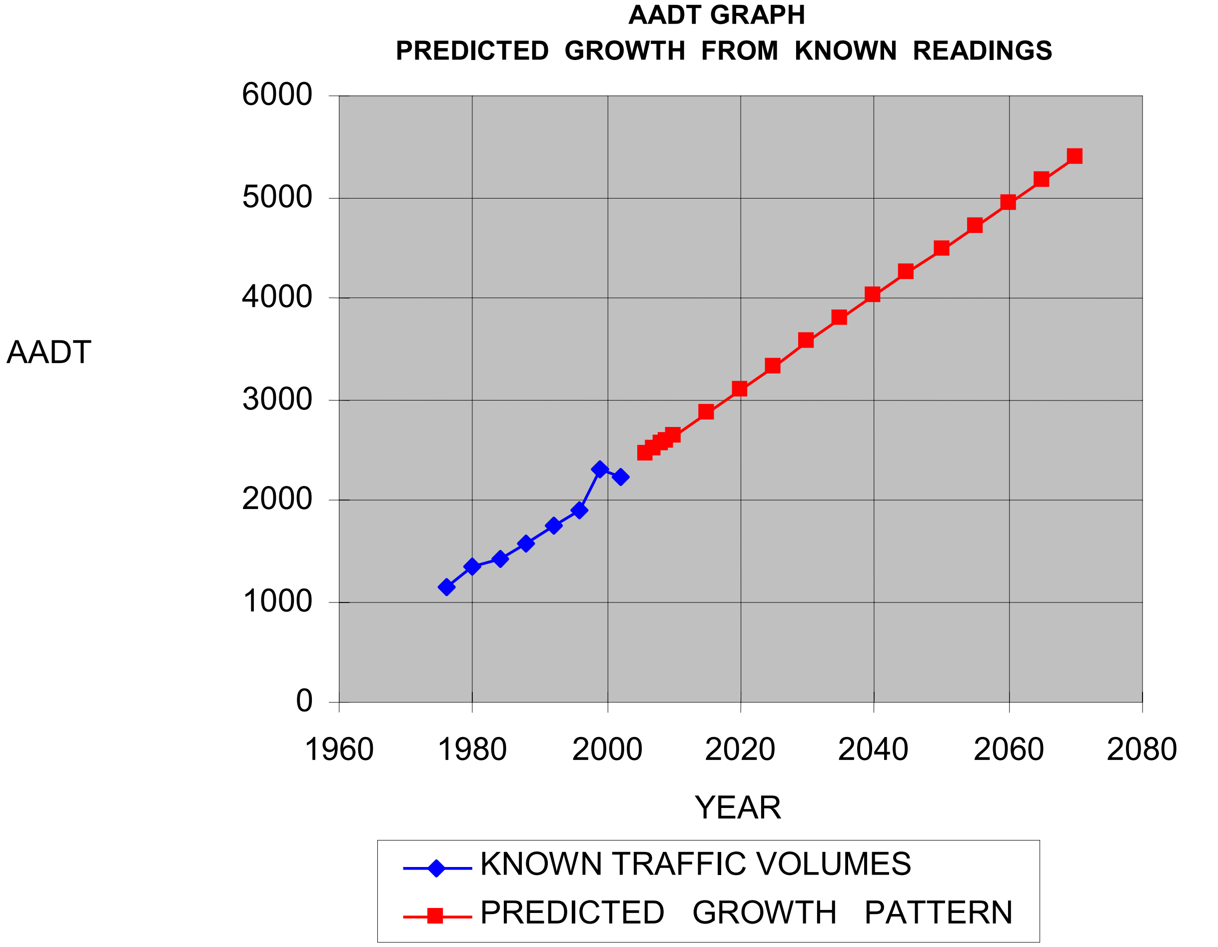

Figure 4B.25
RTA STATION 92.289 TRAFFIC PROJECTION

Table 4B.48
Annual Average Daily Traffic Projection – Kamilaroi Highway

Year	Light Vehicles	Heavy Vehicles
2007	1256	444
2008	1301	459
2009	1330	470
2010	1352	478
2015	1375	485
2020	1404	496
2025	1522	538
2030	1648	582
2040	1766	624
2050	1892	668
2060	2010	710
2070	2136	754
2080	2254	796

Source: RTA Traffic Projection Spreadsheet.

Access to the Pit Top Area would involve the use of an 80m section of Kurrajong Creek Road from where it intersects with the Kamilaroi Highway for a distance of approximately 40m west of a level crossing with the North Western Branch Railway. The level crossing is currently controlled by a "Stop" sign.

Annual average daily traffic levels on Kurrajong Creek Road near Kamilaroi Highway are understood to be in the order of approximately 50, the bulk of which are light vehicles. It is understood there is no school bus service on Kurrajong Creek Road.

"Bow Hills" Gravel Quarry Traffic

As noted in Section 2.4.4, an intended source of road gravel for the construction of the Site Access Road would be from the "Bow Hills" gravel quarry immediately east of the Kurrajong Creek Road / Kamilaroi Highway intersection. This quarry currently supplies Narrabri Shire Council and other local users, with a variety of rigid and articulated heavy vehicles periodically entering and exiting this site from the Kamilaroi Highway at an approved entrance approximately 100m north of the subject intersection. The majority of the truck movements from the "Bow Hills" gravel quarry are to and from Narrabri to the north and therefore do not pass by the Kurrajong Creek Road / Kamilaroi Highway intersection. Traffic levels from this quarry are variable but not substantial.

4B.8.2.3 Rail Traffic

The North Western Branch Railway provides rail access (with a single standard gauge track) between Werris Creek and Moree. Daily rail traffic on this line between Boggabri and Narrabri is currently as follows.

- Passenger train – 1 return journey (2 movements).
- Wheat train – 2 return journeys (4 movements).

Container train - 2 return journeys (4 movements).During a busy grain season, the number of wheat trains per day could increase to 6 or 7 return journeys (12 to 14 movements), however, a representative of Pacific National (pers. comm. T. Kaminski) indicated that this has not occurred for several years and was unlikely in the future as local agriculture moved away from cropping cereals to grazing or other land uses, eg. mining.

The average pass-by time for these train across the Kurrajong Creek Road level crossing varies from less than 30 seconds for the shorter passenger train to an estimated 90 seconds for the longer wheat and container trains (pers. comm. T. Kaminski – Pacific National).

Further to the south on the North Western Branch Railway, rail transportation of coal is already occurring with coal being despatched from:

- the Whitehaven rail siding near Gunnedah (Whitehaven Coal Mining Pty Ltd) – currently drawing coal from the Whitehaven and Tarrawonga Coal Mines;
- the Idemitsu rail siding 4km north of Boggabri (Idemitsu Boggabri Coal Pty Ltd) – drawing coal from the Boggabri Coal Mine; and
- the Werris Creek rail siding 3km southwest of Werris Creek (Werris Creek Coal Pty Ltd) – drawing coal from Werris Creek Coal Mine.

Collectively, the operators of these rail loading facilities currently share a total of eight movements per day to Port Newcastle.

4B.8.3 Proposed Traffic Increase

4B.8.3.1 Roads

During the 12 month site establishment period, the project would increase light vehicle traffic on the Kamilaroi Highway by up to 80 light vehicle and 10 heavy vehicle movements per day.

Truck movements associated with the transportation of gravel from the "Bow Hills" property would increase average heavy vehicle movements at the Kurrajong Creek Road – Kamilaroi Highway intersection by an average of 25 and maximum of 50 per day for a 4 to 6 week period.

Once operational, it is anticipated the project would increase the projected traffic volumes by an average of 144 light and 8 heavy vehicles, and a maximum of 220 light and 20 heavy vehicles. The light vehicle movements are expected to be concentrated around shift changeover times of 7:00am (entry only), 4:30pm, 10:00pm and 2:30am (exit only). Based on a production crew of 34 (see **Table 2.13**), it is expected that up to 30 light vehicles may enter the Kamilaroi Highway intersection over a 30min period prior to each shift and exit via this intersection following the completion of each shift. Heavy vehicle movements would generally be restricted to daylight hours but without any specific scheduling.

4B.8.3.2 Rail

For Stage 1 of the project, an average of 4 rail movements would be generated for the transportation of coal from the Project Site. Based on existing rail path times on the North Western Branch Railway, it is anticipated that the two daily 42 wagon coal trains would most commonly arrive at the Project Site between 8:30am and 9:30am, and 11:30am and 12:30pm.
Given each coal train would be required to come to a complete stop prior to entering the rail loop to allow for the manual movement of the rail ground frame, it is anticipated it would take up to 6 minutes to completely exit the North Western Branch Railway and Site Access Road rail crossing. This timing is commensurate with the observed times taken for coal trains to exit the North Western Branch Railway at the Whitehaven Siding (pers. comm. E. Heap – WCM). The rail crossing would be closed for the entire period and any entering traffic required to wait at the rail crossing and possibly within the Kamilaroi Highway intersection.

4B.8.4 Design Features, Operational Safeguards and Ongoing Maintenance

4B.8.4.1 Design Features

The following features have been incorporated into the design of the Site Access Road, Kurrajong Creek Road level crossing and the three intersections that would carry project-related traffic to ensure the impact on local roads and road users is minimised. Where these have been previously outlined or discussed, reference is made to the relevant sub-section.

