ATLAS-CAMPASPE
Mineral Sands Project
ENVIRONMENTAL IMPACT STATEMENT

SECTION 5 › REHABILITATION STRATEGY

CRISTAL Resource Strategies

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5 REHABILITATION STRATEGY

This section outlines the rehabilitation strategy for the Project landforms and associated infrastructure areas. The rehabilitation strategy includes rehabilitation concepts, objectives, methods and measures that have been developed to achieve the proposed final land use for the Project. In developing the rehabilitation strategy for the Project, Cristal Mining has drawn on relevant rehabilitation experience at Cristal Mining's current Ginkgo and Snapper Mines and the former Wemen Mine.

Cristal Mining received a highly commended award at the 2012 NSW Minerals Council Excellence Awards for the rehabilitation planning and practices implemented at the Ginkgo Mine. The Cristal Mining presentation provided at the 2012 NSW Minerals Council Excellence Awards can be accessed on the NSW Minerals Council website (www.nswmin.com.au).

The rehabilitation concepts presented should be regarded as provisional to allow for consideration of the outcomes from future rehabilitation trials and research. Final rehabilitation and mine closure requirements would ultimately be formulated in consultation with key government agencies and other relevant stakeholders. In accordance with the NSW *Mining Act, 1992*, rehabilitation would be subject to regulatory authority agreement and approval.

This strategy has been prepared in consideration of the principles and relevant concepts provided in the *Leading Practice Sustainable Development Program for the Mining Industry Mine Rehabilitation Handbook* (Commonwealth Department of Industry, Tourism and Resources [DITR], 2006a). The Project's rehabilitation concepts described in this Section have been developed with assistance from Dr Rob Loch, a member of the Mine Rehabilitation Working Group which developed the DITR (2006a) *Leading Practice Sustainable Development Program for the Mining Industry Mine Rehabilitation Handbook*.

The mine closure goal, strategic completion criteria and proposed Mine Closure Plan strategy described in this Section have been prepared in consideration of the *Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure and Completion* (DITR, 2006b) and the *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2000).

5.1 RELEVANT REHABILITATION EXPERIENCE FROM CRISTAL MINING'S MURRAY-DARLING BASIN OPERATIONS

Cristal Mining currently operates the Ginkgo and Snapper Mines (Sections 2.1.2 and 2.1.3, respectively) and previously operated the former Wemen Mine in the Murray-Darling basin. Rehabilitation experience gained by Cristal Mining from these mines has included landform design and large scale rehabilitation works of mine landforms and rehabilitation trials and research outcomes.

Rehabilitation experience from Cristal Mining's current and former Murray-Darling basin operations provide a relevant indication of the likely performance of rehabilitation at the Project because:

- the Ginkgo Mine, Snapper Mine, the former Wemen Mine and the Project are owned by the same parent company, Cristal Mining, and therefore operate with the same rehabilitation principles; and
- given the Ginkgo Mine, Snapper Mine and former Wemen Mine are located approximately 100 km and 105 km to the west and 100 km to the south-west, respectively, the mines would all:
  - experience similar climatic conditions;
  - have similar rehabilitation land use objectives (including establishment of self-sustaining ecosystems including native species characteristic of surrounding vegetation communities);
  - have similar revegetation species; and
  - have similar design parameters for final landforms (e.g. overburden emplacement slopes).

The sub-sections below provide a description of the Ginkgo and Snapper Mines and the former Wemen Mine and include a summary of the rehabilitation experiences relevant to the Project. The plates of rehabilitation (and rehabilitation trial areas) at the Ginkgo Mine, Snapper Mine and former Wemen Mine shown on Plates 5-1 to 5-6 and referred to in the following sub-sections provide an indication of what rehabilitated areas of the Project could look like following the implementation of the Project rehabilitation strategy.

Plate 5-1: Rehabilitation at the Ginkgo Mine - (aerial view of overburden emplacement)

Plate 5-2: Two year old Chenopod revegetation on an overburden emplacement at the Ginkgo Mine

Plate 5-3: Woody debris (salvaged from vegetation clearance activities) placed on overburden emplacement batters at the Ginkgo Mine to enhance slope stability

Plate 5-4: Rehabilitation trial area at the Snapper Mine including native grass and Chenopod species

Plate 5-5: Cereal crop established on a section of rehabilitated mine path at the former Wemen Mine

Plate 5-6: Almond orchard plantation on a section of rehabilitated mine path at the former Wemen Mine

Ginkgo Mine Rehabilitation

The Ginkgo Mine is a mineral sands mine located approximately 100 km west of the Project (Section 2.1.2 and Figure 1-1). Rehabilitation planning at the Ginkgo Mine commenced in 2006 and has involved landform design, rehabilitation works and rehabilitation trials.

A rehabilitation campaign focussing on one of the Ginkgo Mine's overburden emplacements (OB3) commenced in 2008. The campaign involved landform design suited to the rehabilitation materials available and climate experienced at the Ginkgo Mine, and erosion modelling to assess erodibility of rehabilitation materials. The campaign was supported by revegetation works using local native species sown via direct seeding and hand planting methods undertaken to coincide with seasonal rainfall.

The landform design concept for the OB3 emplacement included dividing the top surface of the emplacement into catchment areas (approximately 3 to 5 ha in area) which were surrounded by bunded walls (up to approximately 1 m in height). These catchment areas were constructed to prevent surface water runoff from the top surface of the overburden emplacement down the batters. The purpose of the catchment areas is to minimise erosion on overburden emplacement batters and maximise rainfall storage and infiltration and enhance vegetation establishment within the catchment areas. Plate 5-1 shows a rehabilitated overburden emplacement at the Ginkgo Mine which has been constructed using bunded catchment areas.

Rehabilitation monitoring of the rehabilitated overburden emplacement shows the landform is stable and includes well-established vegetation which is providing habitat for and is being colonised by local fauna species (Bemax, 2012c). The rehabilitation campaign also included undertaking various revegetation trials including native species characteristic of the surrounding woodland/shrubland vegetation communities.

The landform design and rehabilitation planning principles and the results from the rehabilitation trials and monitoring undertaken at the Ginkgo Mine have been used to inform the Project rehabilitation strategy described in this section.

A detailed description of the Ginkgo Mine OB3 rehabilitation programme, rehabilitation monitoring results and outcomes of rehabilitation trials are provided in the *Ginkgo Mineral Sands Mine Annual Environmental Management Reports* which can be accessed on the Cristal Mining website (www.cristalmining.com).

Plates 5-1, 5-2 and 5-3 provide examples of rehabilitation success at the Ginkgo Mine.

Snapper Mine Rehabilitation

The Snapper Mine is a mineral sands mine located approximately 105 km west of the Project (Figure 1-1). Since operations commenced at Cristal Mining's Snapper Mine in 2010, rehabilitation planning and implementation is only in its early stages and has focussed on commencing rehabilitation of the initial mine components (e.g. initial water dam and initial sand residue dam) that can be rehabilitated, including a portion of overburden emplacement OB1.

Rehabilitation of approximately 20 ha of overburden emplacement OB1 commenced during 2012 and has involved using similar rehabilitation concepts as implemented for Cristal Mining's Ginkgo Mine overburden emplacement OB3.

Rehabilitation planning and design of final landforms for the Snapper Mine will continue to draw on relevant experience from Cristal Mining's Ginkgo Mine.

The Snapper Mine is located on Western Lands Leases which are pastoral leases administered by the NSW Land and Property Management Authority under the NSW *Western Lands Act, 1901*. These leases are predominantly used for light intensity grazing by livestock on native pastures. A rehabilitation goal for the Snapper Mine is to rehabilitate disturbance areas to a condition suitable for a final land use including light intensity grazing on native pastures.

A rehabilitation trial area has been established on a portion of rehabilitated haul road at the Snapper Mine including native grass and Chenopod species applied with various treatments of an organic mulch product (Plate 5-4). A replicate rehabilitation trial area is proposed to be established on a section of backfilled mine path at the Snapper Mine during 2012. These rehabilitation trials aim to assess the performance of native pasture vegetation species on rehabilitated landforms at the Snapper Mine which may support a final land use of light intensity grazing by livestock.

A detailed description of rehabilitation undertaken at the Snapper Mine to date and rehabilitation monitoring trial results are provided in the *Snapper Mineral Sands Mine Annual Environmental Management Reports* which can be accessed on the Cristal Mining website (www.cristalmining.com).

Wemen Mine Rehabilitation

The Wemen Mine was a former mineral sands mine located approximately 100 km south-west of the Project that was operated by Murray Basin Titanium Pty Ltd (a wholly owned subsidiary of Cristal Mining) between 2000 and 2004.

The rehabilitation goal for the Wemen Mine was to rehabilitate the land to its previous character and functions (Bemax, 2009). The land uses prior to the Wemen Mine included (Bemax, 2009):

- predominantly cleared farmland used for irrigated vegetable cropping or for dry land wheat and/or sheep enterprises; and
- remnant native vegetation which occurred in farm blocks and along roadsides.

To achieve the rehabilitation goal and to mitigate the potential risks to rehabilitation success (i.e. soil salinity), rehabilitation practices included burying dried saline material and capping the material with more than 4 m of overburden material (Bemax, 2009). Layers of subsoil and topsoil were then placed on top of the overburden to provide a suitable growth medium for revegetation (Bemax, 2009).

As a result of the rehabilitation practices undertaken by Cristal Mining, the land formerly associated with the Wemen Mine path has been successfully returned to agricultural land. Since the completion of rehabilitation, the land has been used for wheat and cereal cropping (Plate 5-5) and is currently an almond orchard (Plate 5-6).

The rehabilitation programme at the Wemen Mine also involved revegetation trials including hand-planting tube-stock of various revegetation species including Spinifex, Mallee Eucalypts, Hakea and Chenopod species on a cleared paddock area adjacent to the Wemen Mine path in 2001.

Results of the revegetation trials undertaken over 10 years indicated an overall plant survivability of 58%, with Spinifex species particularly successful with 93% plant survivability (Ogyris Ecological Research, 2012b).

