Mt Arthur Coal

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Section 4 –
Environmental Assessment

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4 ENVIRONMENTAL ASSESSMENT

4.1 ENVIRONMENTAL RISK ASSESSMENT

In accordance with the Modification DGRs, Appendix L presents an Environmental Risk Assessment (ERA) for the Modification. The key potential issues for further assessment which were identified in the ERA, along with the EA section or appendix which addresses the issue are provided in Table 4-1.

4.2 CLIMATE

Regional climatic conditions of the Upper Hunter consist primarily of seasonal variations of hot, wet summers giving way to mild, dry winters resulting in a warm temperate climate. Winter months are dominated by high pressure systems that alternate with cold fronts, combining to form cool, dry conditions. In these cooler, drier months from mid-autumn to late spring, regular frosts and fog are common (HVEC, 2009).

Summer months are largely dominated by synoptic high pressure systems that lie over the Great Australian Bight producing dry conditions and warm temperatures. Synoptic low pressure systems occur intermittently during summer, resulting in periods of heavy rain and thunderstorms (HVEC, 2009).

HVEC's meteorological station at Macleans Hill was used to characterise the meteorological environment at HVEC (2009), however this station has since been decommissioned. Climatic data for the Mt Arthur Coal Mine includes data from the new meteorological station at Macleans Hill (WS02) and WS09 meteorological stations.

In addition to meteorological data from Macleans Hill, the Commonwealth Bureau of Meteorology (BoM) monitoring stations at Jerrys Plains and Scone have also been used during the preparation of this EA. The locations and recording periods for these stations relative to the Mt Arthur Coal Mine are provided in Table 4-2. Meteorological data are summarised in Table 4-3 and discussed with key parameters below.

Temperature and Humidity

Temperature recorded at Jerrys Plains indicates that summer months are warm with January reaching a mean daily high temperature of 31.7 degrees Celsius (°C) (Table 4-3). July is the coolest month recorded at Jerrys Plains, with a mean daily low temperature of 3.8°C (Table 4-3).

Humidity levels exhibit variability and seasonal fluctuations throughout the year. Mean morning (9.00 am) humidity levels range from 59 to 78 percent and mean afternoon (3.00 pm) humidity levels range from 39 to 58 percent (Table 4-3). Spring months are generally drier than the rest of the year.

Rainfall

Rainfall in the Upper Hunter Valley is summer dominant with falls peaking in summer and declining in winter. The annual mean rainfall for Jerrys Plains is approximately 644 millimetres (mm), falling on 67 rain days (Table 4-3). Typical mean rainfall in the Upper Hunter ranges from 36 up to 77 mm per month with summer months being predominantly wetter than the cooler winter months.

Evaporation

Data from the BoM Scone Meteorological Station were used to assess representative evaporation trends in the Upper Hunter (Table 4-3) as the Jerrys Plains BoM station and Mt Arthur Coal's Macleans Hill Station do not record evaporation data.

The higher daily evaporation in summer months highlights a direct correlation between increased temperature and afternoon winds in the Upper Hunter. Evaporation is greater than annual precipitation with the mean monthly pan evaporation rates varying seasonally from 220 mm during December to 48 mm in June, with an annual mean of 1,583 mm (Table 4-3).

Wind Speed and Direction

Annual and seasonal windroses prepared for the Macleans Hill Station presented in Appendix F indicate that the Mt Arthur Coal Mine predominately receives winds from the east-southeast in summer and from the west-northwest during winter. Autumn and spring months experience a combination of these wind conditions (Appendix F).

Table 4-1
Key Potential Environmental Issues Identified in the ERA to be Further Assessed in this EA

Issue	Aspect and Impact	EA Study Area
Air Quality	Vegetation clearing, drilling and topsoil stripping. Impacting through - windblown dust and machinery exhaust fumes contributing to elevated dust levels in excess of applicable criteria.	Section 4.8 and Appendix F
	Overburden emplacement. Impacting through - windblown dust and machinery exhaust fumes contributing to elevated dust levels in excess of applicable criteria.	Section 4.8 and Appendix F
	Coal, rejects and overburden haulage. Impacting through - dust emissions and machinery exhaust fumes contributing to elevated dust levels.	Section 4.8 and Appendix F
Acoustics	Plant and equipment working in-pit and on overburden dumps. Impacting through - noise generation in excess of applicable criteria.	Section 4.10 and Appendix G
	Train movements on the rail loop and spur. Impacting through - noise generation in excess of applicable criteria.	Section 4.10 and Appendix G
	Stationary trains on the Antiene Rail Spur. Impacting through - noise generation in excess of applicable criteria.	Section 4.10
	Rail noise impacts on the Main Northern Railway due to increase in peak train movements. Impacting through - noise generation in excess of applicable criteria.	Section 4.10 and Appendix G
	Construction noise for duplication of rail loop. Impacting through - noise generation in excess of applicable criteria.	Section 4.10 and Appendix G
Ecology	Vegetation clearing, drilling and topsoil stripping. Impacting through - loss of biodiversity and disruption to threatened flora and fauna or habitats.	Section 4.6 and Appendix D
Cultural Heritage	Vegetation clearing, drilling and topsoil stripping. Impacting through - disturbance of Aboriginal objects, sites or places of cultural significance.	Section 4.7 and Appendix E
Water Management	Loss of catchment from Saddlers Creek due to conveyor corridor overburden emplacement. Impacting through - failure of water management controls and release of dirty water into the creek.	Section 4.5 and Appendix C
	Loss of catchment from Saddlers Creek due to conveyor corridor overburden emplacement. Impacting through - excision of catchment results in loss of surface water flow.	Section 4.5 and Appendix C
	Loss of catchment associated with the Whites Creek diversion. Impacting through - excision of catchment results in loss of surface water flow.	Section 4.5 and Appendix C
	Conveyor corridor overburden emplacement would occur on mapped Saddlers Creek alluvium. Impacting through - potential for degradation of groundwater quality in Saddlers Creek alluvium due to conveyor corridor overburden emplacement.	Section 4.4 and Appendix B
	Coal extraction and overburden removal. Impacting through - additional groundwater inflow into pit.	Section 4.4 and Appendix B
Traffic and Transport	Increased vehicle movements from employees, deliveries and train loading. Impacting through - increased traffic movements associated with the use of the proposed access to the explosives facility off Edderton Road.	Section 4.13 and Appendix K
Hazardous materials	Explosives magazine and storage area would be moved under the Modification. Impacting through – off-site impacts due to explosives magazine.	Section 4.15
Agricultural Impacts	A portion of the Modification disturbance area potentially mapped as Biophysical Strategic Agricultural Land (BSAL) - direct impacts of mining activities. Impacting through - impacts on BSAL. A portion of the Modification on disturbance area potentially mapped as BSAL – indirect impacts of mining activities (such as dust generation and groundwater drawdown). Impacting through – impacts on BSAL.	Section 4.3 and Appendix A

Source: Appendix L.

Table 4-2
Meteorological Stations

Name	Operator	Station No.	Location	Period of Record
Jerrys Plains	BoM	061086	Approximately 12 km south of Mt Arthur Coal Mine.	1884 to current.
Scone	BoM	061089	Approximately 27 km north of Mt Arthur Coal Mine.	1950 to current.
Macleans Hill	Mt Arthur Coal	N/A	Northern Open Cut.	2003 to 2009.
Meteorological Station WS02	Mt Arthur Coal	N/A	Figure 2-2.	2009 to current.
Meteorological Station WS09	Mt Arthur Coal	N/A	Figure 2-2.	2009 to current.

Table 4-3
Meteorological Data Summary

Month	Mean Daily Temperature (°C)				Mean Monthly Rainfall (mm)		Mean Monthly Rain Days		Mean Monthly Relative Humidity (%)*		Mean Monthly Evaporation (mm)*
	Jerrys Plains		Aggregate Site Data#		Jerrys Plains	Aggregate Site Data#	Jerrys Plains	Aggregate Site Data#			
	Min	Max	Min	Max					9 am	3 pm	
January	17.2	31.7	15.9	34.4	76.8	50.8	6.5	4.3	67	43	217.0
February	17.1	30.9	16.4	32.7	72.8	81.5	6.0	6.2	73	47	175.2
March	15.0	28.9	14.0	30.5	58.8	47.2	5.8	5.4	73	47	155.0
April	11.0	25.3	9.9	25.9	44.3	32.5	4.9	4.3	71	47	105.0
May	7.4	21.3	6.1	21.9	40.8	34.0	4.9	4.7	76	56	68.2
June	5.3	18.0	4.4	18.7	48.0	58.9	5.5	6.8	78	58	48.0
July	3.8	17.4	4.6	18.3	43.6	30.5	5.2	3.8	75	54	55.8
August	4.4	19.4	4.3	21.1	36.3	33.5	5.2	4.5	67	46	83.7
September	7.0	22.9	7.0	23.8	41.8	37.9	5.2	4.3	62	43	117.0
October	10.3	26.2	9.7	27.7	52.2	44.0	5.9	4.6	59	42	155.0
November	13.2	29.1	12.1	30.8	61.1	70.4	6.2	7.1	62	41	183.0
December	15.7	31.2	13.8	32.4	67.9	50.4	6.4	6.3	61	39	220.1
Annual Mean	10.6	25.2	9.9	26.5	644.4	571.6	67.7	62.3	69	47	1,583.0

Source: BoM (2012).

* Scone Meteorological Station.

\# Aggregate site data consists of Macleans Hill data for Years 2003 to 2008 (HVEC, 2009) and data from Meteorological Stations WS02 and WS09 (Figure 2-2) for Years 2009 to 2011 obtained from the 2009, 2010 and 2011 AEMRs (BHP Billiton, 2009, 2010a, 2011a).

4.3 LAND RESOURCES

4.3.1 Existing Environment

Landforms and Topography

The topography surrounding the Mt Arthur Coal Mine is gently undulating to hilly, dominated by Mount Arthur (482 m AHD), located within the mine operational area, and Mount Ogilvie (468 m AHD), located to the west of the Mt Arthur Coal Mine. The north of the Mt Arthur Coal Mine gently slopes up from the alluvial flats of the Hunter River at an elevation of approximately 120 m AHD, rising to approximately 230 m AHD at Macleans Hill and becoming progressively steeper in the vicinity of Mount Arthur and Mount Ogilvie. From Mount Ogilvie, the southern portion of the Mt Arthur Coal Mine slopes down to form part of the Saddlers Creek floodplain (Appendix A).

On-site, the Mt Arthur Coal Mine is characterised by mine landforms and infrastructure associated with current and historic mining operations. Disturbance areas are progressively rehabilitated to pasture or woodland. Approximately 920 ha had been rehabilitated at the Mt Arthur Coal Mine to the end of 2011 (BHP Billiton, 2011a).

Generally, rainfall runoff from undisturbed areas flows north-west from Mount Ogilvie and Mount Arthur into Quarry Creek and associated tributaries and then into the Hunter River. Rainfall which falls to the south of Mount Ogilvie and Mount Arthur flows into Saddlers Creek before travelling south-west and entering the Hunter River approximately 17 km downstream of Denman (Appendix A).

Soils Land Capability

A desktop study and soil survey were conducted by GSS Environmental (2012) to characterise and assess the soils in the Modification area as part of the Soil and Land Resource Assessment (Attachment A of Appendix A).

The desktop study consisted of developing an initial soil map by analysing and interpreting aerial photography, topographic maps, previous reports and other reference information (e.g. cadastral data, current resource studies) and determining preferred locations for soil pits through visual assessment of surface soil exposures, topography and vegetation present in the Modification area (Appendix A).

