

LIDDELL COAL OPERATIONS

APPENDIX **S**

Rehabilitation Strategy (Umwelt, 2013b)

APPENDICES



**Liddell Coal Operations
Pty Limited**

REHABILITATION STRATEGY

Liddell Coal Operations Extension Project

July 2013

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Liddell Coal Operations Extension Project

July 2013

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
Liddell Coal Operations Pty Limited

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Executive Summary

The purpose of this document is to outline the proposed rehabilitation strategy for the Liddell Coal Operations Extension Project, which has been developed in consideration of a number of factors including site opportunities and constraints, ecological and rural land use values and existing strategic land use objectives, including the integration of rehabilitation with the strategies developed for surrounding operations within the Greater Ravensworth Area. Whilst rehabilitation is a key component of the overall mine closure process, a full mine closure assessment is outside of the scope of this document. However, it is understood that this will be documented as part of the LCO Project Environmental Assessment (EA) (GSSE 2013) as well as incorporated into the review and update of the existing LCO Conceptual Mine Closure Plan.

The indicative post mining land use for the Project Area will primarily involve the establishment of areas of grassland as well as native vegetation corridors to promote regional fauna movements between Ravensworth Operations, Mt Owen Complex, Lake Liddell and the Ravensworth Operations Hillcrest Offset Area. A large proportion of the site, including the tops of overburden dump areas and capped tailings dams will be revegetated with open grassland that incorporate pockets of native vegetation. Subject to the outcomes of final land use analysis to be completed as part of detailed closure planning process, it is the intent that these areas could be used for sustainable agricultural purposes such as grazing. As such, revegetation may involve the use of suitable pasture species for the establishment of grasslands in these areas. In regards to native vegetation corridors, revegetation will involve the establishment of species that are consistent with the native vegetation community types that occur in the area, primarily the Central Hunter Box – Ironbark Woodland vegetation community.

In addition, the rehabilitation strategy will focus on the creation of substantial foraging and denning habitat for the spotted-tailed quoll (*Dasyurus maculatus maculatus*). A key component of this will be habitat enhancement works to be undertaken along Bowmans Creek (approximately 200 metres wide) for the spotted-tailed quoll. This will include a mixture of tree plantings and habitat structures such as log piles (such as that containing the known den site) constructed adjacent to the creekline.

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1 Native Revegetation Species Lists

1.0 Introduction

Liddell Coal Operations (LCO) is an open cut mine, located to the east of Lake Liddell and approximately 25 kilometres (km) north of Singleton along the New England Highway (refer to **Figure 1.1**). LCO is operated and managed by Liddell Coal Operations Pty Limited, a wholly owned subsidiary of Glencore Coal Pty Limited (Glencore Coal), on behalf of a joint venture between Glencore Coal (67.5 per cent) and Mitsui Matsushima Australia (32.5 per cent).

LCO has an existing approval (DA 305-11-01) to conduct mining operations until the end of the year 2023 within an approved mining footprint; however anticipate that open cut mining areas will reach this approved footprint in 2014. LCO are consequently seeking to gain approval for the modification (Modification 5) of the existing development consent DA 305-11-01 in order to extend their currently approved mining activities.

The LCO Extension Project (herein referred to as the Project) was identified as enabling the opportunity to maximise the recovery of coal resources within the existing development consent boundary and mining lease by the extension of existing open cut activities. The key components of this Project (refer to **Figure 1.2**) are:

- **Extension of the open cut mining footprint** – extension of the existing South and Entrance Pits to the south-east, and, upon completion of mining in these pits, the mining of coal resources under the Mine Infrastructure Area (MIA) during which the MIA will be relocated to a temporary facility. The extension will enable the recovery of approximately an additional 38 Mt of coal.
- **Extension to the life of mine** – the extension of open cut mining activities will lead to an associated extension of the life of mine at LCO from 2023 to 2028.
- **Additional tailings emplacement areas** – A tailings emplacement area will be constructed within the final void of the South Pit to dispose of the additional tailings associated with the extension of open cut mining activities.
- **Minor additional infrastructure:**
 - construction and commissioning of a transfer point and conveyor connected to the existing Mount Owen/Glendell/Macquarie Generation conveyor is proposed, enabling LCO to send coal to Ravensworth, and receive coal and crushed gravel from Mt Owen, via the existing conveyor system. The new conveyor will deliver/take material to/from a new 50,000 tonne stockpile; and
 - infrastructure and auxiliary surface disturbance to support the new mining areas will be required, including but not limited to, powerlines, water management infrastructure and haul roads.

No changes to mining method, production rates or operating hours are proposed as part of the Project. The activities that are subject to Project are those that will result in additional surface disturbance as a result of the extension of open cut mining activities.