Ogyris Ecological Research (2012b) has recommended that high plant survivability can be achieved by hand planting Spinifex and Mallee Eucalypt tube-stock at high densities.

Ogyris Ecological Research (2012b) also recommended that more cost-effective revegetation methods including direct seeding of Eucalypt species should be pursued (with regard to landscape position).

The outcomes from the revegetation trials conducted at the former Wemen Mine have been considered in the Project rehabilitation strategy outlined in this section.

Plates 5-7 and 5-8 show examples of revegetation success associated with the revegetation trials undertaken adjacent to the former Wemen Mine path.

5.2 REHABILITATION OBJECTIVES

The primary objectives of the Project rehabilitation strategy are:

- the creation of safe, stable and non-polluting landforms;
- restoring self-sustaining ecosystems suitable for a final use determined in consultation with landholders and relevant government agencies; and
- progressive rehabilitation of the mine path scheduled to make best use of favourable climatic conditions.

Other objectives of rehabilitation include:

- preservation of existing vegetation and topography, where practicable;
- establishing permanent self-propagating vegetation cover including native species characteristic of vegetation communities cleared by Project development that could be used for a final land use involving either light intensity grazing or for nature conservation purposes;
- maintaining overland flow to local closed depressions to minimise disturbance to Black Box Woodlands (and potential threatened flora species) in the vicinity of the Project;
- exclusion of livestock from rehabilitation areas during operations and revegetation development;

Plate 5-7: Rehabilitation trial area adjacent to the former Wemen Mine including ten year old Spinifex and Mallee Eucalypt revegetation

Plate 5-8: Rehabilitation trial area adjacent to the former Wemen Mine including ten year old Chenopod and Mallee Eucalypt revegetation

- development of flexible rehabilitation concepts that facilitate trial-based improvements to the rehabilitation strategy; and
- conducting rehabilitation monitoring at select rehabilitation areas to assess rehabilitation performance on an annual basis against nominated performance standards and completion criteria.

These objectives are considered consistent with the NSW *Mining Act 1992* and relevant Government guidelines (refer to Section 5.3.2).

5.3 REHABILITATION OF THE PROJECT

Relevant rehabilitation experience from the Ginkgo and Snapper Mines and the former Wemen Mine has enabled Cristal Mining to develop a refined rehabilitation strategy for the Project. The rehabilitation concepts and objectives presented in this section and the general methodologies and measures described in Section 5.4 reflect experiences gained from Cristal Mining's Murray-Darling basin operations (Section 5.1).

Cristal Mining has developed the following seven step approach to rehabilitation for their Murray-Darling basin operations (Ogyris Ecological Research, 2010):

1. Undertake mining pre-clearance flora and fauna surveys in accordance with a vegetation clearance protocol.
2. Undertake mining pre-clearance soil surveys to describe soil profiles, identify any impediments and provide soil budgets and soil stripping plans.
3. Undertake topsoil and subsoil stripping and overburden removal and storage.
4. Return overburden, subsoil and topsoil.
5. Achieve stable and non-eroding landforms.
6. Restore self-sustaining vegetation comprised of native plant species similar to those occurring in surrounding areas.
7. Maintain and enhance revegetation where necessary.

These seven principles have been incorporated into the Project rehabilitation strategy where relevant.

At the completion of mining, the key final landforms and features at the Project would include:

- elevated overburden emplacements located adjacent to and within the rehabilitated mine paths;
- rehabilitated areas level with the natural ground surface associated with the backfilled mine paths;
- partially backfilled final voids located at the north-western corner of each rehabilitated mine path;
- shallow depressions associated with rehabilitated water management infrastructure;
- local closed depressions generally consistent with pre-mining topography; and
- diversion banks/channels to maintain overland flow to local closed depressions.

Further detail on the rehabilitation concepts and objectives for the Project final landforms by domain is provided in Section 5.3.2. This section also describes the rehabilitation concepts for other Project development components including the Ivanhoe Rail Facility and roadworks along the mineral concentrate transport route in Sections 5.3.4 and 5.3.5, respectively.

The general rehabilitation methods and measures described in Section 5.4 would be implemented to achieve the Project final land use. The methods and measures are considered consistent with the Project rehabilitation objectives described in Section 5.2.

Rehabilitation of mined lands and lands disturbed by Project development components would be considered suitable when the nominated completion criteria (Section 5.7.1) have been met, or if the relevant Minister(s) otherwise accept the rehabilitation status.

5.3.1 Final Land Use

Rehabilitation of the Project would aim to restore self-sustaining ecosystems including native species characteristic of vegetation communities cleared by Project development that could be used either for light intensity grazing or for nature conservation purposes.

The nature of grazing in the region primarily involves light intensity grazing by livestock on native vegetation (Landloch, 2006). Therefore, Cristal Mining aims to restore self-sustaining ecosystems including endemic native species which could be used for either light intensity grazing or protected for nature conservation.

A rehabilitation strategy that establishes self-sustaining ecosystems capable of light intensity grazing (i.e. that is compatible with pre-mining land capability) is considered consistent with the purpose and conditions of the relevant Western Lands Leases over the Project area and the general conditions of leases under the *Western Lands Act, 1901*.

Areas proposed for nature conservation would be fenced to exclude grazing and vegetation clearance to protect the conservation area in the long-term.

5.3.2 Rehabilitation Domains and Conceptual Final Landforms

For rehabilitation planning and mine closure it is useful to separate the Project area into smaller conceptual domains. The DTIRIS-DRE's (2011) *Interim Mining Operations Plan Guidelines-Guidance Note 1* (the Guidelines) has been considered for development of rehabilitation domains relevant to the Project.

The Guidelines describe three steps to identifying rehabilitation domains (DTIRIS-DRE, 2011):

1. Identifying primary domains according to operational function.
2. Identifying secondary domains according to post-mining land use.
3. Combining primary and secondary domains to produce Rehabilitation Domains.

Project conceptual primary domains are relevant to the key final landforms and include (1) Off-Path Overburden Emplacements; (2) Mine Paths; (3) Final Voids; and (4) Infrastructure and Facilities Areas.

As the final land use for the Project would involve restoring self-sustaining ecosystems comprising endemic native vegetation in the first instance, only one secondary domain is relevant to the Project, *viz*. secondary domain A - native vegetation including appropriate woodland/shrubland species.

Therefore in accordance with the Guidelines (DTIRIS-DRE, 2011), the primary and secondary domains are combined to form the following rehabilitation domains relevant to the Project:

- Domain 1A – Off-Path Overburden Emplacements.
- Domain 2A – Mine Paths.
- Domain 3A – Final Voids.
- Domain 4A – Infrastructure and Facilities Areas.

These rehabilitation domains are shown conceptually on Figure 5-1. Figure 5-2 illustrates the Project conceptual final landforms post-mining.

Rehabilitation Domain Objectives

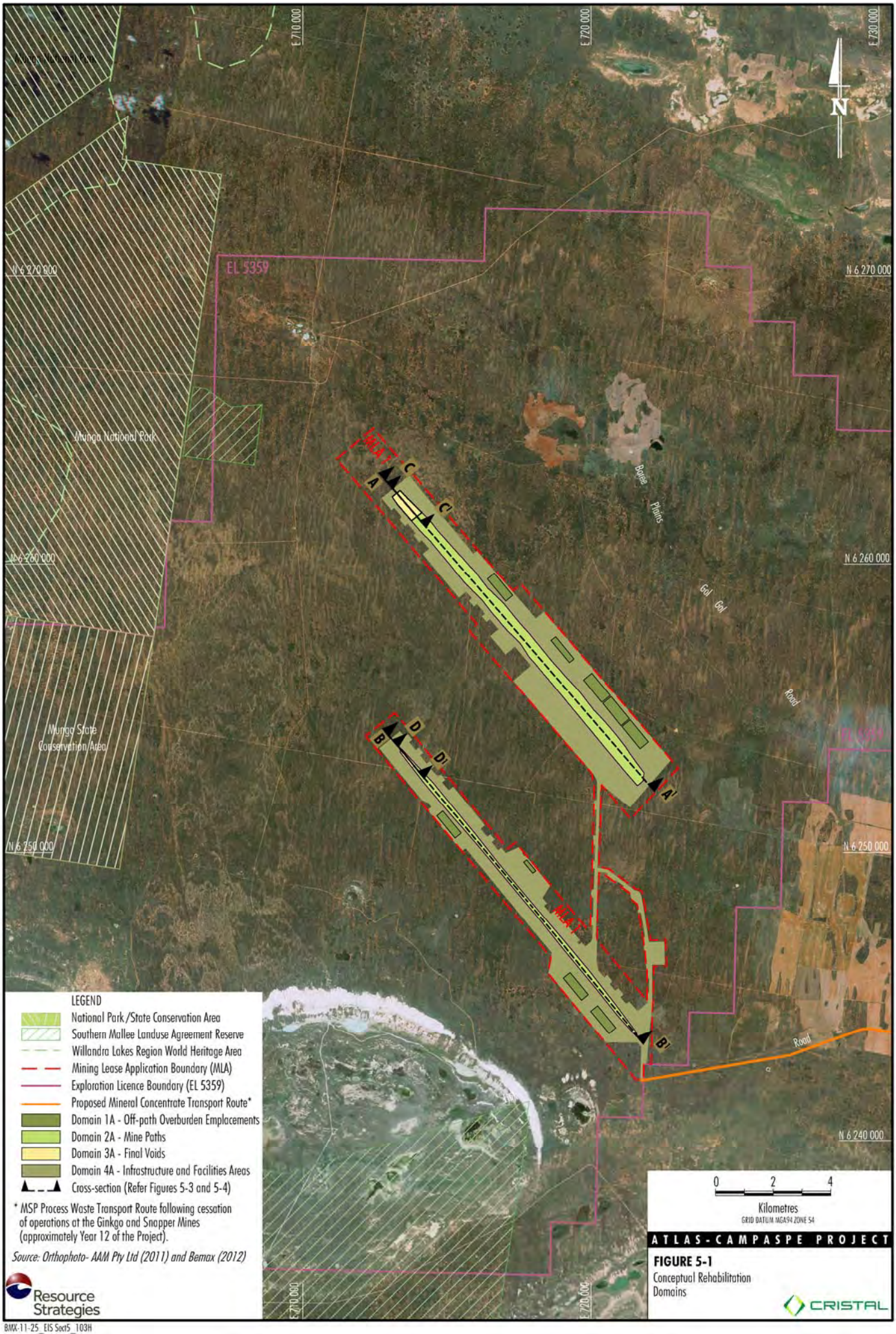
The rehabilitation domain objectives have been based on the rehabilitation objectives for the Project (Section 5.2) and are applicable to each domain (considering the final land use would be universal) and are as follows:

- the domain would be safe, stable and non-polluting;
- the domain would be revegetated with native vegetation species characteristic of vegetation communities cleared and include suitable woodland and shrubland species; and
- the domain would include self-sustaining ecosystems suitable for a final use of light intensity grazing or conservation.

