APPENDIX V

Appendix V - Conceptual Mine Closure Plan

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global environmental solutions

Tahmoor South Project

Conceptual Mine Closure Plan

Report Number 634.10066

November 2018

Tahmoor Coal Pty Ltd

Version: Final

Tahmoor South Project

Conceptual Mine Closure Plan

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Executive Summary

Tahmoor Coal Pty Ltd commissioned SLR Consulting Australia Pty Ltd to prepare a Conceptual Mine Closure Plan for the proposed Tahmoor South Project (the proposed development). This Conceptual Mine Closure Plan has been developed as an accompanying stand-alone report to form part of the Environmental Impact Statement for the proposed development.

The proposed development includes the extension of underground coal mining at Tahmoor Mine, to the south and east of the existing surface facilities area. The proposed development seeks to extend the life of underground mining at Tahmoor Mine until approximately 2035 and will enable mining to be undertaken within the southern portion of Tahmoor Coal's existing lease areas and for operations and employment of the current workforce to continue for approximately a further 13 years beyond the current life of mine.

In order to effectively address the various land uses at the Tahmoor South Project, the Project Area has been divided into six management 'domains'. The domains identified within this Plan are defined as:

- Domain1: Mining Infrastructure Area;
- Domain 2: Stockpiles;
- Domain 3: Rejects Emplacement Area;
- Domain 4: Mine Ventilation;
- Domain 5: Roads; and
- Domain 6: Other Lands.

As the proposed development is over 17 years from closure, a preliminary closure land use option analysis was undertaken. The preliminary options analysis identified a number of potential land use options for each of the Domains within the Project Area. A comprehensive analysis of closure land use options is proposed to be undertaken during detailed closure planning, which is typically undertaken no later than five years out from permanent closure of the site.

In view of this, this Plan has been prepared on the basis that at closure, all existing mine related infrastructure and associated aspects will be entirely removed and the affected land returned to as close to pre-mining land use as possible.

Conceptual rehabilitation success criteria have been developed to provide long-term performance goals for rehabilitation activities. As the proposed development is within the planning phase, the rehabilitation success criteria are considered conceptual. Final rehabilitation success criteria will be developed for the proposed development during the detailed closure planning.

An indicative closure timeline has also been developed for the proposed development. The key rehabilitation and decommissioning activities include closure planning, decommissioning and rehabilitation, maintenance and monitoring, relinquishment and post relinquishment activities.

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1 INTRODUCTION

1.1 Tahmoor South Project

1.1.1 Overview

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine between the townships of Tahmoor and Bargo, approximately 80 km south-west of Sydney in the Southern Coalfields of NSW (**Figure 1**). The Tahmoor Mine produces up to 3 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

Tahmoor Coal is seeking approval for the Tahmoor South Project (the proposed development), being the extension of underground coal mining at Tahmoor Mine to the south of the existing Tahmoor Mine surface facilities area. The proposed development seeks to extend the life of underground mining at Tahmoor Mine until approximately 2035. The proposal will enable mining to be undertaken within the southern portion of Tahmoor Coal's existing lease areas and for operations and employment of the current workforce to continue for approximately a further 13 years.

The Project Area is shown on **Figure 2** and comprises an area adjacent to, and to the south of, the Existing Tahmoor Approved Mining Area. It also overlaps a small area of the Existing Tahmoor Approved Mining Area comprising the surface facilities area, historical workings and other existing mine infrastructure. The Tahmoor South Project Area covers approximately 6,498 hectares, with a combined underground and surface disturbance area of 2,635 hectares, including a total of 43 hectares of surface disturbance for the REA expansion.

The proposed development will be accessed via the existing surface facilities at Tahmoor Mine and will extend mining within the Project Area, using longwall methods, with the continued use of ancillary infrastructure at the existing Tahmoor Mine surface facilities area.

1.1.2 Proposed Development

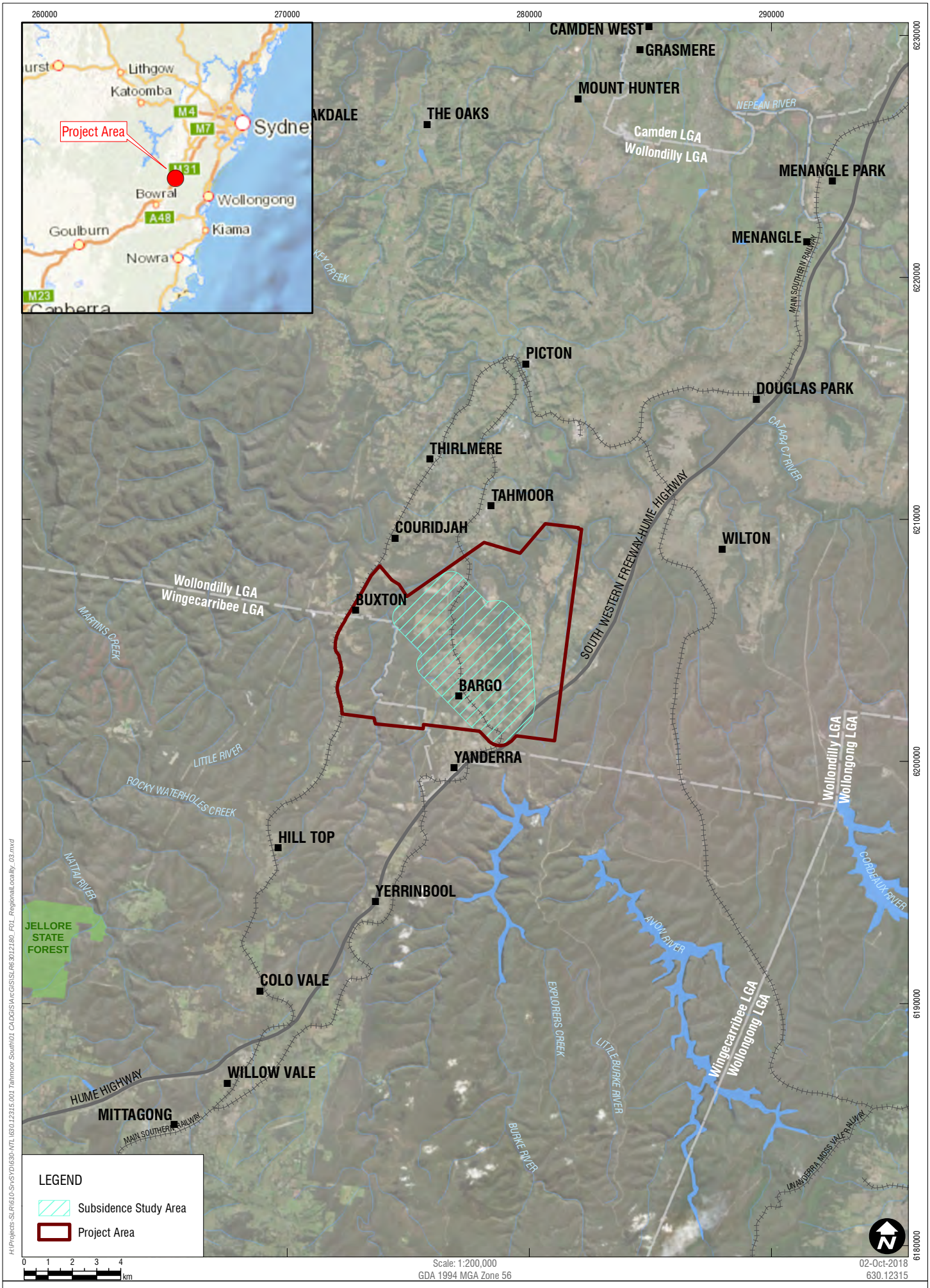
The proposed development will use longwall mining to extract coal from the Bulli seam within the bounds of CCL716 and CCL747. Coal extraction of up to 4 million tonnes of ROM coal per annum is proposed as part of the development, with extraction of up to 48 million tonnes of ROM coal over the life of the project. Once the coal has been extracted and brought to the surface, it will be processed at Tahmoor Mine's existing Coal Handling Preparation Plant (CHPP) and coal clearance facilities, and then transported via the existing rail loop, the Main Southern Railway and the Moss Vale to Unanderra Railway to Port Kembla and Newcastle (from time to time) for Australian and international markets.

The proposed development will utilise the existing surface infrastructure at the Tahmoor Mine surface facilities area. Some upgrades are proposed to facilitate the extension. The proposed development also incorporates the planning for rehabilitation and mine closure once mining ceases.

The key components of the proposed development comprise:

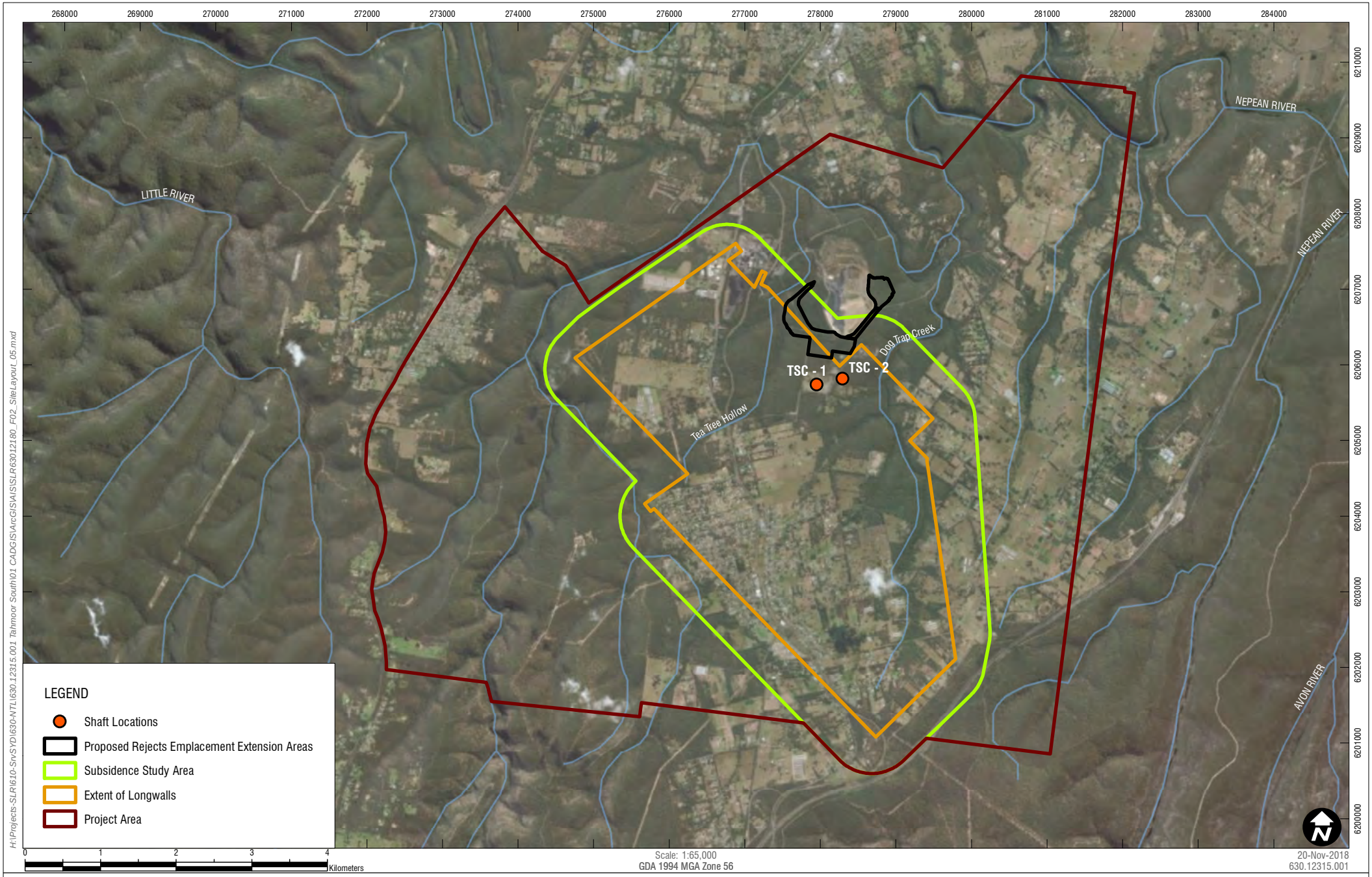
- First workings including pit bottom redevelopment, vent shaft construction, pre-gas drainage and service connections;
- Longwall mining in the Central Domain;
- Upgrades to the existing mine infrastructure area (MIA) including:
    - upgrades to the CHPP;

  - expansion of the existing Rejects Emplacement Area (REA);
  - additional mobile plant for coal handling;
  - additions to the existing bathhouses, stores and associated access ways; and
  - upgrades to off-site service infrastructure, including electrical supply.
- Rail transport of product coal to Port Kembla, and Newcastle (from time to time);
- Mine closure and rehabilitation; and
- Environmental management.



Regional Locality

FIGURE 1



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Site Layout

FIGURE 2

1.2 Purpose of the Report

1.2.1 Secretary's Environmental Assessment Requirements

In preparing this Conceptual Mine Closure Plan the relevant components of the Secretary's Environmental Assessment Requirements (SEARs) issued for the Tahmoor South Project (SSD 17_8445), on 9 June 2017 have been addressed as required by Clause 75F of the EP&A Act. The key matters raised by the Secretary for consideration in the Conceptual Mine Closure Plan, and where this report addresses the SEARs is outlined in **Table 1**.

Table 1 SEARs Applicable to the Conceptual Mine Closure Plan

Rehabilitation and Final Landform – Including:	
an assessment of the likely impacts of the development on existing landforms and topography, including justification of the final landform design of the rejects emplacement area expansion and its long term geotechnical stability;	Sections 10 and 11
a detailed description of the progressive rehabilitation measures that would be implemented for the development;	Sections 9, 10 and 11
a detailed description of the proposed rehabilitation and mine closure strategies for the project, having regard to Resources Regulator's (RR) requirements (see Attachment 2) and the key principles in Strategic Framework for Mine Closure, and the:	Sections 10 and 11
• rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;	Sections 4, 5, 9, 10, 11 and 12
• decommissioning and management of surface infrastructure;	Section 10.1
• nominated final land uses, having regard to any relevant strategic land use planning or resource management plans or policies; and	Section 7
• potential for integrating the rehabilitation strategy with offset strategies proposed for the development; and	Sections 6.6 and 10.6
the measures which would be put in place for the long-term protection and management of the site, any biodiversity offset areas following the cessation of mining, and	Section 11
measures to avoid the propagation of acid sulphate soils.	Section 11.5

1.3 Responsibilities

The key responsibilities with regard to the Conceptual Mine Closure Plan are outlined in **Table 2**.

Table 2 Key Responsibilities

Personnel	**Responsibility**
Operations Manager	Provide sufficient resources to facilitate development, implementation and periodic review of this closure plan.
Environment and Community Manager	Manage the review process to ensure this plan is reviewed as required and monitor the progress with the necessary actions.
Environment and Community Coordinator	Facilitate the continued development and on-going review of this plan, co-ordinate the resources required to complete the necessary actions, and to plan and execute the progressive rehabilitation program.

Personnel	Responsibility
Commercial Manager	Ensure there are adequate provisions available for mine closure by implementing and updating an accrual system over the life of mine.

1.4 Report Structure

This report is structured as follows:

Section 1.0 Introduction – outlines the proposed development and the purpose of the report.

Section 2.0 Regulatory Framework – describes the legislation and guidelines considered during the preparation of the Conceptual Mine Closure Plan.

Section 3.0 The General Environment – provides an overview of the environment prior to the proposed development commencing.

Section 4.0 Environmental Performance Objectives

Section 5.0 Risk Based Approach to Rehabilitation and Closure – outlines the risk-based approach to be adopted for closure.

Section 6.0 Assigning Rehabilitation and Closure Domains – describes the infrastructure within each of the six domains.

Section 7.0 Preliminary Land Use Option Analysis – provides a summary of potential post-mining land use options.

Section 8.0 Stakeholder Engagement – describes the proposed stakeholder engagement.

Section 9.0 Planning for Decommissioning – provides a summary of the proposed activities to be undertaken during planning for decommissioning.

Section 10.0 Decommissioning and Rehabilitation Works – provides an outline of the proposed decommissioning and rehabilitation works for each domain.

Section 11.0 Rehabilitation and Revegetation Strategy – outlines the proposed rehabilitation and revegetation works.

Section 12.0 Conceptual Rehabilitation Success Criteria – describes the proposed conceptual rehabilitation success criteria.

Section 13.0 Indicative Closure Timeline – provides an indicative timeframe for closure activities.

2 LEGISLATION AND REGULATORY REQUIREMENTS

2.1 Legislation

2.1.1 Mining Act 1992

The *Mining Act 1992* regulates environmental protection, rehabilitation and closure conditions included in all mining leases. Tahmoor Mine currently holds a number of mining leases and exploration licences issued under the *Mining Act 1992* over the Project Area. New mining leases will be required to support the proposed development; specifically to accommodate the expanded REA over Crown Land as well as additional surface mining leases for the proposed ventilation shafts. Lease conditions relevant to mine closure will be incorporated into the Conceptual Mine Closure Plan when a new lease is granted.