FIGURE 1.1
Locality Map

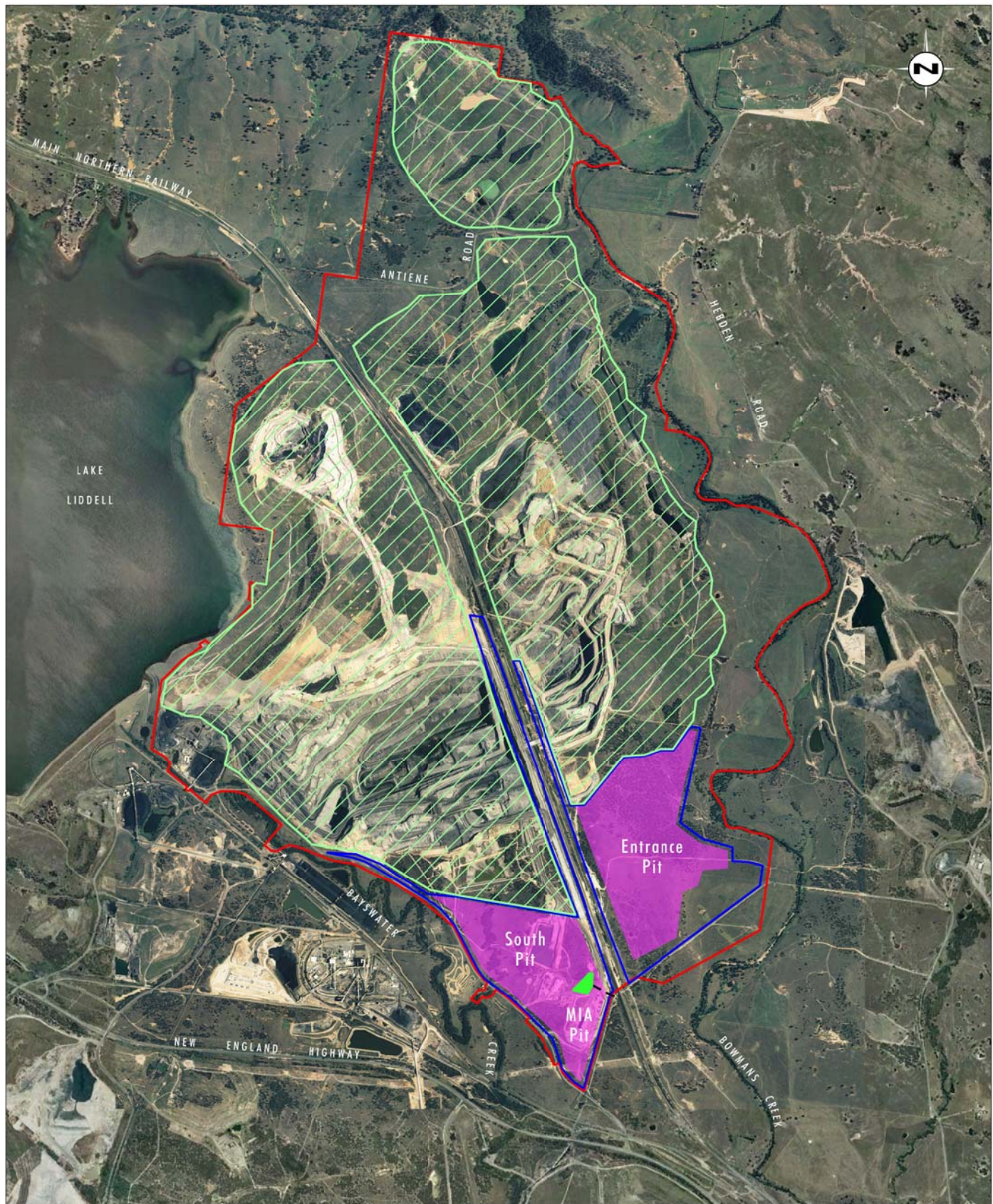


Image Source: Xstrata (2013), Google Earth (2008)
Data Source: Xstrata (2012)

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1:40 000

Legend

- Liddell Coal Operations Approved DA Boundary
- Approved Mining Footprint
- Proposed Modification Area
- Proposed limit of open cut mining
- Proposed Conveyor
- Proposed Stockpile location including hopper/crusher

FIGURE 1.2

Existing and Proposed Operations
at Liddell Coal Operations

2.0 Context for Rehabilitation

2.1 Glencore Coal Mine Closure Planning Process

Glencore Coal has implemented a proactive approach to rehabilitation and mine closure by developing a range of standards that are to be implemented across its business units which includes LCO. These standards require that planning for closure is an integrated part of the life of mine planning process. Specific guidance is provided for developing, implementing and reviewing mine closure plans taking into consideration economic, social and environmental factors so that each of Glencore Coal's operations meet statutory requirements and achieves a sustainable post-closure land use.

As part of the ongoing operations of LCO, the existing Conceptual Closure Plan will be revised as part of the implementation of the Project. As such, this plan will be updated in consideration of the commitments outlined within the EA and will include details regarding final land use objectives and closure criteria, rehabilitation and final void management strategies.

2.2 Alignment with Strategic Land Use Objectives

The strategic land use objectives for the area, which have been considered as part of the concept closure planning process for the Project, include those within the Singleton Local Environment Plan 1996 (Singleton LEP), DRE's Synoptic Plan and the recently developed Strategic Regional Land Use Plan for the Upper Hunter (Department of Planning and Infrastructure (DP&I) 2012). Discussion of the alignment of the conceptual closure plan with these strategies is outlined below.

2.2.1 Singleton and Muswellbrook Local Environmental Plans

LCO is divided between the Singleton and Muswellbrook Local Government Areas (LGAs). As a result both the Singleton LEP (1996) and the Muswellbrook LEP 2009 apply. The rehabilitation and closure strategy has been developed in consideration of the objectives of each of these LEPs. Amendments that may occur to these LEPs will be evaluated as part of ongoing revisions to LCO's mine closure plan.

Singleton Local Environmental Plan 1996

The portion of LCO within the Singleton LGA is classified under the Singleton LEP as 1(a) Rural Zone. The objectives of zone 1(a) are:

- to protect and conserve agricultural land and to encourage continuing viable and sustainable agricultural land use;
- to promote the protection and preservation of natural ecological systems and processes;
- to allow mining where environmental impacts do not exceed acceptable limits and the land is satisfactorily rehabilitated after mining;
- to maintain the scenic amenity and landscape quality of the area;
- to provide for the proper and co-ordinated use of rivers and water catchment areas; and
- to promote provision of roads which are compatible with the nature and intensity of development and the character of the area.

It is noted that in December 2012, Singleton Council adopted the draft version of the Singleton LEP 2012. As the draft plan was unlikely to be finalised before 2013, the draft plan has been renamed to Singleton LEP 2013. Under the new draft Singleton LEP 2013 the portion of LCO within the Singleton LGA is classified as RU1 Primary Production. The objectives of zone 1(a) are outlined below.

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.

Muswellbrook Local Environmental Plan 2009

The portion of LCO within the Muswellbrook LGA subject to this modification is classified as RU1 Primary Production. The objectives of zone RU1 Primary Production are:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.
- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.
- To protect the agricultural potential of rural land not identified for alternative land use, and to minimise the cost to the community of providing, extending and maintaining public amenities and services.
- To maintain the rural landscape character of the land in the long term.
- To ensure that development for the purpose of extractive industries, underground mines (other than surface works associated with underground mines) or open cut mines (other than open cut mines from the surface of the flood plain), will not:
 - (a) destroy or impair the agricultural production potential of the land or, in the case of underground mining, unreasonably restrict or otherwise affect any other development on the surface;
 - (b) detrimentally affect in any way the quantity, flow and quality of water in either subterranean or surface water systems; or
 - (c) visually intrude into its surroundings, except by way of suitable screening.
- To protect or conserve (or both):
 - (a) soil stability by controlling development in accordance with land capability;
 - (b) trees and other vegetation;

-
- (c) water resources, water quality and wetland areas, and their catchments and buffer areas, and
 - (d) valuable deposits of minerals and extractive materials by restricting development that would compromise the efficient extraction of those deposits.

Incorporation of Intent of LEPs into LCO's Rehabilitation Design

In consideration of the LEPs, provision has been included within the rehabilitation strategy to maintain the rural landscape by establishing native vegetation corridors to promote regional fauna movements across the greater Ravensworth area and to re-establish land for sustainable agricultural purposes. As shown in **Figure 2.1**, this includes the establishment of areas in the flatter portion of mine rehabilitation areas for potential future grazing. However, the ultimate extent and location of these areas will be subject to further detailed closure planning prior to the cessation of mining. Some of the key considerations for the development of these areas will be the suitability of soil, proximity to roads, avoidance of steep areas and access to water resources for stock.

The agricultural value of the non-mined alluvial areas along Bowman's Creek has also been recognised, where parts of which will be maintained for future agricultural use. However, the strategy also allows for the creation of suitable regional corridor habitat in this area for a range of fauna species including the spotted-tailed quoll (*Dasyurus maculatus maculatus*).