A description of the native plant species proposed for use during the Project revegetation works is provided in Section 5.4.3.

The remainder of this section describes the conceptual final landforms and rehabilitation concepts relevant to each rehabilitation domain.

The concepts presented in the following sub-sections may be refined over the life of the Project based on results of rehabilitation trials and research and rehabilitation performance in consultation with relevant government agencies and key stakeholders (Section 5.7.2). A Rehabilitation Management Plan (Section 5.6) would be developed and would provide a more detailed description of the concepts provided below.



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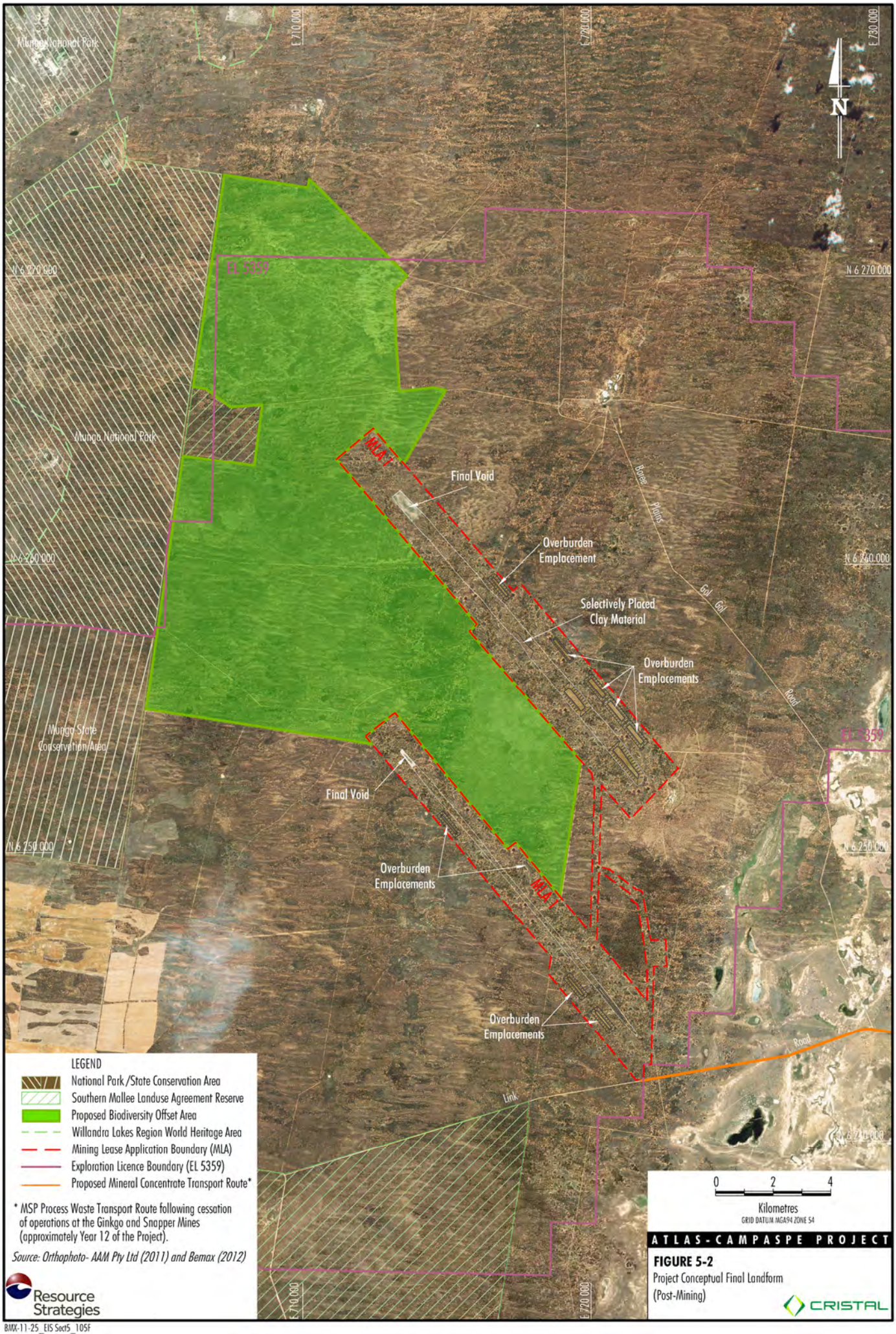

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Domain 1A – Off-path Overburden Emplacements

As described in Section 2.7.3, overburden emplacements would be located off-path within the Atlas and Campaspe footprints (Figures 2-4 and 2-6). The landform design and rehabilitation concepts for the off-path overburden emplacements have been developed based on relevant rehabilitation experience at the Ginkgo Mine (Section 5.1).

The off-path overburden emplacements would be constructed to a maximum height of approximately 20 m above the natural ground surface and the batters would have an approximate 1:7 (vertical:horizontal) slope or an appropriate alternative determined by slope and erodibility investigations.

Details of the overburden emplacement construction strategy is provided in Section 2.7 and a description of overburden material geochemistry and the potential effects on groundwater resources is provided in Section 4.4.2.

The rehabilitation concepts for the top surfaces and batters of the off-path overburden emplacements are described below.

Top Surfaces

The top surface of the off-path overburden emplacements would be divided into areas (approximately 3 to 5 ha in area) surrounded by bunded walls (up to approximately 1 m in height). These catchment areas would prevent surface water runoff from the top surface of the overburden emplacement down the batters. This aims to minimise erosion on overburden emplacement batters and maximise rainfall storage and infiltration and enhance vegetation establishment within the catchment areas.

Plate 5-1 shows a rehabilitated overburden emplacement at the Ginkgo Mine which has been constructed using bunded catchment areas. The top surfaces of the Project off-path overburden emplacements are expected to look similar to the rehabilitated overburden emplacement at the Ginkgo Mine shown in Plate 5-1.

The cover system concept for the top surface of the off-path overburden emplacements would include:

- spreading approximately 400 mm of growth medium material including a 200 mm layer of subsoil and 200 mm layer of topsoil (gypsum treated if necessary) on top of replaced overburden to support revegetation establishment (Landloch, 2006);
- ripping the growth medium material to a depth of approximately 300 mm using conventional tines (instead of winged tines) to reduce erosion potential (Landloch, 2006); and
- revegetating by direct seeding an initial cover crop to stabilise the growth medium material and hand-planting tube-stock including selected native revegetation species within approximately two months of completion of landform construction (subject to climatic conditions or water availability).

Batters

The cover system concept for the batters of the off-path overburden emplacements would include:

- spreading approximately 400 mm of growth medium material including a 200 mm layer of subsoil and 200 mm layer of topsoil (gypsum treated if necessary) on top of replaced overburden to support revegetation establishment (Landloch, 2006);
- spreading woody debris salvaged during vegetation clearance activities associated with Project development to stabilise the growth medium material and assist revegetation growth (refer to Plate 5-3 as an example);
- ripping the growth medium material to a depth of approximately 300 mm using conventional tines (instead of winged tines) to reduce erosion potential (Landloch, 2006); and
- revegetating by direct seeding an initial cover crop to stabilise the growth medium material and hand-planting tube-stock including selected native revegetation species within approximately two months of completion of landform construction (subject to climatic conditions or water availability).

A toe drain would be constructed on the downstream face of the emplacement batters to collect surface water runoff which would be directed into small evaporation/sediment sumps for containment (Section 2.9.1). As revegetation develops it is expected that surface water runoff would reduce and the toe drain would eventually become redundant. The rehabilitated landform would be fenced to exclude grazing to assist in maintaining the stability of the rehabilitated landform in the long-term.

A detailed description of the potential impacts of the Project on surface water resources is provided in Section 4.5.2. As described in Section 4.5.3, for all the features of Project, the risk of surface water impact is inherently low and would be further reduced by the proposed mitigation measures. The proposed mitigation measures are detailed in the Surface Water Assessment (Appendix G) and summarised in Section 4.5.3.

As described in Section 5.4.3, the Project revegetation works would be scheduled to make use of favourable climatic conditions.

Domain 2A – Mine Paths

As described in Sections 2.5.3 and 2.7, the mine path would be progressively backfilled with overburden as mining advances and would comprise encapsulated cells of process waste materials. The majority of the rehabilitated mine paths would be level with the natural ground surface.

At the completion of mining, the final landforms associated with the rehabilitated mine paths would be as follows:

- The Atlas mine path would include an overburden emplacement at the south-eastern end of the path approximately 10 m in height. The remaining extent of the rehabilitated mine path would be level with the natural ground surface except for the final void at the north-western end of the mine path.
- The Campaspe mine path would include two overburden emplacements (approximately 10 m in height) at the south-eastern end of the path which would be separated by an area level with the natural ground surface. The remainder of the rehabilitated mine path would be at natural ground surface level except for the final void at the north-western end of the mine path.

Conceptual cross-sections of the rehabilitated Atlas and Campaspe mine paths are shown on Figure 5-3.

Mine Path Overburden Emplacements

The design and cover systems of the top surface and batters of the mine path overburden emplacements would be the same as for the off-path overburden emplacements of Domain 1A.