2.1.2 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal piece of legislation overseeing the assessment and determination of development proposals in NSW. Objectives of the EP&A Act include:

> *"(a) to encourage:*
>
> > *(i) the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment,*
> >
> > *(ii) the promotion and co-ordination of the orderly and economic use and development of land,*
> >
> > *(vi) the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats, and*
> >
> > *(vii) ecological sustainable development ..."*

This Plan has been prepared with consideration of the EP&A Act.

2.1.3 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes the State's environmental regulatory framework and includes licensing requirements for certain activities. The objectives of the POEO Act that relate to decommissioning and rehabilitation include protecting, restoring and enhancing the environment, to reduce risks to human health and prevent degradation of the environment. This Act has been considered in the preparation of this Plan.

2.2 Environmental Planning Instruments and Planning Policies

2.2.1 State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) aims to provide for the proper management and development of mineral, petroleum and extractive material resources for the social and economic welfare of NSW. The SEPP provides that development for the purpose of mining may be carried out with development consent. It also defines mining developments that are prohibited, exempt from the need for consent or can be undertaken provided they comply with pre-determined criteria/standards (complying development).

Development listed under the Mining SEPP as being exempt from the need for planning approval which specifically relates to the decommissioning process, includes the demolition of a building or structure. Such demolition needs to be carried out in accordance with *Australian Standard AS2601-2001, Demolition of Structures*. Furthermore, such development is only defined as exempt if the building or structure is not a heritage item, is not within a heritage conservation area and the demolition takes place on an approved mine site and is of minimal environmental impact.

2.2.2 Wollondilly Local Environmental Plan 2011

The objectives of the Wollondilly Local Environmental Plan 2011 include:

- *"provide management for the management of natural resources and the protection of the natural landscape character;*
- *to protect, enhance and conserve the build, landscape and Aboriginal cultural heritage;*
- *to protect water quality in land that is situated with water supply catchments;*
- *to encourage development that provides for the integrated transport and infrastructure system and adequate facilities and service provision for future growth;*
- *to recognise, manage and protect rural resource lands for sustainable agriculture and extractive industry practices; and*
- *to maintain the separation between towns and villages to retain their unique character and rural and natural settings".*

The main disturbance area, including the MIA and the REA are zoned RU2 Rural Landscape. Development for the purpose of mining (and related activities) is permissible with development consent under the provisions of the Wollondilly Local Environmental Plan within zone RU2 Rural Landscape.

As stated in **Section 1.1.2**, the disturbance as a result of the proposed development will comprise continuation of subsidence effects from underground mining, expansion of the REA, and augmentation of existing surface infrastructure. Within five years of mine closure the Wollondilly Local Environmental Plan, or equivalent, will be considered when assessing potential final land use options for the site post closure.

2.3 Other Policies and Guidelines

Strategic Framework for Mine Closure, Minerals Council of Australia (2000)

The Strategic Framework for Mine Closure has evolved as a cooperative development between the Australian and New Zealand Minerals and Energy Council (ANZMEC) and the Australian Minerals Industry (represented by the Minerals Council of Australia). It is designed to provide a broadly consistent framework for mine closure across various Australian jurisdictions.

The objective of the Strategic Framework for Mine Closure is to encourage the development of comprehensive closure plans that return all mine sites to viable, and whenever practicable, self-sustaining ecosystems, and to ensure these plans are adequately financed, implemented and monitored within all jurisdictions.

The Strategic Framework for Mine Closure is structured around a set of objectives and principles under six key areas:

- Stakeholder Engagement: to enable all stakeholders to have their interests considered during the mine closure process;
- Planning: to ensure the process of closure occurs in an orderly, cost effective and timely manner;
- Financial Provisioning: to ensure the cost of closure is adequately represented in company accounts and that the community is not left with a liability;
- Implementation: to ensure there is clear accountability, and adequate resources, for the implementation of the closure plan;
- Standards: to establish a set of indicators which will demonstrate the successful completion of the closure process; and
- Relinquishment: to reach a point where the company has met agreed completion criteria to the satisfaction of the responsible authority.

A Guide to Leading Practise Sustainable Development in Mining, Leading Practice Sustainable Development Program for the Mining Industry, Australian Government, 2011

This Guide consolidates a series of handbooks relevant to all stages of a mine's life, being exploration, feasibility, design, construction, operation, closure and rehabilitation. The aim of the guideline is to identify key issues affecting sustainable development in the mining industry and provide information and case studies to enable a more sustainable basis for its operation. This Conceptual Mine Closure Plan has been developed in accordance with a number of guides generated through the Leading Practice Sustainable Development Program for Mines. These include:

- Mine Closure and Completion;
- Mine Rehabilitation;
- Biodiversity Management;
- Tailings Management;
- Water Management;
- Community Engagement and Development; and
- Hazardous Materials Management.

Enduring Value the Australian Minerals Industry Framework for Sustainable Development, Minerals Council of Australia

In 2003 the ICMM adopted a set of sustainable development principals. The Australian minerals industry subsequently developed *Enduring Value – the Australian Industry Framework for Sustainable Development* to provide a practical and operational effect to the development principals. Enduring Value builds on the industry's commitment to continuous improvement in performance as outlined in the Australian Minerals Industry Code for Environmental Management (1996).

As a business unit of Coal Assets Australia, Glencore, a signatory to Enduring Value, Tahmoor Coal Pty Ltd is committed to adhering to these principals. A number of obligations specifically relating to 'Enduring Value' have been considered in the preparation of this mine closure plan.

The following objectives relating to mine closure within 'Enduring Value' (Principal 6) have specifically been considered:

- Consult relevant stakeholders and develop a closure plan that clearly defines the post-closure land use;
- Where appropriate, rehabilitated progressively over the life of the operations;
- Undertake and support research into land and water rehabilitation practices;
- Use appropriate technologies to reduce negative environmental impacts and improve site rehabilitation techniques;
- Manage and, where appropriate, rehabilitate historical disturbances to an appropriate standard;
- Plan operations to minimise costs and risks; comply with relevant laws, standards, and guidelines; maximise sustainable development opportunities; and deliver post-closure landforms that are safe and stable from physical, geochemical and ecological perspectives;
- Provide adequate resources to achieve social objectives of closure including and costs associated with community dislocation;
- Set aside funds externally held and not accessible for other purposes to implement the closure plan and to undertake closure monitoring and maintenance, taking risk into account; and
- Periodically review closure plans in light of changing regulatory requirements and community expectations.

NSW Department of Planning and Environment – Resources Regulator (RR) Guidelines

RR also has in place a series of environmental management guidelines that are either directly or indirectly relevant to rehabilitation and mine closure issues. These include:

- ESG3: Mining Operations Plan (MOP) Guideline - September 2013 (ESG3);
- EDG17: Applications for Subsidence Management Approvals – February 2015 (EDG17);
- Rehabilitation Cost Estimation Tool (Department of Planning & Environment 2017).
- ESG1 Rehabilitation Cost Estimate Guidelines (Department of Planning & Environment 2017).

3 THE GENERAL ENVIRONMENT

This section provides a description of the existing environment which sets the basis on which a number of potential post mining land uses have been considered as part of this Plan.

3.1 Existing Land Use

The existing land uses identified during the preparation of the *Agricultural Impact Assessment Tahmoor Mine, Tahmoor South Project* (SLR, 2018) included:

- Rural residential, including agriculture;
- Market gardens;
- Rail corridor;
- Native grazing; and
- Poultry farming.

3.2 Topography and Hydrology

Topography in the region ranges from gently undulating plateaus, ridges and low hills in the upland areas, to a rugged landscape of deeply dissected valleys and gorges within the Hawkesbury Sandstone.

Topography within the Project Area is generally undulating, with a fall from the south-west to the north-east. The major topographical features are the Bargo and Nepean River valleys. Surface levels within the Project Area vary from a low point of approximately 105 metres Australian Height Datum (AHD), in the base of the Nepean River valley, to a high point of approximately 375 metres AHD, at the southern end of the Project Area.

The proposed development is located in the Bargo River catchment. The Bargo River flows in a generally north-easterly direction to its confluence with the Nepean River, near the Pheasants Nest Weir. The Bargo River consists of a sequence of pools, glides and rock bars across sandstone bedrock, with occasional boulder fields and cobblestone riffles. The Bargo River drains a total catchment of approximately 13,000 hectares at its confluence with the Nepean River.

The Bargo River has ephemeral flow in its upper reaches, which are (to some degree) regulated by the Picton Weir, approximately 14 kilometres upstream of the Nepean River confluence. Downstream of the Tea Tree Hollow confluence flow of the Bargo River is perennial due to licenced discharges from the Tahmoor Mine pit top. The Bargo River flows into the Nepean River 9 kilometres downstream of the Tea Tree Creek confluence.

The Nepean River rises in the Great Dividing Range to the west of the Project Area. Flows in the upper reaches of the Nepean River are highly regulated by the Upper Nepean Water Supply Scheme, operated by the Sydney Catchment Authority, incorporating four major water supply dams on the Cataract, Cordeau, Avon and Nepean Rivers. The Nepean Dam is situated approximately 18 kilometres upstream of the Bargo River confluence.

The Nepean River has been extensively modified by the construction of a series of in-stream weirs which have created a series of pondages, with the nearest to the Project Area being the Malden Weir.

The central part of the Project Area is predominantly drained by Tea Tree Hollow and Dog Trap Creek which generally flow north and eastward toward the Bargo River. A small area on the south-west of the central part is drained by headwater tributaries of Hornes Creek which flows into the Bargo River at Picton Weir. Licenced discharges from the Tahmoor Mine pit top enter Tea Tree Hollow at LDP 1.

The eastern part of the Project Area is predominantly drained by Eliza Creek which flows northward to the Nepean River.

3.3 Geology and Soil Landscape

The Tahmoor South Project is located within the southern part of the Permo-Triassic Sydney Basin. The main coal bearing sequence is the Illawarra Coal Measure, which contains four workable seams. The proposed development will target to upper most seam, known as the Bulli Seam.

Overlying the Bulli Seam is the Hawkesbury Techtonic Stage which is comprised of three stratigraphic units, namely the Narrabeen Group, Hawkesbury Sandstone Group and the Wianamatta Group. The Narrabeen Group overlies the Bulli Seam and is comprised of interbedded sandstones and claystone units and is up to 310 metres thick. Above the Narrabeen Group is the Hawkesbury Sandstone Group is comprised of a series of bedded sandstones and is up to 185 metres thick. The Wianamatta Group overlies Hawkesbury Sandstone, and is comprised of shales and siltstones and is relatively thin.

The Nepean Fault is located within the Project Area, and the proposed mine plan has been developed with consideration of the fault location. The Nepean Fault is east of the Tahmoor North operations and runs in an approximate north-south direction.

As reported in the *Agricultural Impact Statement* (SLR, 2018) prepared for the proposed development, there are seven soil landscape units within the Project Area, including the Blacktown, Gymea, Hawkesbury, Lucas Heights, Luddenham, Volcanic and disturbed terrain soil landscape units. The Lucas Heights soil landscape unit is the most prevalent, comprising 69% of the Project Area. The majority of the Project Area for the *Agricultural Impact Statement* (SLR, 2018) is highly to severely constrained for cultivation (cropping) enterprises.

The Lucas Heights, Blacktown, Volcanic and Luddenham soil landscape units comprise 86% of the Project Area and have a low to moderate agricultural limitation rating. These soil landscapes represent the land most suitable for grazing.

Four major soil orders are present within the Project Area, namely, Kurosols, Tenosols, Rudosols and Dermosols. The Kurosols have moderately low inherent fertility and are the most prevalent soil type, making up approximately 56% of the Project Area.

3.4 Land and Soil Capability and Agricultural Suitability

An *Agricultural Impact Assessment* was undertaken for the Tahmoor South Project Area by SLR (2018). The aim of this assessment was to assess the potential impacts of the proposed development on agricultural resources and/or industries within and surrounding the Project Area. SLR (2018) found that within the Project Area there are three dominant Land and Soil Capability (LSC) classes present, namely LSC Classes 4, 6 and 7. These are summarised below:

- LSC Class 4 is rated as having moderate agricultural capability and has moderate to high limitations for high-impact land uses and comprises 4,615 hectares of the Project Area.

- LSC Class 6 land is rated as having low agricultural capability and has very high limitations for high-impact land uses and covers 1,000 hectares of the Project Area.
- LSC Class 7 land is rated as having very low agricultural capability and has severe limitations that restrict most land uses and covers 509 hectares of the Project Area.

In addition, 374 hectares of land within the Project Area is not classed for agricultural production, this comprises 271 hectares of Metropolitan Special Area restricted land, which is part of the catchment for Nepean and Avon Dams and 103 hectares of mine disturbed terrain.

Importantly, SLR (2018) concluded that the Project will have economic benefits to the region, whilst having negligible impact on the agricultural resources, enterprises and related industries.

The Strategic Agricultural Land Map – Sheet STA_041 (Map identification number: SEPP_MPEI_STA_041_20130910) which includes proposed development area indicates there is no Biophysical Strategic Agricultural Land (BSAL) present within the Project Area.

3.5 Ecology

3.5.1 Flora

A *Terrestrial Ecological Assessment* was undertaken for the Tahmoor South Project by Niche Environment and Heritage (Niche) (2018). Eight vegetation communities have previously been mapped within the Project Application Area as part of the Native Vegetation of Southeast NSW mapping project (Tozer et al. 2006). These vegetation communities include:

- Coastal Sandstone Ridgetop Woodland;
- Cumberland Shale Sandstone Transition Forest;
- Hinterland Sandstone Gully Forest;
- Lower Blue Mountains Wet Forest;
- Sandstone Riparian Scrub;
- Southern Highlands Shale Woodland;
- Sydney Hinterland Transition Woodland; and
- Wingecarribee-Burragorang Sandstone Forest.

The Cumberland Shale Sandstone Transition Forest vegetation community is listed as an Endangered Ecological Community (ECC) under the NSW *Biodiversity Conservation Act 2016* (BC Act). In addition, the Southern Highlands Shale Woodland is listed as an EEC under the BC Act.

Niche undertook vegetation mapping within the proposed surface facilities sites and identified four vegetation communities:

- Shale Sandstone Transition Forest (derived grasslands, shrubland, regenerating);
- Upper Georges Sandstone Woodland (woodland and shrubland);
- Western Sandstone Gully Forest; and
- Exotic pasture.

During the vegetation mapping Niche identified five threatened flora species, *Epacris purpurascens var. purpurascens, Grevillea parviflora subsp. parviflora, Persoonia bargoensis, Persoonia glaucescens and Pomaderris brunnea*. In addition, habitat for *Acacia bynoeana* and *Persoonia hirsute* was also identified.

The proposed surface works for the Tahmoor South Project will include clearing of approximately 49 hectares of native vegetation (43 hectares for the REA and 6 hectares for TSC2). Approximately 43 hectares of the Shale Sandstone Transition Forest, which is an ECC under the BC Act and the EPBC Act, is proposed to be removed. A majority of the Shale Sandstone Transition Forest that is proposed to be disturbed is located within the REA. Niche concluded that removal of the Shale Sandstone Transition Forest is likely to result in a significant impact on the community. In addition, Niche concluded that the proposed development is likely to have a significant impact on *Persoonia bargoensis*, which is listed under both the BC and EPBC Acts.

Given the potential impact on threatened biodiversity as a result of the proposed development, Niche has prepared the *Tahmoor South Project – Biodiversity Offset Strategy (2018)*. The Biodiversity Offset Strategy outlines the approach to securing the required biodiversity offsets and addresses the requirements of the State and Commonwealth legislative biodiversity offsetting requirements. This strategy also outlines the various offsetting options available to Tahmoor Coal, including a preliminary assessment of the vegetation and previous threatened species records within properties under its landholdings.

3.5.2 Fauna

During the terrestrial fauna assessment undertaken by Niche (2018) for the Tahmoor South Project, thirty-four threatened and migratory fauna are considered to be subject species, given they have habitat within the Project Area. The majority of these species are highly mobile species (such as threatened birds and microbats) whose use of the Project Area would be largely limited to foraging. It is unlikely these species would be solely dependent upon the habitat features within the area to be disturbed by the surface infrastructure works, and are unlikely to be impacted by subsidence. Of these species considered, the Gang-Gang Cockatoo, Koala, Red Crowned Toadlet, and Broad-Headed Snake are the only Species credit species that have a moderate or greater likelihood of occurrence. However, the likelihood for impacts toward these species from the clearing works, and subsidence related impacts are relatively low to unlikely. As such, no biodiversity offset is proposed for any threatened fauna.

Threatened fauna listed under the EPBC Act with the potential to occur and be impacted include: Swift Parrot, Rainbow Bee-Eater, Satin Flycatcher, Regent Honeyeater, Broad-Headed Snake, Large-Eared Pied Bat and Grey-Headed Flying-Fox. An EPBC Act Assessment of Significance for each of these species has been completed and concluded that a significant impact to any EPBC Act listed threatened fauna is unlikely.

3.6 Subsidence

(MSEC) undertook a subsidence assessment for the Tahmoor South Project; the results of the assessment are presented in the report *Tahmoor South Project – Longwalls 101 to 109, Subsidence Predictions and Impacts Assessment for Natural Features and Surface Infrastructure in Support of the Environmental Impact Statement* (2018). The maximum subsidence predicted by MSEC (2018) is shown in **Table 3**.

