COWAL GOLD MINE E42 MODIFICATION

SECTION 4 – ENVIRONMENTAL ASSESSMENT

JULY 2008
Project No. HAL-06-26
Document No. SECTION 4-K (00229214)

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4 ENVIRONMENTAL ASSESSMENT

4.1 METEOROLOGY

4.1.1 Existing Environment

The Cowal region is located on the boundaries of the south-eastern semi-arid and the south-eastern temperate regions of Australia (Austin and Nix, 1978).

The nearest meteorological stations operated on behalf of the Commonwealth Bureau of Meteorology (BOM), which have continuous temperature, humidity, rainfall and evaporation data are:

- Forbes (Camp Street - Station No. 065016);
- Forbes (Airport AWS – Station No. 065103);
- Quandialla Post Office (Station No. 073032); and
- Wyalong Post Office (Station No. 073054).

The location of these stations is shown on Figure 4-1 and details of each station are provided in Table 4-1.

Meteorological conditions (including the parameters in Table 4-2) are currently being monitored at the mine site in accordance with the *Cowal Gold Project Surface Water, Groundwater, Meteorological and Biological Monitoring Programme – Mine Operations* (SWGMBMP) (Barrick, 2005a). The location of the on-site meteorological station is shown on Figure 4-1. Meteorological data collected from the stations outlined in Table 4-1 are summarised in Table 4-3 and discussed below.

Table 4-2
Meteorological Parameters

Parameter	Units
Rainfall	mm
Temperature	degrees Celsius (°C)
Relative Humidity	%
Wind Direction	degrees
Wind Velocity	kilometres per hour (km/h)
Barometric Pressure	hectopascals (hPa)
Solar Radiation	watts per square metre (W/m^2)

Source: Barrick, 2005a

A summary of meteorological data collected from the various regional stations is presented below.

Temperature

Table 4-3 indicates that regional temperatures are warmest from November to March and coolest from May to August/September. Average daily maximum temperature records indicate that January is typically the hottest month and July the coldest (Table 4-3).

Wind Speed and Direction

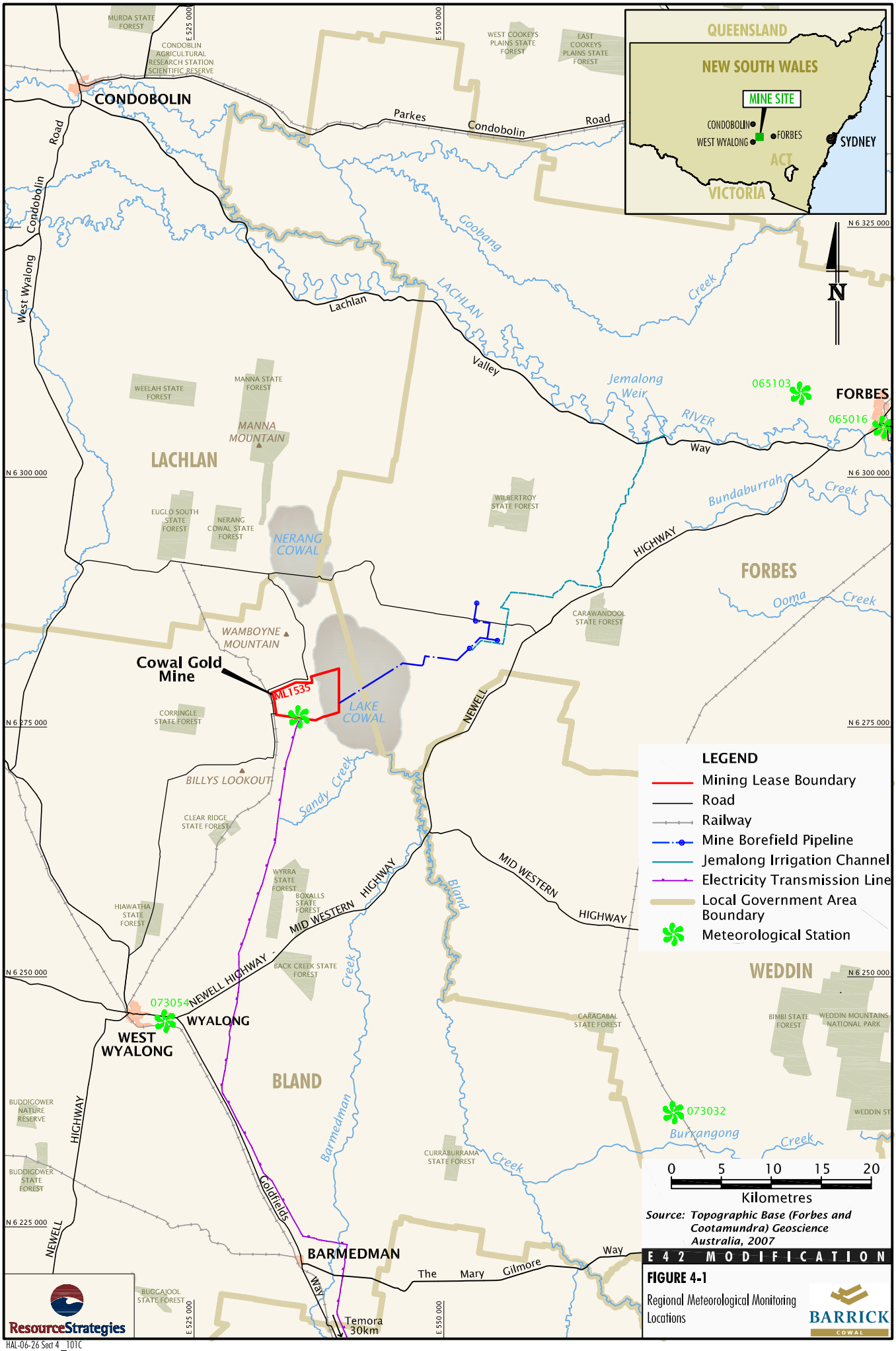
Representative windroses for the CGM were generated using data from the CGM meteorological station (Appendix G). Annual and seasonal windroses for the CGM are illustrated on Figure 4-2.

The windroses indicate that, over the year, the area experiences winds from all directions but most commonly from the south-west. In summer and spring, the south-westerly winds prevail, while in autumn and winter, the most common winds are from the south-southeast.

Table 4-1
BOM Station Locations and Recording Periods

BOM Station	Station Number	Approximate Location Relative to CGM	Period of Record
Forbes (Camp Street)	065016	55 km north-east	1873 - 1999
Forbes (Airport AWS)	065103	55 km north-east	1995 - Present
Quandialla Post Office	073032	55 km south-east	1925 – Present
Wyalong Post Office	073054	38 km south-west	1895 - Present

Source: BOM (2008a, 2008b, 2008c, 2008d)

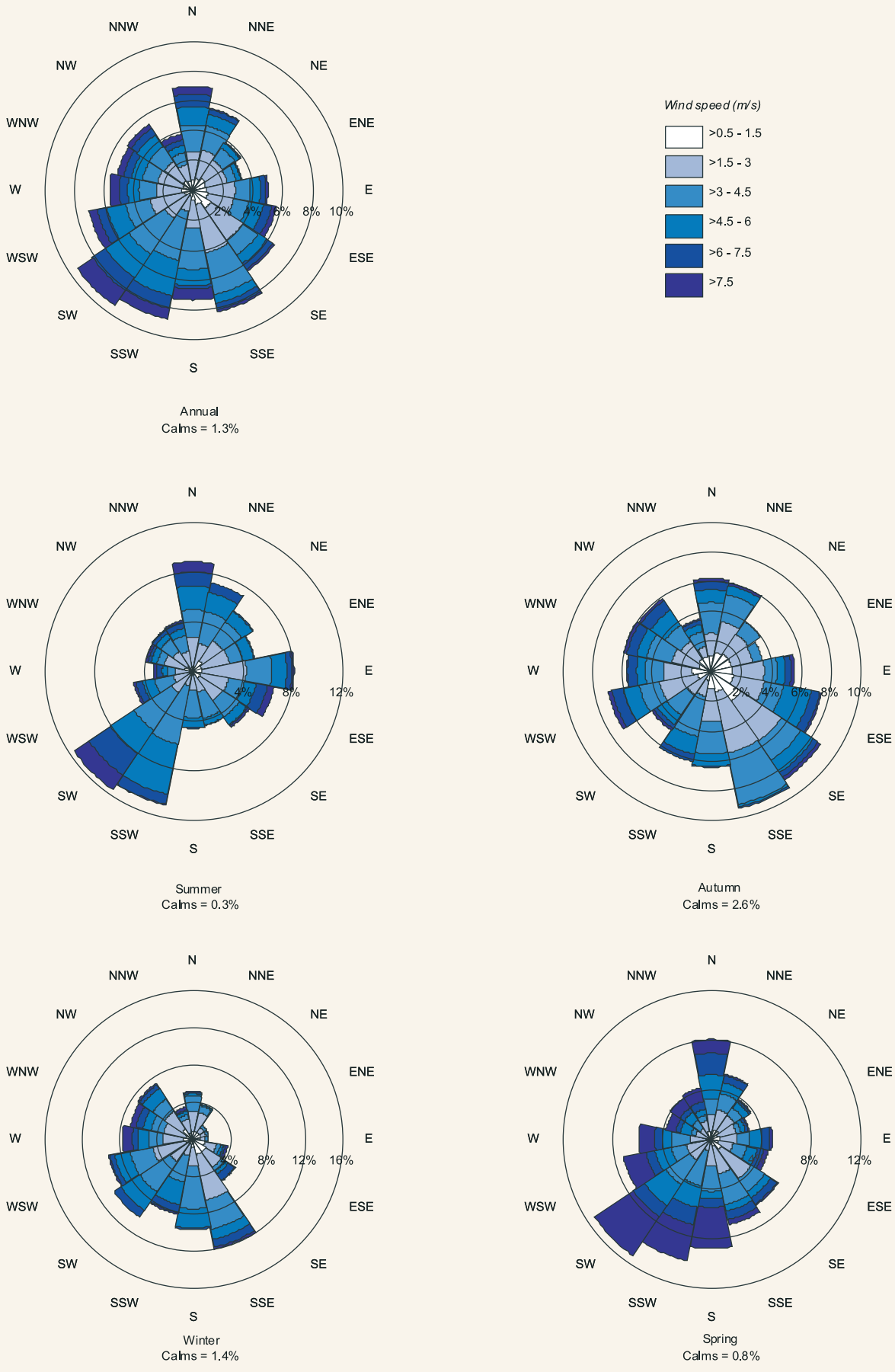


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Table 4-3
Historical Meteorological Data Summary

Month	Relative Humidity Monthly Historical Average (%)								Historical Average Daily Temperature (˚C)								Historical Average Rainfall (mm)			
	Wyalong Post Office		Quandialla Post Office		Forbes (Camp Street)		Forbes Airport		Wyalong Post Office		Quandialla Post Office		Forbes (Camp Street)		Forbes Airport		Wyalong Post Office	Quandialla Post Office	Forbes (Camp Street)	Forbes Airport
	9 am	3 pm	9 am	3 pm	9 am	3 pm	9 am	3 pm	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.				
January	55	33	57	31	54	35	48	26	17.4	32.6	17.1	32.9	17.4	32.7	18.1	34.2	42.6	49.6	49.9	23.7
February	61	36	63	33	58	38	54	30	17.4	31.9	16.9	32.1	17.1	32.1	17.5	32.9	37.3	42.1	43.8	42.3
March	63	37	66	35	62	41	58	31	14.5	28.8	13.8	29.0	14.2	29.1	14.1	29.6	36.0	43.3	42.7	29.3
April	67	43	68	40	68	46	59	34	10.0	23.6	9.6	24.1	9.8	24.0	9.1	24.7	35.7	42.0	40.3	17.9
May	79	52	80	53	78	55	77	47	6.8	18.6	6.4	19.1	6.1	19.0	5.5	19.5	39.3	43.7	44.5	31.0
June	87	62	86	64	83	64	89	60	4.0	14.9	3.9	15.1	4.1	15.1	3.3	15.4	42.5	40.3	43.4	46.9
July	88	62	86	62	82	63	91	59	3.0	14.0	2.8	14.3	2.7	14.2	2.5	14.5	41.9	44.1	42.4	39.5
August	79	53	81	57	77	57	81	51	3.9	15.9	3.6	16.2	3.9	16.3	2.8	16.6	39.4	42.9	42.7	40.6
September	70	48	73	52	69	48	70	46	6.1	19.4	5.5	19.4	6.2	19.8	5.7	20.4	36.9	40.5	42.3	47.3
October	59	40	65	41	61	43	55	36	9.3	23.3	8.7	23.6	9.5	24.2	8.6	24.3	46.0	51.0	48.9	39.2
November	58	36	62	37	54	36	51	29	12.3	27.0	11.8	27.4	12.8	28.2	12.5	28.6	36.2	41.2	40.3	40.4
December	55	35	58	33	52	35	45	24	15.3	30.6	14.9	31.4	15.6	31.2	15.2	31.8	42.7	42.8	45.2	40.3
Annual Average	**68**	**45**	**70**	**45**	**67**	**47**	**65**	**39**	**10.0**	**23.4**	**9.6**	**23.7**	**10.0**	**23.8**	**9.6**	**24.4**	-	-	-	-
Annual Average Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**476.4**	**523.7**	**526.5**	**435.7**

Source: BOM (2008a, 2008b, 2008c, 2008d). Current as at 3 July 2008.



Source: Holmes Air Sciences, 2008

E 4 2 M O D I F I C A T I O N

FIGURE 4-2

Annual and Seasonal Wind Roses for the CGM - September 2006 to September 2007

ResourceStrategies

BARRICK COWAL

Rainfall

Average monthly rainfall data recorded at stations in the region indicate moderate seasonality, with higher average monthly rainfall totals being recorded in the winter months (Table 4-3).

Since the mine operations commenced, the region has experienced consistently lower than average rainfall (Appendix A).

Relative Humidity

Relative humidity records for each of the regional stations indicate higher humidity in winter and lower humidity in summer (Table 4-3).

Evaporation

The annual average pan evaporation at the CGM is estimated to be approximately 1,740 mm (Appendix A).

4.1.2 Meteorological Monitoring

The on-site meteorological monitoring station would continue to monitor the parameters presented in Table 4-2. Data from the on-site meteorological monitoring station would continue to be used for predicting potential noise, dust and blasting impacts on nearby residences and bird breeding areas.

4.2 LAND RESOURCES

4.2.1 Existing Environment

Topography and Landuse

The land proposed for the E42 Modification is characterised by flat to gently undulating topography with scattered remnant vegetation. It is located on the central western plains of NSW towards the western edge of the exposed rocks of the Lachlan Fold Belt geological formation and is on the western edge of the ephemeral Lake Cowal. Landforms found on and near ML 1535 are mainly ephemeral lacustrine (e.g. Lake Cowal), extensive gilgai areas, stagnant alluvial plains with ephemeral drainage lines and low hills (e.g. Cowal West Hill) (Appendix D).

Local elevations in areas surrounding the CGM range from approximately RL 201.5 m AHD in Lake Cowal (bed level), to approximately RL 368 m AHD at Billys Lookout (approximately 7 km south-west of ML 1535) and Wamboyne Mountain rising to RL 412 m AHD (approximately 5 km north of ML 1535) (Figure 4-1). A north-south oriented ridgeline system runs approximately 3.5 km west of Wamboyne Mountain and approximately parallel to the edge of Lake Cowal 8 km to the west. The ridgeline reaches a maximum elevation of RL 368 m AHD at Billys Lookout. As described in the EIS, the gentle eastern slopes of this ridgeline drain east into Lake Cowal.

Prior to the development of the approved CGM, elevations on the mine site ranged from about RL 205 m AHD to RL 223 m AHD (Cowal West Hill), with a slope of around 1% falling to the east. ML 1535 is now a developed mine site, dominated by mining infrastructure, tailings storage facilities, waste emplacements, open pit area, water storages, soil stockpiles and various bunds including the lake protection bund (Figure 1-3).

Lake Cowal

Lake Cowal is listed on the Register of the National Estate (DEWHA, 2008a), due to its importance as a waterbird concentration area. The attributes and function of Lake Cowal are described in detail in the EIS.

Landuse

The landuse within ML 1535 is mining. Lands surrounding ML 1535 are predominantly used for agriculture.

Geology

Relevant geology is discussed in Section 2.1.

Soils

King (1998) has mapped five soil landscapes which cover ML 1535, namely the:

- Reefton Erosional Soil Landscape (Cowal West Hill);
- Marsden Gilgai Soil Landscape (gilgai areas);
- Wah Way Alluvial Soil Landscape (Colluvial Plains);
- Transferral Boxalls Soil Landscape; and
- Alluvial Boxalls Soil Landscape.

In accordance with the NSW Department of Land and Water Conservation (DLWC) (1994), ML1535 is characterised by the Euglo Stagnant Alluvial Soil Landscape (King, 1998). The dominant soils of the Euglo Soil Landscape are red earths and red podzolic soils. The red earth A1 horizon is a dark reddish brown sandy clay loam about 10 centimetres (cm) deep (pH 5.5) above a weakly differentiated similar A2 horizon about 15 cm deep with a weakly pedal B2 horizon of dark reddish brown sandy clay loam more than 60 cm deep (pH 7.5). The red podzolic soil has a similar sandy loam topsoil (pH 6.0) to the red earth, but with a reddish brown medium clay moderately pedal subsoil (pH 5.5) extending beyond 80 cm deep (King, 1998). In addition to the red earth and red podzolic soil types, soil types associated with Cowal West Hill, gilgais and Lake Cowal also occur.

The topsoils on Cowal West Hill are reported to be a very shallow (<10 cm) dark reddish brown, gravelly sandy loam, often over bedrock. Where developed, the subsoils are a reddish brown, gravelly sandy clay loam. The soils are very strongly acidic and of very low fertility (DLWC, 1994).

The gilgai soils include red, brown and grey clays (King, 1998). The DLWC (1994) describe the gilgai soils as follows:

> *The surface soil is typically 5-10 cm deep, moderately to strongly structured and has medium clay texture. Colour varies from greyish olive to dark reddish brown. There is a clear to gradual change to the underlying strongly pedal, medium to heavy clay textured subsoil. The colour of the upper subsoil is typically greyish olive (grey clays), brown (brown clays) or dark reddish brown (red clays). These clays extend to at least 2 metres depth.*
>
> *Surface soils are moderately acid to moderately alkaline (pHw 5.8-8.3). Subsoils shallower than about 1 metre depth are neutral to very strongly alkaline (pHw 6.9-9.3). Below about 1 metre the soil varies from extremely acid to very strongly alkaline (pHw 4.4-9.6).*

Field textures on Lake Cowal are commonly medium clays, silty light clays and silty clay loams (DLWC, 1994).

The pH varies widely within layers of otherwise similar material. Sediments are usually neutral to slightly alkaline (pH 1 soil: 5 water [pH_w] 6.7 to 7.8), but moderately to strongly alkaline sediments (pH_w 7.9 to 9.0) also occur (DLWC, 1994).

Agricultural Suitability and Land Capability

The agricultural suitability and rural land capability of the land within ML 1535 prior to the approved CGM are discussed in detail in the EIS. The EIS recognised that changes would occur to the existing agricultural suitability and rural land capability classes of land disturbed by mining activities of the approved CGM, *viz*. the *rehabilitation objective for land disturbed by mining within the proposed MLA involves a change in landuse from agricultural production to native ecosystem*.

Land Contamination

A disused historic sheep dip has been identified in the southern waste emplacement footprint area.

In response (as described in Section 3.2.3), the area of contamination has been further investigated in accordance with the *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (DUAP, 1998a). Preliminary investigations by Barrick included a site inspection, past use investigation and soil sampling. The results indicate that the disused sheep dip was used between the 1950s and the 1980s, and that arsenic concentrations exceed the *National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999* (National Environment Protection Council, 1999) limits at some locations.

Existing Management Measures

The approved CGM implements the following environmental management plans and other documents (prepared in accordance with the Development Consent Conditions) relevant to the management of land resources at the approved CGM:

- ESCMP;
- BMP;
- LMP;
- ERP; and
- HWCMP.

In accordance with the ESCMP, the following erosion and sediment control measures are implemented at the approved CGM (Barrick, 2003b):

- Scheduling of progressive soil stripping to reduce potential erosion and sediment generation and minimise the extent of topsoil stockpiles and the period of soil storage.

- Avoidance of soil stripping operations during particularly wet or dry periods, minimising compaction during soil excavation and movement and the use of ameliorants where required (e.g. gypsum application to dispersive soils).
- Soil stockpile management, including soil handling measures that optimise the retention of soil characteristics (in terms of nutrients and micro-organisms) favourable to plant growth.
- Maintenance of soil stockpile slopes at or below maximum acceptable angles to resist erosion.
- Use of silt fences and temporary sediment traps to minimise sediment movement.
- Use of diversion banks, channels and rip-rap structures to divert surface water around disturbed areas and control runoff velocity.
- Saline and dispersive soil horizons left *in-situ* beneath mine landforms, where possible.

Bushfire management measures and hazard reduction strategies implemented at the approved CGM are described in the BMP and include the following (Barrick, 2003c):

- procedures for the detection, reconnaissance and reporting of fires;
- details of fire fighting activities;
- provision of adequate fire breaks/protection works and fire fighting equipment on-site (including one emergency fire fighting unit); and
- provision of appropriate staff training (relating to bushfires).

Pest and weed management measures are detailed in the LMP and include (Barrick, 2003d):

- identification of weeds by annual site inspections;
- communication with other landholders/leaseholders and regulatory authorities to keep weed management practices in line with regional weed control activities;
- mechanical removal of identified noxious weeds and/or the application of approved herbicides in authorised areas (herbicide use in wetland areas will be strictly controlled);
- implementing follow-up site inspections to determine the effectiveness of the weed control measures;
- where practicable, prevention of the establishment of new weeds on Barrick-owned land by minimising seed transport of weed species through the use of a vehicle wash bay; and
- pest control activities.

The ERP includes a plan of action to recover any spilt materials at the approved CGM.

Spill response procedures are also described in the HWCMP. The HWCMP includes detail on the following (Barrick, 2003e):

- spill notification;
- spill classification;
- spill response procedures;
- clean-up materials and equipment; and
- notification of emergency services and/or regulatory authorities.

In accordance with the Development Consent, a summary of the effectiveness of the measures outlined in the ESCMP, BMP, LMP and HWCMP are required to be included in each AEMR. No significant impacts on land resources have been reported by Barrick and the implementation of control strategies were considered to have minimised impacts on land resources in each of the reporting periods (Barrick, 2005b; 2006a; 2007a; 2008a).

4.2.2 Potential Impacts

The E42 Modification has the potential to alter:

- topography and landscape features;
- soils and erosion potential;
- soil properties due to contamination through the leakage from water pipelines carrying saline water and other potential contamination sources; and
- the level of bushfire hazard.

These potential impacts are described in the following subsections. Measures to mitigate these potential impacts are provided in Section 4.2.3.

Topography and Landscape Features

The main modifications to the existing topography that would result from the E42 Modification comprise:

- increasing the height and surface areas of waste emplacements;
- increasing the height of tailings storage facilities;
- increasing the size of the final void that would remain following cessation of mining; and
- other minor landform alterations associated with construction of internal access roads and erosion and sediment control measures.

Potential visual impacts associated with changes in topography are identified in the Visual Assessment, which is presented in Appendix I and summarised in Section 4.3. The potential visual impact (including that associated with the abovementioned modifications) was assessed by evaluating the level of visual modification of the development in the context of the visual sensitivity of relevant surrounding landuse areas (i.e. those areas from which the proposed development may be visible), following techniques employed by EDAW Australia (EDAW) (2006).

The results of the Visual Assessment indicate a low potential visual impact at rural residences in the vicinity of the modified CGM (with the closest residence to the ML being approximately 2.5 km south-west) and a moderate to low potential visual impact from roads directly adjacent to the ML (i.e. approximately 200 to 300 m from the ML) (Appendix I).

Soils and Erosion Potential

The potential soil and erosion-related impacts identified in the EIS that would be relevant to the modifiefd CGM include:

- loss of *in-situ* soil resources from beneath mine landforms (i.e. material not stripped);
- alteration of physical and chemical soil properties during stripping and stockpiling operations;
- reduced soil quality (structure, fertility and microbial activity) of long-term stockpiles;
- contamination of soil with saline water, process reagents and chemicals;
- erosion of soil from the outer batters of waste emplacements and tailings storage facilities, the verges of access and haul roads and areas in which vegetation has been cleared or where water is concentrated;
- instability of earthen containment structures due to inherent dispersive characteristics of CGM area soils;
- erosion of stockpiled soil;
- soil erosion and sediment movement during construction of the saline groundwater supply borefield pipeline to the process water dam; and
- increased erosion rates due to the exposure of dispersive soils.

Land Contamination – Past Landuse

There is potential that minor areas of soil contamination could occur if the contaminated area identified as a disused sheep dip is stripped during soil stripping and reapplied during rehabilitation.

Land Contamination – Other

Section 4.15 summarises the results of the hazard and risk assessments conducted for both the approved CGM and the modified CGM, and identifies sources of potential risk to the environment. The primary potential land contamination risks have been identified as fires (resulting in the release of hazardous materials), spills associated with the transport, storage and usage of hazardous materials, and from rupture or leakages from the saline groundwater supply borefield pipeline.

Leakage of saline water (prior to automatic shut-down) into a dry Lake Cowal would increase the salinity of the soil in the local area surrounding the pipeline rupture in the unlikely event this occurs. This localised increase in soil salinity would be minimal (given the leak detection and automatic shut-down mechanisms inherent in the design of the system) and would be cleaned up quickly by the removal of affected material for disposal within the waste emplacement(s).

When Lake Cowal contains sufficient water to inundate the borefield, its operation would cease, thereby removing the potential for saline water leakage.

Bushfire Hazard

Bushfire hazard within ML 1535 is generally considered to be low due to the extensive areas of cleared grazing land and low fuel loads that occur (Barrick, 2003c). The degree of potential impact would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel (e.g. grasses and native vegetation).

4.2.3 Mitigation Measures and Management

As described in Section 4.2.1, potential impacts to land resources are currently managed via implementation of measures included in the following:

- ESCMP;
- BMP;
- LMP;
- ERP; and
- HWCMP.

These measures would continue to be implemented where relevant and management plans would be updated as described below. Additional measures that would be implemented for the modified CGM are also described.

Potential Topography and Landscape Impacts

Integration of constructed landforms with the surrounding landscape via progressive rehabilitation is discussed in the Rehabilitation and Landscape Management Strategy provided in Section 5. Section 4.3 discusses additional measures for mitigating potential impacts on visual character.

Soils and Erosion Potential

The mitigation measures and management for erosion and sediment for the approved CGM are presented in the ESCMP (2003b). The SWMP (2003f) would be revised to incorporate the relevant mitigation and management measures from the ESCMP required for the modified CGM (Section 4.5.3). Management measures would include the construction of erosion and sediment controls (e.g. sediment basins and silt fences) and the continued implementation of the ICDS.

The SWMP would also be revised to incorporate the relevant soil stripping management measures from the SSMP for the modified CGM.

Land Contamination – Past Landuse

Subject to further investigations, Barrick's preferred management option for the disused sheep dip area is to construct the southern waste emplacement on the area. That is, the contaminated soil would be left *in-situ* and buried beneath approximately 50 m of waste rock and the base drainage control zone (Section 2.4.3) of the southern waste emplacement.

As described in Section 2.4.3, the base drainage control zone is a low permeability basement layer constructed with compacted oxide material which slopes towards the open pit. Any waters permeating through the emplacement are expected to be intercepted by the base drainage control zone (Section 2.4.3) and preferentially flow towards the open pit (North Limited, 1998), thereby minimising seepage to the contaminated area. Alternatively, subject to further investigation, contaminated material may be removed and disposed in the tailings storage facilities.

Land Contamination – Saline Groundwater Supply Borefield Pipeline

The SWMP would be revised to include changes to water management required for the modified CGM, including mitigation measures for the saline groundwater supply borefield, *viz*.:

- installation of a containment drain for the saline groundwater supply borefield pipeline; and
- leak detection mechanisms including automatic shutdown capability.

In the unlikely event of pipeline failure and leakage of saline water, the spill would be controlled, contained and cleaned-up in accordance with the spill response procedures described in the HWCMP.

Land Contamination – Other

Measures used to prevent or reduce the potential for contamination of land from diesel and hazardous materials would include the following:

- Implementation of management measures to reduce risks related to transport scenarios, as discussed in Section 4.15.1.
- Maintenance of the register of hazardous substances and dangerous goods used on-site in accordance with the HWCMP. The register includes auditing and review procedures, safety and hazard management procedures for potential incidents, personnel training procedures and contingency, clean-up and disposal procedures.
- Bunded storage areas and storage of substances in accordance with the Material Safety Data Sheets (as described in the HWCMP and the CMP).

Bushfire Hazard

In addition to environmental responsibilities, significant economic incentives exist to prevent fire damage to the considerable investment in mining infrastructure and equipment at the CGM. The ERP details responsibilities in the event of emergencies in and around the CGM area, and describes bushfire emergency response and evacuation procedures.

Bushfire management measures are detailed in the BMP, which provides for the following (Barrick, 2003c):

- fuel management and hazard reduction strategies;
- procedures for the detection, reconnaissance and reporting of fires;
- details of fire fighting activities;
- provision of adequate fire breaks/protection works and fire fighting equipment on-site (including one emergency fire fighting unit); and
- provision of appropriate staff training (relating to bushfires).

The above measures would continue for the modified CGM.

4.3 VISUAL CHARACTER

Potential visual impacts that are expected to arise as a result of the E42 Modification have been assessed and are presented in Appendix I. The methodology employed by the Visual Assessment is based on the visual management system developed by the United States Department of Agriculture – Forestry Service (USDA-FS) (1974). The potential visual impact was assessed by evaluating the level of visual modification of the development in the context of the visual sensitivity of relevant surrounding landuse areas (i.e. those areas from which the proposed development may be visible), following the techniques employed by EDAW (2006).

The level of visual modification of a proposed development can be measured as an expression of the visual interaction, or the level of visual contrast between the development and the existing visual environment. Throughout the visual catchment (or zone of visual influence) the level of visual modification generally decreases as the distance from the development to various viewpoint locations increases (EDAW, 2006).

Visual (viewer) sensitivity is a measure of how critically a change to the existing landscape is viewed from various use areas, and is a function of both landuse and duration of exposure (i.e. individuals generally view changes to the visual setting of their residence more critically than changes to the visual setting of the broader setting in which they travel or work) (EDAW, 2006).

The visual sensitivity of the development depends on a range of viewer characteristics. The major components of the E42 Modification would be contained within ML 1535. The primary characteristics used in the Visual Assessment are landuse, the distance to the ML and modified CGM landforms from viewers and its visibility from critical viewpoints (Appendix I).

For the purposes of the Visual Assessment, landuse areas in the vicinity of the ML were characterised in terms of low, moderate or high visual sensitivity, as follows (Appendix I):

- Low visual sensitivity – local roads (e.g. Lake Cowal Road).
- Moderate visual sensitivity – major roads (e.g. Newell Highway).
- High visual sensitivity – rural residences and natural/recreation areas.

The extent to which the viewer has become accustomed to the approved CGM, which is an existing modification to the landscape, was also considered (Appendix I).

4.3.1 Existing Environment

ML 1535 has been heavily modified over time with the majority of vegetation disturbed as a result of both historic agricultural clearing and the approved CGM.

The area surrounding the ML is comprised of a number of distinct landuse types and landscape units of varying levels of landscape quality. These have been defined as follows (Appendix I):

- Agricultural Areas – the ML is predominantly surrounded by heavily cleared dryland agriculture areas with opportunistic irrigation farming in the Jemalong/Wyldes Plains Irrigation Districts adjoining the north-east edge of Lake Cowal. These areas include Lake Cowal, approximately 8 km wide by 13 km long, located immediately to the east of the ML. Lake Cowal is ephemeral, generally flat and shallow.

- Residential Dwellings - detached dwellings to the north, east, west and south-west of the ML.
- Game Reserve – located approximately 3 km south-east of the ML.
- Billys Lookout and Associated Ridgeline System – ridgeline which runs generally north/south approximately 5 km to the west of the ML. The ridgeline system reaches a maximum elevation of RL 368 m AHD at Billys Lookout located approximately 7 km south-west of the ML.
- Wamboyne Mountain – approximately RL 412 m AHD. Wamboyne Mountain is a major tree-covered landform of regional significance located about 5 km north of the ML and visible from surrounding areas.

These landuse types and landscape units are described below in the context of regional, sub-regional and local settings. The visual settings (e.g. local, sub-regional and regional) are based on distance from the ML as follows (Appendix I):

- Regional Setting – greater than 5 km from the ML;
- Sub-regional Setting – 1 to 5 km from the ML; and
- Local Setting – up to 1 km from the ML.

Regional Setting (>5 km)

The regional setting has attributes of moderate to high scenic quality due to the presence of a wooded north-south oriented ridgeline system running approximately 5 km west of the CGM. The contrast between the vegetation and topography of the ridgelines and adjacent agricultural areas adds to the visual interest. The ridgeline system has an average elevation level of approximately RL 205 m AHD, reaching a maximum elevation of RL 368 m AHD at Billys Lookout (located approximately 7 km south-west of the ML). The other major topographic feature in the regional setting is Wamboyne Mountain, located approximately 5 km north of the ML (RL 412 m AHD). The regional setting also has attributes of low scenic quality due to the generally flat, cleared dryland agricultural areas that dominate the landscape (Appendix I).

Sub-regional Setting (1 to 5 km)

Lake Cowal is listed on the Register of the National Estate, however no aspects relating to visual amenity are described (DEWHA, 2008a).

Most of the Lake Cowal area, including the Lake itself, has been cleared for grazing and/or cultivation which results in a low to moderate scenic quality, with remnant tree and shrub vegetation (e.g. lignum) occurring primarily on rocky elevated ground, areas of impeded drainage, patches of sandy soils, the shoreline of Lake Cowal and road verges (North Limited, 1998). Historically, Lake Cowal is substantially inundated seven years out of ten (North Limited, 1998), however there has been no substantial water in Lake Cowal since 1997 (Appendix I).

Local Setting (<1 km)

The local setting has been heavily modified over time with the majority of vegetation disturbed by historic agricultural clearing and the approved CGM, which includes a number of modifying elements including active tailings storage facilities and waste emplacements, process plant and infrastructure areas and a mine access road.

Cowal West Hill is a small tree-covered hill generally oriented north/south (approximately RL 223 m AHD), located west of the existing northern waste emplacement. A small tree-covered hill of low relief (approximately RL 260 m AHD) is also located immediately to the south of the ML. Due to their highly disturbed nature, these areas are considered to be of low scenic quality (Appendix I).

Other features of the local setting include the local road network (including Lake Cowal Road), the approved ETL and Burcher-West Wyalong rail line (Figure 1-2).

Sensitive Visual Settings

The main issues to consider in the assessment of potential visual impacts are (EDAW, 2006):

- the number of sensitive viewing locations; and
- the level to which the proposed works are visible - if they are not seen, then there is no impact.

Locations with potential views of the modified CGM landforms include those that already have views of the approved CGM. Potential views of the modified CGM landforms would be available from the following locations (Appendix I):

- rural residences to the north, east, west and south-west of the ML;
- Lake Cowal Road looking south, east and north towards the ML;
- Newell Highway located to the east of the ML;

- Billys Lookout looking north-east over the ML;
- Wamboyne Mountain looking south over the ML;
- Lake Cowal looking west towards the ML;
- Game Reserve looking north-west towards the ML; and
- Burcher-West Wyalong Railway looking east towards the ML.

The most sensitive visual settings in the vicinity of the modified CGM are rural residences. The views in the modified CGM area and surrounds vary according to intervening topography and vegetation between the residence and the mine. Residences with views of the mine at distances of 5 km or less have a moderate to high level of sensitivity (Appendix I).

Whilst it is acknowledged that Billys Lookout, the associated ridgeline system and Wamboyne Mountain overlook the ML, the potential views from these locations are considered to be negligible given the relatively low topography, wooded vegetation coverage and the fact these areas are not routinely accessed by or available to the public (Appendix I).

Limited views of the approved CGM are currently available from viewpoints along the Newell Highway, where roadside vegetation and topography permit (Appendix I).

The modified tailings storage facilities and waste emplacements would be visible from the Burcher West Wyalong railway and given its close proximity to the ML, the level of visual modification at this location is considered moderate (Appendix I).

The distance of the Game Reserve from the ML together with the nature of its use (i.e. recreational use including fishing) means the visual sensitivity of this location would be moderate (Appendix I).

Night-Lighting

Night-lighting is currently emitted from the following sources at the approved CGM (Appendix I):

- overhead lighting of the process plant area and administration area;
- fixed lights on top of waste emplacements; and
- mobile vehicle-mounted lights (e.g. work vehicles in various locations within the ML).

The glow produced by night-lighting at the approved CGM is visible at nearby residences and along transport routes, while direct views of mobile machinery lights and operational lighting are available from some exposed positions. The night-glow is similar to that associated with existing towns and villages in the region.

In accordance with the LSMP, the following measures have been implemented at the approved CGM to maintain visual amenity:

- trees and shrubs have been established in accordance with the requirements of the BSC for the maintenance of satisfactory visual amenity from outside the ML;
- the visual appearance of buildings, structures, facilities or works have been designed to blend as far as practicable with the surrounding landscape; and
- landscape maintenance works and building material/cladding maintenance.

4.3.2 Potential Impacts

The Visual Assessment has been conducted to identify areas where potential visual impacts are most likely to occur as a result of the modified CGM and to assist in the mitigation of those impacts from sensitive viewpoints. The assessment process has focussed on the potential visual impact that may result on views for the most sensitive visual settings/landuses where routinely accessed or readily accessible viewpoints exist. The assessment has been undertaken from within regional (>5 km), sub-regional (1 to 5 km) and local (<1 km) settings and is detailed in Appendix I.

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

A summary of the Visual Assessment locations analysed in the following subsections is provided in Table 4-5. Visual simulations from the viewing locations are shown on Figure 4-3.

Visual simulations (Figures 4-4 to 4-9) were prepared to show the existing views as well as simulations of the modified CGM landforms during Year 19 of operations, when the landforms would be at their maximum heights, representing the greatest potential for visual impact. A post-mining simulation was also developed to illustrate the conceptual landform following completion of mining and rehabilitation activities.

The post-mining simulations take into account the Rehabilitation and Landscape Management Strategy presented in Section 5.

Regional Settings

Rural Residences in the Regional Setting

The "Gumbelah" dwelling is located more than 5 km from the eastern boundary of the ML (Figure 4-3). The existing view shows that the elevated north-south trending ridgeline is visible on the horizon with the CGM in the background and Lake Cowal in the middle and foreground (Figure 4-4).

