

# VICKERY EXTENSION PROJECT

## ENVIRONMENTAL IMPACT STATEMENT

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# SECTION 5

## REHABILITATION STRATEGY

## TABLE OF CONTENTS

<b>5</b>	<b>REHABILITATION STRATEGY</b>	<b>5-1</b>
5.1	EXISTING REHABILITATION IN THE PROJECT AREA	5-1
5.1.1	Rehabilitation of the Former Canyon Coal Mine	5-1
5.1.2	Rehabilitation of the Former Vickery Coal Mine	5-6
5.2	EXISTING REHABILITATION AT OTHER WHITEHAVEN MINES	5-6
5.2.1	Rocglen Coal Mine	5-6
5.2.2	Tarrowonga Coal Mine	5-6
5.2.3	Werris Creek Coal Mine	5-9
5.3	REHABILITATION OF THE PROJECT	5-9
5.3.1	General Rehabilitation and Mine Closure Criteria for the Project	5-9
5.3.2	Conceptual Post-Mining Land Use and Final Landform	5-10
5.3.3	Rehabilitation Domains and Conceptual Domain Objectives	5-15
5.4	GENERAL REHABILITATION MEASURES	5-20
5.4.1	Vegetation Clearing Measures	5-20
5.4.2	Soil Management	5-21
5.4.3	Stages of Rehabilitation	5-23
5.4.4	Selection of Native Plant Species for Revegetation	5-23
5.4.5	Re-establishment of Agricultural Land	5-24
5.4.6	Erosion and Sediment Control Works	5-24
5.5	REHABILITATION AND REVEGETATION TRIALS AND MONITORING	5-25
5.6	INTEGRATION WITH REHABILITATION AT OTHER MINES	5-25
5.6.1	Canyon Coal Mine	5-25
5.6.2	Rocglen Coal Mine	5-25
5.7	MINING OPERATIONS PLAN	5-26
5.8	PLANNING FOR MINE CLOSURE	5-26

### LIST OF TABLES

Table 5-1	Rehabilitation and Mine Closure Goals for the Project
Table 5-2	Rehabilitation Domains
Table 5-3	Final Void Summary
Table 5-4	Estimate of Soil Volume for Rehabilitation in the Project Mining Area
Table 5-5	Approximate Areas of Disturbance and Progressive Rehabilitation for the Project

### LIST OF FIGURES

Figure 5-1	Project Mining Area Existing Landform
Figure 5-2	Project General Arrangement – Following End of Mining
Figure 5-3	Conceptual Final Landform – Rehabilitation Areas
Figure 5-4	Conceptual Final Rehabilitation and Regeneration
Figure 5-5	Conceptual Cross-Sections of the Project Final Landform
Figure 5-6	Conceptual Final Landform – Rehabilitation Domains
Figure 5-7	Recommended Soil Stripping Depths

### LIST OF PLATES

Plate 5-1	Canyon Coal Mine – Final Void Prior to Reshaping
Plate 5-2	Canyon Coal Mine – Final Void Following Reshaping
Plate 5-3	Canyon Coal Mine – Cover Crop Establishment within Final Void
Plate 5-4	Canyon Coal Mine – Cover Crop Establishment on Waste Rock Emplacement
Plate 5-5	Canyon Coal Mine – Woodland Vegetation Rehabilitation
Plate 5-6	Canyon Coal Mine – Woodland Vegetation Rehabilitation
Plate 5-7	Shannon Hill – Final Void
Plate 5-8	Blue Vale – Final Void
Plate 5-9	Tarrowonga Coal Mine – Northern Emplacement Following Reshaping, Fauna Habitat Placement and Cover Crop Establishment (2013)
Plate 5-10	Tarrowonga Coal Mine – Northern Emplacement with Established Woodland Vegetation Rehabilitation and Fauna Habitat (2017)
Plate 5-11	Headwater Stream Type
Plate 5-12	Valley Fill Stream Type

## 5 REHABILITATION STRATEGY

This section summarises the approach to rehabilitation and landscape management for the Project. It describes how the Project would be progressively rehabilitated and integrated with adjoining natural and modified landscapes, and the measures that would be put in place for the long-term protection and management of the site following the cessation of mining.

The approach to rehabilitation and landscape management for the Project has been developed in consideration of:

- the Project SEARs including comments provided by relevant government agencies (e.g. DRE [now DRG]);
- outcomes of consultation with relevant regulators (Section 3);
- *Vickery Extension Project Biodiversity Assessment Report and Biodiversity Offset Strategy* (Appendix F);
- *Vickery Extension Project Agricultural Impact Statement* (Appendix H);
- *Vickery Extension Project Soil Resource Assessment* (SESL, 2018a); and
- contemporary reviews/assessments of post-mining landforms by DP&E and the Independent Planning Commission (IPC) (previously the Planning Assessment Commission).

### 5.1 EXISTING REHABILITATION IN THE PROJECT AREA

Open cut and underground mining activities have previously been conducted in the Project area at the former Vickery and Canyon Coal Mines (Section 1.2).