Overburden material (approximately 10 m) would be used to cover process waste cells within the mine path overburden emplacements. Landform design investigations conducted at the Ginkgo Mine have indicated that a cover system including approximately 1 m of overburden material placed beneath approximately 200 mm subsoil and 200 mm topsoil would be adequate to prevent capillary rise of salts into the active root zone given capillary rise in sand is typically less than 1 m (Landloch, 2006; Venkatramaiah, 2006). It is expected that the same would apply for the Project. As a result, potential effects of capillary rise and risks to revegetation success from buried saline materials within the mine path overburden emplacements are considered unlikely.

The rehabilitated landform would be fenced to exclude grazing and vegetation clearance to assist in maintaining the stability of the rehabilitated landform in the long-term.

A preliminary list of indicative revegetation species proposed for use in the Project revegetation works is provided in Section 5.4.3.

Backfilled Mine Paths

The backfilled mine path re-profiled to natural ground surface level would be deep ripped to ameliorate the effects of compaction and spread with approximately 200 mm of topsoil (gypsum treated if necessary) and revegetated by direct seeding or hand-planting tube-stock including selected native revegetation species (Section 5.4.3).

Over time, there would be some minor settlement of the final landforms associated with the mine paths, however, this process would unlikely effect the stability of the landforms.

Domain 3A – Final Voids

At the cessation of mining, a final void would remain at the north-western extent of both the Atlas and Campaspe footprints (Figures 5-1 and 5-3).

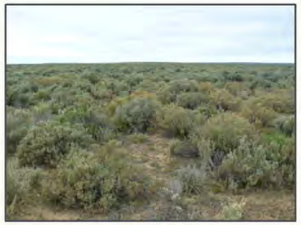
Native Revegetation - Typical Woodland/Shrubland Vegetation Communities

Typical Belah-Rosewood Woodland

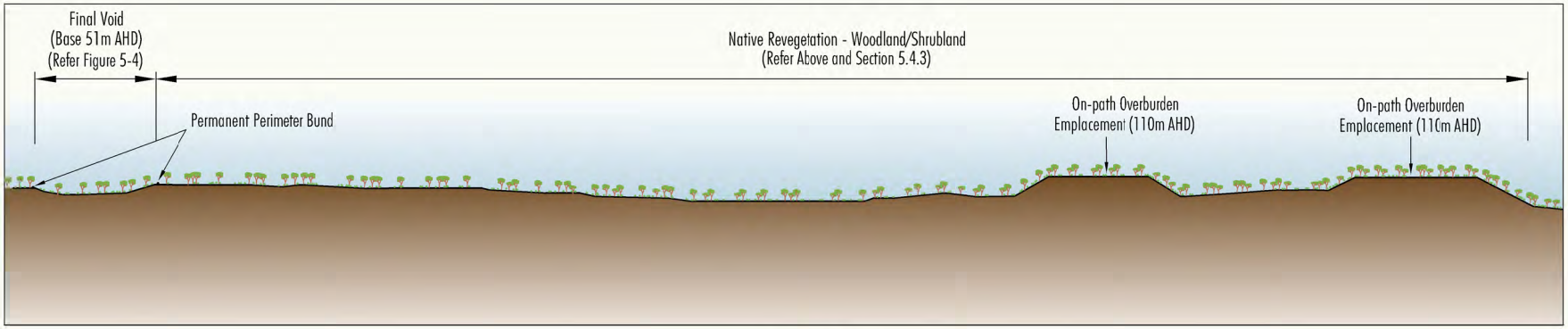
Typical Linear Dune Mallee Woodland

Typical Sandplain Mallee Woodland

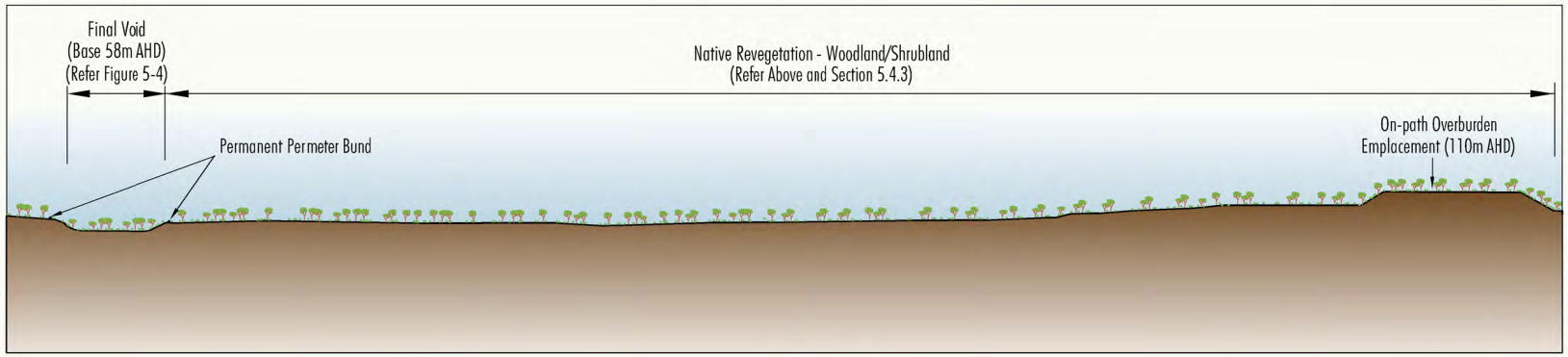
Typical Yarran Shrubland



Typical Bluebush Shrubland



Section A - A[1]
(Refer Figure 5-1)
Rehabilitated Campaspe Mine Path



Section B - B[1]
(Refer Figure 5-1)
Rehabilitated Atlas Mine Path

Not to Scale
Source: GEO-ENG (2013)

ATLAS-CAMPASPE PROJECT

FIGURE 5-3
Conceptual Cross-sections of the Rehabilitated Atlas and Campaspe Mine Paths

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The final voids would be partially backfilled with overburden material pushed down from the void batters and replaced overburden. Figure 5-4 presents conceptual cross-sections of both the Atlas and Campaspe final voids.

The depths of the final voids would remain above the groundwater table (i.e. a permanent water body would not be formed in the void) (Figure 5-4), however, incident rainfall and local surface water runoff following rainfall events would temporarily pond in the void prior to evaporating or infiltrating to the groundwater table.

As described in the Hydrogeological and Water Supply Assessment, capillary rise in sand is typically less than 1 m (Venkatramaiah, 2006) (Appendix F). The minimum depth to the groundwater table from the floor of the Atlas and Campaspe final voids would be approximately 5.3 m and 11.8 m, respectively (Appendix F). The depth of material proposed from the floor of the voids to the groundwater table is significantly more than 1 m. This therefore would prevent direct evaporation from the groundwater aquifer (Appendix F).

The surface catchment of the final voids would be reduced to the minimum practicable by maximising backfilling and installing a bund around the perimeter of the voids.

The cover system concept for the re-profiled surface of the backfilled final voids would include:

- spreading approximately 400 mm of growth medium material including a 200 mm layer of subsoil and 200 mm layer of topsoil (gypsum treated if necessary) on top of replaced overburden to support revegetation establishment (Landloch, 2006);
- ripping the growth medium material to a depth of approximately 300 mm using conventional tines (instead of winged tines) to reduce erosion potential (Landloch, 2006); and
- revegetating by direct seeding an initial cover crop to stabilise the growth medium material and hand-planting tube-stock including selected native revegetation species within approximately two months of completion of backfilling the final void (subject to climatic conditions or water availability).

A description of the revegetation species proposed for use during the Project revegetation works is provided in Section 5.4.3.

To maintain the stability of the rehabilitated final voids in the long-term, the rehabilitated final voids would be fenced to exclude access by livestock.

Domain 4A – Infrastructure and Facilities Areas

During construction and operation of the Project, the majority of the topography of the infrastructure and facilities areas would not be significantly altered.

Following dismantling and decommissioning of infrastructure, the disturbed areas would be deep ripped to ameliorate the effects of compaction as a result of Project development. The area would then be spread with approximately 200 mm of topsoil (gypsum treated if necessary) and revegetated by direct seeding or hand-planting tube-stock including selected native revegetation species (Section 5.4.3).

All groundwater bores (and associated infrastructure) installed during Project development would be permanently decommissioned (except as otherwise agreed with the landholder) in accordance with the relevant conditions with the groundwater licences.

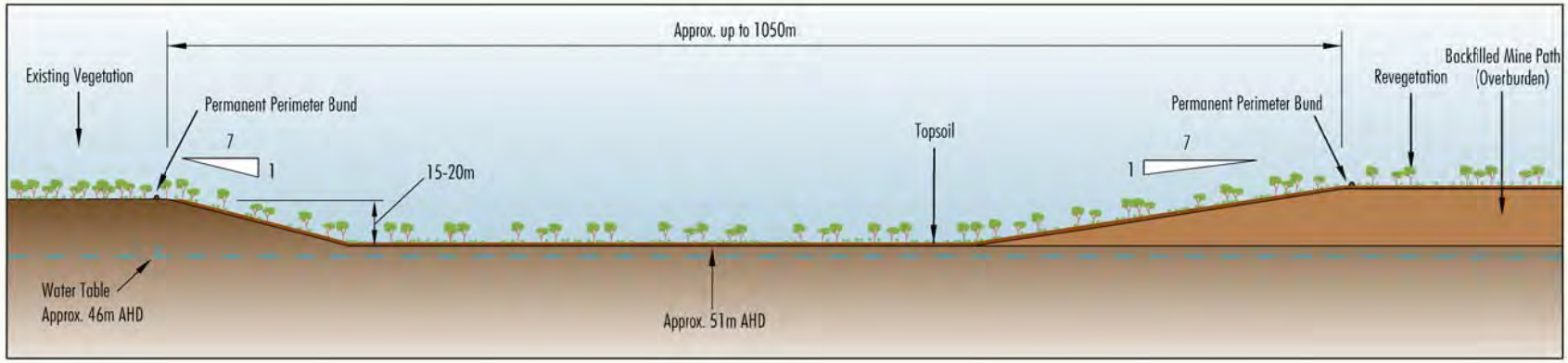
Water Management and Process Waste Materials Infrastructure

As the mine path advances, water management infrastructure (including process water storages and water disposal dams) and process waste infrastructure (i.e. off-path sand residue dams) would be rehabilitated once no longer required. Rehabilitation concepts for these structures are described below.