Site Access Road

The Site Access Road would be constructed as a two lane, sealed road of 8m pavement width with 1m wide unsealed shoulders (as outlined in Section 2.4.4). In order to provide for the continued drainage of surface water towards Tributary 2 of Kurrajong Creek, roadside drainage would direct these flows to culvert structures along at natural drainage points of the existing topography.

Kurrajong Creek Road Level Crossing

Design features of the railway level crossing are as follows.

- Installation of flashing lights and warning bells.
- Strengthening of the road pavement with concrete between and for a distance of 5m on both sides of the railway line.
- Installation of a control box to activate the ground frame of the railway line (to allow movement of the train onto the rail loop).

Kurrajong Creek Road – Site Access Road Intersection

The major design features of this intersection (as introduced in Section 2.4.4) are as follows.

- Changed road priority for traffic on Kurrajong Creek Road. By creating a "T" intersection, this changed priority would be clearly identifiable to road users of Kurrajong Creek Road.
- Bitumen seal and lane markings on Kurrajong Creek Road for 200m beyond the intersection.
- Installation of a "Stop" sign for northbound traffic on Kurrajong Creek Road.

Kurrajong Creek Road – Kamilaroi Highway Intersection

The RTA Road Design Guide requires an intersection be designed to cater for traffic volumes based on either:

- a worst-case scenario for arriving traffic volumes; or
- the proposed longevity of the intersection.

Considering the primary issue of concern regarding the proposed intersection is the storage of vehicles wishing to cross the Western Main Branch Railway during the closure of the level crossing, the intersection layout presented in **Figure 2.8** has been designed by Constructive Solutions for a worst case traffic volume scenario. Therefore, to enable the deceleration from

100km/hr to stationary and storage of the maximum number of vehicles arriving at the intersection during a maximum 6 minute closure, the channelised right and left turn lanes (and deceleration tapers), have been designed for the following distances.

	Storage	Taper
Right Turn Lane	98m	100m
Left Turn Lane	65m	100m

By utilising the 38m distance between the rail crossing hold line and pavement edge, the storage distance for right turning traffic can be reduced by this distance, ie. to 60m. Notably, this 38m distance between the hold line and pavement edge would be sufficient to store the longest vehicle likely to enter Kurrajong Creek Road or the Project Site, ie. a 25m B-double.

Final design of the proposed intersection would include any reasonable modification requested by the RTA.

Kamilaroi Highway – "Bow Hills" Gravel Quarry Access Road Intersection

It is proposed to retain the approved entry to the "Bow Hills" gravel quarry but construct a purpose-built entrance / exit immediately opposite the rail crossing for project-generated truck movements (for gravel supply)(see **Figure 2.8**). This new entrance would be bitumen sealed to the property boundary and a "Stop" sign erected for exiting traffic.

Final design and engineering detail would be submitted to Narrabri Shire Council and/or the RTA for approval prior to construction.

4B.8.4.2 Operational Safeguards

4B.8.4.2.1 Rail Traffic

The Proponent would rely on RailCorp scheduling of coal train movements and therefore would have little control over the operation of rail traffic on the North Western Branch Railway. As far as practicable, however, the Proponent would attempt to have coal train path times occur outside the nominated shift change overs (see Section 2.11.1). Assuming the path schedule follows from that at Whitehaven rail siding (see Section 4B.8.2.2), this would be achieved.

4B.8.4.2.2 Road Traffic

The following safeguards would be implemented to ensure impacts on local road users are minimised.

(i) All transport activities would be undertaken strictly in accordance with the planning approval and environment protection licence. Deliveries of any "oversize" loads, eg. crushing / sizing plant or large earthmoving/mining equipment, would be undertaken in accordance with RTA and Council restrictions on transport hours and safety/warning requirements.

(ii) Applying a covered load policy to all trucks transporting gravel from the "Bow Hills" gravel quarry.

(iii) Ensuring any project-related trucks are well maintained and that the drivers act in a courteous manner at all times.

(iv) All employees would be instructed regarding the possible scenario where the rail crossing is closed at shift change over and requirement for patience as the intersection is cleared following re-opening.

(v) Landowners and surrounding residents would be contacted prior to initial construction and the commencement of any upgrading works to inform each of the operational safeguards to be implemented and discuss the adoption of any additional safeguards proposed by the landowner/resident.

(vi) Routine liaison with local residents to ensure their satisfaction with all aspects of changed traffic conditions.

(vii) A display board would be mounted on the Kamilaroi Highway and Kurrajong Creek Road notifying road users of indicative level crossing closure times.

4B.8.4.3 Ongoing Management

The Proponent would manage the maintenance of the Site Access Road, Kurrajong Creek Road, North Western Branch Railway Crossing and the identified project-related intersections for the life of the project. It is anticipated emphasis would be placed upon maintaining:

(i) the sealed surface and drainage control along the Site Access Road and sealed section of Kurrajong Creek Road;

(ii) the intersections constructed between the Site Access Road and the Kamilaroi Highway and Kurrajong Creek Road; and

(iii) the Kurrajong Creek Road level crossing.

4B.8.5 Assessment of Impacts

4B.8.5.1 Traffic Congestion

Based on the traffic projection figures for the Kamilaroi Highway presented in **Table 4B.48**, average traffic levels generated by the project would represent 10.3% of all light vehicle traffic in 2007. As road traffic levels would not increase throughout Stage 1 of the project, this percentage of Kamilaroi Highway traffic would reduce to 6.0% and 1.0% for light and heavy vehicle traffic respectively. On maximum traffic generating days, the project would generate approximately 15% of Kamilaroi Highway light vehicle traffic and 4.3% of heavy vehicle traffic also reducing over the life of the project.

The predicted increase in traffic as a consequence of the project would not have any noticeable impact on traffic flows and congestion on the Kamilaroi Highway.

By designing the Kurrajong Creek Road – Kamilaroi Highway intersection with channelised right and left turn lanes long enough to cater for the maximum anticipated number of vehicles that might arrive during the 6 minute period for which the rail crossing might be closed, the potential congestion caused by traffic backing up into the Kamilaroi Highway pass-by lane would be avoided. This would also markedly reduce any traffic safety hazard posed by this intersection (see Section 4B.8.5.3).

The closing of the rail crossing for up to 6 minutes during each train movement may result in slight delays to local land owners using Kurrajong Creek Road. Considering the planned safeguards and the number of those affected would be limited, and the minor nature of the inconvenience, the minor delays and congestion caused is considered acceptable.

4B.8.5.2 Road Pavement Condition

The project would not noticeably increase traffic volumes on the Kamilaroi Highway, especially heavy vehicle traffic, and as such would not be expected to cause significant additional deterioration to road pavement condition.

In addition, the Proponent has committed to monitoring and maintaining all other project-related roads and intersections to ensure a suitable standard of pavement is maintained.

4B.8.5.3 Road Safety

The primary road safety hazards associated with the project would be managed to all but eliminate the possibility of an accident involving a project-related vehicle as follows.

- (i) Flashing lights and warning bells would restrict entry to the crossing immediately prior to and while a train is using the crossing.
- (ii) The lane length between the crossing holding line and edge of the left turn lane pavement formation (38m) is sufficient to store the longest vehicle likely to require access to the Project Site or local properties (25m B-double).
- (iii) The Site Access Road – Kamilaroi Highway intersection has been designed to store the maximum number of vehicles considered likely to arrive at the intersection for the maximum closure time of the rail crossing, thereby removing the possible conflict with through traffic.
- (iv) Proponent employees and contractors would be instructed to obey all road rules and act in a safe, courteous and patient manner when entering or exiting the Project Site.

Whilst human error resulting in accident cannot be completely ruled out, the likelihood of an accident caused by a project-related traffic condition alone is assessed as minimal.

4B.8.5.4 Rail Safety

Those hazard management features described in relation to road safety would also minimise the likelihood of a rail incident caused by project-related conditions.

4B.9 NOISE AND VIBRATION

The noise and vibration assessment was undertaken by Spectrum Acoustics Pty Ltd. The full assessment is presented in Part 7 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following sub-sections.

4B.9.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential environmental noise impacts requiring assessment and their unmitigated risk rating are as follows.

- Increased noise levels associated with the Project Site activities causing annoyance, distractions, ie. amenity impacts (moderate risk).
- Increased noise and/or vibration levels associated with the project road and rail traffic causing annoyance, distractions, ie. amenity impacts (moderate risk).
- Maximum noise levels causing sleep disturbance (moderate risk).
- Increased noise levels associated with the project leading to reduced production, ie. impacts on livestock (moderate risk).

In addition, the Director-General's requirements issued by DoP require that the assessment of noise and noise impacts refer to the *NSW Industrial Noise Policy*, *Environmental Criteria for Road Traffic Noise* and *Environmental Noise Control Manual* (Department of Environment and Conservation).

The following sub-sections assess the existing noise environment, environmental noise criteria, proposed operational safeguards and mitigation measures and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4B.9.2 Existing Noise Climate

As identified in Section 4A.3.2 and repeated on **Figure 4B.26**, there are approximately 15 non-project related residences within a 4km radius of the Pit Top Area at which noise may be audible during the site establishment and operational phase of the project.

Given the rural locality, none of the identified residences are currently subjected to significant (ie. present for a high proportion of time) noise levels from transportation or industrial sources. It is therefore assumed that background noise levels are currently at or below 30dB(A) L_{90} at all receivers during day, evening and night periods.

