ATTACHMENT 9

Rehabilitation Strategy
and Mine Closure Addendum

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

A9 REHABILITATION AND MINE CLOSURE

This attachment provides a description of the proposed rehabilitation strategy for the Dendrobium Mine Extension Project (the Project), including decommissioning and rehabilitation of the:

- Dendrobium Pit Top;
- Cordeaux Pit Top;
- Kemira Valley Coal Loading Facility[1];
- ventilation shaft sites;
- Dendrobium/Cordeaux electricity supply infrastructure and Kemira Valley Rail Line infrastructure;
- Dendrobium Coal Preparation Plant (CPP);
- West Cliff Stage 3 Coal Wash Emplacement Area; and
- Project underground mining area, including the remediation of subsidence impacts on natural and built features.

The South32 Limited (South32) company-wide closure standard requires all South32-controlled operations to maintain closure plans, which address closure criteria and post-mining land use (South32, 2021a). This includes requirements for the rehabilitation of disturbed areas, decommissioning of infrastructure, remediation of contaminated sites, treatment and disposal of wastes, land use options, and post-closure monitoring and management. Consideration is also given to economic transitions at mine closure and supporting sustainable communities.

A9.1 REHABILITATION AT THE APPROVED OPERATIONS

The existing *Illawarra Coal Mining Operations Plan - Dendrobium Mine and Cordeaux Colliery* (Dendrobium MOP) (South32, 2015a) describes the approved Dendrobium Mine and Cordeaux Colliery activities, as well as progress towards rehabilitation outcomes required under mining lease conditions and other statutory approvals, including Development Consent DA 60-03-2001 (as modified).

A summary of rehabilitation activities undertaken at the Dendrobium Mine and the Cordeaux Colliery, and relevant rehabilitation monitoring results, are documented in a combined Annual Review.

The West Cliff Stage 3 Coal Wash Emplacement Area was approved under the Dendrobium Mine Development Consent DA 60-03-2001 (by Modification) in December 2007.

It is noted that activities at the West Cliff Coal Wash Emplacement Area are now covered by the Appin Mine Project Approval (which includes Stage 4), approved in December 2011, in accordance with Condition 8, Schedule 5 of Development Consent DA 60-03-2001:

> 8. *All references in this consent (including conditions 3 – 7 of this schedule and Appendix 3) that have direct application to the West Cliff Coal Wash Emplacement shall cease to have force and effect subsequent to the grant of any project approval under Part 3A of the Environmental Planning & Assessment Act 1979 which includes the West Cliff Colliery and the West Cliff Coal Wash Emplacement Area.*

As such, the approved West Cliff Coal Wash Emplacement Area activities and current rehabilitation status of completed sections of the emplacement are described in the *Appin Mine Coal Wash Emplacement Area Management Plan* (Illawarra Metallurgical Coal [IMC, 2020a]) and the *Appin Mine Mining Operations Plan 1 October 2020 to 30 September 2024* (Appin Mine MOP) (IMC, 2020b).

The rehabilitation activities undertaken at the West Cliff Coal Wash Emplacement Area and relevant rehabilitation monitoring results are documented in the Appin Mine Annual Reviews.

Ongoing use of the West Cliff Stage 3 and Stage 4 Emplacements is proposed as part of the Project, notwithstanding, operation of the West Cliff Stage 3 and Stage 4 Emplacement Areas would continue under Appin Mine Project Approval 08_0150 (Section 1.1.7).

1 The Kemira Valley Coal Loading Facility domain includes the O'Briens Drift Base. The O'Briens Drift Base has been decommissioned and is no longer in use.

A9.1.1 Rehabilitation Objectives

Where relevant, existing rehabilitation objectives would be augmented or built upon for the Project (Section A9.3).

The existing overall rehabilitation objectives for the Dendrobium Mine, the Cordeaux Colliery and the West Cliff Coal Wash Emplacement Area are that the final rehabilitated landform must be:

- safe;
- stable;
- non-polluting; and
- consistent with key stakeholder expectations (where practical) and surrounding lands.

For sites other than the Kemira Valley Rail Line and Dendrobium CPP, additional rehabilitation objectives are that:

- ecosystem function should be restored with the establishment of local native plant species; and
- the ecosystem must be self-sustaining.

Specific rehabilitation objectives for the Kemira Valley Rail Line are that access, landscaping and land surfaces (i.e. safety, geotechnical stability and drainage) should be suitable for future rural/residential development.

A9.1.2 Dendrobium Mine

To date, 8.1 hectares (ha) of land has been revegetated at the Dendrobium Mine, including land associated with the Corrimal No 1 and 2 Shafts and No 2 and 3 Shafts (South32, 2021a).

The O'Briens Drift Base, a component of the Kemira Valley Coal Loading Facility, has been decommissioned and is no longer in use. O'Briens Drift Base infrastructure that remains at the Kemira Valley Coal Loading Facility includes a series of old conveyor structures and coal bins.

No further rehabilitation of land disturbed by surface activities required to support longwall mining is planned until mine closure activities commence.

The Dendrobium Mine has approved Subsidence Management Plans (SMPs) for each of the active and completed underground mining areas (Areas 1, 2, 3A and 3B), which describe the ongoing program of subsidence monitoring and management at the Dendrobium Mine (Section 4.13.1).

Subsidence parameters measured during extraction and at completion of longwalls to date are generally similar to, or less than, predictions documented within relevant SMPs. Impacts to natural features during monitoring of completed longwalls have been within the performance measures for the Dendrobium Mine.

A specific remediation program was requested by the Secretary of the Department of Planning, Industry and Environment (now Department of Planning and Environment [DPE]) for impacts to Wongawilli Creek tributary WC21 as a result of extraction of Longwalls 9 and 10. The *WC21 Rehabilitation Plan* (South32, 2015b) was submitted in March 2016 and includes surface flow monitoring and grouting at various impacted pools and rockbars along the tributary. Minor remediation works are also implemented on access tracks as a result of subsidence-induced by mining at the Dendrobium Mine.

The DPE approved the Longwall 18 SMP in November 2020. Schedule 3 Condition 10 of the SMP requires IMC to undertake remediation programs for WC21 and Donalds Castle Creek (DCC). The DPE requested IMC prepare a remediation program for DCC and the *WC21 and Donalds Castle Creek Rehabilitation Plan* (IMC, 2021b) was submitted in September 2017.

IMC is planning to undertake a trial at select remediation sites on WC21 to inform the *WC21 and Donalds Castle Creek Rehabilitation Plan* (IMC, 2021b).

A9.1.3 Cordeaux Colliery

The Cordeaux Colliery has been in care and maintenance since 2001. Since this time, some of the surface facilities associated with the Cordeaux Colliery (Figure 3-10) have been decommissioned and progressively rehabilitated. Table A9-1 summarises the rehabilitation status of the sites at the Cordeaux Colliery.

Table A9-1
Rehabilitation Status of the Cordeaux Colliery

Site	Status
Cordeaux Pit Top	Care and maintenance
Corrimal No 3 Shaft	Care and maintenance
Corrimal No 3 Shaft Coal Bins	Care and maintenance
Corrimal No 2 Shaft	Sealed and rehabilitated
Cataract Weir Pump Facility	Decommissioned and rehabilitated
Cordeaux Re-injection Borehole Field	Decommissioned and rehabilitated
Wilton Spray Irrigation Area	Decommissioned, rehabilitated and sold

The Cordeaux Pit Top was used for personnel and materials access and coal clearance for the Cordeaux Colliery prior to the Colliery being placed on care and maintenance.

The Project would involve use of the Cordeaux Pit Top for mining support activities. Decommissioning and rehabilitation of the Cordeaux Pit Top at the end of the Project life has been included in the rehabilitation planning for the Project.

The remaining sites at the Cordeaux Colliery would continue to be rehabilitated and monitored in accordance with the approved Dendrobium MOP (South32, 2015a) (or the latest approved version).

A9.1.4 West Cliff Coal Wash Emplacement Area

A portion of the coal wash produced at the Dendrobium CPP as part of the Project would be transported by road to the West Cliff Coal Wash Emplacement Area. The West Cliff Coal Wash Emplacement Area consists of four stages that are progressively developed down the valley within the contained Brennans Creek Dam catchment (Figure A9-1).

Stage 1 and Stage 2 of the Coal Wash Emplacement Area were completed in 2001 and 2010, respectively, and are currently undergoing rehabilitation. Rehabilitation of the West Cliff Stage 3 and 4 Coal Wash Emplacement Areas (once fully constructed and emplacement is completed) would continue to be conducted in accordance with Project Approval 08_0150 for the Appin Mine (Figure A9-1).

Plate A9-1 shows the West Cliff Stage 1 Coal Wash Emplacement Area approximately 14 years after completion of landform shaping and revegetation. Plate A9-2 shows the West Cliff Stage 2 Coal Wash Emplacement Area approximately five years after completion of landform shaping, with a dense cover of shrubs and high native species diversity.

The rehabilitation methodology undertaken for the West Cliff Stage 2 Coal Wash Emplacement Area is outlined in the *Appin Mine Coal Wash Emplacement Area Management Plan* (IMC, 2020a). Monitoring of rehabilitation performance of the West Cliff Stage 2 Coal Wash Emplacement Area against set performance indicators has demonstrated (IMC, 2020a):

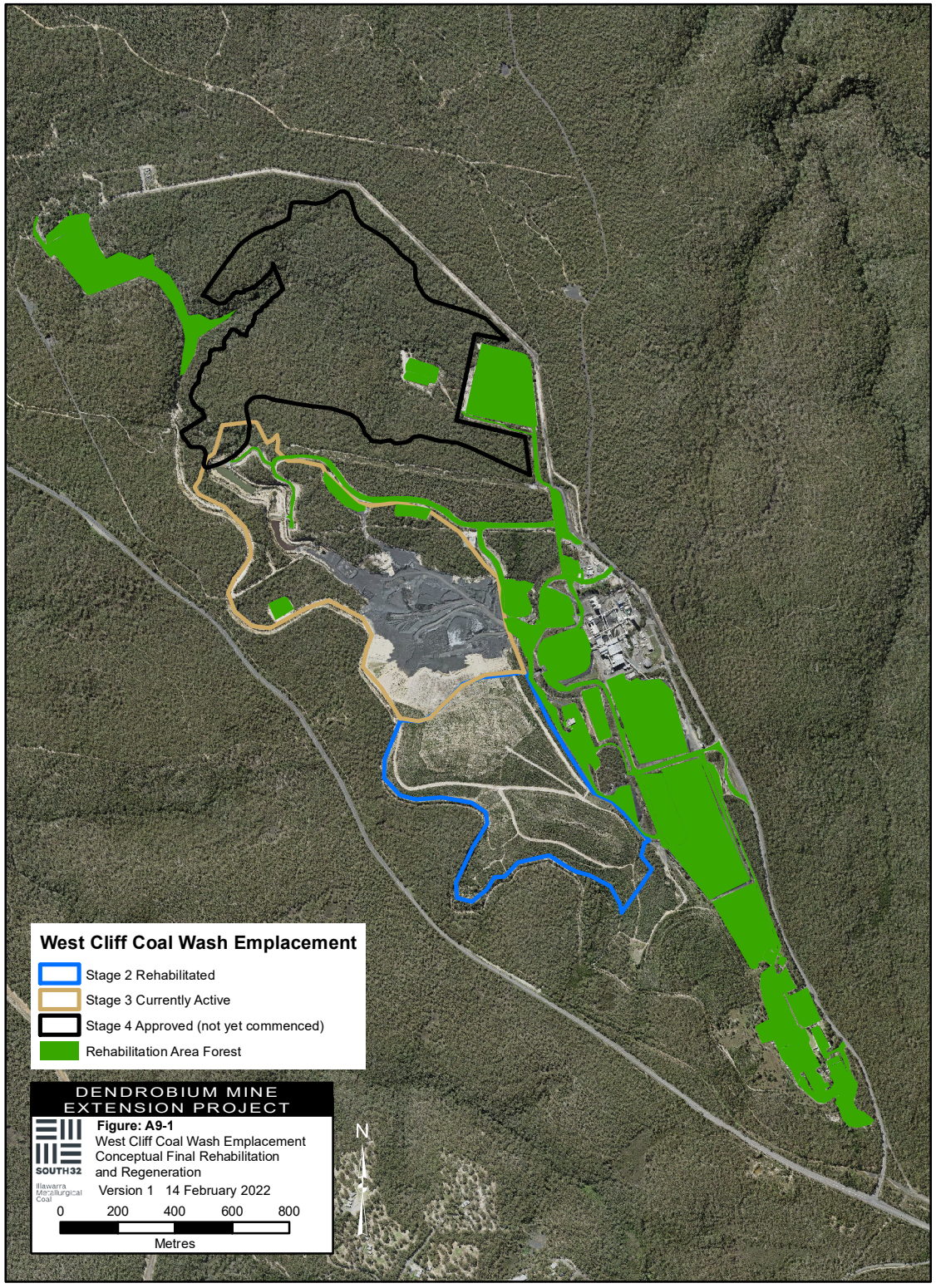
- Between 50 and 70 individual flora species in monitoring transects, significantly higher than benchmark levels recorded for local vegetation types in the surrounding area.
- Good general vegetation cover including difficult to grow species (such as heaths, sedges, rushes, *Persoonia* spp.).
- Two threatened plant species in the rehabilitation area (*Pultenaea aristata* and *Persoonia hirsuta*).
- Evidence that species have seeded multiple times and young germinates are present, indicating the emplacement will be self-sustaining over time (seed fall provides further resilience in the inadvertent event of a bushfire).