Table 3 Maximum Predicted Subsidence

Longwalls	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)
LW101 to LW108	1,450	12
LW109	1,000	8

Note: Adapted from MSEC (2018).

The maximum predicted subsidence of 1,450 millimetres, occurring over longwalls LW101 to LW108, represents approximately 67% of the seam thickness. The maximum predicted total tilt of 12 millimetres per metre represents a grade of 1 in 83 (1.2%). The predicted subsidence varies across the site due to variations in depth of cover, longwall geometry and extraction heights.

MSEC reported that surface cracking resulting from conventional subsidence movement is not commonly observed where the depth of cover is around 400 metres. In view of this and the depth of cover within the Project Area, observed surface cracking is generally isolated and minor in nature. However, cracking more frequently occurs within the base of valleys.

In the Tahmoor South surface water report (HEC 2018), it is reported that based on past experience the following effects may be expected where subsidence and upsidence occurs in watercourses formed in the Hawkesbury Sandstone:

- "*capture of a portion of low flows and the diversion of this water downstream via the created underground fracture network;*
- *re-emergence of surface water downstream of the affected area;*
- *reduced frequency of pools overflowing and lower pool water levels during dry weather;*
- *reduced and periodic loss of interconnection between pools during dry weather;*
- *localised and transient increases in iron concentrations and other minerals due to flushing of iron from exposed fractures in the sandstone rocks containing variable iron/manganese mineralisation;*
- *creation and/or enhancement of existing iron rich springs; and*
- *drainage of strata gas".*

HEC also stated that "*impacts include localised and relatively isolated cracking of bed sediments; creation of transient and permanent pools in subsidence depressions and/or alteration of existing pools and small scale bed and bank scour due to local increases in bed and bank slope".*

MSEC (2018) state that given the distance from the longwall panels and low predicted ground movements, the Bargo and Nepean Rivers are not expected to experience any noticeable subsidence or upsidence movements.

MSEC also reported a number of potential impacts on local streams, namely Dog Trap Creek, Hornes Creek and Tea Tree Hollow. The potential impacts include:

- Dilation cracking along the stream bed and diversion of water into the dilated strata is likely to occur, resulting in partial or complete diversion of surface water;
- Fracturing and surface flow diversion are likely to occur in the sandstone bedrock, particularly where streams are located above longwalls;
- Fracturing could impact on the holding capacity of standing pools, however, no net loss of water from the catchment is predicted; and
- Gas emissions to the atmosphere.

Based on the typical predicted changes in stream bed grade is less than 0.05%, with a maximum predicted change of 1.2%, MSEC determined that the potential for increased scouring was insignificant.

4 ENVIRONMENTAL PERFORMANCE OBJECTIVES

Post-mining, rehabilitation of the Project Area will return a stable landform capable of uses similar to those prior to disturbance. The objectives of rehabilitating disturbed land include:

- Progressively undertaken rehabilitation on areas that cease to be used for mining or mine-related activities within two years of becoming available.
- Achievement of acceptable post-disturbance land use suitability – mining and rehabilitation will aim to create a stable landform with land use capability and/or suitability similar to that prior to disturbance, unless other beneficial land uses are pre-determined and agreed. This will be achieved by setting clear rehabilitation success criteria and outlining the monitoring requirements that assess whether or not these criteria are being accomplished.
- Native vegetation will be revegetated using existing vegetation communities where appropriate, for example Shale Sandstone Transition Forest or Upper Gorges River Sandstone Woodland or other appropriate vegetation communities identified at the Project Area during the pre-mining assessment. The objective of the rehabilitation for the post-disturbance land use of native vegetation is to accomplish and remain a sustainable native bushland.
- Creation of stable post-disturbance landform - mine wastes and disturbed land will be rehabilitated to a condition that is self-sustaining or to a condition where maintenance requirements are consistent with an agreed post-mining land use.
- Preservation of downstream water quality – surface and ground waters that leave the mining leases should not be degraded to a significant extent. Current and future water quality will be maintained at levels that are acceptable for users downstream of the site.

Rehabilitation of the disturbed land associated with mining will proceed as soon as practicable after the areas becoming available for rehabilitation. The rehabilitation of disturbed land at the mine site will be conducted so that:

- suitable vegetation species are used to achieve the nominated post-mine land uses;
- the potential for water and wind induced erosion is minimised, including the likelihood of environmental impacts being caused by the release of dust;
- the quality of surface water released from the site is such that releases of contaminants are not likely to cause environmental harm;
- the water quality of any residual water bodies is suitable for the nominated use and does not have the potential to cause environmental harm; and
- the final landform is stable and not subject to slumping or erosion which would result in the agreed post mining landform not being achieved.

5 RISK BASED APPROACH TO REHABILITATION AND CLOSURE

A risk management processes will be implemented throughout all phases of the Project, including rehabilitation and closure, in accordance with the relevant regulatory requirements and Tahmoor guidelines and standards.

During operations, rehabilitated areas will be considered in compliance with the requirements of the Extraction Plan and associated guidelines.

In addition, as the operation progresses through its life-cycle, potential sustainable development risks relating to closure will be continually identified and appropriate mitigation strategies developed to control or eliminate the risk. Where practicable, mitigation strategies will be implemented as early as possible in the project life-cycle to minimise potential risks at closure.

Following approval of the Tahmoor South Project, a rehabilitation and closure risk register will be developed for inclusion in the Rehabilitation and Closure Management Plan (or similar). The risk register will be updated regularly and will include, but not be limited to, key elements such as:

- Regulatory requirements;
- Internal corporate standards and expectations;
- Stakeholder expectations and requirements;
- Post closure land use options and potential end land users;
- Progressive rehabilitation opportunities;
- Demolition and decommissioning;
- Progressive and residual rehabilitation requirements;
- Revegetation; and
- On-going maintenance and monitoring requirements.

6 ASSIGNING REHABILITATION AND CLOSURE DOMAINS

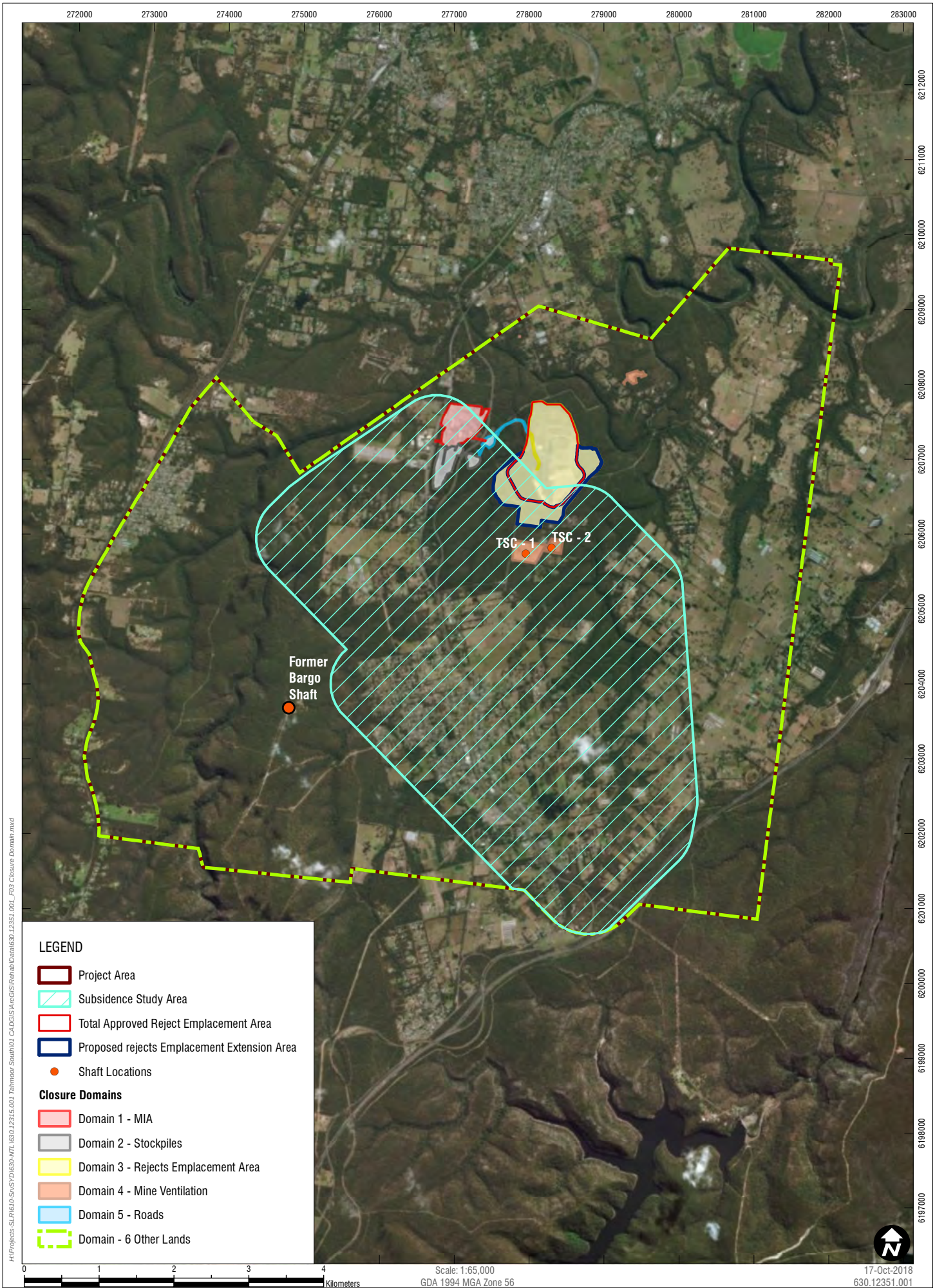
In order to effectively address the complexity of various land uses at Tahmoor Mine, the Project Area has been divided into six management 'domains'. The domains identified within this Plan are shown in **Figure 3** and are defined as:

- Domain1: MIA;
- Domain 2: Stockpiles;
- Domain 3: Rejects Emplacement Area;
- Domain 4: Mine Ventilation;
- Domain 5: Roads; and
- Domain 6: Other Lands (including Biodiversity Offset Areas).

6.1 Domain 1: MIA

The infrastructure to be decommissioned and rehabilitated in Domain 1 includes both the existing CHPP and proposed upgrade. The main features within Domain 1 include:

- The existing CHPP and proposed upgrades to allow for a consistent throughput of 650 tonnes per hour, including;
    - Aerial and ground level conveyors, transfer stations and gantries;
    - Two 1,250 tonne and one 5,000 tonne coal silos;
    - Thickeners.
- Temporary tailings pond.
- The existing vent shaft T3 and the proposed vent shafts:
    - TSC1, which is an upcast ventilation shaft to be located adjacent to the CHPP; and
    - TSC3 – a down cast ventilation shaft to be located adjacent to the product stockpile area.
- The existing site amenities including offices and bathhouses, and proposed upgrades including additional bathhouses.
- Existing workshops.
- A proposed all-weather covered pathway and rail loop bridge to the T3 man lift from the mine amenities and muster area.
- The existing sewerage / water treatment plant.
- The existing car parking area and proposed extension.
- The existing gas plant, cogeneration plant and on-site flare plant.
- The existing drift and a men and material lift to be installed within the existing T3 downcast shaft.
- The existing rail load out facility including a rail loading bin and associated hydraulics, and rail loop.
- The existing water management infrastructure including siltation ponds.
- Existing power lines.



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Closure Domains

FIGURE 3

6.2 Domain 2: Stockpiles

The main features within Domain 2 include:

- ROM coal stockpile.
- ROM coal reclaim tunnel.
- Product coal stockpile.
- Product coal reclaim tunnel.
- Associated water management infrastructure, including dams S2, S3 and S4.

6.3 Domain 3: Reject Emplacement Area

The main features within Domain 3 include:

- The REA.
- Water management infrastructure.

6.4 Domain 4: Mine Ventilation

The main features within Domain 4 include:

- The former Bargo Shaft.
- Two existing ventilation shafts including, T1 and TS3.
- Two proposed ventilation shafts, including:
    - TSC1 – an upcast ventilation shaft to be located on Tahmoor Coal's Charlies Point Road property; and
    - TSC2 – a down cast ventilation shaft to be located on Crown Land adjacent to Tahmoor Coal's Charlies Point Road property.
- A 66 kV electrical power lines to each ventilation shaft and associated sub stations.
- Buildings to house the fans, including outlet flues approximately 30 m high at upcast shafts.
- Water treatment sedimentation controls.
- Hardstand areas.
- The Charlies Point Road ventilation shaft site will also include additional operational service shafts for ballast and concrete delivery to the mine workings and for access for underground mine services.
- Surface gas drainage infrastructure adjacent to the Charlies Point Road vent shafts.

6.5 Domain 5: Roads

The main features within Domain 5 include internal haul roads required for rejects transport.

6.6 Domain 6: Other Lands

The main features within Domain 6 include:

- Subsidence areas.
- Proposed 66 kV power line extension from the REA to the Charlies Point Road vent shaft sites.
- Gas drainage and management infrastructure.
- Exploration boreholes.
- Light vehicle access tracks.
- Biodiversity Offset Areas.

7 PRELIMINARY LAND USE OPTION ANALYSIS

Tahmoor Coal proposes a life of mine for the Tahmoor South Project until approximately 2035. As the mine is over 17 years from closure, the options presented below are considered to be preliminary and a comprehensive analysis of closure land use options has not been undertaken. It is intended that this would be completed during the detailed closure planning process which is typically undertaken no later than five years out from permanent closure of the site.

This Plan has been prepared on the basis that all existing and proposed mine related infrastructure and associated aspects will be entirely removed and the Project Area returned to as close to pre-mining land use as possible. This is considered to be best practice.

A preliminary assessment has been undertaken in the preparation of this Plan, which identified a number of potential land use options for each of the discreet areas within the Project Area. **Table 4** provides a summary of the preliminary land use options. It is anticipated that these options will be reviewed in more detail at the detailed closure planning stage which, as advised above, will be no later than five years from permanent mine closure. During the detailed phase of closure planning, Tahmoor will also undertake additional stakeholder consultation to identify the most suitable post closure land-use.

During closure planning the Wollondilly Local Environmental Plan (or subsequent documents) and any other relevant strategic land use planning and resource management plans or policies will be considered.

The Tahmoor South Project proposes to continue underground mining with surface disturbance as a result of subsidence of an equivalent nature to the current Tahmoor operations. As additional data is collected from the remediation of subsidence impacts and rehabilitation of the REA is progressed, the closure risk register (see **Section 5)** will be updated and regularly reviewed throughout the life of the mine to reflect the required works for effective rehabilitation, and ultimately lease relinquishment.

It has been assumed in the preparation of this Plan that all infrastructure will be demolished and removed to a depth of at least 1.5 metres below the ground surface following closure of the mine.

At the time of closure, there may be opportunities for infrastructure such as roads and buildings to remain to service future industries on-site and/or neighbouring industries. A number of other opportunities for re-use and/or recycling may also be available; however, these opportunities will be considered during the detailed closure planning phase, which will include extensive stakeholder consultation. Where an alternative arrangement is made by way of formal agreement, this Plan will be amended to incorporate the changes.

Table 4 Preliminary Post Mining Land Use Options

Key Area	Preliminary Final Land Use Options
Domain 1 MIA	• Access to future mining areas (additional reserves, subject to potential future approvals) • Re-development of the pit top area for industrial use (coal related) • Re-development of the site for some other industrial use • Re-development of the site for a commercial use • Re-development of the site for residential use • Return to native bushland
Domain 2 Stockpiles	• Access to future mining areas (additional reserves, subject to potential future approvals) • Re-development of the stockpile area for industrial use (coal related) • Re-development of the site for some other industrial use • Re-development of the site for a commercial use • Re-development of the site for residential use • Environmental value (biodiversity) • Grazing or other agricultural use • Return to native bushland
Domain REA	• Return to native bushland
Domain 4 Mine Ventilation	• Return to native bushland
Domain 5 Roads	• Return to native bushland • Remain for access to existing properties
Domain 6 Other lands	• Commensurate with the surrounding land use • Protected for Biodiversity Offsets

8 STAKEHOLDER ENGAGEMENT

The Tahmoor Mine currently undertakes extensive community consultation in accordance with the *Tahmoor Mine Social Involvement Plan* (SIP). The SIP includes a Stakeholder Consultation Program, and a list of stakeholders. Community consultation is currently undertaken through a number of forums including:

- A Face-to-Face Program with for local residents;
- Tahmoor Colliery newsletter which is provided to subscribers on a monthly basis;
- Community information days which are held at a local Community Centre every six months or as required;
- Quarterly meetings of the Tahmoor Community Consultative Committee; and
- The Tahmoor website.

In addition, AECOM has undertaken a Social Impact Assessment as part of the Environmental Impact Statement for the Tahmoor South Project. The findings of this study are presented in the *Social Impact Assessment – Tahmoor South (2018).* The objective of the SIA was to identify and assess the potential social impacts of the proposed development.

The proposed development is anticipated to generate both beneficial and adverse social impacts. The recommendations from this study will be incorporated into the existing SIP and forums to provide continuity in the approach to stakeholder consultation. Where required additional consultation will be undertaken to ensure that effective stakeholder engagement continues throughout the project life cycle.