Table 4-4
Visual Impact Matrix

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

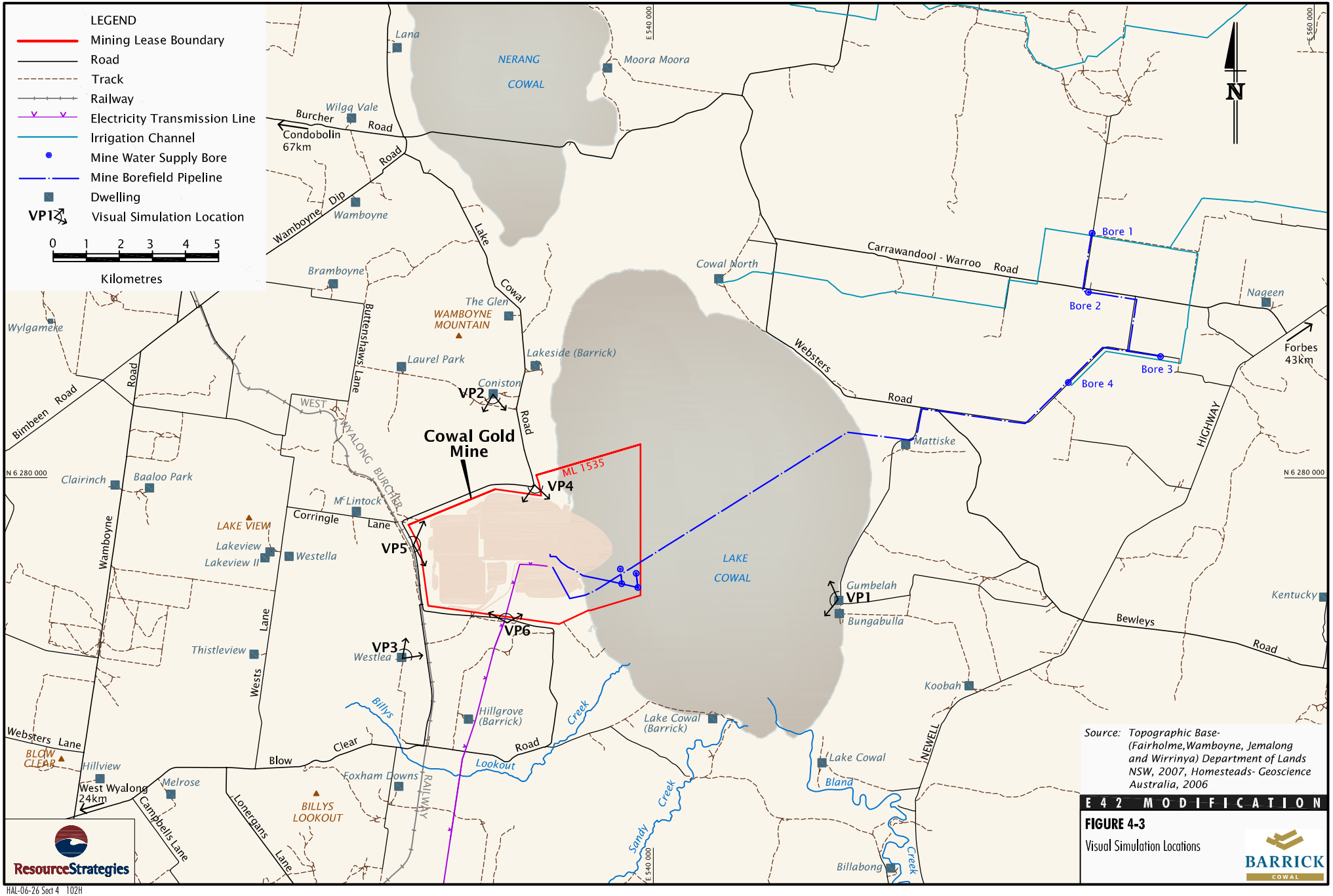
VL = Very Low
L = Low
M = Moderate
H = High

Source: EDAW (2006)

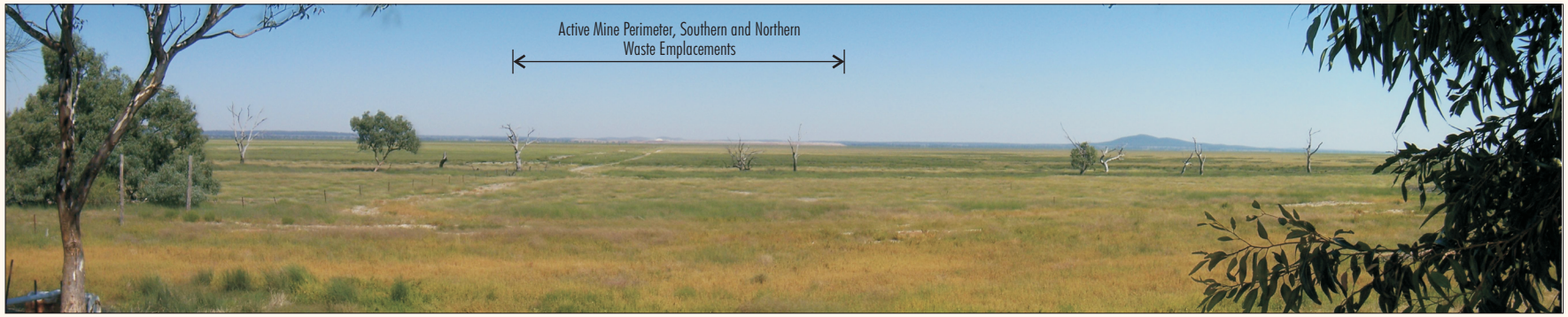
Table 4-5
Summary of Visual Assessment

Setting	Location	Sensitivity	Visual Modification Level	Impact	Impact After Amelioration
Regional Setting (Greater than 5 km from the CGM)	"Gumbelah" Dwelling (Visual Simulation Location 1)	L	L	L	L
Sub-Regional Setting (1 – 5 km from the CGM)	"Coniston" Dwelling (Visual Simulation Location 2)	M	M-L	M-L	L
	"Westlea" Dwelling (Visual Simulation Location 3)	M-H	L	M-L	L
Local Setting (Up to 1 km from the CGM)	Lake Cowal Road (Visual Simulation Location 4)	L	M-H	M	M-L
	Lake Cowal Road (Visual Simulation Location 5)	L	M-H	M	M-L
	Lake Cowal Road (Visual Simulation Location 6)	L	M-H	M	M-L

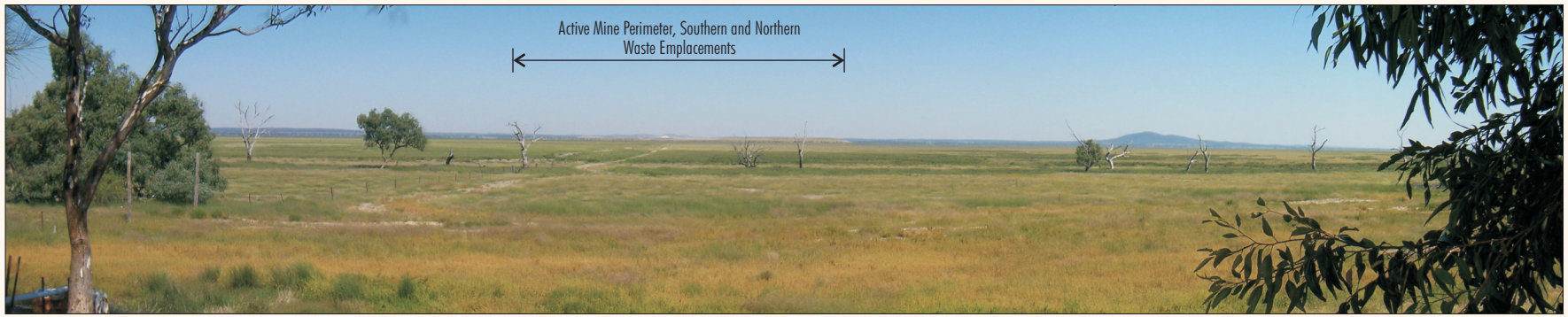
* Minimal visibility
H – High, M – Moderate, L – Low



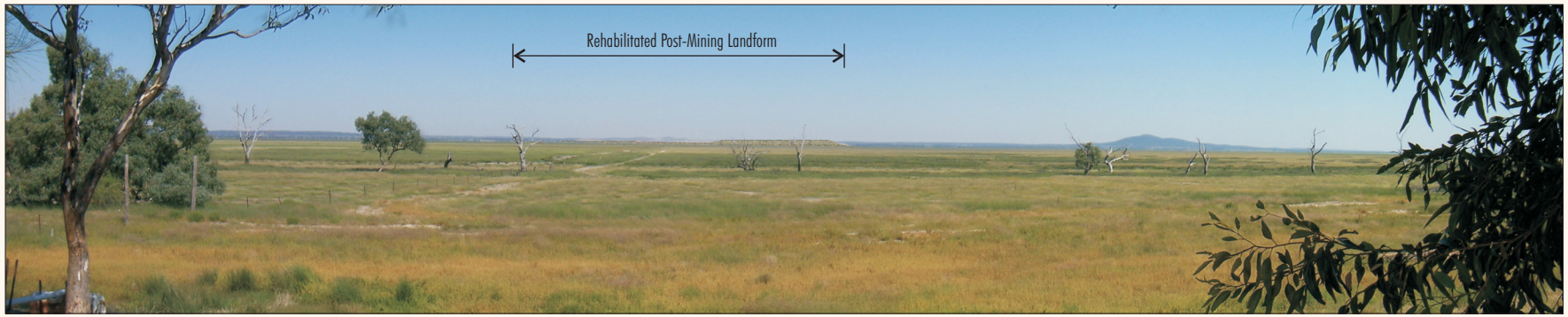
HAL-06-26 Sect 4 _102H



Existing View



Year 19 Simulation



Post-Mining Simulation

E 4 2 MODIFICATION

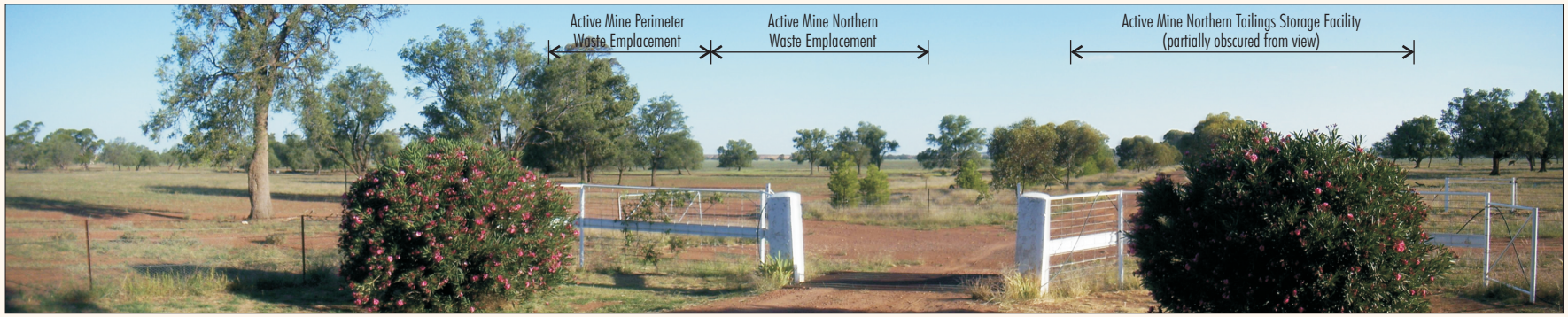
FIGURE 4-4

Existing View and
Visual Simulations -
"Gumbelah" Dwelling (1)

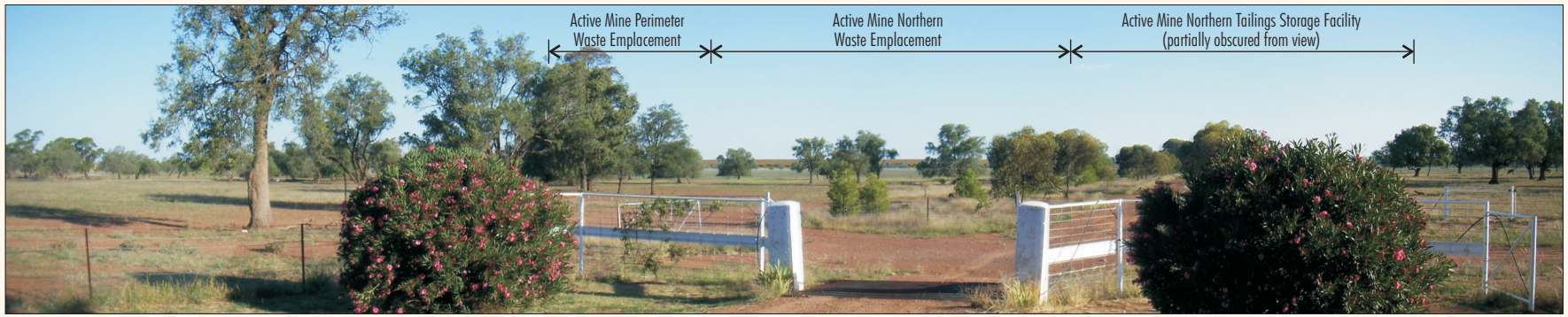
ResourceStrategies

BARRICK COWAL

HAL-06-26 Sect 4_002B



Existing View



Year 19 Simulation



Post-Mining Simulation

ResourceStrategies

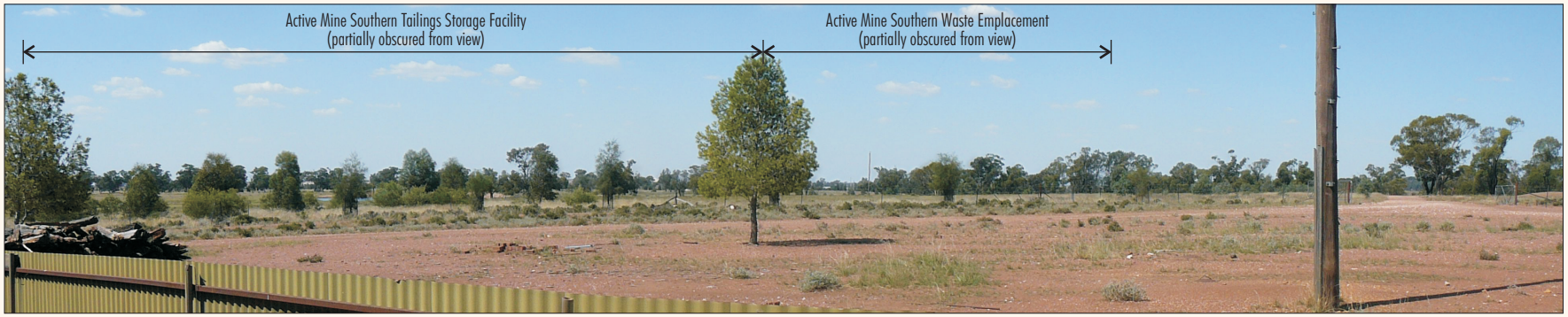
E 4 2 M O D I F I C A T I O N

FIGURE 4-5

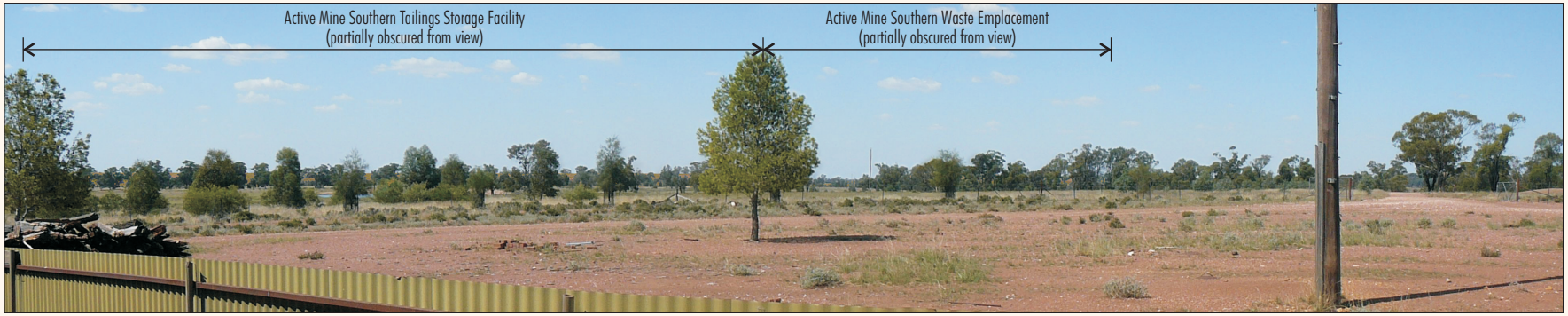
Existing View and Visual Simulations - "Coniston" Dwelling (2)

BARRICK COWAL

HAL-06-26 Sect 4_003B



Existing View



Year 19 Simulation



Post-Mining Simulation

E 4 2 M O D I F I C A T I O N

FIGURE 4-6
Existing View and
Visual Simulations -
"Westlea" Dwelling (3)

ResourceStrategies

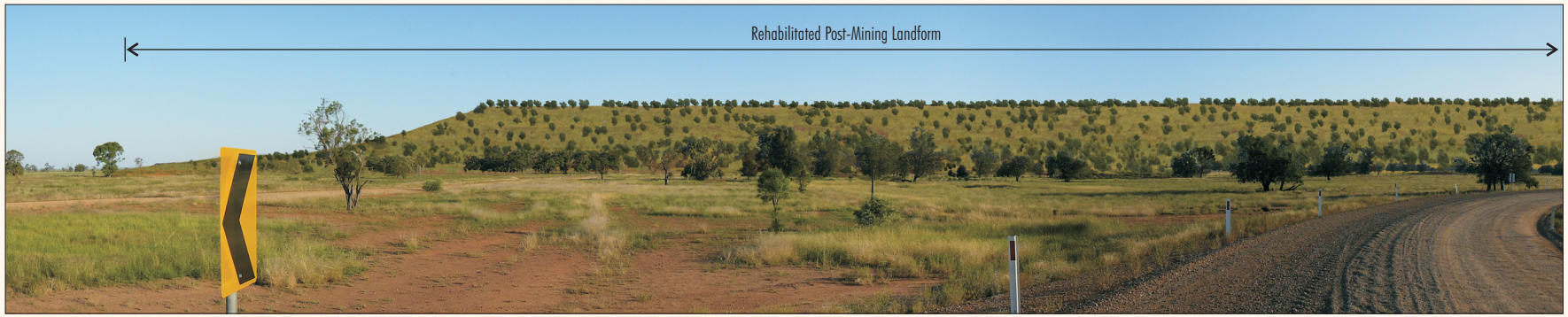
BARRICK COWAL



Existing View



Year 19 Simulation



Post-Mining Simulation

ResourceStrategies

E 4 2 M O D I F I C A T I O N

FIGURE 4-7
Existing View and
Visual Simulations -
Lake Cowal Road (4)

BARRICK COWAL

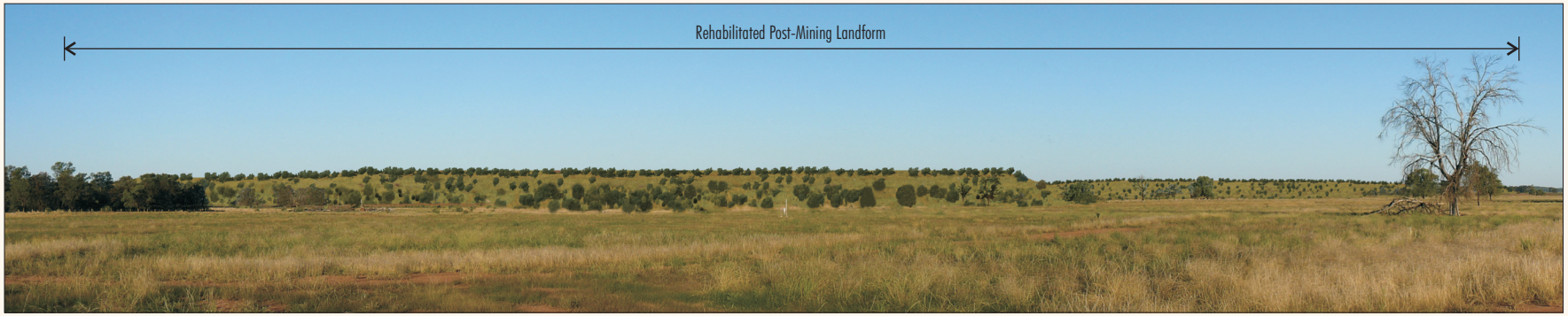
HAL-06-26 Sect 4_005B



Existing View



Year 19 Simulation



Post-Mining Simulation

ResourceStrategies

E 4 2 M O D I F I C A T I O N

FIGURE 4-8
Existing View and Visual Simulations - Lake Cowal Road (5)

BARRICK COWAL

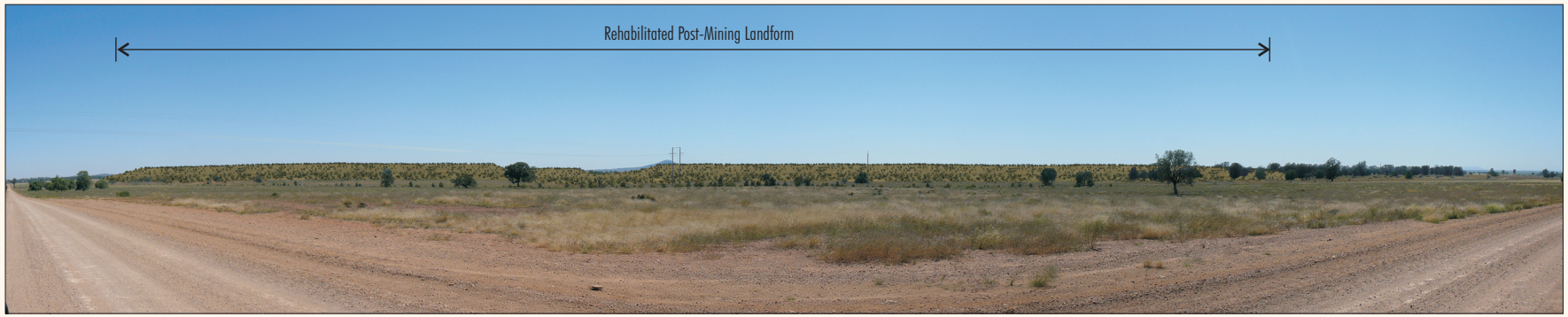
HAL-06-26 Sect 4_006C



Existing View



Year 19 Simulation



Post-Mining Simulation

E 4 2 M O D I F I C A T I O N

FIGURE 4-9
Existing View and
Visual Simulations -
Lake Cowal Road (6)

ResourceStrategies

BARRICK COWAL

The potential visual impact at the "Gumbelah" dwelling would occur during the latter years of the modified CGM, when the heights of the landforms increase beyond their currently-approved elevations. The simulation on Figure 4-4 shows that following progressive and final rehabilitation, the level of visual modification would be low. Further, the heights of the modified CGM landforms would remain below the vegetated ridgeline to the west.

Given the low level of modification coupled with the low visual sensitivity at the "Gumbelah" dwelling, a low level of visual impact is expected (Table 4-5). The level of visual impact would progressively reduce once vegetation cover begins to establish on the rehabilitated waste emplacements.

The same level of visual impact would be expected at the "Bungabulla" dwelling (Figure 4-3) located adjacent to the "Gumbelah" dwelling, given the proximity of these two dwellings.

Sub-Regional Settings

Rural Residences in the Sub-Regional Setting

The "Coniston" dwelling is located approximately 3 km north of the northern boundary of the ML (Figure 4-3). Views from this residence towards the ML are mostly obscured by intervening vegetation and comprise a small proportion of the overall viewscape (Figure 4-5).

The potential visual impact at the "Coniston" dwelling would occur during the latter years of the modified CGM, when the heights of the landforms increase beyond their currently approved elevations. The visual impact of the northern waste emplacement would also result from the contrasting colour and texture of the undisturbed natural areas and the newly placed and unvegetated material before a grass cover is established as part of the rehabilitation process. This impact would be confined to the upper batters of the new landform during progressive construction and rehabilitation. There is also likely to be some contrast between the colour of the newly established grass and the adjoining grassland areas. However, this contrast is likely to be of a short duration following completion of rehabilitation works.

Given the moderate to low level of modification coupled with the moderate visual sensitivity of the "Coniston" dwelling, there would be a moderate to low level of visual impact at this location (Table 4-5). As discussed above, the northern waste emplacement would be the most visually prominent component of the modified CGM from this location and would remain as a permanent landscape feature. The outer batters of the waste emplacements would be planted with grasses, trees and/or shrubs reducing the raw overburden appearance in the long-term as the vegetation establishes. The simulation on Figure 4-5 shows that following progressive and final rehabilitation, the level of visual impact would reduce to low.

The "Westlea" dwelling is the closest residence to the ML (i.e. approximately 2.5 km south-west) (Figure 4-3). Views from this residence towards the ML are mostly obscured by intervening vegetation and undulating topography and relate to a small proportion of the overall viewscape (Figure 4-6).

The potential visual impact at the "Westlea" dwelling would occur during the latter years of the E42 Modification, when the heights of the tailings storage facilities increase beyond their currently-approved elevations. The visual impact of the tailings storage facilities would also result from the contrast in colour and texture between the undisturbed natural areas and the newly constructed outer batters before a grass cover is established during the rehabilitation process. This impact would be confined to the upper batters of the new landform during progressive construction and rehabilitation.

Given the low level of modification coupled with the moderate to high visual sensitivity of the "Westlea" dwelling, the visual impact would be moderate to low (Table 4-5). As discussed above, the tailings storage facilities would be the most visually prominent components of the modified CGM from this location and would remain as permanent landscape features. The outer batters of the tailings storage facilities would be planted with grasses, trees and/or shrubs reducing the raw soil appearance in the long-term as the vegetation establishes. The simulation on Figure 4-6 shows that following progressive and final rehabilitation, the level of visual impact would reduce to low.

Local Settings

Figures 4-7, 4-8 and 4-9 simulate views of the ML from the north (visual simulation location 4), west (visual simulation location 5) and south (visual simulation location 6) along Lake Cowal Road (Figure 4-3). These visual simulation locations are approximately 200 to 300 m from the ML.

The potential visual impact along Lake Cowal Road would occur during the latter years of the E42 Modification when the heights of the landforms increase beyond their currently-approved elevations. The visual impact of the waste emplacements and tailings storage facilities would result from the contrast in colour and texture between the undisturbed natural areas and the newly placed and unvegetated material before a grass cover is established as part of the rehabilitation process. This impact would be confined to the upper batters of the new landform during progressive construction and rehabilitation. There is also likely to be some contrast between the colour of the newly established grass and adjoining grassland areas. However, this contrast is likely to be of a short duration following completion of rehabilitation works.

Grasses, shrubs and/or trees would be planted on the outer batters of the waste emplacements and tailings storage facilities to integrate with the vegetation character of the surrounding landscape to reduce the level of visual modification on the visual setting. Maturation of existing roadside tree and shrub plantings as well as additional tree plantings would provide partial screening of the lower slopes of the landforms. The Rehabilitation and Landscape Management Strategy is discussed further in Section 5.

The low level of visual sensitivity coupled with the moderate to high level of modification means a moderate level of visual impact is expected on users of Lake Cowal Road (Table 4-5). The level of visual impact is expected to decrease from moderate to low following progressive rehabilitation of the modified landform components and maturation of existing and proposed future roadside tree plantings.

Night-Lighting

The E42 Modification would vary the effects of existing night-lighting (i.e. visible at additional locations due to increased elevations of some light sources) over the life of the modified CGM (Appendix I).

As discussed in Appendix I, the nature of night-lighting for the modified CGM would be of a similar intensity when compared to the existing night-lighting at the approved CGM. However, there is potential for the fixed lights to be visible from a wider area surrounding the ML due to the increased elevations of the waste emplacements.

4.3.3 Mitigation Measures and Management

The mitigation measures and management measures that have been implemented for the maintenance of visual amenity for the approved CGM are presented in the LSMP (Barrick, 2003g) and are described in Section 4.3.1.

Based on the findings of the Visual Assessment (Appendix I), a LSMP for the modified CGM would not be necessary. Notwithstanding, the MOP would be revised to incorporate the relevant mitigation measures and management from the LSMP as well as the proposed mitigation measures and management for the modified CGM, including those presented below.

Progressive Rehabilitation

Progressive rehabilitation of waste emplacements and tailings storage facilities would be undertaken to reduce the contrast between the modified CGM landforms and the surrounding landscape. This would include progressive rehabilitation with selected grass, shrub and/or tree species (Section 5). Figure 2-4 illustrates the proposed rehabilitated landforms, including the waste emplacements, tailings storage facilities and other areas of surface disturbance. The final void would be screened from public views on Lake Cowal Road by the tailings storage facilities and waste emplacements. The Rehabilitation and Landscape Management Strategy for the E42 Modification disturbance area is presented in Section 5.

Foreground Visual Screening/Vegetation Screens

Earth mounds have been constructed on sections of the western and northern boundaries of ML 1535 to break up continuous views from Lake Cowal Road. These earth mounds as well as vegetation screen areas surrounding the ML (including along Lake Cowal Road) have been be planted with endemic plants that are compatible with the existing surrounding vegetation.

Maintenance of the vegetation screens (e.g. addition and replacement of plants where required) would continue to be undertaken in these areas. An increase in screening effect over time as plants grow, would continue as a result. Further details of proposed revegetation activities are provided in Section 5.

Night-Lighting

Measures that would be employed to mitigate potential impacts from night-lighting would include one or more of the following, where practicable:

- Scheduling of mining operations, where practicable, so that evening and night-time operations on the waste emplacements would be located on the southern waste emplacement (i.e. the lower waste emplacement) to reduce the potential for direct lighting impacts to locations north of the ML.
- Restriction of night-lighting to the minimum required for operations and safety requirements, where appropriate.
- Use of unidirectional lighting techniques, where practicable.
- Use of light shields to limit the spill of lighting, where practicable.
- Provision of curtains, cladding and/or screens at nearby dwellings to help screen any potential night-time lighting impacts, in consultation with the landholder.
- Planting of trees at nearby dwellings to help screen any potential night-time lighting impacts, in consultation with the landholder.

4.4 HYDROGEOLOGY

A Hydrogeological and Tailings Seepage Assessment for the modified CGM was conducted by Coffey Geotechnics (2008a) and is presented in Appendix A.

The objectives of the assessment were to assess the potential for the hydrogeological regime to change from that described in previous CGM hydrogeological assessments by considering:

- open pit dewatering;
- potential effects of pumping from the saline groundwater supply;
- long-term inflows to the final void created by mining operations;
- short and long-term groundwater quality;
- seepage from tailings storage facilities; and
- the hydraulic relationship between Lake Cowal and groundwater and the potential short and long-term effects of mine closure on Lake Cowal.

The E42 Modification would not change the current approved limits on the extraction of water from the CGM Bland Creek Palaeochannel Borefield, or the current system for managing groundwater levels around the CGM Bland Creek Palaeochannel Borefield. Therefore, potential impacts from CGM Bland Creek Palaeochannel Borefield groundwater extraction are not considered in this section.

4.4.1 Existing Environment

Previous Hydrogeological Assessments

A significant number of hydrogeological studies and site testwork have been conducted which are applicable to the CGM area and surrounds, including:

- *Lake Cowal Project – Hydrogeological Modelling and Dewatering Study* (Coffey Partners International Pty Ltd [Coffey Partners International], 1995);
- the EIS, which included the *Groundwater Studies – Hydrogeological Assessment* (Coffey Partners International, 1997) and *Groundwater Studies – Pre-assessment Groundwater Issues* (Kalf and Associates, 1997);
- *Cowal Northern Tailings Storage Facility – Floor Permeability* (URS Australia Pty Limited, 2005);
- *Cowal Southern Tailings Storage Facility – Floor Permeability* (URS Australia Pty Limited, 2006); and
- *Cowal Gold Project – Preliminary Hydrogeochemical Review of the Groundwater System* (Parsons Brinckerhoff Australia Pty Ltd, 2007).

These assessments and site testwork are discussed further in Appendix A and in the following sub-sections, where relevant.

Regional and Local Hydrogeology

Hydrogeological assessments (i.e. EIS and subsequent assessments) have characterised that groundwater resources within the region are generally associated with two geological formations (Appendix A):

- the Lachlan Formation (Bland Creek Palaeochannel), which comprises an aquifer of quartz gravel with groundwater of generally low salinity; and
- the Cowra Formation, which comprises aquifers of isolated sand and gravel lenses in predominantly silt and clay alluvial deposits, with perched groundwater of generally higher salinity.

Locally, four saline aquifers have been identified within ML 1535 (Appendix A):

- two alluvial saline aquifers at varying depths within the alluvium of the Quaternary-aged Cowra Formation;
- a local saline aquifer in an alluvial deposit (Groundwater Consulting Services [GCS], 2008) occurring in the upper part of the profile likely to be a part of the Cowra Formation discussed above; and
- a saline alluvial aquifer that occurs in weathered fractured rock below the Cowra Formation (this aquifer is not part of the Cowra Formation or the Bland Creek Paleaochannel).

Groundwater Inflows to the Open Pit and Open Pit Dewatering

EIS modelling by Coffey Partners International indicated yields from open pit dewatering of 10 ML/day for the first three months with progressive decline over the subsequent 12 to 18 months to about 5 ML/day (North Limited, 1998). Actual dewatering rates are significantly less than the EIS predictions.

Average daily volumes of water collected via in-pit sumps since October 2006 are shown in Table 4-6.

Table 4-6
Water Collected Via In-Pit Sumps

Period	Range (ML/day)*	Average (ML/day)*
Oct 06 to Jan 07	0.9 to 1.0	0.9
Feb 07 to Feb 08	0.3 to 0.6	0.4

Source: Adapted from Appendix A

* Includes rainfall.

The average daily rate of water recovered from the open pit is approximated at 0.4 ML/day (Appendix A).

Current operations utilise 19 dewatering bores located on the periphery and within the approved CGM open pit (Appendix A). Each bore is screened in the local saline alluvial and fractured rock aquifers. In addition, in-pit horizontal drains have been installed on benches to drain areas where groundwater level monitoring had indicated that enhancement of dewatering was required to promote pit slope stability.

Barrick records of dewatering volumes for August 2005 to February 2008 indicate fairly consistent results from approximately August 2005. These are summarised below in Table 4-7.

The average daily extraction rate for the open pit dewatering bores is approximately 0.6 ML/day (Appendix A).

Table 4-7
Water Extracted from Dewatering Bores

Period	Range (ML/day)	Average (ML/day)
August 2005 to December 2005	0.6 to 0.8	0.7
January 2006 to June 2006	0.4 to 1.0	0.8
July 2006 to December 2006	0.7 to 0.9	0.8
January 2007 to June 2007	0.6 to 0.7	0.6
July 2007 to February 2008	0.5 to 0.7	0.6

Source: Adapted from Appendix A

Measured Groundwater Level Drawdown

The EIS included an assessment of potential regional effects of drawdown from open pit dewatering on groundwater users outside ML 1535. This assessment was based on the EIS rates of dewatering that are significantly higher than both the current and expected rates. Coffey Partners International (1995) conducted modelling to determine the dewatering requirements and calculated the drawdown created in the shallow and deeper alluvium and fractured bedrock aquifers. The modelling results indicated that after several years of continuous pumping predicted drawdowns at potentially sensitive locations 10 km to the east would be less than 1 m in the shallow saline alluvium aquifers and 3 m in the fractured rock saline aquifer (North Limited, 1998).

The groundwater monitoring programme for the approved CGM is described in the SWGMBMP. The groundwater monitoring bores within ML 1535 are identified on Figure 4-10.

Drawdowns recorded at monitoring bores around the open pit, including at Bores PDB1 and PDB5 (located approximately 0.5 km to the north and south of the open pit respectively), are provided in Table 4-8.

Table 4-8
Observed Drawdown in Monitoring Bores

Distance from Open Pit	Monitoring Bore	Drawdown to December 2007	
		Fractured Rock Aquifer	Upper-most Alluvial Aquifer
<50 m	PDB4	28 m	14 m
<100 m	PDB2	32 m	Dry (>5 m)
<200 m	PDB3	20 m	9 m
500 m	PDB5	9 m	6 m
700 m	PDB1	4 m	1 m

Source: Appendix A

Bores located further than 700 m from the open pit generally displayed only minor standing water level changes (i.e. less than 20 cm) over the period July 2004 to December 2007. These variations are typical of natural effects and a muted response to rainfall trends (Appendix A). Based on the above and similar records from other bores further from the open pit, it would appear that there has not been any regional impact to date from open pit dewatering (*ibid*.).

Hydrogeology Beneath the Tailings Storage Facilities

Floor Permeability

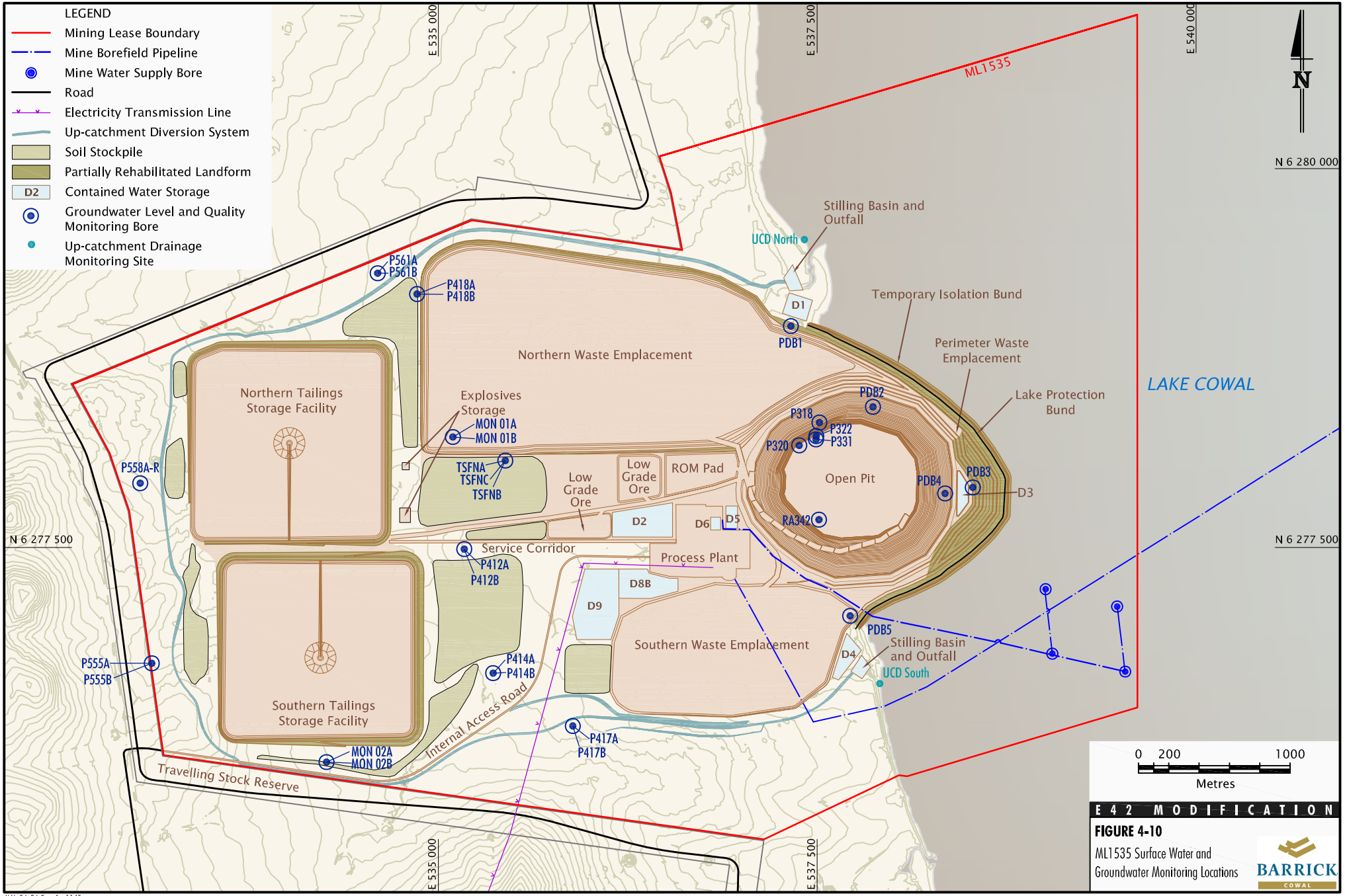
EIS studies of the floor permeabilities of the tailings storage facilities area identified that (Coffey Partners International, 1997):

- The strata expected to be more permeable had low horizontal permeability of the order of 2 to 10 x 10 to 4 metres per day (m/day) for gravelly clay and 0.6 to 3.5 x 10 to 4 m/day for weathered rock.
- Vertical permeability of the less permeable soils was of the order of 0.9 to 1.3 x 10 to 6 m/day.

The initial EPL for the approved CGM required demonstration of the permeability of the floors of the tailings storage facilities prior to their operational use. The EPL required a basal barrier or liner with an equivalent permeability of 10^{-9} metres per second (m/s) over a thickness of 1 m.

URS Australia Pty Limited conducted field investigations and laboratory testing for both tailings storage facilities and found that the measured floor permeabilities were lower than those predicted in the EIS. In summary, they concluded that (URS Australia Pty Limited, 2005, 2006):

- investigations consistently showed the uppermost 5 m of the tailings storage facilities footprints to be essentially clay soils of extremely low permeability;
- laboratory testing of typical samples from within 5 m of floor level yielded permeabilities less than the target permeability of 10-9 m/s; and
- inspections of cut-off trench excavation and the storage floors did not reveal any significant extensive or continuous zones or lenses of high permeability soil that might provide a leakage path.