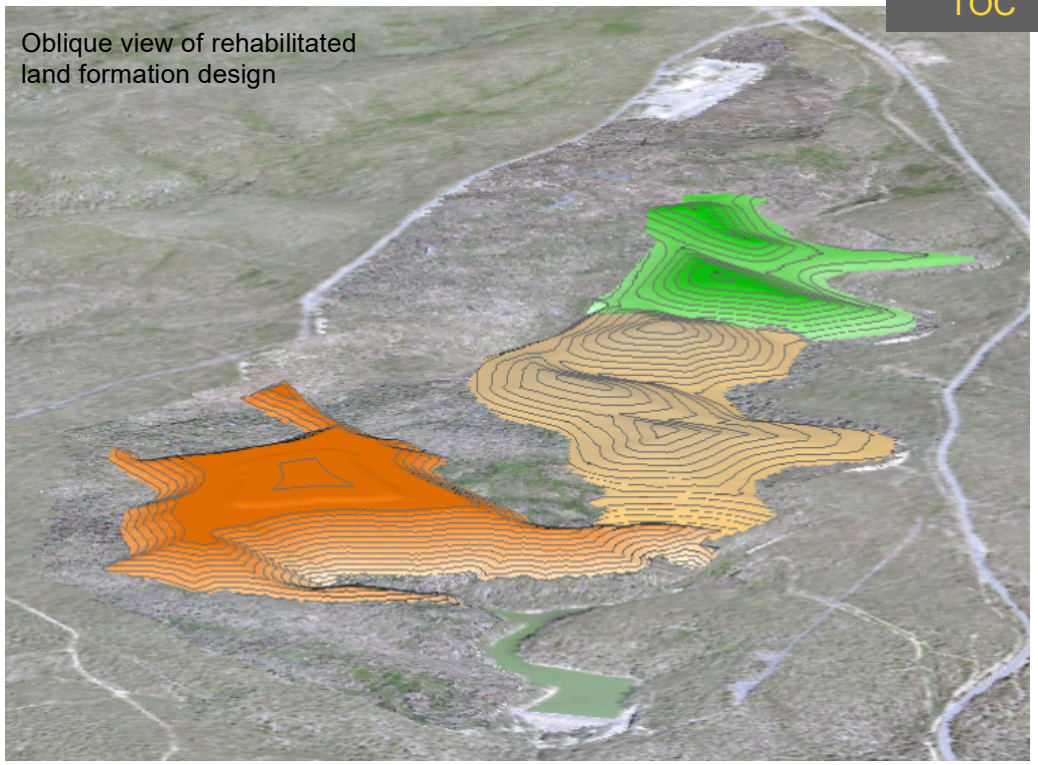
The success of the rehabilitation at the West Cliff Stage 2 Coal Wash Emplacement Area supports the continued use of the current methodology and rehabilitation practices at the West Cliff Stage 3 Coal Wash Emplacement Area (Sections A9.3 and A9.4).

A9.2 REGULATORY REQUIREMENTS

A9.2.1 Regulatory Framework

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and *Environmental Planning and Assessment Regulation 2021* set the framework for planning and environmental assessment in New South Wales (NSW). Approval for the Project will be sought under the State Significant Infrastructure provisions of Part 5 of the EP&A Act. This Addendum forms part of an EIS which has been prepared to accompany an Infrastructure Application for the Project.


West Cliff Coal Wash Emplacement
Stage 2 Rehabilitated
Stage 3 Currently Active
Stage 4 Approved (not yet commenced)
Rehabilitation Area Forest
DENDROBIUM MINE EXTENSION PROJECT
Figure: A9-1
West Cliff Coal Wash Emplacement
Conceptual Final Rehabilitation
and Regeneration
Version 1 14 February 2022
SOUTH32
Illawarra Metallurgical Coal
0 200 400 600 800
Metres
N


Oblique view of rehabilitated
land formation design

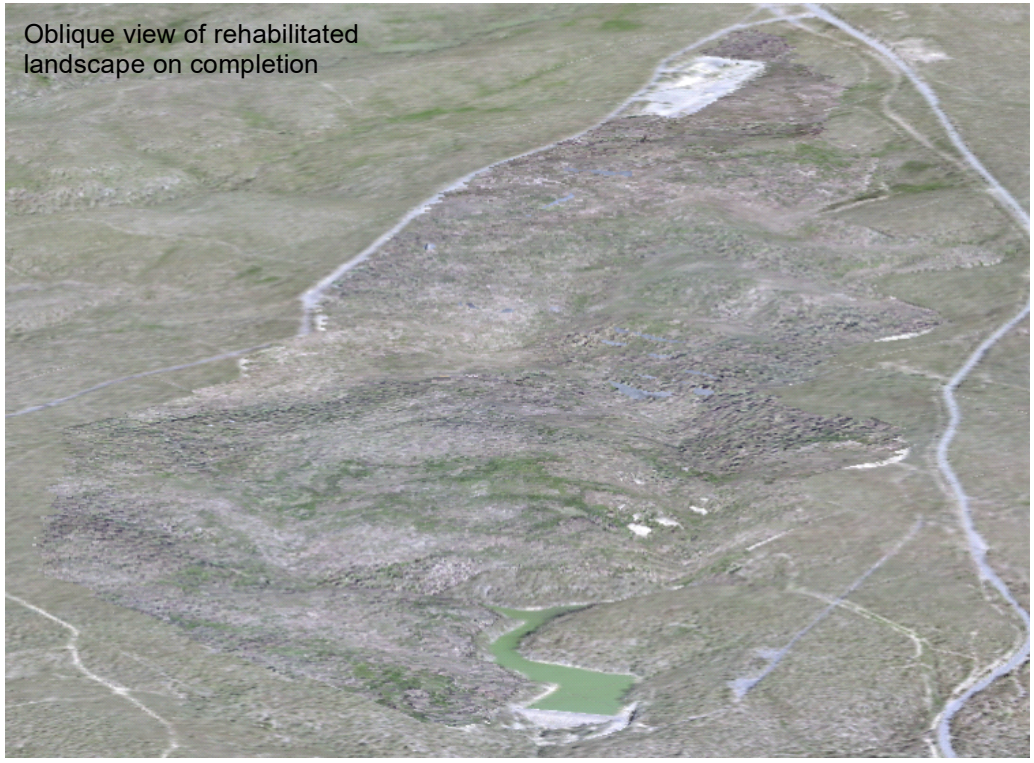

Oblique view of rehabilitated
landscape on completion

Plate A9-1 – West Cliff Stage 1 Coal Wash Emplacement Area – 14 Years After Completion
Source: Illawarra Coal (2015).

Plate A9-2 – West Cliff Stage 2 Coal Wash Emplacement Area – Five Years After Completion
Source: Illawarra Coal (2015).

Subject to approval of the Project under the EP&A Act, an Infrastructure Approval would be issued that would prescribe the rehabilitation and mine closure conditions relevant to the Project. The Infrastructure Application would also require the preparation of management plans that describe how activities would be undertaken at the site to manage potential environmental impacts (including rehabilitation activities).

The objects of the *Mining Act 1992* are to encourage and facilitate the discovery and development of mineral resources in NSW, having regard to the need to encourage ecologically sustainable development. Under the *Mining Act 1992*, environmental protection and rehabilitation are regulated by conditions included in all mining leases, including requirements for the submission of a Forward Program that provides a schedule of mining activities, a Rehabilitation Management Plan (RMP) (formerly MOP), and subsequent Annual Rehabilitation Reports.

Rehabilitation activities must be carried out in accordance with an RMP. The RMP describes the rehabilitation objectives, completion criteria and final land use outcomes (among other things) required under mining lease conditions and approval conditions under the EP&A Act. The Forward Program details the spatial progression of mining development and rehabilitation.

An RMP would be developed to address Project operations at the Dendrobium Mine and the Cordeaux Colliery. Preparation of this RMP would occur in consultation with the relevant Government agencies, and in accordance with the rehabilitation and closure standards outlined in the relevant RMP Guidelines (NSW Government, 2021) (or the latest version).

The RMP would describe how rehabilitation is undertaken, provide rehabilitation performance and completion criteria, and address all aspects of rehabilitation including mine closure, final landforms and final land use.

IMC operates the Dendrobium Mine in accordance with the approved MOP. Where relevant, this Addendum draws on information from the approved MOP. The MOP would change to an RMP in July 2022.

All titleholders engaged in mining activities are required to lodge a security deposit. The security deposit covers the NSW Government's full estimated costs in undertaking rehabilitation in the event of default by the titleholder. The security deposit is reviewed and progressively increased or decreased, based on the extent of disturbed land and rehabilitation activities described in each new or amended RMP.

A9.2.2 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements (SEARs) for the Project were issued by the NSW DPE on 23 December 2021. Relevant Government agencies provided input into the SEARs, including the Resources Regulator.

The SEARs relevant to this Addendum are summarised in Table A9-2.

A9.2.3 Agency Input into Secretary's Environmental Assessment Requirements

A summary of the input provided by the Resources Regulator relevant to this Addendum and where it is addressed, is provided in Table A9-3.

The success of the rehabilitation at the West Cliff Stage 2 Coal Wash Emplacement Area supports the continued use of the current methodology and rehabilitation practices at the West Cliff Stage 3 Coal Wash Emplacement Area (Sections A9.3 and A9.4).

A9.3 REHABILITATION OF THE PROJECT

Rehabilitation planning for the Project was informed by existing mine closure and rehabilitation objectives and current rehabilitation practices implemented for the Dendrobium Mine and the Cordeaux Colliery.

In addition, the Mining Development Rehabilitation Standard SEARs recommended by Mining, Exploration and Geoscience have been considered during rehabilitation planning for the Project. Rehabilitation planning and implementation for the Project would be undertaken in accordance with requirements of the Project MLs and the requirements of the *Mining Act 1992*.

Mine closure and rehabilitation objectives have been developed for the underground mining area and new surface facilities that would be developed for the Project.

Table A9-2
Secretary's Environmental Assessment Requirements

Requirement	Report Section
General Requirements *In particular, the EIS must include:* … - *a rehabilitation strategy;*	This Document
14. Rehabilitation and Final Landform *– including:* - *a Rehabilitation Strategy addressing:* ○ *final land-use options and preferred final land use;*	Sections A9.3.2 and A9.3.3
○ *final landform including the conceptual final landform design;*	Sections A9.3.2 and A9.3.3
○ *how the rehabilitation of the project will relate to the rehabilitation strategies of neighbouring mines;*	Section A9.3.5
○ *management of potential post-mining groundwater discharges; and*	Section A9.8 and Appendix Q
○ *inclusion of rehabilitation objectives and completion criteria to achieve the nominated post-mining land use for each mining domain.*	Sections A9.3.1 to A9.3.4
The Rehabilitation Strategy is to have regard to the advice of the Resources Regulator (see Attachment 2); and	Table A9-3 and this Document
- *identification and discussion of opportunities to improve rehabilitation and environmental outcomes for existing disturbed areas within the project site, and barriers or limitations to effective rehabilitation.*	Section A9.7

Table A9-3
Resources Regulator Advice on the Project SEARs

Requirement	Report Section
• *The environmental assessment that accompanies the development application must include a description and assessment of any exploration activities that will be undertaken throughout the mine life. This must also address the progressive rehabilitation of areas disturbed by exploration activities.*	Section 4 of the EIS
• *The environmental assessment that accompanies the development application must include a separate section entitled 'Rehabilitation Strategy' which addresses the following matters:*	This Document
○ *Final land use(s)*	Sections A9.3.2 and A9.3.3
○ *Identification and assessment of final (i.e. post-mining) land use options.*	Sections A9.3.2 and A9.3.3
○ *Identification and justification of the preferred final land use outcome(s), including a discussion of how the final land use(s) are aligned with relevant local and regional strategic land use objectives and surrounding land uses.*	Sections A9.3.2 and A9.3.3
○ *Identification of how the rehabilitation of the project will relate to the rehabilitation strategies of any neighbouring mines within the region, with a particular emphasis on the coordination of rehabilitation activities along common boundary areas.*	Section A9.3.5
○ *Inclusion of a set of project rehabilitation objectives that clearly define the outcomes required to achieve the final (post-mining) land use for each mining domain. Each mining domain must have a stated final land use and rehabilitation objectives (which describe the desired features and/or characteristics of the final land use domain). Rehabilitation objectives must include, where relevant, target vegetation communities.*	Sections A9.3.1 to A9.3.4
○ *determine (with reference to the groundwater assessment) the likelihood and associated impacts of groundwater accumulating and subsequently discharging (e.g. acid or neutral mine drainage) from the underground workings post cessation of mining; and*	Section A9.8 and Appendices B and Q

Table A9-3 (Continued)
Resources Regulator Advice on the Project SEARs

Requirement	Report Section
○ *consideration of the likely controls required to either prevent or mitigate against these risks as part of the closure plan for the site.*	Section A9.8 and Appendix Q
○ *Where an ecological land use is proposed, demonstrate how the revegetation strategy (e.g. seed mix, habitat features, corridor width, aspect, etc.) has been developed in consideration of the target vegetation community(s).*	Section A9.4.5

The following documents were considered during the review and development of the mine closure and rehabilitation objectives:

- *Guideline: Rehabilitation Objectives and Rehabilitation Completion Criteria* (NSW Resources Regulator, 2021a);
- *Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation* (Commonwealth Department of Industry, Innovation and Science [DIIS], 2016a);
- *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure* (DIIS, 2016b); and
- *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2000).