A social impact assessment will also be undertaken during detailed closure planning. It is anticipated that the social impact study will consider the Tahmoor South Project's expenditure patterns within the local area, community contributions, and location of employees as well as potentially affected local businesses and suppliers. The outcomes of the social impact study will be used to assess feasible final land use options to minimise negative social impacts associated with mine closure.

9 PLANNING FOR DECOMMISSIONING

A decommissioning and demolition plan will form an integral part of the detailed closure planning for the Project. This will be developed for the site prior to closure and will include engaging structural engineers and appropriate technical experts with experience in demolition and the application of relevant Australian Standards and guidelines. A detailed investigation of all structures will be completed to determine the appropriate techniques, equipment required, and the sequence for decommissioning and removal required to execute the demolition activities safely.

9.1 Heritage Management

During detailed closure planning relevant heritage assessments will be undertaken to assess potential heritage items that need to be considered during the detailed closure planning phase. It is anticipated that the heritage assessment will be targeted to specific infrastructure, and the outcomes will be used to ensure that the decommissioning and rehabilitation works are undertaken in accordance with the NSW *Heritage Act 1977*. It is noted that the Historic Heritage Assessment conducted for the Project (Niche, 2018) found that the existing Tahmoor Colliery is of local heritage significance. This will also be considered during the detailed closure planning phase.

9.2 Hazardous Materials

Prior to the demolition of any structures, a hazardous material assessment will be undertaken to determine whether there are any hazardous materials present, including asbestos. Where hazardous materials are identified, they will be assessed and quantified to enable appropriate safety measures to be implemented during removal by a licensed contractor. All hazardous material removed from the buildings will be recorded and disposed of at an approved waste management facility.

9.3 Investigation of the Site

An investigation of the site when planning for decommissioning and demolition will be conducted to confirm the following:

- The type, location and extent of underground services such as conduits, cables and pipe work;
- The location and extent of underground structures to be retained and those to be removed;
- The location, type and extent of overhead services and structures such as power cables, conveyors, light poles and pipe work;
- The location and condition of all tanks and vessels (with emphasis on remaining combustible materials and methods required for their removal);
- The presence of contaminated and hazardous materials and the classification and disposal of these materials;
- The general condition of adjacent structures; and
- Any infrastructure to remain (including roads and tracks) following decommissioning.

9.4 Investigation of Structures

When planning for decommissioning and demolition an investigation of the structures will be completed to identify the following:

- The structures' current condition with regard to their state of disrepair or deterioration;

- The presence of heavy steel within structures that may require specialised demolition equipment and/or techniques;
- Potential imposed loads or changes in the centre of gravity of structures during demolition works; and
- Confined spaces and/or techniques required to be implemented in order to avoid entering such spaces.

9.5 Site Preparation

Prior to the commencement of any demolition activities the following tasks will be undertaken:

- All sumps will be dewatered;
- All items will be decommissioned, de-oiled, depressurised and isolated; and
- All hazardous materials will be removed and transported to appropriately licensed disposal facilities.

9.6 Site Infrastructure and Services

All buildings, including the main administration buildings, workshop areas, coal delivery systems (including conveyors and gantries), drift and other surface infrastructure will be demolished and disposed of in a suitable location. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

Concrete footings and pads will be broken up to at least 1.5 metres below the surface and removed. Options for the re-use of this material (for example, crushed and used for road and track stabilisation or sold for use as road base) will be investigated as the operation approaches closure. If re-use or recycling opportunities aren't available or viable, all "non-contaminated" waste material will be disposed of in a suitable location on-site (for example, in a shaft or the drift) or taken off-site to an approved waste management facility.

9.7 Contamination

Well in advance of final closure a preliminary investigation into potential sources of contamination, including some Phase 1 sampling and analysis, will be undertaken. This will be used to determine whether a detailed assessment (for example, Phase 2 sampling and analysis) should be conducted to quantify the amount of contaminated material that may require remediation.

Where possible all identified sources of contamination will be remediated during the operational phase of the mine. In some cases, however, this may not be possible (for example, under existing slabs, and workshops) and in these circumstances the remediation will be undertaken following cessation of operations and during decommissioning.

9.8 Waste Management

Prior to the commencement of demolition and/or the removal of waste from the site a detailed assessment will be undertaken to classify the waste into streams. The potential waste streams may include:

- Inert Waste (i.e. glass, bricks, steel, iron sheeting, timber, concrete and metal);

- Solid Waste (potentially low-level (<1,000 milligrams per kilogram) hydrocarbon contaminated soil, and municipal waste);
- Hazardous Waste (potentially contaminated soil); and
- Industrial Waste (hazardous materials including asbestos).

During demolition works, wastes will be segregated and managed in accordance with the relevant waste stream and applicable guidelines at the time.

9.9 Traffic Management Plan

Prior to decommissioning activities commencing, a traffic management plan will be prepared, including implementation of any recommendations to reduce potential impacts. In particular, consideration will be given to areas and times of increased truck movements, such as the off-site disposal of waste or importation of fill material to the mine ventilation sites.

10 DECOMMISSIONING AND REHABILITATION WORKS

10.1 Domain 1: Surface Facilities Area

A summary of the infrastructure located within Domain 1 is outlined in **Section 6.1**.

10.1.1 Site Services

All services, including water, data and telephone, that are not required for demolition activities will be safely isolated, disconnected and terminated. Overhead power lines will be removed and the materials, including poles and wire, recovered for potential re-sale or recycling where practicable.

Where also practicable, pipelines and cables with a diameter of approximately 200 millimetres or less will be capped and remain in-situ where they are located greater than 1.5 metres below ground level. This is due to the risk of disturbing the re-established vegetation by excavation and removal.

Pipelines and cables with a diameter greater than 200 millimetres will be removed or filled with an inert material, for example concrete, to avoid the potential for subsidence when the pipe deteriorates and collapses. When assessing the preferred decommissioning methodology, consideration will be given to the environmental significance of the area that the pipeline is to be removed from.

The location of pipelines that are to remain in-situ will be recorded in an abandoned services register and signs will be erected where appropriate.

Pipelines located in critical locations, for example infrastructure crossings of environmentally sensitive areas and/or riparian zones, will be filled with inert a material (such as concrete) to avoid additional disturbance of the environment.

10.1.2 Power Lines

Opportunities for utilisation of the power lines by the surrounding community and/or service providers will be investigated as part of the consultation process undertaken prior to decommissioning. If an alternative use for the infrastructure can be agreed with the relevant stakeholders it will remain in-situ. Alternatively, it will be decommissioned as outlined below.

Power line infrastructure, including but not limited to power poles and transmission lines, will be demolished and disposed of in a suitable approved location. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

10.1.3 Equipment and Buildings

Prior to commencement of demolition hazardous materials will be identified, and subsequently removed by a licensed contractor. All hazardous material removed from the buildings will be recorded and disposed of at an approved waste management facility.

All demountable/transportable buildings will be removed from the surface facility sites. All remaining permanent buildings, including the administration buildings and workshops will be then be demolished, with the component materials recycled or re-sold.

Any materials not recycled or re-sold will be disposed of in a suitable location either on-site or off-site at a licenced waste management facility. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible. Material assessed as “not hazardous or contaminated” by a suitably qualified person may be disposed of within the drift or placed as fill into the shafts.

Concrete footings and pads will be broken up to at least 1.5 metres below the surface and removed. Options for the re-use of this material (for example, crushed and used for road and track stabilisation or sold for road base) will be investigated as the mine approaches closure. If re-use or recycling opportunities are not available or viable, all “non-contaminated” waste material will be disposed of in a suitable location on-site or off-site at an approved waste management facility.

All sumps will be de-watered and de-silted prior to the commencement of demolition. In addition, all items of equipment will be de-oiled, degassed, depressurised and isolated, and all hazardous materials removed from the Project Area. All recoverable scrap steel will be sold and/or recycled. Prior to disposal, all wastes will be assessed and classified in accordance with the relevant regulatory requirements.

Once the structures and the associated concrete slabs are removed, all areas would then be reshaped, deep ripped, topsoiled and seeded in accordance with **Section 11** below. Where suitable quantities of topsoil material is not available at the site, the use of other organics such as bio-solids and/or compost will be assessed as an appropriate addition to enable the establishment of an appropriate vegetation

10.1.4 Conveyors

All conveyors will be dismantled, removed from site and recycled at an appropriate facility. Opportunities for the sale and/or re-use of assets and recycling of materials will be maximised to the extent practicable. Over-head conveyors will be dismantled and lowered to the ground before being cut up. On ground conveyors will be cut up in-situ. Underground conveyor systems will be left in the mine when it is sealed (where it is not required for another operation). All gearboxes and other vessels will be drained of oil and depressurised prior to sealing of the mine.

The carbonaceous material below and in the vicinity of the surface conveyors will be stripped to a depth of at least 0.5 metres (or where it is totally recovered). Where possible the material will be considered for reprocessing. If this is not possible, it will be pushed up and stockpiled to be used to backfill the portal or shafts.

10.1.5 Men and Materials Drift and Ventilation Shafts

In preparation for decommissioning a number of activities will be undertaken, including:

- Preparation of an accurate survey plan of the drift or ventilation shaft, including documentation of the conditions at the time of closure.
- Removal of any disused equipment where practicable and any material that has the potential to cause pollution.
- Removal of any hazardous materials and disposal at an approved waste disposal facility.
- Consideration of the potential for accumulation of gas within the workings and any measures required to seal the shaft and / or mitigate the potential risks.

- Liaison with the relevant regulatory bodies regarding the specific decommissioning and rehabilitation requirements.
- Preparation of detailed plans specifying the proposed engineered seal for the drift.

During design of the engineered seals consideration will be given to maintaining the integrity of the existing roof supports and bracing, along with the potential need for additional roof support during the construction of the seal. Where practicable, the engineered seal will be designed to be explosion proof. The engineered seal will also be designed in accordance with the relevant RR (or its equivalent) guidelines at the time of decommissioning.

Prior to the commencement of drift decommissioning works, a plan detailing the proposed works and the safety precautions will be developed. This plan will be approved and signed by a suitably qualified engineer.

All services associated with the drift will be disconnected and made safe. As a minimum, the first 50 metres of the conveyor and services from the surface will be dismantled, removed from site and recycled or disposed of at an appropriate facility.

The drift will be backfilled for a minimum distance of 25 metres (or to a depth of cover of no less than 15 metres) from the surface against an engineered seal. The backfill material will be appropriately compacted to an engineered standard and will be compacted in layers. All face cavities will be backfilled, and the creation of voids will be prevented where possible.

Construction of the engineered seal will be undertaken by component personnel under the supervision of a suitably qualified engineer. Inert material such as concrete and carbonaceous material from around the site will be backfilled against the seal equal to the natural surface. Concrete slabs and/or steel reinforcements used in the works will comply with the relevant construction standards and construction activities will be carried out by competent personnel under the supervision of a suitably qualified engineer. The location will be recorded on an abandoned services register, which will be retained on-site records.

Drainage and ventilation pipes will be incorporated into the engineered seal where required. This may include a blanket drain behind the seal to drain any trapped groundwater. In addition, a 0.1 metre diameter breather pipe may also be installed.

Appropriate drainage infrastructure will be constructed to prevent erosion and to ensure runoff does not enter the mine or cause groundwater contamination. This may include construction of a temporary berm around the drift to divert surface runoff.

It is anticipated that the engineered seals for the ventilation shafts will include construction of two mass reinforced concrete slabs which cover the shaft face and are 0.5 metres thick. One of the slabs will be anchored to competent rock below any weathered material and pinned to the surrounding rock. The second slab will be positioned 1 metre below the surface. In addition, a breather pipe will be installed if required.

Construction of the engineered seal will be undertaken by component personnel under the supervision of a suitably qualified engineer. Concrete slabs and/or steel reinforcements used in the works will comply with the relevant construction standards and construction activities will be carried out by competent personnel under the supervision of a suitably qualified engineer. The location will be recorded on an abandoned services register, which will be retained on-site records.

The final landform will be commensurate with the surrounding land and appropriate water management structures will be installed where required. In addition, a secure fence will be constructed around the drift or shaft and appropriate signage will be constructed. The area of fencing will ensure that heavy vehicular traffic is diverted around the site and does not cause any damage to the seal.

10.1.6 Fuel Farms and Chemical Storage Areas

Prior to closure, a preliminary investigation of potential sources of contamination, including Phase 1 sampling and analysis, will be undertaken to determine whether a more detailed assessment (Phase 2) is required as outlined in **Section 9.7**. The results of a Phase 2 investigation would be used to quantify the amount of contaminated material requiring bio-remediation on-site or requiring off-site disposal at a licensed facility.

Any remaining fuel and/or chemicals will be recycled or disposed of at an appropriately licenced facility. All items of equipment will be de-oiled, degassed, depressurised and isolated, and all hazardous materials removed from the site. All infrastructure associated with fuel farms and chemical storage areas will be demolished and disposed of off-site at a licenced waste management facility. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

Concrete footings and pads will be broken up to at least 0.5 metres below the surface and removed. Options for the re-use of this material (for example, crushed and used for road and track stabilisation) will be investigated as the operation approaches closure. If re-use or recycling opportunities are not available or viable, all “non-contaminated” waste material will be disposed of in a suitable location on-site or off-site at an approved waste management facility. Material assessed as “not hazardous or contaminated” by a suitably qualified person can be crushed and disposed of within the drift or placed as fill into the shafts.

10.1.7 Roads and Tracks

Roadways and/or tracks may be required to remain to provide ongoing access for rehabilitation monitoring and maintenance activities. Alternatively, roads and/or tracks may remain on-site if agreed in writing by the landowner.

All bitumen sealed surfaces, such as access roads, car parks and hardstands, will be scalped to approximately 0.5 metres below the surface to remove stabilised and compacted material. The inert waste will be disposed of in a suitable location on-site or off-site at an approved waste management facility. Material assessed as “not hazardous or contaminated” by a suitably qualified person can be crushed and disposed of within the main drift or placed as fill into the shafts.

Minor reshaping work may be undertaken to ensure surface level consistency with the surrounding areas and rehabilitated. Any creek crossings (such as culverts) will be removed and the pre-existing drainage line re-instated.

10.1.8 Sewage and Water Treatment Plant

Opportunities for utilising the sewage and water treatment plant and associated dams/ponds by surrounding land owners will be investigated as part of the consultation process during detailed closure planning. If an agreed use for the treatment plant or dams is identified, which has been agreed in writing with the future landowner and/or the regulator, the infrastructure may be left on-site following the removal of any residual produce water and sediment (if assessed and determined not to be suitable for the proposed use).

Unless an alternate suitable and agreed use is identified, the sewage and water treatment plant will be decommissioned as outlined below. The water pipelines will be drained and isolated. In addition, tanks and vessels will be pumped dry and services that are not required will be disconnected.

All buildings, and other surface infrastructure, pre-treatment equipment, control rooms, etc., will be dismantled or demolished and recycled or disposed of in a suitable approved location. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

Concrete footings and pads will be broken up to at least 1.5 metres below the surface and removed. The dams and/or ponds will be decommissioned as follows:

- Draining the water from the dam;
- Sampling and analytical testing of the sediment within the dam, and appropriate treatment or disposal of the sediment based on the analytical results;
- Backfilling of the dam and reshaping to a landform similar to that of the surrounding undisturbed areas;
- If required topsoiling and/or amelioration the disturbed area; and
- Revegetating with species that are commensurate with the surrounding vegetation and proposed post closure land use.

10.1.9 Gas Plant, Cogeneration Plant and On-Site Gas Flare

During detailed closure planning the ongoing requirement for the gas plant, cogeneration plant and on-site gas flare will be assessed. In particular, consideration will be given to ongoing operation to manage gas levels within the underground workings.

Prior to decommissioning activities commencing the gas pipelines leading into the gas plant, co-generation plant and the on-site flare will be drained, isolated, and flushed with an inert gas. In addition, tanks and vessels will be pumped dry and where relevant flushed with an inert gas. Services will be disconnected.

All buildings, and other surface infrastructure, including the compressors, drive engines and/or motors, separators, electrical panels, pipework, control rooms, etc., will be demolished and disposed of in a suitable approved location. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible. All associated infrastructure, for example fencing, and security systems, will also be removed.

Concrete footings and pads will be broken up to at least 1.5 metres below the surface and removed.

Note that buried services may remain in-situ if they will not impact on the future land use, i.e. buried cables are at sufficient depth that they will not interfere with the post closure land use.

10.1.10 Rail Load Out and Rail Loop

Well before closure, a preliminary investigation of potential sources of contamination, including Phase 1 sampling and analysis, will be undertaken to determine whether a more detailed assessment (Phase 2) is required, as outlined in **Section 9.7**. The results of a Phase 2 investigation would be used to quantify the amount of contaminated material requiring bio-remediation on-site or requiring off-site disposal at a licensed facility.

The rail loading facilities and the rail loop with be removed and disposed of in a suitable location, for example disposed of off-site at a licenced waste management facility, unless an alternative purpose has been established through consultation with relevant stakeholders during detailed closure planning. This will include breaking up the concrete pit beneath the rail loading bin. The rail track will be reused or recycled and ballast material will be used to backfill the drift or shafts.

Opportunities, for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible.

Carbonaceous material will be stripped and where possible the material will be considered for reprocessing. If this is not possible, it will be pushed up and stockpiled to be used to backfill the drift or shafts, alternatively it may be placed in the REA.