The areas previously disturbed by mining have been successfully rehabilitated such that the land is suitable for grazing. Areas of woodland vegetation have also been successfully established on the steeper slopes and other areas of the open cut mining landforms.

The existing rehabilitated landform includes the following five final voids (Figure 5-1):

- Canyon final void;
- Red Hill final void;

- Blue Vale final void;
- Greenwood final void; and
- Shannon Hill final void.

An evaluation of current rehabilitation techniques and performance against existing rehabilitation objectives and completion criteria is provided in the following subsections.

#### 5.1.1 Rehabilitation of the Former Canyon Coal Mine

Whitehaven maintains the former Canyon Coal Mine site, which ceased operations in 2009 and is in closure, in accordance with the *Canyon Coal Mine Closure Mining Operations Plan* (SLR Consulting, 2015a) and Development Consent (DA-8-1-2005).

The rehabilitation activities conducted at the Canyon Coal Mine site have included reshaping of waste rock emplacements, soil placement, installation of water management control measures, establishment of a cover crop, planting of tube stock, and monitoring and maintenance of rehabilitated areas.

The Canyon Coal Mine site has been successfully returned to a mixture of open pasture areas and established woodland. Photographs showing the progressive implementation of rehabilitation stages at the Canyon Coal Mine are provided in Plates 5-1 to 5-6.

Rehabilitation monitoring at the Canyon Coal Mine indicates that (ELA, 2017a):

- Rehabilitation at the Canyon site has proven successful to date.
- A stable landform has been developed that has allowed for the relocation and establishment of a functional soil cover with appropriate nutrient and water cycling capabilities.
- Woodland structure and composition elements are trending towards those found in nearby control sites.
- Vegetation affected by a fire event in 2013 appears to be resprouting.
- Rhodes Grass (*Chloris gayana*) remains present at some sites, however, is no longer used in plantings.



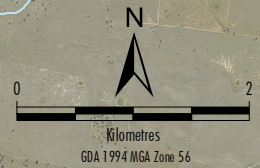


- LEGEND**
- State Forest
  - Existing 66kV Powerline
  - Former Mining Area

Source: LPMA - Topographic Base (2010) and Orthophoto (Boggabri 2011); Department of Industry (2015)



**VICKERY EXTENSION PROJECT**  
**Project Mining Area Existing Landform**



**Figure 5-1**





**Plate 5-1** Canyon Coal Mine - Final Void Prior to Reshaping



**Plate 5-2** Canyon Coal Mine - Final Void Following Reshaping

WHC15-33\_EIS\_Sect5\_001A

Source: Whitehaven (2013)



VICKERY EXTENSION PROJECT  
Canyon Coal Mine Rehabilitation





**Plate 5-3** Canyon Coal Mine - Cover Crop Establishment within Final Void



**Plate 5-4** Canyon Coal Mine - Cover Crop Establishment on Waste Rock Emplacement

WHC15-33\_EIS\_Sect5\_002A

Source: Whitehaven (2013)



VICKERY EXTENSION PROJECT  
Canyon Coal Mine Rehabilitation





**Plate 5-5** Canyon Coal Mine - Woodland Vegetation Rehabilitation



**Plate 5-6** Canyon Coal Mine - Woodland Vegetation Rehabilitation

WHC-15-33\_EIS Ser15\_003B

Source: Whitehaven (2017)



- Animals are more frequently using rehabilitated areas, and bird diversity is increasing with rehabilitation age and is trending toward the diversity found in the nearby control sites.
- With ongoing management, it is highly likely that the site's woodland environment will continue to develop into an important ecological resource.

### 5.1.2 Rehabilitation of the Former Vickery Coal Mine

Three rehabilitated open cut mining areas (i.e. Blue Vale, Shannon Hill and Greenwood) and one underground and open cut mining area (i.e. Red Hill) are associated with the former Vickery Coal Mine.

Mining operations at the former Vickery Coal Mine ceased in 1998, when approval from the DPI was granted to suspend operations and complete rehabilitation works on-site.

Rehabilitation of approximately 405 ha of mining areas was completed in 2000 and the site is currently in closure.

The areas previously disturbed for mining have been rehabilitated with ground cover suitable for grazing, with areas of woodland vegetation on the steeper slopes and other areas of the open cut mining landforms.

The rehabilitated areas have been successfully grazed for over a decade with graziers reporting stock perform well on the rehabilitated areas (Appendix H).

Plate 5-7 shows rehabilitation at the Shannon Hill final void, and Plate 5-8 shows rehabilitation at the Blue Vale final void.

## 5.2 EXISTING REHABILITATION AT OTHER WHITEHAVEN MINES

### 5.2.1 Rocglen Coal Mine

The Rocglen Coal Mine is located to the east of the Vickery State Forest.

Rehabilitation at the Rocglen Coal Mine is undertaken in accordance with the *Rocglen Coal Mine Mining Operations Plan* (SLR Consulting, 2016) and Project Approval (06\_0198).

The rehabilitation strategy for the Rocglen Coal Mine includes the establishment of native vegetation on the western side of the site to connect with the vegetation in the Vickery State Forest and predominantly rehabilitated pasture on the eastern side (GSS Environmental, 2011).