The above guidelines have been applied as they relate to this initial stage of rehabilitation planning. The guidelines and applicable future guidance materials would continue to be considered further in the subsequent RMPs over the life of the Project, should the Project be approved.

A9.3.1 General Rehabilitation and Mine Closure Criteria

In the long-term, all sites would be rehabilitated to a safe, stable and sustainable landform of a similar character to surrounding areas.

The general rehabilitation and mine closure goals for the Project would be to:

- comply with relevant or applicable legislative requirements;
- protect public and employee health, safety and welfare;
- limit or mitigate adverse environmental effects;
- protect Indigenous values; and
- achieve sustainable land use as agreed with the applicable Government regulator, and engagement with local communities.

The objectives of mine subsidence remediation specific to rehabilitation would be to:

- avoid or minimise impacts to significant environmental values;
- implement Trigger Action Response Plans to identify, assess and respond to impacts;
- carry out mitigation and remediation works in a manner that is reasonable and feasible, to minimise impacts on the environmental values of the area;
- achieve the defined performance measures; and
- monitor and report on the effectiveness of the mitigation and remediation works.

Further investigations would be conducted closer to the end of the Project life to further inform mine closure planning and may include, but not be limited to:

- geotechnical investigations;
- hazardous materials investigations;
- non-Aboriginal heritage studies;
- water flow and quality assessments;
- risk assessments;
- the preparation of detailed rehabilitation plans;
- the preparation of detailed engineering design drawings; and
- mine closure (sealing) studies.

Mined lands would be considered suitable for relinquishment when the nominated standards and/or completion criteria have been met, or if the relevant Minister(s) otherwise accept(s) the rehabilitation status. Anticipated mine lease relinquishment criteria are outlined in Section A9.9.

Stakeholder consultation is recognised as an important component of the mine closure process. A stakeholder consultation strategy specific to closure would be developed and implemented at an appropriate time prior to Project closure, and would include consideration of the potential adverse socio-economic effects due to a reduction in employment (Sections 7.19 and 7.20).

A9.3.2 Final Land Use and Conceptual Final Landform

Final Land Use

IMC has assessed potential final (post-mining) land uses (e.g. nature conservation, agriculture), taking into account relevant strategic land use objectives for the area in the vicinity of the Project. The potential benefits of the final land use to the environment, future landholders and the community have also been considered.

The proposed life of the Project is to 31 December 2041. This extended timeframe limits the certainty with which the final land use can be defined, as mine and stakeholder requirements may be subject to change over this period.

A number of final land uses have been considered for the Project in consideration of strategic land use objectives and land zoning and may be appropriate if agreed with the final landholder and relevant stakeholders. The final land uses considered for various components of the Project include:

- Native vegetation/conservation.
- Light/heavy industrial land uses (Dendrobium CPP, Kemira Valley Coal Loading Facility and Dendrobium Pit Top).
- Special-purpose historical tourism (Pit Tops and Kemira Valley Coal Loading Facility and O'Briens Drift Base).
- Continuation of use of the Kemira Valley Rail Line for materials handling/transportation.
- Rail terminus/line for tourist activity (Kemira Valley Coal Loading Facility and Rail Line).
- Residential development opportunities in land surrounding the Dendrobium Pit Top.
- Pastoral land.
- Wildlife/green corridor (Kemira Valley Rail Line).

For the purposes of rehabilitation and mine closure planning for the Project, a final land use of native vegetation has been selected for the majority of domains. Native vegetation represents the highest standard of rehabilitation likely to be required for all relevant sites.

An interim final land use of light industrial has been selected for the Dendrobium CPP, although a final land use of heavy industrial may also be adopted in consultation with relevant stakeholders. The Dendrobium CPP is located within the Port Kembla Steelworks precinct. The Port Kembla Steelworks precinct is owned and operated by a separate legal entity (BlueScope Steel), which has responsibility for the closure of the Dendrobium CPP. IMC pays a fee for the use of the facility, and the funds for closing the site are set aside from these fees.

Further discussion on alternative final land uses is provided in Section A9.3.2.

Conceptual Final Landforms

The final landform in surface development areas has been designed to be generally consistent with the topography of the surrounding landscape and appropriate for the final land use.

The land disturbed by surface activities associated with the Project would be re-profiled, as per the approved final landform design. The final landform design aims to reduce the slope lengths by constructing contour banks and armouring channels to prevent erosion (Section A9.4.9). Depending on the agreed final land use, surface drainage would be reinstated as closely as possible to pre-mining conditions.

Figure A9-1 illustrates the approved conceptual rehabilitated final landform of the West Cliff Stage 3 Coal Wash Emplacement Area.

The West Cliff Stage 3 Coal Wash Emplacement Area final landform has been designed to:

- mimic micro-topographic features;
- have batter slopes constructed at a maximum grade of 1(Vertical):3(Horizontal); and
- limit erosion and sediment runoff using concave slope profiles and slope angles seen in natural landforms.

The finished surface profile of the emplacement would be in accordance with design contours, as defined in the approved *Appin Mine Coal Wash Emplacement Area Management Plan* in accordance with the Appin Mine Project Approval 08_0150 (IMC, 2020a).

Figure A9-2 provides cross-sections of the approved conceptual final landform of the West Cliff Stage 3 Coal Wash Emplacement Area. The cross-section indicates that the final landform for the emplacement is compatible with natural topographic variation in the area.

A9.3.3 Final Land Use Domains and Conceptual Objectives

Conceptual final land use domains for the Project have been developed based on the mining domains for the Project operational/disturbance areas and the Project final land use, consistent with the NSW Resources Regulator's (2021b) *Form and Way Rehabilitation Management Plan for Large Mines* (Figures A9-3 to A9-5) (Table A9-4).

The Project would comprise the following mining domains[2]:

- Pit tops and ROM coal handling facilities – Dendrobium Pit Top, Cordeaux Pit Top and Kemira Valley Coal Loading Facility and O'Briens Drift Base (Domains 1, 2 and 5).
- Ventilation shaft sites – including Dendrobium No 1 Shaft, No 2 and 3 Shafts and Shaft Site No. 5A (Domains 3, 7 and 11).
- Powerlines and rail line – Dendrobium/Cordeaux powerlines, electricity transmission line (ETL) to Shaft Site No. 5A and Kemira Valley Rail Line (Domains 8, 9 and 11).
- Underground Mining Area (Domain 10).
- West Cliff Coal Wash Emplacement Area (Domain 12).
- Dendrobium CPP (Domain 13).

Conceptual mine closure and rehabilitation objectives were determined for the mining domains based on the following rehabilitation phases, as defined by *Guidelines: Rehabilitation Objectives and Rehabilitation Completion Criteria* (NSW Resources Regulator, 2021a):

- Decommissioning;
- Landform Establishment;
- Growth Medium Development;
- Ecosystem and Land Use Establishment; and
- Ecosystem and Land Use Development.

The mine closure and rehabilitation objectives for the final land use for the Project mining domains are summarised in Table A9-5.

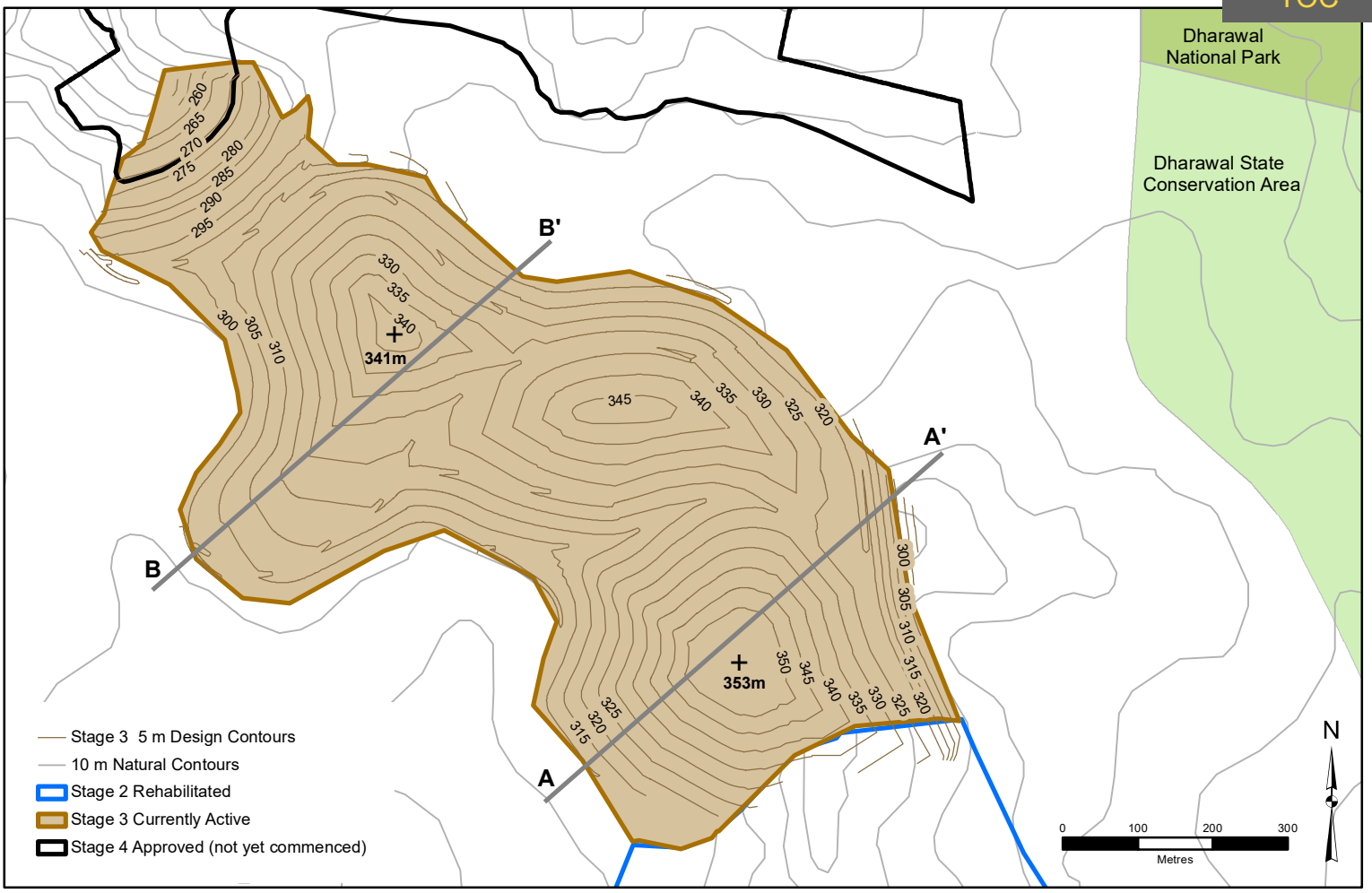
A9.3.4 Provisional Rehabilitation Completion Criteria

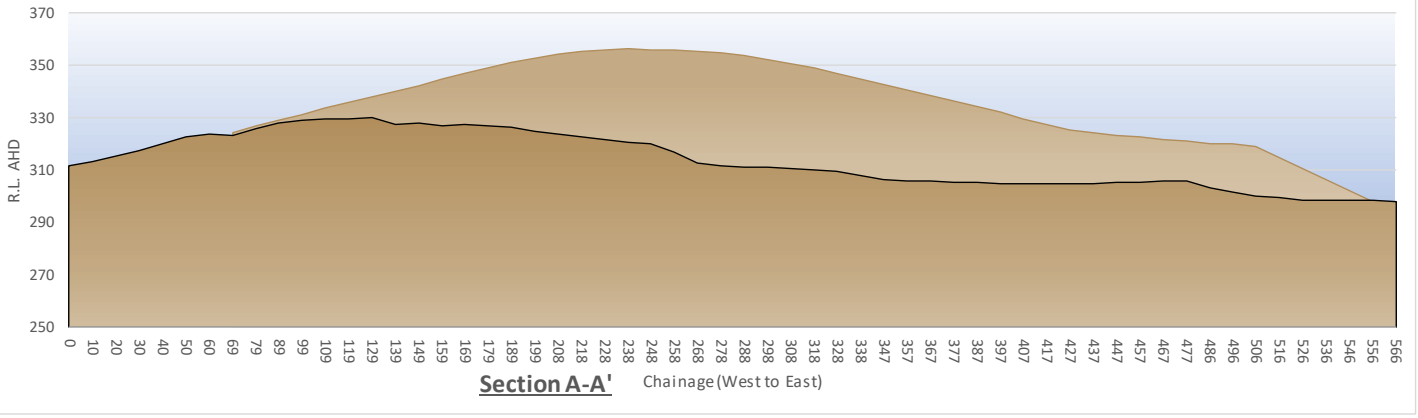
Provisional rehabilitation completion criteria have been developed for the Project with regard to the *Guidelines: Rehabilitation Objectives and Rehabilitation Completion Criteria* (NSW Resources Regulator, 2021a) and the *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure* (DIIS, 2016b).