2.2.2 Muswellbrook Shire Council (MSC) Land Use Development Strategy 2010 (Coal Mine Land Use Strategy)

MSC is developing a Land Use Development Strategy (LUDS) as part of identifying the long term direction for land use and development in the Shire. This document includes a Coal Mining LUD, which sets strategic objectives for coal mining activities with particular emphasis on the rehabilitation of land. In particular that the use of land for coal mining purposes should not fetter the future use of land for more sustainable purposes and that mine land is rehabilitated to a satisfactory standard for future use.

It is considered that the rehabilitation strategy developed for LCO is consistent with the strategic directions set out in the MSC LUDS, particularly as it focuses on the establishment of native habitat and corridor areas whilst also allowing for the potential use of land for sustainable agricultural practices. The rehabilitation methodologies as described in the document have been developed based on best practice techniques that consider a range of aspects that affect the quality of revegetation such as geomorphology, soil ameliorants, vegetation community establishment and runoff controls.

The MSC LUDS will be considered as part of the ongoing review and refinement of the LCO Mine Closure Plan to provide that the final land use represents the most sustainable use of the land.

2.2.3 DRE Synoptic Plan (Andrews Neil 1999)

The DRE Synoptic Plan aims to provide a basis for the development of a long term integrated strategy for rehabilitation of mines. The rehabilitation strategy for the Project has been developed to meet the intent of the Synoptic Plan and considers the potential regional outcomes for visual amenity, biodiversity and sustainable post closure use. The final landform aims to provide habitat corridors. This is generally consistent with the intent of the broader regional corridor system outlined within the Synoptic Plan.

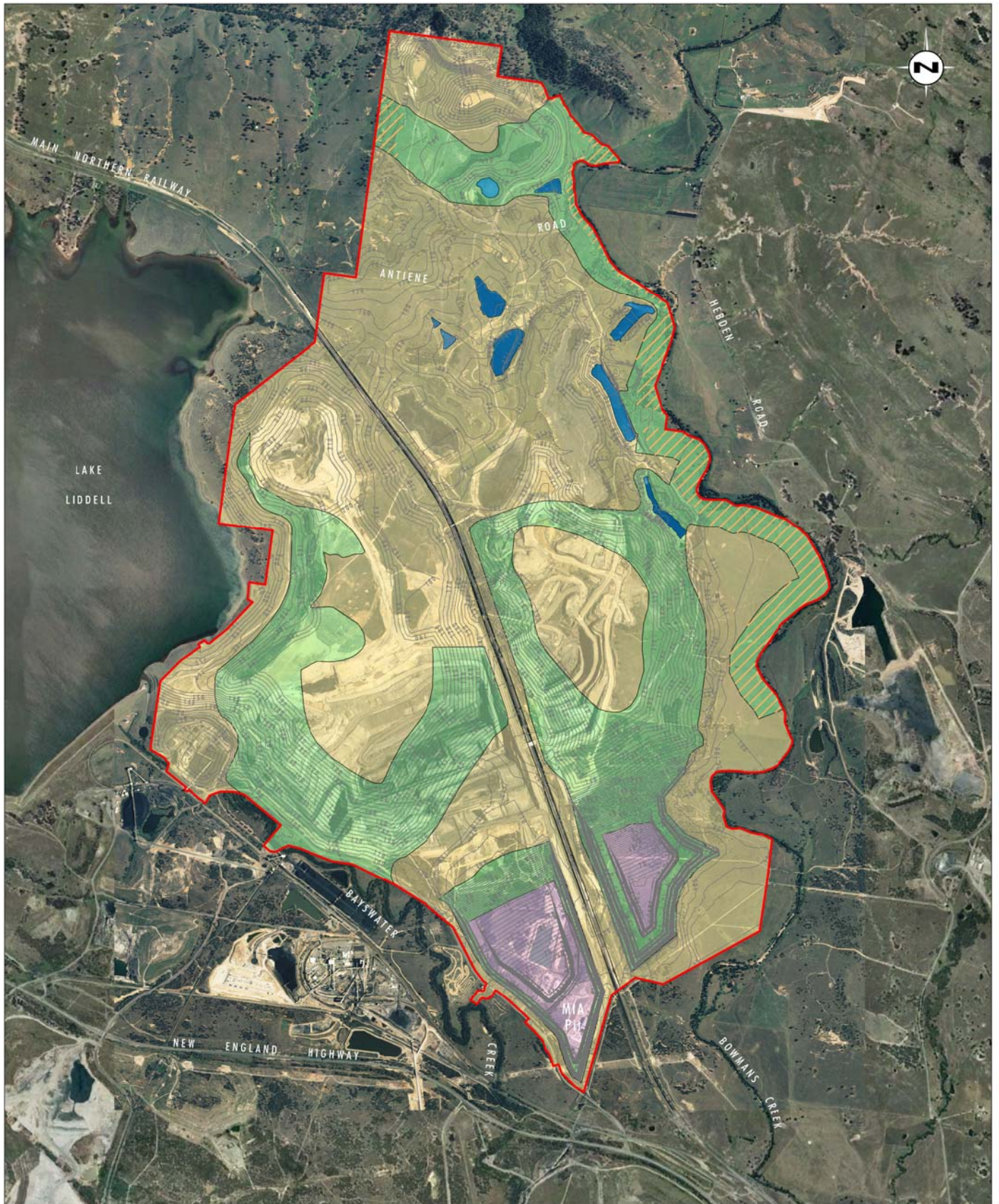


Image Source: Xstrata (2013), Google Earth (2008)
Data Source: Xstrata (2012), ELA (2012)
Note: Contour Interval 5m

0 0.5 1.0 2km
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Legend

- Liddell Colliery Approved DA Boundary
- Native Woodland
- Grassland for Stabilisation
- Open Grassland (potential grazing areas) with Pockets of Native Vegetation
- Dams
- Contour
- Corridor Habitat Enhancement on Non-Mined land

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FIGURE 2.1

Liddell Colliery
Proposed Post Mining
Land Use Design

2.2.4 Upper Hunter Strategic Regional Land Use Plan (DP&I 2012)

The Strategic Regional Land Use Plan for the Upper Hunter has been developed to provide a strategic framework for delivering the necessary context for government investment priorities, servicing strategies and local environmental plan making for the Upper Hunter. Amongst the various land use types, the Strategy outlines the importance of the protection of biodiversity through strategic land use planning. It recognises that post mining rehabilitation has the potential to contribute to biodiversity conservation in the longer term, but will require effective design and planning to maximise its landscape in the future.