Rehabilitation of the Rocglen Coal Mine has primarily involved revegetation of the Western and Northern Emplacements.

Fauna recorded within the rehabilitated areas were observed coming from and returning to the Vickery State Forest. Bird and terrestrial fauna species richness has increased in the woodland rehabilitation site since 2014 (ELA, 2017c).

### 5.2.2 Tarrawonga Coal Mine

Rehabilitation activities at the Tarrawonga Coal Mine commenced in 2007 and have focused on the Northern and Southern Emplacements.

Photographs showing rehabilitation at the Tarrawonga Coal Mine are provided in Plates 5-9 and 5-10.

The current rehabilitation objective is to re-profile the completed sections of the Northern Emplacement batters to a stable overall slope of approximately 10° and to revegetate the completed landform to open native woodland with flora species characteristic of the local area (Tarrawonga Coal Pty Ltd, 2015). Fauna habitat features (e.g. tree trunks) are being incorporated into the rehabilitation areas.

A mid-storey layer has developed that consists of juvenile eucalyptus species that are expected to form the canopy as they mature (ELA, 2017d).

A number of endemic species continue to be recorded at the rehabilitation sites, including the Eastern Grey Kangaroo (*Macropus giganteus*), the Common Wallaroo (*Macropus robustus*), the Wall Skink (*Cryptoblepharus virgatus*), the Lace Monitor (*Varanus varius*) and the Red-necked Wallaby (*Macropus rufogriseus*) (ELA, 2017d).

During 2016, a threatened bird species (Speckled Warbler [*Chthonicola sagittata*]) was recorded within the Tarrawonga Coal Mine rehabilitation area (ELA, 2017d).



**Plate 5-7** Shannon Hill - Final Void



**Plate 5-8** Blue Vale - Final Void

WHC15-33\_EIS\_Sect5\_004A

Source: Whitehaven (2013)





**Plate 5-9** Tarrawonga Coal Mine - Northern Emplacement Following Reshaping, Fauna Habitat Placement and Cover Crop Establishment (2013)



**Plate 5-10** Tarrawonga Coal Mine - Northern Emplacement with Established Woodland Vegetation Rehabilitation and Fauna Habitat (2017)

WHC15-33\_EIS\_Sect5\_005B

Source: Whitehaven (2013; 2017)



### 5.2.3 Werris Creek Coal Mine

Whitehaven has completed more than 150 ha of rehabilitation at the Werris Creek Coal Mine.

The mine rehabilitation areas were only recently established, however native species richness has increased and improved and these results are expected to continue.

Tubestock plantings have reached a height of 4 to 5 m and are progressing towards establishing a native overstorey cover. A large groundcover of native species has also established in the rehabilitation sites.

The rehabilitated landform has slopes of up to approximately 10° and has remained stable since its construction. Other processes such as infiltration and nutrient cycling as indicated by the Soil Surface Assessment (an outcome of landscape function analysis [LFA]) are relatively low but have continued to increase. These results are typical for recently established rehabilitation, and in time it is expected that vegetation and soil characteristics will continue to progress towards woodland habitat.

## 5.3 REHABILITATION OF THE PROJECT

The sections above provide both site-specific evidence of successful mine rehabilitation at the Project site, and demonstration of Whitehaven’s successful rehabilitation at other sites.

The rehabilitation strategy for the Project has been developed based on this experience gained from extensive rehabilitation works undertaken by Whitehaven at the Project site and in the region (at the Rocglen, Tarrawonga and Werris Creek Coal Mines), including consideration of the successful methodology used at these sites (e.g. slope of the batters, soil depth, revegetation techniques and plant selection).

Consideration has also been given to the *Leading Practice Sustainable Development Program for the Mining Industry – Mine Rehabilitation* (Commonwealth of Australia, 2016a), *Leading Practice Sustainable Development Program for the Mining Industry - Mine Closure* (Commonwealth of Australia, 2016b) and the *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2000).

The proposed Project rehabilitation strategy is generally consistent with the strategy for the Approved Mine, with the following improvements:

- Reduction in the number of final voids from five to two within the Project area (noting that three final voids would be retained for the Approved Mine).
- Removing the requirement for the Eastern Emplacement as a waste rock emplacement (i.e. creating a permanent change to the final landform), with its approved footprint to be used as a temporary secondary infrastructure area for the Project.
- Introduction of micro-relief (i.e. gently undulating surface typically ranging in elevation by 1 to 2 m) to the waste rock emplacement to assist in drainage design that replicates natural drainage systems.
- Introduction of macro-relief (i.e. 10 to 20 m hills similar to those found in the Vickery State Forest) to the top surface of the waste rock emplacement to improve the integration of the landform with the surrounding environment and mitigate potential visual impacts.
- Increased areas of woodland/forest revegetation to enhance the biodiversity value of the rehabilitated Project mining area and improve the connectivity of woodland between the Vickery State Forest and the Namoi River.

### 5.3.1 General Rehabilitation and Mine Closure Criteria for the Project

The Approved Mine will progressively disturb a total area of approximately 2,242 ha, consisting of approximately 1,284 ha of grassland, 464 ha native woodland/forest, 405 ha of rehabilitated land associated with the previous Vickery Coal Mine and approximately 89 ha of existing dams, tracks, roads and infrastructure areas.