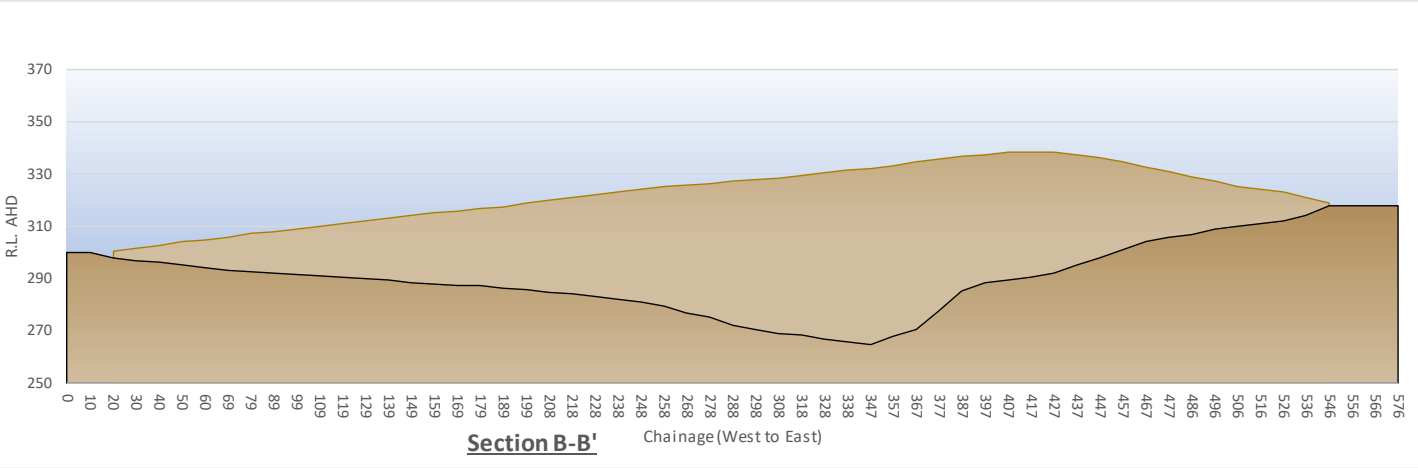
It is appropriate that the rehabilitation completion criteria described remain provisional and at the strategic level for this EIS.

An RMP would be developed for the Project and would incorporate the proposed changes in operations at the Dendrobium Mine and the Cordeaux Colliery.

[2] Domain numbers have been adopted for consistency with the existing Dendrobium MOP (2015-2022). Domain 4 (O'Briens Drift Top) and Domain 6 (Corrimal No 3 Shaft and Coal Bins) would not form part of the Project. Domains 4 (O'Briens Drift Top) and 6 (Corrimal No 3 Shaft and Coal Bins) would continue to be managed and rehabilitated in accordance with the Dendrobium MOP.





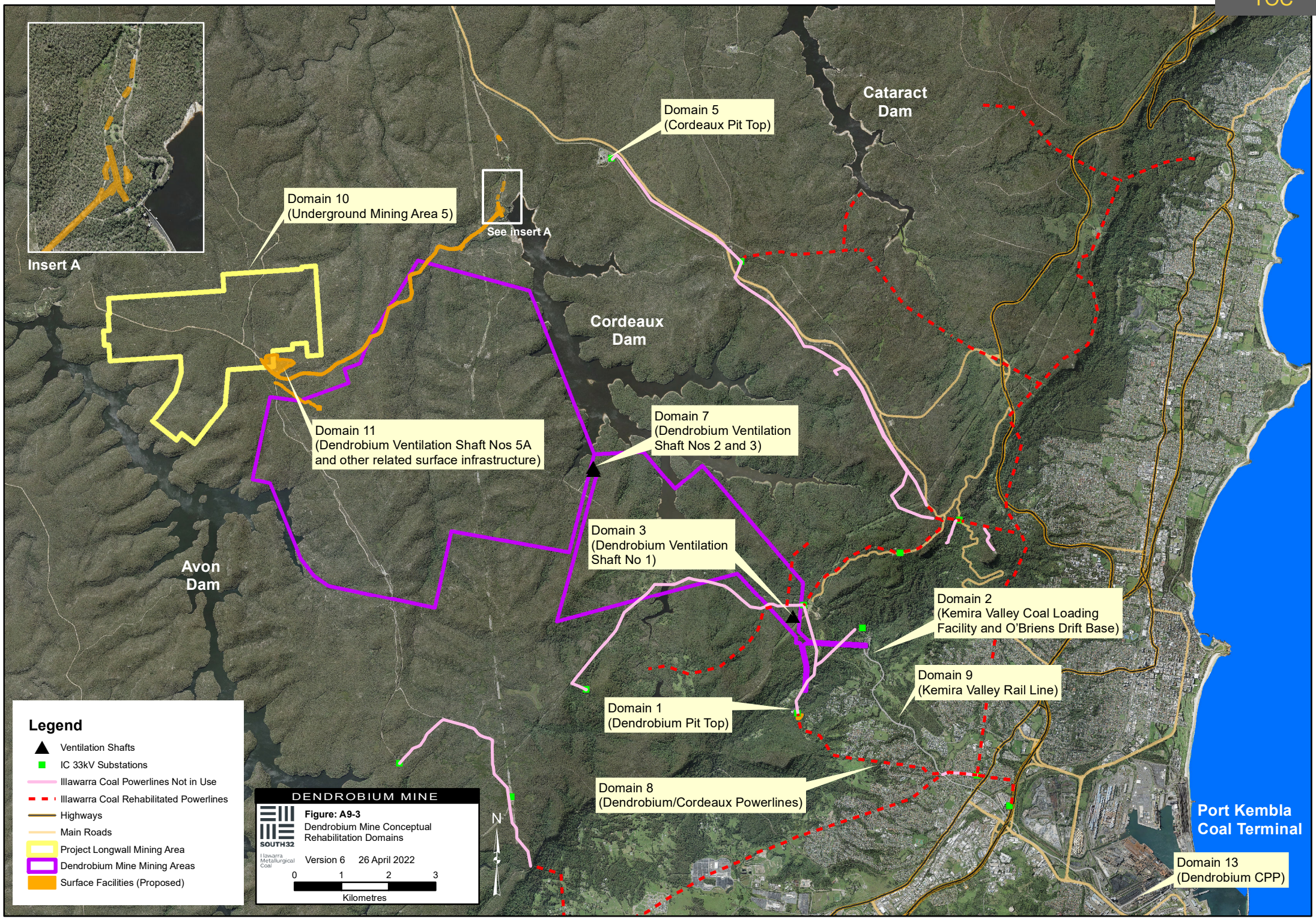


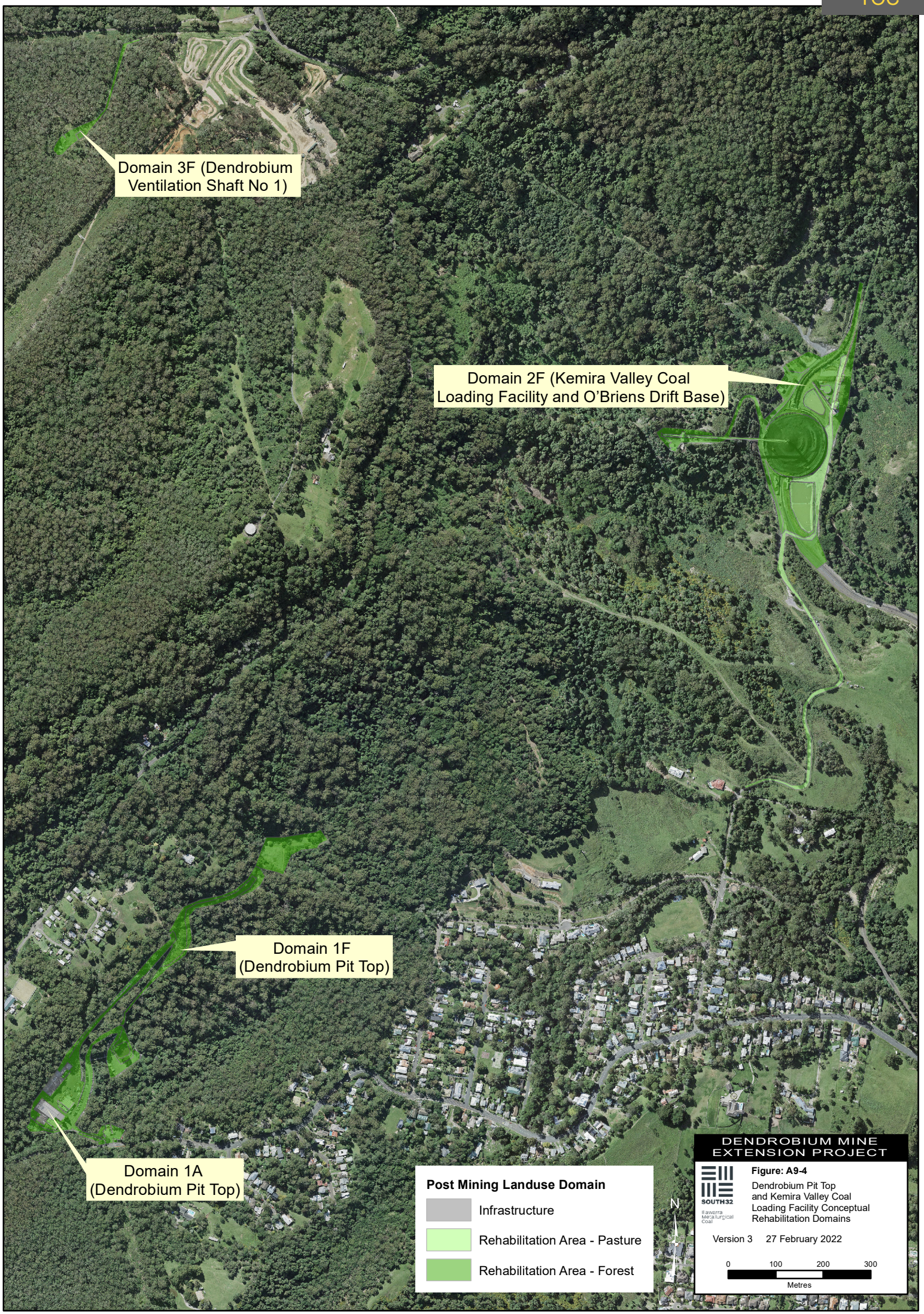
DENDROBIUM MINE EXTENSION PROJECT

Figure: A9-2

Conceptual Cross Sections of the Rehabilitated Mine Landform of the West Cliff Stage 3 Coal Wash Emplacement

Version 1 14 February 2022


Insert A
Domain 10
(Underground Mining Area 5)
See insert A
Domain 5
(Cordeaux Pit Top)
Cataract
Dam
Cordeaux
Dam
Domain 11
(Dendrobium Ventilation Shaft Nos 5A
and other related surface infrastructure)
Domain 7
(Dendrobium Ventilation
Shaft Nos 2 and 3)
Domain 3
(Dendrobium Ventilation
Shaft No 1)
Avon
Dam
Domain 2
(Kemira Valley Coal Loading
Facility and O'Briens Drift Base)
Domain 9
(Kemira Valley Rail Line)
Domain 1
(Dendrobium Pit Top)
Domain 8
(Dendrobium/Cordeaux Powerlines)
Port Kembla
Coal Terminal
Domain 13
(Dendrobium CPP)
Legend
Ventilation Shafts
IC 33kV Substations
Illawarra Coal Powerlines Not in Use
Illawarra Coal Rehabilitated Powerlines
Highways
Main Roads
Project Longwall Mining Area
Dendrobium Mine Mining Areas
Surface Facilities (Proposed)
DENDROBIUM MINE
SOUTH32
Illawarra Metallurgical Coal
Figure: A9-3
Dendrobium Mine Conceptual
Rehabilitation Domains
Version 6 26 April 2022
0 1 2 3
Kilometres
N


Domain 3F (Dendrobium Ventilation Shaft No 1)
Domain 2F (Kemira Valley Coal Loading Facility and O'Briens Drift Base)
Domain 1F (Dendrobium Pit Top)
Domain 1A (Dendrobium Pit Top)
Post Mining Landuse Domain
Infrastructure
Rehabilitation Area - Pasture
Rehabilitation Area - Forest
N
DENDROBIUM MINE EXTENSION PROJECT
SOUTH32
Illawarra Metallurgical Coal
Figure: A9-4
Dendrobium Pit Top and Kemira Valley Coal Loading Facility Conceptual Rehabilitation Domains
Version 3 27 February 2022
0 100 200 300
Metres