The Strategic Regional Land Use Plan has provided a regional conservation assessment and has identified and mapped areas of high (Tier 1) and moderate (Tier 2) terrestrial and aquatic values. Several pockets of Tier 2 Terrestrial Biodiversity areas have been identified within the Ravensworth area. It is considered that the proposed final land use within LCO will be consistent with these values, with vegetation corridors designed to facilitate linkages with the biodiversity values of the broader area.

2.3 Indicative Post Mining Land Use

The indicative post mining land use for the Project Area will primarily involve the establishment of areas of grassland. The rehabilitation strategy also involves the establishment of native vegetation corridors to promote regional fauna movements, including for the spotted-tailed quoll, between Ravensworth Operations, Mt Owen Complex, Lake Liddell and the Ravensworth Operations Hillcrest Offset Area. A large proportion of the site, including the tops of overburden dump areas and capped tailings dams will be revegetated with open grassland with pockets of native vegetation. Depending on outcomes of final land use analysis to be completed as part of detailed closure planning process five years from closure, it is the intent that these areas could be used for sustainable agricultural purposes such as grazing. As such, revegetation may involve the use of both native and suitable pasture species for the establishment of grasslands in these areas. In this instance, pockets of native vegetation may be established as shelter belts to support grazing activities. The proposed rehabilitation strategy is shown in **Figure 2.1**.

However, in recognition of the proposed 15 year operational life of the Project, the potential for other sustainable and economically productive post-closure land uses will be investigated in light of the local and regional land uses strategies that may have further evolved towards the end of the mine life. This process will be undertaken as part of the detailed mine closure process and in consultation with relevant stakeholders.

Rehabilitation activities will be undertaken progressively throughout the life of mine to allow maximum opportunities for the development of vegetation prior to mine closure. However, alternative post-mining land use options (in addition to sustainable agriculture and native woodland) may still be investigated as part of the detailed mine closure plan. These options may include, potential industrial uses, particularly in consideration of the availability of the rail line as well as the suitability of infrastructure associated with the workshop, office complex and other surface facilities including lay down storage areas, stockpiles and water management structures.

2.4 Rehabilitation Objectives

The proposed rehabilitation strategy for the Project, as discussed in this document and displayed in **Figure 2.1**, has been developed in consideration of a number of factors including site opportunities and constraints, ecological and rural land use values and existing strategic land use objectives. In particular, the strategy considers the integration of rehabilitation at LCO with the strategies developed for surrounding operations within the Greater Ravensworth Area.

The overall objectives of the proposed post-mining land use design at LCO include:

- to provide opportunities for future agricultural activities such as sustainable grazing;
- to contribute to effective native corridors through the area which promote fauna movements between Ravensworth Operations, Mt Owen Complex, Lake Liddell and the Ravensworth Operations Hillcrest Offset Area;
- to maintain and provide additional suitable habitat for the spotted-tailed quoll, particularly along Bowmans Creek, and to increase landscape linkages to facilitate the movement of this species along Bowmans Creek to the offset areas to the north;
- to improve the visual amenity of the area; and
- not to preclude other potential post mining land use options should they be determined to be viable and preferable as part of the detailed mine closure planning process that commences at least five years prior to the planned cessation of mining.

Considering the above and the Ecological Assessment for the Project (Umwelt 2013), the key assumptions that relate to the proposed post-mining land use and rehabilitation strategy for the modification area and broader LCO holdings are outlined in the list below.

- Habitat enhancement works will be undertaken for the spotted-tailed quoll along Bowmans Creek (being approximately 200 metres wide along the majority of its length), which is outside of the disturbance area from LCO's mining operations. This will include a mixture of tree plantings and habitat structures such as log piles (such as that containing the known den site) constructed adjacent to the creekline on non-mine disturbed land. It will be the intention to link this area with native vegetation corridors established on rehabilitated mine land to facilitate movement of the spotted-tailed quoll (*Dasyurus maculatus maculatus*) and other fauna species to other remnant native vegetation area in the region such as the Hillcrest Offset Area managed by Glencore's Ravensworth Operations. Management actions within this Offset Area are currently defined within the Draft Offset Area Management Programme, and (to date) have included baseline ecological monitoring, detailed planning of required revegetation and vegetation reconstruction works and pest and weed control works.
- Native woodland areas to be established across the slopes of overburden spoils and higher portions of the lowwalls associated with the final voids as the steepness of these areas and the nature of the substrate is likely to provide limited potential for sustainable grazing. The location of these woodland areas have been designed to promote fauna movement through Liddell for linkages to Ravensworth Operations, Mt Owen Complex (including Ravensworth State Forest and its associated biodiversity offset areas), Lake Liddell and the Ravensworth Operations Hillcrest Offset Area.
- Planting/seeding of native vegetation (canopy, mid-canopy and groundcover) on the highwall benches to improve long term visual amenity of void.

-
- The lower portions of the lowwalls will be established initially with exotic grassland species with the objective to stabilise these areas until they are submerged by surface and groundwater that are predicted to accumulate in the final voids.
 - The proportion of native vegetation at Mountain Block has been increased, particularly as steep slopes in this area provides significant limitations to sustainable grazing. The establishment of native vegetation in this area will provide a valuable linkage to the Ravensworth Operations Hillcrest Offset Area and Bowmans Creek.

Flatter areas on site, including the tops of overburden areas and tailings dams to be established to open grassland with pockets of native vegetation. Depending on outcomes of final land use analysis to be completed as part of detailed closure planning process five years from closure, there is the potential that these flatter areas could be used for sustainable agricultural purposes such as grazing.

Further detail in regards to the rehabilitation criteria and specific revegetation methodology related to the establishment of these areas as outlined above are included in **Sections 2.5** and **3.6** respectively.

2.5 Rehabilitation Completion Criteria

Completion criteria are objective target levels or values assigned to a variety of indicators (i.e. slope, species diversity, groundcover etc.), which can be measured against to demonstrate progress and ultimate success of rehabilitation. As such, they provide a defined end point, at which point in time rehabilitation can be deemed successful and the lease relinquishment process can proceed.

The preliminary rehabilitation completion criteria for the Project are outlined in **Table 2.1**. The criteria have been developed considering site specific issues and objectives, Glencore Coal's standards and the outcomes of the 2005 ACARP study entitled 'Development of Rehabilitation Completion Criteria for Native Ecosystem Establishment on the Coal Mines in the Hunter Valley'.

These completion criteria, which may be subject to refinement as the Project progresses, including through consultation with the relevant stakeholders, will be utilised to demonstrate achievement of rehabilitation objectives. The achievement (or otherwise) of the completion criteria will be monitored and reported within the annual reports to be submitted to relevant government agencies.