The Project would require the progressive disturbance of an additional 77.8 ha of native woodland/forest vegetation, 502 ha of derived native grassland and 196 ha of cleared land (including rehabilitated land associated with the former Canyon Coal Mine).

Table 5-1 describes the rehabilitation and mine closure goals for the Project.

**Table 5-1  
Rehabilitation and Mine Closure Goals for the Project**

Short-term	Medium to Long-term
<ul style="list-style-type: none"> <li>▪ Minimise active disturbance areas by progressively rehabilitating, and by restricting clearing to the minimum required for operations.</li> <li>▪ Salvage vegetation and habitat resources during clearing activities and re-use in rehabilitated areas to provide habitat resources for fauna (e.g. tree hollows and logs).</li> <li>▪ Strip soil from areas of disturbance, as required, to reduce the potential for erosion and sediment generation, and to minimise the extent of soil stockpiles and the period of storage.</li> <li>▪ In preference to stockpiling, replace stripped soil directly on completed sections of the final landform, wherever practicable.</li> <li>▪ Install erosion and sediment control measures prior to the commencement of soil stripping and rehabilitation activities.</li> <li>▪ Plant cover crops as appropriate on newly rehabilitated mine landform areas (and soil stockpiles) following completion of earthworks, to minimise the potential for soil erosion.</li> <li>▪ Stabilise new infrastructure disturbance areas (e.g. roads and dam embankments) as soon as possible by placement of soil and seeding.</li> <li>▪ Plant vegetation screens in key areas ahead of Project disturbance activities, to allow growth and screening to occur over time.</li> <li>▪ Progressively place waste rock within the footprint of the open cut void and reshape completed areas to their final landform shape so that they can be progressively rehabilitated.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provide self maintaining, geotechnically stable and safe landforms that complement existing surrounding landforms in terms of slope, geomorphological characteristics, vegetation and land use.</li> <li>▪ Revegetate the mine landforms to predominately native woodland/forest.</li> <li>▪ Rehabilitate the mine infrastructure areas with predominately groundcover (i.e. grass species) and scattered trees that would return these areas to land suitable for grazing.</li> <li>▪ Construct the waste rock emplacement to incorporate micro-relief and landform features (macro-relief) similar to the natural landforms found in the Vickers State Forest.</li> <li>▪ Construct the final top surface of the waste rock emplacement so that rainfall runoff drains in a natural, stable manner that minimises the use of engineered drop structures as far as practical.</li> <li>▪ Create a final void that does not impact the groundwater systems and receiving surface waters surrounding the Project.</li> </ul>

The overall rehabilitation goal for the Project mining area is to enhance the cover and connectivity of native woodland, while retaining some areas of agricultural land capable of supporting cattle grazing.

The MOP would include detailed and quantifiable performance measures and completion criteria (based on Development Consent requirements for the Project). The rehabilitation performance measures and completion criteria included in the MOP would be specific, measureable, achievable, realistic and time-bound.

The MOP, and any subsequent amendments, would present mining plans and progressive rehabilitation schedules, which would reflect mine planning at that time.

Mined lands would be considered suitable for relinquishment when the nominated standards and/or completion criteria for land use, landform stability, revegetation, and beneficial use have been met, or if the relevant Minister(s) otherwise accepts the rehabilitation status.

### **5.3.2 Conceptual Post-Mining Land Use and Final Landform**

#### *Conceptual Post-Mining Land Use*

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

The conceptual post-mining land uses would be consistent with the surrounding existing land uses (e.g. vegetation and fauna habitat in the Vickery State Forest and along the Namoi River and cattle grazing on flatter, lower lying areas).

The conceptual post-mining land uses are also generally consistent with the aims of the Gunnedah and Narrabri LEPs (Attachment 5) (e.g. to conserve and enhance the quality of valuable environmental assets and provide for ecologically sustainable agriculture).

Figures 5-2, 5-3 and 5-4 illustrate the conceptual rehabilitated final landform and post-mining land uses.

The conceptual post-mining land uses of the Project would continue to comprise a combination of nature conservation (woodland/forest) and agricultural (pasture) land uses, consistent with the post-mining land use of the Approved Mine.

The conceptual final landform and revegetation program would provide for a combination of approximately 2,385 ha of native woodland/forest and some 342 ha of agricultural land suitable for grazing (of which 256 ha would be located in the Project mining area).

Revegetation trials would be used to inform the ultimate land use for the Project. Revegetation trials would be used to determine species types and soil and weed management practices to be used to achieve the Project post-mining land use objectives.

### **Conceptual Final Landform**

The conceptual final landform has been designed to integrate with the surrounding natural landforms, including consideration of elevation, slope and drainage.

Natural landforms in the vicinity of the Project are characterised by:

- Dissected and steep topography within the Vickery State Forest to the east of the Project, which rises to an elevation of approximately 479 m AHD.
- Undulating grazing lands in the Project mining area with ephemeral drainage lines and some woodland regrowth associated with rehabilitated mining areas (Section 5.1).
- To the north, south and west of the Project mining area the topography is gently sloping to almost flat, and generally drains towards the Namoi River. These floodplain areas typically have elevations of between 250 to 260 m AHD.