Domain 5F
(Cordeaux Pit Top)
Post Mining Landuse Domain
Rehabilitation Area - Forest
N
DENDROBIUM MINE
EXTENSION PROJECT
Figure: A9-5
Cordeaux Pit Top Conceptual
Rehabilitation Domains
SOUTH32
Illawarra
Metallurgical
Coal
Version 2 24 February 2022
0 50 100 150
Metres

Table A9-4
Mining and Conceptual Final Land Use Domains

Project Mining Domain		Indicative Final Land Use Domain for the Project[3]
Domain 1: Dendrobium Pit Top	1. Infrastructure Area 3. Water Management Area	A. Infrastructure F. Rehabilitation Area – Forest
Domain 2: Kemira Valley Coal Loading Facility and O'Briens Drift Base[2]	1. Infrastructure Area 3. Water Management Area 5. Stockpiled Material	A. Infrastructure D. Rehabilitation Area – Pasture F. Rehabilitation Area – Forest
Domain 3: No 1 Shaft	1. Infrastructure Area	F. Rehabilitation Area – Forest
Domain 5: Cordeaux Pit Top	1. Infrastructure Area 3. Water Management Area	F. Rehabilitation Area – Forest
Domain 7: No 2 and 3 Shafts	1. Infrastructure Area 3. Water Management Area	E. Rehabilitation Area – Woodland
Domain 8: Dendrobium/Cordeaux Powerlines	1. Infrastructure Area	F. Rehabilitation Area – Forest
Domain 9: Kemira Valley Rail Line	1. Infrastructure Area	A. Infrastructure E. Rehabilitation Area – Woodland
Domain 10: Underground Mining Area (other surface infrastructure)	8. Underground Mining Area	A. Infrastructure F. Rehabilitation Area – Forest
Domain 11: Shaft Site No 5A (No 4 and 5 Shafts) and related surface infrastructure (e.g. ETL, water supply pipelines, etc).	1. Infrastructure Area	F. Rehabilitation Area – Forest or fire break
Domain 12: West Cliff Coal Wash Emplacement Area[4]	2. Tailings and Rejects 3. Water Management Area 9. Conservation and Biodiversity Offset Area	F. Rehabilitation Area – Woodland
Domain 13: Dendrobium CPP	1. Infrastructure Area	A. Infrastructure

1 Domain numbers have been adopted for consistency with the existing Dendrobium MOP (2015-2022). Domain 4 (O'Briens Drift Top) and Domain 6 (Corrimal No 3 Shaft and Coal Bins) would not form part of the Project. Domains 4 (O'Briens Drift Top) and 6 (Corrimal No 3 Shaft and Coal Bins) would continue to be managed and rehabilitated in accordance with the Dendrobium MOP.

2 The O'Briens Drift Base has been decommissioned and is no longer in use.

3 Final land use domains for the Project are indicative and subject to change following preparation of future RMP and stakeholder engagement.

4 The West Cliff Coal Wash Emplacement Area is covered by the *Appin Mine Coal Wash Emplacement Area Management Plan* (IMC, 2020a) and Appin Mine MOP.

Table A9-5
Rehabilitation Phases and Objectives

Rehabilitation Domain	Final Land Use Domain	Rehabilitation Phase	Domain Rehabilitation Objective
Pit Tops and ROM Coal Handling Facilities	A. Infrastructure F. Rehabilitation Area – Forest	Decommissioning	• All infrastructure removed to ensure site is safe and free of hazardous materials (subject to heritage and alternative end use considerations). • Site is safe, stable and non-polluting. • Portals and mine entrances are decommissioned and sealed. • Any contaminated soils identified are remediated by removal, encapsulation or land-farming on-site.
		Landform Establishment	• Final landform established is consistent with the surrounding environment or final land use. • Final landform is stable with minimal erosion.
		Growth Medium Development	• Plant growth medium is established.

Table A9-5 (Continued)
Rehabilitation Phases and Objectives

Rehabilitation Domain	Final Land Use Domain	Rehabilitation Phase	Domain Rehabilitation Objective
Pit Tops and ROM Coal Handling Facilities (continued)	A. Infrastructure F. Rehabilitation Area – Forest	Ecosystem and Land Use Establishment	• Ecosystem function is restored with local native plant species.
		Ecosystem and Land Use Development	• Ecosystem is self-sustaining.
Ventilation Shaft Sites	E. Rehabilitation Area – Woodland F. Rehabilitation Area – Forest	Decommissioning	• All infrastructure removed to ensure site is safe and free of hazardous materials (subject to heritage and alternative end use considerations). • Site is safe, stable and non-polluting. • Ventilation shafts are decommissioned and sealed. • Any contaminated soils identified are remediated by removal, encapsulation or land-farming on-site.
		Landform Establishment	• Final landform established is consistent with the surrounding environment. • Landform is stable with minimal erosion.
		Growth Medium Development	• Plant growth medium is established.
		Ecosystem and Land Use Establishment	• Ecosystem function is restored with local native plant species.
		Ecosystem and Land Use Development	• Ecosystem is self-sustaining.
Powerlines and Rail Line	A. Infrastructure F. Rehabilitation Area – Forest or fire break	Decommissioning	• All infrastructure removed to ensure site is safe and free of hazardous materials (subject to heritage and alternative end use considerations and landowner requirements, as relevant). • Site is safe, stable and non-polluting. • Any contaminated soils identified are remediated by removal, encapsulation or land-farming on-site.
		Landform Establishment	• Final landform is stable with minimal erosion.
		Growth Medium Development	• Plant growth medium is established.
		Ecosystem and Land Use Establishment	• Disturbed sites' rehabilitation is consistent with surrounding land use.
		Ecosystem and Land Use Development	• Site is returned to agreed final land use.
Underground Mining Area (other surface infrastructure)	A. Infrastructure[2] F. Rehabilitation Area – Forest	Decommissioning	• All infrastructure removed to ensure site is safe and free of hazardous materials (subject to heritage and alternative end use considerations). • Site is safe, stable and non-polluting. • Any contaminated soils identified are remediated by removal, encapsulation or land-farming on-site.
		Landform Establishment	• Landform is stable with minimal erosion.
		Growth Medium Development	• Plant growth medium is established.
		Ecosystem and Land Use Establishment	• Ecosystem function is restored with local native plant species.
		Ecosystem and Land Use Development	• Ecosystem is self-sustaining.

Table A9-5 (Continued)
Rehabilitation Phases and Objectives

Rehabilitation Domain	Final Land Use Domain	Rehabilitation Phase	Indicative Domain Rehabilitation Objective
West Cliff Coal Wash Emplacement Area	F. Rehabilitation Area – Forest	Decommissioning	• Remove all infrastructure to ensure site is safe, as required (i.e. water management infrastructure may be retained) (subject to alternative end use considerations).
		Landform Establishment	• Final landform established is consistent with the surrounding environment or final land use. • Final landform is stable with minimal erosion.
		Growth Medium Development	• Plant growth medium is established.
		Ecosystem and Land Use Establishment	• Ecosystem function is restored with local native plant species.
		Ecosystem and Land Use Development	• Ecosystem is self-sustaining.
Dendrobium CPP	A. Infrastructure	Decommissioning	• Remove all infrastructure to ensure site is safe and free of hazardous materials (subject to heritage and alternative end use considerations). • Site is safe, stable and non-polluting. • Any contaminated soils identified are remediated by removal, encapsulation or land-farming on-site.
		Landform Establishment	• Final landform established is consistent with the surrounding environment or final land use and facilitates drainage. • Final landform is stable with minimal erosion.

[1] Subsidence remediation is described in Sections A9.4.6 to A9.4.8.

[2] Other surface infrastructure may include service boreholes, access tracks, etc.

The RMP would describe the provisional rehabilitation completion criteria, including more detailed and quantified criteria where applicable (based on the Infrastructure Approval conditions for the Project). The rehabilitation completion criteria included in the RMP would be specific, measurable, realistic and time-bound and would be developed in consideration of the NSW Resources Regulator (2021a) *Guideline: Rehabilitation Objectives and Rehabilitation Completion Criteria*.

Rehabilitation of the West Cliff Coal Wash Emplacement Area would continue to be conducted in accordance with the *Appin Mine Coal Wash Emplacement Area Management Plan* (IMC, 2020a) and the Appin Mine MOP (IMC, 2020b) or future RMP.

Over the life of the Project, rehabilitation completion criteria would, periodically, be updated and refined in consultation with relevant regulatory authorities and stakeholders to reflect evolving mine site rehabilitation practices and standards.

The key provisional rehabilitation strategic completion criteria for the Project are described below.

Decommissioning

1. All non-heritage listed buildings and infrastructure decommissioned and removed (including offices, workshops, fuel tanks, ventilation shaft infrastructure [i.e. fan housing and winders], transformers, electrical services [i.e. powerlines and posts], rail infrastructure [i.e. rails and sleepers], roads and other buildings).
2. Portals, ventilation shafts and mine entrances decommissioned and sealed in accordance with the RMP and Department of Mining, Exploration and Geoscience (within the Department of Regional NSW) (MEG) requirements (Section A9.8).
3. Water and soil contaminants are within applicable National Water Quality Management Strategy, ANZECC and EPL guidelines.

Landform Establishment

1. Each domain re-profiled to the final landform design in accordance with the RMP (Section A9.8).
2. Surface water management infrastructure designed and implemented in line with the approved Water Management Plan.

Growth Medium Development

1. Bare or stripped areas that are to be returned to vegetation would be topsoiled or ameliorated in accordance with the RMP. Topsoil depth would be determined by the desired vegetation, quantity and quality of the surface and subsoil available, and the nature of the underlying material.

Ecosystem and Land Use Establishment

1. Each domain rehabilitated as per the Project RMP, utilising local and native species. Generally, the area would be ripped and seeded using the appropriate method.

Ecosystem and Land Use Development

1. Adequate species diversity, succession and habitat development that meets applicable benchmark levels, as confirmed by survey (e.g. using BioMetric attributes).
2. Satisfies the final land use objective, as agreed with relevant regulatory authorities and stakeholders. Followed by lease relinquishment where applicable.

A9.3.5 Interaction of Rehabilitation of the Project with Neighbouring Mines

The following sub-sections describe the potential interaction of the following Project activities with the rehabilitation and mine closure activities of neighbouring mines:

- longwall mining in Area 5;
- surface activities (i.e. continued use of existing surface facilities and development of Project surface facilities); and
- underground mine closure.

Longwall Mining

Project longwall mining within Area 5 would not interact with the rehabilitation and mine closure activities of relevant neighbouring mines. Area 5 is not located proximal to any neighbouring mines, and is located to the west of the approved Dendrobium Mine Areas 1, 2 and 3, more than 12 kilometres to the north-west of the Illawarra Escarpment.

Surface Activities

The Project would interact with surface rehabilitation activities at the following operations:

- Dendrobium Mine (DA 60-03-2001) – continued use of existing surface facilities (e.g. Dendrobium Pit Top, Kemira Valley Coal Loading Facility, Dendrobium CPP and Dendrobium Shafts) beyond the currently approved mine life of the Dendrobium Mine (i.e. 2030);
- Appin Mine (Project Approval 08_0150) – use of the West Cliff Stage 3 and/or Stage 4 Coal Wash Emplacement Area; and
- Cordeaux Colliery – under care and maintenance.

As described in Section A9.3, rehabilitation planning for the Project was informed by existing mine closure and rehabilitation objectives and current rehabilitation practices implemented for the Dendrobium Mine and the Cordeaux Colliery.

An RMP would be developed to address Project operations at the Dendrobium Mine (and the Cordeaux Colliery, as relevant) which would describe how rehabilitation is undertaken, provide rehabilitation objectives and completion criteria, and address all aspects of rehabilitation including mine closure, final landforms and final land use (Section A9.5).

Similarly, Project operations at the Appin Mine would be covered by the future RMP developed for the Appin Mine (i.e. the West Cliff Coal Wash Emplacement Area).

The Cordeaux Colliery is currently under care and maintenance, and there would be no interaction of proposed surface rehabilitation activities for the Project with the Cordeaux Colliery.

Mine Closure

There are a number of underground connections at the Dendrobium Mine (i.e. Dendrobium Drift, Dendrobium Shafts and Kemira Valley Coal Loading Facility), as well as at adjacent inactive workings (e.g. historical Bulli Seam workings) located proximal to the Project underground mining area (SLR, 2022).

As such, closure planning for the Project post-mining (i.e. sealing of portals) considers the potential interaction with existing Dendrobium Mine portals and current and historical mine workings.

IMC has undertaken work on the design concepts for the sealing of the portals and mine entrances post-closure for the Project, which builds on the existing mine closure design work undertaken for the Dendrobium Mine and considers the potential interaction with Dendrobium Mine portals and historical mine workings (SLR, 2022).

A9.4 GENERAL REHABILITATION PRACTICES AND MEASURES

Rehabilitation progress of the Project and rehabilitation techniques and materials would be regularly evaluated. The results would inform future rehabilitation initiatives and refinement/amendment of the practices and measures described below through adaptive management.

A9.4.1 Vegetation Clearing Measures

The clearance of vegetation would be undertaken progressively, with the area of vegetation cleared at any particular time generally being no greater than that required to accommodate projected development activities for the next 12 months.