The fieldwork undertaken was an integrated, qualitative 'free survey' at a scale of 1:25,000. Fifteen exposed soil profiles were assessed that covered the main variations in vegetation type, landforms and geology with a focus on the areas to be potentially disturbed by the Modification. The soil pit locations and field soil description methods are outlined in Attachment A of Appendix A. The soil profiles were assessed according to the *Australian Soil and Land Survey Field Handbook* Soil Classification Procedures (National Committee on Soil and Terrain, 2009).

The main soil types mapped in the Modification area comprise: Brown Sodosol (45 percent), Red Chromosol (29 percent) and Shallow Brown Chromosol (13 percent), while lesser areas of Brown Chromosol, and Red Sodosol were also observed (Appendix A). The Northern Open Cut area contains Red Chromosol, Shallow Brown Chromosol, Brown Chromosol and most of the Brown Sodosol whilst the overburden emplacement area contains the Red Sodosol and the rest of the Brown Sodosol.

Land Use

The Mt Arthur Coal Mine is situated within the Upper Hunter region which has a long history of rural land use for a variety of agricultural and industrial activities, predominantly livestock grazing and coal mining. Other land uses include equine industries and viticulture. The current dominant land uses within and adjacent to the existing mining lease boundaries include open cut coal mining, power generation and industrial activities, agriculture, rural residential and residential areas.

Land in the Modification area is currently used for limited periodic grazing activities and mining operations.

Agricultural Activities and Productivity

Agricultural activities known to have been conducted in the Modification area include cattle grazing for beef in the north-west of the Mt Arthur Coal Mine. There is no evidence of crop production for grains (irrigated or unirrigated) or intensive horticulture (Appendix A).

Rural Land Capability and Agricultural Suitability

A land capability and agricultural suitability assessment of the Modification area (i.e. areas outside the approved disturbance area of the Consolidation Project) was conducted as part of the Agricultural Impact Statement (AIS) (Appendix A). The AIS was prepared in consideration of the *Guideline for Agricultural Impact Statements* (DP&I, 2012). The assessment identified the lands within the Modification area as ranging from Capability Class II to Class VII (Appendix A). A summary of the land capability surveyed within the Modification area is provided in Table 4-4.

Surveyed agricultural suitability areas as well as land capability and agricultural suitability mapping is provided in Appendix A.

Biophysical Strategic Agricultural Lands

A review of the regional mapping in the Upper Hunter Strategic Regional Land Use Plan (SRLUP) indicates that a small area of land in the north-west of the Modification disturbance may be classed as BSAL.

GSS (2012) undertook site verification of BSAL within the Modification areas. This assessment commenced with a desktop review of Land Capability, regional soil fertility, BSAL mapping provided in the draft Upper Hunter SRLUP and other factors relevant to the definition of BSAL. GSS (2012) then undertook a detailed soil fertility mapping campaign to verify the presence of BSAL in the Modification area, with a focus on areas defined as class II Land Capability and with moderate to high soil fertility based on regional (OEH) mapping.

This campaign included some 15 observation points and included laboratory assessment of:

- electrical conductivity (EC);
- pH;
- exchangeable cations and cation exchange capacity;
- phosphorus, sulphur and nitrogen;
- organic carbon; and
- trace elements.

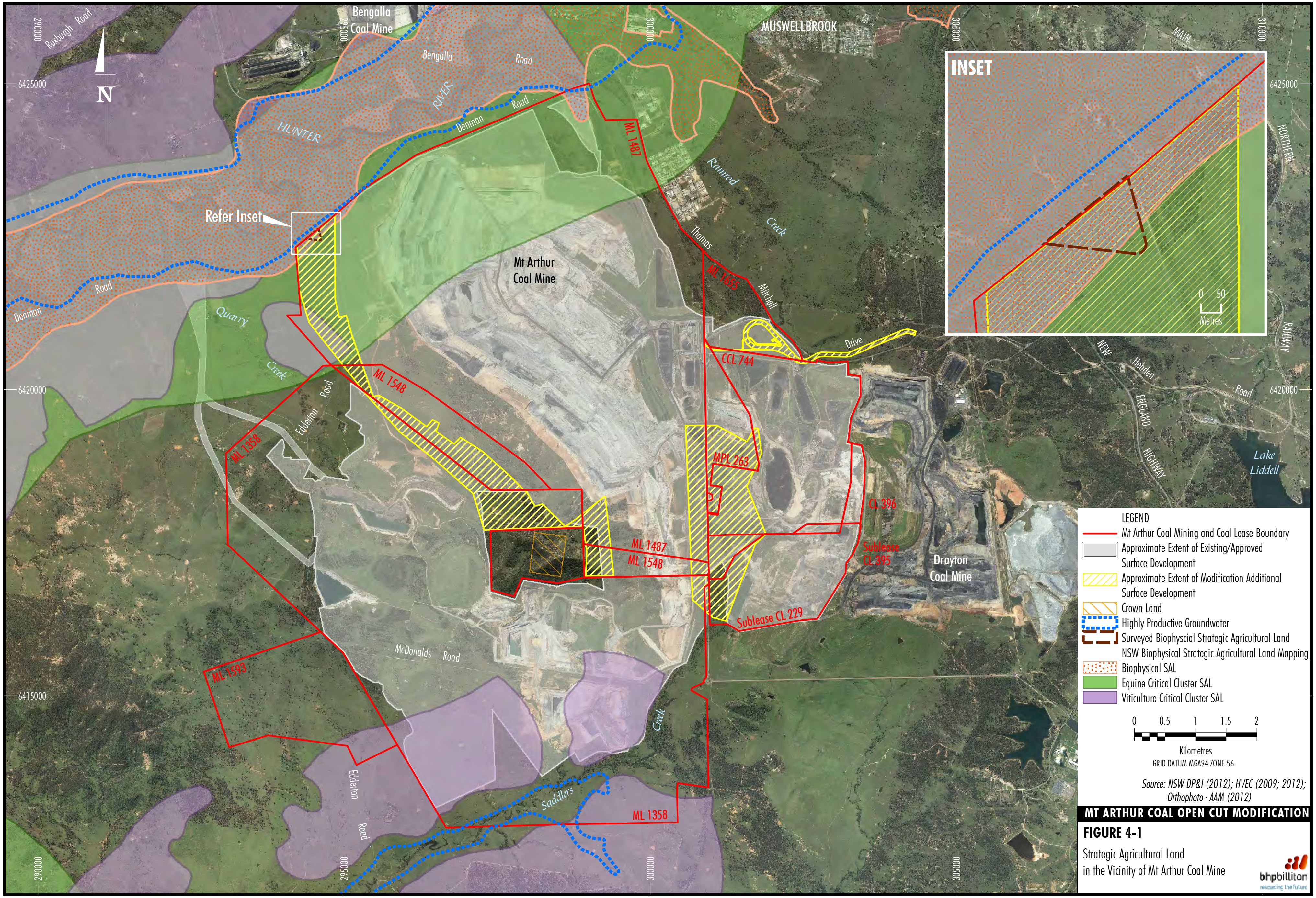
Site verification surveys undertaken by GSS Environmental (Appendix A) indicate that an area of 2.4 ha within the Modification area would be classed as BSAL as per the Upper Hunter SRLUP as shown on Figure 4-1. The remainder of class II Land Capability areas do not meet BSAL criteria because they have low soil fertility characteristics (GSS, 2012).

The NSW government released the fact sheet *Development of protocol for site verification and mapping of Biophysical Strategic Agricultural Land (BSAL)* (DPI, 2012a) in November 2012. The fact sheet provides information to support the SRLUPs by outlining the process and criteria that should be used to verify BSAL. In accordance with this fact sheet (DPI, 2012a), for a site to be classified as BSAL, the area of BSAL must be greater than or equal to 20 ha. However, as described below, a subsequent BSAL verification protocol has further clarified this aspect.

Table 4-4
Summary Description of Land Capability Classes within the Modification Area

Class	Land Use	Management Options	Occurrence (ha)	Occurrence (%)
I	Regular Cultivation	No erosion control requirements	0	0
II	Regular Cultivation	Simple requirements such as crop rotation and minor strategic works	33.1	14
III	Regular Cultivation	Intensive soil conservation measures required such contour banks and waterways	0	0
IV	Grazing, occasional cultivation	Simple practices such as stock control and fertiliser application	0	0
V	Grazing, occasional cultivation	Intensive soil conservation measures required such contour ripping and banks	131.0	56
VI	Grazing only	Managed to ensure ground cover is maintained	62.1	26
VII	Unsuitable for rural production	Green timber maintained to control erosion	8.9	4
VIII	Unsuitable for rural production	Should not be cleared, logged or grazed	0	0

Source: After Appendix A.



MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 4-1

Strategic Agricultural Land in the Vicinity of Mt Arthur Coal Mine

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Version 7 of the Draft (February 2013) *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (NSW Government, 2013) describes that:

> *BSAL must have a contiguous area equal to or exceeding 20Ha which meets the verification criteria. The minimum area refers to the extent of the biophysical resource not the lot or holding size. Hence if the mining lease area or holding includes less than 20 Ha of BSAL but this BSAL is part of a larger contiguous mass that equals to or exceeds 20Ha then the land is regarded as BSAL.*

It is noted that the area to the immediate north of the potential BSAL (Figure 4-1) is associated with Hunter River alluvium. Whilst detailed site verification has not been undertaken on these adjacent areas, it is conservatively assumed that the BSAL is contiguous to the north (i.e. the 2.4 ha of BSAL in the Modification area is part of a larger contiguous mass that equals to or exceeds 20 ha).

Accordingly, the AIS (Appendix A) has conservatively assumed and assessed this 2.4 ha area as BSAL.

Regional mapping in the Upper Hunter SRLUP indicates that part of the Modification area is within areas mapped as Equine Critical Industry Cluster and Viticulture Critical Industry Cluster. However, currently no viticulture or equine enterprises are undertaken within the Modification area.

The Modification is wholly within existing mining tenements and therefore the gateway process would not apply under the Upper Hunter SRLUP.

Bushfire Regime

The Modification is located in the Muswellbrook Bush Fire Management Committee (MBFMC) Bush Fire Management Plan area (Muswellbrook BFMC area). In the Muswellbrook BFMC area, the bushfire season generally runs from September to March (MBFMC, 2011).

The main sources of bushfire ignition in the Muswellbrook BFMC area include (MBFMC, 2011):

- lightning;
- electrical power lines;
- loss of fire control during legal burning-off;
- illegal burning-off;
- dumping of cars and setting them alight; and
- arson.

HVEC is suitably equipped to respond to any fires on-site and to assist the Rural Fire Service and emergency services if there is a fire in the area.

The following fire prevention measures are carried out at the Mt Arthur Coal Mine:

- fuel management (e.g. cattle grazing or slashing to control grasslands);
- installation and management of fire breaks;
- induction program;
- equipment maintenance; and
- operation of flammable substances in accordance with Australian Standards.

The following fire suppression and control measures are undertaken at the Mt Arthur Coal Mine:

- maintaining access for fire fighting trucks; and
- on-site fire fighting equipment.

Further details on the bushfire prevention and fire suppression and control measures are provided in the *Mt Arthur Bushfire Management Plan* (BHP Billiton, 2010b).

4.3.2 Potential Impacts

The Modification of the Mt Arthur Coal Mine has the potential to alter:

- landforms and topography;
- soils;
- land use, agricultural activities and productivity; and
- bushfire hazards.

These potential impacts are described in the following sub-sections. Measures to mitigate and manage potential impacts are provided in Section 4.3.3.