10.1.11 Water Management Infrastructure

All water management infrastructure will be removed unless it is required for ongoing water management, for example to prevent erosion and to ensure runoff does not enter the mine or cause groundwater contamination. Where practicable underground water management infrastructure will be removed, however, some underground water management infrastructure may be made safe and left buried in-situ. Any concrete to be removed will be broken up and reused if practical as outlined in **Section 10.1.3**. The location of water management infrastructure that is to remain in-situ will be recorded in an abandoned services register and signs will be erected where appropriate.

10.2 Domain 2: Stockpiles

A summary of the infrastructure located within Domain 2 is outlined in **Section 6.2**.

10.2.1 Site Services

All services associated with the stockpiles that are not required for demolition activities will be safely isolated, disconnected and terminated. Overhead power lines will be removed and the materials, including poles and wire, recovered for potential re-sale or recycling where practicable.

Where practicable, pipelines and cables with a diameter of approximately 200 millimetres or less will be capped and remain in-situ where they are located greater than 1.5 metres below ground level. This is due to the risk of disturbing the re-established vegetation by excavation and removal.

As outlined in **Section 10.1.1**, pipelines and cables with a diameter greater than 200 millimetres will be removed or filled with an inert material to avoid the potential for subsidence when the pipe deteriorates and collapses.

10.2.2 Stockpile Areas

The carbonaceous material on the base of the ROM and product stockpile areas will be stripped to a depth of at least 1.5 metres. Where possible the material will be considered for reprocessing prior to the cessation of CHPP operations. Alternatively the carbonaceous material will be disposed of within the drift or shafts, or placed in the REA.

The stockpile areas will be trimmed and reshaped, and if required rock raked to remove all surface rocks to a size of less than 0.5 metres and ripped to a depth of at least 1 metre.

10.2.3 Reclaim Tunnels

The conveyors and any associated services will be removed and where practicable the material overlying the reclaim tunnels will be removed to expose the roof of the tunnel. Once the roof is exposed the concrete will be broken up (i.e. with a hydraulic jack hammer) and placed back into the tunnel or disposed of in a suitable location on-site, filling the drift of shafts, or off-site at an approved waste management facility. These works will aim to leave minimal cavities prior to backfilling the tunnel. Once the reclaim tunnels are backfilled and compacted, all areas will then be reshaped, deep ripped, topsoiled and seeded.

10.2.4 Conveyors, Transfer Stations and Gantries

All conveyors, transfer stations and gantries will be dismantled and removed from site. Opportunities for the sale and/or re-use of assets and recycling of materials will be maximised to the extent practicable. Over-head conveyors will be dismantled and lowered to the ground before being cut up. On ground conveyors will be cut up in-situ. All gearboxes and other vessels will be drained of oil and depressurised to remove any potential for contamination prior to demolition.

The carbonaceous material below and in the vicinity of the surface conveyors will be stripped. Where possible the material will be considered for reprocessing. If this is not possible, it will be pushed up and stockpiled to be used to backfill portals or shafts.

10.2.5 Water Management Infrastructure

All water management infrastructure will be removed unless it is required for ongoing water management, for example to prevent erosion. Where appropriate the location of water management infrastructure that is to remain in-situ will be recorded in an abandoned services register and signs will be erected where appropriate.

As outlined in **Section 10.1.3** any concrete to be removed will be broken up and reused if practicable.

The dams and / or ponds will be decommissioned as follows:

- Draining the water from the dam;
- Sampling and analytical testing of the sediment within the dam, and appropriate treatment or disposal of the sediment based on the analytical results;
- Backfilling of the dam and reshaping to a landform similar to that of the surrounding undisturbed areas;
- If required topsoiling and/or amelioration the disturbed area; and

- Revegetating with species that are commensurate with the surrounding vegetation and previous land use.

10.2.6 Roads and Tracks

Roadways and/or tracks may be required to remain to provide ongoing access for monitoring and maintenance activities. Alternatively, roads and/or tracks may remain on-site if agreed in writing by the future landowner. Access roads and tracks that are not required will be rehabilitated as outlined in **Section 10.1.7**.

10.3 Domain 3: Rejects Emplacement Area

A summary of the infrastructure located within Domain 3 is outlined in **Section 6.3**.

10.3.1 Rejects Emplacement Area

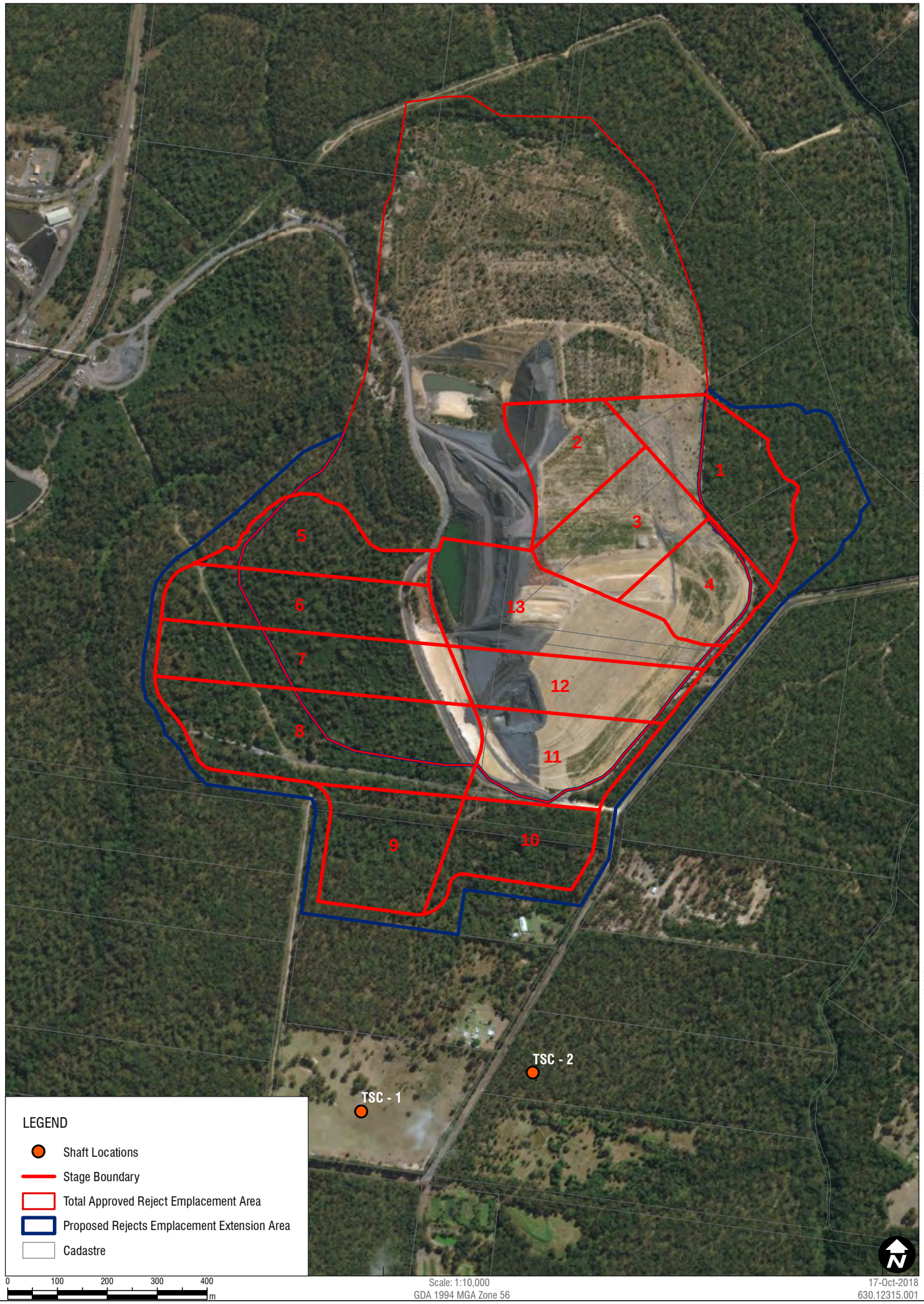
The REA is proposed to be expanded and continued to be used throughout the proposed project life. The development of the closure plan for the REA will require consultation with technical specialist to design and implement an appropriate management strategy. As part of the EIS, a geotechnical desktop study and investigation report was prepared by Sinclair Knight Merz (SKM) (2017) to support civil design, filling schedule and water management plan for the expanded REA. This report, including the justification of the final landform design of the REA and associated stability assessment results, is appended to the EIS.

Progressive rehabilitation of the REA will be undertaken during operation where possible. Rehabilitation will only start once the portion of the REA to be rehabilitated is sufficiently dry to allow the placement of permanent capping material.

The REA is proposed to be progressed in 15 stages throughout the life of the mine. Where practicable each stage of the REA will be progressively rehabilitated when it is no longer in use. The proposed stages of the REA are shown in **Figure 4.**

During detailed closure planning for the REA a specific long-term management strategy will be developed in consultation with the State regulators and regulatory guidelines. Key objectives of this strategy will include:

- Maintaining a stable landform;
- Ensuring the landform surface is resistant to erosion;
- Maintaining a surface cover that minimises the risk of infiltration, promotes shedding of surface water and promotes growth of vegetation; and
- Minimises the risk of environmental harm from seepage.



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Proposed REA Stages

FIGURE 4

The capping of the REA will be designed and constructed so that the surface will be free draining. The rejects will be capped with a layer of compacted clay or similar impermeable substance over which a layer of free draining material will be placed. Topsoil will then be used to resurface the area which will then be revegetated. This will inhibit the ponding and infiltration of surface water and minimise the potential for leachate. Rock armouring will also be considered if required to prevent excessive slope erosion. Suitable clean fill and topsoil are proposed to be imported on-site as required during life of the project to ensure the progressive rehabilitation of the REA.

The operational performance of the REA and decant water management will have a significant influence on the final strength and consolidation properties of the materials. Strategies that will be further considered during development of rehabilitation plans will include:

- Ongoing monitoring and maintenance of the final landform to assess the rate of ongoing settlement and to maintain the surface integrity of the landform.
- Design the landform surface to promote sheet flow of surface water to eliminate the need for engineered drainage structures across the final landform surface. This requirement will likely limit the maximum final height of the landform above the original ground surface level. However, it will also limit the impact of ongoing surface settlement on the drainage and integrity of the final landform.

10.3.2 Water Management Infrastructure

The water management infrastructure will be decommissioning, with the component materials being recycled or re-sold. Any materials not recycled or re-sold will be disposed of in a suitable location either on-site or off-site at a licenced waste management facility. Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible. Material assessed as “not hazardous or contaminated” by a suitably qualified person may be crushed and disposed of within the drift or placed as fill into the shafts.

10.4 Domain 4: Mine Ventilation

A summary of the infrastructure located within Domain 4 is outlined in **Section 6.4**.

10.4.1 Security

Where practicable, the existing fencing and signage will be maintained around the mine ventilation locations. If required, temporary fencing will be constructed and appropriate signage posted. In addition, during the demolition and rehabilitation works, including filling and capping the ventilation shafts, a security firm is proposed to be engaged to prevent public access to the mine ventilation locations.

10.4.2 Site Services

All services associated with the mine ventilation shafts that are not required for demolition activities, will be safely isolated, disconnected and terminated. Overhead power lines will be removed and the materials, including poles and wire, recovered for potential re-sale or recycling where practicable. See **Section 10.1.1** for details regarding the decommissioning of site services.

10.4.3 Ventilation Shafts

Refer to **Section 10.1.5** for details on the decommissioning of ventilation shafts.

10.4.4 Gas Drainage Infrastructure

Gas drainage bores will be decommissioned in accordance with relevant RR (or its equivalent at the time of decommissioning) requirements. The aim of well decommissioning is to prevent the leakage of gas and water or to ensure that the well is safe to leave for ongoing venting to the atmosphere. The outcomes for the decommissioning of the wells include:

- Disassembling of temporary infrastructure components and transport away from the remote gas well site;
- Modification of the remaining venting infrastructure to achieve long term objectives which may include removing of the well head, sealing and capping wells or venting to the atmosphere unabated; and
- Stabilising and rehabilitation of the well site along with any associated access tracks.

10.4.5 Associated Infrastructure

All associated infrastructure, including fencing, offices, storage sheds, hardstand areas, power lines and substations etc., will be demolished and disposed of in a suitable approved location. Opportunities for the sale and/or re-use of assets and recycling will be maximised where possible. Overhead power lines will be removed and the materials, including poles and wire, recovered for potential re-sale or recycling where practicable.

10.5 Domain 5: Roads

A summary of the infrastructure located within Domain 5 is outlined in **Section 6.5**.

10.5.1 Haul Roads

All haul roads will require rehabilitation unless an alternative use has been determined through consultation with relevant stakeholders and potential third-party owners during detailed closure planning. Decommissioning and rehabilitation of haul roads involves:

- Remove top layer including scraping any stabilised material and excess carbonaceous material and dispose of in an appropriate location. Where practicable the excess carbonaceous material will be reprocessed prior to the CHPP being decommissioned. It is recommended that at least the wearing course, base layer and sub-base layer be removed.
- Reshaping to be commensurate with the surrounding landform.
- Rip and scarify the road alignment, verges and berms, etc.
- Apply soil ameliorants and fertilizer after soil testing.
- Apply topsoil or bio solids (or similar ameliorant) to achieve the desired land capability.
- Seeding to establish appropriate vegetation.
- Ensure the final profile of the fill is convex so that drainage occurs radially outwards, and erosion deflection berms constructed to prevent erosion.

All crossings, including culverts, will be removed. Where practicable, all associated infrastructure, including fencing and signage, and water management infrastructure, will be removed. Re-use and/or recycling opportunities will be investigated, or alternately all “non-contaminated” waste material will be disposed of in a suitable approved location.

All areas should then be reshaped, deep ripped, topsoiled and seeded in accordance with **Section 11** below.

10.5.2 Roads and Tracks

Roadways and/or tracks may be required to remain to provide ongoing access for rehabilitation monitoring and maintenance activities. Alternatively, roads and/or tracks may remain on-site if agreed in writing by the prosed future landowner. Refer to **Section 10.1.7** for details on the decommissioning of roads and tracks.

10.6 Other Lands

A summary of the infrastructure located within Domain 6 is outlined in **Section 6.6**.

10.6.1 Subsidence Areas

The Subsidence Advisory NSW is responsible for administering the *Mine Subsidence Compensation Act 1961.* The Act provides for the compensation or repair of services where improvements are damaged by mine subsidence resulting from the extraction of coal.

Subsidence modelling of each of these areas predicts the maximum slope in the final topography over the longwall panels after subsidence to be 12 millimetres per metre. The maximum subsidence predicted is 1,450 millimetres.

Remedial activities required during operations will include excavations through these areas to re-establish the channel. The monitoring and maintenance to ensure long term stability of these areas will be included in the surface water management plan.

The Extraction Plan will include additional information for the management of subsidence including details in the following areas:

- Mitigation of surface ponding;
- Mitigation of surface cracking;
- Mitigation of subsidence impacts on natural channels;
- Mitigation of subsidence impacts on the diversion channel; and
- Mitigation of subsidence impacts on levees.

There will also be an increased focus on habitat creation around watercourse diversions and riverine areas impacted by subsidence. This includes, but is not limited to; the reinstatement of sandy substrate and placement of logs and large woody debris as in-stream habitat, and the placement of nest boxes in trees along the banks to encourage migrating, nesting or denning birds and mammals.

10.6.2 Subsidence Marker Pegs

It is anticipated that a majority of the subsidence marker pegs will be removed during the operation of the mine. However, once all subsidence monitoring has been completed suitable personnel will traverse the subsidence monitoring lines to identify any remaining markers. All markers identified will be cut-off at or below ground level to minimise potential impacts to public safety.

10.6.3 Gas Drainage and Management Infrastructure

Refer to **Section 10.4.4** for details on the decommissioning of gas drainage and management infrastructure.

10.6.4 Power Lines

The power lines with be removed, unless an alternative purpose has been established through consultation with relevant stakeholders during detailed closure planning. Overhead power lines will be removed and the materials, including poles and wire, recovered for potential re-sale or recycling where practicable.

10.6.5 Exploration Boreholes

Exploration and groundwater monitoring wells will be decommissioned in accordance with relevant RR (or its equivalent at the time of decommissioning) requirements. The aim of well decommissioning is to prevent the leakage of gas and water. The outcomes for the decommissioning of the wells include:

- Removal of the well head; and
- Any disturbance associated with historical drill pads, sumps or access roads to drill sites will be reshaped as required and revegetated to be consistent with the surrounding vegetation.

10.6.6 Roads and Tracks

Roadways and/or tracks may be required to remain to provide ongoing access for rehabilitation monitoring and maintenance activities. Alternatively, roads and/or tracks may remain on-site if agreed in writing by the prosed future landowner. Refer to **Section 10.1.7** for details on the decommissioning of roads and tracks.

10.6.7 Associated Infrastructure

Where practicable, all associated infrastructure, including fencing and signage, will be removed. Re-use and/or recycling opportunities will be investigated, or alternately all “non-contaminated” waste material will be disposed of in a suitable approved location.