E42 MODIFICATION

FIGURE 4-10

ML1535 Surface Water and Groundwater Monitoring Locations

BARRICK COWAL

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Groundwater Levels and Seepage Rates

Test drilling, geophysical studies and piezometer installation undertaken for the EIS in the tailings storage facilities area identified (Coffey Partners International, 1997):

- A silty clay foundation with some gravelly clay, and highly weathered rock occurring at shallow depth in the west (with the thickness of unconsolidated sediments decreasing from east to west).
- An absence of groundwater (including perched aquifer systems) less than 10 m beneath the tailings storage facilities area. The water table beneath the southern tailings storage facility area was in excess of 20 m and therefore the majority of alluvial sequence in this area appeared to be dry. Depth to the water table beneath the northern tailings storage facility area was recorded from 20.5 m to 17.9 m in a south to north direction, in conformity with surface topography.

Based on the above, the EIS predicted low rates of groundwater seepage from the tailings storage facilities (North Limited, 1998). The EIS predicted that this seepage would flow toward the open pit due to the depressurisation at the open pit caused by dewatering (*ibid*.).

Between July 2004 and December 2007, standing water level records for 25 monitoring bores proximal to the tailings storage facilities indicated no response to potential seepage effects through relatively consistent groundwater levels (Appendix A). Some potential seepage effects were recorded as groundwater levels rose in one monitoring bore near the southern tailings storage facility. This potential effect was found to be consistent with EIS predictions (*ibid*.).

Groundwater Quality

Potential Tailings Storage Facility Seepage Effects

The abovementioned EIS seepage parameters were used by Kalf and Associates (1997) to assess solute transport from the tailings storage facilities. Kalf and Associates concluded that, under the most severe conservative conditions of continuous tailings ponding, maximum permeability and low retardation and degradation, the cyanide plume would not move more than 200 m beyond the tailings storage facilities (*ibid*.). Under the most probable conditions (i.e. conditions including EIS permeability assumptions), the plume would not move significantly beyond the base of the tailings storage facilities (*ibid*.).

In the long-term, cyanide would degrade in the tailings storage and surface of the underlying aquitard and would be effectively removed from the subsurface (*ibid*.). Under probable conditions, Kalf and Associates (1997) also concluded that arsenic and zinc would be virtually immobilised in the profile, even over periods of hundreds of years (*ibid*.).

Water quality testing undertaken to date for monitoring bores proximal to the tailings storage facilities indicates that levels of arsenic and cyanide remain below detection limits (Appendix A). Records for these monitoring boreholes also indicate relatively consistent pH (*ibid*.). Electrical conductivity is more variable, but the fluctuations do not show a specific trend, and do not appear more variable than other monitoring bores within ML 1535 (*ibid*.). These results are consistent with EIS predictions.

Potential Open Pit Dewatering Effects

An assessment undertaken for the EIS by Coffey Partners International (1997) reported the following pre-mining groundwater salinity levels:

- Alluvial aquifers had very high salinity in the range of 19,000 to 72,000 μS/cm measured beneath the open pit and 6,000 μS/cm to 44,400 μS/cm beneath the tailings storage facilities area.
- In the fractured rock aquifer, the salinity ranged from 50,900 μS/cm to 63,700 μS/cm.

Groundwater quality monitoring results reported in 2006 are consistent with the above and indicate that (Appendix A):

- Groundwater facies within ML 1535 are characterised by saline conditions (total dissolved solids [TDS] vary from 18,000 to 47,000 mg/L attributed to heterogeneous aquifer material, geochemistry and depth in the profile).
- Electrical conductivities are within a similar range to those observed pre-mining.
- Groundwater generally has a slightly alkaline to weakly acid pH range (6.0 to 7.5).

Whilst open pit dewatering is causing a localised reduction in groundwater levels, no changes in groundwater chemistry appear to be associated with this drawdown (Appendix A). The chemical groundwater data collected shows little variation for each bore and analysis has demonstrated good chemical correlation between data from the pre-mining and operational phases of the approved CGM (*ibid*.).

Hydraulic Relationship between Lake Cowal and Groundwater

With regard to the hydraulic relationship between Lake Cowal and groundwater, Coffey Partners International (1997) found that:

- the clay underlying Lake Cowal has a minimum thickness of 6 m, with an average of around 9 m (with average vertical permeability values several orders of magnitude less than that recommended for landfill liners);
- the piezometric surface of the shallow saline alluvial aquifer was lower than the lake surface level but above lake bed level, indicating a lack of significant hydraulic continuity between surface and subsurface water;
- test pumping in the Upper Transported Alluvial aquifer indicated an absence of rapid leakage response from the lake;
- the salinity of the Upper Transported Alluvial aquifer ranges from 32,400 µS/cm to 72,000 µS/cm, in contrast to the low salinity of the lake water (around 600 µS/cm); and
- no salinity scalding has been observed by local landowners in the lake bed in dry conditions, nor has this been detected by satellite radiometric imaging.

These results indicate a very low potential for significant quantities of water to infiltrate from Lake Cowal into the underlying aquifers. Further, Coffey Partners International (1997) stated that the only way for low salinity water to mix with saline groundwater from the pit would be by surface breaching of both the lake protection bund and perimeter waste emplacement.

The EIS assessed the potential for seepage from Lake Cowal to the final void as a result of open pit dewatering and the resultant potential for Lake Cowal water balance changes and final void balance characteristics.

Modelling conducted by Kalf and Associates (1997) for the EIS indicated that seepage from Lake Cowal to the final void would be an insignificant component of overall seepage because of the very low permeability of the clay pan deposits that form the lake bed and isolate Lake Cowal from the underlying aquifers.

Lake Cowal has not filled during the period that the approved CGM has been operational. Accordingly, no relevant observations during approved CGM operations have been made to date.

4.4.2 Potential Impacts

Groundwater Inflows to the Open Pit

A slight increase (i.e. approximately 15%) in currently predicted inflow rates is anticipated as a result of the increased open pit area for the E42 Modification (Appendix A). The increased depth of the open pit for the E42 Modification is not considered to be a significant factor in relation to groundwater inflow given that the rock permeability reduces substantially with depth (*ibid*.). As stated in Section 4.4.1, currently predicted inflow rates to the approved CGM open pit are significantly less than those predicted in the EIS. The E42 Modification would therefore result in a modified CGM which would experience open pit inflows significantly less than predicted in the EIS.

The prospective local saline alluvial aquifer located within ML 1535 assessed by GCS (2008) would be pumped at a rate of 1 ML/day total (from up to four pumping bores) to provide an additional mine water supply. The water source comprises the upper sands and gravels in a probable localised palaeochannel to the south-east of the approved CGM open pit. Given the prevailing ground slope and the sources of inflow at the open pit, drawdown from the pumping bores is not likely to significantly influence currently predicted inflow rates to the open pit.

Groundwater Drawdown

The Lachlan Formation (Bland Creek Palaeochannel) is a substantial regional aquifer containing water of good quality which is widely used for irrigation (Appendix A). This aquifer occurs some 10 km east of the approved CGM and is hydraulically well separated from the open pit dewatering borefield and saline groundwater supply borefield (*ibid*.). Due to this separation and the relatively small rate of dewatering from the open pit and saline groundwater supply borefield (i.e. both approximately 1 ML/day), no regional groundwater drawdown impacts on the Lachlan Formation (i.e. Bland Creek Palaeochannel) are anticipated as a result of the E42 Modification open pit dewatering (*ibid*.).

Coffey Geotechnics (Appendix A) concluded that the potential drawdown impacts resulting from the E42 Modification would be less than those predicted in the EIS (Appendix A). GCS (2008) (Appendix A) also indicated that at the much smaller dewatering rates expected for the modified CGM, predicted drawdown impacts were likely to be less than EIS predictions. GCS also reported that no groundwater users have been identified that may be affected by use of the saline groundwater supply borefield for the E42 Modification (*ibid*.).

Seepage from the Tailings Storage Facilities

As described in Section 2.6.2, the E42 Modification would increase the heights of the northern and southern tailings storages to a final elevation of RL 252 m AHD (from approximately RL 233.5 m AHD) and RL 256 m AHD (from approximately RL 241.5 m AHD), respectively. A conceptual cross-section of the modified northern tailings storage facility is shown on Figure 2-9. The increase in elevation in the northern and southern tailings storage facilities would increase the head of water in the tailings storage facilities, thereby increasing the pressure on the underlying material (Appendix A). Notwithstanding, tailings permeability would tend to reduce following consolidation (*ibid*.). As the tailings consolidate, the thickness of low permeability consolidated tailings material would increase (*ibid*.). This would increase the thickness of low permeability consolidated tailings at the base of the tailings storage facilities (*ibid*.).

Seepage from the tailings storage facilities to the underlying aquifers would be expected to ultimately migrate slowly toward the modified CGM open pit via flows through the uppermost saline alluvial aquifer (Appendix A), as predicted in the EIS. Barrick is the only known user of this aquifer, and hence no seepage impacts to other users have been predicted to occur (*ibid*.).

Seepage Quality

Observations to date, together with the construction methodology implemented for the tailings storage facilities and the predicted geochemistry of CGM tailings (i.e. similar to the predicted geochemistry described in the EIS [Appendix C]) indicate that the E42 Modification would not significantly change EIS predictions for solute transport in seepage from the tailings storage facilities described in Section 4.4.1 (Appendix A).

Groundwater Quality

Predicted changes to the natural groundwater chemistry described in the EIS would not alter significantly as a result of the E42 Modification (Appendix A).

Hydraulic Relationship between Lake Cowal and Groundwater

Whilst the E42 Modification would increase the area and depth of the final void, it would not change the depth of the relatively impermeable clay that separates the Lake Cowal bed from the saline aquifer system (Appendix A).

Piezometric response in the saline alluvial aquifers has been small and localised, consistent with low vertical and horizontal permeability, and inflows to the open pit have been small compared with the inflows predicted in the EIS.

On this basis, the E42 Modification would not change the disconnectivity between Lake Cowal and the open pit as described in the EIS (Appendix A).

Potential Effects of Mine Closure on Lake Cowal

Kalf and Associates (1997) determined that once dewatering and open pit excavation commenced, the open pit would become a groundwater sink. Based on the results of Coffey Partners International (1995), Kalf and Associates (1997) presented groundwater flow directions towards the open pit. These flow directions were described to be fundamentally maintained during and post-mining, although the gradients and flow rates would decrease over time (*ibid*.).

At the completion of mining (and hence dewatering), the final void was described to be a permanent sink to local groundwater (Kalf and Associates, 1997) and would gradually fill with water from incident rainfall, runoff from adjacent mine areas and seepage from the intercepted aquifers. These flow directions would be fundamentally maintained during and post-mining, as the water level in the open pit recovered and reached an equilibrium level lower than the current potentiometric surface level at the open pit (Coffey Partners International, 1997). Mining has and would continue to create a sink for surrounding groundwater which flows toward the final void created by the mine (Appendix B).

4.4.3 Mitigation Measures and Management

Existing management measures for CGM groundwater quality and quantity (including groundwater beneath ML 1535 and the Bland Creek Palaeochannel Borefield) are documented in the SWMP (Barrick, 2003f). Management measures for open pit groundwater inflows, tailings storage facility water and the Bland Creek Palaeochannel are presented along with monitoring requirements. These measures are based on EIS predictions and are therefore conservative as described in Section 4.4.2. The E42 Modification would not affect the approved CGM to the extent that these measures would require changing.

Notwithstanding, the SWMP would be updated to include changes to water management required for the E42 Modification, including water extraction from saline groundwater supply bores (and associated management and monitoring).

Groundwater Monitoring

The groundwater monitoring programme is described in the SWGMBMP. The groundwater monitoring component of the SWGMBMP would continue and its description would be updated to reflect the modified CGM (Section 6).

4.5 SURFACE WATER

A Hydrological Assessment of the modified CGM was undertaken by Gilbert and Associates Pty Ltd (2008) and is presented in Appendix B.

4.5.1 Existing Environment

Physical and Hydrological Setting

The physical and hydrological setting of the approved CGM is described in the EIS and summarised below.

The CGM is located on the western side of Lake Cowal, an ephemeral, fresh water lake filled by runoff from the Bland Creek catchment to the south and flood breakout from the Lachlan River to the north (North Limited, 1998). The Lachlan River is the major regional surface water system, forming part of the Murray-Darling Basin. During periods of flood, (i.e. when flows at Jemalong Weir exceed 15,000 to 20,000 ML/day) the Lachlan breaks out at two points known as the 17 and 21-mile breakouts (*ibid*.). The breakout flows then combine and flow via the Lake Cowal floodway into Lake Cowal (*ibid*.). Water balance studies indicate that breakout flows from the Lachlan account for approximately 35% of total Lake inflows (Gilbert and Sutherland, 1997).

The Bland Creek system, which drains a catchment area of approximately 9,500 square kilometres (km²), is thought to contribute approximately 38% of total Lake inflows, with the remainder being contributed by incident rainfall on the Lake itself (*ibid*.).

Lake Cowal is a large, shallow water body covering an area of approximately 10,500 ha and holding some 150,000 ML of water when full (Gilbert and Sutherland, 1997). The Lake forms part of the Wilbertroy-Cowal wetlands that are situated on the Jemalong Plain. The Lake overflows into Nerang Cowal, an ephemeral Lake to the north of Lake Cowal. When flows are sufficient to get through the system they ultimately drain into the Lachlan River via Bogandillon Creek (North Limited, 1998).

The Cowal region is semi-arid with an average annual rainfall of some 440 mm compared to average pan evaporation of 1,740 mm (Gilbert and Sutherland, 1997). Rainfall is typically highest in winter. Flow records for the gauging station on the mid reaches of Bland Creek indicate that runoff is low and averages less than 5% of annual rainfall (*ibid*.). Average runoff at the mine site as a proportion of rainfall would also be expected to be small due to the flat, poorly drained nature of the terrain. Rainfall intensities for the area are also relatively low (compared to coastal areas of NSW) contributing to the low overall runoff potential (*ibid*.).

Baseline water quality reported in the EIS was based on results of an intensive sampling programme conducted in 1991 and 1992 and included 34 monitoring locations along four transects across the Lake. Results indicated that Lake water was typically slightly to moderately alkaline (pH 8.27 to 8.67) with low to moderate suspended solids concentrations, (total suspended solids concentrations of 24 to 222 mg/L) (North Limited, 1998). Conductivity, as a surrogate of dissolved solids, was also low varying between 222 and 1,557 μS/cm (*ibid*.) and appeared to be inversely related to lake volume which suggests solute concentrations are responding to evapo-concentration effects (Appendix B). Metals (cadmium, arsenic, lead, mercury and zinc) were low and mostly below detection limits (North Limited, 1998). Particulate copper concentrations were however found to be higher than Australian and New Zealand Environmental and Conservation Council (ANZECC) limits for aquatic ecosystems (*ibid.)*.

Since commencement of the approved CGM, drought conditions have kept Lake Cowal too dry to enable any lake water monitoring in accordance with the SWGMBMP.

Approved CGM Water Management

Approved CGM water supply sources and surface runoff management measures are described in Sections 2.7 and 2.8, respectively. Further detail is provided below and in Appendix B and the SWMP.

The management of erosion and sedimentation Is described in the existing ESCMP. The approved CGM surface water monitoring programme is described in the existing SWMP and SWGMBMP.

The approved CGM water management system has been designed such that the ecological integrity of the Cowal wetland system is not compromised (North Limited, 1998). Mine infrastructure and landforms have been constructed within the ICDS (Section 2.8.3). The ICDS consists of contained water storages for CGM runoff (i.e. D1, D2, D3, D4, D5, D8A and D8B) and the internal catchment divide (i.e. a bund constructed on the outer bounds of the CGM catchment to direct runoff toward the contained water storages).

As described in Section 2.8, the ICDS combines with the lake isolation system (which comprises the temporary isolation bund and permanent lake protection bund) to isolate Lake Cowal from mine development activities. The lake protection bund comprises a large engineered embankment that provides a permanent barrier between Lake Cowal and the open pit. Runoff from areas upslope of the ICDS is diverted via an UCDS, around the mine area to the Lake Cowal.

The ICDS has remained isolated from Lake Cowal for approved CGM operations to date (Barrick, 2008a).

Post-Closure Water Management

The post-closure water management strategy described in the EIS included concepts for runoff minimisation from waste rock emplacements and tailings storage facilities, and the provision of stable drainage channels to drain site surface water to the final void. These concepts would remain for the modified CGM and are described in Appendix B and are summarised below.

Waste Emplacements

At the completion of mining the top surface of the northern and southern waste emplacement areas would be graded such that any surface runoff would flow toward the final void. A cover layer comprising low salinity sub-soil and topsoil would be laid over the graded top surface of the waste emplacements.

The cover material and thicknesses would be selected consistent with the overall objective of minimising runoff from the emplacement surface by encouraging infiltration and storage of rainfall in a relatively thick cover layer where it would be available for surface vegetation. Deep rooting, high transpiration capacity vegetation species would be utilised as cover vegetation to ensure take-up and use of available moisture in the cover layer. The final surface of the waste emplacement areas would be purposely left with a high degree of irregularity to provide surface retention of rainfall for longer term infiltration and take-up in the surface cover system. A network of low energy drainage swales would be provided on both waste emplacement areas for drainage of any net runoff to the final void. The external faces of the waste emplacements would be constructed in a regular series of batters and berms. The berms would be constructed with reverse grades to prevent overflow of berm runoff over the batters. Runoff retention areas and deep vegetated soil cover layers would minimise net runoff.

These post-closure water management concepts have been integrated into the Rehabilitation and Landscape Strategy presented in Section 5.

Tailings Storage Facilities

Concepts developed for rehabilitation of the external batters and berms of the tailings storage facilities involve a similar approach as those developed for the outer faces of the waste emplacements as described above. The concepts developed for the top surface of the tailings storage facilities include retention of the final inverted cone shape of the final beach surface which would, by virtue of the planned peripheral tailings discharge regime, slope downward from the embankment perimeters toward the central decant area.

The final surface would be covered with a relatively thick layer of low salinity sub-soil and topsoil to support a deep rooting plant cover. A capillary break layer between the final tailings surface and the cover would also be constructed to minimise the potential for salt rise into the overlying soil cover layer. Planned surface irregularities, mounds and swale-like channels would provide for transient retention of surface runoff, enhance moisture retention within the cover system and provide a formal pathway for any net runoff under extreme conditions to be diverted to the final void.

These post-closure water management concepts have been integrated into the Rehabilitation and Landscape Strategy presented in Section 5.

Final Void

The final pit would be left as a void. The UCDS and the ICDS would be retained. Surface drainage from the mine area would be diverted to the final void via a series of low energy swales. Drainage from areas upslope of the mine area would flow to Lake Cowal via the UCDS and original creek lines.

At the completion of mining and processing, pit dewatering operations would cease and groundwater and inflows from rainfall runoff over the mine site area would accumulate in the open pit. Final void water and solute balance model simulations conducted as part of the EIS showed that, in the long-term, the void would fill over a considerable period of time to a level some 22 to 24 m below the original ground level at the low point in the perimeter of the open pit.

Modelling also indicated that water levels would fluctuate seasonally by a few metres above and below this level. The quality of the final void was predicted to be dominated by the naturally high salinity of the surrounding groundwater which had reported salinity in the range of 31,000 to 38,000 mg/L that was characterised predominantly by sodium chloride.

The final void water levels were such that it was predicted to act as a permanent sink for the surrounding groundwater system. Because the void had no outflow, other than direct evaporation, the salinity of void waters was predicted to continue to increase in the longer term due to evapo-concentration. The quality of void water was also predicted to vary with depth due to stratification which would occur due to temperature and salinity differentials.

4.5.2 Potential Impacts

Potential impacts associated with the modified CGM on surface water features are:

- localised surface water contamination in the unlikely event of a saline groundwater supply borefield pipeline leak;
- surface water contamination through failure or inappropriate sizing of the UCDS and/or ICDS (i.e. contained water storages);
- seepage of lake water into the open pit (or vice versa);
- surface water contamination due to exposure of saline materials during placement of waste materials; and
- alteration of the hydrology of Lake Cowal.

Saline Groundwater Supply Borefield

Sections 2.7 and 4.4.2 describe the proposed saline groundwater supply borefield.

The potential surface water impacts associated with this borefield would be limited to impacts associated with pipeline failure and leakage of saline water (Appendix B).

As described in Section 2.7, the saline groundwater supply borefield would be operated when it is not inundated by Lake Cowal. There would be no potential for saline water leakage to Lake Cowal and, therefore, no potential for surface water quality impacts to lake water quality (Appendix B).

Risks to the public, environment and public property associated with the borefield are discussed in Section 4.15.

The potential groundwater impacts associated with extraction from the saline groundwater supply borefield are assessed in Section 4.4 and Appendix A.

Internal Catchment Drainage System

Section 2.8.3 describes the ICDS water balance modelling conducted by Gilbert and Associates using the CGM site water balance model (Appendix A) which identified revised storage requirements for runoff water in the ICDS. Changes proposed to the ICDS are described in Section 2.8.3 as:

- an increase in storage capacity of D2 and D8B for containment of runoff from larger catchment areas;
- removal of D8A once the modified open pit encroaches on the D8A footprint and replacement by an increase to D8B; and
- minor changes to collection drains around enlarged stockpile and waste emplacement areas.

The storage capacities of the modified ICDS contained storages are shown in Table 2-6. The design criteria for these storages would remain unchanged.

The revised requirements would also involve temporary storage for contained runoff in D9 and the tailings storage facilities during wet conditions, whilst storage capacities in contained water storages (i.e. D1-5, D8A [whilst operational] and D8B) are being reinstated as required.

Up-catchment Diversion System

Section 2.8.1 describes the UCDS.

The expansion of the northern waste emplacement to the north would require the re-alignment of the northern component of the UCDS. The re-alignment would include construction of a low-flow channel and bund and a stilling basin and rock-armoured outfall at the point of outflow to Lake Cowal. This arrangement would mirror the existing features constructed for the southern component of the UCDS (Appendix B).

Lake Interaction

As part of the EIS, a model of Lake Cowal and its catchment was used to investigate the potential effects that the mine would have on the water balance dynamics of Lake Cowal, including changes to average water levels in the Lake and changes to the frequency and volume of spills from Lake Cowal to Nerang Cowal downstream.

The mine area is physically isolated from Lake Cowal by the lake isolation system (Section 2.8). The outer face of the isolation system extends approximately 1 km into Lake Cowal and will form a new lake foreshore. The excursion of the lake isolation system into the Lake floor has the potential effect of reducing the overall capacity of the Lake.

The E42 Modification would not change the lake isolation system (which was constructed during the approved CGM construction phase and described in Section 2.8.2). Therefore, the EIS predictions made regarding changes to lake volume and the potential effects on runoff water quality remain the same (*ibid*.).

Implications of Geochemical Characteristics of Waste Rock on Surface Water Quality

An assessment of the geochemistry of the tailings and waste rock associated with the E42 Modification was undertaken by Geo-Environmental Management Pty Ltd (2008) and is presented in Appendix C. This assessment was based on geochemical characterisation tests on representative samples of waste rock recovered from the E42 Modification open pit area.

Waste Rock Geochemistry

Geo-Environmental Management Pty Ltd (Appendix C) concluded that the geochemical characteristics of E42 Modification waste rock (primary and oxide), including pH, salinity, acid forming characteristics and element enrichment and solubility are expected to be similar to the geochemical characteristics of the waste rock from the approved CGM operations (Appendix C). These characteristics include (Appendix C):

- Both oxide and primary waste would be slightly alkaline.
- The oxide waste would be highly saline and primary waste would be moderately saline.
- Both oxide and primary would be NAF with the oxide waste being relatively inert (i.e. low sulphur and low acid neutralising capacity [ANC]) and the primary waste being relatively reactive (i.e. high sulphur and moderate ANC).
- Elements that have been identified as being enriched in the waste rock (i.e. arsenic, cadmium, lead and zinc) are not expected to be readily soluble.

Given these findings, no modifications to the operational or long-term mine waste management or water management practices specifically relevant to waste rock geochemistry (e.g. construction of the waste emplacement base drainage controls described in Section 2.4.3) would be required as a result of the E42 Modification (Appendix C). Water management measures are described in Section 4.5.3.

Post-Closure Water Management

The potential impacts to surface water as a result of the E42 Modification proposal to increase the area and volume of the final void were assessed by Gilbert and Associates in Appendix B and are summarised below.

Final Void

As a result of the E42 Modification, the final void would be larger in area and deeper than the original void (Section 2.3.2). The change in the size of the final void would have an effect on the water balance during the filling phase and potentially to the longer term post-equilibrium water levels.

Groundwater inflows to the void were originally estimated based on results of predictive groundwater modelling. Groundwater inflow rates to the mine during the operational phase were predicted to be initially high and to reduce over time (North Limited, 1998). Experience at the approved CGM to date has shown that actual groundwater inflow rates to the mine are significantly lower than those that were originally predicted (partly reflecting the conservative assumptions applied to the original modelling) (Section 4.4.1).

When adopting the lower groundwater flows obtained from experience and recent groundwater assessments undertaken by Coffey Geotechnics (2008b) (Appendix A), the average inflow rates during the void filling phase would initially be about 1 ML/day and would decline to low levels as the water level in the open pit approaches the original (pre-mine) groundwater table.

Modelling indicates that the void would fill slowly, reaching a level of RL 48 m AHD after approximately 200 years, ultimately reaching an equilibrium water level between RL 140 AHD and RL 150 m AHD (Appendix B). This anticipated level is lower than the original EIS predictions due to the lower groundwater inflows and higher evaporation rates from the larger void surface area (*ibid*.). Mining has and would continue to create a sink for surrounding groundwater which flows toward the final void created by the mine (*ibid*.).

The final void water quality would reflect the influence of the highly saline groundwater. Predictions of average final void salinity based on a solute balance between inflows and outflows confirm that salt concentrations in the final void would slowly increase. The lower groundwater inflow rates, however, mean that salinity would increase more slowly than was originally predicted (reaching about 67,000 mg/L after approximately 200 years) (Appendix B). Salinity is predicted to continue to increase trending to hyper-salinity as was predicted in the EIS (*ibid*.).

An assessment of the potential changes to pit void water quality based on the geochemistry of representative drill-hole samples was included in the Tailings and Waste Rock Geochemical Assessment (Appendix C). Consistent with the findings of previous geochemical investigations undertaken for the approved CGM, the assessment found that oxidation of primary rock exposed along the open pit walls is likely to generate a moderate load of sulphate salts, due to the presence of reactive sulphides (*ibid*.).

However, given the regional groundwater has a reported salinity in the range of 31,000 to 38,000 mg/L, the contribution of sulphate salts from the open pit walls to the overall salinity of open pit water is expected to be negligible for the modified CGM (*ibid*.).

Implications of Climate Change on the Final Void

To assess potential effects of climate change on the longer term water balance of the final void, current predictions of the future effects of climate change were obtained from CSIRO (Suppiah *et al*., 2007).

The predicted change in rainfall and evaporation affects the final void predictions (Appendix B). On average, the current predictions include a decline in average rainfall and an increase in potential evaporation (*ibid*.). Using lower rainfall and higher evaporation would have the effect of slowing the rate of void filling and of reducing the final long-term water level (*ibid*.). It would also increase salt concentrations due to greater evapo-concentration effects (*ibid*.).

Given that the critical outcome for the void is long-term containment security, a conservative set of climate change predictions (most likely to produce faster filling and the highest long-term final void water levels) was modelled (although it is contrary to the average trend of all predictions).

The void filling predictions obtained from this analysis for both the original model predictions and with adverse climate change predictions are presented in Appendix B.

The comparison presented in Appendix B shows that currently predicted effects of climate change (including those predictions which would produce adverse outcomes for long-term containment security) would not change the EIS predicted final void water levels significantly.

4.5.3 Mitigation Measures and Management

Surface water management measures to be implemented for the E42 Modification which are additional to existing measures (which would remain in place) are described in Section 4.5.2.

Surface water management and mitigation measures for the approved CGM are described in the SWMP. The SWMP describes:

- details of the site water management system;

- measures to prevent the quality of water in Lake Cowal or any surface waters being degraded below the relevant ANZECC water quality classification;
- changes in flood regime on productive agricultural land in Nerang Cowal as a result of the mine perimeter bund intruding into Lake Cowal, and appropriate compensation measures for affected landholders;
- development of contained water storages D1 and D4 to operate as first flush systems with initial captured run-off waters from the outer batters of the northern and southern waste emplacements reporting to process water storage D6;
- integration of the Lake Cowal Land and Water Management Plan and Jemalong Land and Water Management Plan; and
- a programme for reporting the effectiveness of the water management systems and performance against objectives contained in the approved SWMP and the EIS.

The SWMP would be revised to include changes to water management required for the modified CGM, including:

- Water extraction from the saline groundwater supply borefield (and associated management and monitoring).
- New/modified contained water storages.
- A description of erosion and sediment control systems (including monitoring and maintenance) and salinity and soil management measures.
- Mitigation measures and management for the saline groundwater supply borefield, including:
  - installation of a containment drain for the saline groundwater supply borefield pipeline;
  - leak detection mechanisms including automatic shutdown capability; and
  - operation of the borefield during times when it is not inundated by Lake Cowal.

The surface water monitoring programme is described in the SWGMBMP. The approved surface water monitoring programme would be continued for the modified CGM.

4.6 FLORA

A Flora Assessment has been prepared for the E42 Modification by FloraSearch (2008) and is presented in Appendix D. The Flora Assessment was prepared in accordance with the *Draft Guidelines for Threatened Species Assessment* (NSW Department of Environment and Conservation [DEC] and DPI, 2005).

4.6.1 Existing Environment

Regional Setting

The ML is located in the Central Western Slopes Botanical Division of NSW (Anderson, 1968; Harden, 1990-2002). It is also located within the NSW South Western Slopes Biogeographic Region as defined by the *Interim Biogeographic Regionalisation for Australia* (IBRA) (Thackway and Cresswell, 1995; DEWHA, 2008b). The South Western Slopes Bioregion is based within the southern half of the inland slopes of the Great Dividing Range, approximately between altitudes of RL 200 m AHD and RL 500 m AHD. The South Western Slopes Bioregion comprises 80,017 km^2 in NSW.

Local Setting

The ML area is former cleared and semi-cleared farmland that was used for grazing of predominantly native pastures by livestock. The main landuse within ML 1535 is now mining. The original native tree cover has largely been removed except for scattered individual trees, often Wilga or Rosewood, or small stands of Belah (*Casuarina cristata*) and Bimble Box (*Eucalyptus populnea*). The exception is Cowal West Hill which retains a higher proportion of its original tree cover, due to its shallow soils and poorer grazing potential (Appendix D).

The tree cover on Cowal West Hill has been thinned by logging of White Cypress Pine (*Callitris glaucophylla*) in the past (Appendix D). Lands surrounding ML 1535 are predominantly used for agriculture.

Previous Vegetation Studies

A vegetation survey of the ML area and surrounds was conducted by Anne Clements and Associates (1995) and Charles Sturt University (1997). Vegetation mapping for the EIS and *Cowal Gold Project Species Impact Statement* (SIS) (Resource Strategies, *et al.* 1997) was produced from studies by Charles Sturt University (1997) (Figure 4-11). Bower mapped vegetation along the approved pipeline route to the approved CGM borefield on the eastern side of Lake Cowal (Figure 1-1) (Bower, 2003a) and along the access road from West Wyalong to the approved CGM (Figure 1-1) (Bower, 2003b).

Broader vegetation studies covering the ML area and surrounds have been conducted by Sivertson and Metcalfe (1995) and Austin *et al.* (2000). Sivertson and Metcalfe (1995) described the vegetation on the Forbes 1:250,000 map sheet and Austin *et al.* (2000) analysed the vegetation of the Central Lachlan Region. A number of distinct vegetation associations were identified for the region around Lake Cowal in the definitive study by Austin *et al.* (2000).

Previous Targeted Searches

Since 1998, Bower (Orchid Research and FloraSearch) has conducted a number of targeted threatened species searches within the ML area and surrounds. Targeted threatened species searches were conducted at the approved CGM and pipeline (Bower, 1997, 1998a, 1998b, 2003a; Barrick, 2003h), along the Temora to Cowal ETL (Bower, 2003c; Country Energy, 2004) and along the approved CGM access road upgrade (Bower, 2003b; Barrick, 2003i).

These previous targeted threatened species searches were conducted for all threatened flora species considered likely to occur within the ML area.

Supplementary Flora Survey

A supplementary flora survey was conducted for the E42 Modification by FloraSearch in autumn 2008 (Appendix D). The survey focused on the proposed disturbance area for the E42 Modification (Figure 1-3) and took into consideration the previous vegetation studies and targeted searches described above.

The survey was used to:

- confirm the distribution of vegetation communities in the E42 Modification disturbance area;
- confirm flora species present in each vegetation community; and
- identify any threatened flora species and ecological communities within the E42 Modification disturbance area (including those listed under the schedules of the TSC Act and the EPBC Act).

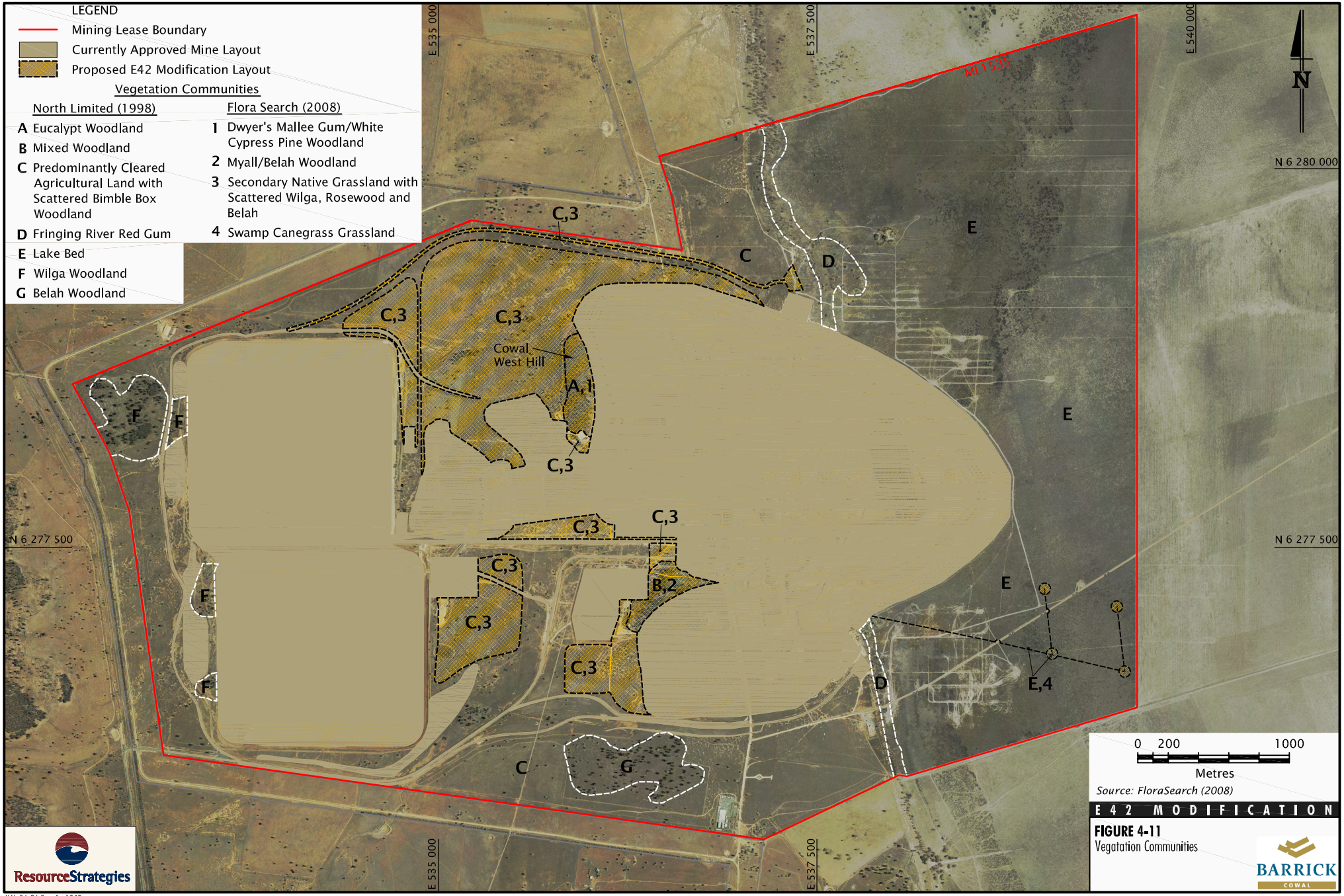
Targeted searches for threatened flora species and ecological communities considered possible occurrences within the E42 Modification disturbance area were conducted. All habitat types were surveyed to maximise the chances of finding populations of any threatened species that may occur.

Vegetation Communities within the E42 Modification Disturbance Area

As shown of Figure 4-11, the proposed E42 Modification disturbance area is predominantly previously cleared agricultural land, and is currently located within ML 1535 and not accessible to stock. Some remnant vegetation occurs on Cowal West Hill and in areas with Myall/Belah Woodland as described below.

Four plant communities were identified in the E42 Modification disturbance area (Figure 4-11). The vegetation communities identified are listed below and are described in detail in Appendix D:

- Dwyer's Mallee Gum/White Cypress Pine Woodland – a component of the Eucalypt Woodland (*Eucalyptus dwyeri/E. populnea/ E. microcarpa/Calitirs glaucophylla/ Casuarina cristata*) community identified in the EIS.
- Myall/Belah Woodland – equivalent to the Mixed Woodland (*Acacia pendula/C. cristata*) community identified in the EIS.
- Secondary Native Grassland with Scattered Wilga, Rosewood and Belah – equivalent to the Predominantly Cleared Agricultural Land with Scattered Bimble Box (*E. populnea*) community identified in the EIS. This community is a product of prior agricultural clearing.
- Swamp Canegrass Grassland – equivalent to the Lakebed (*Eragrostis australasica*/*Medicago polymorpha*) community identified in the EIS.


LEGEND
Mining Lease Boundary
Currently Approved Mine Layout
Proposed E42 Modification Layout
Vegetation Communities
North Limited (1998)
A Eucalypt Woodland
B Mixed Woodland
C Predominantly Cleared Agricultural Land with Scattered Bimble Box Woodland
D Fringing River Red Gum
E Lake Bed
F Wilga Woodland
G Belah Woodland
Flora Search (2008)
1 Dwyer's Mallee Gum/White Cypress Pine Woodland
2 Myall/Belah Woodland
3 Secondary Native Grassland with Scattered Wilga, Rosewood and Belah
4 Swamp Canegrass Grassland
E 535 000
E 537 500
E 540 000
N 6 280 000
N 6 277 500
ML 1535
Cowal West Hill
C,3
A,1
B,2
E,4
0 200 1000
Metres
Source: FloraSearch (2008)
E42 MODIFICATION
FIGURE 4-11
Vegetation Communities
ResourceStrategies
BARRICK
COWAL
HAL-06-26 Sect 4 _104G

The Dwyer's Mallee Gum/White Cypress Pine Woodland and Myall/Belah Woodland represent the original native climax vegetation communities (i.e. vegetation which would have occurred prior to agricultural clearing) (Appendix D). The Secondary Native Grassland with Scattered Wilga, Rosewood and Belah vegetation community is a secondary native grassland resulting from extensive clearing for previous agricultural purposes (*ibid*.). The Swamp Canegrass Grassland occurs within the lakebed and is adapted to the irregular wetting and drying cycle (*ibid*.). Historically throughout its drying cycle the lakebed has been subject to livestock grazing and, in some areas, cropping (*ibid.*).

The condition of the vegetation in the E42 Modification disturbance area is influenced by a number of factors including land clearing, former prolonged grazing by livestock and the effects of recent drought conditions (Appendix D). The floristic condition of the vegetation communities ranges from poor (Secondary Native Grassland with Scattered Wilga, Rosewood and Belah) to moderate (Dwyer's Mallee Gum/White Cypress Pine Woodland) and good (Myall/Belah Woodland – although the tree health of the Myall was generally poor and prior grazing has suppressed regeneration in past decades) (*ibid*.). The condition of the Swamp Canegrass Grassland would vary with the flooding cycle of the Lake (*ibid*.).