Landforms and Topography

The Modification would alter the landforms and topography within the Modification area. Some topographic changes would be temporary (e.g. temporary bunds/drains) and some would be permanent (e.g. final mine landforms).

The extent of the existing open cut mining areas and overburden emplacements would be increased by the Modification (Figure 3-1).

Overburden mined during the development of the Modification would be used to in-fill mine voids, as well as being placed in the out-of-pit overburden emplacements.

These changes, while altering the layout and extent of the approved/existing Mt Arthur Coal Mine, are effectively extensions to existing approved mine landforms.

A range of lesser topographic changes would be associated with the construction of roads, hardstands, water management, and erosion and sediment control features over the life of the Modification.

Soils

Potential impacts of the Modification on soils would relate primarily to:

- disturbance of in situ soil resources within the Modification disturbance areas (e.g. development of the new open cut mining areas);
- alteration of soil structure beneath infrastructure items, hardstand areas and roads;
- possible soil contamination resulting from spillage of fuels, lubricants and other chemicals;
- increased erosion and sediment movement due to exposure of soils during construction (e.g. road realignments); and
- alteration of physical and chemical soil properties (e.g. structure, fertility, permeability and microbial activity) due to soil stripping and stockpiling operations.

A review of the physical and chemical properties of the soils within the Modification area has established that there are soil resources present that would be suitable as a rehabilitation medium for agricultural land uses (grazing) and for native plant revegetation post-mining (Appendix A).

Land Use – Agricultural Activities and Productivity

The Modification would disturb an additional 235 ha[1] of land, of which 170 ha is considered to be potential agricultural land based on existing Rural Land Capability and Agricultural Suitability mapping and recent aerial photography. The Modification disturbance area is generally of low land capability and suitability class, and is not currently used for agricultural purposes (e.g. cattle grazing or cropping).

However, approximately 33.1 ha of land to be disturbed is of class II land capability and is used periodically to graze cattle. The Modification would potentially remove approximately 2.4 ha of BSAL that exists within this class II land.

Notwithstanding, the Modification would not materially affect the land use in these areas. This is because agricultural activity in these areas is currently limited and would be excluded for the life of the mine and could potentially resume after rehabilitation and mine closure, subject to agreement on the post-closure land use.

In addition, although regional mapping indicates the Modification area is within the Equine and Viticulture Critical Industry Cluster areas, these activities do not occur in the Modification area and therefore would not be directly impacted (Appendix A).

The potential for indirect impacts on agricultural production, such as air quality, noise and road transport effects, has also been considered. Appendix A concludes that no such potential impacts have been identified that would materially affect agricultural productivity.

Bushfire Hazard

Any uncontrolled fires originating from Modification activities may present potentially serious impacts to nearby rural properties.

Similarly, fires originating in nearby rural areas could pose a significant risk to Mt Arthur Coal Mine infrastructure and HVEC staff, contractors and equipment.

The degree of potential impacts of a bushfire would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel.

[1] Approximately 25 ha of additional land adjacent to the existing rail spur would also be disturbed through the rail loop duplication. However, because this land is within the rail spur corridor, no change of land use would occur.

4.3.3 Mitigation Measures and Management

Landforms and Topography

The extensions to the Mt Arthur Coal Mine have been designed and located to minimise the additional land impacted by incorporating as much of the extensions into existing disturbance areas as possible. Additional measures to integrate existing and proposed infrastructure with existing topography include:

- Producing slope angles, lengths and shapes that are compatible with the proposed land use and not prone to an unacceptable rate of erosion. This would be integrated with drainage structures and dams capable of conveying runoff from the newly created catchments whilst minimising the risk of erosion and sedimentation. This includes contour furrows or contour banks at intervals down the slope, contour ripping across the grade, and graded banks where required.
- Engineered waterways, spillways and sediment control dams (using erosion blankets, groundcover vegetation and/or rip rap) are implemented to capture sediment laden runoff prior to off-site release and designed and located so as to safely convey the maximum anticipated discharge.
- Progressively rehabilitating the site to further integrate constructed landforms with the surrounding landscape. Rehabilitation and landscape management strategies are detailed in Section 5.

Soils

A number of soil resource management strategies are currently implemented at Mt Arthur Coal, as follows, which would continue to be implemented for the Modification:

- Materials are stripped to indicated levels preferably in moist conditions, and placed directly onto reshaped areas where practical.
- Where topsoil must be stockpiled, efforts are made to reduce compaction with as coarsely textured a condition as possible.
- Stockpiles are a maximum of 3 m in height and if stored for greater than 12 months, seeded and fertilised and treated for weeds prior to respreading at around 0.1 m in depth.
- An inventory of designated areas and available soil would be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.
- Thorough seedbed preparation is undertaken to ensure optimum establishment and growth of vegetation with all topsoiled areas lightly contour ripped (after topsoil spreading) to create a "key" between the soil and the spoil.

Mitigation measures used at the Mt Arthur Coal Mine to prevent or reduce the potential for contamination of land from spills and leaks of hazardous materials include the following:

- maintenance of mobile equipment and fixed plant in accordance with the manufacturer's recommended maintenance schedule;
- operator and driver training and licensing for their job descriptions; and
- construction of all civil engineering structures in accordance with applicable codes, guidelines and Australian Standards.

Land Use – Agricultural Activities and Productivity

Agricultural land resource management at the Modification would include the following key components:

- minimisation of disturbance to agricultural lands, where practicable;
- management of soil resources at the Mt Arthur Coal Mine so that they can be used for rehabilitation; and
- inclusion of agricultural lands in rehabilitation areas.

Minimisation of Disturbance to Agricultural Lands

The area of agricultural land disturbed by the Modification at any one time would be minimised so that beneficial agricultural uses can continue to be undertaken on available Modification grazing lands. As demonstrated by HVEC at the existing Mt Arthur Coal Mine, grazing agricultural activities can be undertaken in conjunction with the operation of a mine.

In addition, HVEC supports agricultural activities in the vicinity of the Mt Arthur Coal Mine, as evidenced by Edinglassie (horse breeding) and Roxburgh Vineyard (viticulture) (Appendix A).

Management of Soil Resources

Soil resource management measures that would be used during the life of the Modification are described above.

Re-establishment of Agricultural Lands

The rehabilitation and mine closure strategy for the Modification includes restoration of agricultural land (Section 5). The rehabilitation of this land reduces the area of agricultural land that would otherwise be sterilised by the Modification.

Bushfire Hazard

HVEC would continue to implement the existing bushfire management measures as per the Bushfire Management Plan and consult with the Muswellbrook BFMC and the Rural Fire Service, and provide assistance to these organisations as required.

4.4 GROUNDWATER

A Groundwater Impact Assessment for the Modification was undertaken by Australasian Groundwater & Environmental Consultants Pty Ltd (AGE) (2012) and is presented in Appendix B.

4.4.1 Background

The potential hydrogeological impacts of the Mt Arthur Coal Mine were assessed by Mackie Environmental Research (2000) as part of the *Mount Arthur North Coal Project Environmental Impact Statement* (Coal Operations Australia Limited, 2000). The study included assessment of the potential cumulative impacts of the Mt Arthur Coal Mine and surrounding mining operations on groundwater resources using numerical modelling techniques.

Subsequent to the *Mount Arthur North Coal Project Environmental Impact Statement* (Coal Operations Australia Limited, 2000), a number of additional studies have been undertaken to assess the potential hydrogeological impacts of the Mt Arthur Coal Mine, the two most recent studies include the:

- *Mt Arthur Underground Project Environmental Assessment Groundwater Management Studies* conducted by Mackie Environmental Research (2007) as a component of the Mt Arthur Underground Project; and
- *Mt Arthur Coal Consolidation Project Groundwater Impact Assessment* conducted by AGE (2009) as a component of the Consolidation Project EA.

Hydrogeological Regime

The hydrogeological regime of the Mt Arthur Coal Mine area is considered to consist of three groundwater systems, including (Appendix B):

- alluvium along the Hunter River and Saddlers Creek;
- weathered bedrock (regolith); and
- the coal seams of the Permian Wittingham Coal Measures.

Alluvial Aquifers

Deposits of unconsolidated silts, sand and minor fine gravels of mixed colluvial-alluvial origin occur in the valleys of the creeks and gullies at the Mt Arthur Coal Mine (Appendix B). These deposits are thin and of limited extent, and hence do not have significant groundwater storage capacity (Appendix B).

Comparatively, the alluvial deposits of the Hunter River to the immediate north of the Mt Arthur Coal Mine are a significant source of groundwater (Appendix B). Monitoring data suggests that the Hunter River alluvial groundwater levels have remained relatively constant with no direct correlation to rainfall trends, indicating some buffering of the alluvial groundwater levels by the potentially interconnected Hunter River (Appendix B). Recharge to the Hunter River alluvium is likely to occur from direct infiltration of rainfall and runoff from elevated bedrock sub-crop areas, in addition, recharge from flow in the Hunter River potentially occurs during very dry periods (Appendix B).

Consistent with the regional hydraulic gradient, groundwater within the alluvium indicates a shallow hydraulic gradient towards the Hunter River (Appendix B). The alluvial watertable also has a general downstream hydraulic gradient coinciding with the topographic gradient of the alluvium and flow of the Hunter River (Appendix B).

Regolith

The regolith or shallow bedrock groundwater systems comprise surficial soils and weathered bedrock (Appendix B). The depth of the profile is variable and depends on factors including the depth of weathering and the extent and frequency of fracturing (Appendix B).

The regolith acts as a potential temporary water store during sustained wet periods and provides a potential source for recharge to the underlying coal measures, however, it is inferred that this recharge is limited (Appendix B).

Permian Aquifers

The Permian strata occurs across the whole of the Mt Arthur Coal Mine area and may be categorised into the following hydrogeological units (Appendix B):

- hydrogeologically "tight" (e.g. very low permeability) and hence very low yielding to essentially dry sandstone and lesser siltstone that comprise the majority of the Permian interburden/overburden; and
- low to moderately permeable coal seams which are the prime water bearing strata within the Permian sequence.

Groundwater level data suggests the regional potentiometric surface of the Permian Aquifers is a subdued reflection of the topography, with a groundwater mound beneath topographically elevated areas, and a hydraulic gradient towards the Hunter River valley to the north, and Saddlers Creek to the south (Appendix B).

Historical and ongoing mining within the Mt Arthur Coal Mine area (including surrounding mining operations) has resulted in depressurisation of the Permian coal measures. This depressurisation has resulted in localised changes to the groundwater gradient beneath the alluvium with discharge from the coal seams to the alluvium reversed to leakage from the alluvium to the coal seams in the vicinity of open cut mining (Appendix B).

Groundwater Monitoring Program

Groundwater monitoring for the Mt Arthur Coal Mine is undertaken in accordance with the *Ground Water Monitoring Program* (BHP Billiton, 2012e) which details the groundwater monitoring programme, groundwater impact assessment criteria and groundwater monitoring methodology. The groundwater monitoring bores included in the *Ground Water Monitoring Program* (BHP Billiton, 2012e) are shown in Figure 2-2.

Groundwater levels and quality are generally monitored bi-monthly at all bores, with groundwater levels recorded continuously at a number of bores. In accordance with the *Ground Water Monitoring Program* (BHP Billiton, 2012e) chemical speciation is also undertaken twice a year in all bores (BHP Billiton, 2012e).

Surface and Groundwater Response Plan

A Surface and Groundwater Response Plan (BHP Billiton, 2012f) for the Mt Arthur Coal Mine details the surface water and groundwater exceedance protocols and the protocol for adverse affects to nearby users. The *Surface and Groundwater Response Plan* (BHP Billiton, 2012f) also details the measures to mitigate groundwater leakage from alluvial aquifers.