Under the NSW Industrial Noise Policy, it is a standard requirement that noise levels below 30dB(A) can be taken as 30dB(A) for the purposes of assessing industrial noise, such as noise from a coal mine like that proposed. As such, a 30dB(A),L_{90} background level has been adopted for all residences during the day, evening and night.

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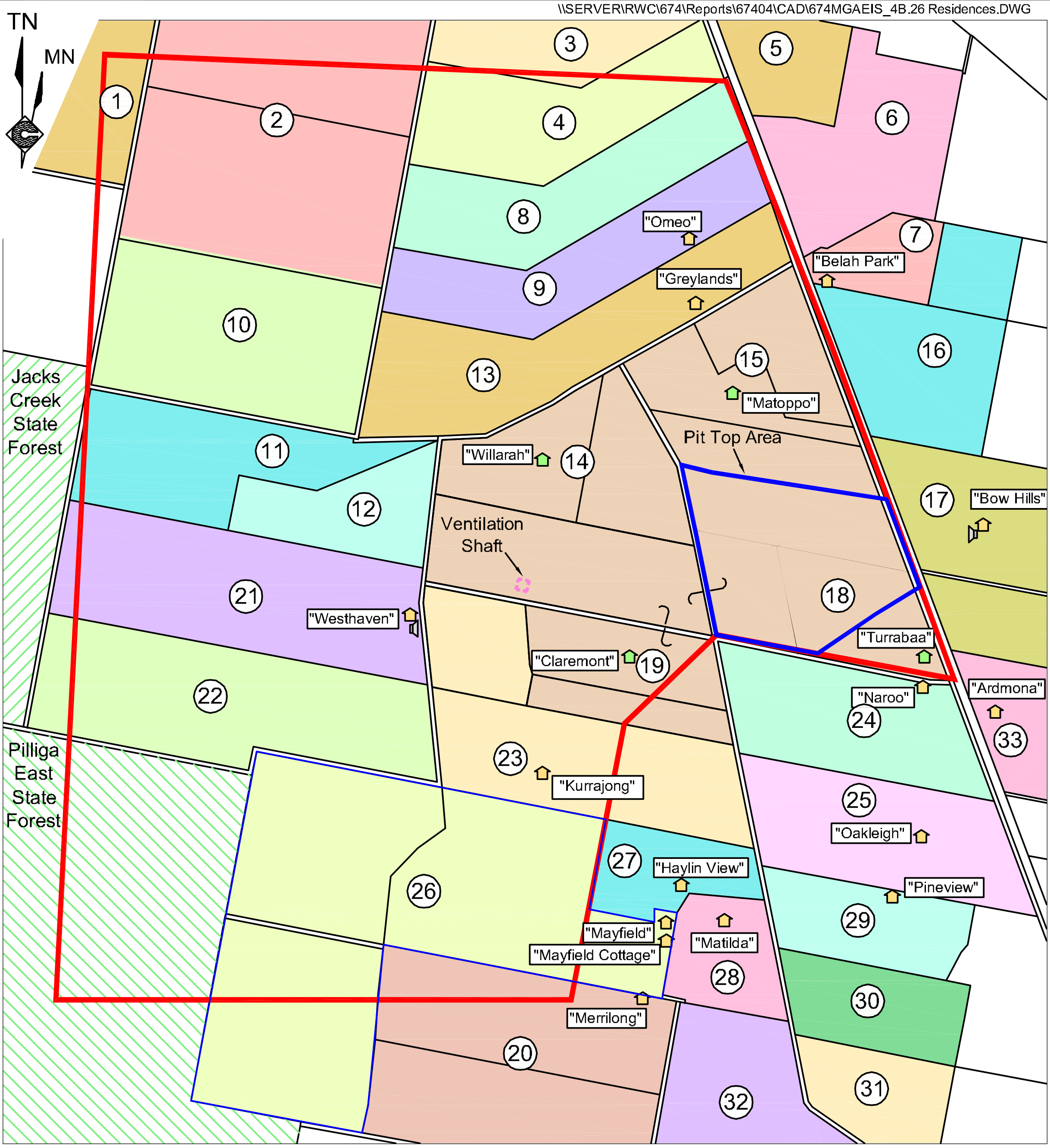

LAND OWNERSHIP

1	N. & F. King	18	Narrabri Coal Pty Ltd
2	C. & M. Clarke	19	Narrabri Coal Pty Ltd
3	A. & L. Grumley	20	R. & S. Chappel
4	K. & J. Scott	21	A. Castro
5	W. & A. Tick	22	D.,P.,B. & N. Grnearski
6	P. Smart	23	J. & G. Lennox
7	G. & C. Sevil	24	M. W. Foster
8	J. & M. Bish	25	C. Towns
9	A. Day	26	A. & L. Grumley
10	F. & A. Desanti	27	E. & L. Tuckey
11	P. & A. Mato	28	W. Chapman
12	R. & M. Cook	29	C. & D. Kirkby
13	M. & D. White	30	M. Thomas
14	Narrabri Coal Pty Ltd	31	B. Scott
15	Narrabri Coal Pty Ltd	32	G. & L. Stuart
16	C. Healion	33	P. C. Webb
17	J. & R. Stieger		

REFERENCE
- Project Site Boundary
- Pit Top Area Boundary
- Residence (Project Related)
- Residence (Non-project Related)
- Noise Monitoring Location

SCALE 1:60 000

1 0 1 2 3km

Land Ownership Source: Dept. of Lands

Figure 4B.26
NON-PROJECT RELATED RESIDENCES

4B.9.3 Environmental Noise Criteria

4B.9.3.1 Introduction

The assessment of impacts of the project on the local noise climate has been undertaken by calculating likely noise levels during both the site establishment and operational stages of the project and comparing those noise levels against the noise criteria established through reference to:

- relevant sections of the DEC *Environmental Noise Control Manual* (ENCM) - for site establishment and construction activities (EPA, 1994);
- the *Industrial Noise Policy* (INP) - for site operational noise (EPA, 2000); and
- NSW *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999).

Criteria relevant to assessing the likelihood of sleep disturbance are drawn from current DEC (EPA) considerations which as yet are not fully documented.

For the purposes of defining relevant criteria, the DEC (EPA) nominate the following times relevant to daytime, evening, night-time periods, ie. for Monday to Saturday.

- Daytime – 7.00am to 6.00pm
- Evening – 6.00pm to 10.00pm
- Night-time – 10.00pm to 7.00am

For Sundays and public holidays, night-time extends from 10.00pm to 8.00am.

4B.9.3.2 Site Establishment Noise

Recommended noise criteria for site establishment activities vary depending on the duration of the activities, as outlined in Section 157 of the ENCM, and reproduced as follows.

- For a period less than 4 weeks:
  - L_{A10} level restricted to background (L_{A90}) + 20dB
- For a period more than 4 weeks but less than 26 weeks:
  - L_{A10} level restricted to background (L_{A90}) + 10dB
- For periods longer than 26 weeks, the operational noise criteria discussed in Section 4B.9.3.3 are assumed to apply.

Given the site establishment and construction activities for the project, including the drift construction, are expected to take up to 12 months to complete, the operational noise criterion discussed in Section 4B.9.3.3 would apply.

4B.9.3.3 Operational Noise

The INP specifies two noise criteria, namely:

- an *intrusiveness criterion* which limits L_{Aeq} noise levels from the industrial source to a value of 'background plus 5dB(A); and
- an *amenity criterion* which aims to protect against excessive noise levels where an area is becoming increasingly developed with numerous noise sources.

Since there is no existing major industry or numerous noise sources dominating noise levels in the vicinity of the Project Site, and road traffic noise is not continuous, only the intrusiveness criteria would be considered for setting project-specific operational noise limits.

Based on the assumed background noise level of 30dB(A),L_{90} the intrusiveness criterion is 35dB(A),$L_{eq(15\text{-minute})}$ at all non-project related residences.

4B.9.3.4 Sleep Disturbance

In order to protect against sleep disturbance at surrounding residences, the DEC (EPA) recommends that 1-minute L_{A1} noise levels (effectively, the maximum noise level from impacts) would not exceed the background level by more than 15dB(A) at the façade of a residence. The "sleep disturbance" criterion is only applicable to night-time operations.

The sleep disturbance criterion applicable for this project at each residence is equal to the intrusiveness criterion plus 10dB(A), that is, 45dB(A), $L_{1(1\text{-minute})}$.

4B.9.3.5 Road Traffic Noise

In NSW, noise from vehicle movements associated with an industrial source is assessed in terms of the INP if the vehicles are on the industrial site, in this case, the Project Site. If the vehicles are travelling on a public road, the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN) applies. The project would produce additional traffic on the Kamilaroi Highway due to employee and delivery vehicles (refer to Section 4B.8.3.1). Although the Kamilaroi Highway would be classified as an arterial road, it is recognised that the additional noise generated by the project would be concentrated in short periods of time around shift change, whereas the criteria for arterial roads are for the entire day/night periods due to the relatively constant nature of traffic of major freeways. It has therefore been assumed that the Kamilaroi Highway is a collector road due to its more intermittent traffic which, in accordance with the ECRTN, implies traffic noise criteria of $L_{Aeq(1hr)}$ 60 (day) and $L_{Aeq(1hr)}$ 55 (night) for traffic generated by the Narrabri Coal Project.

4B.9.3.6 Rail Traffic Noise

The project would result in additional train movements on the North Western Branch and Main Northern Rail Lines between the Project Site and Port Newcastle and there would be a corresponding increase in noise exposure at residences adjacent to the train line.