Flora Species Composition

As discussed above and in Appendix D, a significant number of flora surveys have been conducted which are applicable to the CGM area and surrounds.

The regional study conducted by Anne Clements and Associates (1995) recorded a total of 411 flora species, of which 90 (21%) were weed species. Of the 411 species found in the regional study 122 (30%) were recorded in the CGM area (Anne Clements and Associates, 1995).

The flora survey and assessment of the mining operations area undertaken by Charles Sturt University in 1997 recorded a total of 141 species of which 42 (30%) were weed species.

During the 2008 Flora Assessment, FloraSearch recorded a total of 87 plant species within the E42 Modification disturbance area, of which 75 were native and 12 (14%) were weed species (Appendix D).

The most prominent families of native plants in descending order were the Poaceae (Grasses) – 22 species, Chenopodiaceae (Saltbushes) – 16 species, Asteraceae (Daisies) – six species and Cyperaceae (Sedges) – five species. The dominant families of introduced species were the Asteraceae (Daisies) – three species, Boraginaceae (Heliotropes) - two species and Cucurbitaceae (Melons) – two species. A list of the plant species recorded during the survey in the E42 Modification disturbance area is provided in Appendix D.

Threatened Flora Species

A desktop assessment was undertaken to determine the threatened species which occur within the wider region (i.e. for a 400 km^2 search area surrounding the E42 Modification disturbance area), which considered the results from previous studies and surveys. The seven threatened flora species identified from the desktop assessment are presented in Table 4-9.

The *Pilularia novae-hollandiae* is the only threatened flora species to have been previously recorded within ML 1535 (although outside the E42 Modification disturbance area) (Appendix D).

Targeted searches for threatened flora species were conducted in the E42 Modification disturbance area during the supplementary survey.

No species listed as threatened under the TSC Act or the EPBC Act were identified during the survey (Appendix D).

Although the survey timing was unsuitable for *Pilularia novae-hollandiae*, *Diuris tricolor*, *Swainsona sericea* and *S. murrayana*, which are only positively identifiable when flowering or actively growing in spring (Appendix D), the potential impacts on those species were assessed (*ibid.*).

Previous targeted searches for these threatened flora species in the CGM area and surrounds have identified the following:

- *Pilularia novae-hollandiae* has been found in the Lake Cowal area, including within ML 1535, growing most commonly in gilgai depressions with a sticky grey mud base and was absent from depressions with friable or stony soils (Bower, 1998a).

- *Diuris tricolor* was detected in targeted surveys on the route of the approved access road to the approved CGM and in the nearby region (Bower, 2004a). It was found on coarse sandy granitic soils in communities dominated by *Eucalyptus dwyeri*, *E. populnea* and *Callitris glaucophylla* (*ibid*.).
- *Swainsona sericea* has been found as a roadside population on a granite outcrop near Billys Lookout some 9.5 km south-west of the E42 Modification area in 2004 (Bower 2004b). A second much larger population was found beside the Ungarie-Condobolin Road about 30 km north-west of Billys Lookout, also in 2004 (Bower, 2004b).
- *S. murrayana* has been recorded approximately 30 km south of the CGM although this species has not been recorded within ML 1535 or surrounding areas in similar habitat to the southern records despite several flora surveys (Appendix D).

Threatened Flora Populations

No threatened flora populations listed under the TSC Act or EPBC Act were identified by the Flora Assessment (Appendix D).

Threatened Ecological Communities

One threatened ecological community listed under the TSC Act was found during the survey, *viz. Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions* (Appendix D). The Myall Woodland Endangered Ecological Community (EEC) equates to the Myall/Belah Woodland vegetation community described above and shown on Figure 4-11. The potential impacts of the E42 Modification on this ecological community are assessed in Section 4.6.2.

The closest area of Myall Woodland EEC outside of ML 1535 (approximately 75 ha) occurs to the south of ML 1535, within a reserve of Crown land on the edge of Lake Cowal.

Table 4-9
Threatened Flora Species Recorded or Predicted within the Wider Area

Scientific Name	Common Name	Conservation Status		Source of Record			
		TSC Act[1]	EPBC Act[2]	DECC Atlas of NSW Wildlife[3]	Sydney Royal Botanic Gardens[4]	EPBC Act Protected Matters Search[5]	BioNet[6]
Lepidium aschersonii	Spiny Pepper-cress	V	V	-	✓	-	✓
Pilularia novae-hollandiae	Austral Pillwort	E	-	-	✓	-	✓
Swainsona sericea	Silky Swainson-pea	V	-	-	✓	-	✓
Diuris tricolor syn. *Diuris sheaffiana*	Tricolour Diuris	V	V	-	-	Predicted	-
Austrostipa wakoolica	A Speargrass	E	E	✓	-	Predicted	✓
Austrostipa metatoris	A Speargrass	V	V	-	-	Predicted	-
Swainsona murrayana	Slender Darling-pea	V	V	-	-	Predicted	-

Source: Appendix D

1 Threatened Species Status under the TSC Act.

2 Threatened Species Status under the EPBC Act.
V Vulnerable E Endangered

3 DECC (2008b).

4 Sydney Royal Botanic Gardens (2008).

5 DEWHA (2008c).

6 BioNet (2008).

Critical Habitat

No critical habitats have been identified in the Register of Critical Habitat held by the Commonwealth Minister for the Department of Environment, Heritage and the Arts (DEWHA, 2008d), Register of Critical Habitat held by the Director-General of the DECC (DECC, 2008c) or within the Bland LEP (BSC, 2008), as occurring within the E42 Modification disturbance area or surrounds (Appendix D).

Matters of National Environmental Significance

As described in Section 3.4, an action that is determined by the Commonwealth Minister for the Environment, Heritage and the Arts as likely to have a significant impact on a matter of national environmental significance or other matter protected by the EPBC Act is considered to be a "controlled action".

The CGM was referred for consideration under the EPBC Act on 29 August 2001. The Commonwealth Minister for the Environment and Heritage determined that the CGM was not a controlled action on 29 September 2001.

Matters of national environmental significance relevant to flora at the modified CGM, *viz*. threatened flora species and ecological communities listed under the EPBC Act, are considered above and in Appendix D.

Introduced Flora Species and Noxious Weeds

Twelve species of introduced plants were recorded in the E42 Modification disturbance area comprising about 14% of the total species observed (Appendix D). The relative lack of introduced species (despite the high levels of grazing to which the land had been subjected by previous pastoral owners, which tends to favour many introduced weeds) is largely due to the mid-autumn timing of the survey, since in western NSW most introduced species are annuals that germinate and grow in late autumn and winter, with flowering in early spring before they die back in late spring (*ibid*.). By contrast, much of the native flora comprises perennial species that tend to grow and flower later and remain in evidence throughout the year (*ibid*.).

Two species recorded during the survey, African Boxthorn (*Lycium ferocissimum*) and Bathurst Burr (*Xanthium spinosum*), are listed as Class 4 noxious weeds in the Bland Shire (DPI, 2008). Barrick currently manage weeds at the approved CGM in accordance with measures described in the LMP (Barrick, 2003d).

Existing Management Measures

The CGM currently implements the following environmental management plans and other documents (prepared in accordance with the Development Consent Conditions) relevant to the management of flora at the approved CGM:

- FFMP, which includes the Vegetation Clearance Protocol (VCP);
- TSMP;
- CWMP;
- LMP;
- LSMP;
- BMP;
- DMP; and
- MOP (2007 – 2009).

In accordance with the FFMP, the following flora-related issues are required to be reported in each AEMR (Barrick, 2003j):

- vegetation clearance activities;
- weed and pest management;
- results of flora monitoring programmes; and
- the progress of remnant vegetation and wetland enhancement programmes.

In accordance with the Development Consent, a summary of the effectiveness of the measures outlined in the FFMP and TSMP are required to be included in each AEMR. No significant impacts on flora have been reported by Barrick and the control strategies implemented during each of the reporting periods were considered to be effective in minimising impacts to threatened flora (Barrick, 2005b, 2006a; 2007a, 2008a). This is consistent with predictions of potential impacts on flora described in the EIS.

Where relevant to potential impacts on flora, the performance of flora management measures has been considered and is described below where appropriate.

4.6.2 Potential Impacts

The EIS and SIS assessed the short-term and long-term potential impacts of the approved CGM on flora. The type of E42 Modification potential impacts would be largely the same as those identified in the EIS and SIS, the difference due to an increase in the area proposed to be cleared (Appendix D).

The following sub-sections evaluate the potential impacts of the modififed CGM on flora species, populations and ecological communities, and their habitats in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). This evaluation includes identification of the magnitude, extent and significance of the potential impacts. Proposed measures to avoid, minimise, mitigate, offset, manage and monitor potential impacts on flora are provided in Section 4.6.3.

Vegetation Clearance

It is conservatively estimated that approximately 290 ha of land would be cleared or modified for the E42 Modification (Figure 4-11). Remnant climax vegetation communities that would be cleared or modified include:

- approximately 15 ha of Dwyers Mallee Gum/White Cypress Pine Woodland; and
- approximately 15 ha of Myall/Belah Woodland (equivalent to the Myall Woodland EEC which is assessed below).

Approximately 10 ha of Swamp Canegrass Grassland would also be cleared for the saline groundwater supply borefield (including the associated pipeline).

Approximately 250 ha of the Secondary Native Grassland with Scattered Wilga, Rosewood and Belah vegetation community would also be cleared for the E42 Modification.

Clearing native vegetation is a key threatening process listed under the TSC Act and the EPBC Act, however, the vegetation clearance required for the E42 Modification is unlikely to significantly impact any vegetation communities, given (Appendix D):

- the relatively small areas of climax vegetation required to be cleared;
- all vegetation communities have been subject to partial or nearly complete land clearing; and
- the disjunct nature of the vegetation patches that are located adjacent to approved mine infrastructure.

Potential indirect effects of vegetation clearance include weed and pest proliferation, as discussed below.

Introduced Flora Species

Native vegetation disturbance can act as a catalyst for weed incursion and, if management initiatives are not implemented, proliferation of weeds can occur.

The E42 Modification is not considered to significantly increase the potential for weed incursion, given the weed control measures outlined in the LMP, which would continue to be implemented (Appendix D).

Introduced Fauna Species

Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) is a key threatening process listed under the TSC Act (NSW Scientific Committee, 2002). Rabbits and other introduced animal species (e.g. the Red Fox, Feral Cat, Brown Hare, House Mouse and Sheep) have been recorded within ML 1535 (Appendix E). The Rabbit and other introduced animals can result in erosion problems as well as reduce recruitment and survival of native plants (Appendix D).

Introduced animals have the potential to increase or become concentrated in the vicinity of the mine without the appropriate measures. However, given the pest control measures currently implemented at the approved CGM (Section 4.6.3), the modified CGM is unlikely to significantly increase the potential introduced animal impacts on flora (Appendix D).

Vegetation and Dust

Studies have shown that excessive dust can impact on the health and viability of vegetation. Dust can affect vegetation by inhibiting physiological processes such as photosynthesis, respiration and transpiration, and allow penetration of phytotoxic gaseous pollutants (Farmer, 1993; Eller, 1977).

A study on the effect of dust on photosynthesis and its significance for plants (Thompson *et al.*, 1984) found that photosynthesis and leaf diffusion resistance was reduced at 5 to 10 grams (g) of dust per square metre (m^2) leaf surface.

The survey of the vegetation communities in the E42 Modification disturbance area did not identify dust impacting the vegetation condition, despite their locations immediately adjacent approved CGM dust-generating activities.

An assessment of the potential generation and dispersion of atmospheric dust resulting from the modified CGM was carried out by Holmes Air Sciences and is presented in Appendix G.

Given that predicted dust deposition contours (Appendix G) indicate that levels of approximately 0.4 grams per square metre per month (g/m^2/month) or less are predicted to be contributed from the modified CGM or a total of 3.2 g/m^2/month or less with background contributions, vegetation species diversity and abundance in areas outside the ML are unlikely to be deleteriously affected. Further, the approach used by Holmes Air Sciences for predicting dust concentrations provides for a conservative assessment because the background levels are likely to include some contribution from the approved CGM (Appendix G). Potential dust impacts are discussed in Section 4.9, along with proposed dust controls.

Threatened Flora Species and Ecological Communities

No threatened flora species were recorded during the survey. However, potential habitat for the Austral Pillwort (*Pilularia novae-hollandiae*), Tricolour Diuris (*Diuris tricolor*) and Silky Swainson-pea (*Swainsona sericea*) were found by the survey (Appendix D). The potential impacts from the E42 Modification on these three species were assessed based on the questions in the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). The potential impacts from the E42 Modification on other threatened flora species, which are less likely to be affected, were also assessed by FloraSearch (Appendix D).

Appendix D concluded that the modified CGM would unlikely lead to the extinction of any flora species, population or ecological community or place any at risk of extinction.

As described in Section 4.6.1, one threatened ecological community listed as endangered under the TSC Act was found, namely, 15 ha of the Myall Woodland EEC (Figure 4-11).

Appendix D concluded that the E42 Modification would result in the loss of a local occurrence of the Myall Woodland EEC, however, it is unlikely to lead to the loss of the community in the surrounding area.

Matters of National Environmental Significance

FloraSearch undertook an assessment of the potential impact on matters of national environmental significance relevant to flora, *viz*. threatened flora species and ecological communities listed under the EPBC Act (Appendix D).

Based on the above, Appendix D concluded that no matters of national environmental significance relevant to flora are likely to be significantly impacted by the modified CGM.

Summary of Potential Impacts on Flora

The Flora Assessment concluded the following (Appendix D):

- The biodiversity values of the region would be likely to be maintained, and possibly improved, considering the proposed measures to mitigate and/or offset potential impacts (Section 4.6.3).
- The E42 Modification would result in the loss of a local occurrence of the Myall Woodland EEC, however, it is unlikely to lead to the loss of the community in the surrounding area.
- The E42 Modification would be unlikely to lead to the extinction of any flora species, population or ecological community or place any at risk of extinction.
- The E42 Modification would not affect any listed threatened population of a flora species.
- The E42 Modification would be unlikely to adversely affect critical habitat as no critical habitats are known to occur within the vicinity of the E42 Modification area.
- The E42 Modification would be very unlikely to adversely affect areas of high conservation value.
- Vegetation that would be removed or modified by the E42 Modification would not be likely to adversely impact the long-term viability of any flora species, population or ecological community.
- Matters of national environmental significance relevant to flora would not be likely to be significantly impacted by the modified CGM.

4.6.3 Mitigation Measures and Management

As described in Section 4.6.1, potential impacts to flora are currently managed via implementation of measures included in the following:

- FFMP, which includes the VCP;
- TSMP;
- CWMP;
- LMP;
- LSMP;
- BMP;
- DMP; and
- MOP (2007 – 2009).

These measures would continue to be implemented where relevant and management plans would be updated as described below.

FloraSearch (Appendix D) and Western Research Institute (Appendix E) concluded that biodiversity values would be maintained or improved in the medium to long-term considering the following:

- proposed impact avoidance and mitigation measures which have been implemented at the approved CGM (e.g. minimising disturbance to native vegetation, control of weeds and pests and monitoring) and would continue at the modified CGM;
- progressive rehabilitation and revegetation of the mine disturbance area; and
- the E42 Modification offset (see below).

Details relevant to these conclusions is provided below.

Flora Management

The mitigation measures and management for flora (including threatened ecological communities, populations and species) at the approved CGM are presented in the FFMP (Barrick, 2003j). The objectives of the FFMP are to fulfil the relevant consent conditions by providing:

- methods to conserve and enhance wildlife values around Lake Cowal and within ML 1535;
- monitoring of flora within the Lake Cowal region as documented in the EIS and SIS;
- details to relocate any threatened species and/or its habitat away from disturbed areas that are created by mine operations;
- details of monitoring the mine's impacts particularly on threatened flora, and contingency measures should impacts be identified as occurring; and
- a threatened species management protocol, including provisions for targeted searches prior to construction and proposed mitigation measures where threatened flora species are found.

The FFMP would be revised to incorporate the modified CGM.

Vegetation Clearance Protocol

A VCP has been implemented at the approved CGM to minimise the potential impact of vegetation clearance activities on flora and is described in the FFMP. The VCP would be continued for the modified CGM. In accordance with the VCP, clearance activities would be restricted to the areas occupied by the mine activities, buildings and paved surfaces, and those necessary for fire control.

In accordance with the VCP, the boundary of the disturbance area would be clearly marked or fenced to prevent accidental damage to adjacent areas during vegetation clearance and/or construction works. Accordingly, disturbance to potential habitat of threatened flora species would be avoided and/or minimised, where practicable.

Implementation of the Threatened Species Management Protocol

The TSMP (Barrick, 2003h) describes how the threatened species management protocol is to be implemented. The key components of the TSMP include: database interrogation, preliminary assessment, secondary assessment, threatened species management strategy and regulatory review. The TSMP includes threatened species management strategies prepared for threatened species which have been recorded in the course of targeted surveys or for which habitat resources typically associated with the lifecycle components of a threatened species have been identified.

The TSMP has been implemented at the approved CGM and would be continued for the modified CGM.

Rehabilitation Planning

In accordance with the TSMP, as a component of the rehabilitation programme for the approved CGM, consideration is to be given to trialling the establishment of the *Pilularia novae-hollandiae* (Barrick, 2003h). Trials would be conducted in the event it is determined to be advantageous to the local population of this species. This determination would be made in consideration of the success of the other management strategies implemented. The trials would be conducted when edaphic conditions are suitable.

The revegetation programme for the modified CGM would aim to revegetate new landforms with selected species of native and/or endemic vegetation that are both suitable to the physiographic and hydrological features of each landform, and which expand on the areas of remnant endemic vegetation that currently exist in the immediate region. This would include species characteristic of the Myall Woodland EEC (e.g. Myall [*Acacia pendula*] and Belah [*Casuarina cristata*]), as described in the existing TSMP (Barrick, 2003h).

Further details of the Rehabilitation and Landscape Management Strategy for the modified CGM are provided in Section 5.

Dust Management

The mitigation and management measures for wind blown and mine generated dust at the approved CGM are presented in the DMP (Section 4.9). These management and mitigation measures described in the DMP would continue to be implemented for the for the modified CGM (Section 4.9).

Weed Management

Barrick currently manage weeds at the approved CGM in accordance with measures described in the LMP (Barrick, 2003d). The weed management programme is aimed at minimising the possibility of new weed incursion and controlling the spread of any existing noxious weeds on Barrick-owned land (Barrick, 2003d). The weed management programme described in the LMP would be continued for the modified CGM.

Pest (Animal and Vermin) Control

Pest control activities implemented at the approved CGM are described in the LMP and FFMP include (Barrick, 2003d, 2003j):

- regular property inspections to assess the status of pest populations within Barrick-owned land;
- mandatory pest control for declared pests (i.e. rabbits, pigs and wild dogs) in accordance with Pest Control Orders under the *Rural Lands Protection Act, 1998*; and
- inspections to assess the effectiveness of control measures implemented and review these if necessary.

These pest control activities described in the LMP and FFMP would be continued for the modified CGM.

Compensatory Wetland Management

The CWMP details the compensation measures developed for the loss of wetland disturbed by the approved CGM. These compensation measures include the enhancement of existing wetland within ML 1535 during mine operation and following closure of the mine.

These compensation measures would be continued for the modified CGM.

E42 Modification Offset

The DGRs (Attachment 1) require a description of the measures that would be implemented to ensure there is no net loss of the biodiversity values of the region in the medium to long-term[4].

The following discussion describes an offset which, when combined with the mitigation measures described above and the rehabilitation proposal described in Section 5, would maintain or improve biodiversity values in accordance with the objectives of the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

Two offset areas which are located on land owned by Barrick are proposed (i.e. a northern offset area and a southern offset area) (Figure 4-12).

[4] This requirement is taken to be relevant only to Barrick CGM activities.

Table 4-10 provides a summary of the E42 Modification offset. It is proposed that significant areas of existing native vegetation would be enhanced (some 340 ha) and significant areas of cleared agricultural land would be revegetated (some 120 ha).

Flora Characteristics

The southern offset area (Figure 4-12) provides the following vegetation types (Appendix D):

- Dwyer's Mallee Gum/Black Cypress Pine/Currawang Woodland (*Eucalyptus dwyeri*/*Callitris endlicheri*/*Acacia doratoxylon*);
- Dwyer's Mallee Gum Grassy Woodland (*E. dwyeri*);
- Dwyer's Mallee Gum/White Cypress Pine Woodland (*E. dwyeri*/*C. glaucophylla*);
- Secondary Native Grassland with Scattered Wilga, Rosewood and Belah (*Geijera parviflora*/*Alectryon oleifolius*/*Casuarina cristata*);
- Inland Grey Box/Mugga Ironbark Tall Woodland (*E. microcarpa*/*E. sideroxylon*);
- Inland Grey Box/Wilga/White Cypress Pine Tall Woodland (*E. microcarpa*/*G. parviflora*/ *C. glaucophylla*); and
- White Cypress Pine regeneration (*C. glaucophylla*).

The northern offset area (Figure 4-12) provides the following vegetation types (Appendix D):

- Secondary Native Grassland with Scattered Wilga, Rosewood and Belah (*Geijera parviflora*/*Alectryon oleifolius*/*Casuarina cristata*); and
- Secondary Native Grassland on Gilgai with Scattered Myall/Belah/Rosewood and Inland Grey Box (*A. pendula*/*C. cristata*/ *A. oleifolius*/*E. microcarpa*).

The northern offset area also provides the opportunity to increase the area of Myall Woodland in the landscape through natural regeneration and revegetation (Appendix D).

During a targeted survey, large populations of the threatened species *Pilularia novae-hollandiae* were recorded from gilgai within the northern proposed offset area in 1998 (Bower, 1998a). An excess of 4,000 *Pilularia novae-hollandiae* were recorded (Bower, 1998a).

Cleared agricultural land also occurs within the offset areas. The proposal to revegetate these cleared areas with woodland vegetation provides the opportunity to increase existing remnant patch sizes.

Management

The conservation of the offset areas would be secured through rezoning and/or re-conditioning of relevant landholdings to reflect conservation purposes. The rezoning and/or re-conditioning would be undertaken in consultation with the BSC. The rezoning and/or re-conditioning of relevant landholdings would be undertaken within three years of the Development Consent being modified or a time period to the satisfaction of the Director-General of the DoP.

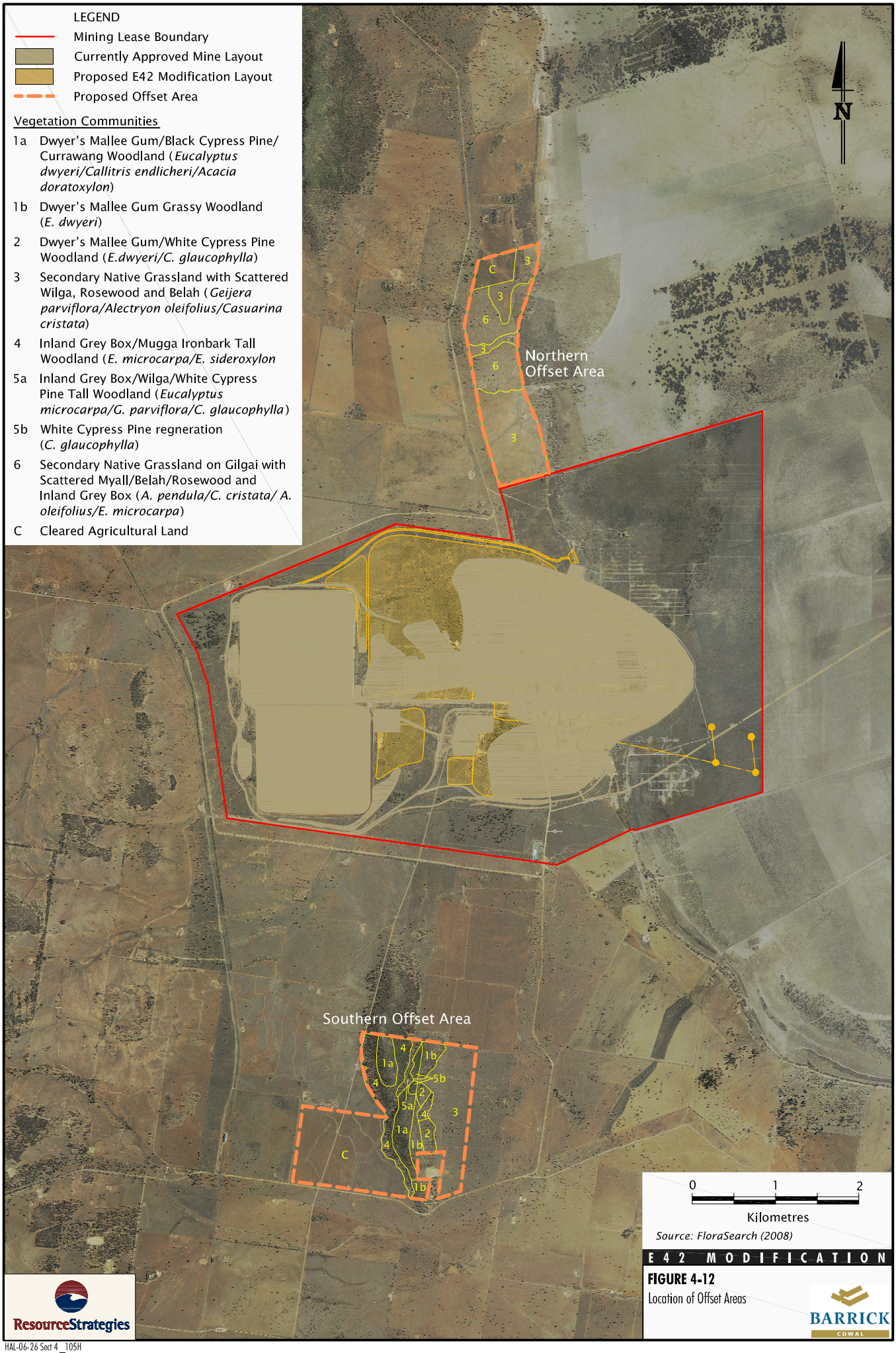
In addition, an Offset Management Plan would be prepared to facilitate the management of the relevant lands. The plan would detail measures including:

- revegetation planting;
- exclusion of grazing to facilitate the regeneration of native vegetation;
- weed and pest management;
- soil erosion remediation;
- selective use of native plant fertilizer;
- signage of the vegetation offset areas; and
- monitoring the performance of the offset by suitably qualified person(s).

Table 4-10
E42 Modification Offset

Area	Description	Approximate Size (ha)*
Enhancement Area	Enhancement through natural regeneration and management for conservation.	340
Revegetation Area	Re-establishment of woodland in cleared agricultural land by revegetation.	120
	Total Area Conserved (ha)	460

Approximate areas are based on vegetation mapping shown on Figure 4-12.


LEGEND
Mining Lease Boundary
Currently Approved Mine Layout
Proposed E42 Modification Layout
Proposed Offset Area
Vegetation Communities
1a Dwyer's Mallee Gum/Black Cypress Pine/ Currawang Woodland (Eucalyptus dwyeri/Callitris endlicheri/Acacia doratoxylon)
1b Dwyer's Mallee Gum Grassy Woodland (E. dwyeri)
2 Dwyer's Mallee Gum/White Cypress Pine Woodland (E.dwyeri/C. glaucophylla)
3 Secondary Native Grassland with Scattered Wilga, Rosewood and Belah (Geijera parviflora/Alectryon oleifolius/Casuarina cristata)
4 Inland Grey Box/Mugga Ironbark Tall Woodland (E. microcarpa/E. sideroxylon
5a Inland Grey Box/Wilga/White Cypress Pine Tall Woodland (Eucalyptus microcarpa/G. parviflora/C. glaucophylla)
5b White Cypress Pine regneration (C. glaucophylla)
6 Secondary Native Grassland on Gilgai with Scattered Myall/Belah/Rosewood and Inland Grey Box (A. pendula/C. cristata/ A. oleifolius/E. microcarpa)
C Cleared Agricultural Land
N
Northern Offset Area
Southern Offset Area
0
1
2
Kilometres
Source: FloraSearch (2008)
E42 MODIFICATION
FIGURE 4-12
Location of Offset Areas
ResourceStrategies
BARRICK
COWAL
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The proposed offset areas are considered suitable for offsetting against potential residual impacts associated with the E42 Modification (after the avoidance and mitigation measures provided above), given the anticipated improvement in the flora value of the land within the offset areas in the medium to long-term (Appendix D).

4.7 FAUNA

A Fauna Assessment was prepared for the E42 Modification by Western Research Institute (2008) and is presented in Appendix E. The Fauna Assessment was prepared in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

4.7.1 Existing Environment

Bioregion and Zoogeographic Region

The CGM is located in the central north-west of the NSW South Western Slopes Bioregion (Section 4.6.1) and also within the Eyrean zoogeographic region. The ML area is former cleared and semi-cleared farmland that was used for grazing of predominantly native pastures by livestock. The main landuse within ML 1535 is now mining. Lands surrounding ML 1535 are predominantly used for agriculture.

Previous Fauna Surveys and Studies

A significant number of vertebrate fauna surveys and studies have been conducted which are applicable to the CGM area and surrounds, including:

- historic surveys (Vestjens, 1977; Braithwaite *et al*. 1985a, 1985b, 1986a, 1986b; Kingsford *et al*. 1989, 1990, 1991; Lawler, 1989 and Goldney and Bowie, 1990);
- fauna surveys and assessments conducted for the EIS and the SIS (Lane, 1989, 1990, 1991a, 1991b, 1991c; Gunninah Consultants, 1995; Fisheries Research Institute, 1997; Greg Richards and Associates, 1997a, 1997b; Mount King Ecological Surveys, 1997);
- bird breeding monitoring (Lane, 1989, 1990, 1991a, 1991b, 1991c; Crome, 1995; Environmental and Educational Services, 1992-2000; Gell and Peake, 2001; Gell, 2002-2005, 2007, 2008; Peake, 2006);
- fauna surveys and assessments conducted for the TSMP (Barrick, 2003h, 2003i; Country Energy, 2004);
- fauna species recorded within ML 1535 from January 2005 to February 2008 (Donato and Rowntree, 2006; Donato, 2007; Donato and Smith, 2008; Barrick, 2005c-z, 2005zi, 2005zii, 2005ziii, 2005ziv; 2006b-d; 2007b-e; 2008b, 2008c); and
- a recent vertebrate fauna assessment of the Lachlan Catchment (Goldney *et al*., 2008).

These fauna surveys and studies are discussed further in Appendix E and below where relevant.

Supplementary Fauna Survey

A supplementary vertebrate fauna survey was conducted for the E42 Modification by Western Research Institute in autumn 2008 (Appendix E). The survey focused on the proposed disturbance area for the E42 Modification (Figure 1-3) and took into consideration the previous vertebrate fauna surveys and studies described above.

The survey was used to:

- identify the fauna habitat resources within the E42 Modification disturbance area;
- identify any terrestrial vertebrate fauna species (native and introduced) and their relative abundance within the E42 Modification disturbance area, including any threatened terrestrial vertebrate fauna species within the E42 Modification disturbance area (including those listed under the schedules of the TSC Act and the EPBC Act); and
- compare the vertebrate diversity of the E42 Modification disturbance area with those identified in nearby or regional faunal survey projects.

Targeted searches for threatened terrestrial vertebrate fauna species considered possible occurrences within the E42 Modification disturbance area were conducted. All habitat types were surveyed to maximise the chances of finding populations of any threatened species that may occur.

Fauna Habitat within the E42 Modification Disturbance Area

The following four broad fauna habitat types were identified within the E42 Modification disturbance area (Appendix E):

- Eucalypt Woodland – occurring on Cowal West Hill and dominated by *Eucalyptus dwyeri* and *Callitris glaucophylla.* This remnant woodland is elevated about 15 to 20 m above the surrounding landscape and is immediately adjacent to the currently approved northern waste emplacement to the east, ore and soil stockpiles to the south and predominantly cleared agricultural land to the north and west (Figure 4-13).
- Mixed Woodland – dominated by Belah (*Casuarina cristata*) and Myall (*Acacia pendula*). This habitat type is equivalent to the Myall Woodland EEC described in Section 4.6.1. This remnant woodland is surrounded by approved developments: the southern waste emplacement, process plant to the immediate west and north-east, and soil stockpiles to the south (Figure 4-13).
- Cleared Agricultural Land with Scattered Trees - a human-made landscape created through extensive clearing and a range of agricultural practices (with grazing being the dominant practice) (Figure 4-13).
- Lakebed – the grassland vegetation on the lakebed of Lake Cowal is adapted to the irregular wetting and drying cycle. When inundated, propagules of ephemeral aquatic plants germinate and grow. When dry, the bare lakebed is colonised by the seeds of many grasses and herbs creating a temporary grassland. Historically throughout its drying cycle the lakebed has been subject to livestock grazing and, in some areas, cropping (Figure 4-13).

The overall fauna habitat condition was assessed as being moderate. The assessments indicated that these habitats within the E42 Modification disturbance area have been degraded due to pastoral land management practices, although native plant recoveries have been improving following the reduction of grazing with the commencement of mining. The assessments also found that there was a low level of weed invasion, the presence of fallen logs and the presence of micro and macro tree hollows in sufficient numbers to support a limited number of hollow dependent fauna. However, the extent of these moderate habitats and their relative isolation within the landscape would be expected to support relatively low vertebrate species diversity (Appendix E).

Fauna Species Composition

As discussed above and in Appendix E, a significant number of vertebrate fauna surveys have been conducted which are applicable to the CGM area and surrounds.

A comprehensive list of fauna species from within ML 1535 has been recorded for the CGM. Between January 2005 to February 2008, 111 native vertebrate species have been identified within ML 1535, including 6 native amphibians, 16 native reptiles, 70 native birds and 19 native mammals (Donato and Rowntree, 2006; Donato, 2007; Donato and Smith, 2008; Barrick, 2005c-z, 2005zi, 2005zii, 2005ziii, 2006ziv; 2006b-d; 2007b-e; 2008b, 2008c).

Bird breeding monitoring since 1989 has provided information on the waterbirds present at Lake Cowal when the lake contains water (Lane, 1989, 1990, 1991a, 1991b, 1991c; Crome, 1995; Environmental and Educational Services, 1992-2000; Gell and Peake, 2001; Gell, 2002-2005, 2007, 2008; Peake, 2006).

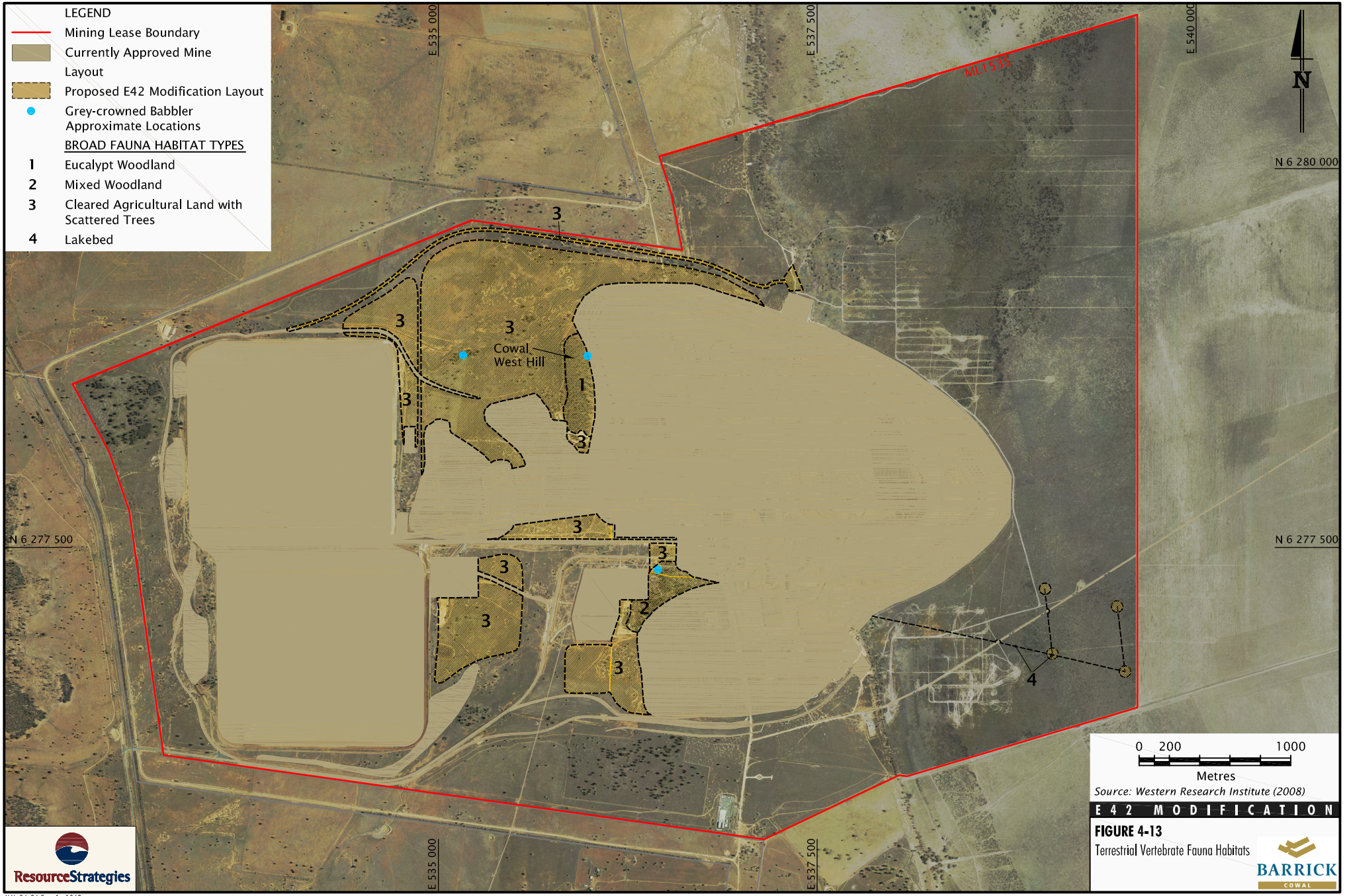
During the supplementary fauna survey for the E42 Modification, 39 native species were identified (Appendix E). The most diverse group of species recorded were birds (30 native species observed), followed by amphibians, reptiles and mammals (three native species of each group recorded).

The fauna habitat within the E42 Modification disturbance area is limited and surrounded by the approved CGM disturbance area. As expected, the vertebrate species detected in the E42 Modification disturbance area was a relatively small subset of species that were once located within ML 1535 prior to approved CGM development, as well as a subset of those species located during approved CGM pre-clearance surveys within ML 1535 between January 2005 and February 2008.

Threatened Fauna Species

A desktop assessment was undertaken to determine the threatened species within or proximal to ML 1535, which considered the results from previous studies and surveys. The 13 threatened fauna species identified from the desktop assessment are presented in Table 4-11.

Targeted searches for threatened fauna species were conducted in the E42 Modification disturbance area during the supplementary survey.



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Table 4-11
Threatened Fauna Species with Records within or Proximal to ML 1535

Scientific Name	Common Name	Conservation Status	
		TSC Act[1]	EPBC Act[2]
Amphibians			
Crinia sloanei	Sloane's Froglet	V	-
Birds			
Woodland Birds			
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V	-
Polytelis swainsonii	Superb Parrot	V	V
Waterbirds			
Anseranas semipalmata	Magpie Goose	V	-
Oxyura australis	Blue-billed Duck	V	-
Stictonetta naevosa	Freckled Duck	V	-
Botaurus poiciloptilus	Australasian Bittern	V	-
Grus rubicunda	Brolga	V	-
Limosa limosa	Black-tailed Godwit	V	-
Rostratula benghalensis australis	Australian Painted Snipe	V	V
Mammals			
Chalinolobus picatus	Little Pied Bat	V	-
Nyctophilus timoriensis	Eastern Long-eared Bat (South-east form)	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-

Source: Appendix E
1 Threatened Species Status under the TSC Act.
2 Threatened Species Status under the EPBC Act.
V Vulnerable

One threatened fauna species, the Grey-crowned Babbler (*Pomatostomus temporalis temporalis*), was recorded during the supplementary fauna survey (Appendix E) at locations shown on Figure 4-13.