11 REHABILITATION AND REVEGETATION STRATEGY

This rehabilitation strategy provides details on the proposed final land form and planned rehabilitation activities for the entire Tahmoor South project area. This section covers the following key activities relating to mine site rehabilitation:

- Proposed post mining land classification;
- Landform design and planning;
- Rehabilitation principles;
- Staged/progressive rehabilitation;
- The management of topsoil resources for use in rehabilitation of the Project Area, including a topsoil mass balance;
- Subsidence;
- The proposed revegetation strategy for the Project area;
- Weed management;
- Rehabilitation success criteria; and
- Rehabilitation monitoring and maintenance requirements which will apply.

These aspects are discussed further in the sections below.

11.1 Landform Design and Planning

Rehabilitation planning at the Project Area will aid in minimising the total area of disturbance at any one time, so reducing the potential for wind-blown dust, visual impacts and increased sediment-laden run-off.

Rehabilitation will be designed to achieve a stable final landform compatible with the surrounding environment. This will involve the reshaping of the majority of REA to 10 degrees or less. Should slopes exceed 10 degrees an assessment will be made as to whether additional drainage and revegetation works are required. These control measures will help to prevent erosion and aid in groundcover establishment.

The Geotechnical Desk Study and Supplementary Investigations (SKM, 2017) provided technical justification of the proposed final landform of the REA including stability assessment of the substrates to be used and water management designs.

11.1.1 Rehabilitation Principles

Rehabilitation of the disturbed land associated with mining will proceed as soon as practicable after the areas becoming available for rehabilitation. In some situations however, rehabilitation may be delayed due to interactions with other nearby areas that are unavailable for rehabilitation. Where this is the case, temporary rehabilitation methodologies may be applied to provide short-term stabilisation of the areas.

The rehabilitation of disturbed land at the mine site will be conducted so that:

- Suitable vegetation species are used to achieve the nominated post-mine land uses;

- The potential for water and wind induced erosion is minimised, including the likelihood of environmental impacts being caused by the release of dust;
- The quality of surface water released from the site is such that releases of contaminants are not likely to cause environmental harm;
- The water quality of any residual water bodies is suitable for the nominated use and does not have the potential to cause environmental harm; and
- The final landform is stable and not subject to slumping or erosion which would result in the agreed post mining landform not being achieved.

11.2 Progressive Rehabilitation

It is noted that the Tahmoor South Project proposes to continue underground mining activities at the site. Therefore, due to the relatively small disturbance footprint associated with surface infrastructure it is considered that there are limited opportunities for progressive rehabilitation.

To what extent is appropriate, rehabilitation will be progressively undertaken on areas that cease to be used for mining or mine-related activities as soon as reasonably practicable. In particular, the REA is proposed to be completed in stages and progressive rehabilitation is proposed to be undertaken once each stage has been completed. **Figure 4** shows the proposed stages.

11.3 Topsoil Management

Tahmoor Colliery currently has a Soil & Water Management Plan. This plan will be updated, with respect to the proposed development and to ensure industry best practice is maintained, and implemented for the Tahmoor South Project.

The Soil & Water Management Plan will specifically address topsoil stripping, stockpiling (includes specific locations), the development of topsoil inventories for the Project Area, handling, re-spreading, amelioration and seedbed preparation.

11.4 Topsoil Mass Balance

As part of the preparation of this Conceptual Mine Closure Plan, SLR undertook a soil stripping assessment and topsoil mass balance. The aim of this soil stripping assessment and topsoil balance is to:

- Provide a soil stripping assessment and mapping of the Project Area based on literature review of existing baseline soil information; and
- Provide a topsoil balance of the Study Area based on the soil stripping assessment.

The area subject to the assessment encompasses a portion of the existing REA (**Figure 5**). The total new maximum disturbance area for the proposed REA Extension Areas is 43 hectares.

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Topsoil Stripping Areas

FIGURE 5

11.4.1 Methodology

Literature review of the following documentation was conducted to identify the dominant soil properties for the Study Area:

- *NSW Natural Resources Atlas* (http://www.nratlas.nsw.gov.au/);
- *Soil Landscapes of the Wollongong – Port Hacking 1:100 000 Sheet* (Hazelton & Tille, 1990);
- *Soil Survey and Materials Management Plan – Tahmoor Colliery* (AECOM, 2010); and
- *Tahmoor South Project REA Expansion Civil Design – Geotechnical Desk Study and Supplementary Investigations Report* (SKM, 2017)

From the available information a topsoil stripping map has been developed using the *Procedure for the selection of materials for use in topdressing of disturbed areas* (Elliot & Reynolds, 2007). This map can be used as a guide to the depth of topsoil available for stripping and has been used in the calculation of the available topsoil balance.

11.4.2 Background

The area subject to the assessment encompasses two soil landscape units, Lucas Heights and Gymea (**Figure 6**). The Lucas Heights Soil Landscape Unit covers gently undulating crests, ridges and plateau surfaces, with slopes less than 10% and local relief of 10 – 50 metres. It occurs on the Mittagong Formation geological unit consisting of shale, laminite and quartz sandstone. The dominant soils are typically moderately deep Yellow Podzolic Soils and Yellow Soloths on ridges and plateaus. Lateritic Podzolics are also present on crests, Yellow Earths on shoulders of plateaus and ridges, and Earthy sands occur in valley flats.

The Gymea Soil Landscape Unit covers undulating to rolling rises and low hills, with slopes between 10-25% and local relief of 10 – 80 metres. It occurs on the Hawkesbury Sandstone geological unit consisting of sandstone with some shale and laminite. The dominant soils are typically shallow to moderately deep Yellow Earths and Earthy Sands on crests and inside benches, Gleyed and Yellow Podzolic Soils on shale lenses, and shallow to moderately deep Siliceous Sands and Leached Sands along drainage lines.

11.4.3 Soils Assessment

The previous soil survey of the existing REA, performed by AECOM, determined that the soils within the current REA correlated with the predicted Lateritic Podzolic Soils of the Lucas Heights Soil Landscape Unit, as defined in the *Soil Landscapes of the Wollongong – Part Hacking 1:100 000 Sheet* (Hazelton and Tille, 1990).

The geotechnical survey, performed by SKM, for the Tahmoor South REA Expansion Civil Design included 15 ‘Test Pit Logs’ with basic descriptive soil information and soil depths. These soil descriptions have been correlated with information in the previous soil survey (AECOM, 2010) and soil landscapes units (Hazelton and Tille, 1990), as well the topography and slopes to create a base soils map. The soils within the Project Area are described below.

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Soil Landscape Units

FIGURE 6

Yellow Earths

Yellow Earths in the Study Area occur on crests and slopes and are characterised by greyish-brown sand to sandy loam topsoil grading to sandy clay loam subsoil, which may grade to sandy clay. Soil depth is up to 1 metre. Structure is generally apedal and the profile is strongly to slightly acidic (pH 4.0 – 6.5). Limitations include low fertility, acidity and increasing sodicity with depth.

Lateritic Podzolic Soils

Lateritic Podzolic Soils in the Study Area occur on crests and plateau surfaces and are characterised by sandy clay loam overlaying yellowish-brown sandy clay to heavy clay. These soils are distinctive by the abundant presence of iron-coated sandstone fragments and stones. The soil depth is up to 1 metre, and shallower closer to steeper slopes. The structure is generally apedal in the topsoil and strong in the subsoil and the profile is strongly to slightly acidic (pH 4.0 – 6.0). Limitations include low fertility, acidity, increasing sodicity with depth and high percentage of sandstone fragments and stones. The different types of Lateritic Podzolics represented in **Figure 7** differ in depths of topsoil and subsoil.

Earthy Sands

Earthy Sands in the Study Area occur on sideslopes and are characterised by loamy sand to sandy loam overlying earthy, yellowish-brown clayey sand. Soil depth is variable and typically 0.3 metres, however can be up to 0.7 metres. Structure is typically apedal and the profile is strongly to slightly acidic (pH 4.0 – 6.5). Limitations include low fertility, acidity and presence of sandstone gravel.

Lithosols

Lithosols in the Study Area occur on crests and sideslopes and are characterised by shallow (less than 0.3 metres), loamy sand to sandy loam. Structure is typically apedal and the profile is strongly to slightly acidic (pH 4.0 – 6.0). Limitations include low fertility, acidity and presence of sandstone gravel and rock outcrop, particularly on steeper slopes.

11.4.4 Topsoil Stripping Assessment and Balance

The soils within the Study Area are limited by strong acidity and sodic characteristics (Hazelton & Tille, 2009 and AECOM, 2010). Whilst the topsoils are generally suitable to facilitate germination and revegetation, they will all require appropriate amelioration with gypsum or lime due to the strong acidity found in the topsoil throughout the Study Area and some localised marginally sodic topsoil.

The soil stripping limitations each soil unit is summarised in **Table 5**. The stripping depth for each soil unit within the Study Area is limited by strong acidity, sodicity and often the presence of stone fragments.

Table 5 Soil Stripping Limitations

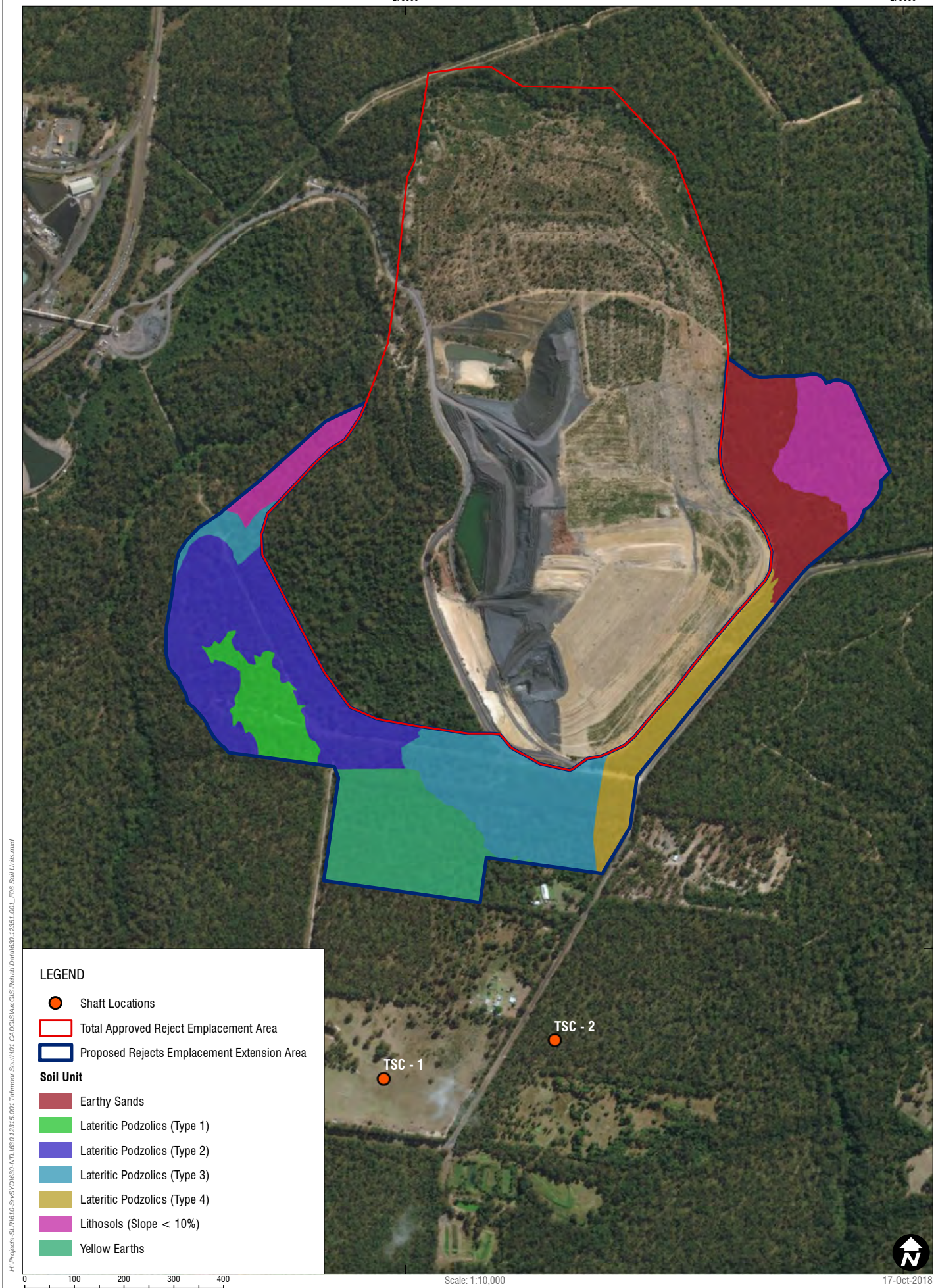
Great Soil Group	Associated Soil Landscape Unit	Soil Stripping Limitations
Yellow Earths	Lucas Heights	Acidity and sodicity.
Lateritic Podzolic Soils	Lucas Heights	Acidity, sodicity and sandstone fragments and stones.
Lithosols	Gymea	Acidity and sandstone fragments and stones, and rock outcrop.
Earthy Sands	Gymea	Acidity, sandstone fragments and stones.

The topsoil structure of Yellow Earths, Earthy Sands and Lithosols are generally marginally suitable for reuse due to coarse topsoil texture and poor soil structure. Material may be stripped and reused in rehabilitation provided appropriate erosion and sediment controls are in place due. They will need organic ameliorants to improve their structure. The topsoil of Lateritic Podzolic Soils will also require organic amelioration to improve soil structure. Subsoil is not recommended for stripping due to the chemical limitations associated with strong acidity and sodicity.

The recommended topsoil stripping depths for each soil is shown in **Table 6** and **Figure 8**. With a total maximum disturbance area of 43 hectares, this provides a maximum topsoil balance of 115,600 cubic metres.

Table 6 Soil Stripping Recommendations

Great Soil Group	Ave. Topsoil Depth (m)	Ave. Subsoil Depth (m)	Stripping Depth (m)	Area (ha)	Volume (m^3)
Yellow Earths	0 – 0.35	0.35 – 0.9	0.35	5.2	18,200
Lateritic Podzolic Soil – Type 1	0 – 0.15	0.15 – 0.7	0.15	2.2	3,300
Lateritic Podzolic Soil – Type 2	0 – 0.25	0.25 – 0.95	0.25	12.4	31,000
Lateritic Podzolic Soil – Type 3	0 – 0.25	0.25 – 0.75	0.25	13.0	32,500
Lateritic Podzolic Soil – Type 4	0 – 0.30	0.3 – 0.60	0.30	1.6	4,800
Lithosols (Slope greater than 10%)	0 – 0.30	N/A	0.30	4.5	13,500
Earthy Sands	0 – 0.30	0.3 – 0.60	0.30	4.1	12,300
			Total	**43**	**115,600**



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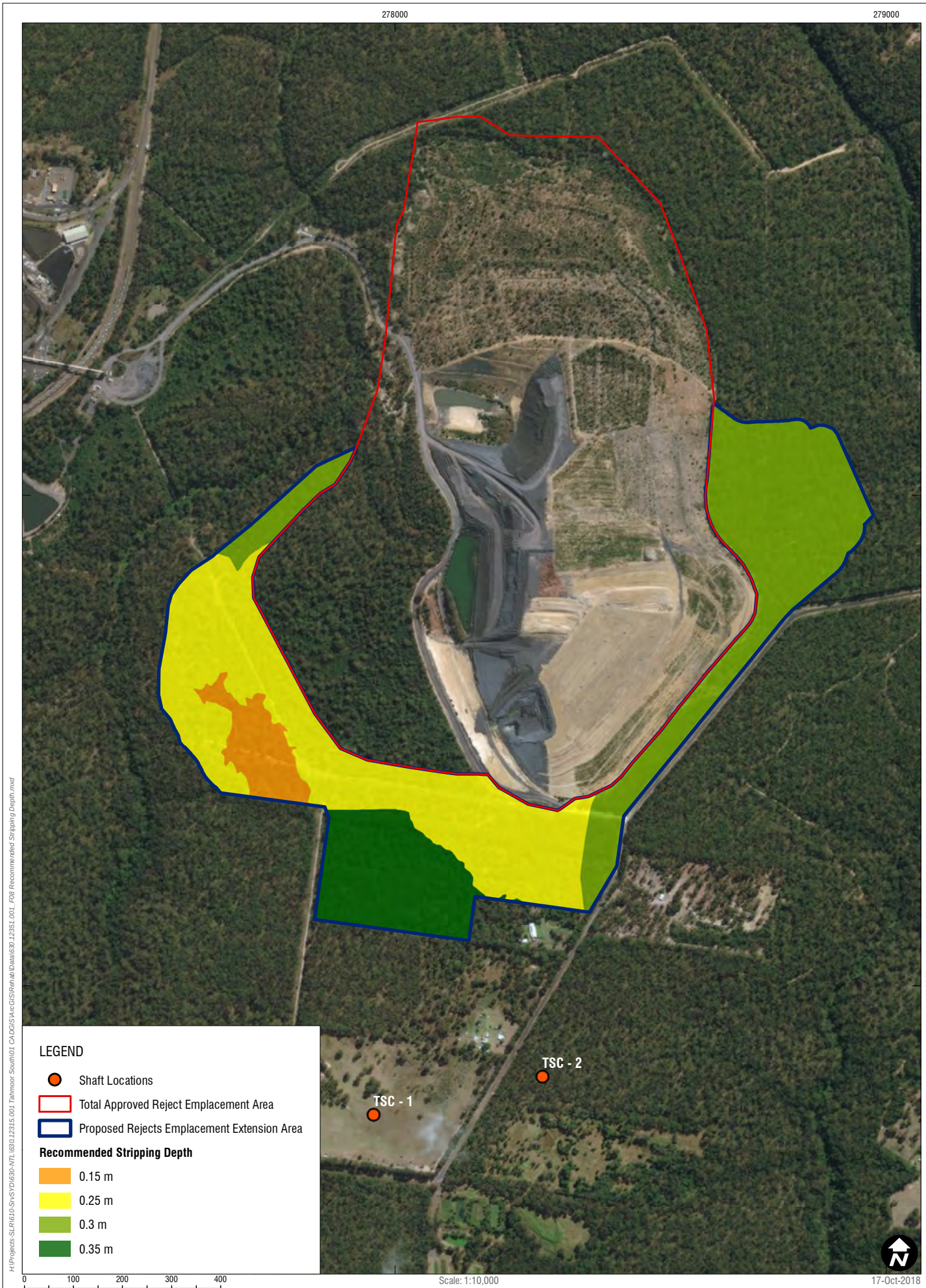
Soil Units

FIGURE 7



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Recommended Stripping Depth

FIGURE 8

11.4.5 Summary

A literature review of baseline soil information was conducted for the area of the proposed REA Extension Areas to provide a soil stripping assessment and mapping. The major points of the assessment are summarised below:

- The Study Area was located within two Soil Landscape Units, Lucas Heights and Gymea;
- Four major soil types were mapped within the Study Area: Yellow Earths, Lateritic Podzolic, Lithosols and Earthy Sands;
- A topsoil balance of 115,600 cubic metres was calculated for the maximum disturbance area of 43 hectares; and
- Amelioration with lime or gypsum is recommended for all stripped topsoil, due to the highly acidic nature of the soil within the Study Area.