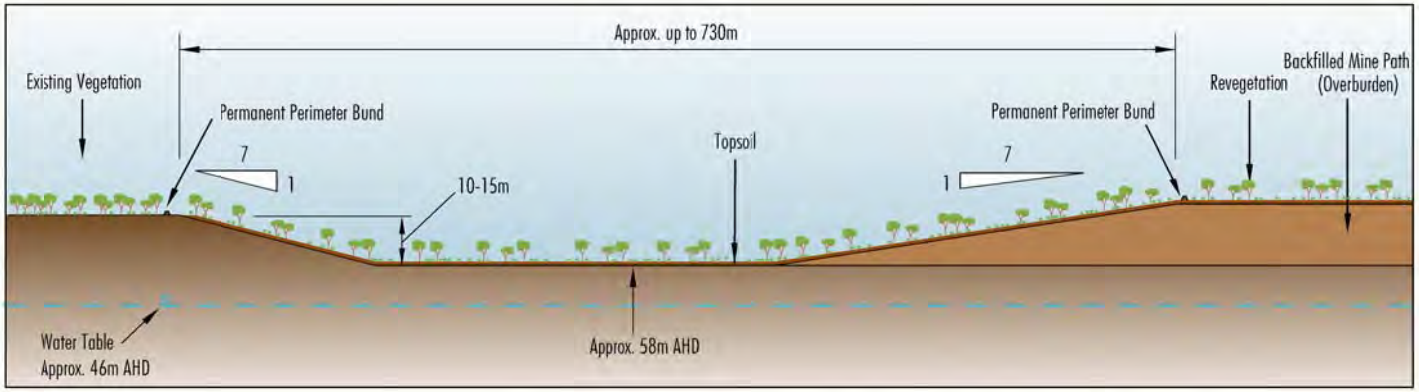
Process Water Storages and Water Disposal Dams

Decommissioning and rehabilitation of process water storage dams and water disposal dams would include:

- draining and/or decanting the dam;
- pushing in the dam walls and re-profiling the area generally consistent with the surface of the rehabilitated mine path as far as practicable;
- deep ripping the base of the dam to facilitate infiltration and minimise the potential effects of compaction;
- spreading approximately 400 mm of growth medium material including 200 mm of subsoil and 200 mm of topsoil (gypsum treated if necessary); and



Section C - C[1]
Rehabilitated Campaspe Final Void
(Refer Figure 5-1)



Section D - D[1]
Rehabilitated Atlas Final Void
(Refer Figure 5-1)

Not to Scale

Source: GEO-ENG (2013)

ATLAS-CAMPASPE PROJECT

FIGURE 5-4
Conceptual Cross-sections of the Rehabilitated Atlas and Campaspe Final Voids

Resource Strategies

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- revegetating by direct seeding an initial cover crop to stabilise the growth medium material and hand-planting tube-stock including selected native revegetation species within approximately two months of completion of decommissioning works (subject to climatic conditions or water availability).

Off-path Sand Residue Dams

During operations, off-path sand residue dams would typically store saline material and would be constructed to minimise the potential for seepage by using clay to line the base and embankments of the dams. Rehabilitation of off-path sand residue dams would therefore be undertaken using a similar concept as would apply to the mine path overburden emplacements containing process waste cells.

Rehabilitation activities would generally include:

- placing a minimum of 1 m of overburden material on top of process waste materials (Landloch, 2006; Venkatramaiah, 2006);
- spreading approximately 400 mm of growth medium material including 200 mm of subsoil and 200 mm of topsoil (gypsum treated if necessary) (Landloch, 2006); and
- revegetating by direct seeding an initial cover crop to stabilise the growth medium material and hand-planting tube-stock including selected native revegetation including salt tolerant species (e.g. Chenopod species) (subject to climatic conditions or water availability).

Landform design investigations conducted at the Ginkgo Mine have indicated that a cover system including approximately 1 m of overburden material placed beneath approximately 200 mm subsoil and 200 mm topsoil would be adequate to prevent capillary rise of salts into the active root zone (Landloch, 2006; Venkatramaiah, 2006). It is expected that the same would apply for the Project.

Final landforms associated with rehabilitated off-path sand residue dams would include a shallow depression above the groundwater table. Incident rainfall and local surface water runoff following rainfall events would temporarily pond in the depression prior to evaporating.

Local Closed Depressions within the Project Area

As described in Section 4.5.2, the main surface water features that could be impacted by the Project are a series of depressions that are strung along a line that runs from north of the Campaspe footprint and continues in a southerly direction traversing both deposits. These depressions, which vary in size, hold water after significant rainfall.

Some depressions are very shallow and any water collected in them evaporates or seeps away after a few days, while larger depressions may hold water for more than a few months (Appendix G). The depression areas typically have a higher proportion of clay in the topsoil which results in a slightly more cohesive material which is less vulnerable to erosion (Appendix G).

These depressions in the landscape provide habitat for Black Box Woodlands (Section 4.6.1 and Appendix A). Black Box (*Eucalyptus largiflorens*) trees typically have a higher water requirement than surrounding Eucalypts (such as Mallees) and the periodic filling of the depressions by rain and surface water is likely to sustain them (Appendix A). Additionally, the Black Box Woodland is considered potential habitat for a number of threatened species, including Winged Peppercress (*Lepidium monoplocoides*) and Australian Painted Snipe (*Rostrutala australis*) (Appendices A and B).

As described in Section 5.2, a key rehabilitation objective for the Project would be to maintain overland flow to local closed depressions to minimise disturbance to Black Box Woodlands (and potential threatened flora species) in the vicinity of the Project. This would be achieved by:

- refining the mine design to minimise disturbance to the depressions as far as practicable;
- selective placement of clay materials in low-lying portions of the re-profiled landform within the mine path to reinstate the water holding capacity of, and run-on to adjacent depressions (Figure 5-2); and
- maximising overland flow to the depressions.

Rehabilitation of disturbed depressions would generally involve:

- re-profiling the area generally consistent with pre-mining topography at the completion of mining;
- ripping the re-profiled surface to minimise the effects of compaction and maximise infiltration following rainfall;

- installing diversion banks/channels (where necessary) to direct overland flow to the depressions;
- spreading topsoil including high clay content at a depth of approximately 200 mm; and
- revegetating by direct seeding or hand-planting tube-stock including selected native revegetation species.

5.3.3 Rehabilitation Materials

In accordance with the Project rehabilitation objective to develop self-sustaining ecosystems including native species consistent with surrounding vegetation communities, it is proposed to use materials which are suitable as growth media for the proposed revegetation species.

A Soils, Rehabilitation Capability and Agricultural Resources Assessment has been conducted to analyse and assess the suitability of the surficial soil resources (i.e. the topsoil and subsoil resources to a depth of approximately 2 m) that would be used for rehabilitation of the Project (Landloch, 2006).

A summary of the soil survey results provided in the Soils, Rehabilitation Capability and Agricultural Resources Assessment (Landloch, 2006) including a description of the surficial soil resources potentially available for use in rehabilitation and their suitability is provided below. A detailed description of the geology, soil profile and types and landform units is provided in Appendix H.

A description of the geochemistry of overburden material is provided in Section 2.7.2 and Appendix G.

Topsoil

The Atlas-Campaspe Mine site consists of the following landform units:

- dune crests and upper dune slopes;
- lower dune slopes and sandplains;
- clayey plains and swales;
- run-on depressions; and
- cropping areas.

Topsoil depths vary across the Atlas-Campaspe Mine site according to landform units and range from approximately 10 cm to 185 cm (Landloch, 2006).

The shallowest topsoils occur on clayey plain and swale landforms and cropping area landforms (average depth of 30 cm) (Landloch, 2006). Whereas dune crest and upper dune slope landforms have significantly greater average topsoil depth of 110 cm compared with other landform units (Landloch, 2006).

Project topsoil resources have inherently low nutrient status which has been further depleted by land management practices (i.e. grazing) over many years.

As a result, Ogyris Ecological Research (2012b) recommends conservation of the surface 5 to 10 cm of topsoil, as the soil surface crust contains important seed stores and has generally elevated nutrient status when compared to the underlying topsoil (Landloch, 2006). The topsoils generally have low to moderately high free lime content, are generally non-sodic, have low soil conductivity and pH, and provide a suitable growth medium for remnant vegetation (Landloch, 2006).

Subsoil

Subsoil material varies across the Atlas-Campaspe Mine site and generally has low to moderate conductivity levels and low boron levels and would generally be suitable for rehabilitation use, depending on the presence of carbonate. Elevated sodicity values for some subsoil types may necessitate application of low to moderate rates of gypsum to improve the permeability of this material (Landloch, 2006).

5.3.4 Ivanhoe Rail Facility

Construction and operation of the Ivanhoe Rail Facility would not significantly alter the topography of the existing site. Decommissioning of the Ivanhoe Rail Facility would commence following the cessation of Project operations and would generally include:

- dismantling and removal of all infrastructure and equipment associated with the facility (with exception of the rail siding which would be retained for use by the ARTC);
- removal of the site office buildings and ablutions facilities;
- removal of the bitumen/pavements associated with the access road and internal haul road;

- decommissioning of the retention basin (which would include decanting/draining the water contained in the basin and backfilling the basin with material excavated during its construction and/or associated with the basin walls and re-profiling to a level surface); and
- removal of the perimeter fencing surrounding the facility.

Following completion of decommissioning activities, the area would be deep ripped (and applied with gypsum if necessary) to ameliorate the effects of compaction. Revegetation would be undertaken by direct seeding or hand-planting tube-stock including selected native revegetation species characteristic of the vegetation communities surrounding the facility (Section 5.4.3).

Detailed decommissioning and rehabilitation measures for the Ivanhoe Rail Facility would be provided in the Rehabilitation Management Plan and Mine Closure Plan.

5.3.5 Mineral Concentrate Transport Route

Rehabilitation activities would be undertaken following completion of roadworks associated with the proposed mineral concentrate transport route. Rehabilitation activities would generally include:

- re-profiling roadside verges and disturbed road reserves in accordance with design criteria requirements of the *Road Design Guide* (RTA, 1996); and
- revegetating with a cover crop including native seed species (and applying mulch if necessary) to stabilise the verge slope and protect against erosion.