Endangered Fauna Populations

No endangered fauna populations listed under the TSC Act or *Fisheries Management Act, 1994* (FM Act) occur within the E42 Modification disturbance area (Appendix E).

Threatened Ecological Communities

One threatened ecological community listed under the TSC Act occurs within the E42 Modification disturbance area, namely the Myall Woodland EEC (Appendix D).

In addition, the Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Lachlan River Endangered Ecological Community (Lachlan River Catchment EEC) is listed under the FM Act and includes *all native fish and aquatic invertebrates within all natural rivers, creeks, streams and associated lagoons, billabongs, lakes, wetlands and paleo-channels, flood runners, floodplains and effluent streams of the Lachlan River* (DPI Threatened Species Unit, 2006). Lake Cowal is included in the listing of the Lachlan River Catchment EEC (DPI Threatened Species Unit, 2006).

Critical Habitat

No critical habitats have been identified in the Register of Critical Habitat held by the Commonwealth Minister for the Environment, Heritage and the Arts (DEWHA, 2008d), Register of Critical Habitat held by the Director-General of the DECC (DECC, 2008c) or within the Bland LEP (BSC, 2008), as occurring within the E42 Modification disturbance area or surrounds (Appendix E).

Matters of National Environmental Significance and Other Matters Protected by the EPBC Act

Matters of National Environmental Significance

As described in Section 3.4, an action that is determined by the Commonwealth Minister for the Environment, Heritage and the Arts as likely to have a significant impact on a matter of national environmental significance or other matter protected by the EPBC Act is considered to be a "controlled action".

The CGM was referred for consideration under the EPBC Act on 29 August 2001. The Commonwealth Minister for the Environment and Heritage determined that the CGM was not a controlled action on 29 September 2001.

Matters of national environmental significance relevant to fauna at the modified CGM, *viz*. threatened fauna species and migratory species listed under the EPBC Act, are considered above and in Appendix E.

Other Matters Protected by the EPBC Act

As heritage values of a place are part of the 'environment', the EPBC Act protects the heritage values of a place on the Register of the National Estate.

Lake Cowal is recognised as a significant waterbird concentration area and was registered as a "Natural" place on the Register of the National Estate in 1992. The Lake's importance to many waterbirds is evidenced by its biological richness when the Lake is full (DEWHA, 2008a).

Lake Cowal's natural value (i.e. the attributes which make it a significant waterbird concentration area) are considered above and in Appendix E.

Introduced Fauna Species

Two introduced vertebrates (i.e. the Red Fox and European Rabbit) were located during the survey (Appendix E). The Feral Cat, Brown Hare, House Mouse and Sheep have been previously recorded within ML 1535 (Appendix E).

Existing Management Measures

The approved CGM currently implements the following environmental management plans and other documents (prepared in accordance with the Development Consent Conditions) relevant to the management of fauna at the approved CGM:

- FFMP, which includes the VCP;
- TSMP;
- CWMP;
- LMP;
- LSMP;
- BMP;
- DMP;
- BLMP;
- NMP;
- SWGMBMP;
- CMP; and
- MOP (2007 – 2009).

In accordance with the FFMP, the following fauna-related issues are required to be reported in each AEMR (Barrick, 2003j):

- a summary of deaths or other incidents involving native fauna;
- fauna usage of tailings storage facilities;
- results of any native fauna autopsies;
- vegetation clearance activities;
- weed and pest management;
- results of fauna monitoring programmes; and
- the progress of remnant vegetation and wetland enhancement programmes.

In accordance with the Development Consent, a summary of the effectiveness of the measures outlined in the FFMP and TSMP are required to be included in each AEMR. No significant impacts on fauna have been reported by Barrick and the implementation of control strategies were considered to have minimised impacts on threatened fauna species in each of the reporting periods (Barrick, 2005b, 2006a, 2007a, 2008a). This is consistent with predictions of potential impacts on fauna described in the EIS.

Where relevant to potential impacts on fauna, the performance of fauna management measures has been considered and is described below where appropriate.

4.7.2 Potential Impacts

The EIS and SIS assessed the short-term and long-term potential impacts from the approved CGM on fauna. The type of E42 Modification potential impacts would be largely the same as identified in the EIS and SIS, the difference due to an increase in the area proposed to be cleared.

The following sub-sections evaluate the potential impacts of the E42 Modification on vertebrate fauna species, populations and their habitats in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). This evaluation includes identification of the magnitude, extent and significance of the potential impacts. Proposed measures to avoid, minimise, mitigate, offset, manage and monitor potential impacts on vertebrate fauna are provided in Section 4.7.3.

Habitat Removal/Modification

Habitat removal and modification resulting from the E42 Modification would involve the following key threatening processes listed under the TSC Act:

- Clearing of Native Vegetation;
- Removal of Dead Wood and Dead Trees;
- Bushrock Removal;
- Loss of Hollow-bearing Trees; and
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.

Clearing of Native Vegetation

The E42 Modification disturbance area covers approximately 290 ha of land (Figure 4-13). Broad fauna habitat types which would be cleared or modified include:

- approximately 15 ha of Eucalypt Woodland;
- approximately 15 ha of Mixed Woodland;
- approximately 10 ha of Lakebed; and
- approximately 250 ha of Cleared Agricultural Land with Scattered Trees.

The Eucalypt Woodland and Mixed Woodland fauna habitats which occur within the E42 Modification disturbance area are relictual habitat patches in the landscape which have low to no connectivity with lands outside ML 1535.

Removal of Dead Wood and Dead Trees

Scattered dead trees (i.e. stag trees) and logs occur within the 290 ha of land to be disturbed by the E42 Modification. These include scattered timber piles relocated from previously cleared areas to increase reptile habitat within ML 1535. Although stag trees may be utilised by fauna (primarily birds and bats) the removal of these trees is unlikely to significantly impact any fauna species (Appendix E).

Bushrock Removal

Bushrocks were primarily recorded in the Eucalypt Woodland on Cowal West Hill (Figure 4-13). The removal of these are unlikely to significantly impact any fauna species as the bushrocks are predominantly small (~10 cm round) and were found to provide habitat mainly for invertebrate species (Appendix E). However, it is likely that they provide some habitat for cryptic small reptile species within the Eucalypt Woodland (*ibid*.).

Loss of Hollow-bearing Trees

Hollow-bearing trees with small to large hollows were recorded in the Eucalypt Woodland on Cowal West Hill and the Cleared Agricultural Land with Scattered Trees habitat. Micro–hollows were found in all tree species. The removal of these hollow-bearing trees is unlikely to significantly impact any fauna species, given the patches of habitat are relatively small and disjunct from other areas of habitat in the surrounds (Appendix E).

Alteration to the Natural Flow Regimes of Rivers and Streams and their Floodplains and Wetlands

As described in Section 2.7, a saline groundwater supply borefield would be developed within ML 1535 to supply saline water. The borefield would be operated during times when the borefield is not inundated by Lake Cowal.

As described in Section 4.4.1 and Appendix A, with regard to the hydraulic relationship between Lake Cowal and groundwater, Coffey Partners International (1997) found that the piezometric surface of the shallow saline alluvial aquifer was lower than the lake surface level but above lake bed level, indicating a lack of significant hydraulic continuity between surface and subsurface water. The potential impacts on the hydrology of Lake Cowal are assessed in Section 4.5.2 and Appendix B.

As stated in Section 2.7, in the unlikely event of pipeline failure and leakage of saline water, the spill would be controlled, contained and cleaned-up in accordance with the spill response procedures described in the HWCMP.

The borefield pipeline would extend only partially into the Lake and would therefore not significantly alter the natural flow regime of Lake Cowal.

An ephemeral drainage line in the north of the E42 Modification area would be diverted as part of a modified UCDS which comprises the re-alignment of a drainage channel conveying up-catchment water around the proposed modified northern waste emplacement. The diversion of this ephemeral drainage line is unlikely to significantly impact any fauna species given it is located within cleared agricultural land and more permanent habitat exists in the surrounding area (e.g. Bland Creek and within Lake Cowal when inundated) (Appendix E).

Fauna and Vehicular Traffic Movements

Vehicular traffic movements associated with the modified CGM have the potential to increase the incidence of fauna mortality via vehicle strike.

Fauna and Noise

A number of recent literature reviews have been conducted on the effects of noise on wildlife (Radle, 2007; Kaseloo, 2005; Institute for Environmental Monitoring and Research, 2001).

Noise can potentially impact certain fauna species, although studies on the effect of noise on wildlife have shown potential impacts are varied. Many studies have shown that fauna are well adapted to human activities and noise, while other studies have shown that noise can cause masking of vocalisation, physiological stress and changes in movement/patterns of behaviour (Radle, 2007; Kaseloo, 2005; Institute for Environmental Monitoring and Research, 2001).

The E42 Modification would involve an increase to the existing levels of noise from the mine, which may have the potential to disrupt the routine activities of vertebrate fauna. A Noise Assessment for the modified CGM is provided in Appendix F. It describes the potential noise levels from the modified CGM as a result of the E42 Modification to be from approximately 43 A-weighted decibels (dBA) at the closest monitored bird breeding area (Bird Breeding Area South [N03]) during Year 9 (with the Lake full) to approximately 38 dBA in northern areas of Lake Cowal.

Given the proposed continuation of noise and bird behaviour monitoring in accordance with the FFMP (Section 4.7.3), as well as the contingency measures in place in the event that assessment and monitoring results indicate that adverse impacts are occurring on fauna in accordance with the FFMP (Section 4.7.3), noise emissions from the modified CGM would be unlikely to significantly impact any fauna species.

Fauna and Blasting

Blasting overpressure and vibration has the potential to disturb routine activities of vertebrate fauna, particularly birds. For example, disruptions to normal breeding and behaviour patterns may result from birds taking flight as a result of the blasting stimulus (i.e. blast noise and/or vibration) (North Limited, 1998).

The *Cowal Gold Project 2005 Annual Environmental Management Report* (Barrick, 2006a) includes a summary of bird observations during the first ten blasts at the approved CGM. The observation was overseen by Dr Peter Gell from the Geographical and Environmental Studies Department of the University of Adelaide. Dr Peter Gell has been involved in monitoring and reporting on waterbird populations and breeding activities at Lake Cowal since 1992 and has completed over 45 surveys during that time. The four fauna specialists who conducted the monitoring found that *there was no abrupt change in the behaviour of any bird species to any blast. In fact, there was no evidence that any bird perceived any blast* (Gell, 2002-2005).

Given the proposed continuation of blast and bird behaviour monitoring in accordance with the FFMP (Section 4.7.3), as well as the contingency measures in place in the event that assessment and monitoring results indicate that adverse impacts are occurring on fauna (Section 4.7.3), the E42 Modification would be unlikely to significantly impact any fauna species.

Fauna and Artificial Lighting

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

As discussed in Section 4.3, the nature of night-lighting for the modified CGM would be of a similar intensity when compared to the existing night-lighting at the approved CGM. However, there is potential for the fixed lights to be visible from a wider area surrounding the ML due to the increased elevations of the waste emplacements. It is considered unlikely that artificial lighting required for the modified CGM would significantly impact fauna.

Interaction of Fauna with the Tailings Storage Facilities

There is potential for fauna to be impacted as a result of interaction with the modified CGM tailings storage facilities, due to increased exposure to cyanide in the tailings water given the extension of the life of the mine. Cyanide in the tailings storage facilities could either be ingested through the drinking of water, inhaled as hydrogen cyanide gas or absorbed through skin contact with water or tailings slurry.

Although the tailings storage facilities would increase in height as a result of the E42 Modification, their surface areas would remain largely unchanged and the management of the tailing storage facilities and the types of potential impacts would not change from those described in the EIS and SIS.

The approved CGM Development Consent requires cyanide concentrations of the aqueous component of the tailings slurry stream to not exceed 20 mg/L CN_{WAD} (90 percentile over six months) and 30 mg/L CN_{WAD} (maximum permissible limit at any time) at the discharge point to the tailings storage facilities. The SIS reported that the findings of Donato (1997) indicated that fauna mortalities approach zero at CN_{WAD} concentrations below 50 mg/L. Monitoring conducted to date indicates the approved CGM has complied with these limits (Barrick, 2007a, 2008a).

In accordance with the approved CGM *Implementation Plan to Protect Fauna from Interactions with the Tailings Storage Facilities* (Barrick, 2005zv), Donato and Rowntree (2006), Donato (2007) and Donato and Smith (2008) have conducted surveys of seasonal wildlife use patterns of the approved CGM tailings storage facilities since 2006. They found that:

- there has been no recorded deaths or effects of cyanide on wildlife and the cyanide concentrations recorded were not considered to be a risk to wildlife;
- the 2 m high perimeter fence has been effective in preventing the entry of most terrestrial fauna; and
- wildlife most likely to interact with the tailings storage facilities are birds and bats.

As described in the EIS and SIS, the management of the tailings storage facilities in accordance with the measures described in Section 4.7.3 would result in a low likelihood that fauna would be significantly impacted by the tailings storage facilities.

Movement of Dust to Lake Cowal

Atmospheric dust emissions produced near Lake Cowal have the potential to impact the Lake.

The atmospheric dust emissions produced by the approved CGM would increase slightly as a result of the modified CGM (Appendix G) to predicted levels of deposition from approximately 0.05 g/m^2/month to 2 g/m^2/month over Lake Cowal. This increase is primarily associated with on-going construction activities, mining activities and waste rock handling and stockpiling activities.

The approved CGM operates with a dust monitoring programme and a Lake Cowal monitoring programme. These programmes would continue for the modified CGM as further discussed in Section 4.9.3. Analysis of monitoring results indicates that the area generally experiences, on average, dust deposition levels below 4 g/m^2/month (Appendix G). No evidence of adverse impacts to fauna from dust have been identified to date (Barrick, 2005b, 2006a, 2007a, 2008a).

It is unlikely that any vertebrate species would be impacted either directly or indirectly by any dust increase generated as a result of the E42 Modification.

Introduced Flora Species

Native vegetation disturbance can act as a catalyst for weed incursion and, if management initiatives are not implemented, proliferation of weeds can occur.

The modified CGM is not considered to significantly increase the potential for weed incursion given the weed control measures outlined in the LMP would continue to be implemented.

Introduced Fauna Species

The European Rabbit, European Red Fox and Feral Cat are introduced animal species which have been recorded within ML 1535 and wider region. Each of these species have a corresponding key threatening process listed under the TSC Act (NSW Scientific Committee, 2000, 2002, 2004), *viz*.:

- predation by the Feral Cat;
- competition and grazing by the Feral European Rabbit; and
- predation by the European Red Fox.

There would be potential for further colonisation of the E42 Modification area by introduced animal species due to potentially increased refuge sites/scavenging areas and potential for introduced species to be transported to the area via vehicles.

Fauna and the Final Void

The EIS found that salinity of void waters for the CGM is likely to be comparable with the ranges found in natural salt lakes and that the final void would support salt tolerant species of phytoplankton.

The CGM final void would become greater in depth and area as a result of the E42 Modification. An assessment of void water quality for the modified CGM was undertaken by Geo-Environmental Management Pty Ltd and is presented in Appendix C.

In their assessment, Geo-Environmental Management Pty Ltd found that, consistent with the previous findings of geochemical studies undertaken for the approved CGM, oxidation of primary rock exposed along the pit walls is likely to generate a moderate load of sulphate salts, due to the presence of reactive sulphides (Appendix C). However, given the regional groundwater has a TDS count of around 40,000 to 45,000 mg/L, the contribution of sulphate salts from the open pit walls to the overall TDS of open pit water is expected to be negligible for the modified CGM (*ibid*.). With regard to metals, consistent with the EIS, the results of the assessment indicate that none of the identified enriched elements in the waste rock (i.e. final void wall rock) samples are readily soluble under the neutral to slightly alkaline pH test conditions (*ibid*.).

The final void is unlikely to significantly impact any fauna species given the proposed measures to avoid and mitigate for potential impacts discussed in Section 4.7.3.

Threatened Fauna Species, Ecological Communities and Migratory Species

As stated in Section 4.7.1, there are 13 threatened fauna species with records within or proximal to ML 1535. The potential impacts from the modified CGM on threatened fauna species were assessed based on the questions in the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

Appendix E concluded that the modified CGM would unlikely lead to the extinction of any vertebrate species or population or place any at risk of extinction.

The potential impacts from the modified CGM on the Myall Woodland EEC and Lachlan River Catchment EEC are assessed in Appendix E, as they provide potential fauna habitat and would be affected by the modified CGM.

Appendix E concluded that removal or modification of habitat is not considered to adversely affect the long-term viability of any vertebrate species, population or ecological community.

Matters of National Environmental Significance

Western Research Institute undertook an assessment of the potential impact on matters of national environmental significance relevant to fauna, *viz*. threatened fauna species and migratory species listed under the EPBC Act (Appendix E).

Based on the above, Appendix E concluded that no matters of national environmental significance or other matters protected by the EPBC Act relevant to fauna are likely to be significantly impacted by the modified CGM.

Other Matters Protected by the EPBC Act

Western Research Institute undertook an assessment of the potential impact on other matters protected by the EPBC Act, *viz.* Lake Cowal which is registered as a "Natural" place on the Register of the National Estate. Based on the above, Appendix E concluded that no other matters protected by the EPBC Act are likely to be significantly impacted by the modified CGM.

Summary of Potential Impacts on Fauna

The Fauna Assessment concluded the following (Appendix E):

- It is likely that the vertebrate fauna values of the region would be maintained and possibly improved, considering the proposed measures to avoid, mitigate and/or offset potential impacts (Section 4.7.3).
- The E42 Modification is unlikely to reduce the long-term viability of any local population of vertebrate fauna species.
- The E42 Modification is unlikely to lead to the extinction of any vertebrate fauna species or population or place any at risk of extinction.
- The E42 Modification would not adversely affect critical habitat as no critical habitats are known to occur within the E42 Modification area.
- The E42 Modification is very unlikely to adversely affect areas of high conservation value.
- Habitat that would be removed or modified by the E42 Modification is not considered to adversely affect the long-term viability of any vertebrate species, population or ecological community.
- Matters of national environmental significance or other matters protected by the EPBC Act relevant to fauna are not likely to be significantly affected by the E42 Modification.
- Given the above, from a regional perspective, biological diversity is likely to be maintained and potential adverse effects from the E42 Modification on vertebrate fauna are likely to be minimal.

4.7.3 Mitigation Measures and Management

As described in Section 4.7.1, potential impacts to fauna are currently managed via implementation of measures included in the following:

- FFMP, which includes the VCP;
- TSMP;
- CWMP;
- LMP;
- LSMP;
- BMP;
- DMP;
- BLMP;
- NMP;
- SWGMBMP;
- CMP; and
- MOP (2007 – 2009).

These measures would continue to be implemented where relevant and management plans would be updated as described below.

FloraSearch (Appendix D) and Western Research Institute (Appendix E) concluded that biodiversity values would be maintained or improved in the medium to long-term considering the following:

- proposed impact avoidance and mitigation measures which have been implemented at the approved CGM and would continue at the modified CGM;
- progressive rehabilitation and revegetation of the mine disturbance area; and
- the E42 Modification offset (see below).

Details relevant to these conclusions are provided below.

Fauna Management

As described in Section 4.6.3, the mitigation measures and management for flora and fauna (including threatened ecological communities, populations and species) at the approved CGM are presented in the FFMP. The objectives of the FFMP are to fulfil the relevant consent conditions by providing:

- methods for monitoring daily and seasonal fauna usage of the tailings storage facilities and whether deaths or other effects or incidents involving native fauna are occurring;
- a protocol for the reporting of any deaths or other incidents involving native fauna on the ML;
- fauna autopsy facilities to enable the cause of any wildlife deaths to be quickly determined;
- contingency measures for reducing cyanide levels in the tailings storage facilities in the event it is established that fauna deaths are occurring from cyanide in tailings storage facilities water;
- mechanisms to keep fauna and avifauna away from the tailings storage facilities;
- plans for the rescue and rehabilitation of wildlife that may become bogged/sick/trapped in the tailings storage facilities or elsewhere within ML 1535;

- methods to conserve and enhance wildlife values around Lake Cowal and within ML 1535;
- monitoring of fauna, fish and aquatic invertebrate within the Lake Cowal region as documented in the EIS and SIS;
- for the investigation of fauna deaths off the mine site, if requested by the Director-General;
- details to relocate any threatened species and/or its habitat away from disturbed areas that are created by mine operations;
- details of monitoring the mine's impacts particularly on birdlife in bird breeding areas, threatened fauna and fish and aquatic invertebrates around Lake Cowal, and contingency measures should impacts be identified as occurring; and
- a threatened species management protocol, including provisions for targeted searches prior to construction and proposed mitigation measures where threatened fauna species are found.

The above objectives would continue for the modified CGM.

The FFMP would be revised to incorporate the E42 Modification.

Vegetation Clearance Protocol

As discussed in Section 4.6.3, a VCP has been implemented at the approved CGM to minimise the potential impact of vegetation clearance activities on fauna and is described in the FFMP. The VCP would be continued for the modified CGM. In accordance with the VCP, clearance activities would be restricted to the areas occupied by the mine activities, buildings and paved surfaces, and those necessary for fire control.

In accordance with the VCP, the boundary of the disturbance area would be clearly marked or fenced to prevent accidental damage to adjacent areas during vegetation clearance and/or construction works. Accordingly, disturbance to potential habitat of threatened fauna species would be avoided and/or minimised, where practicable.

Implementation of the Threatened Species Management Protocol

As described in Section 4.6.3, the TSMP describes how the threatened species management protocol is to be implemented. The key components of the TSMP include: database interrogation, preliminary assessment, secondary assessment, threatened species management strategy and regulatory review. The TSMP includes threatened species management strategies prepared for threatened species which have been recorded in the course of targeted surveys or for which habitat resources typically associated with the lifecycle components of a threatened species have been identified.

The TSMP has been implemented at the approved CGM and would be continued for the modified CGM.

Traffic

As discussed in Section 4.7.2, the potential increase in vehicles movements associated with the E42 Modification has the potential to increase the incidence of fauna mortality via vehicular strike beyond that observed to date.

In accordance with the FFMP, speed limits have been imposed on vehicles using roads and tracks within ML 1535 to reduce the potential of fauna mortality via vehicular strike. Signposting has also been installed to remind personnel of the danger of vehicles to wildlife, as committed to in the FFMP. These measures would be continued for the modified CGM.

Noise Control and Monitoring

A range of noise control measures have been implemented at the approved CGM to minimise noise emissions, in accordance with the NMP (Barrick, 2004) (Section 4.8.3). As described in Section 4.7.2, monitoring has not identified adverse noise effects on fauna. Given noise levels would increase for the modified CGM and that fauna have been observed to respond to varying noise levels, these noise control and monitoring measures would continue for the modified CGM. In accordance with the NMP and/or FFMP, noise control measures which may be implemented at the modified CGM (if monitoring indicates demonstrable disturbance to bird breeding or other wildlife) include:

- restricting movement of trucks on ridgelines and exposed haul routes where their noise can propagate over a wide area, especially at night;

- scheduling the use of noisy equipment during the daytime;
- siting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise sensitive area;
- orienting equipment so that noise emissions are directed away from any sensitive areas, to achieve maximum attenuation of noise;
- scheduling operations so that noisy equipment items are used separately rather than concurrently;
- keeping equipment well maintained;
- employing 'quiet' practices when operating equipment (e.g. positioning idling trucks in appropriate areas);
- adjusting reversing alarms on heavy equipment to make them 'smarter', limiting acoustic range to the immediate danger area;
- using equipment with efficient mufflers and using quieter engines (such as electric instead of internal combustion);
- using high-pressure hydraulic systems to split rock, instead of hydraulic or hammers; and/or
- damping or lining metal trays.

These measures would be applicable for the modified CGM.

Blasting Management

A number of measures to minimise the potential impact of blasting activities are implemented at the approved CGM in accordance with the BLMP (Barrick, 2003k) (Section 4.8.3). In accordance with the BLMP, control measures which may be implemented at the modified CGM (if monitoring of bird breeding indicates a demonstrable disturbance) include eliminating secondary blasting, varying the direction of initiation, keeping face heights to a practical minimum, and exercising strict control over the burden, spacing and orientation of all blast drill holes. In accordance with the FFMP, additional measures that may be implemented (in the event demonstrable disturbance of bird breeding is identified as occurring) include the following:

- Reduce the MIC or charge mass per delay, to the lowest possible level.
- Ensure stemming type and length is adequate.
- Eliminate exposed detonating cord.
- Investigate alternative initiation methods.
- Reduce the need for toe shots (e.g. better control of drill patterns).
- Orientate faces where possible so that they do not face directly towards residences (or bird breeding areas).
- Ensure that all delays are designed to eliminate wave front reinforcement.
- Take particular care where the face is already broken or where it is strongly jointed, sheared, or faulted.
- Consider deck loading where appropriate to avoid broken ground or cavities in the face (e.g. from back break).

These measures would be applicable for the modified CGM under the same prevailing conditions as for the approved CGM.

Dust Management

The mitigation and management measures for wind blown and mine generated dust at the approved CGM are presented in the DMP (Section 4.9). These management and mitigation measures would continue to be implemented for the modified CGM (Section 4.9).

Weed Management

Barrick currently manage weeds at the approved CGM in accordance with measures described in the LMP (Barrick, 2003d). The weed management programme aimed at minimising the possibility of new weed incursion and controlling the spread of any existing noxious weeds on Barrick-owned land (Barrick, 2003d). The weed management programme described in the LMP would be continued for the modified CGM.

Pest (Animal and Vermin) Control

Pest control activities are implemented at the approved CGM in accordance with the LMP and FFMP and include:

- regular property inspections to assess the status of pest populations within Barrick-owned land;
- mandatory pest control for declared pests (i.e. rabbits, pigs and wild dogs) in accordance with Pest Control Orders under the *Rural Lands Protection Act, 1998*; and
- inspections to assess the effectiveness of control measures implemented and review of these measures if necessary.

These pest control activities described in the LMP and FFMP would be continued for the modified CGM.

Monitoring of Fauna Usage of the Final Void

The current commitment to develop a monitoring programme to monitor fauna usage of the final void at the approved CGM would remain for the modified CGM. The monitoring programme will be developed as a component of the strategy to be developed for the long-term management and monitoring of the area. The strategy will be submitted by Year 7 of mining operations, or five years before mine closure, whichever is the earlier.

Mechanisms to Keep Fauna Away from the Tailings Storage Facilities

Mechanisms have been developed to keep threatened waterbirds away from the approved CGM tailings storage facilities and are documented in the FFMP. These mechanisms include (Barrick, 2003j):

- Minimising the area of open water in the tailings storage facilities. To reduce the attractiveness of the tailings storage facilities to threatened waterbirds, the area of open water in the tailings storage facilities will be minimised by maximising the dry density of tailings and maximising the re-use of water from the tailings storage facilities in the process plant (North Limited, 1998).
- Making the area non-conducive to the establishment of wildlife habitats. Rehabilitation of the tailings storage facility area during operations will be such that minimal habitat opportunities will be created for threatened waterbirds. Rehabilitation of the tailings storage facility batters will achieve soil stabilisation yet will not create desirable habitat.

Avifauna deterrence mechanisms are also utilised at the tailings storage facilities (e.g. audio and visual stimuli to scare/repel birds).

As described in Section 4.7.2, in accordance with the approved CGM *Implementation Plan to Protect Fauna from Interactions with the Tailings Storage Facilities* (Barrick, 2005zv), Donato and Rowntree (2006), Donato (2007) and Donato and Smith (2008) have conducted surveys of seasonal wildlife use patterns of the approved CGM tailings storage facilities since 2006. They found that:

- there has been no recorded deaths or effects of cyanide on wildlife and the cyanide concentrations recorded were not considered to be a risk to wildlife;
- the 2 m high perimeter fence has been effective in preventing the entry of most terrestrial fauna; and
- wildlife most likely to interact with the tailings storage facilities are birds and bats.

The measures to keep threatened waterbirds away from the approved CGM tailings storage facilities would be continued for the modified CGM.

Cyanide Destruction Process

The cyanide destruction process at the approved CGM has been designed to result in cyanide concentrations of the aqueous component of the tailings slurry stream to not exceed 20 mg/L CN_{WAD} for 90% of the time and less than 30 mg/L CN_{WAD} for the remainder of the time, in accordance with the CMP (Barrick, 2006e) (note: monitoring conducted to date indicates the approved CGM has complied with these limits [Barrick, 2007a, 2008a]). This level is in accordance with industry experience that indicates bird mortalities approach zero at levels of cyanide exposure below 50 mg/L CN_{WAD} (Donato, 1997).

The CN_{WAD} levels of the aqueous component of the tailings slurry stream would continue to be maintained to the limits described above for the modified CGM.

Artificial Lighting

As described in Section 4.3.3, based on the findings of the Visual Assessment (Appendix I) and the implementation of visual amenity plantings, a LSMP for the modified CGM would not be necessary. Notwithstanding, the MOP would be revised to incorporate the relevant mitigation measures and management from the LSMP as well as the proposed mitigation measures and management for the modified CGM. Measures that would be employed to mitigate potential impacts from night-lighting would include one or more of the following, where practicable:

- Restriction of night-lighting to the minimum required for operations and safety requirements where appropriate.
- Use of unidirectional lighting techniques, where practicable.
- Use of light shields to limit the spill of lighting, where practicable.

Site Water Management

Measures have been developed for the approved CGM for the management and monitoring of surface water quality and quantity within and around the mine site in accordance with the SWMP. Management strategies to prevent the degradation of the quality of water in Lake Cowal include a variety of erosion, sediment and salinity control measures. These site water management and monitoring strategies would be continued for the modified CGM.

Rehabilitation

The revegetation programme for the modified CGM would aim to revegetate new landforms with selected species of native and/or endemic vegetation that are both suitable to the physiographic and hydrological features of each landform, and which expand on the areas of remnant endemic vegetation that currently exist in the immediate region. This would include species characteristic of the Myall Woodland EEC (e.g. Myall [*Acacia pendula*] and Belah [*Casuarina cristata*]), as described in the existing TSMP (Barrick, 2003h).

Further detail of the Rehabilitation and Landscape Management Strategy for the modified CGM are provided in Section 5.

E42 Modification Offset

As described in Section 4.6.3, the DGRs (Attachment 1) require a description of the measures that would be implemented to ensure there is no net loss of the biodiversity values of the region in the medium to long-term[5].

The following discussion describes an offset which, when combined with the mitigation measures described above and the rehabilitation proposal described in Section 5, would maintain or improve biodiversity values in accordance with the objectives of the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

As stated in Section 4.6.3, two offset areas which are located on land owned by Barrick are proposed (i.e. a northern offset area and a southern offset area) (Figure 4-12).

A summary of the E42 Modification offset is provided in Table 4-10. It is proposed that significant areas of existing native vegetation would be enhanced (some 340 ha) and significant areas of cleared agricultural land would be revegetated (some 120 ha).

Fauna Characteristics

The fauna characteristics of the offset areas were assessed by Western Research Institute (Appendix E) and are summarised below.

The southern offset area provides Eucalypt Woodland fauna habitat (i.e. Dwyers Mallee Red Gum Woodland on hill tops with ecotonal Grey Box and Ironbark Woodland) and Cleared Agricultural Land with Scattered Trees. The inclusion of the Cleared Agricultural Land in the offset area provides the possibility of increasing the existing remnant patch area through revegetation. Furthermore there is the opportunity of significant regeneration of existing native vegetation within the remnant and around its perimeter.

The hill remnant vegetation in the southern offset area has relatively high conservation value in the context of the Lake Cowal landscape because of its relatively large area and the scarcity of other such remnants. However, given the current degraded condition of the remnant and the lack of connectivity with other areas of habitat it is very likely that this remnant has impoverished vertebrate species diversity. The effects of previous pastoral practices are evident including extensive grazing (now ceased) adversely impacting understorey diversity and quality, significant on-going sheet erosion, partial clearing by logging, ringbarking, and past shooting.

A dam is located at the edge of the hill remnant at the boundary of the remnant-farming land and is no doubt an important source of water for a range of vertebrate species. An opportunity exists to enhance habitat at the existing dam.

A Grey-crowned Babbler colony, a threatened species, was recorded within the southern offset area during a site evaluation in April 2008 and a targeted search in 2003 (Appendix E). The offset area also contains potential habitat for other threatened fauna species recorded within the E42 Modification disturbance area (*ibid*.).

The northern offset area provides the opportunity to increase the area of Myall Woodland in the landscape through natural regeneration and revegetation.

[5] This requirement is taken to be relevant only to Barrick CGM activities.

Management

The conservation of the offset areas is discussed in Section 4.6.3.

In addition, the Offset Management Plan proposed in Section 4.6.3 would detail measures relevant to fauna, including:

- revegetation planting;
- regeneration of existing native vegetation communities;
- exclusion of grazing to facilitate the regeneration of native vegetation;
- weed and pest management;
- soil erosion remediation;
- selective use of native plant fertilizer;
- a proposal (within the remnant) for ecological thinning of locked thicket regrowth to encourage plant succession and to create increased habitat heterogeneity;
- fire management measures to include irregular mosaic burnings to maintain and/or increase habitat heterogeneity;
- increasing nesting resources (nest boxes and logs available from vegetation clearance activities at the mine site);
- habitat enhancement at the existing dam in the southern offset area;
- provision for consultation with the DECC regarding the management of common invasive native birds (e.g. Noisy Miners and Kurrawongs);
- re-introduction of species captured at the mine site (e.g. during vegetation clearance activities) within the southern offset area (e.g. frogs and smaller reptiles);
- signage of the vegetation offset areas; and
- monitoring the performance of the offset by suitably qualified person(s).

The offset areas are considered suitable for offsetting against potential residual impacts associated with the E42 Modification (after the avoidance and mitigation measures provided above), given the anticipated improvement in the fauna habitat value of the land within the offset areas in the medium to long-term (Appendix E).

4.8 NOISE

A Noise and Blasting Assessment has been prepared for the modified CGM by Heggies Pty Ltd (2008) and is presented in Appendix F. The Noise and Blasting Assessment was prepared in accordance with the *NSW Industrial Noise Policy* (INP) (EPA, 2000), ANZECC *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990), *NSW Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999) and was also guided by Australian Standard (AS) 2187.2-2006 *"Explosive - Storage and use Part 2: Use of Explosives - Appendix J"*.

The procedure for assessing the potential impacts of industrial noise sources in NSW is set out in the INP (EPA, 2000). This procedure was introduced after Development Consent was issued for the CGM. Accordingly, the EIS does not include a noise assessment based on the same assessment procedure and is not comparable to this modified CGM assessment. The INP assessment presented in Appendix F is, however, a cumulative assessment which predicts the noise emissions from the modified CGM, incorporating emissions from the approved CGM and the E42 Modification.

The Noise and Blasting Assessment includes assessment of:

- potential on-site operational noise impacts;
- potential blasting impacts; and
- potential off-site road traffic noise impacts.

The assessed noise levels described in this section are expressed in dBA. This system simulates the response of the human ear, which is more sensitive to high-frequency sounds and de-emphasises lower frequency sounds.

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

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

Table 4-12 provides information on common noise sources in dBA for comparative reference.

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

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

Discernible blast emission effects can be divided into three main categories:

1. Occupants of a building are inconvenienced or disturbed.
2. Contents of a building are affected.
3. Integrity of a building structure may be compromised.

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

4.8.1 Existing Environment

The NMP has been implemented at the approved CGM. The NMP includes noise monitoring requirements, noise complaints procedures, investigation plans, noise reduction strategies, remedial measure implementation, stakeholder consultation requirements and property acquisition processes (Barrick, 2004).

Additionally, the TNMP has been implemented at the approved CGM. The TNMP includes monitoring requirements, noise management and ameliorative measures, complaint response and property acquisition processes (Barrick, 2003l).

Background Noise Levels

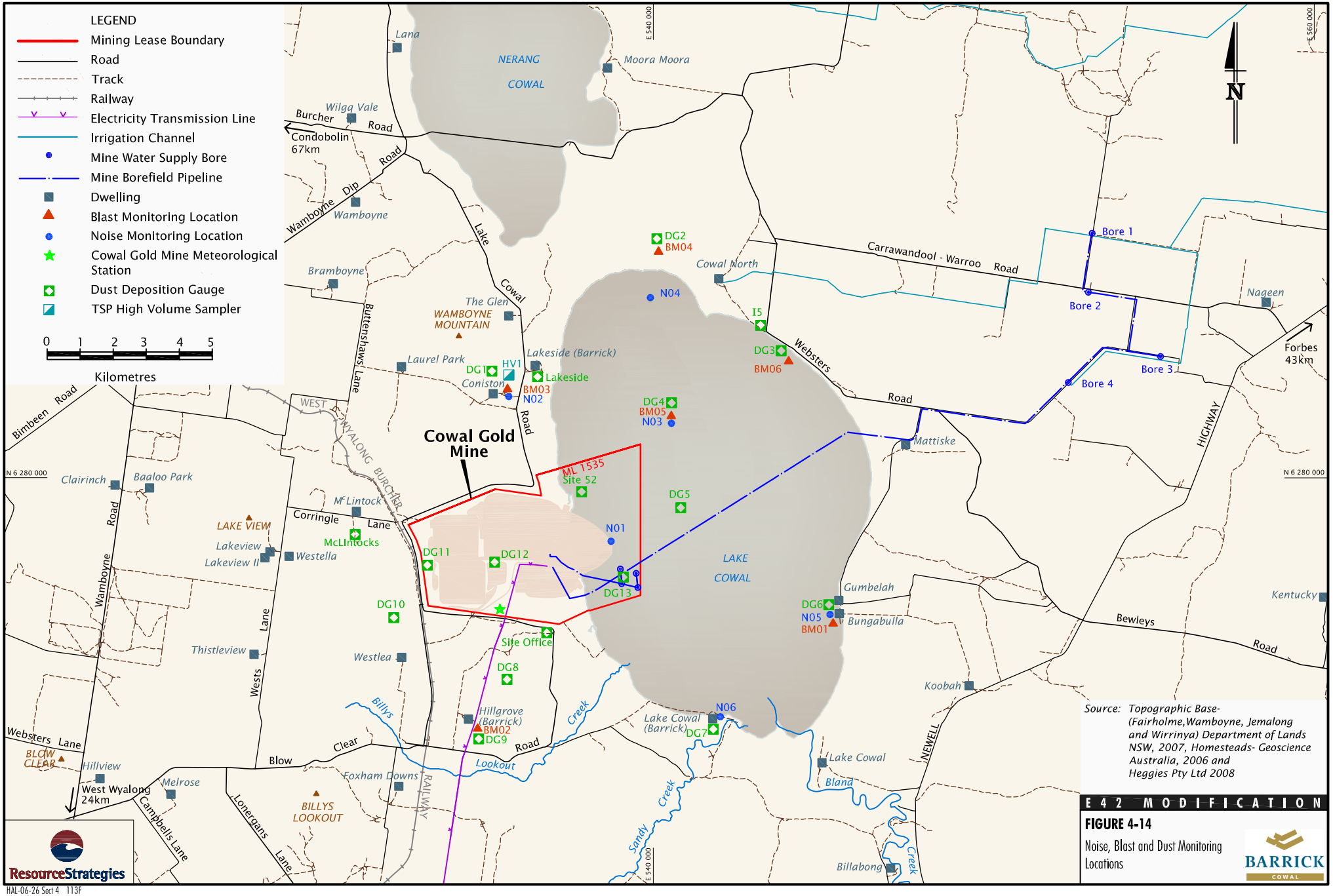
Background Noise Monitoring 1994

Background noise surveys to characterise and quantify the background (i.e. prior to the development of the CGM) acoustical environment in the area surrounding ML 1535 were conducted in July and December 1994. Unattended noise loggers were positioned at "Coniston", "Lakeside", "Lake Cowal (Barrick)" and "Gumbelah" (Figure 4-14).

Table 4-12
Relative Scale of Various Noise Sources and Effect on People

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

After: United States Department of the Interior (1994) and Richard Heggie Associates (1995).
* Reference level – 70 dBA.