11.4.6 Topsoil Stripping and Handling

The Topsoil Management Plan (TMP) will include detailed protocols for soil stripping and handling. The following proposed techniques will be adopted to prevent excessive soil deterioration as a result of soil stripping and stockpiling:

- Topsoil will be maintained in a slightly moist condition during stripping. Where possible, material will not be stripped in either an excessively dry or wet condition.
- Stripped topsoil will be placed directly onto regraded disturbed areas and spread immediately (if mining sequences, equipment schedules and weather conditions permit) to avoid the requirement for stockpiling.
- Where stockpiling is required soil will be graded or pushed into windrows with excavators, graders or dozers for loading into rear dump trucks by front-end loaders. This is the preferred method as it minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.
- The surface of soil stockpiles will be left in as coarsely textured condition as possible in order to promote infiltration and minimise erosion until vegetation is established, and to prevent anaerobic zones forming.
- Where possible, a maximum stockpile height that prevents biological and structural degradation will be maintained. Clayey soils will be stored in lower stockpiles for shorter periods of time compared to soils that have a coarser texture.
- Free-draining stockpiles will be created to minimise the formation of anaerobic zones. Stockpiles will be formed in a “chevron” profile with batters graded to achieve slopes approaching 18°, where practicable.
- If long-term stockpiling is planned (i.e. greater than 12 months), stockpiles will be seeded and fertilised. An annual cover crop species that produce sterile florets or seeds will be sown. A rapid growing and healthy annual pasture sward provides sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species will not persist in the rehabilitation areas but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil.

- Prior to re-spreading stockpiled topsoil onto regraded disturbed areas (particularly onto designated tree seeding areas), an assessment of weed infestation on stockpiles will be undertaken to determine if individual stockpiles require herbicide application and/or “scalping” of weed species prior to topsoil spreading.
- Topsoil will be spread to a nominal depth range of 0.1 metres (steep slopes) to 0.2 metres (flatter areas). Soil respreading on steep slopes at depths exceeding 0.1 m can be deleterious because of the “sponge” effect which can cause slippage of the topsoil from the slope.

11.4.7 Topsoil Respreading and Seedbed Preparation

Where possible, suitable topsoil will be re-spread directly onto reshaped disturbance areas and where topsoil resources allow, topsoil will be spread to a nominal minimum depth range of 0.1 to 0.2 metres on all rehabilitation areas. Specific topsoil respreading depths for different post mining landform elements will be specified in the project’s TMP and Soil and Water Management Plan (SWMP).

The spreading of topsoil, addition of soil ameliorants and application of seed will be carried out in consecutive operations to reduce the potential for topsoil loss to wind and water erosion.

Thorough seedbed preparation will be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas will be lightly contour ripped (after topsoil spreading) to create a “key” between the soil and the subsoil/capping materials. This process will be undertaken on the contour and the tynes lifted for approximately 2 metres every 200 metres to reduce the potential for channelized erosion. Where possible it will be undertaken when the soil is moist and immediately prior to sowing for best results. The respread topsoil surface will be scarified prior to, or during seeding to reduce run-off and increase infiltration.

Some of the soils in the Project Area may exhibit sodic properties. Sodic soils are not optimal for rehabilitation works as the clay particles tend to disperse and swell producing poor physical soil conditions. These conditions include water-logging and hard-setting crusts which in turn negatively affect infiltration rates, plant-available water capacity, seedling emergence and root development. Where practicable, topsoil resources for rehabilitation works will be selected to minimise potential soil sodicity effects. For some soils, the application of soil ameliorants that decrease soil dispersibility and increase soil aggregate stability will be an important soil rehabilitation management tool.

Soil organic matter increases soil aggregate stability and adding carbon as a soil ameliorant will improve soil structure. Carbon ameliorants such as mulch will be beneficial for rehabilitated landforms within the Project Area. Organic amendments will supplement elevated organic carbon levels in the Project Area’s soils to improve structural stability. Fertiliser additions will be undertaken if required.

11.5 Acid Sulfate Soils

The site is not considered at risk of acid sulfate soil or acid generation as a result of disturbance, due to the distance and elevation from the low lying coastal soils, as well as the soil types identified on site. In the event acid generation is observed measurements of soil acidity will be taken and remedial action in accordance with NSW OEH Acid Sulfate Soil Manual (1998).

11.6 Erosion and Sediment Control

The Tahmoor Colliery SWMP will be revised prior to the commencement of the Tahmoor South Project commencing to include all aspects of the project lifecycle (construction, operations and closure). The principle objectives of the SWMP are:

- To minimise erosion and sedimentation from all active and rehabilitated areas, thereby minimising sediment ingress into surrounding surface waters;
- To ensure the segregation of contact water (surface runoff from disturbed catchments (e.g. active areas of disturbance, stockpiles and rehabilitated areas (until stabilised)) from non-contact water (surface runoff from catchments that are undisturbed or relatively undisturbed by project-related activities and rehabilitated catchments), and maximise the retention time of contact water such that any discharge from the Project Area complies with the appropriate discharge criteria;
- To minimise the volume of water discharged from the Project Area but, should the discharge of water prove necessary, ensure sufficient settlement time is provided prior to discharge such that suspended sediment within the water meets the objectives identified in the point above;
- To manage surface flows upstream of the Project Area so that rehabilitation and coal recovery activities are not affected by flooding, non-contact water diversion channels will be constructed prior to commencement of clearing in the REA;
- To prevent erosion of the ephemeral watercourses that traverse the site;
- To manage erosion of the remedial works required as a result of subsidence impacts on the surface;
- To develop sustainable long-term surface water features following rehabilitation of the Project Area, including implementation of an effective revegetation and maintenance program; and
- To monitor the effectiveness of surface water and sediment controls and to ensure all relevant surface-water quality criteria are met.

Effective erosion and sediment control for the Project Area will require appropriate activities to be carried out over the life of the project including:

- Construction;
- Operations; and
- Rehabilitation and closure.

The effectiveness of erosion and sediment controls during the operational and closure stages will be optimised through effective mine planning and design. Suitable strategies will include:

- Designing and operating drainage systems for the life of the mine so that they do not cause erosion. This will involve scour protection of open drains and energy dissipaters located at drain outlets.

- Designing the REA geometry to create a landform that allows free drainage of surface runoff while minimising erosion.

Where possible, contact and non-contact water will be segregated to minimise the requirement for on-site storage. This would allow water suitable for direct discharge (e.g. undisturbed catchments) to be diverted and on-site containment of water requiring treatment (e.g. settling suspended sediment).

Contact water from disturbed areas will be captured in sediment dams to allow suspended solids to settle and, if necessary, allow a flocculent to be added to remove fine or dispersive sediment to meet allowable turbidity discharge limits. Opportunities for the use of contact water within the mining operations will be maximised to reduce overall water requirements for the site.

11.7 Subsidence

Where surface cracks as a result of subsidence are small, it is not anticipated that intervention will be required, as these cracks tend to self-seal after a few rainfall events as fine sediments wash into and seal up the cracks. Where cracks are large, or are not self-sealing, further remediation works will then be undertaken where required behind the advancing face of the longwall as soon as practical post-subsidence. Inspections will be conducted over subsided areas in order to identify these locations. Remedial works will include the ripping and seeding of subsidence areas. If the cracks are too wide, clay will be imported to fill the cracks and the area will be spread with topsoil and seeded.

MSEC (2018) note that fracturing and surface flow diversions have previously occurred in the sandstone bedrock along streams, in particular in streams located directly above longwalls. In some instances, the fracturing impacted the holding capacity of standing pools; however, it was considered unlikely that there was any net loss of water from the catchment.

In streams with significant sediment accumulation, it is anticipated that the fractures will naturally fill over time (MSEC, 2018). However, in streams with lower sediment accumulation it may be necessary to seal the fractures and voids with grout. Tahmoor Colliery currently has Subsidence Management Plan (SMP) that considers potential impacts on steams due to mining activities, including monitoring and trigger response plans. An Extraction Plan will be prepared and implemented for the Tahmoor South Project.

Subsidence impacts have previously been observed relating to the Tahmoor Colliery, including impacts to roads, houses and infrastructure. The Extraction Plan will also consider the potential impacts to roads, houses, infrastructure etc. In addition, potential impacts and trigger response actions relating to archaeological sites will also be included in the Extraction Plan.

Tahmoor Colliery also has a risk management plan to manage potential impacts to residential structures. This includes prior identification of buildings in poor pre-mining condition that could potentially become hazardous. Where impacts are identified, claims and repairs will be addressed via the process managed by Subsidence Advisory NSW.

To ensure subsided land is suitable for grazing, initial repair works will be undertaken where required behind the advancing face of the longwall. Repair works will focus on any surface disturbances such as existing highly eroded access tracks and erosion gullies that will concentrate the flow of water and increase erosion associated with subsidence cracking.

Rehabilitation of subsidence cracks will be undertaken as soon as practical post-subsidence. This will include as appropriate:

- Carrying out inspections over subsided areas and locating surface cracking.
- Undertaking minimal clearing, if required, of areas around cracks to allow for ripping and seeding.
- Ripping and seeding of areas where required. Following initial ripping and seeding, if trees are to be planted, they will not be planted until sufficient rain has fallen. This will enable the soil to consolidate, and finer particles to fill underground air pockets. Otherwise if not done, air pockets can cause roots to dry out which will result in poor growth rates or seedling deaths.
- Seeding and/or planting appropriate species of vegetation to achieve a post-subsidence land use the same as that pre-subsidence (i.e. low intensity cattle grazing).
- Subsided areas to be regraded and some may be backfilled with mine spoil to control surface water flow and minimise erosion and sedimentation. Drainage works such as graded banks and diversion drains may be used to partially drain the larger subsidence voids and direct water into stable areas or sediment control dams.

For areas where ripping is not feasible due to the width of cracks:

- Topsoil will be stripped and stockpiled;
- Clay material will be imported to fill and seal cracks;
- Topsoil will be respread once cracks have sealed; and
- The area will be seeded with appropriate plant species.

Where required, stock will be excluded from subsided and rehabilitated areas, including riparian areas, to prevent injury to animals and to increase grass cover and seed store. This will be achieved through the erection of fences in consultation with the relevant landholder(s). Where required, people will also be excluded and appropriate signage warning of the potential hazards due to subsidence will be erected.

The rehabilitation undertaken on subsided areas will be monitored annually. Where the regeneration of dominant species disturbed by remediation works does not occur within one year, additional vegetation will be seeded or planted as required.

11.7.1 Subsidence of Watercourse and Drainage Lines

Tahmoor Colliery has existing management plans regarding potential impacts to streams resulting from the mining of longwalls. These management plans will be updated where relevant and adopted for this Project. The plans will include monitoring requirements and trigger response plans. Monitoring is proposed to continue for a period following mining.

General rehabilitation of the subsided riparian subsidence areas will involve the following key design and planning factors:

- Provide a cover of topsoil in a weathered rock matrix to create a stable substrate for revegetation of channel banks. Weathered rock provides temporary erosion protection by covering erodible soils and minimising topsoil loss.
- Replace sand across the channel bed, including higher sand deposits suitable for re-creation of in-channel benches.

- Install timber groynes/pile field retards at the base of the channel banks (extending into the channel) to mitigate erosion undercutting the channel banks and to facilitate creation of in-channel benches.
- In areas where less active bank erosion develops, large woody debris will be placed in-stream to encourage the deposition of sediment and revegetation over time.
- Design local drainage works to prevent the uncontrolled flow of runoff over the channel banks. Small diversion bunds directing runoff to properly engineered rock chute structures will be installed to minimise bank erosion.
- Topsoiling and revegetation on banks. Stock will be excluded to a width of at least 30 metres from the top of bank and subsided areas in order to minimise further impacts on vegetation cover and land condition.
- A targeted revegetation will be undertaken in areas where surface water patterns have been affected.
- Stream rehabilitation as per the requirements of any Corrective Management Action Plans approved by the RR (or its equivalent at the time of remediation).

Any additional mechanisms, as identified by the annual subsidence monitoring, will also be considered.

11.8 Revegetation

11.8.1 Revegetation Program Implementation

A revegetation strategy is proposed for the Project Area that seeks to compliment desirable post-mining land-use objectives whilst maintaining effective erosion and weed controls.

Revegetation activities will be scheduled to occur after the completion of reshaping, re-topsoiling and drainage works. Where possible, the timing of these works will enable a preferred seasonal sowing of pasture and tree seed in autumn or spring.

On prepared surfaces, selected tree, shrub and pasture species will be sown using seed stock and/or planted depending on the species, slope gradients and area to be revegetated. Tree and shrub species will be established at a density and richness consistent with the nominated post-mine ecosystem.

11.8.2 Species Selection

Plant selection for areas to be rehabilitated to pre-existing conditions will focus on those species that will successfully establish on the available growth medium, bind the soil and will result in a variety of structure and food/habitat resources. Native species will be established through direct seeding or planting of tube stock/nursery-raised stock from local propagules. Seed will be collected locally where possible to ensure it is adapted to environmental conditions in the area.

Prior to application, some of the tree seed will be pre-treated (i.e. inoculated and scarified) in order to break dormancy restrictions to promote earlier germination, develop more robust seedlings, wider and more uniform germination and increased germination rates.

Revegetation will be undertaken based on the proposed final land-use objectives for the disturbed areas, using species identified during the terrestrial ecology assessment undertaken by Niche (2018). The proposed species to be used includes a range of trees, shrubs, grasses and groundcovers which are outlined in **Table 7**.

Table 7 Indicative Species for Revegetation

Scientific Name	Common Name
Trees	
Eucalyptus crebra	Narrow-leaved Ironbark
Eucalyptus eugenioides	Thin-leaved Stringybark
Eucalyptus fibrosa	Red Ironbark
Eucalyptus punctata	Grey Gum
Allocasuarina littoralis	Black She-Oak
Corymbia gummifera	Red Bloodwood
Eucalyptus racemosa	Narrow-leaved Scribbly Gum, Snappy Gum
Shrubs	
Acacia decurrens	Black Wattle, Green Wattle, Sydney Green Wattle
Bursaria spinosa	Blackthorn, Boxthorn, Sweet Bursaria, Kurwan
Exocarpos cupressiformis	Cherry Ballart, Native Cherry
Indigofera australis	Australian Indigo, Duwabili
Kunzea ambigua	Tick Bush
Melaleuca thymifolia	Thyme Honey-Myrtle
Pultenaea villosa	Hairy Bush-pea
Olearia microphylla	Small-leaved Daisy Bush
Ozothamnus diosmifolius	Rice Flower, Dog Wood, Pill Flower, Sago Bush
Acacia ulicifolia	Prickly Moses
Acacia terminalis	Sunshine Wattle
Acacia linifolia	White Wattle
Banksia spinulosa var. spinulosa	Hill Banksia, Golden Candlestick
Hakea sericea	Needle Bush
Persoonia levis	Broad-leaved Geebung
Persoonia linearis	Narrow-leaved Geebung
Leptospermum trinervium	Flaky-barked Tea-tree, Slender Tea-tree
Grasses	
Anisopogon avenaceus	Oat Speargrass
Aristida ramosa	Purple Wiregrass
Aristida vagans	Threeawn Speargrass
Cyathochaeta diandra	Sheath Rush, Spear Grass
Entolasia stricta	Wiry Panic
Eragrostis brownii	Brown's Lovegrass
Microlaena stipoides	Weeping Grass

Scientific Name	Common Name
Themeda australis	Kangaroo Grass, Durawi
Ground Covers	
Billardiera scandens	Hairy Apple Berry
Cassytha glabella	Slender Devil's Twine
Cheilanthes sieberi	Poison Rock Fern, Mulga Fern
Einadia hastata	Berry Saltbush
Lomandra filiformis	Wattle Mat-rush
Lomandra obliqua	Fish Bones
Lepidosperma laterale	Variable Saw Edge
Phyllanthus hirtellus	Thyme Spurge
Pratia purpurascens	Whiteroot
Solanum prinophyllum	Forest Nightshade
Goodenia hederacea	Forest Goodenia, Ivy Goodenia
Pimelea linifolia subsp. linifolia	N/A
Xanthosia tridentata	Rock Xanthosia

The revegetation seed mix may include a cereal cover crop and/or improved pasture species to maximise the potential for rapid re-colonisation of the disturbed areas and minimise erosion and soil loss. These complimentary species will be selected with consideration for the proposed final land-use, and the appropriate completion criteria that will facilitate lease relinquishment and/or on-sale of the land.