- Ephemeral drainage lines, with ‘headwater’ stream types typically in the steep topography within Vickery State Forest and ‘valley fill’ stream types typically found on the flatter areas (Fluvial Systems, 2012). Example headwater and valley fill streams in the vicinity of the Project are shown on Plates 5-11 and 5-12.



**Plate 5-11 Headwater Stream Type**

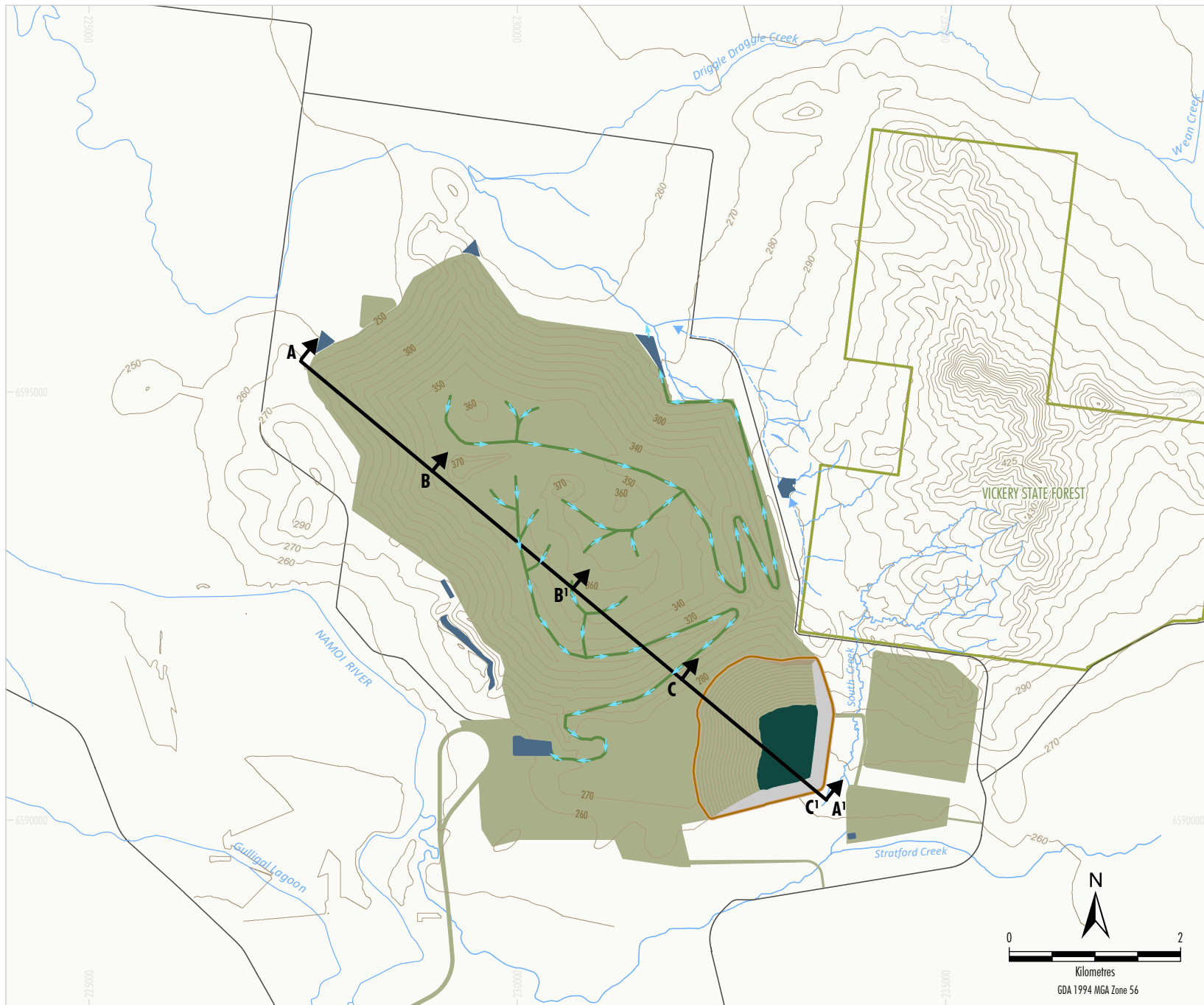


**Plate 5-12 Valley Fill Stream Type**

Key features of the final landform include:

- A waste rock emplacement incorporating natural landform design features (i.e. micro-relief and macro-relief) that reflect characteristics of the topography found in the adjacent Vickery State Forest (e.g. elevated landforms with steeper slopes in some areas relative to the surrounding plains).
- Drainage features designed to be stable in the long-term.
- Rehabilitated infrastructure areas and rail corridor that are flat and contiguous with the surrounding agricultural areas.