Vegetation clearance protocols would be documented in the RMP. Key components of the vegetation clearance protocols would include aspects such as the delineation of vegetation areas to be cleared, clearing inspections and re-use of cleared vegetation debris in revegetation.

Vegetation clearance at the West Cliff Stage 3 Coal Wash Emplacement Area would continue to be undertaken in accordance with the *Appin Mine Coal Wash Emplacement Area Management Plan* (IMC, 2020a). Where possible, clearing of hollow-bearing trees would be performed in a two-stage process. This involves the clearance of surrounding vegetation separately, before the removal of habitat trees, to allow fauna the opportunity to move.

Further detail on management of potential impacts on flora and fauna during clearing is provided in Section 7.9.2.

A9.4.2 Soil Stripping and Handling Measures

The soils within the Project surface disturbance areas are characterised in Section 7.4.1.

West Cliff Stage 3 Coal Wash Emplacement Area

Following vegetation clearance, soil would be stripped from the West Cliff Stage 3 Coal Wash Emplacement Area surface in layers.

The top 50 mm of soil contains the majority of soil-stored seed and propagules, plant nutrients and beneficial soil microbes. This layer would be stripped and mixed with cleared vegetation (where suitable) and stockpiled adjacent to or on the selected and pre-prepared recipient site for spreading.

Stripping and stockpiling of subsoil horizons would be undertaken depending on the depth of bedrock. Where possible, the depth of subsoil removal would be greater than 500 mm.

Soil stripped from the West Cliff Stage 3 Coal Wash Emplacement Area would be utilised as soon as possible for rehabilitation activities associated with completed emplacement sections, or would be stockpiled in the event that direct replacement is not possible.

Soil horizons would not be removed during, or immediately following, rain in order to minimise damage to soil structure during temporary stockpiling.

These activities would be described in detail in the *Appin Mine Coal Wash Emplacement Area Management Plan* (IMC, 2020a) and Appin Mine MOP (or future RMP).

Other Project Surface Disturbance

Soil stripping would occur by layer to allow for appropriate management of topsoil and subsoil resources independently.

Recovered topsoil and subsoil would be stockpiled for later use in rehabilitation, where relevant. Any long-term soil stockpiles would be managed to maintain long-term soil viability through the implementation of the following management practices:

- soil stockpiles would be located outside of active operational areas;
- stockpiles would be constructed with a "rough" surface condition to reduce erosion hazard, improve drainage and promote revegetation;
- stockpiles that are inactive for extended periods would be fertilised and seeded, to maintain soil structure, organic matter and microbial activity (subject to any conservation requirements);
- sedimentation controls would be installed around soil stockpiles to control potential loss of soil where necessary; and
- long-term soil stockpiles would be deep-ripped to establish aerobic conditions, prior to soil use in rehabilitation.

An RMP would provide specific details on the soil resource management measures that would be implemented for each Project surface disturbance area.

A9.4.3 Geotechnical Stability

Existing geotechnical stability management and monitoring measures conducted at the Dendrobium Mine would continue to be applied for the Project (e.g. for the construction and monitoring/management of surface water storages).

The Project would not result in any material additional geotechnical issues with the continued implementation of the management and monitoring measures.

As described in Section A9.1, rehabilitation activities associated with the West Cliff Coal Wash Emplacement Area are undertaken in accordance with Appin Mine Project Approval 08_0150 and the *Appin Mine Coal Wash Emplacement Area Management Plan* (IMC, 2020a) and the Appin Mine MOP (IMC, 2020b).

A9.4.4 Decommissioning of Surface Infrastructure

Subject to the agreed final land use, decommissioning of surface infrastructure would include, but not be limited to, the following actions:

- de-energising equipment (e.g. removing connections to power, water, gas, compressed air and sewerage) and isolation of power to the site (if appropriate);
- removal of underground infrastructure (where practical), such as mining equipment and service infrastructure;
- sale or scrapping of underground equipment or transfer to other IMC sites;
- demolition and removal of major building infrastructure (pending non-Aboriginal heritage assessment outcomes);
- demolition and removal of major infrastructure from ventilation shaft sites;
- removal of roadway, concrete footings, drainage structures, hardstand and foundations up to 1.5 m below ground level, if not required for the final land use;
- removal of retired underground equipment, discarded conveyor belts, pipes, hoses, cables, etc. from laydown areas;
- removal and disposal of any hazardous materials such as fuel, lubricants, chemicals or other substances of concern;
- removal of infrastructure at water release points where no longer required and investigation to confirm discharge points and drainage lines are stabilised appropriately to prevent erosion;
- filling and/or sealing portals, ventilation shafts and underground roadways in accordance with the RMP and MEG requirements;
- demolition and removal of concrete slabs, bitumen surfaces, redundant pipelines and services and redundant powerlines;
- removal of rail line and sleepers;
- excavation and removal of rail ballast (this may be used as shaft backfill or other construction material);

- demolition and removal of all rail bridges and concrete foundations associated with the Kemira Valley Rail Line unless required for agreed final land use; and
- blocking of the Kemira Valley Rail Line tunnel at both ends in accordance with the requirements of MDG 6001 (DRE, 2012).

A9.4.5 Selection of Native Plant Species for Revegetation

Disturbed areas to be revegetated with native vegetation would initially be prepared by ripping and applying a non-persistent cover crop where appropriate. Suitable native tubestock and/or seeds would then be planted/sown.

Flora species endemic to the local area would be preferentially used for rehabilitation, except where seed or tubestock supply may be a limiting factor. In this case, other appropriate native species which have performed well in the region would also be considered.

Native plant species to be planted in revegetation areas would be selected on a site-by-site basis, depending on nearby remnant vegetation associations, soil types, aspect and site conditions.

The species selected would aim to establish vegetation that reflects the composition and structure of vegetation communities present in the area. A provisional list of vegetation communities that would be considered as target rehabilitation communities is provided in Table A9-6.

It is anticipated that this list of provisional Plant Community Types (PCTs) and species would be reviewed and refined prior to final decommissioning and rehabilitation, based on experience at other IMC operations and in consultation with key stakeholders. The specific areas that would be targeted for each PCT and the area to be targeted in rehabilitation works would be defined in the RMP.

A9.4.6 Remediation of Subsidence Impacts on Streams

The Project may result in the following subsidence impacts on streams and associated environmental consequences:

- fracturing of rockbars and dilation and cracking of bedrock along streams, resulting in a reduction in pool levels and/or reduction in visible surface water flow;
- alteration of surface drainage patterns, resulting in localised erosion or scour or changes in soil moisture; and
- localised changes in water quality as a result of freshly exposed fractures in sandstone rocks.

These subsidence impacts and environmental consequences are described further in Section 7.

Current mitigation and remediation methods for subsidence impacts on streams at the Dendrobium Mine are described within the *Watercourse Impact, Monitoring, Management and Contingency Plan* (WIMMCP) (IMC, 2020d).

It is proposed that similar remediation methods would be implemented for the Project as required, incorporating any learnings and experience from existing operations using an adaptive management approach.

Performance measures for subsidence impacts on streams would be derived from the Project Infrastructure Approval. An Extraction Plan would be developed, specific to Project activities, to demonstrate that performance measures can be met through avoidance, minimisation of impact, management and/or remediation.

In the event that performance measures are exceeded, IMC would implement actions to mitigate and remediate subsidence impacts and associated environmental consequences.

Table A9-6
Provisional Target Revegetation Communities

Vegetation Community	PCT Code	Formation	Class	Potential Key Canopy Species	Potential Key Shrub Species
Exposed Sandstone Scribbly Gum Woodland	1083	Dry Sclerophyll Forests (Shrubby Sub-formation)	Sydney Coastal Dry Sclerophyll Forests	*Corymbia gummifera* *Eucalyptus haemastoma* *Eucalyptus oblonga* *Angophora costata* *Eucalyptus sieberi* *Eucalyptus piperita*	*Acacia suaveolens* *Acacia ulicifolia* *Banksia ericifolia* *Banksia serrata* *Banksia spinulosa* *Leptospermum trinervium*
Sandstone Gully Peppermint Forest	1250			*Banksia serrata* *Eucalyptus piperita* *Angophora costata* *Corymbia gummifera*	*Leptospermum polygalifolium* *Banksia ericifolia* *Acacia terminalis* *Leptospermum trinervium* *Banksia spinulosa* *Acacia suaveolens*
Escarpment Moist Blue Gum Forest	1245	Wet Sclerophyll Forests (Shrubby Sub-formation)	North Coast Wet Sclerophyll Forests	*Acmena smithii* *Livistona australis* *Synoum glandulosum* *Pittosporum undulatum* *Cryptocarya glaucescens* *Eucalyptus saligna* *Eucalyptus quadrangulate* *Eucalyptus pilularis* *Syncarpia glomulifera*	*Notelaea venosa* *Clerodendrum tomentosum* *Eupomatia laurina*
Moist Gully Gum Forest	878		Southern Escarpment Wet Sclerophyll Forests	*Eucalyptus smithii* *Eucalyptus piperita* *Eucalyptus muelleriana*	*Elaeocarpus reticulatus* *Notelaea venosa* *Synoum glandulosum*
Coastal Warm Temperate Rainforest	905	Rainforests	Northern Warm Temperate Rainforests	*Acmena smithii* *Livistona australis* *Ceratopetalum apetalum* *Cryptocarya glaucescens* *Synoum glandulosum*	*Tasmannia insipida* *Cyathea australis* *Eupomatia laurina* *Ficus coronate* *Psychotria loniceroides*

Source: IMC (2021a); Office of Environment and Heritage (OEH) (2017).

Avoidance and Minimisation

The Project longwall layout has been designed to minimise the potential for impacts on surface features (including key stream features) due to subsidence. The longwall design considered potential environmental impacts in conjunction with mine planning, scheduling and economic sustainability (Sections 7.3.4 and 8.2.1).

Mitigation and Remediation Methods

The following subsections outline the available methods to mitigate and/or remediate the subsidence impacts and environmental consequences outlined above.

These methods would be revised to incorporate results of rehabilitation trials, which will allow for continued improvements in rehabilitation and remediation practice (Section A9.6.2).

Remediation of Surface and Bedrock Fracturing

Surface and bedrock fracture remediation methods would depend on the type and extent of fracturing. Fracturing is able to be remediated via surface sealing and injection grouting of either high or low viscosity materials (selected based on the formation of the fracture network).

Where the surface or bedrock base of a significant permanent pool or controlling rockbar is impacted as a result of mine subsidence, and there is limited ability for the fractures to close naturally, the fractures would be sealed with grout. Grouting would be focused on fractures that result in the diversion of flow.

Grouting Materials

Grouting materials available include cementitious grout and Polyurethane Resin (PUR).

Cementitious grout can contain various additives and can be used with or without fillers (such as clean sand) (Commonwealth of Australia, 2014). Cementitious grout has previously been successfully implemented by IMC during remediation works in the Georges River. The remediation techniques used by IMC in areas of the Georges River focused on grouting of mining-induced fractures and strata dilation to reinstate the structural integrity and water-holding capacity of the bedrock of the Georges River.

The Metropolitan Colliery is currently rehabilitating areas of the Waratah Rivulet and the Eastern Tributary impacted by subsidence using PUR and other alternative grouting materials. IMC is currently trialling these technologies at Dendrobium Mine Area 3B in watercourse WC21.

Should remediation of fractures of pools or controlling rockbars be necessary for the Project, the best grout material option at the time of the rehabilitation work would be identified and implemented with appropriate approvals.

Grouts would be mixed on-site and placed by hand or injected into a fracture network (described further below). Both methods of placement have been successfully implemented in the Georges River.

Grouting has the potential to result in additional environmental impacts and, therefore, would be carefully planned and executed to minimise the risk of contamination. The selection of grouting materials would be:

- determined in consultation with WaterNSW and other stakeholders;
- based on demonstrated effectiveness; and
- designed to avoid significant impacts to water quality or ecology.

Methods for Surface Sealing

Surface fractures can be sealed by application of grout by hand, using cement-based grout. Generally, surface grouting would require only small amounts of grout material, which can be mixed and placed on-site. The Marhnyes Hole rockbar on the Georges River demonstrates that hand grouting of large surface cracks is a successful remediation technique (Commonwealth of Australia, 2014).

Injection Grouting

Injection grouting involves the delivery of grout through holes drilled into bedrock to target remediation of fractures. The purpose of injection grouting is to achieve a low permeability layer below any affected pool, as well as the full depth of any significant rockbar.

Current practice indicates that grouting holes should be drilled in a pattern with grid spacing of 1 m x 1 m to 2 m x 2 m, using handheld drills powered by compressed air (Plate A9-3). Grout is then delivered via mechanical packers (Plate A9-4). The grout would be mixed and pumped according to a predetermined grout design (Commonwealth of Australia, 2014).

Plate A9-3 – Drilling into Bedrock to Form Grouting Holes
Source: Good *et al.* (2010).

Plate A9-4 – Example of Rockbar Grouting Injection Undertaken in the Georges River
Source: Good *et al.* (2010).

Grout with a high viscosity (shorter setting time) may be used if vertical fracturing is believed to be present. A low viscosity grout is ideal for use when cross-linking between fractures is noted.