Chapter 163 of the DEC *Environmental Noise Control Manual* (ENCM) specifies limits on train noise levels within the Rail Infrastructure Corporation (RIC) corridor. These are presented in **Table 4B.49**.

Table 4B.49
Rail Noise Criteria

Descriptor	Planning Levels	Maximum Levels
$L_{eq, 24 hour}$	55dB(A)	60dB(A)
L_{max}	80dB(A)	85dB(A)

4B.9.3.7 Rail Vibration Levels

Vibration criteria associated with train movements for this assessment were obtained from Chapter 174 of the ENCM "Noise Control Guideline - Vibration in Buildings".
DEC (EPA) limits are for vibration in buildings relate to personal comfort and not structural integrity of the building and a maximum allowable vibration velocity of 2.82mm/s applies to train-induced ground vibration, which are typically at frequencies greater than 10Hz.

4B.9.3.8 Blasting

4B.9.3.8.1 Annoyance Criteria

Noise and vibration levels from blasting are assessable against criteria proposed by the Australian and New Zealand Environment and Conservation Council (ANZECC) in their publication *"Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990"*.

These criteria are summarised as follows.

- The recommended maximum overpressure level for blasting is 115dB.
- The level of 115dB may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120dB at any time.
- The recommended maximum vibration velocity for blasting is 5mm/s Peak Vector Sum (PVS).
- The PVS level of 5mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10mm/s at any time.
- Surface blasting should generally only be permitted during the hours of 9am to 5pm Monday to Saturday, and should not take place on Sundays and Public Holidays.
- Surface blasting should generally take place no more than once per day.

These criteria are typically adopted by the DEC when issuing Environment Protection Licences for projects involving surface blasting. No restrictions are necessary in the event underground blasts are required.

4B.9.3.8.2 Building Damage Criteria

Building damage assessment criteria are nominated in AS 2187.2-1993 *"Explosives – Storage, Transport and Use Part 2: Use of Explosives"*, however, as the annoyance (ANZECC) criteria are more stringent, the building damage criteria are not considered further.

4B.9.4 Noise Controls

A preliminary acoustic assessment identified that under some meteorological conditions, activities undertaken as part of site establishment would likely generate noise levels above the Project Site noise criteria. In order to minimise the potential for any such noise exceedance, the following controls would be adopted.

Noise Controls during Site Establishment

- Prior to being brought onto site, all earthmoving equipment would be required to exhibit sound power levels consistent with the schedules in the noise assessment by Spectrum Acoustics (see Appendix A of Spectrum Acoustics (2007)).
- Construction of the eastern end of the rail loop would not be undertaken at times when temperature inversions are likely, ie. cool mornings when wind speed is below 1m/s or there is significant cloud cover.
- Until the excavator can be operated below natural surface topography, construction of the conveyor drift box cut would not occur under temperature inversion conditions or when winds less than 3m/s occur from the sector between the south and east (bearing 90^o to 225^o).
- Excavated material from the ventilation shaft and elsewhere would be used to construct a 4m acoustic bund around the ventilation shaft to shield fan noise from surrounding residences, particularly the "Westhaven" residence.
- Noise monitoring would be undertaken at the residences most likely to be affected by construction noise.

Operational Noise Controls

- The ventilation fan located within the Ventilation Shaft Area would be enclosed to reduce the sound power level of the fan to 102 dB(A).
- The approved hours of operation would be adhered to.
- A Noise Management Protocol would be prepared by the Proponent prior to the commencement of mining activities. The Protocol would incorporate the specific details of all noise controls and the measures to address noise criteria exceedances and/or complaints.

Transport Noise Controls and Operational Procedures

- The Site Access Road would be sealed and regularly maintained.
- Strict adherence to hours of operation, including transport activities would be enforced by Mine Management.
- All project employees and contractors would be instructed to enter and exit the Project Site in a courteous manner and without causing undue traffic noise.

Other Noise Controls and Operational Procedures

In addition to the design and operational features of the proposal, the Proponent would apply the following noise controls.

- Equipment with lower sound power levels would be used in preference to more noisy equipment.
- All equipment used on-site would be regularly serviced to ensure the sound power levels remain at or below the levels used in the modelling to assess generated noise levels and compliance with the criteria.
- The on-site road network would be well maintained to limit body noise from empty trucks travelling on internal roads.
- The Proponent would maintain dialogue with it neighbours and the local community to ensure any concerns over construction, operational or transport noise are addressed.

4B.9.5 Assessment of Impacts

4B.9.5.1 Method of Assessment

The assessment of potential noise impacts arising from activities within the Project Site and those road and rail traffic was undertaken using a range of methods by Spectrum Acoustics. The complete report of Spectrum Acoustics (Spectrum, 2007), is provided as Part 7 of the *Specialist Consultant Studies Compendium* with a summary for each assessment method provided as follows.

Site Establishment Activities Noise Assessment

Noise levels generated by construction activities on the Project Site at the 15 non-project related residences were predicted through modelling[2] the following construction activities under neutral and adverse weather conditions.

- Limited tree clearing and topsoil removal within the footprint of the Pit Top Area and Ventilation Shaft Area.
- Construction of the Site Access Road and upgrade of Kurrajong Creek Road.

[2] Spectrum (2007) used the RTA Technology's Environmental Noise Model v3.06 (ENM).

- Construction of the Pit Top Area infrastructure including the surface buildings, coal processing and loading rail loop area, box cut and mine drifts and the ventilation shaft.

For modelling purposes, it was assumed that construction of internal roads, mine drifts, rail loop and surface facilities would take place largely simultaneously at the start of the site establishment phase. Construction of the ventilation shaft would occur at a later time when ventilation of the underground workings becomes necessary.

Operational Noise Assessment

Operational noise levels at the 15 non-project related residences were predicted using the ENM model for a scenario in which the following items of plant and equipment were fully operational.

- Ventilation shaft.
- Crushing / sizing plant between ROM and product stockpile areas.
- Tracked dozer in the stockpile areas.
- Maintenance activities in workshop.
- Personal carrier approaching transport drift.
- Train on the rail loop and coal being loaded.

Typical sound power levels for each item of plant/equipment were assumed. To account for varying meteorological conditions which would influence the noise levels received, the model was run under the following meteorological conditions.

- *Daytime lapse* - 20^0C, 70% relative humidity (RH), no wind, -1^oC/100m vertical temperature gradient (dry adiabatic lapse rate, DALR).
- *Inversion* – 10^0C, 70% RH, +4^oC/100m vertical temperature gradient.
- *Prevailing wind* – 20^0C, 70% RH, 3m/s wind from the northwest.

Sleep Disturbance

Impact noise (L_{Amax}) was modelled using the ENM program under the same meteorological conditions as for the operational noise modelling. Typical sound power levels for items of operational machinery or equipment, ie. within the maintenance workshop, coal handling with the dozer and coal (train) loading operations, were assumed.

Rail and Road Traffic Noise

Additional road and rail traffic generated by the project would be of an intermittent rather than constant nature. Considering this fact, Spectrum (2007) sourced their assessment methodology from the US Environmental Protection Agency document No. 550/9-74-004 (1974) *Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*.

The document refers to 'triangular' and 'trapezoidal' time signals, where a triangular time signal rises from the background level to a peak noise level and then immediately begins to subside while a trapezoidal time signal rises from the background level to a maximum level and sustains that level for a period of time before subsiding.

A trapezoidal time signal has been used to represent train traffic while a triangular time signal has been used for the intermittent road traffic.

Rail Vibration

Vibration levels from laden and unladen coal trains have been widely studied in the Hunter Valley. A thorough assessment conducted in 1997 (*Noise and Vibration Assessment, Jerrys Plains Rail Spur, Wilkinson Murray Pty Limited*) found that the ground vibration level from coal trains is below the criterion at approximately 20m from the track. Since there are no potentially affected receivers this close to the track on the North Western Branch Line between the Project Site and the junction with the Main Northern Line, rail vibration has not been considered further in this assessment.

Blasting

Given the small size and limited number of surface blasts required for the project ie. for the box cut and possibly the ventilation fan shaft, assessment was undertaken as a comparative study to similar mining projects throughout the local area.

Impacts on Livestock

The impact of noise generated by the project on livestock has been assessed through reference to a report prepared assessing the impacts of noise, blasting and dust deposition on livestock and pastures (Hunt, 1999) and the results of noise modelling.

4B.9.5.2 Assessment Results

4B.9.5.2.1 Noise Generated by Site Establishment Activities

Table 4B.50 presents a summary of the predicted noise levels during the site establishment phase.

Minor (1dB(A) to 2dB(A)) exceedances of the noise criterion are predicted at two residences under inversion conditions. Adherence to the noise controls described in Section 4B.9.4, however, would mitigate the occurrence of these exceedances (Spectrum, 2007).

During the first six months of the site establishment phase, gravel would be extracted from the "Bow Hills" quarry during the day and hauled across the Kamilaroi Highway to the Project Site at a rate of up to 5 truck loads per hour (with a daily average of 2 to 3 truck loads per hour).