Table 2.1 – Preliminary Project Rehabilitation Completion Criteria

Aspect	Objective	Preliminary Closure Criteria
Decommissioning	<ul style="list-style-type: none"> All infrastructure removed, unless otherwise agreed with relevant stakeholders, and the site left in a safe, non-polluting and stable state. 	<ul style="list-style-type: none"> All mine-related infrastructure such as buildings, water management infrastructure, road, powerlines, boreholes and other infrastructure have been removed unless agreed with relevant stakeholders for their retention. All sites have been assessed by a suitably qualified expert as not containing contaminants above the relevant criteria for the proposed final land use.
Landform Establishment	<ul style="list-style-type: none"> Landform suitable for final land use and compatible with surrounding landscape as sustainable native ecosystem. 	<ul style="list-style-type: none"> Rehabilitated slopes are generally 10 degrees except low walls where slopes are less than 18 degrees. Landform/slope is commensurate with the post mining land capability committed to for each domain. No significant erosion is present that would constitute a safety hazard or compromise the capability of supporting the end land use. Drainage structures are stable and there is no evidence of overtopping or significant scouring as a result of runoff. Surface layer is free of any hazardous materials. Any final void and associated highwall has been assessed by a qualified geotechnical engineer to validate that it is stable and does not pose a safety risk. Tailings and reject emplacement areas will be capped and reshaped and be free draining. Runoff water quality from rehabilitation areas is within the range of water quality data recorded from analogue sites and does not pose a threat to downstream water quality.
Growing Media Development	<ul style="list-style-type: none"> Growing media is capable of supporting sustainable vegetation growth. 	<ul style="list-style-type: none"> The rehabilitation surface is a suitable growing medium. Soil pH to be in the range of analogue sites. Monitoring demonstrates soil profile development in rehabilitated areas (e.g. development of organic layer, litter layer). Growth media properties are commensurate with the post- mining land capability committed to for each domain,

Table 2.1 – Preliminary Project Rehabilitation Completion Criteria (cont.)

Aspect	Objective	Preliminary Closure Criteria
Ecosystem Establishment (native woodland)	<ul style="list-style-type: none"> Revegetation is sustainable for the long term and only requires maintenance that is consistent with the intended final land use. 	<ul style="list-style-type: none"> Revegetation areas contain flora species assemblages characteristic of the desired native vegetation communities. Native woodland areas comprise of a canopy cover in the range of 10 per cent to 30 per cent. Second generation trees are present or likely to be, based on monitoring in comparable older rehabilitation sites (i.e. evidence of fruiting of native species observed). More than 75 per cent of trees are healthy and growing as indicated by long term monitoring. There is no substantial weed infestation such that management requirements are similar to reference native vegetation sites. Appropriate bushfire hazard controls have been implemented on the advice from the NSW Rural Fire Service.
Ecosystem Development (native woodland corridors)	<ul style="list-style-type: none"> Woodland corridors will provide habitat value in the future. 	<ul style="list-style-type: none"> Rehabilitated areas provide a range of vegetation structural habitats (e.g. eucalypts, shrubs, ground cover, developing litter layer, etc.) to encourage use by native fauna species.
Corridor Habitat Enhancement	<ul style="list-style-type: none"> Woodland and riparian corridors provide habitat that is suitable for foraging and denning by the spotted-tailed quoll. 	<ul style="list-style-type: none"> Rehabilitated areas provide a range of contiguous structural habitats (e.g. native trees, shrubs, ground cover, developing litter layer, native grassland etc.) suitable for foraging, and habitat (e.g. log piles, boulder piles etc) suitable for denning by the spotted-tailed quoll.
Open grassland and sustainable agricultural use areas (i.e. grazing)	<ul style="list-style-type: none"> Revegetation is sustainable for the long term and only requires maintenance that is consistent with the intended final land use. 	<ul style="list-style-type: none"> In areas returned to broad-acre grazing, grazing returns are sustainable and pastures have similar yields to nearby properties. Pasture species to consist of grasses and legumes appropriate to the district and recognised as suitable for grazing. Weed and feral animal populations are appropriately managed. Pockets of native vegetation contain flora species assemblages characteristic of the desired native vegetation communities. More than 75 per cent of trees are healthy and growing as indicated by long term monitoring.

The preliminary rehabilitation completion criteria will be reviewed and revised throughout the Project life through consideration of the results of rehabilitation monitoring programs; any relevant research trials; and consideration of stakeholder feedback. It is envisaged that this process will occur as part of the development of the Mining Operations Plan (MOP) and subsequent annual report that are submitted to relevant government agencies and made available to the community. The completion criteria will be finalised as part of the detailed mine closure planning process and presented in the Final Closure Plan for approval by the relevant government agencies.

The gradual achievement (or otherwise) of these completion criteria will be assessed and discussed in the annual report, which will include the identification of any failures of the criteria, and measures taken to address any such issues. Proposed rehabilitation monitoring is discussed in **Section 4.0**.

3.0 Rehabilitation Implementation Strategy

Rehabilitation will be undertaken in accordance with a MOP that will be prepared for the Project and submitted to DRE for approval. The MOP will detail performance measures and criteria for specific rehabilitation areas, to be used as benchmarks against which performance of the rehabilitation strategy can be measured. The monitoring of rehabilitation performance will be reported in an annual report.

Disturbed areas will be progressively rehabilitated over the life of the Project. Whilst it is intended to maximise opportunities for progressive rehabilitation and reduce the disturbance footprint, potential deviations from the indicative schedule may occur due to:

- changes or delays in the mining schedule; and
- postponement of rehabilitation activities to avoid seeding and planting in conditions which may lead to poor quality rehabilitation or failure.

Where rehabilitation is delayed due to the above scenarios, overburden areas will be shaped to final landform as close as reasonably practicable behind the active mining operation and suitable cover crops applied on exposed areas to minimise dust and erosion.

Temporary revegetation will also be undertaken on unshaped overburden dumps and other disturbed areas that are planned to be inactive for one to two years. Temporary revegetation of these areas will improve both visual amenity and the control of dust emissions.

3.1 Tailings Dam Decommissioning

The tailings emplacement areas on site will be filled and shaped to the conceptual final landform plan and subsequently capped. The primary objective of the capping design will be to minimise the potential for exposure of potentially environmentally sensitive tailings material in the rehabilitated landform and prevent the occurrence of spontaneous combustion. Following capping, these areas will be revegetated in accordance with the rehabilitation strategy as displayed in **Figure 2.1**.

To promote the geotechnical stability of capped tailings emplacement areas and avoid the potential sterilisation of land in the post-mining landform, dewatering strategies will be incorporated into the design of the tailings dams. The aim of the strategy will be to progressively dewater the tailings dams and promote the consolidation of material throughout the tailings profile. Water extracted from the process will be re-utilised for on-site purposes such as the processing of coal or for dust suppression.

3.2 Coarse Reject

Coarse reject material will be co-disposed with overburden material and incorporated into the final landform. The coarse reject material will be placed at a suitable depth within the final landform to minimise any potential interference to rehabilitation establishment as well as minimise the potential for spontaneous combustion or ignition of carbonaceous material in the event of bushfire occurring within the revegetated landscape.