Currently Approved Impacts

AGE (2009) developed a three-dimensional transient, groundwater flow model for the Mt Arthur Coal Mine in order to assess the potential cumulative impacts of the Mt Arthur Coal Mine and surrounding mining operations.

The numerical groundwater model incorporated the Mt Arthur Coal Mine (including Mt Arthur Underground Mine) and the Bengalla Mine.

The assessment found that the cumulative cone of depression resulting from the Mt Arthur Coal Mine would extend beneath the Hunter alluvium on the southern side of the Hunter River by 2016 but was not predicted to join the cone of depression resulting from the Bengalla Mine beneath the Hunter River (AGE, 2009).

Pit inflows were predicted to increase from 0.85 megalitres per day (ML/day) in 2009 to a maximum of 2.45 ML/day in 2016 (AGE, 2009). By 2022 pit inflows were predicted to stabilise to approximately 2.4 ML/day by (AGE, 2009).

Flows from the Permian coal seam aquifers to the Hunter River alluvium were predicted to reverse by 2011, with recharge to the Permian coal seam aquifers from the Hunter River alluvium (i.e. loss from the Hunter River alluvium) predicted to increase to 0.74 ML/day by 2022.

Flow from the Permian coal seam aquifers to Saddlers Creek alluvium was also predicted to reverse with flow from Saddlers Creek alluvium to the Permian coal seam aquifers predicted to stabilise at approximately 0.09 ML/day by 2019 (AGE, 2009).

AGE (2009) also predicted that a number of bores in Permian aquifers would observe drawdowns in excess of 2 m. No private bores in alluvium were predicted to be impacted.

4.4.2 Potential Impacts

Numerical modelling has been undertaken to inform the Groundwater Assessment (Appendix B) for the Modification.

The model developed by AGE (2009) used for the Modification was used as a basis for the numerical groundwater model. The AGE (2009) model was updated to include refinement of the model mesh within the Modification area and to incorporate new mine plan data for the years 2016 to 2026.

Verification against the latest available transient groundwater level data determined that the 2009 model parameterisation was adequate for prediction of the Modification and therefore re-calibration of the AGE (2009) model was not undertaken (Appendix B).

Potential groundwater impacts associated with the Modification are described in the Groundwater Impact Assessment (Appendix B) and include:

- extension of the zone of depressurisation/drawdown to the west;
- groundwater inflows to the open pits;
- minor changes in leakage rates from the alluvial systems;
- minor loss of groundwater yield at existing bore locations; and
- change in groundwater quality.

These potential impacts are summarised below.

Regional Groundwater Level Drawdown

The progression of open cut mining resulting from the Modification would contribute to the development of a localised groundwater sink within the immediate area of mining activities.

The incremental increase of contours in watertable drawdown associated with the Modification was developed from reconciliation of the drawdown predicted by the numerical model for years 2022 and 2026 (i.e. represents the difference between 2026 and 2022 to simulate the additional years of the Modification) and is presented in Figure 4-2.

The incremental increase in watertable drawdown associated with the Modification is located entirely within HVEC-owned land (with the exception of a small portion of crown land associated with Mount Arthur) and extends partially into the Hunter River alluvium (but does not extend under the Hunter River) (Appendix B).

The numerical model also shows that while the cumulative drawdown at year 2026 extends into the Hunter River alluvium, it does not extend under the Hunter River (Appendix B).

Groundwater Inflows to the Open Pit

The Modification is not expected to result in an increase in the maximum total average pit inflow. The numerical model predicted a maximum average pit inflow for the Modification period of approximately 2.5 ML/day in 2026 (Appendix B). Comparatively, the maximum total average pit inflow predicted by the updated model for the approved operations is approximately 2.6 ML/day in 2016 (Appendix B).

Leakage of Groundwater from Alluvium

The impacts on the Hunter River Alluvium were assessed to be minor, and, the numerical modelling shows that the Modification is likely to result in an increase in the maximum flux from the Hunter River alluvium of approximately 0.03 ML/day (Appendix B). The maximum flux from the Hunter River alluvium for the Modification period is predicted to be approximately 0.72 ML/day in 2026 while that predicted by the updated model for the approved operations is approximately 0.69 ML/day (Appendix B).

The model also predicts that the Modification would not result in an increase in flux from Saddlers Creek alluvium (Appendix B). The maximum flux from the alluvium predicted for the Modification period is approximately 0.01 ML/day, equal to the maximum flux predicted by the updated model for the approved operations (Appendix B).

Impact on Groundwater Users

A search of the NOW database identified 50 registered bores within a 5 km radius of Mt Arthur Coal Mine mining leases (Appendix B). The numerical modelling predicted that three of these bores would experience additional drawdown greater than 2 m as a result of the Modification, however, these bores are located on HVEC-owned land (Appendix B).

There are currently no high priority groundwater dependent ecosystems identified within the Water Sharing Plan in the Hunter Unregulated and Alluvial Water Sources in the vicinity of Mt Arthur Coal Mine. Further to this, no groundwater dependent vegetation comprising groundwater dependent ecosystems occurs within the Modification area or immediate surrounds (Appendix D).

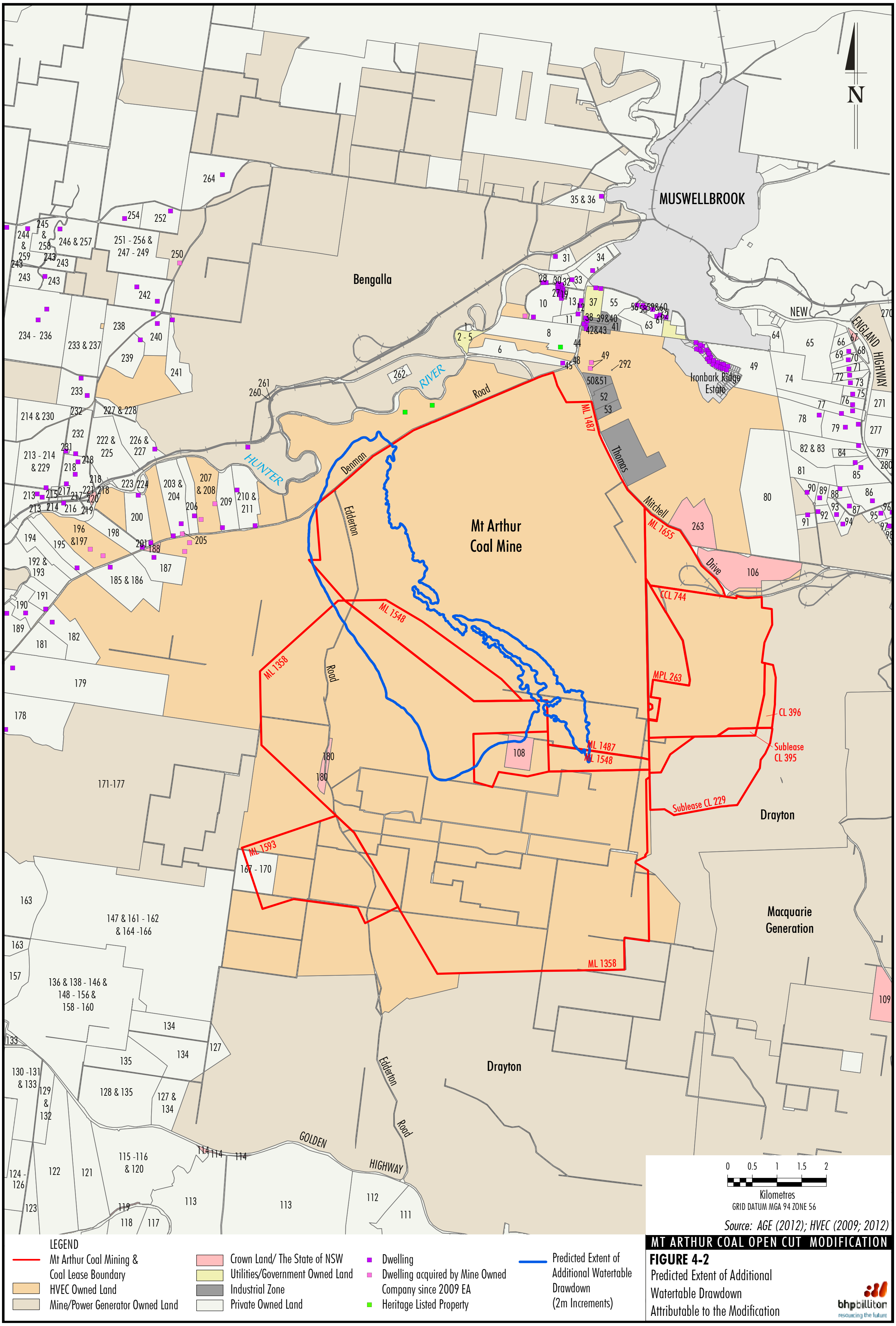

FIGURE 4-2
Predicted Extent of Additional Watertable Drawdown Attributable to the Modification

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Groundwater Quality

The numerical model predicts the Modification would result in an ongoing localised groundwater sink in the Permian coal measures. Due to this ongoing sink there is not expected to be significant migration or deterioration in groundwater quality of the mine lease resulting from the Modification (Appendix B).

As the Modification includes the placement of overburden in an upper section of Saddlers Creek Alluvium, potential groundwater quality impacts to Saddlers Creek Alluvium were considered. The soil profile in this area is moderately drained in the topsoil, becoming poorly drained thereafter (Attachment A of Appendix A). The mapping of soil within this area includes depositional sediments associated with the creek flow, however, due to limited size and poor texture and structural characteristics, these alluvial are not commonly associated with good agricultural land (Attachment A of Appendix A). Therefore, it is expected that any rainfall that is captured and may infiltrate into the overburden is likely to emerge at the base of the overburden as minor seep, rather than infiltrate to alluvium or weathered bedrock (Appendix B).

Groundwater Recovery

A variation of the numerical model was also developed in order to simulate the long-term recovery of regional groundwater levels and to investigate the interaction between the final void and the regional groundwater system following cessation of the mining activities (Appendix B).

Numerical modelling of the post-mining recovery of groundwater levels shows that the groundwater system would recover over time with substantial recovery predicted after about 30 years (Appendix B).

The model also showed the final void water levels would recover to a level well below the Hunter River elevation and the final void spill level (Appendix B).

A final void water balance model was also developed as part of the Surface Water Assessment and is described in Section 4.5.

Aquifer Interference Policy

An assessment of the Modification against the *NSW Aquifer Interference Policy* (DPI, 2012b) is provided in Attachment 3 of this EA.

4.4.3 Mitigation Measures and Management

Groundwater Licensing

HVEC currently holds adequate licences to account for the potential incremental increase in take of water associated with the Modification (Attachment 3).

Licensing requirements associated with the Modification are discussed in Attachment 3 which includes a summary of the implications of the *NSW Aquifer Interference Policy* (DPI, 2012b) on the Modification.

Groundwater Monitoring

Groundwater monitoring at the Mt Arthur Coal Mine would continue to be undertaken in accordance with the *Ground Water Monitoring Program* (BHP Billiton, 2012e). The *Ground Water Monitoring Program* would be reviewed and, if necessary, revised to incorporate the Modification.