The roads associated with the mineral concentrate transport route would be retained at the completion of the Project operations.

Surface water runoff from mineral concentrate transport route road services during/following rainfall events would be collected by the road verges/drains. Consistent with the management practices carried out at the Ginkgo and Snapper Mines, residue salts from the road surfaces collected in the drains would be periodically removed and deposited at the Atlas-Campaspe Mine behind the advancing ore extraction area.

5.4 GENERAL REHABILITATION METHODS AND MEASURES

General rehabilitation methods and measures that would be implemented to achieve the Project rehabilitation objectives are described in the following sub-sections.

The performance of the rehabilitation concepts described in Section 5.3 and the methods and measures described in this section would be regularly evaluated and the results would inform future rehabilitation initiatives and refinement or amendment to the methods and measures described below.

5.4.1 Vegetation Clearing and Salvage Measures

Clearance of vegetation would be undertaken progressively as the mine path advances. The area of native remnant vegetation cleared at any particular time would generally be no greater than that required to accommodate projected development activities for the next 12 months.

Seed would be selectively collected from felled trees/shrubs (e.g. those plants listed in Section 5.4.3) and propagated for use on the rehabilitated areas. Prior to land clearance, specific targeted searches would be undertaken in the appropriate season for the following vegetative material:

- Cobar Greenhood Orchid (*Pterostylis cobarensis*) tubers;
- Winged Peppercress seed; and
- Yarran (*Acacia melvillei*) seed.

If found, the vegetative material would be collected in accordance with appropriate licences and used in revegetation trials (Section 5.7.2), then if successful, propagated for use on the rehabilitated areas. The seedlings would be planted in a location that provides habitat for the species. The seedlings would be monitored as part of the ongoing monitoring of the rehabilitation (Section 5.7).

Ground cover (e.g. logs, fallen branches and leaf litter) would be retained within the stripped topsoil to improve the viability of the soil when it is used in rehabilitation. Select habitat features (e.g. trunks, logs, branches, small stumps and roots) would be salvaged during vegetation clearance activities and stockpiled for relocation to rehabilitated areas (Section 5.4.6).

Further detail on management of potential impacts on flora and fauna is provided in Sections 4.6.2 and 4.7.2.

5.4.2 Soil Stripping and Materials Handling Measures

Stripping of rehabilitation growth media (i.e. suitable topsoil and subsoil) would be undertaken progressively ahead of the advancing mine path. In accordance with Cristal Mining's Murray-Darling basin operations rehabilitation principles, pre-clearance soil surveys would be undertaken to characterise soil profiles, identify impediments and improve soil budgeting and stripping plans (Section 5.3).

Cleared vegetation would either be directly placed on rehabilitation areas or stockpiled adjacent to the mine path. Cleared vegetation would be used to incorporate woody debris or vegetative material into the rehabilitation growth media to enhance soil stability and revegetation establishment (Landloch, 2006).

Suitable media would be stripped from areas to be disturbed and stockpiled in accordance with procedures to be detailed in the MOP and Rehabilitation Management Plan. Stripping of media would be undertaken progressively and stockpiling procedures would aim to minimise degradation of the stockpiled media.

Soil stripping and materials handling activities would be guided by landform unit type and rehabilitation growth media depth (in particular the depth of the carbonate layer) (Landloch, 2006). As a result, stripping activities would be conducted in stages (Landloch, 2006). Topsoil stripping would be undertaken in two stages to remove the surface soil crust (i.e. to a maximum depth of 10 cm) separately from the underlying topsoil material (Landloch, 2006).

The following management strategies would be implemented for the stripping of soils at the Project:

- conducting pre-clearance soil surveys including delineating areas requiring soil stripping following vegetation clearing;
- quantification and characterisation of topsoil and subsoil materials prior to commencement of stripping (particularly the presence and depth of the carbonate layer) (Landloch, 2006);
- stripping in accordance with nominated depths and scheduling, as well as procedures for avoiding contamination of soils with material from the carbonate layer to minimise potential risks to the success of revegetation works; and
- preference for the direct placement of rehabilitation growth media in a manner which maintains the long-term viability of the soil.

Following the salvage techniques outlined in Section 5.4.1, and prior to vegetation clearance, the top 5-10 cm of topsoil around the known Winged Peppercress and the Cobar Greenhood Orchid populations in the Atlas-Campaspe Mine areas would be collected and selectively placed on the rehabilitated mine landform in an attempt to retain viable Winged Peppercress seed and Cobar Greenhood Orchid tubers.

This topsoil would be placed on the rehabilitated mine landform in a location that provides habitat for the species. For example, the topsoil would be placed amongst Mallee vegetation on a relatively flat surface.

The topsoil would be monitored in the subsequent two years (during mid-October) for signs of the Winged Peppercress or Cobar Greenhood Orchid. If the species are found, the population would be monitored as part of the ongoing monitoring of the rehabilitation (Section 5.7).

Rehabilitation Materials Storage

Topsoil and subsoil materials suitable for future rehabilitation use and not placed directly on rehabilitated areas would be stored according to each stripping stage and would include (Landloch, 2006):

- topsoil stockpiles; and
- subsoil stockpiles.

Topsoil stockpiles (including the surface soil crust stockpiles) would be stored over areas where the topsoil layer has been retained (i.e. undisturbed surfaces). Whereas subsoil stockpiles would be stored overlying areas where topsoil resources have been stripped, to maximise use of all topsoil resources and minimise the potential for mixing of topsoil and subsoil resources during soil replacement activities.

Stripped topsoil and subsoil materials including a high clay content (e.g. associated with local depressions) would be stored separately for selective placement in low-lying portions of the re-profiled landform within the mine path to reinstate the water holding capacity of, and run-on to adjacent depressions.

Soil stockpiles would be managed to maintain soil viability by using the following key management practices (Landloch, 2006):

- Topsoil and subsoil stockpiles would be limited to a maximum height of 5 m.
- Soil stockpiles would be constructed with a "rough" surface condition by cross ripping to minimise erosion, encourage drainage and promote revegetation.
- Stockpiles would be sown with a stabilising cover crop and may include the fast growing native species Bladder Saltbush (*Atriplex vesicaria*), as well as species which can provide a natural nutrient benefit, such as native herbaceous legumes including Red-flowered Lotus (*Lotus cruentus*) and Poison Swainson-pea (*Swainsona micropyhlla*).
- Where additions such as lime, gypsum or fertiliser are needed to improve the condition of stripped soil, they would be applied to the soil stockpiles as a component of soil stockpiling activities.

Overburden excavation and handling would be undertaken within areas where surface runoff is contained (Section 2.9). Overburden material not used directly in rehabilitation areas would be stored within designated off-path overburden emplacements away from topsoil and subsoil stockpiles.

Soil Resources

A preliminary estimate of topsoil and subsoil resources available for rehabilitation of the Project has been completed by (Landloch, 2006). The results of these calculations are summarised in Table 5-1 and indicate that there would be sufficient topsoil and subsoil available to meet the Project rehabilitation concepts (Landloch, 2006).

Table 5-1
Preliminary Estimate of Soil Resources Available for Rehabilitation

Soil Resource Accounting	Volume (m^3)
Estimated Available Topsoil Volume	*22,198,314*
Estimated Available Subsoil Volume	*12,960,000*
Topsoil required for rehabilitation[1]	17,280,000
Subsoil required for rehabilitation[1]	8,640,000
Net Topsoil Surplus	*4,918,314*
Net Subsoil Surplus	*4,320,000*

Source: Landloch (2006).

[1] Assuming an average cover depth of 200 mm.

m^3 = cubic metres.

A detailed rehabilitation materials balance including suitable topsoil and subsoil materials would be developed for the Project. Details of available soil resources, stripping and application schedules, and soil stockpile inventories would also be provided in the MOP and Rehabilitation Management Plan. A summary of soil management activities would be provided annually in the Annual Review and to meet the requirements of the Mining, Rehabilitation and Environmental Management Process (MREMP) (NSW Department of Primary Industries – Mineral Resources [DPI-MR], 2006).

5.4.3 Plant Species Selection

As described in Section 4.6.2, it is estimated that the Project would require the progressive removal of approximately 4,158 ha of native vegetation and approximately 305 ha of previously cleared land over approximately 20 years. The disturbance areas associated with the Project would be progressively rehabilitated and revegetated with species characteristic of the vegetation communities proposed to be cleared to provide compatibility with the vegetation of the surrounding landscape and the proposed final land use (i.e. light intensity grazing or nature conservation) (Section 5.3.1).

Revegetation species would be selected on a domain by domain basis and in consideration of nearby remnant vegetation communities, landform unit types, soil types, aspect and site conditions. Revegetation of final landforms and disturbance areas would involve direct seeding including local native plant species collected from areas cleared ahead of the advancing mine path and surrounding areas. Suitable native tube-stock and/or seeds would then be hand-planted/sown.

Suitable native plant species to be used in revegetation of Project rehabilitation domains would be documented in the Rehabilitation Management Plan, MOP (and Mine Closure Plan) and would ultimately be confirmed in consultation with relevant government agencies and landholders. Revegetation trials would also be conducted to determine suitability of revegetation species on various types of rehabilitation growth media.

Outcomes from large scale revegetation works and revegetation trials undertaken at Cristal Mining's Ginkgo Mine and former Wemen Mine would be used to inform the Project revegetation works.

Proposed Revegetation Species

Table 5-2 provides a preliminary list of indicative species proposed for use in revegetation of the Project (including the Ivanhoe Rail Facility and mineral concentrate transport route areas). The indicative species list has been based on:

- vegetation communities recorded by Australian Museum Business Services in the Flora Assessment for the Project (Appendix A);
- operational rehabilitation experience at Cristal Mining's Ginkgo Mine; and
- results from revegetation trials conducted at Cristal Mining's former Wemen Mine.