3.3 Topsoil Management

LCO has a topsoil stockpile handling strategy to maintain the quality of topsoil for subsequent use in rehabilitation. This strategy will be implemented for the Project. Materials management and monitoring techniques to be adopted this strategy include:

- material characterisation of topsoil and subsoil will be undertaken at an appropriate scale across the site, prior to pre-stripping activities or the re-handling of topsoil that has been stored on site for a period of two years or more. Representative samples will be taken to characterise the nature of the soil material (e.g. sodicity, acid-generating potential, etc.) to determine the potential limitations to rehabilitation and sustainable plant growth. The results will be used to determine specific ameliorant techniques that may be applied to the soil material in order to overcome potential limitations and enhance vegetation establishment;
- topsoil and subsoil stripping activities are to be restricted during adverse weather conditions to minimise the potential for dust generation;
- when stripping topsoil and subsoil a water cart is available to minimise dust emissions during stripping activities;
- topsoil and subsoil will be stripped using appropriate equipment (e.g. dozer or scraper) to the appropriate depths identified in the LCO Modification 5 Soil and Land Resource Assessment (GSSE 2013) or in accordance with the outcomes of further investigations undertaken as required;
- topsoil and subsoil layers will be assessed and managed so that they can be appropriately re-applied in areas to be rehabilitated;
- wherever practicable, topsoil is to be transferred directly from stripping location to areas that have been reshaped for rehabilitation, eliminating the need for storage and re-handling;
- topsoil stockpiles are to be located away from traffic areas and at an appropriate distance from watercourses;
- appropriate sediment controls will be installed around topsoil stockpiles;
- stockpiles will be generally less than 3 metres high to retain biological activity within the topsoil;
- stockpiles to be kept longer than six months will be sown with a suitable cover crop to minimise soil erosion and invasion of weed species;
- where required, machinery used to handle and transport topsoil shall be washed down prior to and at the completion of works to minimise the transfer of weeds;

-
- weed growth will be monitored and subsequently controlled if necessary;
 - prior to re-spreading, any weed growth will be scalped from the top of the stockpiles to minimise the transport of weeds into rehabilitated areas; and
 - stockpiles will be appropriately identified to minimise the potential for inadvertent use or disturbance.

3.4 Substrate Preparation

Surface preparation activities for rehabilitated areas will commence as soon as practicable following the completion of mining activities. The general surface preparation activities to be undertaken at LCO include:

- prior to the commencement of rehabilitation of the shaped overburden surface, representative samples will be taken to characterise the nature of the spoil material (e.g. sodicity, acid-generating potential, etc.) to determine the potential limitations to rehabilitation and sustainable plant growth. Results from this process will be used to determine specific amelioration techniques (e.g. addition of gypsum, lime, organic matter etc.) that may be required for spoil to overcome potential limitations for landform stability, plant establishment and growth;
- soil ameliorants will be applied where appropriate;
- in areas to be returned for future agricultural use, measures such as additional soil amelioration works or further application of topsoil (or suitable alternative) may be required to provide that rehabilitated land is capable of supporting sustainable agricultural use post mining;
- where direct tree seeding is planned, final shaped surfaces will be deep ripped parallel with the contour prior to the application of seed to provide for an adequate seed bed;
- where grassland (i.e. pasture) seeding is planned the surface will be harrowed/tilled across the contour to provide for an adequate seed bed;
- suitable erosion control measures will be implemented to minimise soil loss from areas undergoing rehabilitation;
- where appropriate and practical, structures such as tree hollows, logs and other woody debris will be incorporated into the final landform to augment the habitat value of the proposed vegetated corridors; and
- the installation of appropriate habitat structures (e.g. ponds) will be undertaken where practical.

3.5 Revegetation

Rehabilitation of post-mining areas will be completed as soon as practicable after shaped areas become available. As discussed in **Section 1.1.2** the rehabilitation strategy will primarily involve the establishment of areas of grassland for potential future agricultural activities such as grazing. In addition, native vegetation corridors will be established to promote regional fauna movements between Ravensworth Operations, Mt Owen Complex, Lake Liddell and the Ravensworth Operations Hillcrest Offset Area (refer to **Figure 2.1**).

In addition to the rehabilitation of post-mining areas, restoration of a native vegetation corridor on a mixture of previously-mined and non-mined disturbed land along Bowmans Creek and in the northwest portion of the site will be designed to augment habitat for the spotted-tailed quoll (refer to **Section 3.5.3**).

Revegetation techniques will be continually developed and refined over the life of the Project through a continual process of research, trialling, monitoring and improvement. An outline of the proposed revegetation techniques for the establishment of both native woodland establishment and agricultural areas are discussed below.

3.5.1 Native Woodland Establishment

Rehabilitated woodland areas will be created to contain flora species assemblages characteristic of the dominant vegetation communities impacted by the Project. Revegetation of the post-mining landscape, including native woodland areas will focus on establishing vegetation that is predominantly consistent with the Central Hunter Box – Ironbark Woodland vegetation community.

To a lesser extent, revegetation activities should also target the establishment of vegetation that is predominantly consistent with the following vegetation communities adjacent to Bowmans Creek:

- Central Hunter Box – Ironbark Woodland (Rough-barked Apple dominated); and
- Hunter Valley River Oak Forest.

In regards to rehabilitation of areas adjacent to Bayswater Creek, revegetation activities should target the establishment of vegetation that is predominantly consistent with the Central Hunter Swamp Oak Forest vegetation community.

A list of the key species to be utilised in the revegetation mix for target vegetation communities is contained in **Appendix 1**. Due to seasonal variability, it is not realistic for the direct seeding mix or tube stock composition to include all of the species, however, the species composition for revegetation should be selected from the species listed. A seed collection and handling program aimed at maximising the viability and diversity of local seed in the revegetation mix will be implemented as part of the rehabilitation program. As a priority, revegetation will involve the use of local provenance seed that will either be utilised for direct seeding or for the propagation of tubestock for planting. However, where adverse seasonal conditions (i.e. drought) or other factors may affect the availability of local provenance seed, supplementation with non-local provenance seed may be required.

Revegetation will primarily involve direct seeding of native species along with a suitable cover crop or other organic material (e.g. mulch, brush matting or OGM (organic growth medium) etc.) as required to prevent soil loss and add biomass to the profile. A range of other techniques including the planting of tubestock may also be utilised where appropriate over isolated areas associated with steep slopes.

3.5.2 Establishment of Sustainable Agricultural Areas

Areas that may be established as open grassland or for potential viable and sustainable agricultural use have been identified in the flatter portions of the proposed final landform as shown in **Figure 2.1**. Revegetation may involve the use of both native and suitable exotic pasture species for the establishment of grasslands in these areas with pockets of native vegetation, which may ultimately be utilised as shelter for livestock.