Impact on Groundwater Users

The *Surface and Groundwater Response Plan* (BHP Billiton, 2012f) would be reviewed and, if necessary, revised to incorporate the Modification. Notwithstanding the negligible effects due to the Modification predicted at surrounding private bores (Appendix B), consistent with the Project Approval for the Mt Arthur Coal Mine – Open Cut Consolidation Project Statement of Commitments:

> *In the event of interruption to water supply resulting from the Project, an alternative water supply will be provided, until such interruption ceases.*

The process for identifying and compensating the interruption to water supply resulting from Mt Arthur Coal operations would be in accordance with the “protocol for adverse affects to nearby users” outlined in the *Surface and Groundwater Response Plan* (BHP Billiton, 2012f).

Impacts on Hunter River Alluvium

In addition, notwithstanding the minor impacts to alluvium associated with the Modification, consistent with the Project Approval for the Mt Arthur Coal Mine – Open Cut Consolidation Project Statement of Commitments:

> *Mt Arthur Coal will continue to monitor hydro-geomorphological conditions and scrutinise for evidence of any groundwater ingress or endwall instability indicators as it progresses the previously approved mining towards the Hunter River Alluvials. Mining (other than that already approved in the MAN [Mt Arthur North] EIS) will not extend beyond a nominal 150 m buffer zone from the Hunter River Alluvials until agreement is reached with DWE regarding the installation of a lower permeability barrier along the point of connections of mining and the alluvium or other appropriate safeguards.*

4.5 SURFACE WATER

A Surface Water Assessment for the Modification was undertaken by Gilbert & Associates Pty Ltd (Gilbert & Associates) (2013) and is presented in Appendix C.

4.5.1 Existing Environment

Background

The potential impacts on local and regional surface water resources of the Mt Arthur Coal Mine were initially assessed by Dames and Moore (2000a) as part of the *Mount Arthur North Coal Project Environmental Impact Statement* (Coal Operations Australia Limited, 2000).

Subsequent to the *Mount Arthur North Coal Project Environmental Impact Statement* (Coal Operations Australia Limited, 2000), a number of additional studies have been undertaken to assess the potential impacts on local and regional surface water resources of the Mt Arthur Coal Mine, the most recent study is the *Mt Arthur Coal Consolidation Project Surface Water Assessment* conducted by Gilbert & Associates (2009) as a component of the Mt Arthur Coal Consolidation Project.

Regional Hydrology

The Mt Arthur Coal Mine is located to the south of the Hunter River, wholly within the Hunter River catchment area. The Hunter River is one of the six major regulated river basins in NSW and has a catchment area of approximately 22,000 square kilometres (km^2). Flow is regulated in the Hunter River by three main water storages, Glenbawn Dam, Glennies Creek Dam and Lostock Dam (Appendix C). Near the Mt Arthur Coal Mine the Hunter River is regulated by Glenbawn Dam which is located approximately 30 km upstream (Appendix C).

Local Hydrology

Local hydrology comprises a number of drainage lines and creeks flowing north and south-west towards the Hunter River. Quarry Creek, Ramrod Creek, Fairford Creek, Whites Creek and a number of small unnamed creeks drain the western and northern parts of the Mt Arthur Coal Mine area and flow northwards into the Hunter River (Appendix C). Southwards flowing drainage lines in the Mt Arthur Coal Mine area report to Saddlers Creek which flows generally to the south-west and joins the Hunter River downstream of Denman (Appendix C).

The catchment areas of Quarry Creek, Fairford Creek, Whites Creek, Ramrod Creek and a small unnamed tributary have been reduced by the development of open cut pits which form part of the Mt Arthur Coal Mine (Appendix C). Quarry Creek has a current catchment area of approximately 19 km^2 and drains the westernmost portion of the Modification Area. Fairford Creek is a tributary of Whites Creek and has a current catchment of approximately 8.6 km^2. Whites Creek, which had a pre-mining catchment area of approximately 21.5 km^2, has been diverted to the east of the mine (Appendix C). Ramrod Creek has a current catchment area of approximately 32.4 km^2 downstream of the existing mine rail loop and the neighbouring Drayton Coal Mine.

The small unnamed tributaries drain the area north of the Northern Open Cut and have a current catchment area of approximately 2 km^2 (Appendix C).

Catchments to the south of the Modification area are bounded by Mount Arthur and an associated ridgeline (Appendix C). Southward flowing tributary gullies report to Saddlers Creek, which has a total current catchment area of 91.3 km^2 (Appendix C).

Surface drainage within the Mt Arthur Coal Mine mining tenements generally comprises ephemeral and first order creeks (Appendix C).

Surface Water Management

Surface water management at the Mt Arthur Coal Mine is undertaken in accordance with the *Site Water Management Plan* (BHP Billiton, 2012a). A description of the existing site water management system is provided in Section 2.4.

A *Surface and Ground Water Response Plan* (BHP Billiton, 2012f) details the surface water and groundwater exceedance protocols and the protocol for adverse affects to nearby users.

Surface Water Quality

Surface water quality monitoring for the Mt Arthur Coal Mine is undertaken in accordance with the *Surface Water Monitoring Program* (BHP Billiton, 2012g) which details the surface water monitoring programme, surface water impact assessment criteria and surface water monitoring methodology. The surface water monitoring sites included in the *Surface Water Monitoring Program* (BHP Billiton, 2012g) are shown in Figure 2-2.

The median pH in local creeks has a tendency to trend towards slightly alkaline levels (Appendix C). While median EC is elevated relative to Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and is variable at most sites (Appendix C). Monitoring results for additional water quality parameters including turbidity, total dissolved solids (TDS), filtered iron, nitrate and sulphate are discussed in Appendix C.

Water quality data are available for the Hunter River upstream and downstream of the Mt Arthur Coal Mine. Salinity of the Hunter River is monitored upstream of the Mt Arthur Coal Mine at the Muswellbrook Bridge gauging station (GS210002) and downstream at the Denman gauging station (GS210055). EC at both gauging stations has been highly variable due to varying flow and ranges from 93 to 1,011 microSiemens per centimetre (µS/cm) at the Muswellbrook Bridge gauging station, and from 119 to 1,178 µS/cm at the Denman gauging station (Appendix C).

The median conductivity at the upstream and downstream sites is 447 and 512 µS/cm, respectively (Appendix C).

The HRSTS regulates salinity discharged to the Hunter River. The amount of saline water that may be discharged from a given discharge licence holder is determined by reference to the salinity of the discharge waters, the river flow, the number of credits held and any overriding limit that may be applied as a condition of the licence (Appendix C). HVEC currently holds 16 discharge credits under the HRSTS. If required, controlled releases of excess water from the Mt Arthur Coal Mine to the Hunter River are undertaken in accordance with the HRSTS (Appendix C).

Surface Water Users

Agricultural properties located immediately north of the Mt Arthur Coal Mine contain on-stream dams which are used for irrigation and stock watering on Whites Creek, Fairford Creek and the unnamed creeks (Appendix C). The majority of these properties are owned by HVEC. Two current private extraction entitlements for less than 16 megalitres (ML) per annum of water, each for irrigation, have been licensed by the NOW on two adjoining properties on Ramrod Creek downstream of the Modification area (Appendix C).

Water usage downstream of the Mt Arthur Coal Mine area on Saddlers Creek includes stock watering and irrigation from on-stream dams (Appendix C). Agricultural users in the region surrounding the mine area may also rely on groundwater bores to provide water for irrigation, stock watering and domestic usage (Appendix C).

Site Water Balance

Gilbert & Associates (2009) developed a site water balance model as part of the Surface Water Assessment. The site water balance model simulated the inflows, outflows, transfers and changes in storage of water on-site on a daily continuous basis from 2009 to 2022.

The site water balance model found that the majority of the Mt Arthur Coal Mine water demand was able to be sourced from site rainfall runoff with supply reliability predicted to be greater than 91 percent for all components of the Mt Arthur Coal Mine (Gilbert & Associates, 2009). Water demand required to be extracted from the Hunter River was predicted to be within the limits of licensed volumes for the majority of time, with the exception of extreme drought years (Gilbert & Associates, 2009).

In addition, the assessment showed that the Mt Arthur Coal Mine would be able to operate within the rules of the HRSTS (Gilbert & Associates, 2009).

Flooding

The north-western portion of the Northern Open Cut, in the vicinity of Fairford Creek and Whites Creek, is relatively low-lying and includes some area below the 1955 flood levels (Appendix C). The 1955 flood levels are estimated to be equivalent to a 100 year average recurrence interval event (Appendix C). For this reason flood bunding is planned to be constructed in proximity to Denman Road to at least the 1955 peak flood level plus 0.5 m freeboard.

4.5.2 Potential Impacts

Potential impacts on local and regional surface water resources associated with the Modification are described in the Surface Water Impact Assessment (Appendix C) and include:

- changes to flows in local creeks due to extension of the open cut and overburden emplacements and subsequent capture and use of drainage from mine area catchments;
- potential for export of contaminants (principally sediments and soluble salts) in mine area runoff and accidental spills from containment storages (principally sediments, soluble salts, oils and greases), causing degradation of local and regional watercourses; and
- short-term increases in salinity during periods of licensed discharge under the HRSTS.

Site Water Balance

Gilbert & Associates (Appendix C) updated the site water balance model for the Mt Arthur Coal Mine to reflect the Modification. The updated model simulates the inflows, outflows, transfers and changes in storage of water on-site on a daily continuous basis from 2012 to 2026.

The Modification would include the alteration of the Whites Creek diversion (Section 3.3.1) and this has been incorporated in the updated model.

The updated site water balance model found that the majority of the Mt Arthur Coal Mine water demand was able to be sourced from site rainfall runoff with supply reliability predicted to be greater than 87 percent for all components of the Mt Arthur Coal Mine (Appendix C).

The updated site water balance model showed that the Modification would result in a greater reliance on extraction from the Hunter River when compared to that required for the currently approved operations (Appendix C). While the Modification would result in an increased reliance on extraction from the Hunter River, this extraction is predicted to be within the limits of currently licensed volumes, with the exception of extreme drought years (Appendix C).

Salt Balance

The water management system would continue to be developed in accordance with best management principles including minimising contamination of site water, maximising re-use of mine water on-site and managing water so that any releases from site are controlled in accordance with the HRSTS. By segregation and preferential re-use of the more saline water on-site, off-site discharges of salt to the Hunter River would be controlled (Appendix C).

It is estimated that, for the period of the Modification, an average 235 ML per annum controlled release to the Hunter River under the HRSTS would occur (reduced from a predicted 351 ML per annum. From the water balance model results, Gilbert & Associates (Appendix C) has calculated the amount of salt that would be released from the site (i.e. a salt budget). Based on a median TDS of 754 milligrams per litre (from Environmental Dam monitoring), this represents an average salt discharge of 177 tonnes per annum (tpa) (a reduction of 88 tpa compared with predictions in Gilbert & Associates [2009]) (Appendix C). It should be emphasised that discharges would occur during periods of high or flood flow (as mandated in the HRSTS) and would therefore not affect the salt content in the river during low flows (Appendix C).

Flow Regime in Local Creeks

The Modification would result in changes to flows in local creeks due to the progression of open cut mining and associated subsequent capture and re-use of drainage from operational catchment areas.

Table 4-5 summarises the potential changes in catchment area reporting to local creeks as a result of the Modification. The change in average flow rates of the local creeks is expected to be directly proportional to the changes in catchment area summarised in Table 4-5 (Appendix C).

Table 4-5
Predicted Maximum Changes to Contributing Catchments of Local Creeks

	Total Catchment Area prior to Mining (km^2)	Catchment Area for Maximum Extents of Currently Approved Operations (km^2)	Catchment Area for Maximum Extents of the Modification (km^2)
Quarry Creek	22.0	18.6	16.5
Fairford Creek	10.8	2.7	1.4
Whites Creek	21.5	2.2	3.6
Unnamed Creeks	4.2	2.8	3.3
Ramrod Creek	33.4	32.2	31.6
Saddlers Creek	99.0	88.1	89.6

Source: Appendix C.