The preliminary list of revegetation species includes:

- native plant species likely to be successful early colonisers to provide a stabilising cover crop on Project final landforms including overburden emplacements;
- native tree species characteristic of remnant woodlands in the surrounding landscape and vegetation communities proposed to be removed by vegetation clearance associated with Project development; and
- a mix of species associated with the *Acacia melvillei* Shrubland EEC including Yarran.

Revegetation species would be selectively trialled and, based on performance, used during revegetation works (subject to commercial availability). The Rehabilitation Management Plan would provide a detailed description of the revegetation works and the measures that would be implemented to achieve the Project final land use. The Rehabilitation Management Plan would also detail the rationale behind selection of the native revegetation species relevant to each domain.

A description of the anticipated components of the Rehabilitation Management Plan is provided in Section 5.6.

Climatic Variation and Revegetation Activities

As described in Section 4.2.1, the average monthly rainfall is relatively uniform throughout the year and no seasonal variation is obvious.

Notwithstanding, the majority of revegetation works would be scheduled to commence with direct seeding in late April and planting of tube-stock following winter rainfall in June. However, revegetation works would also be undertaken on a campaign basis at any time during the year when climatic conditions are favourable.

Endemic plant species well adapted to the local climate and natural climatic variability would be used for revegetation activities during the life of the Project. In the event of a prolonged drought that precludes the successful establishment of these endemic species, further options may be explored to provide an alternative source of water for plant establishment.

5.4.4 Erosion and Sediment Control

The low rainfall and lack of defined drainage channels in the Project area limits the potential for fluvial erosion and sedimentation. Notwithstanding, a Water Management Plan would be developed for the Project prior to construction in consultation with the relevant government agencies and would contain on-site water management measures including erosion and sediment control. Erosion and sediment control plans would be developed as part of the Water Management Plan.

Operational sediment and erosion control works would be maintained during the establishment of revegetation. However, once self-sustaining stable final landforms have been achieved within an area, key elements of the operational water control structures would be left as passive water controls (i.e. overburden emplacement toe drains and structures associated with the reinstated local catchment depressions).

Table 5-2
Indicative Species Proposed for Revegetation

Scientific Name	Common Name	Growth Form
Mallee Woodland Complex		
Acacia brachybotrya	Grey Mulga	Large Shrub
Acacia rigens	Needle Wattle	Large Shrub
Acacia wilhelmiana	Wilhemi's Wattle	Shrub
Austrostipa nitida	-	Grass
Enchylaena tomentose	Ruby Saltbush	Shrub
Eucalyptus costata subsp. murrayana	Yellow Mallee	Tree
Eucalyptus dumosa	White Mallee	Tree
Eucalyptus gracilis	Yorrell	Tree
Eucalyptus leptophylla	Narrow-leaved Red Mallee	Tree
Eucalyptus oleosa subsp. oleosa	Red Mallee	Tree
Eucalyptus socialis	Red Mallee	Tree
Lomandra leucocephala	Woolly Mat-rush	Herb
Maireana decalvans	Black Cotton Bush	Shrub
Maireana georgei	Slit-wing Bluebush	Shrub
Maireana radiata	Grey Bluebush	Shrub
Maireana triptera	Three-wing Bluebush	Shrub
Olearia pimelioides	Pimelea Daisy-bush	Shrub
Schoenus subaphyllus	Desert Bog-rush	Herb
Sclerolaena diacantha	Grey Copperburr	Herb
Sclerolaena parviflora	-	Herb
Triodia scariosa	Spinifex/Porcupine Grass	Grass
Belah-Rosewood Woodland		
Alectryon oleifolius ssp. canescens	Rosewood	Tree
Atriplex stipitata	Mallee Saltbush	Shrub
Austrostipa nitida	-	Grass
Callitris glaucophylla	White Cypress Pine	Tree
Casuarina pauper	Belah	Tree
Dissocarpus paradoxus	Cannonball Burr	Shrub
Enchylaena tomentose	Ruby Saltbush	Shrub
Geijera parviflora	Wilga	Tree
Maireana pyramidata	Black Bluebush	Shrub
Yarran Shrubland		
Acacia melvillei	Yarran	Large Shrub/Tree
Austrodanthonia setacea	Smallflower Wallaby Grass	Grass
Austrostipa nitida	-	Grass
Dissocarpus paradoxus	Cannonball Burr	Shrub
Enchylaena tomentose	Ruby Saltbush	Shrub
Maireana triptera	Three-wing Bluebush	Shrub
Sclerolaena diacantha	Grey Copperburr	Herb
Black Box Woodland		
Acacia melvillei	Yarran	Large Shrub/Tree
Austrostipa nitida	-	Grass
Eucalyptus largiflorens	Black Box	Tree

Source: Appendix A and Ogyris Ecological Research (2010 and 2012b).

5.4.5 Weed Control and Exotic Animal Management

Weed Control

Weed control measures that would be undertaken as part of the Project would include:

- regular inspections of the mining tenement (including along internal roads, surface water diversions and areas undergoing rehabilitation) to identify and demarcate areas of noxious and environmental weeds;
- mechanical removal and/or the application of approved herbicides in areas identified as being affected by weeds;
- specific control for noxious weeds; and
- follow-up site inspections to evaluate the effectiveness of weed control programmes.

Management of Exotic Animals

Measures to control exotic animals would be undertaken within the mining lease include:

- trapping and/or baiting of exotic animals (e.g. feral goats [*Capra hircus*], European rabbits [*Oryctolagus cuniculus*] and European red foxes [*Vulpes vulpes*]); and
- follow-up site monitoring to determine the effectiveness of trapping and/or baiting programmes.

Measures to control exotic animals would be implemented by an appropriately qualified person(s). A report would be prepared annually that includes a summary of previous monitoring and control efforts, results of that years monitoring and proposed intervention strategies, if required.

5.4.6 Bushfire Prevention

Bushfire preventative measures would include:

- educating employees and contractors on general fire awareness and response procedures;
- provision and maintenance of fire fighting equipment on-site;
- fire would be controlled and outbreaks managed in consultation with the local Rural Fire Service (Lower Western Bush Fire Management Committee and the Central Darling Bush Fire Management Committee);
- establishment and maintenance of fire breaks to contain fires within the mining tenements;
- land clearing would be minimised during periods of extreme fire danger to mitigate risk of fire ignition from machinery, where practicable;
- annual inspections to identify areas requiring bushfire control measures including assessment of surrounding fuel loads;
- if hazard reduction burns are undertaken, they would be undertaken in a manner to maintain and enhance biodiversity;
- restriction of smoking in fire prone areas; and
- appropriate management of dangerous goods.

5.4.7 Increasing Habitat Complexity

Select habitat features (e.g. trunks, logs, branches, small stumps and roots) would be salvaged during vegetation clearance activities and stockpiled for relocation to rehabilitated areas. When relocated, these features are likely to provide habitat resources for a range of invertebrate and ground dwelling fauna.

A nest box programme would be implemented on the rehabilitated mine landform. Nest boxes would aim to provide potential habitat for hollow-dependent species (bats and other arboreal fauna). Nest boxes would be placed on poles if required, to provide refuge areas in advance of vegetation re-establishment.

Once installed, the nest boxes would be monitored by an appropriately qualified and experienced person to observe fauna usage. A monitoring report would be prepared annually that includes a summary of previous monitoring reports, results of that years monitoring and proposed intervention strategies, if required.

5.5 INTEGRATION WITH THE PROPOSED BIODIVERSITY OFFSET STRATEGY

Following mine closure, Project rehabilitation areas may be designated for nature conservation (i.e. restricted from grazing and vegetation clearance) in consultation with relevant government agencies. It is anticipated that the conserved rehabilitated areas would supplement the proposed biodiversity offset strategy for the Project by enhancing habitat connectivity and removing the impacts of grazing and feral pests and clearing, thereby facilitating the improvement of flora in the conserved areas. This strategy is considered consistent with other land use planning or resource management in the region.

Additional detail on the proposed biodiversity offset strategy for the Project is provided in Section 4.6.4.

5.6 REHABILITATION MANAGEMENT PLAN

A Rehabilitation Management Plan would be developed to guide rehabilitation planning for the Project (including the Ivanhoe Rail Facility) and would describe in detail the rehabilitation strategy and revegetation programme proposed to achieve the final use and relinquishment of the Atlas-Campaspe Mine site.

The Rehabilitation Management Plan would be progressively updated over the life of the Project to reflect refined rehabilitation and mine closure goals and updated regulatory requirements relevant to rehabilitation.

It is expected that the Rehabilitation Management Plan for the Project would include the following (subject to the Development Consent conditions):

- a description of the nature and timing of rehabilitation works;
- how the planned rehabilitation works relate to the rehabilitation and mine closure goals for the Project;
- rehabilitation performance objectives, performance standards and completion criteria (Section 5.7.1);
- the programme for rehabilitation monitoring (Section 5.7) to be used to evaluate the performance of rehabilitation against the performance standards and completion criteria;
- the mechanisms to be used to regularly report on the status of the rehabilitation works and the rehabilitation monitoring results;
- a mine closure strategy (Section 5.8); and
- a description of how the Rehabilitation Management Plan relates to the other relevant management plans required for the Project (e.g. Biodiversity Management Plan, MOP and Mine Closure Plan).

The Rehabilitation Management Plan would be prepared in consultation with the relevant government agencies, and in accordance with the relevant DRE rehabilitation and mine closure guidelines.

5.7 REHABILITATION AND REVEGETATION MONITORING

Ongoing monitoring and maintenance of rehabilitation areas at the Project would be conducted to assess:

- progress of rehabilitation areas;
- the effectiveness of the rehabilitation concepts and measures being used; and
- performance of rehabilitation and/or revegetation trials.

Rehabilitation Monitoring

The rehabilitation monitoring proposed would be documented in the Rehabilitation Management Plan and would describe the methods that would be used to:

- evaluate soil profile characteristics prior to seeding and the behaviour of placed soil over time (i.e. erosion or dispersion, compaction, salting or hard setting);
- assess germination success in revegetation areas (including recording of diversity and abundance) and revegetation performance over time (e.g. survival rate, plant growth, species diversity, weed content and fauna usage);
- monitor drains, sediment dams and rehabilitated mine landforms for localised failures or rilling and loss of topsoil after rainfall events;
- evaluate potential threats to rehabilitated areas (e.g. weed invasion, exotic animals and erosion);
- assess the stability of rehabilitated mine landforms (and other rehabilitated Project components [i.e. rehabilitated road verges along the mineral concentrate transport route]); and
- record key rehabilitation information (e.g. taking photographic records, documenting rehabilitation Landform Function Analysis[1] [LFA] surveys).