In regards to the establishment of grazing areas, revegetation techniques will be consistent with local agricultural practices and are likely to involve sowing with grasses and legumes appropriate to the district and recognised as suitable for grazing. A similar mix may also be used in areas such as steeper slopes to prevent scouring and subsequent soil loss.

3.5.3 Corridor Habitat Enhancement

In regards to restoration of the corridor area adjacent to Bowmans Creek, revegetation activities should target the establishment of a riparian strip that is predominantly consistent with the Hunter Valley River Oak Forest vegetation community. Outside of the riparian strip, the remainder of this corridor should focus on restoration of the Central Hunter Box – Ironbark Woodland (Rough-barked Apple dominated), to complete the corridor. In relation to the non-mined land situated on the northwest portion of the site, restoration of native woodland areas should focus on establishing vegetation that is predominantly consistent with the Central Hunter Box – Ironbark Woodland vegetation community.

These native vegetation communities are all likely to provide suitable habitat for the spotted-tailed quoll. Measures such as the establishment of log piles/boulder piles for potential denning habitat will also be undertaken to further enhance the habitat for this species. It is noted that the known breeding den located along Bowmans Creek is within one such constructed timber pile.

Prior to the commencement of restoration activities in these areas, mapping of baseline ecological condition will be undertaken in order to confirm the scope of ecological management works required. The details of the scope of works will be developed in consideration of the following principles:

- all planting or seeding within revegetation areas will be designed with structural and floristic diversity suitable to meet the benchmark vegetation community targets;
- where practicable, revegetation will involve the use of local provenance seed that will either be utilised for direct seeding or for the propagation of tubestock for planting;
- revegetation areas will be subject to a formal care and maintenance program that will be developed to include the control of weeds, replacement of failed plantings, bushfire protection etc.;
- education of LCO workforce to raise levels of awareness regarding the spotted-tailed quoll; and
- revegetation areas will be subject to formal monitoring program (success/failure, as well as floristic monitoring) that will be developed to include a feedback loop to achieve continual improvement in the methodology and results.

4.0 Proposed Rehabilitation Monitoring

Rehabilitation performance will be monitored to ensure that target vegetation is establishing and to determine the need for any maintenance and/or contingency measures. Rehabilitation/regeneration will be monitored in existing remnant vegetation, agricultural land and temporary rehabilitated areas. The objectives of the program will be to:

- assess the long term stability and functioning of re-established ecosystems and or agricultural areas on mine affected land;
- assess rehabilitation performance against the closure criteria; and
- facilitate continuous improvement in rehabilitation practices.

LCO will record the details of each rehabilitation campaign so that they are available for later interpretation of rehabilitation monitoring results with the aim of continually improving rehabilitation standards on site. The key monitoring parameters to be recorded include the following:

- landform design details;
- drainage design details;
- substrate characterisation;
- site preparation techniques (e.g. topsoil and source, time of sowing, soil ameliorants used etc.);
- revegetation methodologies (e.g. rate and type of fertiliser, cover crop and rate, seed viability including watering and weed management);
- weather conditions;
- photographic records; and
- initial follow-up care and maintenance works (including watering and weed management).

The monitoring program will be continued within rehabilitated as well as non-mined areas until it can be demonstrated that rehabilitation has satisfied the closure criteria. Information from this monitoring program will also be used to refine closure criteria as required.

As part of future ecological monitoring programs, LCO will ensure appropriate monitoring of rehabilitated landscapes, including specific denning habitat features, to ascertain if the area is being used by the spotted-tailed quoll. Monitoring is likely to take the form of both remote (e.g. infra-red cameras) and direct (e.g. spotlighting, trapping) techniques.

4.1 Revegetation Care and Maintenance

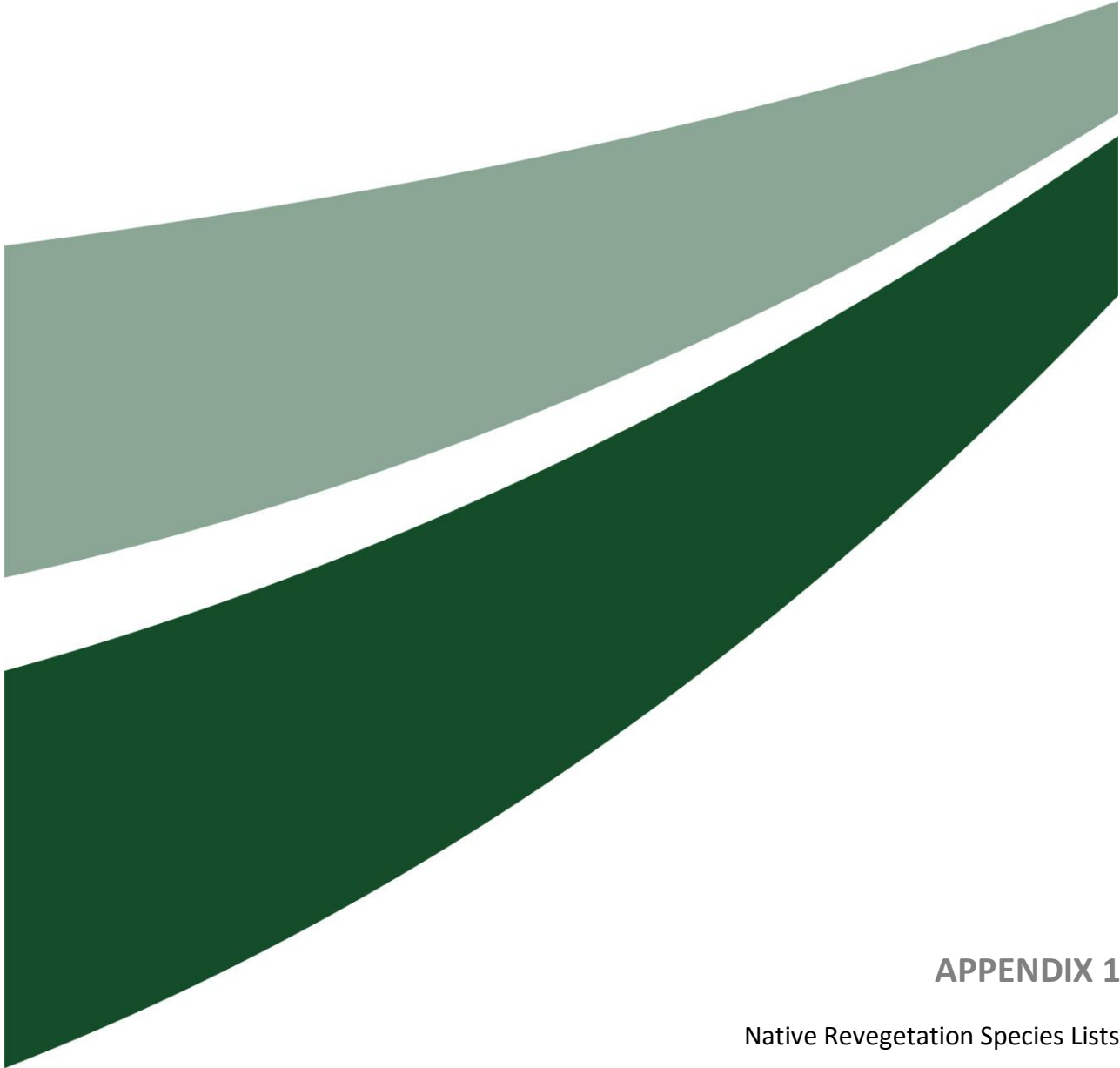
Based on the outcomes of the rehabilitation monitoring program as outlined above, a care and maintenance program will be implemented until rehabilitation is shown to meet the acceptable completion criteria. The scope of the care and maintenance program may include weed and feral animal control, fertilising, re-seeding or planting (where required) and erosion and sediment control works. It is envisaged that this program will be continued as required until it can be demonstrated that the rehabilitation of the Project area has satisfied the closure criteria.