The catchment areas of Quarry Creek, Fairford Creek and Ramrod Creek for the maximum extent of the Modification would be slightly less than those for the maximum extent of the currently approved operations (Table 4-5).

The decrease in catchment area and corresponding decrease in average flow rates are unlikely to have a material effect on riparian flows or licensed extraction from Ramrod Creek (Appendix C).

The catchment areas for Whites Creek, the unnamed creeks and Saddlers Creek for the maximum extent of the Modification would be greater than those for the maximum extent of the currently approved operations (Table 4-5). The increase in catchment area for Whites Creek and the unnamed creeks are expected to result from progressive rehabilitation of overburden emplacements (Appendix C). The increase in catchment area for Saddlers Creek is a result of redesign of overburden emplacements (Appendix C).

The maximum decrease in Hunter River catchment resulting from the Modification is approximately 0.6 km^2 (Appendix C). This represents less than a 0.02 percent reduction in the catchment area reporting to the Hunter River at the Mt Arthur Coal Mine and a corresponding reduction of less than 0.02 percent in average flow rates in the Hunter River at the Mt Arthur Coal Mine (Appendix C).

Flooding

The Modification would not result in an extension of open cut operations in an area below the recorded 1955 peak flood levels. The 1955 flood levels are estimated to be equivalent to a 100 year average recurrence interval event. On this basis, no additional flood mitigation works are required for the Modification (Appendix C).

Water Quality

Runoff and Contaminants

The Modification may potentially result in surface water quality impacts due to surface water runoff from disturbed areas. Surface water runoff from disturbed areas could potentially contain sediments, dissolved solids, oil, grease, metals and salts. Sediment dams capturing runoff from areas of pre-strip and rehabilitation would be designed in accordance with the *Erosion and Sediment Control Plan* (BHP Billiton, 2012b) and with the provisions for sediment retention basins in Landcom (2004) and NSW Department of Environment and Climate Change (DECC) (2008).

Hunter River Water Quality

Potential impacts on water quality in the Hunter River due to the Modification are associated with off-site discharge of saline water (Appendix C). Discharge of saline water off-site is limited by the segregation and preferential re-use of the more saline water on-site (Appendix C). Water with other contaminants (e.g. hydrocarbons) resulting from the Modification would be retained and treated for re-use on-site (Appendix C).

Controlled releases under the HRSTS for the Modification are predicted to be less than those predicted for the approved operations (Appendix C). Controlled releases under the HRSTS for the Modification period are predicted to average 235 ML per annum (Appendix C).

A salt budget was calculated for the Modification based on the water balance results and site salinity monitoring data (Appendix C). The salt budget showed that the Modification would result in an average salt discharge of 177 tpa, 88 tpa less than that predicted for the approved operations (Appendix C). In accordance with the HRSTS these releases would be made during periods of high or flood flow and would therefore not affect low flows (Appendix C).

Post-Mining Surface Water Impacts

Final voids would remain in the Northern Open Cut, McDonalds Pit and Belmont Pit. The Saddlers pit, which would remain as a void under the existing/approved operations, would be backfilled as part of the Modification.

The total catchment reporting to the final void of the Mt Arthur Coal Mine is estimated to be approximately 14.2 km^2 (Appendix C). The catchment area reporting to the final voids for the currently approved operations was estimated to be approximately 15.9 km^2 (Appendix C). Therefore the Modification would result in a reduction in catchment area reporting to the final landform of approximately 10 percent compared to the currently approved operations (Appendix C).

Post-mining inflows to the final void would comprise of incident rainfall, runoff and groundwater inflows. Water would be lost from the final void through evaporation. Recovery of the regional groundwater levels was simulated as part of the Groundwater Assessment (Appendix B) and is discussed in Section 4.4.2.

A final void water balance model was developed for the final void to predict the long-term behaviour of the final void water body (Appendix C). This modelling predicted that final water levels would recover to a level more than approximately 135 m below spill level and no spill would occur from the final void in the long-term (Appendix C).

4.5.3 Mitigation Measures and Management

Surface water management at the Mt Arthur Coal Mine would continue to be undertaken in accordance with the *Site Water Management Plan* (BHP Billiton, 2012a) and supplementary appendices (i.e. the *Site Water Balance, Erosion and Sediment Control Plan*, *Surface Water Monitoring Program*, *Groundwater Monitoring Program* and *Surface and Groundwater Response Plan*). The *Site Water Management Plan* (BHP Billiton, 2012a) would be reviewed, and if necessary, revised to incorporate the Modification.

4.6 FLORA AND FAUNA

An Ecological Assessment has been prepared for the Modification by Colin Driscoll of Hunter Eco (2013) and is presented in Appendix D. The assessment was conducted in accordance with the *Draft Guidelines for Threatened Species Assessment* (NSW Department of Environment and Conservation [DEC] and DPI, 2005).

A description of the existing environment relating to flora and fauna is provided in Section 4.6.1. Section 4.6.2 describes the potential impacts of the Modification on flora and fauna, including cumulative impacts, and Section 4.6.3 outlines measures to avoid or mitigate impacts on flora and fauna. Section 4.6.4 describes the components of the Modification biodiversity offset strategy relevant to flora and fauna.

4.6.1 Existing Environment

Regional and Local Setting

The Modification is located in the Hunter-Central Rivers CMA, the Sydney Basin Bioregion as defined in the *Interim Biogeographic Regionalisation for Australia: a Framework for Establishing the National System of Reserves* (Thackway and Cresswell, 1995; SEWPaC, 2012a) and is at the eastern edge of the Central-West Slopes botanical division (Centre for Australian National Biodiversity Research, 2012).

The existing Mt Arthur Coal Mine is located in a mining and agricultural landscape. The natural vegetation in and around the Mt Arthur Coal Mine had been predominantly cleared for a variety of agricultural purposes prior to mining.

Flora and Fauna Surveys

Hunter Eco (Appendix D) and Niche Environment and Heritage (Niche) (2012) (Appendix 1 of Appendix D) undertook detailed baseline flora and fauna surveys within the Modification area. The surveys involved flora plot sampling, linear transects and meanders and vegetation mapping conducted by Hunter Eco (Appendix D) as well as various fauna survey techniques such as arboreal Elliot trapping, infra-red camera traps, hair tubes, ultrasonic call recoding for bats, diurnal bird surveys, spotlighting, call playback, stag watching, Koala scat searches, herpetological searches and aquatic habitat searches conducted by Niche (Appendix 1 of Appendix D).

These baseline surveys provided information on the biodiversity within the Modification area, and a means to assess the potential biodiversity impacts from the Modification.

In addition to the baseline surveys, annual flora and fauna monitoring has occurred within the Mt Arthur Coal Mine since 2003 (Umwelt, 2003, 2005, 2006a, 2007b; Wildthing Environmental Consultants, 2008; Cumberland Ecology, 2009a, 2010a, 2010b). Targeted surveys for the Pine Donkey Orchid (*Diuris tricolor*) have also occurred since 2008 (Umwelt, 2008b, 2010; Cumberland Ecology, 2010c, 2011). Nest box monitoring has also been undertaken (Umwelt, 2008c). The results of the monitoring are reported by HVEC in the AEMR.

Flora

The land within each of the Modification areas differs due to previous clearing and agricultural practices.

The Northern Open Cut Modification area (adjacent to Edderton Road) is dominated by grassland and widely scattered trees (Appendix D) (Figure 4-3).

The Northern Open Cut Modification area (north of Mount Arthur) is characterised by a mixture of open grassland and woodland (Appendix D) (Figure 4-3). The two main communities in the Southern Open Cut Modification area (east of Mount Arthur) are dominated by Spotted Gum (*Corymbia maculata)* and by Blakely's Red Gum (*Eucalyptus blakelyi*), with the remainder of the area open grassland (Appendix D) (Figure 4-3).

A central feature of the proposed conveyor corridor overburden emplacement area is a drainage line, being the upper reaches of Saddlers Creek, that is dominated by Broadleaf Cumbungi (*Typha orientalis*) reeds (Appendix D) (Figure 4-3). Patches of Forest Red Gum (*Eucalyptus tereticornis*), Spotted Gum (*Corymbia maculata*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) are present along the edges of the central creekline (Appendix D). The proposed rail loop duplication area is dominated by open grassland (Appendix D) (Figure 4-3). Disturbed areas alongside the rail line have been planted with a variety of exotic grasses such as Rhodes Grass (*Chloris gayana*), Red Natal Grass (*Melinis repens*) and Reed Canary Grass (*Phalaris arundinacea*) (Appendix D).

The vegetation communities mapped by Hunter Eco (Appendix D) are listed in Table 4-6 and shown on Figure 4-3.

Several flora species previously recorded within the Mt Arthur Coal Mine are listed by the DPI (Agriculture) as noxious weeds for the Upper Hunter County Council. One species previously recorded listed as a Class 3 noxious weed includes Mother of Millions (*Bryophyllum delagoense*) (Appendix D).

Class 4 noxious weeds include: Nodding Thistle (*Carduus nutans*), Bathurst Burr (*Xanthium spinosum*), Tiger Pear (*Opuntia aurantiaca*), Creeping Pear (*Opuntia humifusa*), Common Prickly Pear (*Opuntia stricta* and *Opuntia stricta* var. *stricta*), St. Johns Wort (*Hypericum perforatum*), Johnson Grass (*Sorghum halepense*), Blackberry Bramble (*Rubus fruticosus* sp. agg.), African Boxthorn (*Lycium ferocissimum*) and Trailing Lantana (*Lantana montevidensis*) (Appendix D). Class 5 noxious weeds includes the Annual Ragweed (*Ambrosia artemisiifolia*) (Appendix D).

The threatened ecological communities (TECs) recorded within the Modification area, as listed in Table 4-7, are described in detail below. Threatened flora populations and species recorded within the Modification area are also described in detail below.

Threatened Ecological Communities

Six of the vegetation communities identified in the Modification area represent five TECs listed under the TSC Act and one TEC listed under the EPBC Act (Table 4-7). The locations of TECs within the Modification area are shown on Figure 4-4.

The White Box Yellow Box Blakely's Red Gum Woodland EEC (listed under the TSC Act and listed as the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community [CEEC] under the EPBC Act) is the most common TEC within the Modification area (Figure 4-4). The least common TEC within the Modification area is the Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC (Figure 4-4).

FIGURE 4-3

Vegetation Communities

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Table 4-6
Vegetation Communities within the Modification Area

Vegetation Community		Area (ha)*
Grassland		
1	Derived Native Grassland (no HRVP equivalent)	136.8
2	Derived Native Grassland, with Cooba Wattle Regrowth (no HRVP equivalent)	1.0
3	Derived Native Grassland, derived from Box-Gum Woodland[1, 2] (no HRVP equivalent)	35.2
Woodland		
4a	Central Hunter Box – Ironbark Woodland[1, 2, 3] (MU10)	23.0
4b	Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant (MU10)	17.9
4c	Central Hunter Box – Ironbark Grassy Woodland (MU10)	0
5	Upper Hunter Hills Box – Ironbark – Red Gum Woodland (MU9)	3.4
6	Blakely's Red Gum Woodland[1, 2] (no HRVP equivalent)	0.2
7	Western Hunter Narrabeen Footslopes Ironbark - Cypress Pine Woodland (MU8)	0
Forest		
8	Hunter Lowlands Red Gum Forest[4] (MU24)	1.7
9	Central Hunter Ironbark – Spotted Gum – Grey Box Forest[5] (MU27)	7.1
10	Central Hunter Bulloak Forest Regeneration (MU34)	0
11	Upper Hunter Hills Sheltered Moist Forest (MU29)	0
Acacia Shrubland		
12	Weeping Myall Woodland[6] (MU19)	0.1
Reeds and Rushes		
13	*Typha* Dominated Drainage Line (no HRVP equivalent)	2.5
14	Dominated by Sharp Rush (no HRVP equivalent)	0.1
Other Map Units		
15	Plantation (MU36)	5.8
16	Cleared land (no HRVP equivalent)	25.1
	Total	**259.9**

Source: After Appendix D.