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The unattended ambient noise logger data from each monitoring location together with the on-site weather conditions are presented in the EIS. The background noise levels in the vicinity of the CGM were typically around 30 dBA (or less), consistent with a relatively remote rural environment comprising of agricultural and domestic activity together with seasonal fauna noise sources and with an absence of major industrial development and continuous transportation systems.

Noise Monitoring 2005 to 2008

Unattended noise logging has been carried out at nearby residential monitoring locations on a regular basis since the commencement of construction and mining operations in accordance with the NMP (Barrick, 2004). The monitoring of ambient (operating) noise levels indicates that current noise levels are sometimes above the background noise levels measured in 1994 (Appendix F).

The monitoring results represent ambient noise levels which includes noise from the approved CGM. These results have been used to calibrate modelled noise emission levels from the modified CGM. This is discussed further in Section 4.8.2.

Rating Background Level

In accordance with the requirements of the NSW INP, the rating background level (RBL) is a calculated median background level representing each assessment period (e.g. day/evening/night) over a monitoring period (EPA, 2000).

Notwithstanding that the ambient (operating) noise levels are sometimes above 30 dBA, in accordance with the INP the RBL is 30 dBA (Appendix F).

Road Traffic Background Noise Levels

In accordance with the requirements of the ECRTN (EPA, 1999), assessment of the potential traffic noise impacts of mine traffic against goals for *collector roads* and *local roads* has been undertaken. Table 4-13 presents the applicable traffic noise criteria for the mine access routes for the modified CGM.

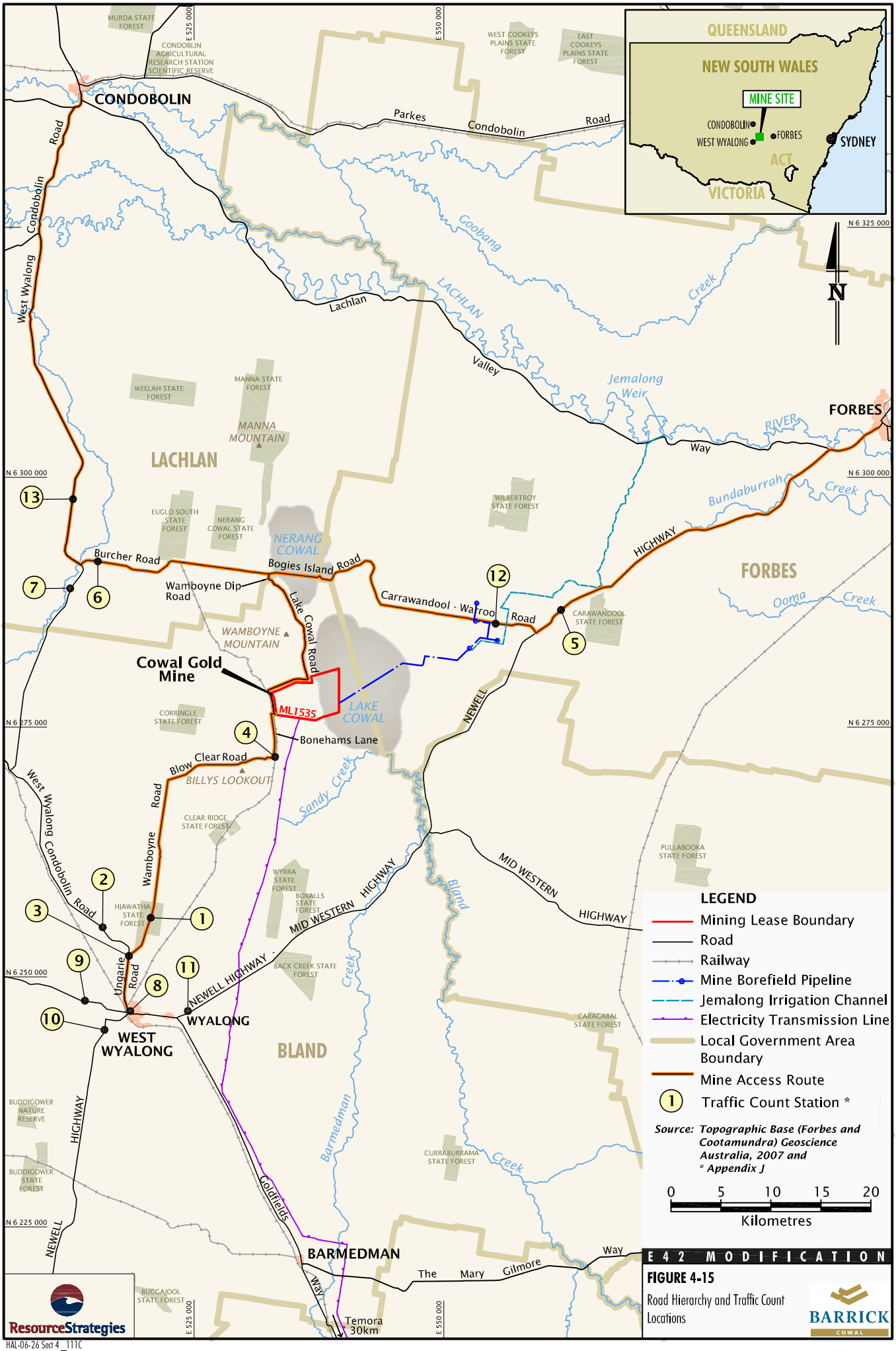
The roads mentioned in Table 4-13 are shown on Figure 4-15.

Ambient road traffic noise levels (i.e. noise from current traffic levels, including road traffic associated with the approved CGM) have been calculated based on existing peak hourly traffic counts on the collector and local roads presented in Section 4.10.

Table 4-13
Mine Access Routes and Applicable Traffic Noise Criteria

Road Classification	Access/Road	General Description	Traffic Noise Criterion	
			Daytime	Night-time
Collector Road	From West Wyalong/ Ungarie Road	Sealed collector road carrying through traffic from West Wyalong to Condobolin. Traffic along this road includes a range of heavy vehicles such as B-Doubles and Road Trains.	$L_{Aeq(1hour)}$ 60 dBA	$L_{Aeq(1hour)}$ 55 dBA
Local Road	From West Wyalong/ Wamboyne Road	Currently sealed (Wamboyne Road) and unsealed local public roads (e.g. Carrawandool-Warroo Road) carrying predominantly local traffic with periods of grain farming heavy traffic in the relevant seasons.	$L_{Aeq(1hour)}$ 55 dBA	$L_{Aeq(1hour)}$ 50 dBA
	From West Wyalong/ Blow Clear Road			
	From Forbes/ Carrawandool-Warroo Road			
	From Condobolin/ Burcher Road			
	From Condobolin/ West Wyalong Condobolin Road			
	From Condobolin/Lake Cowal Road			

Source: Appendix F



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The ambient traffic noise levels form the basis for assessment of the potential road traffic noise impacts. Background noise levels on the Newell Highway and West Wyalong Condobolin Road (arterial roads) have not been calculated given that the average daily percentage increase in light and heavy vehicle movements on these roads is predicted to be only 0.4% and 5%, respectively, and therefore not of a magnitude which would change the ambient road traffic noise levels discernibly (i.e. the change would be less than 1 dBA) (Appendix F).

Estimated peak background traffic $L_{Aeq(1hour)}$ noise levels at various distances from the roads are presented in Table 4-14.

Comparison of the estimated existing traffic noise levels (Table 4-14) and the road traffic noise criteria for these roads indicates that the existing traffic noise on most of the roads exceeds the criteria at distances of up to 75 m from the road.

The calculations of the estimated existing traffic noise levels presented in Table 4-14 are consistent with operator-attended traffic noise monitoring undertaken in January 2007 in accordance with the TNMP. That is, the estimated traffic noise contribution was marginally above the criteria in some instances at a distance of 45 m from the road (Barrick, 2008a).

Where the nominated criteria are already exceeded, traffic associated with the development should not be permitted to lead to an increase in the existing traffic noise levels of more than 2 dBA (EPA, 1999).

Blasting and Vibration Levels

In accordance with the BLMP, monitoring of ground vibration and air over-pressure at nearby residences and bird breeding areas (Figure 4-14) is undertaken for all blast events (Barrick, 2003k). Blasts fired between 2005 and 2007 were not detected at any of the monitors (Barrick, 2008a).

4.8.2 Potential Impacts

Applicable Noise Criteria

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

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

The intrusive criterion is met if the $L_{Aeq(15\ minutes)}$ is less than or equal to the RBL plus 5 dBA. As discussed in Section 4.8.1, the background noise level for the modified CGM assessment was assumed to be 30 dBA (Appendix F). Thus the modified CGM specific intrusiveness criterion is 35 dBA for the assessment for day, evening and night periods.

The applicable project-specific intrusiveness criterion (i.e. 35 dBA) is the most stringent of the criteria described in Appendix F that need to be satisfied. Amenity and sleep disturbance criteria (Appendix F) are therefore not discussed in this section.

In those cases where the INP Project-specific assessment criteria of 35 dBA is exceeded, it does not automatically follow that all people exposed to the noise would find the noise noticeable or unacceptable. In subjective terms, exceedances of the INP Project-specific assessment criteria can be generally described as follows (Appendix F):

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

For the purposes of assessing potential noise impacts, exceedances can be separated into a noise management zone (i.e. 1 to 5 dBA above the criteria) and a noise affectation zone (i.e. greater that 5 dBA above the criteria). Table 4-15 identifies the private (non-Barrick owned) dwellings within the noise management and affectation zones.

Noise Modelling

An acoustic model was developed that simulates the modified CGM components and noise source information (i.e. sound levels and locations). The sources of noise identified for the modified CGM are outlined in Appendix F and include the general loading and operational fleet tailings embankment lift fleet. The model also considers meteorological effects, surrounding terrain, distance from source to receiver and noise attenuation (i.e. at-source mitigation measures adopted).

Table 4-14
Estimated Existing Peak $L_{Aeq(1hour)}$ Noise Levels

Distance from Road	Criteria	Existing Traffic Noise Levels (dBA)		
	(Daytime/ Night-time) (dBA)	Daytime (morning)	Daytime (afternoon)	Night-time
Ungarie Road				
10 m	60/55	64	65	64
30 m	60/55	57	58	57
50 m	60/55	53	54	54
75 m	60/55	51	52	51
100 m	60/55	49	50	49
Wamboyne Road				
10 m	55/50	57	60	61
30 m	55/50	50	53	54
50 m	55/50	47	50	51
75 m	55/50	44	47	48
100 m	55/50	42	45	46
Blow Clear Road				
10 m	55/50	58	61	60
30 m	55/50	50	54	53
50 m	55/50	47	51	49
75 m	55/50	44	48	47
100 m	55/50	43	46	45
Carrawandool-Warroo Road				
10 m	55/50	53	53	53
30 m	55/50	46	46	45
50 m	55/50	42	43	42
75 m	55/50	40	40	39
100 m	55/50	38	38	37
Burcher Road				
10 m	55/50	52	53	52
30 m	55/50	45	45	44
50 m	55/50	42	42	41
75 m	55/50	39	39	38
100 m	55/50	37	37	36
Lake Cowal Road				
10 m	55/50	56	56	55
30 m	55/50	48	49	48
50 m	55/50	45	45	45
75 m	55/50	42	43	42
100 m	55/50	40	41	40

Source: Appendix F

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

Noise emissions were modelled for the following prevailing meteorological conditions:

- Daytime (calm conditions) – wind speed of 0 m/s and a temperature inversion gradient of 0°C/100 m.
- Evening/Night-time (moderate conditions) – wind speed of 0 m/s and a temperature inversion gradient of 3°C/100 m.
- Evening/Night-time (strong conditions) – wind speed of 0 m/s and a temperature inversion gradient of 8°C/100 m.

In addition, Lake Cowal was modelled as being both full and empty for each of the above set of meteorological conditions. Less attenuation would occur when the Lake is full than when the Lake is empty. The lake full scenario provides for a conservative assessment of potential noise impacts (Appendix F).

Noise Emission Scenarios

Predictive noise emission modelling has been undertaken for two representative periods in the modified CGM mine life, based on the provisional ore mining and processing schedule (Table 2-1). Operational activities would be undertaken 24 hours per day, seven days per week (although tailings embankment lift works would be scheduled to occur between 8.00 am and 8.00 pm, in an effort to reduce noise outside these hours).

These two operational noise modelling scenarios included all significant fixed plant and mobile equipment operating concurrently to simulate the likely intrusive $L_{Aeq(15minute)}$ emission levels (Appendix F).

Operation Year 7

This operational year would be representative of the maximum noise emissions from the modified CGM for the nearest receptors to the south of the modified CGM (i.e. tailings embankment lift works would occur at the southern tailings storage facility).

Operation Year 9

This operational year would be representative of the maximum noise emissions from the modified CGM for the nearest receptors to the north of the modified CGM (i.e. tailings embankment lift works would occur at the northern tailings storage facility).

Table 4-15
Private (Non-Barrick Owned) Dwellings within Noise Management and Affectation Zones

Period	Dwellings Located within the Noise Management Zone		Dwellings Located within the Noise Affectation Zone
	1 to 2 dBA above Project-specific Criteria	**3 to 5 dBA above Project-specific Criteria**	**>5 dBA above Project-specific Criteria**
Daytime Calm	Nil	Nil	Nil
Evening/Night-time and early morning up to 8.30 am strong inversion with Lake Cowal full	Mattiske	Bungabulla Gumbelah Laurel Park The Glen Cowal North Lake Cowal	Coniston Westlea McLintock
Evening/Night-time and early morning up to 8.30 am strong inversion with Lake Cowal empty	Bungabulla Gumbelah	Laurel Park The Glen	Coniston Westlea McLintock

Source: Appendix F

Predicted Noise Emissions

Private (Non-Barrick Owned) Dwellings

Table 4-15 identifies private (non-Barrick owned) dwellings where intrusive emissions are predicted to exceed the Project-specific noise assessment criteria during modified CGM operations. Predicted intrusive emissions for other privately-owned dwellings in the vicinity of the mine are tabulated in Appendix F. The intrusive noise contours for Years 7 and 9 under strong inversion conditions and lake full scenarios are presented on Figures 4-16 and 4-17.

Bird Breeding Areas

Section 4.7.2 describes potential noise impacts on fauna.

Road Traffic Noise

Applicable Road Traffic Noise Criteria

As presented in Section 4.8.1, based on the ECRTN (EPA, 1999), Ungarie Road is classified as a "collector road" (i.e. road which connects the sub-arterial roads to the local road system in developed areas) and each of the other roads along the mine access routes is classified as a "local road" (i.e. subdivisional road within a particular developed area, and used solely as local access roads). The applicable road traffic noise criteria are presented in Table 4-13.

In accordance with the ECRTN (EPA, 1999), traffic associated with the development should not be permitted to lead to an increase in the existing noise traffic levels of more than 2 dBA where criteria are already exceeded. As a general rule, traffic noise associated with the modified CGM would not increase the existing traffic noise levels by more than 2 dBA, so long as the increase in light and heavy vehicle movements for the modified CGM is no greater than 60% (Appendix F).

Daytime peak Project-related traffic movements would be between 5.00 pm and 6.00 pm and night-time peak movements would be between 6.00 am and 7.00 am. These times coincide with the expected traffic associated with changes in operational shifts. Under the ECRTN, traffic flows in the early morning (i.e. prior to 7.00 am) are considered under the more stringent night-time criteria (EPA, 1999).

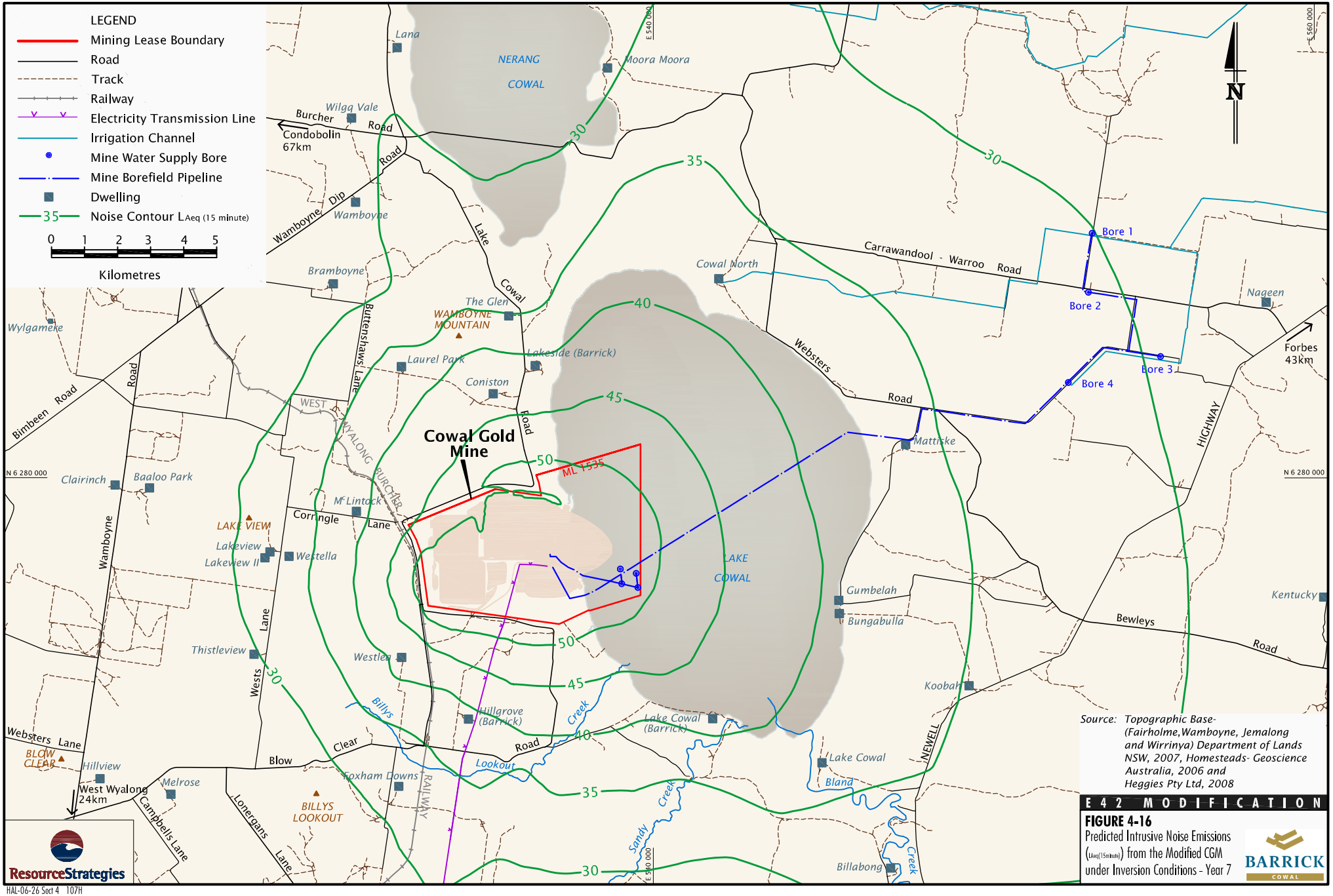
Predicted Road Traffic Noise Emissions

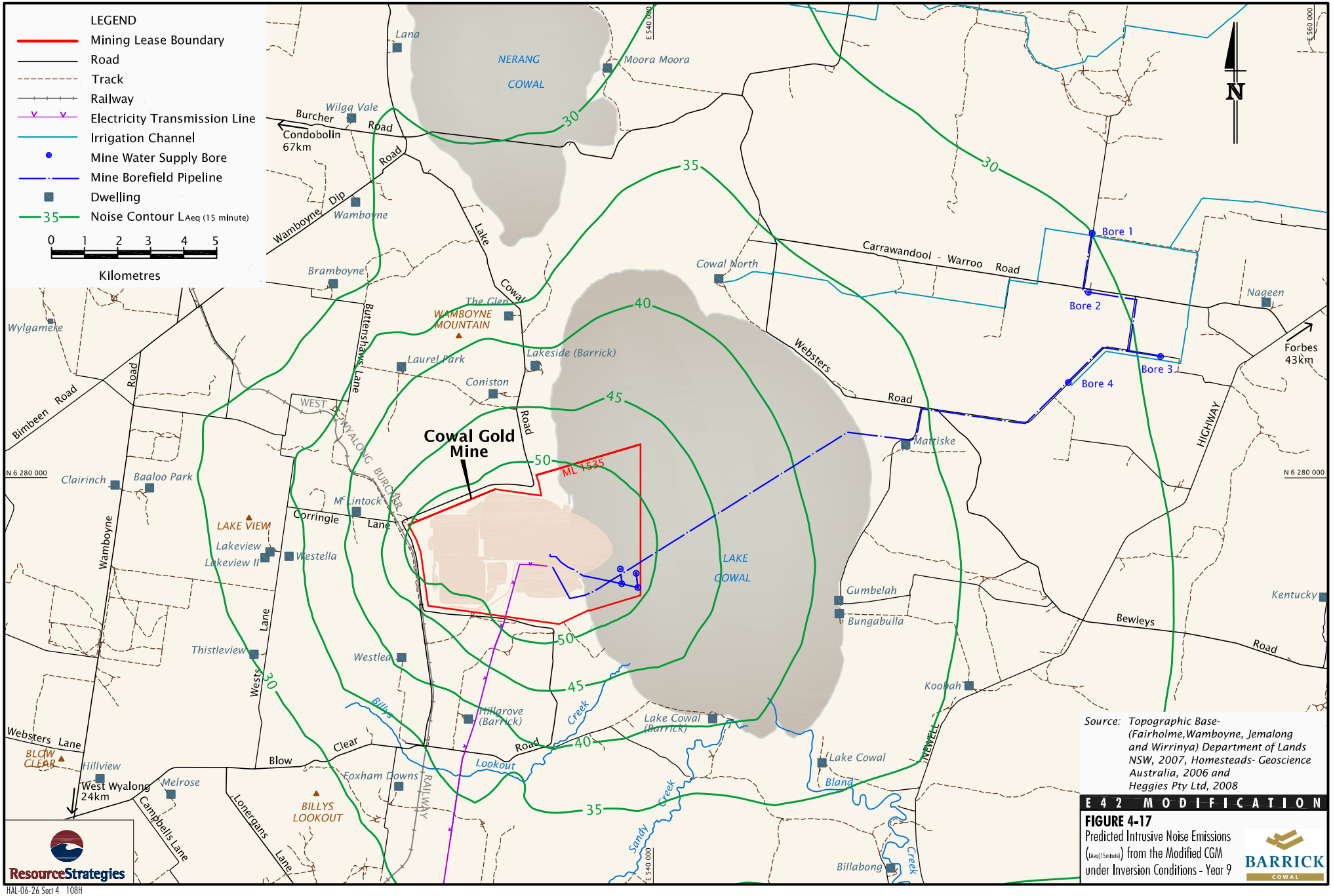
Potential road traffic noise impacts have been considered for the collector and local roads presented in Section 4.10. Predicted noise levels on the Newell Highway and West Wyalong Condobolin Road, (arterial roads) have not been calculated given that the average daily percentage increase in light and heavy vehicles movements on these roads is predicted to be only 0.4% and 5%, respectively, and therefore not of a magnitude which would change the ambient road traffic noise levels discernible (i.e. the change would be less than 1 dBA) (Appendix F). Predictions were calculated using equations presented in Appendix F. These equations take into account various traffic characteristics, including traffic volume, vehicle speed and type, passby duration and location. The predicted peak $L_{Aeq(1hour)}$ noise levels are presented in Table 4-16. Existing noise levels for these roads are presented in Appendix F.

The increases in noise levels arising from the E42 Modification during the daytime (morning and afternoon) and night-time peak hours are less than 2 dBA on all roads assessed (Appendix F).

Blasting and Vibration

The average blasting frequency employed at the approved CGM (i.e. generally limited to one blast per day) would be maintained for the modified CGM. A comparison of the typical blast design details for the approved CGM and modified CGM are presented in Table 4-17.


LEGEND
Mining Lease Boundary
Road
Track
Railway
Electricity Transmission Line
Irrigation Channel
Mine Water Supply Bore
Mine Borefield Pipeline
Dwelling
35 Noise Contour LAeq (15 minute)
0 1 2 3 4 5
Kilometres
N
Cowal Gold Mine
ML 1535
Bore 1
Bore 2
Bore 3
Bore 4
30
35
40
45
50
Lana
NERANG
COWAL
Moora Moora
Wilga Vale
Burcher Road
Condobolin 67km
Wamboyne Dip
Wamboyne
Lake Cowal
Bramboyne
The Glen
WAMBOYNE MOUNTAIN
Laurel Park
Coniston
Lakeside (Barrick)
Cowal North
Carrawandool - Warroo Road
Nageen
Forbes 43km
Websters Road
Mattiske
HIGHWAY
Wylgamere
Buttenshaws Lane
WEST WYALONG
BURCHER
Bimbeen Road
Clairinch
Baaloo Park
Mc Lintock
Corringle Lane
LAKE VIEW
Lakeview
Lakeview II
Westella
Wamboyne
Thistleview
Wests Lane
Westlea
Billys Creek
Hillgrove (Barrick)
Lake Cowal (Barrick)
Lookout
Foxham Downs
RAILWAY
Gumbelah
Bungabulla
Koobah
Kentucky
Bewleys Road
NEWELL
Lake Cowal
Bland
Billabong Creek
Sandy Creek
Websters Lane
BLOW CLEAR
Hillview
Blow Clear Road
West Wyalong 24km
Melrose
Campbells Lane
Lonergans Lane
BILLYS LOOKOUT
E 540 000
E 560 000
N 6 280 000
N 6 260 000
Source: Topographic Base- (Fairholme,Wamboyne, Jemalong and Wirrinya) Department of Lands NSW, 2007, Homesteads- Geoscience Australia, 2006 and Heggies Pty Ltd, 2008
E42 MODIFICATION
FIGURE 4-16
Predicted Intrusive Noise Emissions (LAeq(15minute)) from the Modified CGM under Inversion Conditions - Year 7
ResourceStrategies
BARRICK COWAL
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Source: Topographic Base- (Fairholme,Wamboyne, Jemalong and Wirrinya) Department of Lands NSW, 2007, Homesteads- Geoscience Australia, 2006 and Heggies Pty Ltd, 2008

E42 MODIFICATION

FIGURE 4-17

Predicted Intrusive Noise Emissions ($L_{Aeq(15minute)}$) from the Modified CGM under Inversion Conditions - Year 9

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Table 4-16
Estimated Cumulative Peak $L_{Aeq(1hour)}$ Noise Levels

Distance from Road	Criteria	Cumulative Traffic Noise Levels[1] (dBA)		
	(Daytime/ Night-time) (dBA)	Daytime (morning)	Daytime (afternoon)	Night-time
Ungarie Road				
10 m	60/55 dBA	64	65	65
30 m	60/55 dBA	57	58	57
50 m	60/55 dBA	53	55	54
75 m	60/55 dBA	51	52	51
100 m	60/55 dBA	49	50	49
Wamboyne Road				
10 m	55/50 dBA	57	61	62
30 m	55/50 dBA	50	53	55
50 m	55/50 dBA	47	50	51
75 m	55/50 dBA	44	47	48
100 m	55/50 dBA	42	45	47
Blow Clear Road				
10 m	55/50 dBA	59	62	61
30 m	55/50 dBA	52	55	54
50 m	55/50 dBA	48	52	50
75 m	55/50 dBA	46	49	48
100 m	55/50 dBA	44	47	46
Carrawandool-Warroo Road				
10 m	55/50 dBA	53	54	53
30 m	55/50 dBA	46	47	46
50 m	55/50 dBA	43	43	42
75 m	55/50 dBA	40	40	40
100 m	55/50 dBA	38	39	38
Burcher Road				
10 m	55/50 dBA	53	53	52
30 m	55/50 dBA	45	46	45
50 m	55/50 dBA	42	42	42
75 m	55/50 dBA	39	40	39
100 m	55/50 dBA	37	38	37
Lake Cowal Road				
10 m	55/50 dBA	56	56	56
30 m	55/50 dBA	49	49	48
50 m	55/50 dBA	45	46	45
75 m	55/50 dBA	43	43	42
100 m	55/50 dBA	41	41	40

Source: Appendix F

[1] Project-related traffic and existing traffic noise.

Table 4-17
Approved and Modified CGM Blast Design Parameters

Blast Design Parameter	Approved CGM Typical Dimension	Modified CGM Typical Dimension	Modified CGM Dimension Range
Number of Holes	170	350	200-500
Number of Rows	5	9	3-12
Hole Diameter	165 mm	165 mm	115-200
Hole Inclination (to vertical)	10^0	0^0	$0\text{-}20^O$
Bench Height	10 m	9 m	5-18m
Burden	5 m	4.4 m	3-6m
Spacing	6 m	5.3 m	4-7m
Subdrill	1.5 m	1.3 m	0.6-1.8m
Stemming Depth	3.0 m	3.6 m	3-4.5m
Delay Timing	Nonel (Non-electric)	Nonel (Non-electric)	Nonel (Non-electric)
Column Explosive	ANFO Slurry	Emulsion	ANFO/Slurry/Emulsion
Powder Factor	0.71 kg/bcm	0.82 kg/bcm	0.60-1.00kg/bcm
MIC	213 kg	172 kg	50-350 kg

Criteria for Dwellings

Calculated blast emissions, based on the proposed maximum blast configuration (Table 4-17), were compared against building damage criteria and human comfort criteria. The DECC advocates the use of ANZECC's *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC, 1990), for assessing potential residential disturbance (human comfort) arising from blast emissions. The ANZECC guidelines for the control of potential blasting impacts at a dwelling are as follows (ANZECC, 1990):

- The recommended maximum level for airblast is 115 dBL.
- The level of 115 dBL may be exceeded in up to 5% of the total number of blasts over a period of 12 months, however the level should not exceed 120 dBL at any time.
- The recommended maximum level for ground vibration is 5 mm/s PVS vibration velocity. It is recommended, however, that 2 mm/s PVS vibration velocity be considered as the long-term regulatory goal for the control of ground vibration.
- The PVS level of 5 mm/s may be exceeded in up to 5% of the total number of blasts over a period of 12 months, however the level should not exceed 10 mm/s at any time.

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

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore compliance with the lowest applicable human comfort criteria would minimise the potential to cause structural damage.

The Blast Emission Assessment found that the building damage criteria of 13 mm/s and 133 dBL (peak) would be met at all private dwellings (Appendix F). Similarly, the predicted vibration velocities are well below the comfort criteria of 5 mm/s at all receivers and the airblast levels are well below the 115 dB linear criteria (*ibid*.), as was predicted for the approved CGM in the EIS.

Bird Breeding

Section 4.7.2 describes potential blast , overpressure and vibration impacts on fauna.

4.8.3 Mitigation Measures and Management

Mine Noise Mitigation Measures

Noise mitigation and management measures for the approved CGM are described in the NMP. The NMP describes:

- relevant noise standards;
- potential noise sources and impacts;
- noise management and mitigation measures;
- a noise monitoring programme;
- provisions for the establishment of proactive and responsive noise management protocols; and
- provisions for the establishment of community consultation protocols.

The NMP would be revised to include additional noise monitoring locations (i.e. "Westlea" dwelling) and mitigation procedures, as described below.

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

- Preliminary noise modelling of scenarios representative of the maximum noise emissions from the mine to identify areas of noise management and noise affectation.
- Consideration of various combinations of noise management and mitigation measures to assess their relative effectiveness.
- Adoption by Barrick of a range of noise management and mitigation measures to appreciably reduce noise emissions associated with the modified CGM, including:
    - scheduling the use of any noisy equipment during daytime, where practicable (e.g. tailings embankment lift works scheduled to occur between 8.00 am and 6.00 pm); and
    - optimising the mine equipment fleet and keeping equipment well maintained.

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

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

The use of any noisy equipment would be scheduled during the daytime, where practicable. For example, the tailings embankment lift works would be scheduled to occur between 8.00 am and 6.00 pm.

As detailed in Table 4-15, the private dwellings where noise emissions are predicted to be above Project-specific noise assessment criteria can be divided into a noise management zone (1 to 5 dBA above Project-specific criteria) and a noise affectation zone (greater than 5 dBA above Project-specific criteria). Proposed noise management procedures for these zones are detailed below.

Noise Management Zone

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

- Noise monitoring on-site and within the community.
- Prompt response to any community issues of concern.
- Refinement of on-site noise mitigation measures and operating procedures where practicable.
- Implementation of reasonable and feasible acoustical mitigation at private dwellings (which may include measures such as enhanced glazing, insulation and/or air-conditioning) where noise monitoring shows noise levels from the mine which are 3 to 5 dBA above project-specific noise criteria.

Noise Affectation Zone

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

- Discussions with relevant land owners to assess concerns and define responses.

- Implementation of reasonable and feasible acoustical mitigation at private dwellings (which may include measures such as enhanced glazing, insulation and/or air-conditioning) where noise monitoring shows noise levels from the mine which are >5 dBA above project-specific noise criteria.
- Negotiated agreements with land owners where required.

Road Traffic Noise Mitigation Measures

Traffic noise mitigation and management measures for the approved CGM are described in the TNMP. The mitigation and management measures described in the TNMP would not change as a result of the E42 Modification and would continue for the modified CGM.

Blasting Mitigation Measures

Blast mitigation and management measures for the approved CGM are described in the BLMP. The mitigation and management measures (including monitoring) described in the BLMP would not change as a result of the E42 Modification and would continue for the modified CGM. The BLMP would be revised to include a description of the E42 Modification blast design parameters.

4.9 AIR QUALITY

An Air Quality Assessment for the modified CGM has been undertaken by Holmes Air Sciences (2008) and is presented in Appendix G. The assessment follows the procedures outlined by the DECC in their guidance document titled *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005).

The Air Quality Assessment includes assessment of:

- potential dust and suspended particulate matter emissions;
- potential odour emissions; and
- potential greenhouse gas emissions.

4.9.1 Existing Environment

In accordance with the DMP, air quality monitoring has been carried out at nearby locations on a regular basis since the commencement of CGM construction (Barrick, 2003m). The locations of monitoring sites (i.e. static/gravimetric dust gauges and a high volume total suspended particulates [TSP] sampler) are shown on Figure 4-14. The following section provides an overview of relevant air quality criteria and background air quality (i.e. contribution of air quality emissions from the approved CGM and other sources) for relevant parameters.

Air Quality Criteria

Dust Deposition

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

Concentrations of Suspended Particulate Matter

Exposure to suspended particulate matter can be associated with health and amenity impacts. The likely risk of these impacts depends on a range of factors including the size, chemical make-up and level of the particulate matter and the general health of the person (NSW Health and NSW Minerals Council, 2006).

Such particles (TSP) are typically less than 50 micrometres (μm) in size and can be as small as 0.1 μm. Fine particles less than 10 μm are referred to as particulate matter less than 10 microns in size (PM_{10}). Suspended particulate matter criteria, standards and goals used in the assessment comprise:

- The National Environment Protection Measure (NEPM) 24-hour reporting standard for PM_{10} of 50 micrograms per cubic metre ($\mu g/m^3$) adopted by the DECC as assessment criterion (interpreted as the PM_{10} concentrations due to the E42 Modification only).
- The DECC annual assessment criterion for PM_{10} of 30 $\mu g/m^3$ has been interpreted as a concentration that should be met within the region (interpreted as the PM_{10} concentrations due to the E42 Modification and background).

- The National Health and Medical Research Council's (NHMRC) annual goal for TSP of 90 μg/m^3, adopted by the DECC as assessment criterion (interpreted as the TSP concentrations due to the E42 Modification and background air quality).

Details of the air quality criteria for concentrations of particulate matter are provided in Table 4-18.

Table 4-18
Air Quality Standards/Assessment Criteria for Particulate Matter Concentrations

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

Source: Appendix G

[1] This goal is taken to be non-cumulative for assessment purposes, where the mine operates with best-practice dust control measures (Appendix G).

Dust Deposition

The current dust deposition monitoring undertaken in accordance with the DMP includes gauges at various locations in the vicinity of the CGM (Figure 4-14). Annual averages from data collected between January 2004 and December 2007 (excluding monitors within the ML) are presented in Appendix G.

The monitoring results presented in Appendix G show that the area generally experiences, on average, dust deposition levels below 4 g/m^2/month. For the purposes of the Air Quality Assessment, a value of 3.1 g/m^2/month (average at relevant receptors between 2004 and 2007) was taken to be the background dust deposition level that would apply at all receptors.

The EIS predicted that non-company owned residences outside the ML would receive dust deposition rates from the CGM of less than the mean annual 2 g/m^2/month criterion (North Limited, 1998). Analysis of the dust deposition and meteorological monitoring data collected between January 2004 and December 2007 indicates that emissions from the approved CGM have not caused an exceedance of this criterion (Appendix G). Holmes Air Sciences note in Appendix G that the gauges that have recorded annual average levels above 4 g/m^2/month in the past (i.e. DG2, DG4 and DG6) are generally located further from the mine. The pattern of results suggests that most of the dust deposition gauges are largely influenced by activities taking place very close to each gauge (Appendix G).

Suspended Particulates

TSP

TSP levels are currently monitored in accordance with the DMP by a high volume air sampler at HV1 (located approximately 3 km to the north of CGM [Figure 4-14]), which measures the contribution from a range of particulate matter sources, including traffic on unsealed roads, agricultural activities and dust sources associated with the existing mining operation (Barrick, 2003m).

Appendix G summarises the annual average TSP concentrations for HV1 between 2004 and 2007. Measured annual average TSP concentrations have been below the DECC assessment criterion of 90 μg/m^3 for all four years (i.e. between 24 and 43 μg/m^3) (Appendix G), which is consistent with the EIS which predicted that annual average concentrations of TSP would remain well below 90 μg/m^3 at all non-company owned residences (North Limited, 1998). Based on the measured annual average data, it has been assumed that the annual average TSP background concentration is 43 μg/m^3.

PM_{10}

PM_{10} concentrations have been inferred from the daily TSP data by assuming that 40% of the TSP is PM_{10} (note: this ratio has been revised since the EIS, which assumed 50%). This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (NSW Minerals Council, 2000).

The monitoring shows that the 24-hour average PM_{10} concentrations (inferred from the TSP concentrations) have been above the DECC's assessment criterion of 50 μg/m^3 on approximately seven days in the past four years. The highest PM_{10} concentration to date was approximately 151 μg/m^3, on 12 January 2008. An analysis of meteorological monitoring data from the automatic weather station within ML 1535 showed the prevailing winds on 12 January 2008 were from the north-west. Based on the mine location relative to the monitor, the mine is unlikely to have contributed to the exceedance on this day (Appendix G). Predictions of 24-hour average PM_{10} concentrations were not made in the EIS.

In NSW, it is quite common to measure 24-hour average concentrations above the DECC criterion of 50 $\mu g/m^3$ on occasions (Appendix G). Events such as bushfires or dust storms are often the cause of elevated PM_{10} concentrations, which can be observed over large geographical areas (*ibid*.).

Appendix G summarises the annual average PM_{10} concentrations for HV1. In the past four years the inferred annual average PM_{10} concentrations have been below the DECC's annual average criterion of 30 $\mu g/m^3$ (i.e. between 10 and 17 $\mu g/m^3$) (Appendix G), which is consistent with the EIS (regardless of the inferred ratio between TSP and PM_{10}) which predicted that annual average concentrations of PM_{10} would remain well below 30 $\mu g/m^3$ at all non-company owned residences (North Limited, 1998). Based on inferred concentrations, it has been assumed that the annual average PM_{10} background concentration is 17 $\mu g/m^3$.

Odour

Potential odorants (including the reagents PAX, interfroth and CMS46 or sodium-2-mercaptobenzothiazole) are currently added to the ore slurry during ore processing.

Odour intensity from the approved CGM is considered to be very weak or not discernable at the boundary of ML 1535 (The Odour Unit, 2008).

4.9.2 Potential Impacts

The Air Quality Assessment considered the air quality emissions likely to be generated by the modified CGM and the predicted impact of these emissions in combination with existing background air quality in the vicinity of the mine (Appendix G). The background levels adopted for this assessment include contribution of dust emissions from the approved CGM. Modified CGM levels would therefore double-count some of the approved CGM emissions (since they are also included in the predicted modified CGM levels), providing for a conservative cumulative assessment.