4.2 Proposed Rehabilitation Sign-Off Process

Based on the outcomes of the rehabilitation monitoring programs and in consultation with the relevant government agencies, it is LCO's intention to seek progressive sign-off of rehabilitation areas once the agreed closure and rehabilitation criteria have been satisfied. The aim will be to achieve consensus on the quality of rehabilitation required as a benchmark for future rehabilitation activities.

5.0 References

- ACARP 2005. *Development of Rehabilitation Completion Criteria for Native Ecosystem Establishment on the Coal Mines in the Hunter Valley.*
- Andrews, Neil 1999. *Synoptic Plan Integrated Landscapes for Coal Mine Rehabilitation in the Hunter Valley of NSW.*
- Department of Planning and Infrastructure 2012. *Strategic Regional Land Use Plan: Upper Hunter.*
- GSSE 2013. *Draft Liddell Coal Operations Extension Project Environmental Impact Statement.*
- Muswellbrook Shire Council 2009. *Local Environmental Plan.*
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- Singleton Council 1996. *Local Environmental Plan.*
- Singleton Council 2013. *Draft Local Environmental Plan.*
- Umwelt 2013. *Draft Liddell Coal Operations Pty Limited Ecological Assessment.*



APPENDIX 1

Native Revegetation Species Lists

Appendix 1 – Native Revegetation Species Lists

Scientific Name	Common Name	Plant Form
Central Hunter Box - Ironbark Woodland		
<i>Angophora floribunda</i>	rough-barked apple	tree
<i>Eucalyptus crebra</i>	narrow-leaved ironbark	tree
<i>Eucalyptus moluccana</i>	grey box	tree
<i>Allocasuarina leuhmannii</i>	bulloak	low tree
<i>Brachychiton populneus</i> subsp. <i>populneus</i>	kurrajong	low tree
<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	velvet mock olive	low tree
<i>Aristida ramosa</i>	purple wiregrass	grass
<i>Austrostipa scabra</i>	speargrass	grass
<i>Cymbopogon refractus</i>	barbed wire grass	grass
<i>Brunoniella australis</i>	blue trumpet	ground cover
<i>Calocephalus citreus</i>	lemond beauty-heads	ground cover
<i>Einadia nutans</i> subsp. <i>nutans</i>	climbing saltbush	ground cover
<i>Eremophila debilis</i>	winter apple	ground cover
<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	many-flowered mat-rush	ground cover
<i>Solanum cinereum</i>	Narrawa burr	ground cover
Central Hunter Box - Ironbark Woodland (Rough-barked Apple Dominated)		
<i>Angophora floribunda</i>	rough-barked apple	tree
<i>Eucalyptus crebra</i>	narrow-leaved ironbark	tree
<i>Eucalyptus moluccana</i>	grey box	tree
<i>Allocasuarina leuhmannii</i>	bulloak	low tree
<i>Brachychiton populneus</i> subsp. <i>populneus</i>	kurrajong	low tree
<i>Acacia decora</i>	western silver wattle	small shrub
<i>Austrostipa verticillata</i>	slender bamboo grass	grass
<i>Chloris ventricosa</i>	plump windmill grass	grass
<i>Rytidosperma tenuius</i>		grass
<i>Brunoniella australis</i>	blue trumpet	ground cover
<i>hardenbergia violacea</i>	purple coral pea	ground cover
<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	wattle mat-rush	ground cover
Central Hunter Box - Ironbark Derived Native Grassland		
<i>Angophora floribunda</i>	rough-barked apple	tree
<i>Eucalyptus crebra</i>	narrow-leaved ironbark	tree
<i>Eucalyptus moluccana</i>	grey box	tree
<i>Allocasuarina leuhmannii</i>	bulloak	low tree
<i>Brachychiton populneus</i> subsp. <i>populneus</i>	kurrajong	low tree
<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	velvet mock olive	low tree

Scientific Name	Common Name	Plant Form
Central Hunter Bulloak Forest		
<i>Eucalyptus crebra</i>	narrow-leaved ironbark	tree
<i>Cassinia aculeata</i>	dolly bush	small shrub
<i>Daviesia ulicifolia</i>	gorse bitter pea	small shrub
<i>Templetonia stenophylla</i>	leafy templetonia	small shrub
<i>Aristida ramosa</i>	purple wiregrass	grass
<i>Austrostipa verticillata</i>	slender bamboo grass	grass
<i>Bothriochloa decipiens</i>	red grass	grass
<i>Cymbopogon refractus</i>	barbed wire grass	grass
<i>Rytidosperma tenuius</i>		grass
<i>Calocephalus citreus</i>	lemond beauty-heads	ground cover
<i>Chrycocephalum apiculatum</i>	common everlasting	ground cover
<i>Enchylaena tomentosa</i>	ruby saltbush	ground cover
Central Hunter Swamp Oak Forest		
<i>Angophora floribunda</i>	rough-barked apple	tree
<i>Melaleuca styphelioides</i>	prickly-leaved tea tree	low tree
<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	velvet mock olive	low tree
<i>Cymbopogon refractus</i>	barbed wire grass	grass
<i>Austrostipa verticillata</i>	slender bamboo grass	grass
<i>Einadia nutans</i> subsp. <i>nutans</i>	climbing saltbush	ground cover
<i>Eremophila debilis</i>	winter apple	ground cover
Hunter Valley River Oak Forest		
<i>Eucalyptus tereticornis</i>	forest red gum	tree
<i>Angophora floribunda</i>	rough-barked apple	tree
<i>Cynodon dactylon</i>	common couch	grass
<i>Austrostipa verticillata</i>	slender bamboo grass	grass
<i>Phragmites australis</i>	common reed	reed
<i>Sporobolus creber</i>	slender rat's tail grass	grass
<i>Einadia hastata</i>	berry saltbush	ground cover



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