Legumes may also be selected to assist in the supply of bio-available nitrogen to the soil. If the use of introduced grasses and/or legumes is deemed necessary for erosion control in the bushland areas, pasture seed and fertiliser will be applied at a lower rate than for pasture outcomes to reduce competition with tree seed and/or seedlings.

Where appropriate, native pasture species (warm season perennial, cool season perennial, yearlong green perennial and annual) will be sown. If steep slopes are present and it is not practicable to re-shape the area and/or there is a high risk if erosion introduced, stoloniferous grass species (e.g. Rhodes Grass) will be sown as their growth provides more extensive coverage in a shorter time. If native species are unsuccessful in areas identified as grazing pasture for final land use, Atlas Phalaris, Uplands Cocksfoot or Tall Fescue (or other introduced pasture species) may be used on the condition that there is a sufficient buffer zone.

The use of buffer zones will be site specific and should be considered prior to any revegetation activities. However, buffer zones should be established around any areas of remnant vegetation which are relatively undisturbed and where exotic species are not present.

Buffer zones maybe established by initially seeding with a non-invasive cover crop (e.g. millet, oats or barley) to achieve rapid ground cover and to minimise soil erosion. Native grass seed will be included in the cover crop seed mix. Inclusion of the native grass seed will allow the native species to germinate through the protective cover crop. This will provide rapid surface coverage and erosion protection for the surface soil and provide a buffer from exotic pasture species.

Appropriate buffer zones should be evaluated when considering the used of introduced species and introduced species will only be used on the condition that;

- the area does not border an area allocated for rehabilitation of bushland; or
- border any area of uncleared vegetation.

Aerial sowing and ground broadcasting will be conducted for both tree and pasture seed as the preferred sowing methods and grazing will be restricted whilst the vegetation is establishing.

All revegetated areas will be monitored to ensure long-term groundcover establishment and success. Revegetation techniques will be continually developed and refined over the life of mine through an ongoing process of monitoring at the site and recognition of other industry experiences.

11.8.3 Special Treatment Areas

Additional erosion control measures such as the application of 'Hydromulch' will be considered, particularly in drainage lines and steeper batter areas (e.g. infrastructure "cut and fill" batters). For example, sugar cane mulch as slurry provides cover for the soil to improve pasture growth, modifying the soil surface to control erosion, or a combination of both. Securely pressed against the surface of the soil, the mulch provides a high degree of erosion control and improves moisture availability to establishing pasture. The mulch also has the effect of protecting the soil surface against raindrop impact, improving the micro-environment for seed germination and establishment by reducing evaporation losses, and assisting in the control of surface erosion caused by raindrop impact and overland water flow.

Opportunities for the use of potential soil ameliorants (biosolids) to accelerate the rehabilitation process will also be investigated as appropriate.

11.9 Rehabilitation Monitoring

Regular monitoring of the rehabilitation will be required during the vegetation establishment period, to demonstrate whether the objectives of the rehabilitation strategy are being achieved and whether a sustainable landform has been provided.

In addition to rehabilitated areas, reference sites will be monitored to allow a comparison of the development and success of the rehabilitation against a control. Reference sites indicate the condition of surrounding un-mined areas that the rehabilitated disturbance area must replicate. Monitoring will be conducted periodically by independent, suitably skilled and qualified persons at locations which will be representative of the range of conditions on the rehabilitating areas. Annual reviews will be conducted of monitoring data to assess trends and monitoring program effectiveness.

Monitoring of the rehabilitated areas will broadly involve the following:

- Ongoing chemical analysis of topsoil;
- Comparison of soil erosion rates and rill and gully dimensions with measurements taken from reference sites;
- Comparison of vegetation measurements with measurements taken from reference sites;

- Ongoing analysis of water quality parameters in accordance with the development consent and environmental protection licence conditions from data collected monthly at water storages, ramps and pits, sedimentation dams and sewage effluent outfalls on-site, and continually from creeks (upstream and downstream of mine); and
- Visual surveillance including the use of digital photogrammetry/low level oblique or vertical aerial photography to monitor changes over time in the rehabilitation (e.g. changes in vegetation structure, erosion rates and landform drainage).

Monitoring of specific parameters will be undertaken to determine the level of achievement of success criteria.

11.9.1 Weed Management

The presence of weed species has the potential to be a major impact on revegetation and regeneration activities. In addition to this, the presence of weed species within the surrounding land has the potential to significantly decrease the value of the native vegetation. Weed management will be a critical component of mine rehabilitation and landscape reconstruction. Weeds will be managed across the site through a series of control measures, including:

- Hosing down at-risk equipment in an approved wash down area before entry to site;
- Scalping weeds off topsoil stockpiles prior to re-spreading topsoil;
- Regular inspections of rehabilitation to identify potential weed infestations;
- Identifying and spraying existing weed populations on-site together with ongoing weed spraying over the life of the mine; and
- The use of agricultural herbicides in the areas to be stripped and on topsoil stockpiles.

Weed control, if required, will be undertaken in a manner that will minimise soil disturbance. Any use of herbicides will be carried out in accordance with appropriate state and/or federal regulatory requirements to minimise potential environmental impacts. Records will be maintained of weed infestations and control programs will be implemented according to best management practice for the weed species concerned.

11.10 Rehabilitation Maintenance

Maintenance of rehabilitated areas will be undertaken where necessary and in response to results of the monitoring program, to ensure success criteria are met, or in the case of progressive rehabilitation, are projected to be met at the time of mine closure. Depending on the criteria to be achieved, examples of maintenance works could include re-seeding or planting of tube stock of tree and/or shrub species to meet required revegetation parameters, the application of fertiliser, weed management and the implementation of erosion protection measures such as minor remedial earthworks or soil conservation works.

Post-mining surveys of the rehabilitation will be progressively undertaken across the Project Area to determine whether the site meets success criteria and whether the results are maintained over time. Once maintenance and rehabilitation are no longer required, the area will be relinquished to the relevant stakeholders.

12 CONCEPTUAL REHABILITATION SUCCESS CRITERIA

Conceptual rehabilitation success criteria have been developed to provide long-term performance goals for rehabilitation activities. The Project is within the planning phase and, therefore, the rehabilitation success criteria are considered conceptual and will be developed further following consultation on the final land use with the relevant stakeholders.

To this end, final rehabilitation success criteria will be developed for the Project during the detailed closure planning, which is typically undertaken when the Project is no later than five years from permanent closure. This will include the development of specific, measurable, achievable, realistic, and outcome based, criteria. The criteria will be based on the results of research and ongoing monitoring of the progressive rehabilitation areas.

Conceptual rehabilitation success criteria are provided in **Table 8**. Each criterion is designed as a performance objective or standard against which rehabilitation success can be demonstrated. Meeting the success criteria (as indicated by monitoring results) demonstrates that the rehabilitated landscape is in a sustainable condition, ready to be relinquished, and handed back to the appropriate stakeholders.

The success criteria comprise indicators for vegetation, fauna, soil, stability, land use and safety on a landform-type basis that reflects the nominated post-mine land use of industrial and native bushland.

Table 8 Preliminary Rehabilitation Success Criteria

Rehabilitation Element	Domain	Indicator	Criteria
Phase 1 – Decommissioning			
Infrastructure	Domains 1 and 2	Land use (proposed industrial)	All buildings, water storage, roads and other infrastructure (except those used by the public) have been removed unless agreed with stakeholders for their retention.
	Domains 3 and 4	Land use (Native Bushland)	All infrastructure within areas to be returned to native bushland has been removed, and disposed appropriately, for example to an appropriate waste management facility. Infrastructure may remain if the relevant stakeholders agree to their retention.
	Domain 5 and 6	Land use	Roads (except those used by the public) and other infrastructure have been removed unless stakeholders have entered into formal written agreements for their retention. Minor dozer reshaping work will be undertaken to ensure surface level consistency with the surrounding areas. Any creek crossings (i.e. culverts, etc.) will be removed and the pre-existing drainage line re-instated where applicable. If required the area will be deep ripped to loosen compacted material. A light vehicle access road is to be maintained to enable inspections of the site following closure of the mine. Fertiliser and pasture/tree seed will be applied to assist establish pasture post-mine land use.

Rehabilitation Element	Domain	Indicator	Criteria
	Domain 6	Boreholes	All boreholes (except those retained for monitoring purposes) have been shut down, bore casings near the surface are removed and holes plugged or capped the regulatory standards.
	All Domains	No contamination	All sites have been assessed by a suitably qualified expert as not containing contaminants above the relevant criteria for the proposed final land use.
Safety	All Domains	Physical	Excavations to be rendered safe. All holes/pits and other openings are to be securely capped, filled or otherwise made safe. Access to members of the public and livestock is restricted as appropriate to site conditions. No rubbish should remain at the surface, or at risk of being exposed through erosion. Risk assessment has been undertaken in accordance with relevant guidelines and Australian Standards and risks reduced to levels agreed with the stakeholders. Closure documentation includes the contaminated sites register which identifies contaminated sites and the treatment applied.
Phase 2 – Landform Establishment			
Landform Stability	Domains 1 and 2	Slope Gradient	Area has gradient less than 2 degrees.
	Domain 3	Capping	The REA is capped to a depth to be defined in field trials, which includes a minimum of 200 millimetres of topsoil. No water is observed leaching from the facility.
	Domains 1, 2, 3, 4 and 5	Surface water drainage	The landform is stable and contour banks and diversion drains are installed to direct water into stable areas or sediment control basins.
	Domains 1, 2, 3, 4 and 5	Erosion control	Erosion control structures are installed at intervals commensurate with the slope of the landform.
	Domain 6	Erosion control	Erosion mitigation measures have been applied.

Rehabilitation Element	Domain	Indicator	Criteria
	Domain 6	Subsidence impacts	Perform regular inspections over subsidenec areas to identify any surface cracks and/or sinkholes. Undertake minimal clearing, if required, of areas around cracks and/or sinkholes to allow for ripping and seeding. Ripping and seeding of areas where required. Following initial ripping and seeding, if trees are to be planted, they will not be planted until enough rain has fallen. Seed and/or plant appropriate species of vegetation to achieve a post-subsidence land use the same as that pre-subsidence (i.e. low intensity cattle grazing). Regrade subsidence areas and where necessary backfill with mine spoil to control surface water flow and minimise erosion and sedimentation. If ripping is not feasible due to the width of the cracks, topsoil will be stripped and stockpiled. Clay material will be imported to fill and seal cracks and the topsoil will be respread once the cracks have sealed. The area will then be reseeded with appropraite plant species.
	Domain 6	Surface water drainage	Design local drainage works to prevent the uncontrolled flow of runoff from the subsided floodplain area over the channel banks. Small diversion bunds directing floodplain runoff to properly engineered rock chute structures will be installed to minimise bank erosion.
Water Storage	Domains 3, 4 and 5	Stable landform	Water storages to be rehabilitated to a stable non-polluting condition.

Rehabilitation Element	Domain	Indicator	Criteria
Water Storage and Waterways	Domain 6	Surface water management	Provide a cover of topsoil in a weathered rock matrix to create a stable substrate for revegetation of channel banks. Weathered rock provides temporary erosion protection by covering erodible soils and minimising topsoil loss. Replace sand across the channel bed, including higher sand deposits suitable for re-creation of in-channel benches. Install timber groynes/pile field retards at the base of the channel banks (extending into the channel) to mitigate erosion undercutting the channel banks and to facilitate creation of in-channel benches. The structures will be built between each of the subsided panels affecting the river before subsidence occurs. In areas where less active bank erosion develops, large woody debris will be placed in-stream to encourage the deposition of sediment and revegetation over time. Local drainage works will be designed to prevent the uncontrolled flow of runoff from the subsided floodplain area over the channel banks. Small diversion bunds directing floodplain runoff to properly engineered rock chute structures will be installed to minimise bank erosion. Topsoil will be placed on banks and banks will be revegetated. Stock will be excluded to a width of at least 30 metres from the top of bank and subsided floodplain areas in order to minimise further impacts on vegetation cover and land condition. A targeted revegetation will be undertaken in areas where surface water patterns have been affected.
Phase 3 – Growth Media Development			
Top soil	Domains 1 and 2	Physical and chemical parameters	Where practical, previously stockpiled topsoil will be used to sustain the proposed post-mining land use. Where it is assessed as not being suitable and alternative top-soil substitute will be considered (for example bio-solids, organics, etc.)
	Domains 3, 4, 5 and 6	Physical and chemical parameters	Soil salinity content is less than 0.6 dS/m. Soil pH is between 5.5 and 8.5. Soil Exchange Sodium Percentage (ESP) is greater than 15%. Nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or other micro symbionts. Adequate macro and micro-nutrients are present. Where practical, previously stockpiled topsoil will be used to sustain the proposed post-mining land use. Where it is assessed as not being suitable and alternative top-soil substitute will be considered (for example bio-solids, organics, etc.)

Rehabilitation Element	Domain	Indicator	Criteria
Phase 4 – Ecosystem Establishment			
Vegetation	Domains 3, 4, 5 and 6	Species composition	Where relevant, for example areas where the post-mining land use is native bush, vegetation present is commensurate with the pre-mining environment and/or nearby undisturbed reference sites.
Phase 5 – Ecosystem Development			
Vegetation	Domains 3, 4, 5 and 6	Surface cover	Minimum of 70% vegetative cover is present (or 50% if rocks, logs or other features of cover are present). No bare surfaces greater than 20 square metres in area or greater than 10 metres in length down slope.
	Domains 3, 4, 5 and 6	Community structure	That the community structure is commensurate with pre-mining conditions and/or nearby undisturbed reference sites.
	Domains 3, 4, 5 and 6	Resilience to disturbance	Established species survive and/or regenerate after disturbance. Weeds do not dominate native species after disturbance or after rain. Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Domains 3, 4, 5 and 6	Sustainability	Species are capable of setting viable seed, flowering or otherwise reproducing. Evidence of second generation of tree/shrub species.
Fauna	Domains 3, 4, 5 and 6	Vertebrate Species	The number of vertebrate species does not decrease by more than 25% in the successive seasons prior to mine lease relinquishment or by more than 40% over the two successive seasons prior to mine lease relinquishment.
	Domains 3, 4, 5 and 6	Invertebrate species	Presence of representatives of a broad range of functional indicator groups involved in different ecological processes.
	Domains 3, 4, 5 and 6	Habitat structure	Typical food and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present, including a variety of food plants and signs of natural generation of shelter sources including leaf litter.
Land Use	Domains 3, 4 and 5	Land use	The site can be managed for its designated land use without any greater management inputs than other land in the area being used for a similar purpose.

A conceptual final landform is shown as **Figure 9**.

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Scale: 1:10,000
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Final Landform

FIGURE 9

13 INDICATIVE CLOSURE TIMELINE

An indicative closure timeline is shown in **Table 9** below, including the key rehabilitation and closure activities throughout the life of the project. In particular the key activities include:

- Closure planning;
- Decommissioning and rehabilitation;
- Maintenance and monitoring;
- Relinquishment; and
- Post relinquishment activities.

A revised closure timeline/schedule will be developed during closure planning, and will include activities such as:

- Salvage of plant and equipment from the underground workings and the CHPP;
- Removal of remanent coal from the site for processing through the CHPP where practicable;
- Phase 1 and 2 contamination assessments to identify contamination and the extent;
- Removal of plant, equipment and materials from the surface storage areas;
- Sealing of underground workings following shut down of the ventilation system and removal of electrical supply;
- Demolition of all buildings and surface infrastructure;
- Excavation of any contaminated soil for remediation on-site or off-site disposal;
- Removal of or capping of carbonaceous material;
- Capping and reshaping works to achieve the post-mining land use landform design, including construction of a stable drainage network; and
- Revegetation activities.

Table 9 Indicative Closure Timeline

Years from Closure	Closure Planning					Decommissioning & Rehabilitation				Monitoring & Maintenance				Relinquishment	
	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10
Closure Planning															
Stakeholder consultation regarding closure															
Agreed final detailed closure strategy															
Develop an infrastructure demolition plan															
Closure Activities															
Rejects emplacement capping															
Demolition of infrastructure															
Landform establishment															
Growth media establishment															
Ecosystem establishment															
Ecosystem development															
Post Closure Activities															
Maintenance of rehabilitated areas															
Monitoring and inspections															

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