Table 4B.50
Predicted Noise Levels during Site Establishment

Non-project Related Residence	Meteorological Condition				
	Lapse	Inversion	SE wind	Criterion	Differential
"Omeo"	<20	26	28	35	-7
"Greylands"	22	27	29	35	-6
"Bolah Park"	<20	27	28	35	-7
"Bow Hills"	27	**36**	33	35	**+1**
"Naroo"	24	32	22	35	-3
"Ardmona"	23	31	20	35	-4
"Oakleigh"	23	26	<20	35	-9
"Pineview"	21	25	<20	35	-10
"Merrilong"	<20	22	<20	35	-13
"Mayfield Cottage"	<20	24	<20	35	-11
"Mayfield"	<20	24	<20	35	-11
"Matilda"	<20	24	<20	35	-11
"Haylin View"	<20	25	<20	35	-10
"Kurrajong"	22	30	<20	35	-10
"Westhaven"	27	**37**	34	35	**+2**

Source: Spectrum (2007) – Table 4

The distance from the quarry of each of the closest residences ("Naroo" and "Ardmona") is approximately equal to the distance from site establishment activities to these receivers and it may be assumed at worst, the noise emissions from the quarry could be as high as those from site establishment activities. **Table 4B.50** shows predicted daytime noise levels of 24dB(A) at "Naroo" and 23dB(A) at "Ardmona". Adding the same amount of noise from the quarry (and gravel haulage) would increase these levels to 27dB(A) and 26dB(A), respectively. These cumulative noise levels are well below the 35dB(A) criterion.

4B.9.5.2.2 Operational Noise

Table 4B.51 presents a summary of the predicted noise levels generated by the project over the life of the mine assuming the adoption of all the design and operational controls. With the incorporation of the noise controls, all operational noise criteria would be met at all non-project related residences.

The predicted operational noise levels account for light vehicle movements at shift changeover given that the maximum noise of a passing light vehicle at the closest non-project related residence ("Naroo") would be <25dB(A). Therefore the $L_{eq(15min)}$ for up to 50 passing vehicles would be <20dB(A) and would not increase the predicted worst-case noise level at "Naroo".

During periods when the background noise levels are low, it is likely that operational noise would be audible at some surrounding residences, albeit at very low levels.

Figure 4B.27 presents the operational noise contours predicted under inversion conditions. Under these conditions, noise generated on the Project Site may be audible at surrounding residences, again at very low levels.

Table 4B.51
Predicted Operational Noise Levels - dB(A), $L_{eq(15min)}$

Non-project Related Residence	Meteorological Condition				
	Lapse	Inversion	SE wind	Criterion	Differential
"Omeo"	<20	23	20	35	-12
"Greylands"	20	25	24	35	-10
"Bolah Park"	<20	27	22	35	-8
"Bow Hills"	20	29	<20	35	-6
"Naroo"	21	27	20	35	-8
"Ardmona"	<20	22	<20	35	-13
"Oakleigh"	<20	21	<20	35	-14
"Pineview"	<20	<20	<20	35	-15
"Merrilong"	<20	20	<20	35	-15
"Mayfield Cottage"	<20	20	<20	35	-15
"Mayfield"	<20	20	<20	35	-15
"Matilda"	<20	21	<20	35	-14
"Haylin View"	<20	21	<20	35	-14
"Kurrajong"	<20	26	<20	35	-9
"Westhaven"	25	30	30	35	-5
Source: Spectrum (2007) – Table 5					

4B.9.5.2.3 Sleep Disturbance

The impact on sleep disturbance was assessed for each of the non-project related residences. **Table 4B.52** presents the predicted L_{max} noise levels for the identified scenarios.

No exceedances of the sleep disturbance criterion have been predicted.

Table 4B.52
Predicted Maximum Noise Levels – dB(A),$L_{1(1\text{-minute})}$

Location	Meteorological Condition				
	Lapse	Inversion	SE wind	Criterion	Differential
"Omeo"	28	34	29	45	-11
"Greylands"	30	36	37	45	-8
"Bolah Park"	29	36	36	45	-9
"Bow Hills"	26	36	27	45	-9
"Naroo"	28	32	24	45	-13
"Ardmona"	26	33	26	45	-12
"Oakleigh"	23	28	21	45	-17
"Pineview"	22	28	20	45	-17
"Merrilong"	20	26	<20	45	-19
"Mayfield Cottage"	21	27	<20	45	-18
"Mayfield"	21	27	<20	45	-18
"Matilda"	21	28	<20	45	-17
"Haylin View"	22	28	20	45	-17
"Kurrajong"	20	28	22	45	-17
"Westhaven"	26	31	31	45	-14
Source: Modified after Spectrum (2007) – Table 6					

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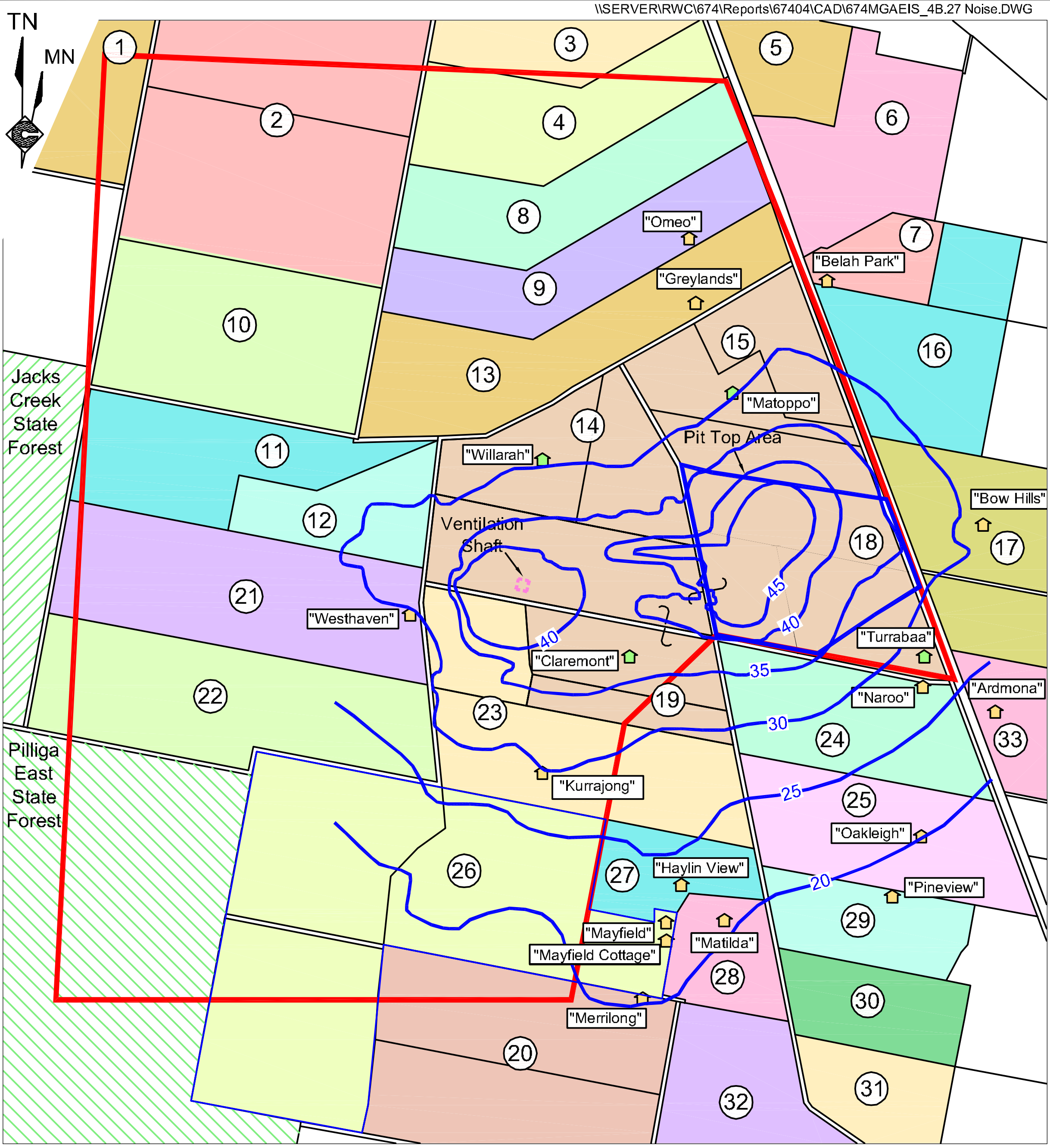

LAND OWNERSHIP			
1	N. & F. King	18	Narrabri Coal Pty Ltd
2	C. & M. Clarke	19	Narrabri Coal Pty Ltd
3	A. & L. Grumley	20	R. & S. Chappel
4	K. & J. Scott	21	A. Castro
5	W. & A. Tick	22	D.,P.,B. & N. Grnearski
6	P. Smart	23	J. & G. Lennox
7	G. & C. Sevil	24	M. W. Foster
8	J. & M. Bish	25	C. Towns
9	A. Day	26	A. & L. Grumley
10	F. & A. Desanti	27	E. & L. Tuckey
11	P. & A. Mato	28	W. Chapman
12	R. & M. Cook	29	C. & D. Kirkby
13	M. & D. White	30	M. Thomas
14	Narrabri Coal Pty Ltd	31	B. Scott
15	Narrabri Coal Pty Ltd	32	G. & L. Stuart
16	C. Healion	33	P.C. Webb
17	J. & R. Stieger		

REFERENCE
- Project Site Boundary
- Pit Top Area Boundary
- Residence (Project Related)
- Residence (Non-project Related)
- 20 Noise Contour (dB(A))

SCALE 1:60 000

1 0 1 2 3km

Source: Spectrum Acoustics (2007) - Figure 6

Figure 4B.27
PREDICTED OPERATIONAL NOISE LEVELS UNDER INVERSION CONDITIONS

4B.9.5.2.4 Rail Noise

Figure 4B.28 presents the predicted noise levels between 10m and 50m from the centre line of a passing coal train, for between 2 and 6 trains per day, based on the methodology described in Section 4B.9.4 and Spectrum (2007).