After the grout material sets, areas may be in-filled with additional grout to target areas where substantial amounts of grout were used in the previous grouting pass (indicating more fracturing). Once grout take has significantly reduced and the material has set, the pool would be tested to determine the rate at which water drains, compared to pre-grouting results. In the Georges River, the majority of pools were sealed within two to three grout passes.

Where flow diversion is observed through a large rockbar, it may be more appropriate to implement alternative grouting techniques, such as a deeper grout curtain delivered via traditional or directional drilling. Where alluvials overlie sandstone, grouts may be injected through grout rods to seal voids in or under the soil or peat material (Commonwealth of Australia, 2014).

Grouting would be undertaken after subsidence movements in the area have ceased, to reduce the risk of the area being re-impacted. This may necessitate delay to remediation works until subsequent longwalls have been completed.

Remediation of Areas of Altered Surface Drainage

The existing surface drainage of streams may be altered as a result of subsidence-induced tilting. Subsidence-induced tilting can concentrate runoff and lead to scour and erosion. In other areas, subsidence-induced tilting can reduce water and soil moisture.

To mitigate scour and erosion impacts, coir log dams can be installed at knickpoints[3], such as those shown in Plate A9-5. The coir log dam slows the water flow in the eroding drainage line to encourage silt build-up.

A trench is cut into the soil so that either the first layer of the coir log dam sits on the underlying substrate or the top layer sits at ground level. Coir log dams would be held in place by wooden stakes and bound together with wire. Small coir log dams would then be constructed at intervals down the eroding drainage line. Where increased sediment filtering of stream flow is required, the coir logs are wrapped in fibre matting (Plate A9-6) (Commonwealth of Australia, 2014).

[3] A knickpoint is a location on a river/channel where a sharp change in channel bed elevation occurs.

Plate A9-5 – Square Coir Logs for Knickpoint Control
Source: *Good et al.* (2010).

Plate A9-6 – Coir Log Dams Constructed at Intervals with Wrapping of Fibre Matting
Source: *Good et al.* (2010).

Maintenance of moisture in rehabilitation areas can be accomplished via water-spreading techniques. These techniques include implementing long lengths of coir logs and hessian “sausages”, linked together in such a way that water flow builds up behind them and slowly seeps through the water spreaders (Plate A9-7).

Erosion control and water spreading involves soft-engineering materials that are biodegradable and would eventually become integrated into the soil profile.

Plate A9-7 – Round Coir Logs Installed to Spread Water
Source: *Good et al.* (2010).

Remediation of Environmental Consequences Associated with Gas Releases

Gas release at the surface above an underground mine is driven by pressure changes and dilation and/or fracturing of the rock mass. In the Southern Coalfield, gas releases have all been documented to reduce over time, typically over a period of months to years.

Grouting and surface treatments discussed above can limit gas flow.

Areas of vegetation impacted by gas release would be revegetated (through seeding/planting) after cessation of gas release or if gas release reduces to a minimal level.

Remediation Options for Changes in Water Quality

There is potential for water quality impacts to occur in streams as a result of subsidence-induced fracturing of bedrock and/or rockbars. These impacts may include changes to pH and mobilisation of suspended metals (e.g. iron and manganese).

If agreed with WaterNSW, water treatment techniques such as liming streams and rivers could be used for remediation of water quality or aquatic ecosystem impacts.

There is potential for atmospheric oxygen to react with ferruginous springs, resulting in excessive precipitation of metals and further generation of local acidity. To remediate this, the point of maximum oxygenation could be moved closer to the ferruginous spring via the deposition of rocks and boulders within affected streams. This would increase the turbulence and, hence, rates of oxygenation, precipitation of hydrous oxides and acid generation, allowing natural effects downstream to ameliorate the effects of the spring.

Other Potential Remediation Methods

Where natural in-filling is not occurring for soil cracking, minor surface treatment works (i.e. manual infilling and compacting) to prevent erosion would be implemented. Larger cracks may require more work to repair them (e.g. mulch protection layer or grout application [see above]). Surface treatments would remain in place until revegetation covers the disturbed area. Wider cracks may require gravel or sand infilling and revegetation using brush matting.

Surface treatment of cracking can also be undertaken with placement of a geofabric material that minimises water flow entering the cracks. Geofabric remediation techniques are not ideal for stream remediation for the Project, as the implementation of these methods generally requires significant additional surface disturbance associated with site preparation and/or installation.

A9.4.7 Remediation of Subsidence Impacts on Upland Swamps

The Project may result in the following subsidence impacts on upland swamps and associated environmental consequences:

- a reduction or loss of water in the swamp sediments as a result of:
  - fracturing of downstream rockbars;
  - fracture networks forming in the bedrock below the swamp; and/or
  - upsidence and dilation of bedrock below the swamp; and
- alteration of surface drainage patterns due to subsidence-induced tilting, resulting in localised erosion or scour or alteration of water distribution.

These subsidence impacts and environmental consequences are described further in Section 7.

Current mitigation and remediation measures for subsidence impacts on upland swamps at the Dendrobium Mine are described within the Swamp Impact Monitoring, Management and Contingency Plan (SIMMCP) (IMC, 2020c).

In accordance with the conditions of the Area 3B SMP Approval, IMC is also conducting research into better understanding and quantifying subsidence impacts on swamps as outlined in the Swamp Rehabilitation Research Program (SRRP), which is being updated in 2022 in consultation with relevant agency stakeholders.

Avoidance and Minimisation

Consideration of avoidance and minimisation of impacts on upland swamps is described in Sections 7.8 and 8.2.1.

Mitigation and Remediation Methods

The following subsections outline the available methods to mitigate and/or remediate the subsidence impacts and environmental consequences outlined above.

These methods would be revised to incorporate results of rehabilitation and remediation trials, which would allow for continued improvements in rehabilitation and remediation practice (Section A9.6.2).

Remediation of Areas of Altered Surface Drainage

The types of erosion that could manifest in swamp areas are sheet, rill, gully, tunnel and stream channel erosion. Sheet and rill erosion processes in upland swamps can reduce vegetation on the surface and/or be a precursor to the formation of gully and stream channel erosion.

Erosion would be monitored in upland swamps in the Project area in addition to reference monitoring of upland swamps outside of the Project area. Erosion has the potential to create preferred flow paths, which could ultimately act to dewater the swamp sediments.

Erosion control techniques may include the installation of coir log dams at knickpoints to slow water flow, and wrapping coir log dams in fibre matting to encourage silting (Commonwealth of Australia, 2014). These methods would be implemented consistent with the description outlined in Section A9.4.9.

Treatment to prevent the formation of channels and maintain swamp moisture involves water-spreading techniques such as the implementation of long lengths of coir logs and hessian "sausages". Water spreading is detailed in Section A9.4.6.

A9.4.8 Remediation of Subsidence Impacts on Other Natural Features

In addition to the stream and upland swamp remediation measures outlined in Sections A9.4.6 and A9.4.7 above, rehabilitation may be undertaken to remediate mine subsidence impacts (e.g. surface cracking or erosion) on other natural surface features.

The requirement and methodology for any subsidence remediation techniques would be determined in consideration of:

- Potential consequences of the unmitigated impact, including potential risks to public safety and the potential for self-healing or long-term degradation.
- Potential impacts of the remediation technique, including potential environmental impacts associated with site accessibility.

Regular visual monitoring above longwall panels would be conducted to identify any areas subject to excessive erosion and sedimentation as a result of Project subsidence effects. Specific mitigation measures that may be employed include:

- filling of cracks and minor erosion, where practicable;
- installation of sediment controls downslope of subsidence-induced erosion areas;
- stabilisation of erosion areas using rock or other appropriate material;
- stabilisation of slopes and banks subject to soil slumping; and
- revegetation using brush matting, seeding or tubestock.

A9.4.9 Erosion and Sediment Control Measures

An Erosion and Sediment Control Plan has been developed and approved as part of the Water Management Plan for the Dendrobium Mine. Similar measures would be adopted for the Project. A site-specific Erosion and Sediment Control Plan would be prepared for the Project (incorporating proposed Shaft Site No. 5A) prior to construction and in consultation with WaterNSW. Surface water management for the site is described and assessed in Appendix C. The site has been planned with a zero-discharge design intent.

As described in Section 7.3.3, mine subsidence has the potential to cause surface cracking, including surface tension cracking near the top of slopes. If tension cracks are left untreated, there is potential for soil erosion to increase. Where significant cracks are detected and the potential for soil erosion (or other environmental consequences) is considered to be material, they would be repaired/filled as soon as practicable (Section A9.4.8).

The active emplacement area of the West Cliff Stage 3 Coal Wash Emplacement Area would be kept to a practicable minimum to reduce erosion potential.

Operational sediment and erosion control works would be maintained during decommissioning and revegetation. Post-closure erosion and sediment control measures would include reducing the slope lengths of final landforms by constructing contour banks and armouring channels to minimise erosion.

Once stable final landforms have been achieved within an area, key elements of the operational sediment control structures would either be left as passive water control storages or would be removed and the area would become free-draining. Depending on the agreed final land use, surface drainage would be reinstated as closely as possible to pre-mining conditions.

A9.4.10 Land Contamination Measures

Dependent on the final land use, investigations would be undertaken at mine closure to identify and remediate any contaminated soil that may exist (e.g. in infrastructure areas), in accordance with the requirements of the *Contaminated Land Management Act 1997*. Contaminated land would be remediated by removal and disposal at an appropriately licensed facility, encapsulation, or appropriate remediation treatment on-site.

A9.4.11 Weeds and Pest Control

Project weed and pest control measures for the Project are described in Section 7.9.4.

A9.4.12 Bushfire Management

Bushfire management measures for the Project are described in Section 7.22.3.

A9.4.13 Post-closure Maintenance

The management and maintenance of rehabilitation areas post-closure would be determined in consultation with relevant Government authorities and stakeholders, and would be outlined in the RMP or Mine Closure Plan (Sections A9.4 and A9.7).

A9.5 REHABILITATION MANAGEMENT PLAN AND FORWARD PROGRAM

An RMP would be developed to address Project operations at the Dendrobium Mine and the Cordeaux Colliery. Preparation of this RMP would occur in consultation with the relevant Government agencies, and in accordance with the Project ML requirements and applicable Resources Regulator guidelines.

The RMP would describe how rehabilitation is undertaken, provide rehabilitation objectives and completion criteria, and address all aspects of rehabilitation including mine closure, final landforms and final land use.

A9.6 MONITORING AND TRIALS

A summary of rehabilitation activities and performance to date is provided in Annual Reviews and the current Dendrobium MOP (South32, 2015a) and Appin Mine MOP (IMC, 2020b). These will change to RMPs in July 2022. Rehabilitation monitoring and trials would be conducted throughout the life of the Project, as described below.

A9.6.1 Rehabilitation Monitoring

Monitoring of rehabilitation areas at the Project would be conducted to assess the:

- progress of rehabilitation areas; and
- the effectiveness of the rehabilitation techniques being used to determine the need for any maintenance and/or contingency measures.

Monitoring would focus on achieving the stated outcomes in terms of:

- contamination remediation;
- gas emissions from former underground mining areas;
- water management;
- land stability (geotechnical);
- revegetation; and
- site safety and security.

The rehabilitation monitoring program for the Dendrobium Mine would be updated to incorporate the Project that, along with the application of adaptive management, would allow the desired outcomes to be achieved. It is expected that the rehabilitation monitoring would include (subject to final land use agreement):

- Baseline monitoring to determine conditions pre-mining and during mining.
- Documentation of all rehabilitation activities undertaken.
- Initial monitoring for a period of 1 to 2 years post-closure and comparison with control sites.
- Ongoing monitoring (less frequently) from two years post-mining until lease relinquishment.
- Post-lease relinquishment monitoring (to be negotiated with future landholders).
- Use of adaptive management techniques and facilitation of research trials where appropriate.

Subsidence monitoring would be conducted two to five years post-mining, although it is expected that monitoring of upland swamps for subsidence impacts would continue for a minimum of 10 years following completion within a domain. Timeframes for subsidence monitoring would be detailed within the Extraction Plans specific to the Project.

Monitoring measures specific to individual domains would be outlined within the RMP. These monitoring measures would be implemented for the Project rehabilitation where suitable.

Rehabilitation Monitoring of the West Cliff Coal Wash Emplacement Area

Rehabilitation monitoring specific to the West Cliff Coal Wash Emplacement Area would be undertaken in accordance with the program outlined in the *Appin Mine Coal Wash Emplacement Area Management Plan* (IMC, 2020a) (or latest approved version) and the Appin Mine Project Approval 08_0150. These rehabilitation monitoring methods would be applied to other Project rehabilitation areas where appropriate.

The rehabilitation monitoring program is designed to monitor success against the following criteria:

- Adequate regeneration of vegetation communities.
- BioMetric attributes relative to local benchmarks.
- Weed cover of less than 20%.
- Use of the rehabilitated area by native fauna.

The monitoring program would include the following assessment methods:

- BioMetric vegetation assessment (including fixed photo points);
- threatened plant random meanders; and
- fauna camera traps.

BioMetric Vegetation Assessment

BioMetric vegetation assessment uses the BioBanking Assessment Methodology outlined in the *BioBanking Assessment Methodology and Credit Calculator Operational Manual* (OEH, 2014).