- LEGEND**
- State Forest
  - Indicative Up-catchment Diversion
  - Indicative Extent of Water Storage
  - Indicative Constructed Channels
  - Indicative Established Rehabilitation
  - Indicative Final Void Pit Lake
  - Indicative Final Void Highwall
  - Indicative Final Void Perimeter Bund
  - Cross-Section Location \*

\* Refer Figure 5-5 for Cross-Sections A-A'; B-B' and C-C'

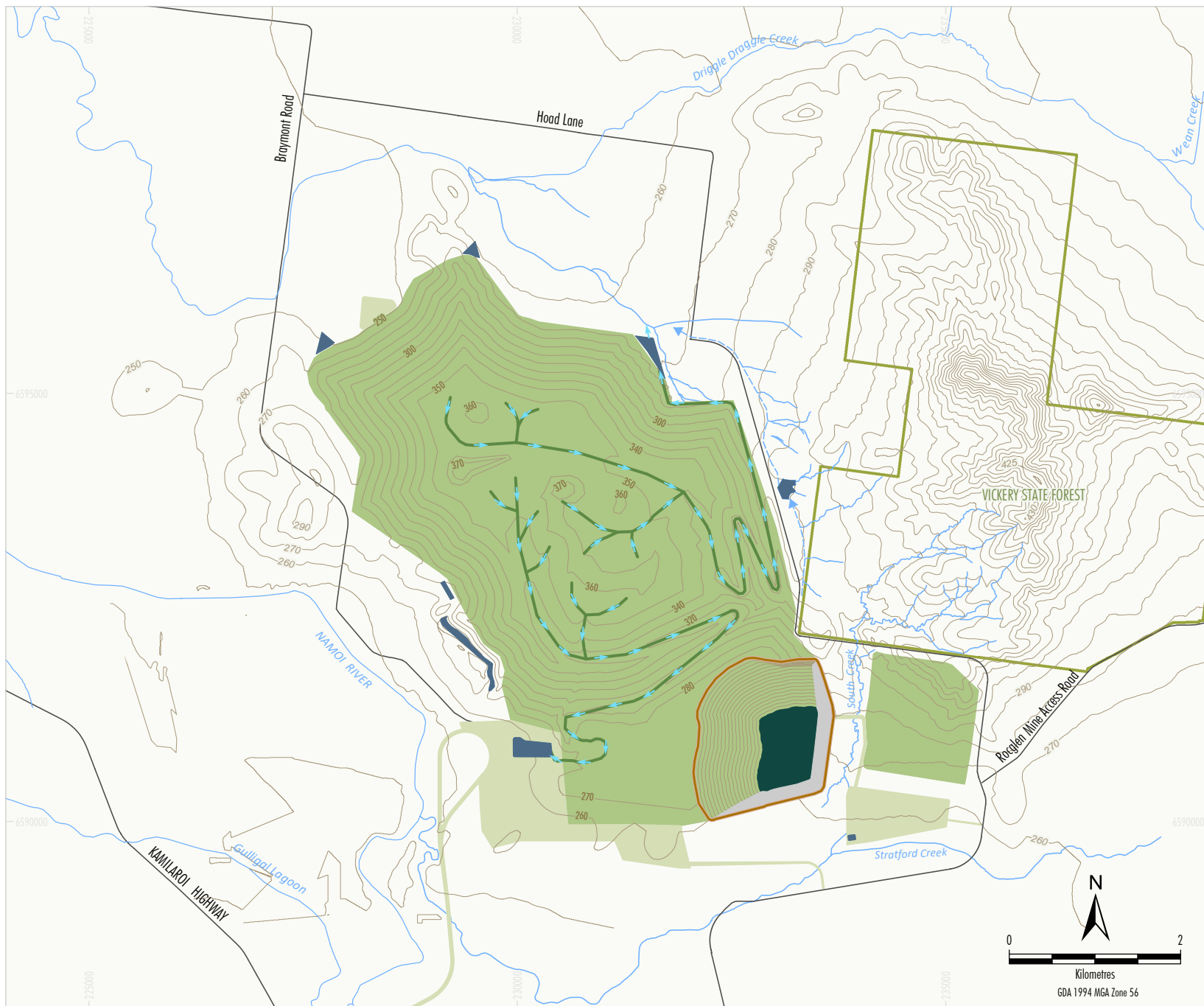
Note: The post-mining landform is conceptual and subject to future detailed mine and rehabilitation planning.

Source: Department of Land and Property Information (2014);  
Department of Industry (2015)



**VICKERY EXTENSION PROJECT**  
Project General Arrangement -  
Following End of Mining

**Figure 5-2**



- LEGEND**
- State Forest
  - Indicative Up-catchment Diversion
  - Indicative Extent of Water Storage
  - Indicative Constructed Channels
  - Indicative Pasture Area
  - Indicative Woodland/Forest Area
  - Indicative Final Void Pit Lake
  - Indicative Final Void Highwall
  - Indicative Final Void Perimeter Bund

Source: Department of Land and Property Information (2014);  
Department of Industry (2015)



VICKERY EXTENSION PROJECT  
Conceptual Final Landform -  
Rehabilitation Areas

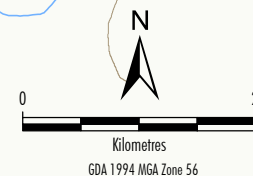


Figure 5-3





- LEGEND**
- State Forest
  - Indicative Final Void Perimeter Bund
  - Indicative Final Void
  - Indicative Constructed Channel
  - Indicative Up-catchment Diversion
  - Natural Drainage Line

Source: Department of Industry (2015)  
 Orthophoto - Department of Land and Property Information,  
 Aerial Photography Flown (July 2011)



**VICKERY EXTENSION PROJECT**  
 Conceptual Final Rehabilitation  
 and Regeneration



**Figure 5-4**



Conceptual cross-sections of the Project final landform are provided on Figure 5-5.