An extrapolation of the curve presented in **Figure 4B.28**, indicates that at a distance of 100m, the proximity of the closest residence ("Ardmona") to the North Western Branch Railway, four trains per day would generate a noise level of 42dB(A),$L_{eq(24\ hour)}$. At a distance of 100m, up to 15 coal trains per 24-hour period would satisfy the DEC criterion of 55dB(A),$L_{eq(24\ hour)}$.

Considering the cumulative impact of the project with other rail utilising projects in Boggabri, the two trains daily travelling to and from the project would combine with a maximum of three trains per day generated by the Boggabri Coal Project. These trains would combine with other container, grain and passenger trains on the rail line and would be subject to the noise limits set by the DEC within the Australian Rail Track Corporation (ARTC) Environment Protection Licence (EPL) No. 3142. The noise limits set by EPL 3142 are as follows.

$L_{eq(15hr)}$ – day : 65dB(A)

$L_{eq(9hr)}$ – night : 60dB(A)

L_{max} – 24 hour : 85dB(A)

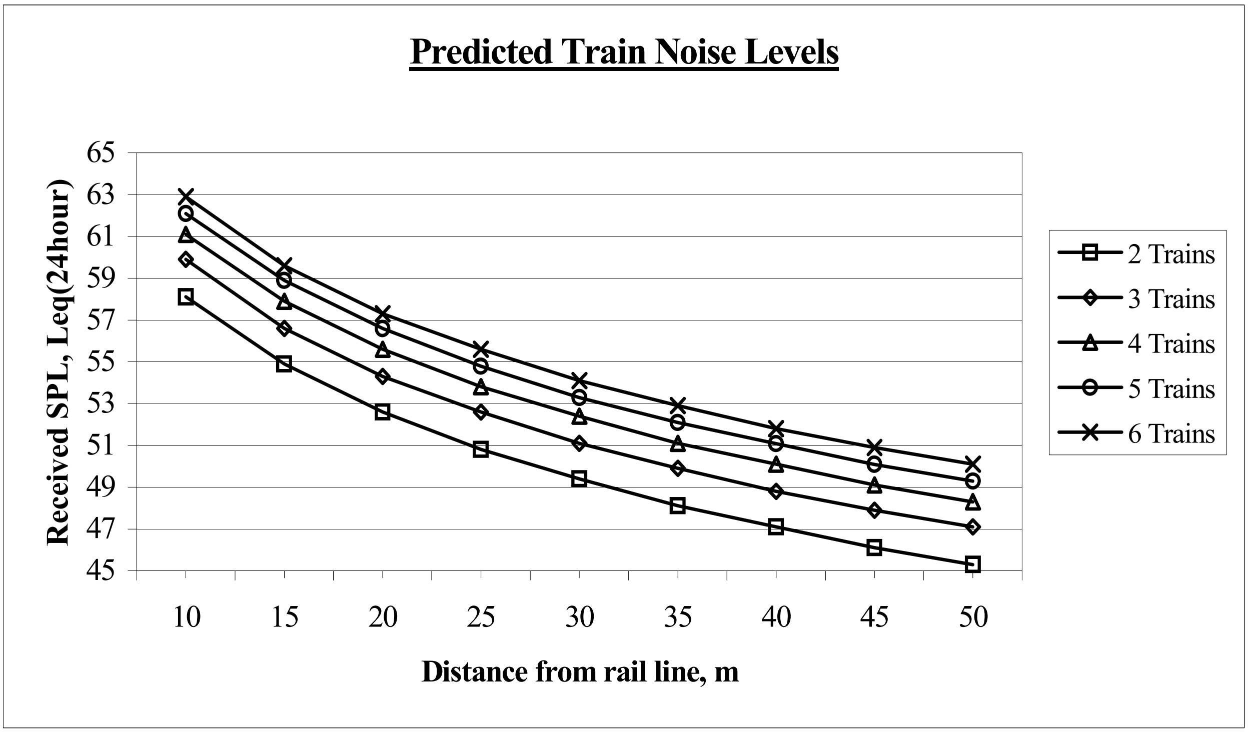

Figure 4B.28
PREDICTED RAIL NOISE

At the closest residence distance to the North West Branch Railway in nearby Baan Baa (60m), it would require 10 to 12 trains of coal train length (1542m) to exceed the criteria. The addition of a maximum three trains per day from the project would not result in cumulative train numbers increasing to this level, even during peak grain/coal production periods (Spectrum, 2007).

4B.9.5.2.5 Road Noise

In assessing road noise, it has been estimated that up to 25% of average daily traffic may occur within 1 hour around shift changeover, ie. up to 50 light vehicle movements. Under a worst-case scenario, the assessment considers the noise level at the two residences in closest proximity to the Kamilaroi Highway ("Bolah Park" and "Ardmona", approximately 50m east), for all project generated traffic (despite the fact that there would be likely to be some segregation of north-bound and south-bound traffic).

Based on a road speed of 100km/h, a sound pressure level of 44dB(A),$L_{eq(1\ hour)}$ is predicted at "Bolah Park" and "Ardmona", which is considerably below the night time criterion level of 55dB(A),$L_{eq(1\ hour)}$. The predicted noise level increases to 49dB(A),$L_{eq(1\ hour)}$ if it is assumed that 10 of the estimated daily total of 20 light and heavy delivery trucks may pass by "Bolah Park" or "Ardmona" in a 1-hour period. Even under this worst case (and unrealistic) assumption, the predicted noise level is well below the night time criterion level of 55dB(A),$L_{eq(1\ hour)}$.

4B.9.5.2.6 Impacts on Livestock

The site establishment and operational noise levels predicted by Spectrum (2007) are not anticipated to have any impact on the grazing nature of local livestock. Low level vibration as would be generated by train pass-by have been found to have little effect on livestock with Hunt (1999) reporting that in paddocks of the Orange Agricultural College adjacent to a rail line, it is common to feel ground vibrations as the XPT passes at speed, but that the sheep, horses and cattle do not seem to react to that vibration. Local stock grazing near the North Western Branch Railway would be familiar with the movements of trains travelling daily along that line.

Hunt (1999) also found that animals exposed to loud noise and ground vibration for the first time may startle but, without continuance of the noise or vibration, would normally settle quickly and with each additional exposure, the startle response would diminish.

4B.9.5.2.7 Blasting

Blasting would be required when excavating the box cut from approximately 25m to 40m below surface. Several small blasts (up to four) may be required to fracture the material prior to removal by excavator and haul truck. The expected area at the base of the box cut requiring blasting would not exceed 5 000m^2 requiring a total of 50 000bcm to 75 000bcm of material to be fragmented. Small blasts (<60m^3 blast) may be required when constructing the ventilation fan shaft.

The blast size required for the box cut would represent a very small blast by open cut mining standards (approximately 5% of a typical blast at the Tarrawonga Coal Mine). Given the blasts at Tarrawonga Coal Mine are designed to comply with DEC criteria for ground vibration and overpressure at residences a similar distance from the blast, and each blast would be at least 25m below surface level, the relevant criteria should be easily met. Similarly, the very small blasts at the ventilation fan shaft would be barely noticeable when operations are within the top 20m to 30m. Below that depth, they would be not be audible and the relevant criteria easily met.

4B.9.6 Monitoring

A noise monitoring program would be established by the Proponent, in consultation with the DEC, and implemented throughout the life of the project. The monitoring program would include the following.

- Compliance Monitoring during the Site Establishment Phase: Quarterly attended and unattended monitoring at the “Bow Hills” and, “Westhaven” residences to monitor compliance with noise criteria applicable to the site establishment period.
- Noise Model Validation Monitoring: Attended and unattended monitoring at the “Bow Hills” and, “Westhaven” residences during noise-enhancing meteorological conditions for initial mining and crushing/screening operations. Should this monitoring indicate noise levels above those predicted by the model, ongoing operational compliance monitoring would be commenced. Should this monitoring confirm low noise levels, permission would be sought from DEC and DoP to discontinue further the validation monitoring program.
- Ongoing Operational Noise Compliance Monitoring: Annual attended monitoring would be undertaken at the “Bow Hills” and, “Westhaven” residences to monitor compliance with operational noise criteria.

It is proposed that each of the blasts initiated during the excavation of the box cut would be monitored by the blasting contractor at the “Naroo” residence, the closest residence to the box cut.

Figure 4B.26 displays the locations of the surrounding residences and the proposed monitoring locations.

Monitoring would also be considered at any other residence whose occupants consider noise levels attributable to the mine development are excessive.

The results of monitoring would be provided to the DEC and DoP in each AEMR along with the identification of any refinements to safeguards and noise controls implemented as a consequence of the monitoring.

4B.10 SOCIO-ECONOMIC SETTING

The social assessment was undertaken by Key Insights Pty Ltd. The full assessment is presented in Part 9 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections. The economic assessment was undertaken with information supplied by the Proponent.

4B.10.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.6**), the potential environmental socio-economic impacts requiring assessment and their unmitigated risk rating are as follows.