This methodology assesses vegetation condition based on a comparison of site attributes against benchmarks for those attributes within relevant vegetation types. Local benchmark data can be collected to reflect local conditions.

BioMetric vegetation plots of 50 m x 20 m would be established within each vegetation monitoring zone. The BioMetric vegetation plots would be stratified across the emplacement area in accordance with existing monitoring sites, with consideration of:

- past vegetation treatment methods;
- established vegetation age; and
- respective occupied area of the vegetation treatment type.

Six control sites are monitored to provide long-term data for comparison. Local benchmark data is collected at these control sites according to the BioBanking Assessment Methodology. The selected control sites are stratified evenly between the locally dominant vegetation types.

BioMetric vegetation assessment, including photographic point monitoring, would continue to be undertaken annually.

Threatened Plant Random Meanders

Random meander monitoring surveys are undertaken by two people, 10 m apart, and target local species such as:

- *Acacia byonoeana*;
- *Epacris purpurascens* var. *purpurascens*;
- *Grevillea parviflora* subsp. *parviflora*;
- *Melaleuca deanei*;
- *Persoonia hirsuta*;
- *Persoonia nutans*; and
- *Pultenaea aristata*.

Random meanders for threatened plants would continue to be undertaken every three years.

Fauna Camera Traps

Infra-red camera traps would continue to be deployed within rehabilitation areas targeting specific habitat features (e.g. logs, hollows, rock crevasses/overhangs) using a passive survey approach (i.e. non-baited). Fauna monitoring using camera traps would be undertaken annually, starting five years after soil translocation.

Generally, a minimum of one camera trap would be deployed within each area of rehabilitation with a similar vegetation age, for a minimum of 12 nights.

A9.6.2 Rehabilitation Trials

IMC would continue to undertake rehabilitation and subsidence remediation trials and investigations over the life of the Project to allow for continued improvements in rehabilitation and remediation practice.

It is anticipated that these trials and investigations by IMC would continue to focus on:

- rehabilitation practices implemented at the West Cliff Coal Wash Emplacement Area and at decommissioned surface facility sites; and
- techniques and processes for remediation of subsidence impacts (particularly remediation of impacts on streams).

Rehabilitation trials to date at the West Cliff Coal Wash Emplacement Area have identified the following best practice methods (South32, 2015a):

- Specific surface reshaping to limit the loss of sediment off the slope and assist with erosion control, by mimicking micro-topographic features and, where possible, using concave slope profiles and angles seen in natural landforms.
- Direct redistribution of stripped soils to a completed emplacement area, wherever possible, to maintain the inherent nutrient and seedbank value in the soil.
- Collection of local native seed that is then spread over completed emplacement areas.
- Creation of fauna habitat through transplanting of dead stags, habitat logs and woody debris, use of nest boxes and reconstruction of rock outcrops.

These measures are implemented across IMC's operations and would be implemented for the Project where relevant and feasible (South32, 2015a).

The *WC21 Rehabilitation Plan* outlines proposed mitigation and remediation methods for identified and predicted surface impacts to pools and rockbars along the WC21 tributary of Wongawilli Creek above the Dendrobium Mine.

The *WC21 Rehabilitation Plan* was prepared based on a review of successful subsidence remediation and mitigation methods, including the measures implemented by IMC for impacts to the Georges River.

The performance of subsidence remediation at tributary WC21 would be monitored and reported. Any lessons learnt from these works would be implemented for future subsidence remediation works for the Project.

The remediation program was updated in September 2017 to include DCC. In addition to trials and investigations undertaken by IMC, industry developments and improvements in rehabilitation techniques and processes would be evaluated by IMC and implemented for the Project if applicable. This would include subsidence remediation techniques trialled at the Metropolitan Mine, the Wongawilli Colliery, the Russell Vale Colliery, the Springvale Colliery, the Angus Place Colliery or other relevant underground mines.

There was an additional update to the rehabilitation plan in May 2021, to include additional trial remediation sites. These trials are currently being implemented at the Dendrobium Mine.

A9.7 POTENTIAL BARRIERS AND LIMITATIONS TO EFFECTIVE REMEDIATION

Table A9-7 outlines potential barriers and limitations to rehabilitation success that would be monitored, and where relevant, addressed by further trials and investigations and suitable mitigation measures throughout the life of the Project.

A9.8 MINE CLOSURE (SEALING)

South32's company-wide closure standard requires all South32-controlled operations to maintain closure plans (South32, 2021).

The existing Dendrobium MOP (South32, 2015a) generally describes the requirements for the decommissioning and sealing of portals, mine entrances and ventilation shafts, which would be described in detail within the Mine Closure Plan for the Project (Section A9.9).

IMC has undertaken preliminary work on the design concepts for the sealing of the portals and mine entrances post-closure, which builds on the existing mine closure design work undertaken for the Dendrobium Mine.

Table A9-7
Identification of Potential Key Barriers and Limitations to Effective Rehabilitation and Management Strategies

Key Barrier/Limitation	Potential Causes/Issues	Key Mitigation Strategies
Community objection to proposed final land use	• Poor community consultation. • Perceived negative environmental impacts. • Perceived loss of social conditions/amenity change. • Community expectation does not align with legal requirements.	• Community consultation throughout the Project life, increasing prior to mine closure. • Ongoing consideration of future land use alternatives.
Unauthorised access to site	• Personal injury. • Property damage. • Environmental damage. • Litigation/fines. • Reputation damage. • Heritage issues.	• Installation of appropriate fencing for the stage of the Project. • Security of all buildings and structures, including patrols. • Provision of signage. • Securing portals and shafts, boreholes and goaf wells. • Emptying and securing bulk storage tanks.
Security of dangerous goods and hazardous substances (e.g. explosives)	• Dangerous goods/hazardous substances remain on-site after closure. • Deterioration. • Theft. • Unauthorised access. • Possible personal injury. • Property damage. • Litigation/fines. • Reputation damage.	• Audits of dangerous goods and hazardous substances. • Management and storage of chemicals in accordance with IMC's prescribed management procedures, Australian Standards and Codes. • Removing dangerous goods and hazardous substances from site. • Emptying and securing bulk storage tanks.
Unplanned delay in commencement/execution	• Inadequate planning process. • Delays in approvals. • Inadequate resources. • Environmental damage. • Reputation damage. • Financial loss.	• Mine closure planning and periodic review. • Rehabilitation undertaken in accordance with Project ML requirements and requirements of the NSW *Mining Act 1992* and mine closure planning.
Contamination greater than expected	• Unidentified previous uses. • Inadequate studies. • Financial loss. • Delays.	• Contaminated land assessments. • Remediation of contaminated land by removal and disposal at an appropriately licensed facility, encapsulation or on-site treatment and remediation.
Failure to fully provide for closure costs	• Inadequate planning process. • Inadequate resources. • Change in scope. • Change in legislation. • Financial loss/delay.	• Financial securities, lodgement and rehabilitation and mine closure planning. Rehabilitation undertaken in accordance with Project ML requirements and requirements of the NSW *Mining Act 1992*.

Table A9-7 (Continued)
Identification of Potential Key Barriers and Limitations to Effective Rehabilitation and Management Strategies

Key Barrier/Limitation	Potential Causes/Issues	Key Mitigation Strategies
Landform instability	• Inadequate planning process. • Poor landform design. • Poor emplacement technique. • Natural slope instability.	• Mine closure planning and periodic review. • Experience at West Cliff Coal Wash Emplacement Area. • Rehabilitation trials and investigations. • Geotechnical supervision. • Compaction testing. • Geotechnical investigations and engineering design prior to decommissioning surface facilities.
Failure to establish suitable plant species/communities	• Inadequate planning process. • Poor species selection. • Climatic/environmental events (e.g. drought, bushfire). • Weed/pest invasion.	• Mine closure planning and periodic review. • Experience at West Cliff Coal Wash Emplacement Area. • Rehabilitation trials and investigations. • Monitoring and maintenance. • Weeds and pest control.
Failure of subsidence remediation techniques	• Inadequate planning process. • Inadequate resources. • Implementation of new technologies. • Climatic/environmental events (e.g. drought, bushfire).	• Extraction Plan approval process. • Subsidence impact performance measures and provisions for offsets. • Rehabilitation trials and investigations. • Monitoring and maintenance.
Groundwater/surface water impacts due to water accumulating in underground workings	• Inadequate planning process. • Inadequate resources.	• Mine closure planning and periodic review. • Sealing of portals, ventilation shafts and mine entrances in accordance with regulatory requirements. • Placement of hydraulic seals in underground workings in accordance with recommendations of specific closure studies such as the Mine Closure Study Report (Appendix Q) (SLR 2022).

Source: South32 (2015a).

The key objectives of sealing of the Dendrobium Mine would be to:

- restrict groundwater re-pressurisation to limit connectivity and seepage into historic mine workings, including legacy shafts and portals, to control seepage at the Illawarra Escarpment;
- facilitate reporting of mine water outflows to controlled locations at the surface for subsequent management; and
- safely exclude public access to the mine workings consistent with relevant standards and policies.

Mine sealing would involve the design and installation of a number of bulkheads within the mine workings and at the existing portals (i.e. the Kemira Valley Coal Loading Facility and Dendrobium Pit Top portals) to achieve the above design objectives.

Further details of the potential post-mining groundwater impacts and preliminary sealing designs for the Project are provided in Appendices B and Q, respectively, and would be detailed in the Mine Closure Plan for the Project.

A9.9 MINE CLOSURE PLAN

A Mine Closure Plan specific to the Project would be developed in consultation with relevant regulatory authorities and community stakeholders. The Mine Closure Plan would be reviewed and updated over the Project life, with more detailed measures developed closer to Project completion.

The Mine Closure Plan would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.

Upon cessation of mining operations, it would be expected that tenure of the mining leases would be maintained by IMC until such time as mining lease and other statutory approval relinquishment criteria were satisfied. These criteria would be formulated and prescribed in consultation with relevant authorities and stakeholders.

It is anticipated that mine lease relinquishment criteria would include, but not necessarily be limited to, the following:

- decommissioning and removal of infrastructure, where appropriate and required;
- landform stability and public safety;
- maintenance of downstream water quality;
- establishment of self-sustaining vegetation in previously cleared areas; and
- fulfilment of mining lease and other statutory approval conditions.

Lease relinquishment criteria would be detailed in the Mine Closure Plan.

The *Strategic Framework for Mine Closure* published by the Australian and New Zealand Minerals and Energy Council and Mineral Resources Council of Australia (2000) (or its contemporary version) would be used as a guide for mine closure, and the NSW Resources Regulator's (2021c) *Guideline: Achieving Rehabilitation Completion (Sign-off).*

A9.10 REFERENCES

Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia (2000). *Strategic Framework for Mine Closure*.

Commonwealth Department of Industry, Innovation and Science (2016a). *Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation.*

Commonwealth Department of Industry, Innovation and Science (2016b). *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure*.

Commonwealth of Australia (2014). *Temperate Highland Peat Swamps on Sandstone: evaluation of mitigation and remediation techniques*.

Department of Energy and Resources (2012). *MDG6001 Guidelines for the Permanent Filling and Capping of Surface Entries to Coal Seams.*

Good, R., Hope, G. and Blunden, B. (2010). *Dendrobium Area 3A Swamp Impact, Monitoring, Management and Contingency Plan.* Report prepared for Illawarra Coal Holdings Pty Ltd.

Illawarra Coal Holdings Pty Ltd (2015). *Monitoring Report – Emplacement Rehabilitation Year 5.*

Illawarra Metallurgical Coal (2020a). *Appin Mine Coal Wash Emplacement Area Management Plan.*

Illawarra Metallurgical Coal (2020b). *Appin Mine Mining Operations Plan 1 October 2020 to 30 September 2024*.

Illawarra Metallurgical Coal (2020c). *Swamp Impact Monitoring, Management and Contingency Plan.*

Illawarra Metallurgical Coal (2020d).*Watercourse Impact Monitoring, Management and Contingency Plan*.

Illawarra Metallurgical Coal (2021a). *Dendrobium Mine And Cordeaux Colliery Annual Review FY21.*

Illawarra Metallurgical Coal (2021b). *WC21 and Donalds Castle Creek Rehabilitation Plan*

New South Wales Government (2021). *Rehabilitation Management Plan Guidelines*.

New South Wales Resources Regulator (2021a). *Guideline: Rehabilitation Objectives and Rehabilitation Completion Criteria*.

New South Wales Resources Regulator (2021b). *Form and Way Rehabilitation Management Plan for Large Mines*.

New South Wales Resources Regulator (2021c). *Guideline: Achieving Rehabilitation Completion (Sign-off)*.

Office of Environment and Heritage (2014). *BioBanking Assessment Methodology and Credit Calculator Operational Manual.*

Office of Environment and Heritage (2017). *BioNet Vegetation Classification.*

SLR Consulting Australia Pty Ltd (2022). *Dendrobium Mine Extension Project Mine Closure Study.*

South32 Limited (2015a). *Illawarra Coal Mining Operations Plan - Dendrobium Mine and Cordeaux Colliery*.

South32 Limited (2015b). *WC21 Rehabilitation Plan.*

South32 Limited (2021). *Sustainable Development Report 2021.*