[1] LFA is a Commonwealth Scientific and Industrial Research Organisation (CSIRO) developed method used to provide indicators of rehabilitation success and allows the assessment of landscape processes. LFA aims to measure the progression of rehabilitation towards a self-sustaining ecosystem through the assessment of landscape function.

Annual surveys of select revegetation areas would be undertaken by an appropriately qualified and experienced person to review rehabilitation performance and identify any additional measures required to achieve ongoing rehabilitation success (e.g. additional plantings or intervention measures).

A detailed monitoring report would be prepared annually that includes a summary of previous year's monitoring results, results of the current year's monitoring and any planned remedial works, if required. The monitoring results would be summarised in the Annual Review and to meet the requirements of the MREMP.

Radiation Monitoring

Environmental gamma radiation monitoring would be conducted at the following locations after rehabilitation to determine if radiation levels equivalent to the natural background radiation level (Section 4.3.3) are being achieved:

- at 200 m intervals along the mine path at the Atlas-Campaspe Mine;
- mineral concentrate and MSP process waste stockpile areas adjacent the HMC treatment facility at the Atlas-Campaspe Mine; and
- mineral concentrate stockpile and MSP process waste container storage areas at the Ivanhoe Rail Facility.

5.7.1 Performance Standards and Completion Criteria

The Rehabilitation Management Plan would detail rehabilitation monitoring proposed and relevant performance standards and completion criteria against which rehabilitation success would be evaluated. Performance standards and completion criteria would be developed based on relevant rehabilitation experience from Cristal Mining's other Murray-Darling basin operations, outcomes from Project rehabilitation trials (Section 5.7.2) and include revegetation performance indicators based on appropriate analogue or reference sites determined by a suitably qualified and experienced person.

Rehabilitation performance standards and completion criteria would be reviewed and refined as part of the mining, rehabilitation and environmental management process. Rehabilitation performance standards and completion criteria would ultimately be determined in consultation with relevant government agencies and documented in the MOP and Rehabilitation Management Plan.

Key strategic rehabilitation completion criteria have been developed for the Project and are described below. These criteria have been developed with regard to *Leading Practice Sustainable Development Program for the Mining Industry–Mine Closure and Completion* (DITR, 2006b) and the Guideline (DTIRIS-DRE, 2011).

It is appropriate that the criteria described below remain at the strategic level for this EIS. Over the life of the Project, rehabilitation completion criteria would periodically be updated and refined in consultation with relevant stakeholders to include additional quantitative criteria and reflect evolving site rehabilitation practices and standards.

Decommissioning

- Project infrastructure and facilities are to be decommissioned in accordance with the Mine Closure Plan to the satisfaction of the relevant government agencies.
- Any potentially contaminated areas are to be tested and where required, remediated, in accordance with the NSW *Land Contamination Management Act, 1997* following infrastructure decommissioning.

Landform Establishment

- Final landform areas (e.g. overburden emplacement batters and backfilled mine paths) are to be re-profiled to final slopes, and drainage structures installed consistent with the requirements of the Rehabilitation Management Plan and MOP.
- Final landform elevations and slopes are to be surveyed to determine compliance with the specifications (e.g. landform slopes and final elevations) set out in the Rehabilitation Management Plan and MOP prior to the placement of rehabilitation growth media.

Growth Medium Development

- Specific soil stripping depths and soil amelioration requirements for each domain are to be based on detailed pre-stripping surveys.
- Suitable topsoil and subsoil growth media is to be stripped, and where necessary, suitably stockpiled for future rehabilitation use. Annual reporting of the site soil balance is to be provided in the Annual Review and to meet the requirements of the mining, rehabilitation and environmental management process.

- Soil application depths, amelioration requirements and soil application equipment on final landforms are to be in accordance with the Rehabilitation Management Plan and to meet the requirements of the mining, rehabilitation and environmental management process.
- Suitable soil preparation (e.g. ripping and gypsum application if required) is to be undertaken prior to establishment of vegetation.

Ecosystem Establishment

- After placement of growth media on profiled final landforms, initial ground cover revegetation species are to be sown to stabilise the growth media and minimise soil erosion. Prior to sowing revegetation species on overburden emplacement batters, coarse woody debris is to be spread across batter slopes to further supplement stabilisation of growth media and revegetation establishment (refer to Plate 5-3 as an example).
- Unless in declared drought conditions, after the placement of growth media on final landform areas, a suitable combination of native woodland/shrubland species characteristic of the surrounding vegetation communities is to be established relevant to the rehabilitation domains (e.g. direct seeding and/or planting of tube-stock). To facilitate revegetation establishment and development, grazing is to be restricted on areas undergoing rehabilitation.
- After revegetation establishment in a domain, representative rehabilitation monitoring transects are to be established in that domain and in corresponding representative analogue sites in accordance with the requirements of the Rehabilitation Management Plan.

Ecosystem Development

- Monitoring of native revegetation is to be undertaken in accordance with the Rehabilitation Management Plan at intervals no longer than tri-annually.
- Results of the native revegetation monitoring are to be reported in the Annual Review and to meet the requirements of the mining, rehabilitation and environmental management process.
- Monitoring is to include the use of LFA or a similar systems-based approach to determine progress towards a self-sustaining ecosystem and compare the condition of the revegetated areas with representative analogue sites in remnant native vegetation.
- Monitoring of rehabilitated and revegetated areas is to be conducted with the aim to indicate development of self-sustaining ecosystems that no longer require intervention or management for ecosystem processes to continue.

5.7.2 Rehabilitation Trials and Research

As a component of the Project rehabilitation strategy, a number of trials would be undertaken to assess the effectiveness of rehabilitation concepts and methods and the suitability of different revegetation species over the life of the Project.

The rehabilitation trials proposed have been developed based on rehabilitation trials and experience at Cristal Mining's Ginkgo and Snapper Mines and former Wemen Mine. Results from ongoing rehabilitation trials at Cristal Mining's other operations would continue to be applied to the Project rehabilitation strategy where relevant.

The rehabilitation trials and research studies would be described in detail in the Rehabilitation Management Plan and MOP and would include the following:

- **Plant Species** – assessment of suitable plant species for types of rehabilitation growth media and revegetation of the rehabilitation domains.
- **Propagation Methods** – assessment of suitability of different propagation methods (e.g. direct seeding, nursery propagation and hand planting of tube-stock).
- **Rehabilitation Growth Media** – confirmation of the suitability of subsoil and topsoil growth media depths for rehabilitation.
- **Cover Depths** – confirmation of total subsoil and topsoil cover depths required over overburden material to minimise risks to revegetation posed by salinity.
- **Plant Establishment Requirements** – assessment of plant species establishment requirements including initial soil moisture and soil amelioration requirements.

- **Material Amelioration** – assessment of suitable gypsum application rates to ameliorate sodicity and evaluation of the effect of the low nutrient status of topsoil material and high boron levels of subsoil material on the revegetation programme.
- **Stability of Rehabilitated Landforms** – confirmation of rehabilitated landform slope design specifications including assessment of slope length, degree and material type erodibility.

Vegetative material from the Winged Peppercress, Cobar Greenhood Orchid and Yarran would be salvaged and included in revegetation trials (Section 5.4.1).

Results from the rehabilitation trials and research would be used to revise components of the rehabilitation strategy where necessary in consultation with relevant government agencies.

A key rehabilitation objective for the Project would be to selectively place clay materials in low-lying portions of the re-profiled landform within the mine path to reinstate the water holding capacity of, and run-on to adjacent depressions. This would provide for the potential for species representative of Black Box Woodlands, e.g. *Eucalyptus largiflorens*, to establish. Following the re-establishment of the depression and run-on to it, and the establishment of these species, these depressions would provide potential habitat for the Winged Peppercress.

5.8 MINE CLOSURE

The mine closure goal for the Project is to achieve relinquishment to the satisfaction of the relevant Minister(s), meeting relevant mining lease and Development Consent conditions.

Cristal Mining would develop a Mine Closure Plan for the Project which would include details of the mine closure strategy and outline proposed post-mine closure management or maintenance measures. The mine closure strategy would be developed in consultation with the DTIRIS-DRE, BSC, CDSC, DP&I and the local community, and would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.

The Mine Closure Plan would include a Post-Closure Management Programme which would outline maintenance measures and monitoring that would be undertaken to assess the performance and effectiveness of the post-closure maintenance measures.

Post-closure maintenance measures are anticipated to include:

- maintenance of erosion and sediment control structures (i.e. evaporation/sediment sumps, sediment dams or diversion banks/channels) until monitoring indicates the structures are redundant and no longer require maintenance;
- weed and animal pest control measures to minimise potential impacts to the performance of rehabilitation areas or nature conservation areas;
- fence maintenance to exclude unauthorised access and livestock from rehabilitation areas during revegetation development;
- bushfire prevention measures including annual inspections to identify areas requiring bushfire control measures (i.e. hazard reduction burns to reduce fuel loads and maintenance of fire breaks and fire access tracks);
- selective use of fertilizer to improve revegetation development in rehabilitation areas or supplementary plantings to replace any revegetation losses; and
- replacement of habitat enhancement measures (i.e. nest boxes) should monitoring indicate that placed nest boxes have been damaged or are missing.

The Project's Rehabilitation Monitoring Programme (Section 5.7) would be continued during the post-closure phase until rehabilitation completion criteria have been met, or until the relevant Minister(s) otherwise accept the rehabilitation status. The Rehabilitation Monitoring Programme would likely be refined during the post-closure phase to reflect the status of the closed rehabilitation site (i.e. monitoring frequency, parameters and sites may be progressively refined as revegetation develops and as rehabilitation areas achieve rehabilitation completion criteria).