- Alteration of social activities or employment due to employment generation and capital expenditure (no risk rating).
- Perceived or real impacts on local amenity of neighbouring properties (moderate to high).

In addition, the Director-General's requirements issued by the DoP require that the assessment of socio-economic impacts make particular reference to any increased demand for infrastructure and services.

4B.10.2 Method

The socio-economic assessment was undertaken in phases. The first phase involved an analysis of previous social and economic assessments in the region in order to obtain a general understanding of the local setting, social issues of greatest concern and community views/opinions on mining.

Phase 2 involved more detailed qualitative research of those social issues identified by the Phase 1 assessment to be of greatest significance to local stakeholders, namely:

- housing;
- education;
- industry diversification;
- employment opportunities; and
- community services and facilities.

Based on the identification of these key themes, the qualitative research component of the assessment focussed on the following.

(i) Consideration of the existing services, facilities and opportunities within the Narrabri and Gunnedah Shires.

(ii) Consultation with professionals working in the key area identified by Phase 1 of the assessment.

4B.10.3 Results

4B.10.3.1 Phase 1 - Literature Review

Three previous social assessments were reviewed, namely:

- the Boggabri Coal Project (AMAX/BHP, 1982);
- the Whitehaven Coal Mine proposal (RWC, 2000); and
- the East Boggabri Coal Mine (Key Insights and Castlecrest Consulting, 2005).

These assessments yielded some common themes, as follows.

- The Narrabri/Gunnedah regions have been experiencing declining populations over recent decades.
- There had been net out-migration from rural areas, especially as a result of young people moving to regional centres in search of further work and educational opportunities.
- There is generally wide community support for mining in the area. Residents apparently welcomed the economic and employment benefits that would flow through to the areas as a result of expanded mining activity.
- The communities saw mining as a positive way to bring population growth and much needed diversity to the local economy.
- Housing supply concerns were raised with separate houses being the overwhelmingly dominant form of housing in the area. While there is land that would accommodate population increase in both Narrabri and Gunnedah, an influx of new workers may provide short-term stress on the market.
- The Narrabri and Gunnedah economies are primarily driven by agriculture and subsequently, the labour market and skills pool are not particularly deep. The labour market is quite tight in the areas of professionals and skilled trades. These structural conditions of the labour market may mean that it is necessary to import a considerable proportion of the workforce, notably those with highly developed, mining-related skills.
- There may be some transfer of workers from the agriculture sector to the better paid mining sector, however, high levels of youth unemployment suggest a considerable pool of young workers, who would be available to engage in low-skill jobs or participate in structured training.

4B.10.3.2 Phase 2 - Qualitative Research

4B.10.3.2.1 Existing Services and Facilities

Educational Facilities and Services

Narrabri is serviced by a range of daycare centres and preschools, 3 primary schools and 1 high school. Narrabri High School is fed by a number of primary schools operating in the smaller towns and villages within the Narrabri Shire. Narrabri TAFE College operates from Barwon St.

Narrabri and offers a range of courses suitable for mine workers (engineering, manufacturing, reception skills, payroll, bookkeeping, IT) as well as courses that may be of interest to mine workers' partners (childcare, business skills, digital photography).

In Gunnedah there are four primary schools: 2 State schools, 1 Catholic and 1 Christian Community School. There are also two high schools in Gunnedah, a State school and a Catholic High School, St Mary's College. Gunnedah is served by a range of childcare centres and preschools. Gunnedah TAFE operates from Hunter Street, providing a range of State-approved courses, and local content. It is most likely that Gunnedah TAFE would benefit from mining growth in the region and is likely to provide flexible delivery options to new and young workers.

The nearest university campus is the University of New England, which has a campus in Armidale.

Healthcare Facilities and Services

Narrabri is serviced by a District Group Level 2 (community acute) Health Service which provides the following services.

- Acute care
- Medical
- Surgical
- Maternal
- Paediatric Services
- 24hr emergency department.

Additional healthcare facilities and services in the Narrabri Shire include:

- community health services in Narrabri and Wee Waa;
- aged care residential facilities in Narrabri; and
- a home and community care program which includes community transport.

Gunnedah has a 50 bed capacity hospital which provides a high standard of general medical and surgical services including a Slow Stream Rehabilitation Unit, a day surgery care facility, a Public Health Dental Clinic and a Physiotherapy Unit. A range of additional healthcare services and facilities are available in Gunnedah, the details of which are provided in Key Insights (2007).

General Facilities and Services

Both Narrabri and Gunnedah, as larger regional centres, provide numerous sporting and recreational clubs, sporting grounds and facilities, restaurants, retail facilities and several franchises.

Narrabri Shire has many services and facilities to meet the needs of mine workers, predominantly centred in the Narrabri township, although a range of services and facilities are also available in towns such as Boggabri and Wee Waa. As "Australia's sportiest shire", sporting clubs and facilities form an important part of recreational pursuits in the Narrabri Shire. Further detail on the facilities and services available within Narrabri and Narrabri Shire are provided by Key Insights (2007).

Gunnedah sees itself as attractive to business because of its rail and road transport links. There is an airport at Gunnedah with daily connections to Sydney, but it is expensive compared to flying in and out of Sydney and Brisbane from Tamworth. A focal point for activity of a cultural nature within Gunnedah and surrounding areas is the Gunnedah Cultural Centre. It includes the Civic theatre, which houses new cinema/theatre facilities. Also included are the original town hall and the creative arts centre. The creative arts centre displays the Shire's art collection. Gunnedah also boasts a swimming centre which includes a 50m Olympic pool, 25m indoor heated pool, children's wading pool, kiosk and BBQ facilities.

Gunnedah has the following business and industry groups.

- Gunnedah and District Chamber of Commerce and Industry.
- Gunnedah Stock and Station Agents Association.
- New South Wales Farmers Association.
- Tourism Gunnedah (Gunnedah Visitors Information Centre).
- Gunnedah District Unlimited. (Main Street Program).

4B.10.3.2.2 Consultation with Relevant Professionals and Key Stakeholders

Due to its size and proximity to the Project Site, Narrabri was identified as the town that most mine workers would be inclined to live in, although given the existence of a mine-related workforce already present in Gunnedah, a significant proportion is anticipated to commute from there. Narrabri and Gunnedah both provide higher levels of services and facilities than the smaller centres of Boggabri and Baan Baa.

Local educators highlighted the quality and capacity of the local school education systems in both Gunnedah and Narrabri. With respect to further education opportunities, it was noted that Narrabri TAFE, part of the New England Institute, is at the forefront of innovation in manufacturing and engineering-related trade courses.

Local real estate agents described a reasonably static, although shallow, housing market. They believed that a population increase associated with the creation of new employment opportunities associated with the project could result in short term shortfall in the availability of rental and sale properties, but that there was enough developable land to meet demand in the medium term. They also identified a cohort of entrepreneurs ready to build housing in anticipation of new mining ventures. It was the general view that new settlement would be limited in Baan Baa because of the lack of a town water supply.

Interviews with Narrabri Shire Council officers revealed an optimistic outlook for a healthy, well serviced community. Issues such as housing supply and unemployment were highlighted, but there was an understanding that these issues could be addressed. A repeated theme amongst Council representatives was that there should be a commitment to employing locals of the region, especially considering the technical courses offered by Narrabri TAFE.

4B.10.3.2.3 Local Capacity: Demand and Supply

As indicated in Section 4B.10.3.2.1, Narrabri and Gunnedah Shires are both well serviced by a range of clubs, service organisations, facilities and government services and have high levels of social capital. The smaller centers of Boggabri and particularly Baan Baa are well serviced by the nearby towns of Narrabri and Gunnedah, their small population size makes a full range of services unsustainable and commercially unviable (the loss of the Chemist in Boggabri and closing of the Baan Baa School in recent years are pertinent examples). A potential increase in population associated with the establishment of the Narrabri Coal Project could help communities establish critical mass and attract more services and facilities.

Key Insights (2007) have prepared a profile of the current demand placed on local services such as health and education, and attempted to quantify the subsequent extra demand placed on local services as a result of new residents being drawn to the area as a result of employment, or employment of an immediate family member. While the estimates on changes in demand for ‘soft’ infrastructure such as access to education and health services are purposefully provided as indicative only, they provide a basis for assessing the potential impact on the ability of Narrabri and surrounding communities to manage any potential population increase.

Existing Supply and Demand

Narrabri is serviced by 3 primary schools and 1 high school. In 2001, there were reportedly, 639 primary school children and 421 high school aged students, most of whom were presumably attending a local school (ABS, 2001).

Narrabri is serviced by a District Group Level 2 (community acute) Health Service and the Barwon Division of General Practice (BDGP) reports that the Narrabri LGA has 10.1 general practitioners servicing a population of 13,932, giving a FTE GP ratio of 1:1,393 (BDGP, 2005).

Additional ‘soft’ infrastructure such as clubs and sporting groups are well represented as indicated in Section 4B.10.3.2.1.

Predicted Changes to Local Demographics

While there is no clear indication where new residents may choose to live, it is predicted that most would choose to reside in Narrabri, due to its higher levels of servicing than smaller towns such as Boggabri and Baan Baa. Subsequently, it is assumed that 80% of all incoming residents would reside there. Given that many mining jobs require skills that may not be readily available in the local workforce, Key Insights (2007) conservatively assumed that up to two thirds of the initial operational workforce would be sourced from outside the local area. The average household size of 2.6 persons for the incoming workforce was assumed (the 2001 NSW average) with a representative split of child ages. Based on these assumptions, the following change in Narrabri demographics is predicted.