1 White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community (EEC).

2 White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC.

3 Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC.

4 Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC.

5 Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC.

6 Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC.

* Includes area around rail spur and loop associated with the rail loop duplication conservatively included in flora and fauna disturbance, however, not included in agricultural assessment.

HRVP = Hunter Remnant Vegetation Project.

Table 4-7
TECs within the Modification Area

Ecological Communities	Status[1]		Vegetation Community
	TSC Act	EPBC Act	
Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	E	-	Vegetation Community 12
White Box Yellow Box Blakely's Red Gum Woodland	E	CE	Vegetation Community 3, Vegetation Community 4a and Vegetation Community 6.
Central Hunter Grey Box – Ironbark Woodland in the NSW North coast and Sydney Basin Bioregions	V	-	Vegetation Community 4a
Central Hunter Ironbark-Spotted Gum-Grey Box Woodland in the NSW North Coast and Sydney Basin Bioregions	E	-	Vegetation Community 9
Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	E	-	Vegetation Community 8

Source: After Appendix D.

1 TEC status under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and/or Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (current at 24 January 2013).

E = Endangered, CE = Critically Endangered

Threatened Flora Populations

Three threatened populations listed as endangered under the TSC Act are likely to be impacted by the Modification and comprise the: *Acacia pendula* population in the Hunter catchment; *Cymbidium canaliculatum* population in the Hunter Catchment. Additionally, potential impact may occur to the *Diuris tricolor* population as suitable habitat was identified in the Modification area (Appendix D). These threatened populations are described in detail below.

The *Acacia pendula* population in the Hunter catchment occurs in the Northern Open Cut Modification area adjacent to Edderton Road (Figure 4-4), while the Northern Open Cut Modification area (north of Mount Arthur) contains suitable host tree species for the endangered *Cymbidium canaliculatum* population in the Hunter Catchment (Appendix D). Although suitable host trees for this species were present within the Modification area no *Cymbidium canaliculatum* were recorded (Appendix D).

This population occurs outside of the Modification area as shown on Figure 4-4. The *Diuris tricolor* population in the Muswellbrook LGA has been recorded in and near the Mt Arthur Coal Mine (Appendix D) (Figure 4-4). Suitable habitat for this population is present in the Modification area (Appendix D). However, no *Diuris tricolor* was identified during field surveys undertaken in April and May 2012. *Diuris tricolor* was flowering in the A171 conservation area (19 September 2012).

Threatened Flora Species

One threatened flora species, the Lobed Blue-grass (*Bothriochloa biloba*), listed as vulnerable under the EPBC Act was recorded within the Northern Open Cut Modification area (adjacent to Edderton Road) (Figure 4-4).

Fauna

Broad fauna habitat types within the Modification area were identified by Niche (Appendix 1 of Appendix D) and include Forest, Disturbed Forest, Grassy Woodland, Disturbed Grassy Woodland, Grassland, Reeds and Rushes, Disturbed and Plantation.

The fauna which use these habitat types has been documented by Niche (Appendix 1 of Appendix D) during the baseline fauna surveys as well as previous monitoring (Umwelt, 2003, 2005, 2006a, 2007b; Wildthing Environmental Consultants, 2008; Cumberland Ecology, 2009a, 2010a, 2010b), targeted surveys (Umwelt, 2008b, 2010; Cumberland Ecology, 2010c, 2011), nest box monitoring (Umwelt, 2008c) and baseline surveys for environmental assessments (Dames and Moore, 2000b; Umwelt, 2006b, 2006c, 2007c; Cumberland Ecology, 2009b).

During the recent surveys conducted by Niche (Appendix 1 of Appendix D), a total of 77 vertebrate species were recorded, comprising 44 birds, 25 mammals (including six introduced species), five reptiles and three frogs.

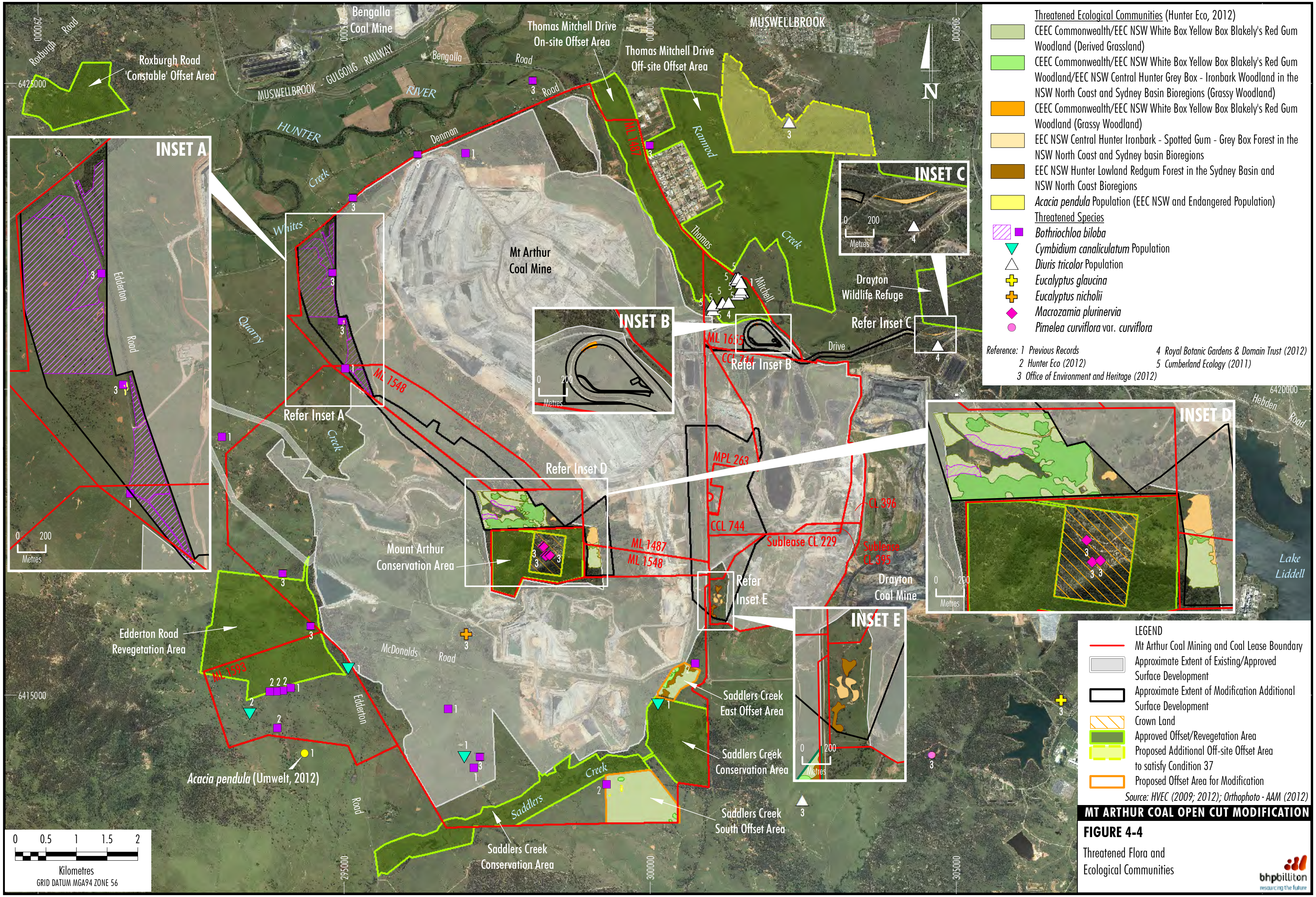

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FIGURE 4-4

Threatened Flora and Ecological Communities

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Introduced pest species recorded within the Modification area are the Black Rat (*Rattus rattus*), Dog (*Canis lupus familiaris*), Fox (*Vulpes vulpes*), Cat (*Felis catus*), Rabbit (*Oryctolagus cuniculus*) and European Cattle (*Bos taurus*) (Appendix 1 of Appendix D).

Threatened Species

Hunter Eco undertook a review of relevant literature and databases (OEH, 2013; SEWPaC, 2012b; Birds Australia, 2012; Australian Museum, 2012) (Appendix D) and identified threatened fauna species within or near the modification area, additionally to surveys for threatened fauna species undertaken by Niche (Appendix 1 of Appendix D).

No threatened species listed under the NSW *Fisheries Management Act, 1994* have been recorded within or near the Modification area (Appendix D), primarily due to the absence of appropriate habitat.

Table 4-8 provides a list of threatened fauna species with records within the Modification area. Two threatened bird species and seven threatened mammal species have been recorded within the Modification area (Table 4-8). The locations of where these species were recorded are shown on Figures 4-5, 4-6 and 4-7.

The Varied Sittella was recorded during the 2004 monitoring period near the base of Mount Arthur within the Modification area in tall open forest dominated by mature Spotted Gum (*Corymbia maculata*) (Umwelt, 2005) (Figure 4-5).

The Grey-Crowned Babbler (eastern subspecies) has been recorded in the Modification area (Cumberland Ecology, 2009b) (Figure 4-5). This species was recorded within a plantation stand within the Modification area, which would be removed as part of the Modification. This species has also been recorded surrounding the Modification area as well as within the Thomas Mitchell Drive Offset area, Saddlers Creek Conservation area and Edderton Road Revegetation area (Umwelt, 2003, 2006a, 2007c) (Figure 4-5). Grey-crowned Babbler nests have been recorded in the Saddlers Creek Conservation area (Cumberland Ecology, 2009b) (Figure 4-5).

The Grey-headed Flying-fox was recently recorded by Niche (Appendix 1 of Appendix D) in the Modification area east of Mount Arthur (Figure 4-6). The species was seen foraging for nectar and pollen on blossoming Spotted Gum. No breeding or roosting colonies were present.

The Eastern Freetail-bat was recently recorded by Niche (Appendix 1 of Appendix D) within the Modification area (Figure 4-7). This species has also been recorded during previous surveys (Umwelt, 2006a, 2007b, 2007c) (Figure 4-7).

The Southern Myotis has been previously recorded within the Modification area by Umwelt (2003) during the 2003 monitoring undertaken annually at the Mt Arthur Coal Mine (Figure 4-7). This species has been recorded within the Thomas Mitchell Drive Offset area and Edderton Road Revegetation area as well as surrounding the Modification area by Umwelt (2006a, 2006b, 2007c) (Figure 4-7).

Table 4-8
Threatened Fauna Species that could Potentially be Impacted by the Modification

Scientific Name	Common Name	Conservation Status[1]	
		TSC Act	EPBC Act
Birds			
Daphoenositta chrysoptera	Varied Sittella	V	-
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-
Mammals			
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Mormopterus norfolkensis	Eastern Freetail-bat	V	-
Myotis macropus	Southern Myotis	V	-
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-
Vespadelus troughtoni	Eastern Cave Bat	V	-

Source: After Appendix D.

[1] Threatened fauna species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).