Emissions associated with operation of the modified CGM would be primarily derived from the mechanical disturbance of soils and waste rock when using conventional mining equipment, the haulage of materials within the ML and particles from diesel exhausts in activities where diesel powered equipment is used, as well as wind blown emissions from open areas.

Modelling Scenarios

Potential impacts for dust deposition and suspended particulates were modelled for two scenarios, Years 7 and 9. A full description of the dispersion model and the emissions inventory (including the locations of fixed and mobile dust sources) and modelling outputs is provided in Appendix G.

Operation Year 7

This operational year would be representative of the maximum dust and suspended particulate emissions from the mine for the nearest receptors to the south of the mine (i.e. tailings embankment lift works would occur at the southern tailings storage facility).

Operation Year 9

This operational year would be representative of the maximum dust and suspended particulate emissions from the mine for the nearest receptors to the north of the mine (i.e. tailings embankment lift works would occur at the northern tailings storage facility).

Dust Deposition

To enable assessment against the DECC's dust deposition criteria, potential dust deposition impacts from the modified CGM including background air quality were assessed. The conservatively assumed annual average background dust emission rate is 3.1 g/m^2/month (Section 4.9.1).

Figures 4-18 and 4-19 show the predicted annual average dust deposition rates resulting from the operation of the modified CGM during Years 7 and 9. Incremental increases in annual average dust deposition due to the modified CGM only are not predicted to exceed the applicable 2 g/m^2/month DECC amenity criterion at any of the receptors in the vicinity of the mine (Appendix G), consistent with EIS predictions. Annual average dust deposition due to the modified CGM plus the assumed background was also not predicted to exceed the applicable 4 g/m^2/month DECC amenity criterion at any receptor (Appendix G).

Suspended Particulates

Concentrations of suspended particulate matter were calculated as 24-hour average and annual average PM_{10} concentrations and annual average TSP concentrations for comparison against the applicable criteria (Table 4-18). The maximum 24-hour average PM_{10} criteria was assessed for the modified CGM alone, whilst the annual average PM_{10} and TSP assessment criterion/standards relate to modified CGM emissions in addition to background concentration levels (Appendix G).

On the basis of dust monitoring data, the background annual average PM_{10} concentration for the modified CGM is inferred to be 17 $\mu g/m^3$ and the inferred annual average TSP background level is 43 $\mu g/m^3$ (Section 4.9.1).

Annual Average PM_{10}

Predicted annual average PM_{10} (modified CGM plus background) concentrations (Figures 4-18 and 4-19) were not predicted to exceed the DECC assessment criterion (i.e. 30 $\mu g/m^3$) at any receptor during Years 7 and 9 (Appendix G), consistent with EIS predictions.

Annual Average TSP

Annual average TSP (modified CGM plus background) concentrations (Figures 4-18 and 4-19) were not predicted to exceed the NHMRC goal (i.e. 90 $\mu g/m^3$) at any receptor during Years 7 and 9 (Appendix G), consistent with EIS predictions.

Maximum 24-hour average PM_{10}

Figures 4-18 and 4-19 show the predicted maximum 24-hour average PM_{10} concentrations resulting from the construction of the modified CGM. Maximum 24-hour average PM_{10} concentrations (modified CGM only) are not predicted to exceed the DECC assessment criterion of 50 $\mu g/m^3$ at any receptor during Years 7 and 9 (Appendix G).

The *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) recommends that for areas where there are already exceedances of the 50 $\mu g/m^3$ criterion, there should be no additional exceedances of 24-hour average PM_{10} air quality criteria due to a new project. At times there would be exceedances of the 50 $\mu g/m^3$ criterion at all receptors in the area, due to natural sources of particulate matter such as dust storms or bushfires (Appendix G).

Existing PM_{10} concentrations vary from day to day but if it were assumed that the existing annual average PM_{10} concentration (i.e. 17 $\mu g/m^3$) occurred every day of the year then a maximum modified CGM contribution of 33 $\mu g/m^3$ or more would be the point at which air quality impacts would be observed (assuming the DECC criterion of 50 $\mu g/m^3$ is the level at which impacts occur). The modified CGM contribution is not predicted to exceed 33 $\mu g/m^3$ at any residence in the vicinity of the mine (Appendix G). Notwithstanding, the probability of the modified CGM causing an exceedance of 50 $\mu g/m^3$ increases with increasing background levels.

Odour

Potential odorants would continue to be added to the ore slurry during ore processing for the modified CGM.

As stated in Section 4.9.1, odour intensity from the approved CGM is considered to be very weak or not discernable at the boundary of ML 1535 (The Odour Unit, 2008). The source of odours and intensity of odours is not expected to increase as a result of the modified CGM. Consequently, off-site odour impacts would not be expected to change (Appendix G).

Greenhouse Gas Emissions

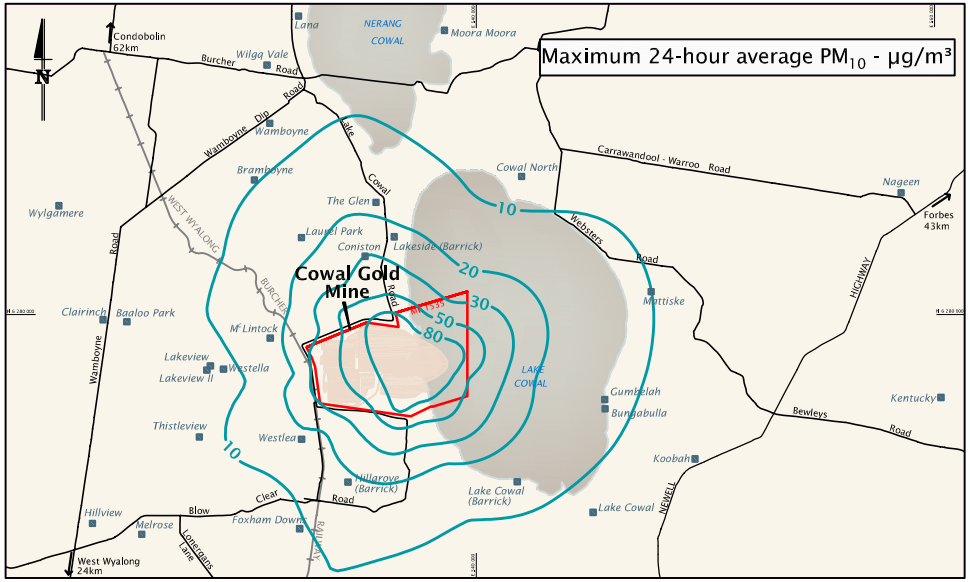
An assessment of modified CGM greenhouse gas emissions is provided in Appendix G. The outcomes of the assessment are summarised below.

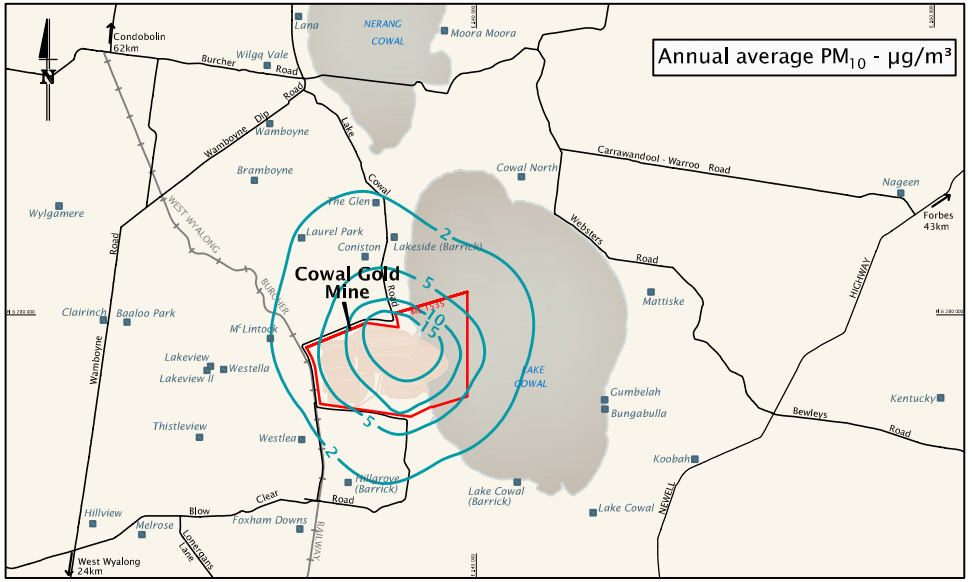
The major source of greenhouse gas emissions from the modified CGM would be the combustion of diesel in mobile equipment on-site and indirectly by the use of electricity to power the process plant (e.g. for the grinding circuit).

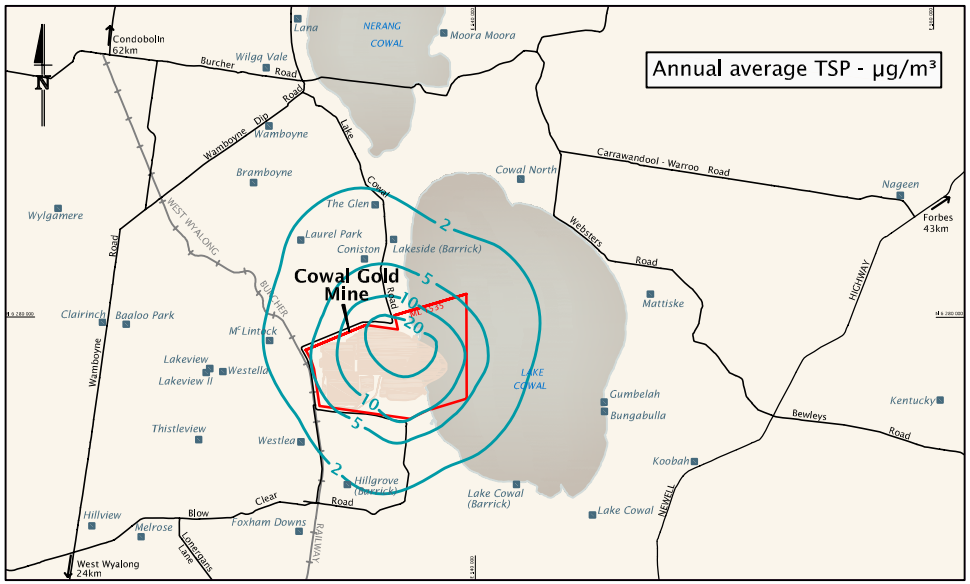
An assessment of the modified CGM greenhouse gas emissions was conducted using empirical emission factors provided by the *National Greenhouse Accounts Factors* (the NGA Factors) (Commonwealth Department of Climate Change [DCC], 2008). The average annual emission estimate for the life of the modified CGM would be approximately 0.29 Mt $CO_{2\text{-}e}$ pa (Appendix G).

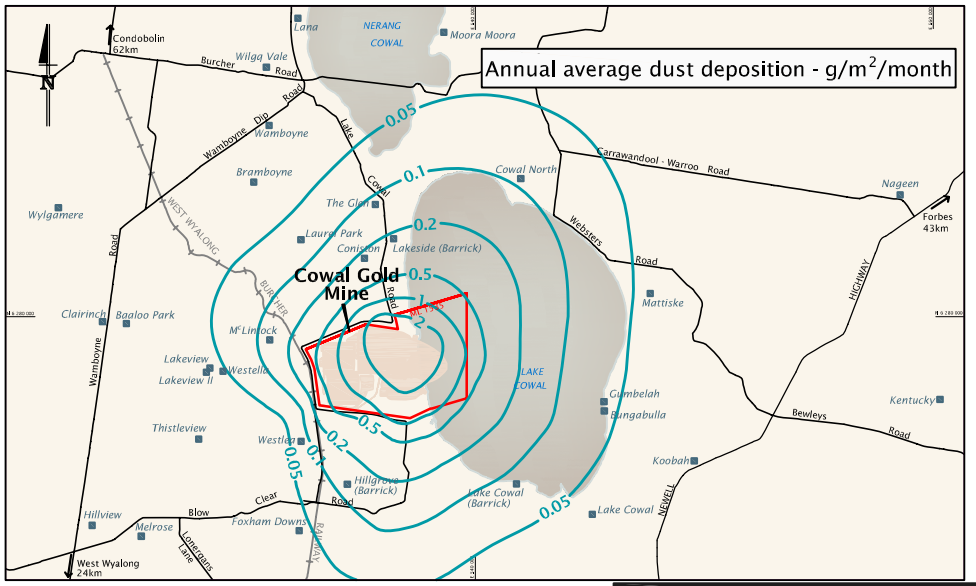
The average annual greenhouse gas emission estimate can be compared with the following 2005 estimates provided by the Australian Greenhouse Office (AGO) in the latest Australian National Greenhouse Gas Inventory report (AGO, 2007) (Appendix G):

- estimate of Australia's 2005 net emissions, 559.1 Mt $CO_{2\text{-}e}$;
- estimate of Australia's 2005 net emissions for the energy sector, which is the major contributor to carbon-dioxide emissions, 391 Mt $CO_{2\text{-}e}$; and
- estimate of Australia's 2005 net emissions for the industrial sector was 29.5 Mt $CO_{2\text{-}e}$.









LEGEND
- Mining Lease Boundary
- Road
- Dwelling
- 30 Air Quality Contour

0 2 4 6 8 10
Kilometres

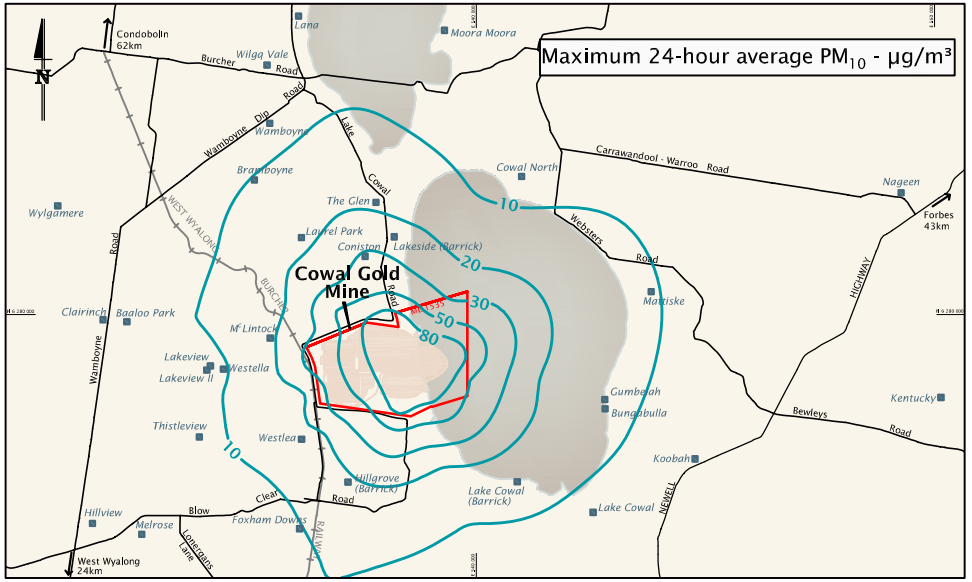
Source: Topographic Base- (Fairholme,Wamboyne, Jemalong and Wirrinya) Department of Lands NSW, 2007, Homesteads- Geoscience Australia, 2006 and Holmes Air Services, 2008

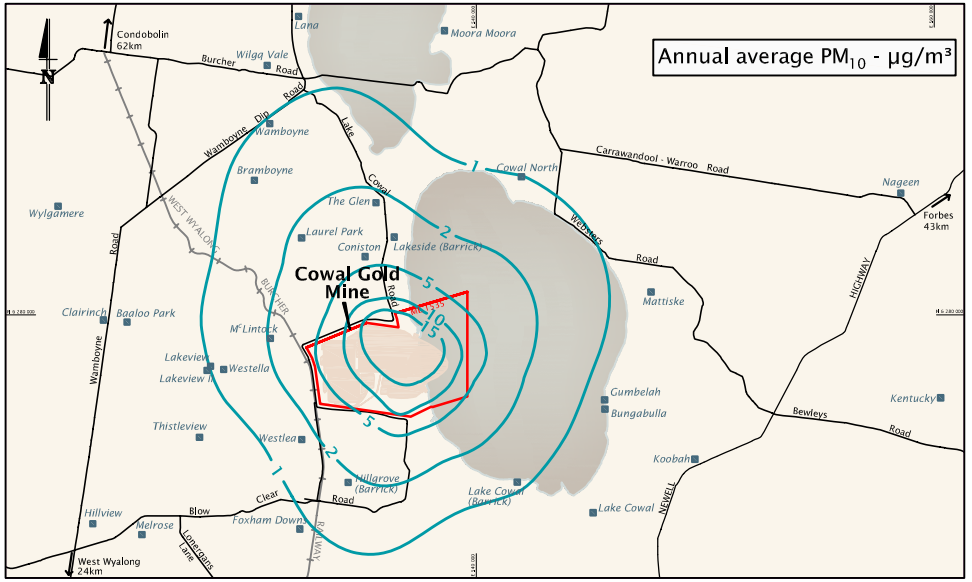
ResourceStrategies

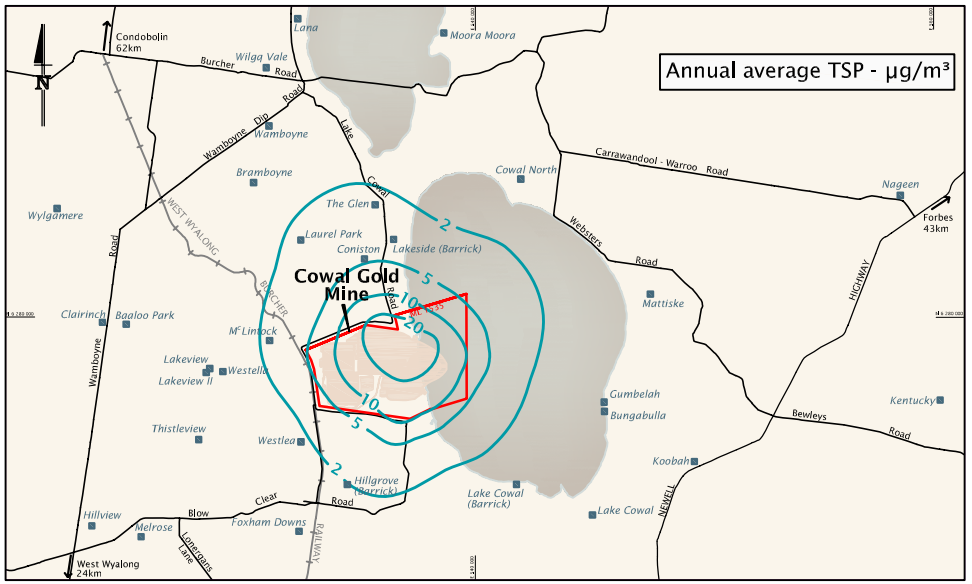
E42 MODIFICATION

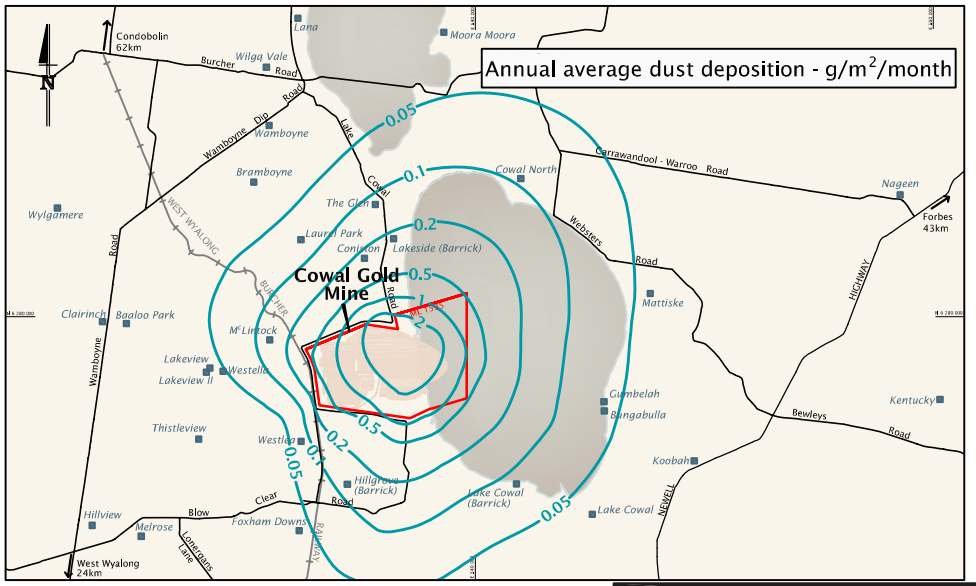
FIGURE 4-18
Predicted Air Quality Emissions from the Modified CGM - Year 7

BARRICK COWAL









LEGEND
- Mining Lease Boundary
- Road
- Dwelling
- 30 Air Quality Contour

0 2 4 6 8 10
Kilometres

Source: Topographic Base- (Fairholme,Wamboyne, Jemalong and Wirrinya) Department of Lands NSW, 2007, Homesteads- Geoscience Australia, 2006 and Holmes Air Services, 2008

E42 MODIFICATION

FIGURE 4-19
Predicted Air Quality Emissions from the Modified CGM - Year 9

ResourceStrategies

BARRICK COWAL

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4.9.3 Mitigation and Management Measures

Dust Deposition and Suspended Particulate Emission Management

The mitigation and management measures for wind blown and mine generated dust at the approved CGM are presented in the DMP. The DMP includes (Barrick, 2003m):

- relevant air quality criteria that apply to the mine;
- air quality control measures (e.g. areas for soil stripping will be minimised, all roads and trafficked areas will be watered, freefall height during ore/waste stockpiling will be limited, etc.);
- the air quality monitoring programme;
- stakeholder consultation and notification requirements;
- complaint resolution and property acquisition requirements; and
- reporting requirements for dust related issues.

The mitigation and management measures described in the DMP would continue to be implemented for the modified CGM.

Greenhouse Gas Emissions

The mitigation of greenhouse gas emissions is inherent in the development of the mine plan. For example, reducing fuel usage by mobile plant is an objective of mine planning. Hence, significant savings of greenhouse gas emissions can be attributed to appropriate mine planning.

Additional management/minimisation of greenhouse gas emissions associated with the modified CGM would be employed via:

- regular maintenance of plant and equipment to minimise fuel consumption; and
- consideration of energy efficiency in plant and equipment selection/purchase.

An Energy Savings Action Plan (ESAP) would be prepared that would describe energy efficiency measures to be employed to minimise greenhouse gas emissions from the modified CGM. The process for developing the ESAP would involve:

- determining current energy use;
- undertaking an energy management review;
- undertaking a detailed technical review; and
- assessing and identifying energy savings measures.

The ESAP would detail procedures/measures to manage/minimise greenhouse gas emissions associated with the modified CGM including:

- regular maintenance of plant and equipment to minimise fuel consumption; and
- consideration of energy efficiency in plant and equipment selection/purchase.

4.10 ROAD TRANSPORT

A Road Transport Assessment for the modified CGM has been undertaken by Masson Wilson Twiney (2008) and is presented in Appendix J. Appendix J provides an assessment of the existing traffic conditions in the immediate CGM surrounds and the estimated increase in traffic generated as a result of the E42 Modification.

As stated in Section 2.10, the primary access to the modified CGM (light and heavy vehicles) would continue to be provided from West Wyalong via the approved road which was upgraded in 2005 (Figure 4-15). This road route was assessed in a 1997 Review of Environmental Factors (REF) (Resource Strategies, 1997). Upgrades to this route were proposed in the REF including widening and sealing pre-existing dirt roads and upgrades of some intersections. Approval for these road works was provided in 1999. Upgrade works were completed in 2005. Two additional routes along existing roads are proposed for use by mine personnel light vehicles and shuttle buses from Condobolin and Forbes (Figure 4-15) as part of the E42 Modification. The access routes proposed for use during the modified CGM are summarised below.

West Wyalong Access Route

This existing access route to the approved CGM from West Wyalong follows Ungarie Road, Wamboyne Road, Blow Clear Road and Bonehams Lane.

Forbes Access Route

Access from Forbes to the modified CGM would be via the Newell Highway, Carrawandool-Warroo Road, Bogies Island Road, Burcher Road, Wamboyne Dip Road, and Lake Cowal Road to the existing CGM.

Condobolin Access Route

Access from Condobolin would be via the West Wyalong-Condobolin Road, Burcher Road, Wamboyne Dip Road, and Lake Cowal Road to the existing CGM entrance.

4.10.1 Existing Environment

The existing road system and traffic flows in the vicinity of the approved CGM are described in detail in Appendix J and are summarised below.

Road Hierarchy

Existing roads proposed for use during the modified CGM are classified as arterial, sub-arterial and local roads in accordance with the RTA's *Guide to Traffic Generating Developments* (RTA, 2002) and Austroad's *Rural Road Design: A Guide to the Geometric Design of Rural Roads* (Austroads Inc, 2003).

Arterial Roads

In the vicinity of the CGM, the Newell Highway (SH17) is a sealed arterial road (Austroads Arterial Roads Class 1) which links West Wyalong and Forbes. Traffic along this highway includes a range of heavy vehicles such as B-doubles and road trains. The Newell Highway is a State Road and is under the management and control of the RTA (Appendix J).

Sub-Arterial Roads

Ungarie Road is a sealed sub-arterial road (Austroads Arterial Roads Class 2) which extends from the Mid-Western Highway (SH6) west of West Wyalong to Ungarie. Ungarie Road carries through traffic from West Wyalong to Condobolin, including a range of heavy vehicles such as B-doubles and road trains.

West Wyalong – Condobolin Road is a sealed sub-arterial road (Austroads Arterial Roads Class 2) which extends from Ungarie Road in Ungarie to Condobolin. West Wyalong – Condobolin Road also carries through traffic from Ungarie to Condobolin, including a range of heavy vehicles such as B-doubles and road trains.

These sub-arterial roads are regional roads are under the care and control of various local councils, with funding assistance provided by the RTA (Appendix J).

Local Roads

In the vicinity of the CGM local roads provide access for local traffic and landholders to access their properties, with periods of grain farming heavy traffic in the relevant seasons associated with grain farming. Local roads of relevance to the E42 Modification include: Wamboyne Road, Wamboyne Dip Road, Blow Clear Road, Bonehams Lane, Lake Cowal Road, Carrawandool-Warroo Road, Bogies Island Road and Burcher Road.

These local roads are under the care and control of various local councils (predominantly BSC) (Appendix J).

Existing Road Conditions

Approved GCM Access Route

The approved CGM access route comprises Ungarie Road, Wamboyne Road, Blow Clear Road and Bonehams Lane. This route was upgraded in 2005 as part of relevant CGM works and is therefore of recent design construction standard and provides a 7 to 8 m carriageway with 1 m sealed shoulders.

Newell Highway (SH17)

The Newell Highway (SH17) is a two lane undivided road with a sealed pavement of generally 7 to 8 m wide with 1 to 2 m wide sealed shoulders (Appendix J).

Ungarie Road

Ungarie Road is a two lane undivided road with a sealed pavement generally 7 to 8 m wide with 1 to 2 m sealed shoulders (Appendix J).

West Wyalong – Condobolin Road

West Wyalong – Condobolin Road is a two lane undivided road with a sealed pavement generally 7 to 8 m wide with 1 to 2 m sealed shoulders (Appendix J).

Carrawandool–Warroo Road

Carrawandool–Warroo Road provides a sealed pavement of 6 m width with 1 m sealed shoulders for a distance of approximately 6.5 km to the west of the Newell Highway (Appendix J). At the intersection of Carrawandool-Warroo Road and the Newell Highway, a wider sealed shoulder up to 4 m is provided on the eastern side of the intersection with additional gravel width which effectively forms a nearside passing bay for through vehicles to pass a right turning vehicle (*ibid*.). The western side of the intersection provides an 8 m wide gravel track (*ibid*.). A number of intersections along its length have been sealed for about 400 m either side of minor side roads (*ibid*.). These works were undertaken in response to requests by local school bus operators, who service routes along Carrawandool – Warroo Road, to provide better traction whilst turning at intersections (*ibid*.). The horizontal and vertical alignment of Carrawandool–Warroo Road on the section between Low's Road and Newell Highway is generally straight and level (*ibid*.). At the side road intersection with Low's Road the route turns through a 90° bend to the north (*ibid*.). Some 5 km to the north of the Low's Road intersection the route continues as Bogies Island Road at the Warroo turn off (*ibid*.).

Bogies Island Road

Bogies Island Road follows a series of right and left hand horizontal curves and at its northernmost point, 26.7 km along the route (from Newell Highway), a left hand horizontal curve bend combines with a vertical crest curve which provides restricted forward visibility (Appendix J). Marker posts are provided for night-time delineation of this combination of horizontal and vertical curvature (*ibid*.). Bogies Island Road has a dry weather surface and during wet seasons is impassable.

At its western end Bogies Island Road connects to Burcher Road at the location of a left-right staggered uncontrolled intersection (*ibid.*).

Wamboyne Dip Road

Wamboyne Dip Road is a dirt track of generally 8m road corridor width which connects to Bogies Island Road in the north and to Wamboyne Road in the south (Appendix J). Some 500 m to the south of Bogies Island Road, Wamboyne Dip Road provides access to Lake Cowal Road via an uncontrolled intersection.

Lake Cowal Road

Lake Cowal Road provides a combination of dirt and gravel track with a general 8 m road corridor width. Lake Cowal Road connects to Wamboyne Dip Road via an uncontrolled intersection in the north and to ML 1535 in the south via a priority controlled intersection (Appendix J). The alignment of Lake Cowal Road has a number of horizontal curves some of which have marker posts and advance directional signage (*ibid*.). At some horizontal curves, trees abut the edge of the road formation (i.e. in the clear zone – an area adjacent to the traffic lane that should be kept free from features that would be potentially hazardous to errant vehicles) where there is no night-time delineation (*ibid*.).

Bonehams Lane

Bonehams Lane connects to Blow Clear Road at its southernmost extent via a priority controlled T-intersection (Appendix J). Approximately 4.5 km north of Blow Clear Road the road turns through 90° to link with the internal access road within ML 1535.

Burcher Road

Burcher Road connects to the West Wyalong-Condobolin Road at its westernmost extent via a priority controlled T-intersection (Appendix J). Approximately 10 km of its western section is sealed with 6 m pavement width and grass shoulders (*ibid*.). The remaining 10 km along its eastern section is a combination of sealed 4 m road with 1 to 3 m wide shoulders and 8 m gravel road corridor width (*ibid*.). The horizontal alignment of the gravel section of Burcher Road is straight, although there are several vertical crest curves which restrict forward visibility to a minor extent (*ibid*.). The sealed section of Burcher Road provides a satisfactory horizontal and vertical alignment (*ibid*.).

Existing Traffic Volumes

As a component of the Road Transport Assessment, available traffic flow data was reviewed and E42 Modification-specific traffic counts were conducted (to supplement available traffic flow data), where required. The relevant traffic counter locations shown on Figure 4-15 and the existing daily traffic volumes and ratio of volume to capacity of the existing road network are summarised in Table 4-19.

The volume to capacity ratios presented in Table 4-19 demonstrate that the roads relevant to the E42 Modification currently operate at a Level of Service B.

Table 4-19
Existing Daily Traffic and Volume to Capacity Ratios

Road	Location	Daily Traffic Volume	Daily Traffic Capacity[1]	Volume/ Capacity Ratio
Wamboyne Rd	East of Ungarie Rd	333	4,800	0.07
Ungarie Rd	North of Wamboyne Rd	551	4,800	0.11
Ungarie Rd	South of Wamboyne Rd	927	4,800	0.19
Blow Clear Rd	West of Clear Ridge Rd	295	4,800	0.06
Newell Highway (SH17)	North of Carrawandool – Warroo Rd	2,548	4,800	0.53
Burcher Road	East of West Wyalong – Condobolin Rd	46	120[2]	0.38
West Wyalong – Condobolin Rd	South of Burcher Road	117	4,800	0.02
Main St (West Wyalong)*	East of Newell Highway (SH17)	4,556	4,800	0.95
Mid Western Highway (SH6)	West of MR57,Girral Rd	566	4,800	0.12
Ardlethan Rd (SH17)*	South of Main St	1,630	4,800	0.34
Newell Highway (SH17)	North of Temora Road (MR57)	4,167	4,800	0.87
Carrawandool – Warroo Rd	East of Newell Highway (SH17)	72	120[2]	0.60
West Wyalong – Condobolin Rd	North of Burcher Road	163	4,800	0.03

Source: Appendix J

[1] Daily traffic capacity of 4,800 vehicles in accordance with *Guide to Traffic Engineering Practice: Part 2 Roadway Capacity* (Austroads Inc, 1999) – based upon K factor of 0.10 and Level of Service B.

[2] Daily traffic capacity of 120 vehicles in accordance with *Source Book For Australian Roads* (Australian Road Research Board, 1985) - an unsealed road maintained under traffic is usually considered suitable for 120 vehicles per day.

* The Newell Highway exists as Main Street and Ardlethan Road where it passes through West Wyalong.

Austroads Inc (1999) defines a Level of Service as a qualitative measure describing operational conditions within a traffic stream (in terms of speed, travel time, room to manoeuvre, safety and convenience) and their perception by mortorists and/or passengers. A scale from A to F is used, with Level of Service A free flowing and F, queuing and delays. Level of Service B is described as (*ibid*.):

> *…in the zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre with the traffic stream, although the general levels of comfort and convenience is a little less than with Level of Service A.*

Road Safety

Masson Wilson Twiney reviewed available traffic accident data for the period 2002 to 2007 for the roads relevant to the E42 Modification (Appendix J).

Analysis of the data identified that there were a total of five reported personal injury and two tow-away accidents in the period reviewed (none of which were fatalities). This accident history is not significant and the roads analysed have no blackspots that would warrant physical changes to the roads (Appendix J).

Transport of Hazardous Materials

The existing arrangements covering the transport of hazardous materials, including details of routes used for the movement of vehicles carrying hazardous materials to or from the approved CGM, are set out in the THMS (Barrick, 2005zvi). As for all heavy vehicle deliveries to the approved CGM, the existing access road from West Wyalong would be used for the E42 Modification traffic.

4.10.2 Potential Impacts

Traffic Generation

Staff Movements

Traffic increases would arise from the movement of the additional personnel (Section 2.12), with the number of personnel travelling to and from the mine on any given day dependent on their shift/roster (Appendix J). With two crew of the four operational crews working each day, there would be an average of 15 additional personnel travelling to and from the mine each day as a result of the E42 Modification.

It is likely that most of these 15 additional personnel would use the existing shuttle bus service. Notwithstanding, the Road Transport Assessment conservatively assumed that the additional personnel would all travel by car, with an average car occupancy of 1.67 persons per vehicle, providing approximately 20 two-way daily movements (*ibid*.).

Truck Movements

The E42 Modification would increase the ore processing rate slightly above current levels and as a consequence, the number of truck movements to and from the approved CGM would increase by an average of six additional daily two-way truck movements above current levels (i.e. a total of 30 daily two-way truck movements).

The number of oversized movements would not increase as a result of the E42 Modification.

Traffic Assessment Scenarios

Masson Wilson Twiney provided for a conservative traffic assessment of increased traffic volumes by assuming the additional staff would be drawn wholly from each of the three local employment centres (i.e. West Wyalong, Forbes and Condobolin).

The three scenarios assessed are as follows (Appendix J):

- Scenario 1 – all additional employees are sourced from West Wyalong (i.e. travel along the existing access route) and all additional truck deliveries arrive via the existing access route.
- Scenario 2 – all additional employees are sourced from Forbes (i.e. travel along the proposed Forbes access route) and all additional truck deliveries arrive via the existing access route.
- Scenario 3 – all additional employees are sourced from Condobolin (i.e. travel along the proposed Condobolin access route) and all additional truck deliveries arrive via the existing access route.

Predicted E42 Modification daily traffic generation includes light traffic associated with workforce and visitor movements as well as heavy vehicle deliveries.

For each of the above scenarios, the predicted additional personnel movements were added to the existing movements on the access routes from West Wyalong, Forbes and Condobolin. The six additional two-way daily truck movements were all assigned to the access route from West Wyalong and the Newell Highway (SH17).

Table 4-20 summarises the predicted daily vehicle movements generated by the E42 Modification for each of the scenarios.

The additional traffic generated by the E42 Modification shown in Table 4-20 would be accommodated by the existing road network and would be imperceptible above the daily variations in existing traffic volumes (Appendix J).

Assessment of the ratio of volume to capacity under each scenario (Table 4-21) shows that all roads proposed for access to the modified CGM would continue to operate at their existing Level of Service (i.e. Level of Service B) (Appendix J).

Peak Hour Intersection Performance

Austroads' *Guide to Traffic Management Part 6: Interchanges, Intersections and Crossings* (Austroads Inc, 2007) provides a guide to determine the need for a detailed traffic analysis of an individual intersection, based on vehicles per hour (vph) road flow.

Maximum traffic increases would occur at the following intersections along each route for the E42 Modification:

- Ungarie Road/Wamboyne Road (West Wyalong Route).
- Newell Highway (SH17)/Carrawandool – Warroo Road (Forbes route).
- West Wyalong – Condobolin Road/Burcher Road (Condobolin route).

These intersections form the boundary between the local road and the higher order sub-arterial and arterial road network considered in the Road Transport Assessment. These intersections therefore accommodate greater traffic volumes compared to other intersections considered in the assessment.

Based on the Austroads thresholds, all three intersections would continue to operate satisfactorily under "stop" or "give-way" control (Appendix J).

Table 4-20
Existing and Predicted Daily Traffic Volumes

Road	Location	Existing Traffic Volume	Predicted Traffic Volume (Scenario 1 - West Wyalong)	Predicted Traffic Volume (Scenario 2 - Forbes)	Predicted Traffic Volume (Scenario 3 - Condobolin)
Wamboyne Rd	East of Ungarie Rd	333	359	339	339
Ungarie Rd	North of Wamboyne Rd	551	551	551	551
Ungarie Rd	South of Wamboyne Rd	927	953	933	933
Blow Clear Rd	West of Clear Ridge Rd	295	321	301	301
Newell Highway (SH17)	North of Carrawandool – Warroo Rd	2,548	2,554	2,574	2,554
Burcher Road	East of West Wyalong – Condobolin Rd	46	46	46	66
West Wyalong – Condobolin Rd	South of Burcher Road	117	117	117	117
Main St (West Wyalong)*	East of Newell Highway (SH17)	4,556	4,582	4,562	4,562
Mid Western Highway (SH6)	West of MR57,Girral Rd	566	566	566	566
Ardlethan Rd (SH17)*	South of Main St	1,630	1,630	1,630	1,630
Newell Highway (SH17)	North of Temora Road (MR57)	4,167	4,173	4,173	4,173
Carrawandool – Warroo Rd	West of Newell Highway (SH17)	72	72	92	72
West Wyalong – Condobolin Rd	North of Burcher Road	163	163	163	183

Source: Appendix J
* The Newell Highway exists as Main Street and Ardlethan Road where it passes through West Wyalong.

With regard to traffic generation and peak hour intersection performance, no capacity improvements at intersections would be required (Appendix J).

Employee Shuttle Bus Service

The E42 Modification would be likely to increase the number of passengers using the existing employee shuttle bus service (i.e. the additional employees would use the employee shuttle buses instead of driving). If all the additional employees utilise the existing shuttle bus services there would be an almost negligible increase in external traffic (Appendix J).

Car Parking

Additional formal parking is not expected to be necessary given that additional personnel would be encouraged to use the shuttle bus service. Notwithstanding, there is potential within the approved CGM car park to accommodate any occasional overspill parking (Appendix J).

Road Safety

The increase in traffic volumes resulting from the E42 Modification would be minimal, and therefore no significant road safety issues are anticipated (Appendix J).

Transport of Hazardous Materials

The E42 Modification does not include any additional hazardous materials that would warrant inclusion in the THMS. Further, the modification would not require any changes to the routes used for the movement of vehicles carrying hazardous materials (currently included in THMS) to or from the E42 Modification.

4.10.3 Mitigation Measures and Management

Traffic Minimisation

Barrick would continue to encourage use of the existing employee shuttle bus service and car pooling where practicable.