Workers sourced from outside local areas 48

NSW mean household size 2.6

Projected incoming population	**125**
Estimated children under 5 (NSW average = 7%)	9
Estimated primary school children (NSW average = 9%)	11
Estimated high school children (NSW average = 7%)	9

These estimates reveal an essentially modest increase in population associated with the project.

4B.10.4 Management Measures

4B.10.4.1 Social

Employment and Training

A key issue identified through consultation with local professionals and stakeholders was the local education & training capacity to prepare local community members for employment at the project and provide opportunities for the families of those employed by the project (children, teenagers and partners).

The Proponent is committed to the implementation of a policy which encourages employment of local district personnel. Arrangements for training and certification of suitable local persons would be made and the Proponent intends to use its association with other operational mines in the region to provide the training required for the bulk of its workforce. Given the reliance of modern farming on heavy machinery, the transition of local residents previously employed in agriculture to mining would be relatively simple. Furthermore, there are a number of former employees from the previous coal mines that still live in the Gunnedah and Narrabri area who have expressed an interest in re-joining the industry. The local indigenous community would be encouraged to be involved in this program.

Acknowledging that a proportion of the initial mine workforce may be sourced from more established mining area such as the Hunter Valley, and to assist in the community integration process, the Proponent would provide assistance, where possible, in identifying job opportunities for the partners of potential employees. The Proponent would also provide a local induction kit to new workers including contact details for community groups and services throughout the region.

Housing

Another issue identified through the consultation phase of the social assessment was ensuring sufficient housing was available to support population growth as a consequence of the increased employment opportunities provided by the project.

To minimise the short term shortage in rental and sale properties, until such time as land in and around Narrabri is developed for residential purposes, the Proponent would firstly encourage and promote the employment of people already residing in the area. In order to assist the local Councils in the planning of development within the respective shires, the Proponent would inform them of the predicted increase in population based on employment at the project.

Economic Development

Contributions from the Proponent which contribute to the economic and social development of the whole community, not just those associated with the project, was identified as important by key local stakeholders.

Apart from direct and indirect employment of local persons, a number of opportunities have also been identified with respect to the potential for the Proponent to contribute to the local community to minimise any potential social impacts that may arise as a result of the project. Additionally, the Proponent intends to be an active member of the local community as they have been in Gunnedah and Boggabri. A number of opportunities for community contribution have been identified and are listed as follows.

- Partnering with Narrabri TAFE to ensure courses are offered that are appropriate for the needs of the project.
- Possible contribution to the TAFE Business Incubator (high-tech manufacturing/engineering related) and / or the TAFE Innovation Centre (encouraging inventors and manufacturing from around Australia).
- Partnering with Narrabri Council in order to promote business in the region, particularly to businesses that may supply or service the project.
- Contribution to community facilities in Narrabri, Gunnedah, Boggabri and / or Baan Baa.

While a number of opportunities have been identified, the exact nature of any contributions would need to be determined in conjunction with Council, TAFE and other community groups as applicable. As such, the Proponent has committed to investigating the potential for implementation of the identified opportunities on commencement of the project.

Infrastructure and Services

With an increase in employment levels and subsequent population growth, a key issue for consideration is the available capacity of local infrastructure, services and facilities to accommodate the population increases.

As identified in Section 4B.10.3.2.1, Narrabri has an established infrastructure and service level which would be able to cater for any population increase. Key stakeholders consulted by Key Insights as part of the qualitative research of Key Insights (2007) indicated that Narrabri has sufficient capacity in the areas of education, health and other more general services such as water, electricity and sewerage to manage the population growth associated with the project. The small centres of Baan Baa and Boggabri have less established infrastructure and services, eg. Baan Baa lacks a town water supply. Therefore, as identified in the discussion of management measures for local economic development, the Proponent would investigate contributing to community facilities and infrastructure in these smaller centres should significant population increases associated with the project impact on the local infrastructure and/or service provision.

Notably, the Proponent has a strong history of contributing to local infrastructure and facilities as part of similar and associated developments.

Agricultural Lands

An additional issue that has been raised is the reduction of agricultural land through construction of the proposed Pit Top Area.

The Proponent has minimised this potential impact through confining the Pit Top Area facilities to the smallest possible area to minimise the area of agricultural land that would be sterilised for the life of the project. The siting of the evaporation / storage ponds within the rail loop makes greatest use of the land disturbed by the project.

4B.10.4.2 Economic

Apart from the potential contributions to the surrounding local communities, which may be either financial or in-kind contributions, the Proponent would be contributing significantly to the local economy through wages and payment for services. The Proponent would a policy that encourages employment of local district personnel, with arrangements for training and certification put in place to ensure suitable applicants can acquire the necessary skills.

4B.10.5 Impact Assessment

4B.10.5.1 Local Capacity

In light of the range of available services in Narrabri and Gunnedah, and particularly the courses and expertise offered by the local TAFE colleges, combined with the positive attitude of the local Councils, Key Insights (2007) suggest that the region currently has, or would quickly develop, capacity in the three key areas of education/training, housing capacity and economic development and economic development to meet the demands of a growing population of mine workers and related trades, even with the cumulative demand with other mines in the region.

With particular focus on the increased demand for 'soft' infrastructure such as health care and schooling, the following assessment has been made.

- The estimated additional 11 primary and 9 high school age children represents an increase of less than 2.5% to potential school enrolments.
- The addition of another 125 people would only marginally alter the person to GP ratio of 1:1,393 to 1:1,405. While both of these ratios are higher than what the BDGP, increased economic activity and vibrancy in the area as a result of mining activity may help Narrabri attract more general practitioners, or explore alternative models such as nurse practitioners.
- The predicted population increase may contribute to the increased vitality of local clubs, sporting groups and volunteer organisations.

It is assessed that any increase in demand on 'soft' infrastructure such as schools and medical services would be relatively minor and manageable:

4B.10.5.2 Social

In addition to the direct and indirect employment opportunities that would arise from the project, employee-related population growth would also increase the numbers of local people available to work for service and sporting organisations and generally enhance the viability of local volunteer groups. The range of clubs, service organisations, facilities and government services available in Narrabri and Gunnedah Shires indicate a well serviced community with high levels of social capital that would be strengthened further by new workers coming to the area and hopefully by a higher retention rate of its young people.

The social assessment concluded that the project would result in the following positive social impacts.

- Reduction of social stress through provision of local jobs and enhanced economic well being.
- Training opportunities for local people, including young people and indigenous people, in a growth industry (mining).
- Contribution to the diversity of the economic base in Narrabri and Gunnedah Shires therefore enhancing the sustainability of rural communities within the Shire.
- Stimulus to local businesses, particularly in Narrabri, including motel and hotel trade, cafes and restaurants, mining-related engineering and surplus spending activity such as gyms, cinema, recreational goods and services, beauty salons, and hair dressers.
- Increased population to participate in locals clubs, sporting groups, cultural activities, and organisations, therefore contributing to stronger social networks and social capital.
- More volunteers for community service organisations.

With respect to potentially adverse social impacts resulting from the project, the following assessments are made.

- The noise assessment identified that the proposed increase in trains through Baan Baa would not raise noise above the applicable noise criteria (refer to Section 4B.9.5.2.4).
- The potential impacts on air quality, traffic, mine-related noise and visibility would all be managed to reduce impacts on surrounding landholders to an acceptable level as addressed in Sections 4B.7, 4B.8, 4B.9 and 4B.6 respectively.

Discussions with the NSW Farmers' Association during the social assessment identified that the issue of the loss of a relatively small parcel of agricultural land for the Pit Top Area was not seen as a significant impact.

4B.10.5.3 Economic

Approximately 65% of the capital costs to establish the project would be related to construction labour, power supply, on site facilities construction and materials. A significant portion of this capital would be spent locally where possible, with labour and materials sourced from the region where possible. The remaining 35% of the capital costs would be directed overseas for the purchase of mining and crushing / sizing equipment.

At the commencement of the project, it is anticipated that annual labour costs would be in the order of $14M, rising to approximately $17M during full-scale operation. A significant portion of this money would be retained locally through payment of local contractors and employees.

Additionally, consumables and the purchase of sundry materials would inject a significant amount of money into the local services and suppliers, as well as those based in the Hunter Valley and beyond.

Royalties would be payable to the NSW government on the coal product which would contribute to the State economy, as would port and rail fees.

4B.11 EUROPEAN HERITAGE

4B.11.1 Desktop Search of Heritage Listed Items

A desktop search of the Narrabri Local Government Area on the following heritage databases was conducted in February 2006.

- Narrabri Local Environmental Plan 1992 – Schedule 2
- Australian Heritage Database (which includes places listed in the World Heritage List, National Heritage List, Commonwealth Heritage list and Register of the National Estate)
- State Heritage Register
- State Heritage Inventory

No listed heritage sites were identified within the Project Site, nor within the vicinity of the Project Site, with the nearest identified sites being in Narrabri. The Register of National Estate identified a Pilliga Indigenous Place, however, this was not identified as being in the local area by the Aboriginal heritage assessment (refer to Section 4B.4). Additionally, no listed sites occur within Baan Baa.

4B.11.2 Management Measures

As no sites were identified, no management measures are required.

4B.11.3 Assessment of Impacts

As no sites were identified, there would be no impact on any items or places of European heritage significance.