V = Vulnerable.

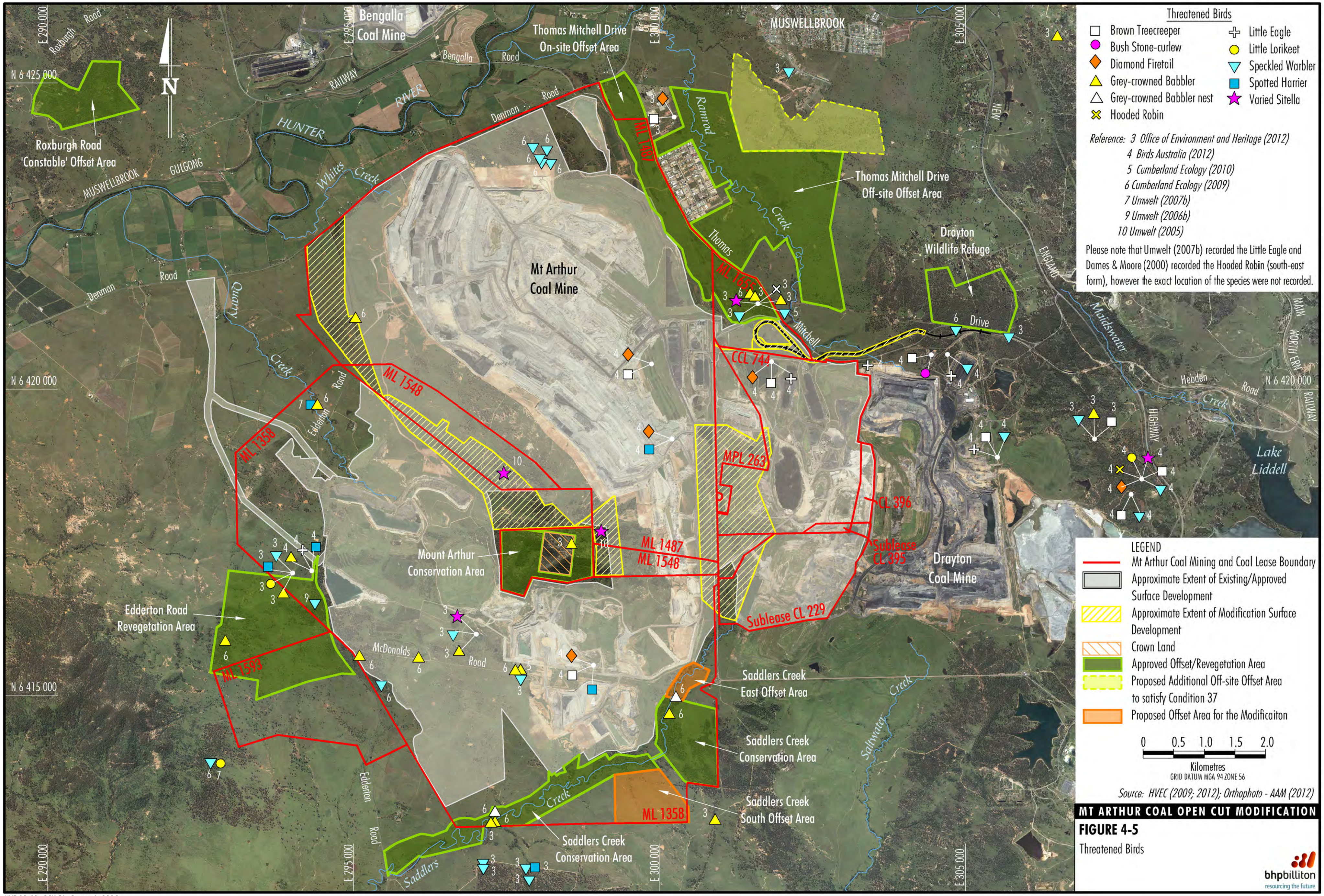

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FIGURE 4-5

Threatened Birds

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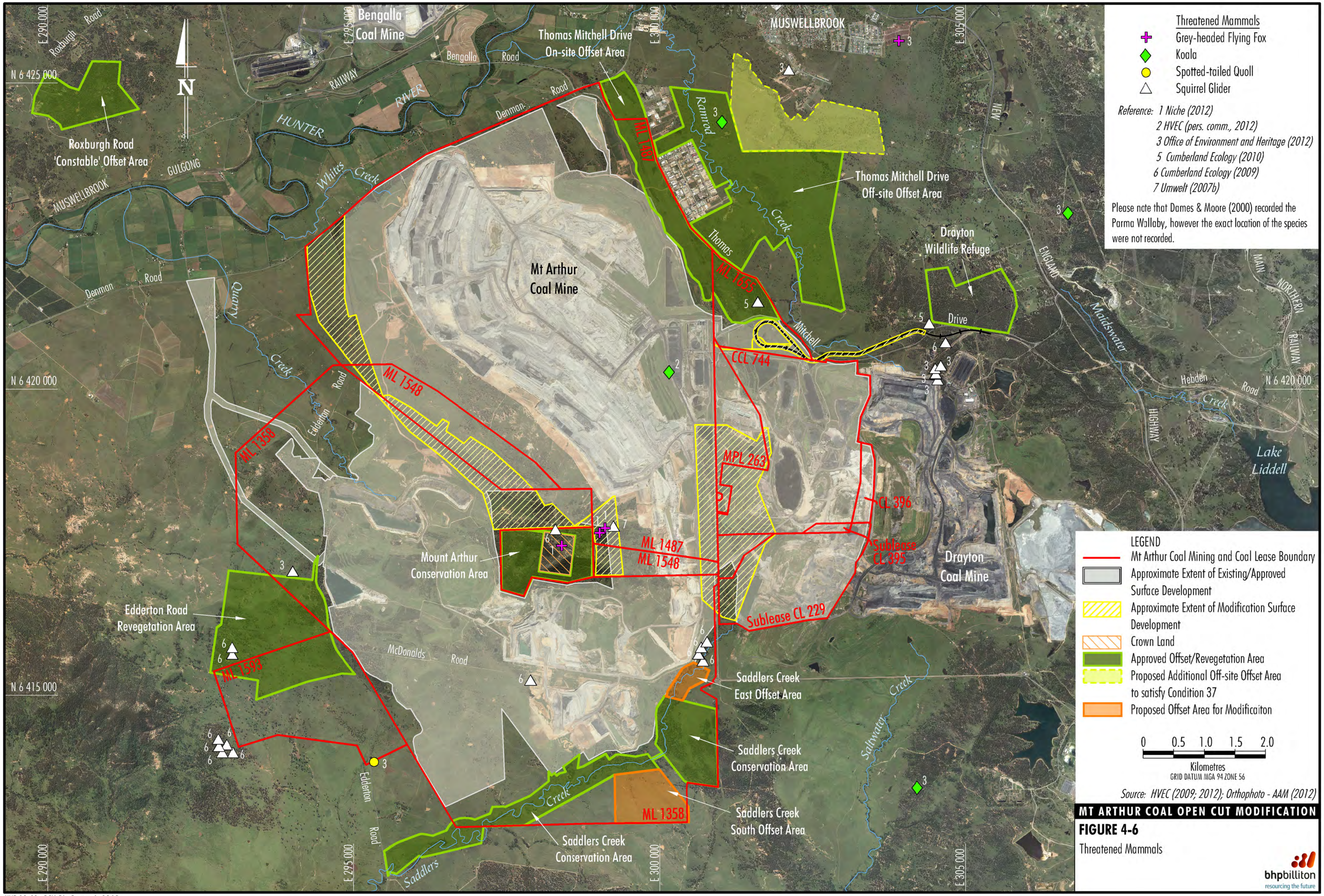

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FIGURE 4-6

Threatened Mammals

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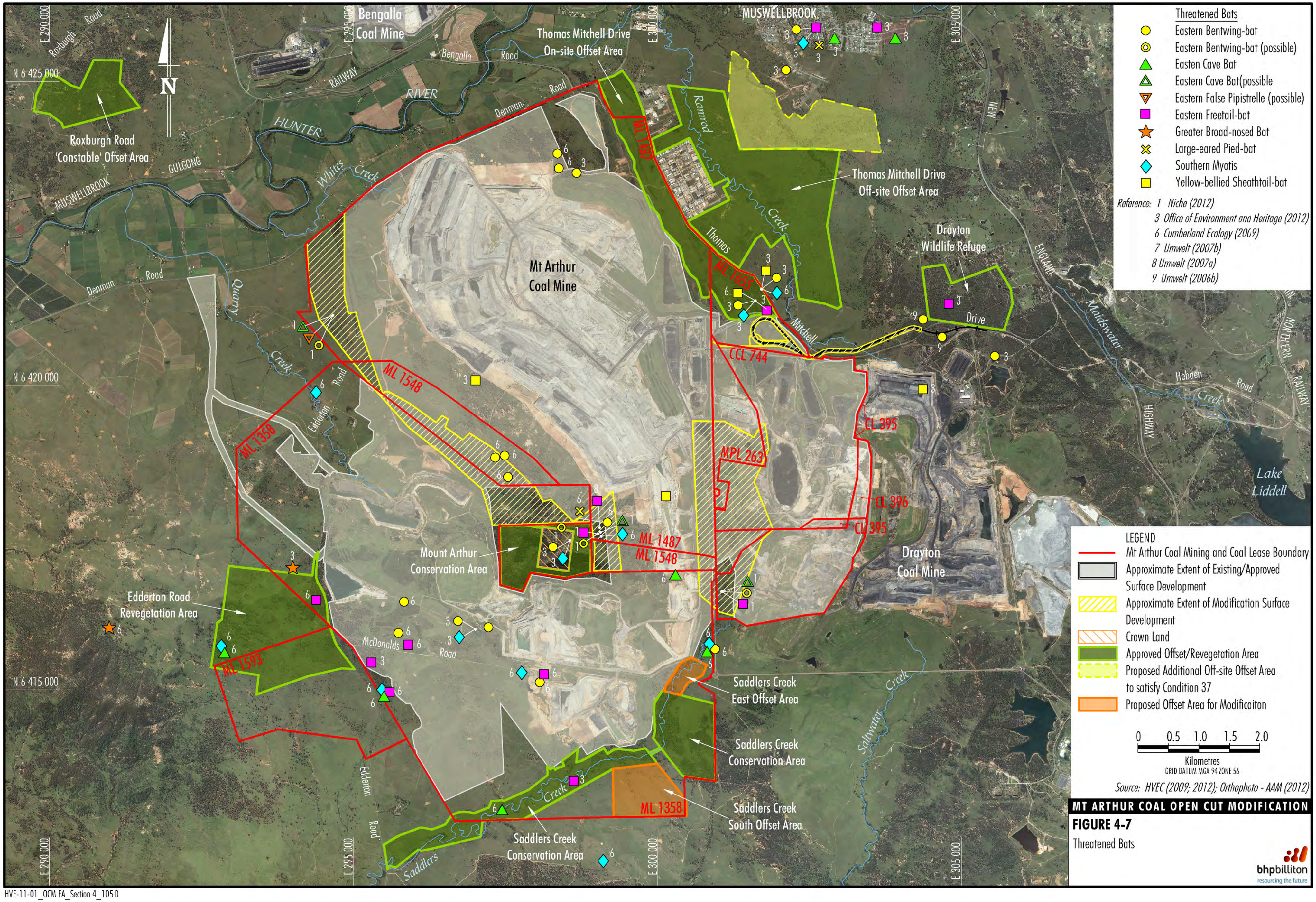

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FIGURE 4-7

Threatened Bats