### 5.3.3 Rehabilitation Domains and Conceptual Domain Objectives

Consistent with contemporary rehabilitation guidelines, conceptual rehabilitation domains would be used to guide the Project rehabilitation program. In accordance with the methodology provided in the *ESG3: Mining Operations Plan (MOP) Guidelines September 2013* (DRE, 2013), Table 5-2 outlines the proposed primary and secondary domains for the Project.

**Table 5-2  
Rehabilitation Domains**

Title	Code
<b>Primary Domains</b>	
Waste rock emplacement	1
Northern part of secondary infrastructure area	2
Mine infrastructure area and southern part of secondary infrastructure area	3
Water management dams	4
Project rail spur corridor	5
Final voids	6
<b>Secondary Domains</b>	
Woodland	A
Agriculture	B
Water management area	C
Final voids	D

Conceptual broad scale rehabilitation domains for planning purposes are shown on Figure 5-6. The conceptual broad scale domains are as follows:

- Domain 1A: Waste rock emplacement;
- Domain 2A: Northern part of the secondary infrastructure area;
- Domain 3B: Mine infrastructure area and southern part of secondary infrastructure area;
- Domain 4B/4C: Water management dams;
- Domain 5B: Project rail spur corridor; and
- Domain 6D: Final voids (Project final void and the existing Blue Vale final void).

### Domain 1A: Waste Rock Emplacement

#### Conceptual Waste Rock Emplacement Design

The top surface of the waste rock emplacement would be approximately 4 km long and between 1 and 3 km wide.

The waste rock emplacement would reach an elevation of approximately 370 m AHD (Figure 5-2) similar to the maximum elevation of the Approved Mine, however it would include natural landform design features that the Approved Mine landform did not incorporate, including:

- Micro-relief (i.e. gently undulating surface typically ranging in elevation by 1 to 2 m) to assist in drainage design that replicates natural drainage systems.
- Macro-relief (i.e. 10 to 20 m hills similar to those found in the Vickers State Forest) to the top surface of the waste rock emplacement to improve the integration of the landform with the surrounding environment and mitigate potential visual impacts.

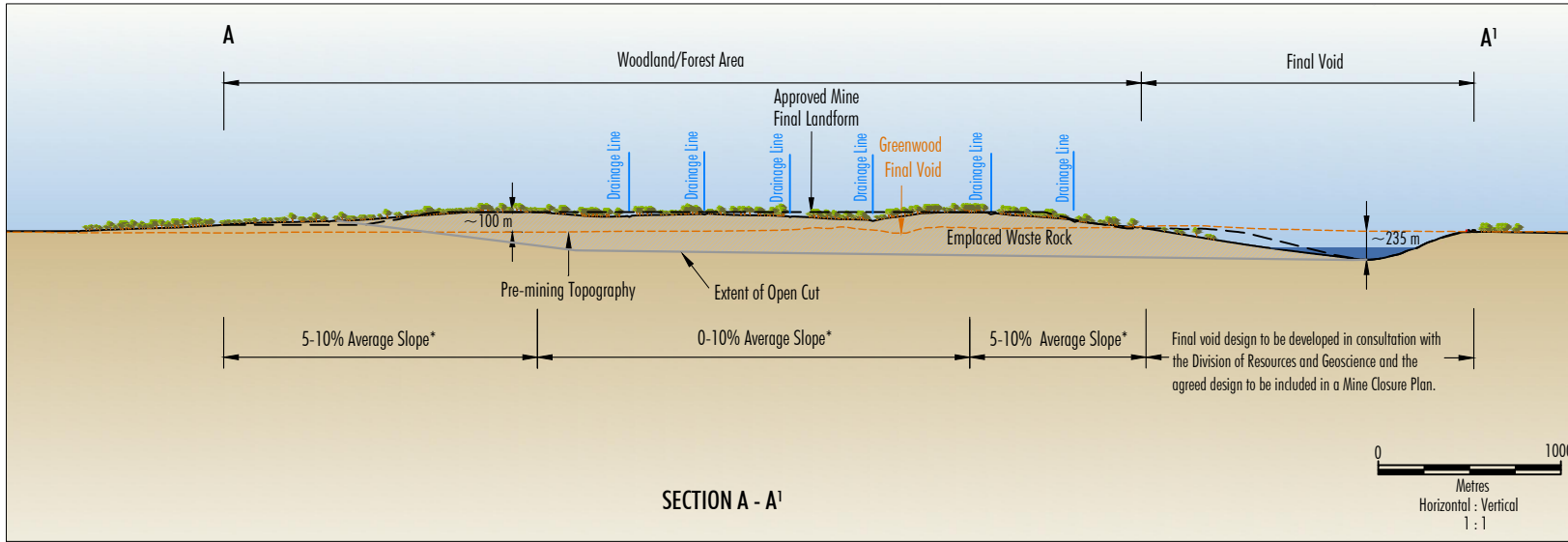
The waste rock emplacement would be approximately 70 m higher than the high points within the Project area and approximately 110 m higher than the surrounding floodplains. The peak of the ridge in the adjacent Vickers State Forest would be approximately 110 m higher than the waste rock emplacement.