Table 4-21
Predicted Daily Traffic Volumes

Road	Location	Predicted Traffic Volume								
		Including All West Wyalong Employees			Including All Forbes Employees			Including All Condobolin Employees		
		Volume	Capacity	V/C Ratio	Volume	Capacity	V/C Ratio	Volume	Capacity	V/C Ratio
Wamboyne Rd	East of Ungarie Rd	359	4,800	0.07	339	4,800	0.07	339	4,800	0.07
Ungarie Rd	North of Wamboyne Rd	551	4,800	0.11	551	4,800	0.11	551	4,800	0.11
Ungarie Rd	South of Wamboyne Rd	953	4,800	0.20	933	4,800	0.19	933	4,800	0.19
Blow Clear Rd	West of Clear Ridge Rd	321	4,800	0.07	301	4,800	0.06	301	4,800	0.06
Newell Highway (SH17)	North of Carrawandool – Warroo Rd	2,554	4,800	0.53	2,574	4,800	0.54	2,554	4,800	0.53
Burcher Road	East of West Wyalong – Condobolin Rd	46	120	0.38	46	120	0.38	66	120	0.55
West Wyalong – Condobolin Rd	South of Burcher Road	117	4,800	0.02	117	4,800	0.02	117	4,800	0.02
Main St (West Wyalong)*	East of Newell Highway (SH17)	4,582	4,800	0.95	4,562	4,800	0.95	4,562	4,800	0.95
Mid Western Highway (SH6)	West of MR57,Girral Rd	566	4,800	0.12	566	4,800	0.12	566	4,800	0.12
Ardlethan Rd (SH17)*	South of Main St	1,630	4,800	0.34	1,630	4,800	0.34	1,630	4,800	0.34
Newell Highway (SH17)	North of Temora Road (MR57)	4,173	4,800	0.87	4,173	4,800	0.87	4,173	4,800	0.87
Carrawandool – Warroo Rd	West of Newell Highway (SH17)	72	120	0.60	92	120	0.77	72	120	0.60
West Wyalong – Condobolin Rd	North of Burcher Road	163	4,800	0.03	163	4,800	0.03	183	4,800	0.04

Source: Appendix J
* The Newell Highway exists as Main Street and Ardlethan Road where it passes through West Wyalong.

The adequacy of the existing employee shuttle bus service would be monitored and modified as necessary when the exact distribution of the sources of the new employees is established. If required, buses with additional seating capacity would be used to transport the additional employees (i.e. the number of bus movements would remain the same).

Transport of Hazardous Materials

The arrangements covering the transport of hazardous materials are set out in the approved CGM THMS. The objectives of the THMS include:

- setting out the arrangements covering the transport of hazardous materials including details of routes to be used for the movement of vehicles carrying hazardous materials to or from the development;
- carrying out the study in accordance with the DUAP's (1995a) *Draft Route Selection: Guidelines for Land Use and Environmental Safety Planning for Hazardous Materials – Road Transport Considerations* (herein referred to as the Draft Route Selection Guidelines);
- addressing issues associated with spills, cleanup procedures, training of clean-up teams, communication, and liaison with organisations such as the fire brigades, District Emergency Management Coordinator (and Committee), Local Emergency Management Committee(s), and state emergency services for the materials subject to the study;
- addressing inspection and monitoring procedures for chemicals such as explosives, xanthates and cyanide prior to the commencement of a trip to verify the integrity of the packaging; and
- addressing measures to be taken to ensure that the temperature of the materials subject to the study does not rise above safe levels.

The THMS would be continued for the modified CGM.

4.11 ABORIGINAL CULTURAL HERITAGE

A summary of the archaeological surveys and assessments undertaken to date for the approved CGM (Section 4.11.1) and a description of the potential impacts (Section 4.11.2) and proposed management and mitigation measures applicable to the Aboriginal cultural heritage sites proposed to be disturbed for the modified CGM (Section 4.11.3) are provided below.

4.11.1 Existing Environment

More than five archaeological surveys and assessments have been conducted in the vicinity of the approved CGM at various times between 1989 and 2003.

Preliminary archaeological inspections were made at Lake Cowal in 1989 by Paton (Paton, 1989). In 1995 project feasibility studies were approved and detailed archaeological surveys along the lake shore and in the vicinity of the approved CGM were conducted by Scott Cane and Roley Williams (Wiradjuri Regional Aboriginal Land Council) (Cane, 1995a). Subsequent development planning led to another archaeological survey of a possible access road, a water pipeline and a transmission line for the proposed mine (Huys and Johnston, 1995). A further archaeological investigation was conducted in the area west of the Lake later that year by Scott Cane assisted by Roley Williams (Wiradjuri Regional Aboriginal Land Council) and a member of the West Wyalong Aboriginal community (Cane, 1995b).

In 1995, another archaeological survey of new locations for tailings storage facilities, part of the water pipeline, a small road realignment and a new ETL route to the south of the Lake was undertaken (Nicholson, 1997).

A number of further surveys conducted by archaeologists Dr Colin Pardoe, Dr Johan Kamminga, emeritus Professor Jim Allen, emeritus Professor Richard Wright, Dr Peter Hiscock, Dr Sally Brockwell, Mr David Johnston and Mr Francis Shawcross have also been undertaken since 2001 in consultation with Aboriginal representatives.

Barrick's consultant archaeologist, Dr Colin Pardoe, prepared a Research Design and Study Plan describing the archaeological works proposed for the approved CGM, which was attached to Barrick's application for Permit 1468 and Permit 1681. This plan identifies the following five zones of management within the vicinity of the approved CGM:

- lake bed zone;
- beach zone;
- slope zone;
- lake edge ridge zone; and
- back plain zone.

Aboriginal heritage sites which occur within ML 1535 and have been registered with the DECC include sites P1, P2, LC1-LC4 and exposures A-N. These sites range from open scatters (e.g. site P1) to base camps (e.g. site LC2) to a scarred tree. The recorded artefacts associated with these sites include quartz flakes, backed blades and axes. The majority of registered sites within ML 1535 are open scatters with concentrations of quartz flakes.

Summaries of the survey results and the registered Aboriginal sites identified in each management zone are outlined in the IACHMP (Barrick, 2003n). The registered Aboriginal cultural heritage sites relevant to the approved CGM are identified on Figure 4-20.

Barrick and its consultant archaeologists have obtained permits and consents under Section 87 and Section 90, respectively, pursuant to the NPW Act for the management of Aboriginal heritage artefacts at the approved CGM. They are:

- Permit 1468 authorising certain archaeological works in the ML area, water pipeline area and borefield area;
- Consent 1467 authorising the destruction of Aboriginal objects in the ML area, water pipeline area and borefield area;
- Permit 1681 authorising certain archaeological works in the relocated travelling stock reserve area and road upgrade area; and
- Consent 1680 authorising the destruction of aboriginal objects in the relocated travelling stock reserve area and road upgrade area.

The above are referred to as the permits and consents.

Activities for the approved CGM have been conducted in accordance with relevant permit and consent conditions and the IACHMP. All construction earthworks have been monitored and no non-compliances have been reported (Barrick, 2005b, 2006a, 2007a, 2008a).

All collected Aboriginal objects are currently retained in a Keeping Place within ML 1535. Of specific relevance to the E42 Modification, sites B, C and LC2 have been the subject of extensive archaeological surveys and recording. Collection works have been undertaken at sites B and C by archaeologists with observation/participation of members of the Aboriginal community. These sites are described in the EIS and the IACHMP and are summarised below.

Site LC2

Site LC2 is more typical of a "base camp" with flaked material scattered along both sides of a stream running into Lake Cowal …

… artefacts and materials found at this site which include flakes, flaked pieces, cores, modified flakes, backed blades, blades, hand axes, hammerstones, adze flakes and ground artefacts.

[Exposure] B

[Exposure] B is located to the west of the foot slopes Cowal West Hill near a number of gilgai depressions. Thirteen artefacts were identified in an area of 40 m x 100 m. Most were quartz flakes …

[Exposure] C

[Exposure] C is located half a kilometre to the west of Cowal West Hill. Twenty six artefacts were found exposed in an area measuring 30 m x 25 m under a tree. Most of the artefacts were quartz flakes.

Works at sites B, C and LC2 have been undertaken in accordance with the requirements of the permits and consents, as described below.

Sites B and C

- Sites B and C have been covered by a geo-textile blanket extending a minimum of 2 m beyond all visible artefacts defining their boundaries. A layer of loam/sand (minimum 200 mm thick) has been hand spread over this blanket. A secondary geo-textile blanket covers the loam and has been pegged down at the edges.
- The protected areas have been sign-posted and fenced.

Site LC2

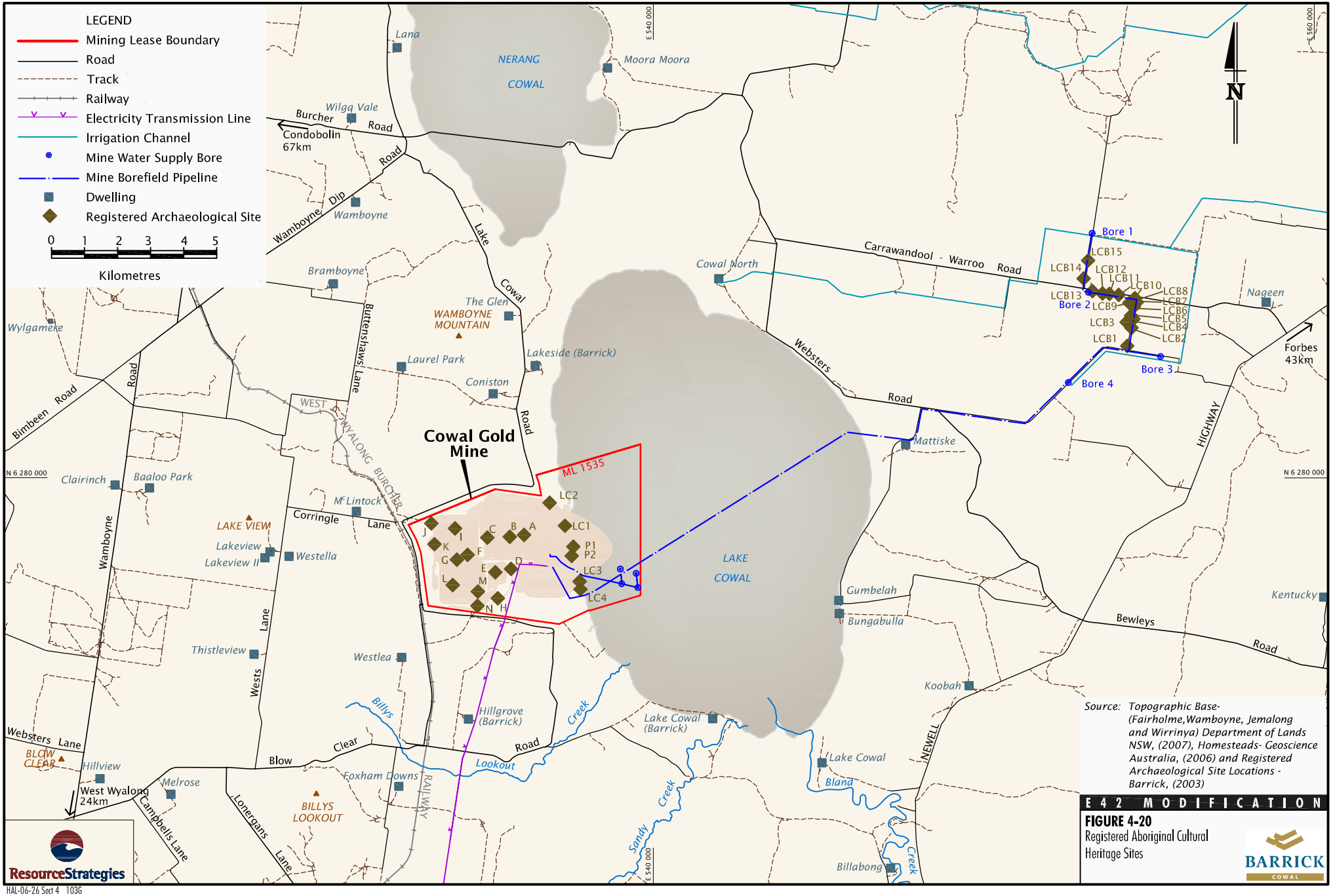
- The protected area has been partially fenced.

Consultation

Consultation with Aboriginal groups about the approved CGM has been extensive and involved various methods including advertisements, meetings, correspondence and archaeological survey attendance prior to the commencement of, and during, the operation of the approved CGM.

The following groups have been consulted about the approved CGM to date:

- Wiradjuri Council of Elders;
- Wiradjuri Condobolin Corporation;



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- Native Title Services;
- West Wyalong Local Aboriginal Land Council;
- Mooka Traditional Owners Council;
- Wiradjuri Regional Aboriginal Land Council; and
- NSW Aboriginal Land Council.

Consultation relevant to EIS Aboriginal heritage suveys is described above. Consultation relevant to Barrick applications for permit and consents is described in relevant applications. Wiradjuri monitors undertake regular clearances during mining operations in accordance with permit and consent conditions, the Ancillary Deed and the IACHMP. The Ancillary Deed is a result of the Native Title Agreement between Barrick and the Native Title Claimants and has resulted in significant positive outcomes for the Wiradjuri community in terms of employment and business opportunities, including the proposed construction of the Wiradjuri Studies Centre in Condobolin.

Cultural Heritage Offsets and Dissemination

In addition to the above management and mitigation measures undertaken to date, Barrick has provided funding for the following offsets for potential impacts to Aboriginal cultural heritage at the approved CGM (as agreed with the Wiradjuri Condobolin Corporation and West Wyalong Local Aboriginal Land Council) including funding by Barrick of the items described below:

- The design and construction of a Keeping Place for Aboriginal objects collected pursuant to Permit 1468 (at a location agreed with the Aboriginal community).
- A regional cultural heritage study and the associated research and publication of a booklet about Wiradjuri cultural heritage and associations with the land.

4.11.2 Potential Impacts

Of the 20 registered Aboriginal heritage sites within ML 1535, sites B, C and LC2 would be disturbed for the E42 Modification.

Sites B and C would be permanently covered by the northern waste emplacement. Site LC2 may be partially disturbed/covered by the northern waste emplacement and/or disturbed by proposed water management works associated with the UCDS.

Aboriginal Group Consultation

Relevant Aboriginal groups were invited to a consultation meeting about the E42 Modification in June 2008 (Section 3.6.2). The purpose of the consultation was to gain views regarding the significance of the Aboriginal cultural heritage values associated with the land proposed for disturbance by the E42 Modification and any likely impacts that the E42 Modification may have on these values.

Based on previous association with the approved CGM, the following groups were invited to attend the information session held in West Wyalong in June 2008:

- Wiradjuri Condobolin Corporation;
- Wiradjuri Council of Elders;
- West Wyalong Local Aboriginal Land Council;
- Condobolin Local Aboriginal Land Council;
- Mooka Traditional Owners Council;
- NSW Aboriginal Land Council;
- BSC;
- DECC; and
- Native Title Services.

West Wyalong Local Aboriginal Land Council, Condobolin Local Aboriginal Land Council and Mooka Traditional Owners Council attended the June 2008 information session. In response to requests during this meeting, representatives from West Wyalong Local Aboriginal Land Council, Condobolin Local Aboriginal Land Council and Mooka Traditional Owners Council also visited the approved CGM to view the sites proposed for disturbance. Feedback was received from West Wyalong Local Aboriginal Land Council, Condobolin Local Aboriginal Land Council and Mooka Traditional Owners Council. The issues raised by the Aboriginal groups during this consultation included:

- Aboriginal cultural heritage values associated with the land proposed for disturbance and any likely impact on these values;
- heritage management measures, including discussion of salvage and storage measures;
- the role of Aboriginal people according to their relationship to the approved CGM area; and
- conservation outcomes with respect to Aboriginal cultural heritage.

Consideration of this feedback is described in Section 4.11.3.

4.11.3 Mitigation Measures and Management

As stated above, Barrick and its consultant archaeologists have obtained permits and consents under Section 87 and Section 90 respectively of the NPW Act for the management of Aboriginal objects at the approved CGM. The management and mitigation measures described below are consistent with the requirements of the Section 87 permits and Section 90 consents.

In addition, feedback received during consultation from representatives of the Aboriginal groups was considered during the development of the future management and mitigation measures described below.

Future works at sites B, C and LC2 would be undertaken in accordance with the permit as described below.

Sites B and C

- 21 days written notice would be provided to the Director-General of the DECC of the intention to undertake archaeological works (referred to in the permit), together with evidence of Barrick's consultation with the Aboriginal community about the proposed archaeological works and any compensatory measures proposed to be undertaken by Barrick.
- Inspection, salvage and collection works would be undertaken at each site by the permit holder or delegate in accordance with the procedure contained in Special Condition 6 of the permit.

Site LC2

- A representative sample of Aboriginal objects from site LC2 is proposed. The position would be recorded by GPS. The representative sample of Aboriginal objects from site LC2 would be temporarily stored in the Keeping Place.
- Collected Aboriginal objects would be replaced in a location as close as possible to their original location at a time when the works within the specific area do not pose a future threat to them. Replacement would be supervised by the permit holder and/or his instructed delegates. The Aboriginal community would be notified of the programme and a representative/s would be invited to observe and where appropriate participate in replacement works.
- A Cultural Heritage Officer retained by Barrick would undertake routine monitoring following replacement as a threat abatement measure.

Further, a representative sample of collected Aboriginal objects from sites B, C and LC2 may be dated by radiocarbon and/or luminescence techniques in an effort to determine their age, at the discretion of the permit holder.

Given that the measures included in the permits and consents are duplicated in the IACHMP and that the E42 Modification would not change the measures, it is proposed to discontinue the IACHMP for the modified CGM.

4.12 NON-ABORIGINAL HERITAGE

4.12.1 Existing Environment

Subsequent to Development Consent being granted for the approved CGM, the Cowal West Homestead and Shearing (Wool) Shed were listed as heritage items under the Bland LEP. The items were listed as an amendment to the Bland LEP which was gazetted in November 1999. The listing recognises the local heritage significance of these buildings to the Bland Shire area. There are no other items listed on the Bland LEP located within ML 1535.

The listed items are located at the Cowal West Homestead Complex (CWHC), which is situated immediately west of the approved CGM southern waste emplacement. The CWHC currently comprises the following buildings:

- Homestead;
- Shearing (Wool) Shed; and
- Hayshed.

In response to this listing:

- a detailed history of the above CWHC buildings has been prepared and is included in the HMP (Barrick, 2003o); and
- the Shearing (Wool) Shed has been the subject of extensive archival recording (including photographs, drawings and plans) undertaken by architects and heritage consultants in consultation with the BSC and BDHS (Pearson, 2003; Freeman, 2004). Photographic records of the Shearing (Wool) Shed were compiled in accordance with the Heritage Information Series - Guidelines for Photographic Recording of Heritage Sites, Buildings and Structures (NSW Heritage Office, 1994).

4.12.2 Potential Impacts

The CWHC is situated within the proposed disturbance area of the modified CGM southern waste emplacement and would be demolished as part of the E42 Modification.

Section 3.2.1 outlines the consent requirements for the demolition of a heritage-listed item under the Bland LEP.

Relevant proposed mitigation measures for the CWHC are provided in Section 4.12.3.

4.12.3 Mitigation Measures and Management

Mitigation measures for non-Aboriginal heritage items located at the CWHC that would be implemented prior to demolition in consultation with the LCF, BSC and BDHS include:

- retrieval and salvage of items of historic uniqueness from the Shearing [Wool] Shed and Hayshed);
- compilation of a photographic record of the Homestead; and
- storage of the salvaged items at the LCCC.

Additionally, an interpretative display would be established at the LCCC in consultation with the LCF, BSC and BDHS. The display would include maps, photographs, narrative and fragments/elements salvaged from the CWHC to illustrate its history.

Re-construction/location of the CWHC was considered as an alternative to demolition. However given the associated high level of risk of loss of physical evidence and aesthetic character (and subsequent loss of any potential heritage benefit), this option was not considered further (Pearson, 2003).

These mitigation measures are consistent with those suggested by the BSC (BSC pers. comm., 2008), Freeman (2004) and Pearson (2003). The BDHS expressed no interest in the CWHC (BDHS pers. comm., 2008; Barrick, 2003o).

With the implementation of these mitigation measures, a HMP for the modified CGM would not be required.

4.13 REGIONAL ECONOMY

A regional economic assessment was prepared for the E42 Modification by Gillespie Economics (2008) as part of the Socio-Economic Assessment and is presented in Appendix H. The assessment in Appendix H included consideration of the regional economic impacts of the E42 Modification on the Lachlan Statistical Sub-division (SSD).

The assessment was conducted at the regional economy level, however, consideration was also given to the potential impacts at the NSW state level for planning purposes.

From a socio-economic perspective there are three important aspects of the proposed modification (Appendix H):

- the economic efficiency of the modification (i.e. consideration of economic costs and benefits);
- the regional economic impacts of the modification (i.e. the economic stimulus that the project would provide to the regional economy); and
- the distribution of impacts between stakeholder groups (i.e. the equity or social impact considerations).

A summary of the assessment considering these three aspects is presented below along with an assessment of the potential regional economic impact of the cessation of the mine.

4.13.1 Economic Efficiency

The main decision criterion for assessing the economic desirability of a project to society is its net benefit. Net benefit is the sum of the discounted benefits to society less the sum of the discounted costs. A positive net benefit indicates that it would be desirable from an economic perspective for society to allocate resources to a proposal, because the community as a whole would be better off.

In a simple framework, the benefits to society of mining relate to the net production benefits, while the economic costs to society relate to any potential environmental impacts.

Net production benefits of the E42 Modification are a function of expected incremental gold production, sale price and costs of production over time associated “with” the E42 Modification compared to “without” the E42 Modification (Appendix H).

Capital Costs

Incremental capital costs for the E42 Modification are associated with the purchase of additional mining fleet, progressive raising of the northern and southern tailings storage facilities, modification of the perimeter waste emplacement and other miscellaneous facilities. These incremental capital costs are estimated at in the order of $76M (Appendix H).

Operating Costs

Incremental operating costs are associated with increased mining and ore processing from Year 5 to Year 18 (i.e. 2009 to 2022) and ore processing only from Year 19 to Year 24 (i.e. 2023 to 2028). These incremental operating costs average approximately $60M per annum over the life of the E42 Modification. Incremental revenues associated with the expected production profile average approximately $84M per annum over the operating life of the E42 Modification(Appendix H).

Decommissioning Costs, Residual Land Value and Residual Capital Value

The modification extends the life of the approved CGM and hence the approximately $14M of decommissioning costs that would have been incurred in Year 14 (i.e. 2018) following cessation of the modified CGM are deferred until Year 25 (i.e. 2029).

This is an economic benefit of the E42 Modification. However, approximately $6M of residual land and capital value that would have been realised in Year 14 (i.e. 2018) would also be deferred until Year 25 (i.e. 2029), representing an additional cost of the E42 Modification (Appendix H).

Threshold Value Analysis

At the NSW Treasury recommended central discount rate of 7%, the E42 Modification is estimated to have net production benefits to Australia of $121M. However, because the potential incremental environmental impacts of the modification have not been valued, the net production benefit of $121M represents a threshold value (Appendix H).

This threshold value is the opportunity cost to society of not proceeding with the E42 Modification. Interpreted another way, any potential environmental impacts from the E42 Modification, after mitigation by Barrick, would need to be valued at greater than $121M to make the E42 Modification questionable from an economic efficiency perspective (Appendix H).

To put this into a regional context, this is equivalent to each household in the Lachlan SSD having a willingness to pay of over $5,800 to avoid any of the potential residual environmental impacts of E42 Modification, after mitigation by Barrick (Appendix H). The equivalent figure for NSW households is $48. In the context of the economic valuation literature, these are very large threshold values (*ibid*.).

4.13.2 Regional Economic Impact

Regional economic impact assessment is primarily concerned with the effect of an impacting agent on an economy in terms of a number of specific indicators, such as income and employment, gross regional product and gross regional output. The assessment in Appendix H considered the additional expenditure in the regional economy as a result of an increase in production and employment levels and an extension in the life of the mine by 11 years. The economy on which the impact is estimated is the Lachlan SSD.

The E42 Modification was estimated to have the following impacts on the regional economy during the peak year of the E42 Modification (Appendix H):

- $292M in annual direct and indirect regional output or business turnover;
- $114M in annual direct and indirect regional value added;
- $59M in annual household income; and
- 868 direct and indirect jobs.

4.13.3 Distribution of Impacts

While Barrick would initially bear the production costs and receive the production benefits (revenue) of the E42 Modification, the net production benefits would be distributed between a number of stakeholders including Barrick and its shareholders in the form of net profits, the NSW government in the form of royalties and the Commonwealth Government in the form of company tax.

The State Government also receives additional income by way of payroll tax while the Commonwealth Government would receive additional revenues in the form of income tax.

4.13.4 End of Mine Life

The construction and operation of the CGM has stimulated demand in the regional economy, leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the modified CGM would lead to a reduction in economic activity in the Lachlan region.

The socio-economic significance of cessation of the modified CGM would depend on the relative significance of the mine to the regional economy and other regional economic factors at the time. Impacts associated with cessation are likely to be greater in a declining economy than in a growing diversified economy.

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

In accordance with the MREMP described in Section 3, Barrick would develop a final MOP in consultation with regulatory agencies and would include consideration of the potential impacts of reductions in employment that would occur at the end of mine life.

4.14 POPULATION, EMPLOYMENT AND COMMUNITY INFRASTRUCTURE

Changes in the workforce and populations of regions and towns can have implications in relation to housing, health and education facilities. A community infrastructure assessment was included in the Socio-Economic Assessment (Appendix H) to consider these issues. The Socio-Economic Assessment considers the distribution of benefits and costs in terms of (Appendix H):

- intra-generational equity effects – the incidence of benefits and costs within the present generation; and
- inter-generational equity effects – the distribution of benefits and cost between present and future generations.

These social impacts were considered by Gillespie Economics in terms of the impacts on employment, population and community infrastructure (Appendix H).

4.14.1 Potential Impacts

Changes in the workforce and population of a region may have implications in relation to access to community infrastructure and human services, which includes for example housing, health and education facilities. This may include the number of services that are available to be used and the accessibility of the population to these services.

While the modified CGM would continue to provide employment for approximately 320 personnel that work at the approved CGM (370 in peak periods), it would also result in an average of 30 additional jobs (80 in peak periods). It is the 30 additional jobs (80 in peak periods) that have the potential to place strain on community infrastructure in the region.

It is estimated that the majority of these workers (90%) would come from the region, with 60% from the Bland Shire. Employment of existing residents of the region would have little impact on community infrastructure. Any impact would arise from the estimated 10% that would migrate into the region. Assuming normal household size for NSW (i.e. 2.6), the direct population change would be in the order of between 8 and 21 people (Appendix H). Making the same assumptions for the additional indirect workforce generated by the modification would give an indirect population change of between 12 and 31 people (*ibid*.).

This total population change of between 20 and 52 people can be considered within the context of recent population changes to the Lachlan (SSD) region and in particular the West Wyalong region (i.e. the Bland Statistical Local Area [SLA]). Table 4-22 shows the population change from 1996 to 2006 for the Lachlan SSD and the Bland SLA.

This population increase is equivalent to between one and three year's recent population loss from the Bland SLA and less than a third of a year's population loss from the wider Lachlan SSD. This recent decline is likely to have resulted in spare capacity in community infrastructure and services. Consequently, the additional population for the region as a result of the E42 Modification is unlikely to place any strain on existing community infrastructure (Appendix H).

Table 4-22
Lachlan SSD and Bland SLA Population Change – 1996 to 2006

Region		1996	2001	2006
Lachlan SSD	Population	55,284	53,907	52,399
	Population change		*-1,377*	*-1,508*
Bland SLA	Population	6,681	6,439	6,273
	Population change		*-242*	*-166*

Source: Australian Bureau of Statistics (2006)

In contrast, extending the life of the approved CGM may slow the decline of the regional population and hence slow any overall decline in the provision of community infrastructure and services to the region (Appendix H). At the same time continued mining would help maintain a more diversified economy that is more resilient to individual shocks such as droughts, changes in agricultural commodity prices, etc. (*ibid*.).

4.15 HAZARD AND RISK

4.15.1 Existing Measures

A PHA, THMS, HAZOP, FSS, HWCMP, FHA, BMP, CMP, Safety Management System (SMS) and ERP have been completed and relevant measures implemented for the approved CGM. A summary of the analyses and studies is presented below.

Preliminary Hazard Analysis

A PHA conducted as part of the EIS analysed the off-site risks to the environment, public safety and public property of potential hazardous events. The study ranked the risks and reviewed the adequacy of the safeguards and recommended improvements where necessary.

The PHA concluded that the highest risks to the environment, public safety and public property from the approved CGM were associated with the following scenarios (ANSTO, 1997):

- spillage of material during transport;
- a major spillage of material from on-site storage tanks coincident with catastrophic bund failure;
- spillage of diesel fuel onto the ground outside the mine site;
- wildlife entering the tailings storages following damage to the fence;
- birds using the tailings storages when an accidental release of cyanide occurs; and
- release of hazardous material in the event of a fire.

The PHA also concluded that for hazardous material to pass off the site in any quantity, it was necessary for the bunding to fail catastrophically or for it to be carried with airborne combustion products (ANSTO, 1997). Site bunding was seen to be a very effective barrier to the release of spilt material with the potential to cause environmental damage off-site and therefore judged to effectively minimise the risks to the Lake Cowal wetland (*ibid*). The remaining identified risks to the Lake Cowal wetland were associated with fires carrying hazardous material off-site, although these were considered small in comparison to the totality of risks to the environment as a whole (*ibid*).

The PHA included a number of recommended risk reduction measures relevant to the environment and public safety that have been incorporated into the CGM design to reduce the likelihood or the consequences of incidents that could cause damage. No recommended risk reduction measures relevant to public property were included in the PHA. The recommended risk reduction measures relevant to the environment and public safety have been incorporated into relevant approved CGM management plans and implemented, as outlined below.

No hazardous events or incidents have occurred at the CGM since the commencement of operations that have changed the assumed consequence and likelihood ratings described in the PHA.

Risks to the Environment

Recommended measures to reduce potential transport risks that have been implemented at the approved CGM include the following:

- Preparation and implementation of the THMS (Section 4.10.3).
- Preparation of an ERP (Section 4.2.1).

- All material suppliers to have prepared emergency response plans in consultation with the local emergency services.
- All carriers transporting hazardous materials to the approved CGM are required to strictly enforce the provisions of the Australian Code for the Transport of Dangerous Goods by Road and Rail (Barrick, 2005zvi).
- All carriers transporting hazardous materials to the approved CGM are required to have a radio or telephone in truck cabs, to increase the likelihood of prompt notification of an accident.
- All trucks transporting NaCN to the approved CGM are required to have a self-contained breathing apparatus in the cab to increase the likelihood of prompt response to an accident.
- All carriers are required to carry transported material in such a manner as to minimise, as far as practicable, the amount of material that would be spilt from a truck involved in an accident, in accordance with the THMS (i.e. consideration of the packaging and type of transported storage vessel) (e.g. isotainers are used to transport NaCN).
- All carriers are required to carry material that is packaged in a manner to restrict water ingress, and therefore reduce the consequences of a spill in or near water, in accordance with the THMS.

Measures that have been implemented at the approved CGM to reduce the potential risk of release of hazardous materials in the event of a fire include the following:

- storage of hazardous materials in such a manner as to minimise the possibility of fire;
- provision of efficient fire alarm systems; and
- provision of efficient fire suppression systems, in accordance with the findings of the FSS.

Recommended measures that have been implemented at the approved CGM to reduce potential risks to fauna include the following:

- A cyanide monitoring programme that includes a robust, reliable, and well maintained system of monitoring cyanide concentrations in the tailings slurry to give a high confidence of promptly detecting inadvertent increase in cyanide levels above the level of concern (Barrick, 2006e).
- Regular monitoring of CN_{WAD} concentrations at the tailings storage facilities to ensure that levels are within prescribed limits, in accordance with the CMP (Barrick, 2006e).
- Fauna visitation deterrence measures at the tailings storage facilities in accordance with the FFMP and *Implementation Plan to Protect Fauna from Interactions with the Tailings Storage Facilities* (Barrick, 2005zv) (e.g. fauna fence around the tailings storage facilities, electronic and visual deterrents).

Risks to the Public

Recommended measures that have been implemented at the approved CGM to reduce potential risks to the public have included the following:

- Preparation and implementation of an ERP (Barrick, 2005zvii).
- Review of procedures undertaken by suppliers to ensure that the requirements of the Australian Code for the Transport of Dangerous Goods by Rail and Road are fully met.
- Actions to be taken in the event of a fire by both the supplier and mine operator have been defined and appropriate equipment obtained.
- On-going liaison with local fire brigades to ensure that they know of and approve the emergency response plans of suppliers and Barrick.

Hazard and Operability Study

In accordance with the HIPAP No. 8 *Hazard and Operability Guidelines* (DUAP, 1995b) and as agreed with the DoP, the scope of the HAZOP study included storage and/or handling areas of the approved CGM relevant to Dangerous Goods, hazardous materials and/or materials with the potential for off-site impact. The HAZOP included a review of the monitoring, control, alarm and shutdown systems associated with the cyanide process. Control measures to maintain cyanide concentrations within compliance levels were also proposed. No hazardous events were determined during the study that had not been previously known and which had the potential for significant off-site risk (Pinnacle Risk Management, 2004b).

Final Hazard Analysis

A FHA was also conducted for the approved CGM and was designed to extend and update the analysis in the PHA. Major findings of the FHA are summarised below (Pinnacle Risk Management, 2004a):

- For the storage quantities of Dangerous Goods and hazardous materials on-site that had increased since the PHA, there was no measurable change to the site's risk profile.
- As per the findings in the PHA, off-site risk to the environment and public was dominated by transport related incidents. The higher risk materials include NaCN, ammonium nitrate, H_2SO_4, H_2O_2 and LPG. It was noted that the routes used to transport the Dangerous Goods would be reviewed in the THMS (see below).
- The cyanide control measures to prevent the cyanide concentrations increasing in the tailings disposal facility presented in the HAZOP study were considered acceptable.
- Two additional hazardous materials were assessed (i.e. SMBS and copper sulphate) and concluded to pose no significant risks.
- As per the PHA, the site bunding system was seen as a very effective barrier to prevent off-site spills and causing potential off-site environmental impact.

Overall, the FHA concluded that the approved CGM complied with the HIPAP No. 4 and HIPAP No. 6 Guidelines for tolerable fatality, injury, irritation and societal risk (Pinnacle Risk Management, 2004a). The FHA also concluded that the risks to the biophysical environment, the risk of propagation and the potential impact on cumulative risks in the area from releases were considered to be generally negligible (*ibid.*). Overall, the assessment concluded that the CGM would not pose any unacceptable levels of risk (*ibid.*).

No hazardous events or incidents have occurred at the approved CGM since the commencement of operations that have changed the assumed consequence and likelihood ratings described in the FHA.

Fire Safety Study

A FSS was conducted for the approved CGM and its objective was to assess the proposed fire prevention, detection, protection and fighting measures for appropriateness for specific fire hazards and adequacy to meet the extent of potential fires at the process plant (Pinnacle Risk Management, 2005). No further actions to those detailed in the HAZOP were recommended in the FSS.

Safety Management System

A SMS has been developed for the approved CGM in accordance with HIPAP No. 9 *Guidelines for the Development of Safety Management Systems* (DUAP, 1998b). The SMS sets out a comprehensive safety management system that covers all on-site operations and associated transport activities involving hazardous materials (Barrick, 2005zvi). The SMS describes all safety related procedures, responsibilities and policies, and identifies mechanisms designed to assist in adherence to procedures.

Transport of Hazardous Materials Study

Transport risks associated with the approved CGM were analysed in the THMS, which is described in Section 4.10.3. The THMS includes a detailed plan of actions to be undertaken to mitigate the potential effects of any spill of hazardous material during transport to the CGM.

Emergency Response Plan

Emergency response procedures for a range of potential emergency situations (e.g. fires, explosions, spills, natural disasters, etc) that could occur at the CGM have been documented in the ERP (Section 4.2.1). The ERP includes provision for annual review to assist in the identification of any new potential hazards as well as opportunities to improve the effectiveness of control measures, if required (Barrick, 2005zvii).

Hazardous Waste and Chemical Management Plan

Hazard prevention and mitigation measures relevant to hazardous wastes and chemicals have been documented in the HWCMP (Section 4.2.1). The HWCMP also requires the maintenance of a fuel and oil register. The HWCMP and associated strategies, inventories and registers have been developed to facilitate efficient audit functions by providing audit criteria that would be used to evaluate the effectiveness of hazard prevention and mitigation measures.

Bushfire Management Plan

Management measures relevant to bushfire hazards are detailed in the BMP (Section 4.2.1).

Cyanide Management Plan

The CMP includes hazard prevention and mitigation measures, particularly with regards to potential risks to fauna associated with the use of cyanide. Measures included in the CMP include the implementation of a cyanide monitoring programme, fauna visitation deterrence measures at the tailings storage facilities, and cyanide storage and handling procedures (Barrick, 2006e).

4.15.2 Hazard Identification and Risk Assessment

The E42 Modification would not introduce new hazardous materials or change the transport routes for the hazardous materials previously assessed in the THMS or increase the frequency of deliveries or quantities per delivery to the extent that it would change the risk levels previously assessed. Revision of the THMS for the modified CGM would therefore not be required.

Overall, apart from hazards and risks associated with the E42 Modification saline groundwater supply borefield, the E42 Modification would not change the potential impact mechanisms to the environment, public and public property, and their associated consequences or likelihoods, to the extent that risk levels would change from those previously assessed in the PHA or FHA. Subsequently, no change to the overall PHA or FHA risk assessment findings would result from the E42 Modification.

Potential hazards and risk associated with the saline groundwater supply borefield, however, were not assessed as part of the PHA or FHA. A hazard analysis was therefore conducted for this component of the E42 Modification.

The assessment of risks for the saline groundwater supply borefield involved the application of the following basic steps undertaken for the PHA and FHA, including:

- assessment of the hazard potential of the materials involved;
- identification of the potential hazardous events (including incidents involving the materials and site/transport specific occurrences);
- evaluation of the consequences of the potential hazardous events;
- evaluation of the likelihood of the potential hazardous events; and
- assessment of the risk of the potential hazardous events.

Hazards identified as relevant to the saline groundwater supply borefield were limited to the following incident types:

- potential leaks or spills from failure of the saline groundwater supply pipeline delivering water from the borefield to the CGM process water dam (D6); and
- potential public safety risks due to possible accidental damage to borefield infrastructure during a lake full scenario.

These incident types were assessed to potentially result in the release of saline water into Lake Cowal (only when dry) or areas outside the Lake and potentially result in public safety issues.

The maximum reasonable consequence of the hazards was assessed as minor (i.e. hazards that could cause minimal localised environmental harm associated with elevated levels of TDS[6] or result in a medical treatment injury [Pinnacle Risk Management, 2004a]). A probability assessment concluded these would be rare events (i.e. unusual and conceivable, but only in extreme circumstances).

[6] This assessment assumes the implementation of preventative and control measures.

An assessment of the combination of the consequence and probability rankings concluded that the overall risk rankings for the above hazards would be low, and therefore tolerable.

Proposed preventative and control measures to address potential hazards are discussed in Section 4.15.3.

4.15.3 Hazard Prevention and Mitigation Measures

The hazard prevention and mitigation measures described in Section 4.15.1 would continue to be implemented for the modified CGM.

Additional Measures

The modified CGM saline groundwater supply borefield control and/or preventative measures proposed for implementation would include:

- shut-down and removal of pumps during periods when the borefield is inundated by Lake Cowal;
- well-heads raised above the full storage level of Lake Cowal by construction of stand pipes;
- steel stand pipes to minimise potential damage to the bore in the unlikely event of an accidental collision;
- prominent signage at the well-heads to minimise the potential for accidental collision and damage;
- an anchored pipeline laid on the ground surface (i.e. above ground level) in a V-drain for potential spill containment;
- an underground powerline to power the pumps; and
- leak detection mechanisms including automatic shut-down capability (i.e. a pressure-based shut-down system).

In the unlikely event of pipeline failure and leakage of saline water, the spill would be controlled, contained and cleaned-up in accordance with the spill response procedures described in the HWCMP.