#### Conceptual Drainage Design

Micro-relief would be integrated into the waste rock emplacement to direct runoff into vegetated drainage paths, and improve the geotechnical performance, stability and hydrological function of the final landform.

The vegetated drainage paths would be designed to minimise flow velocities and located to minimise the overall slope of the drainage path. The drainage paths would be developed in consideration of length, slope, reporting catchment area and final land use. For example, drainage paths with longer overall length and larger catchment would have a lower slope than minor drainage paths of shorter length and smaller catchment.

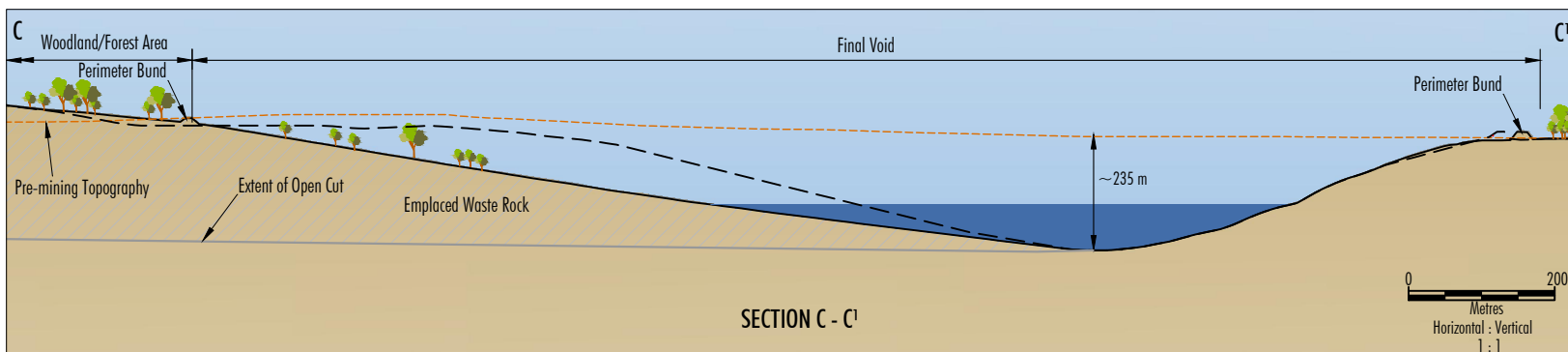
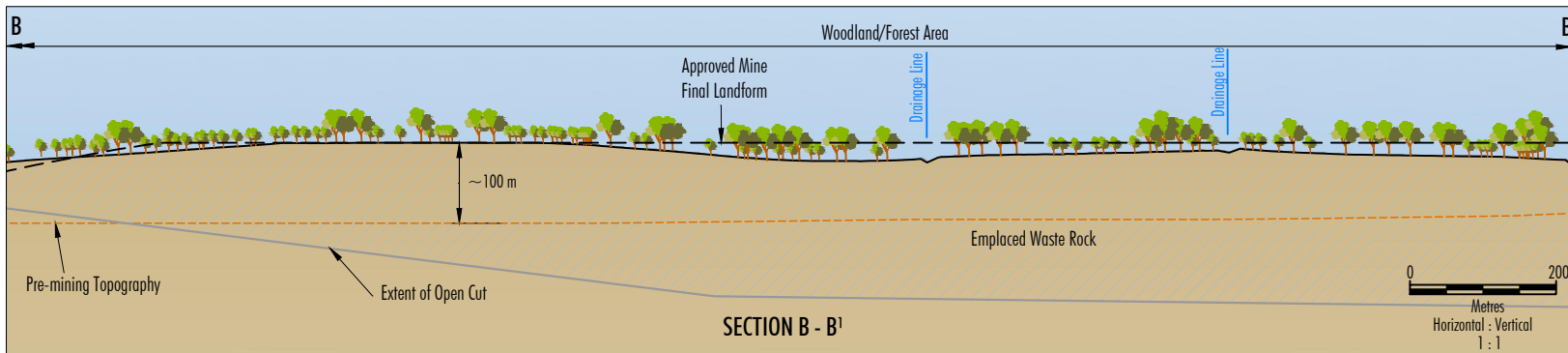
The conceptual drainage paths, shown on Figure 5-2, have an overall slope of approximately 1%.



- LEGEND**
- Pre-mining Topography
  - Approved Mine Final Landform
  - Indicative Extent of Waste Rock
  - Indicative Final Void Pit Lake

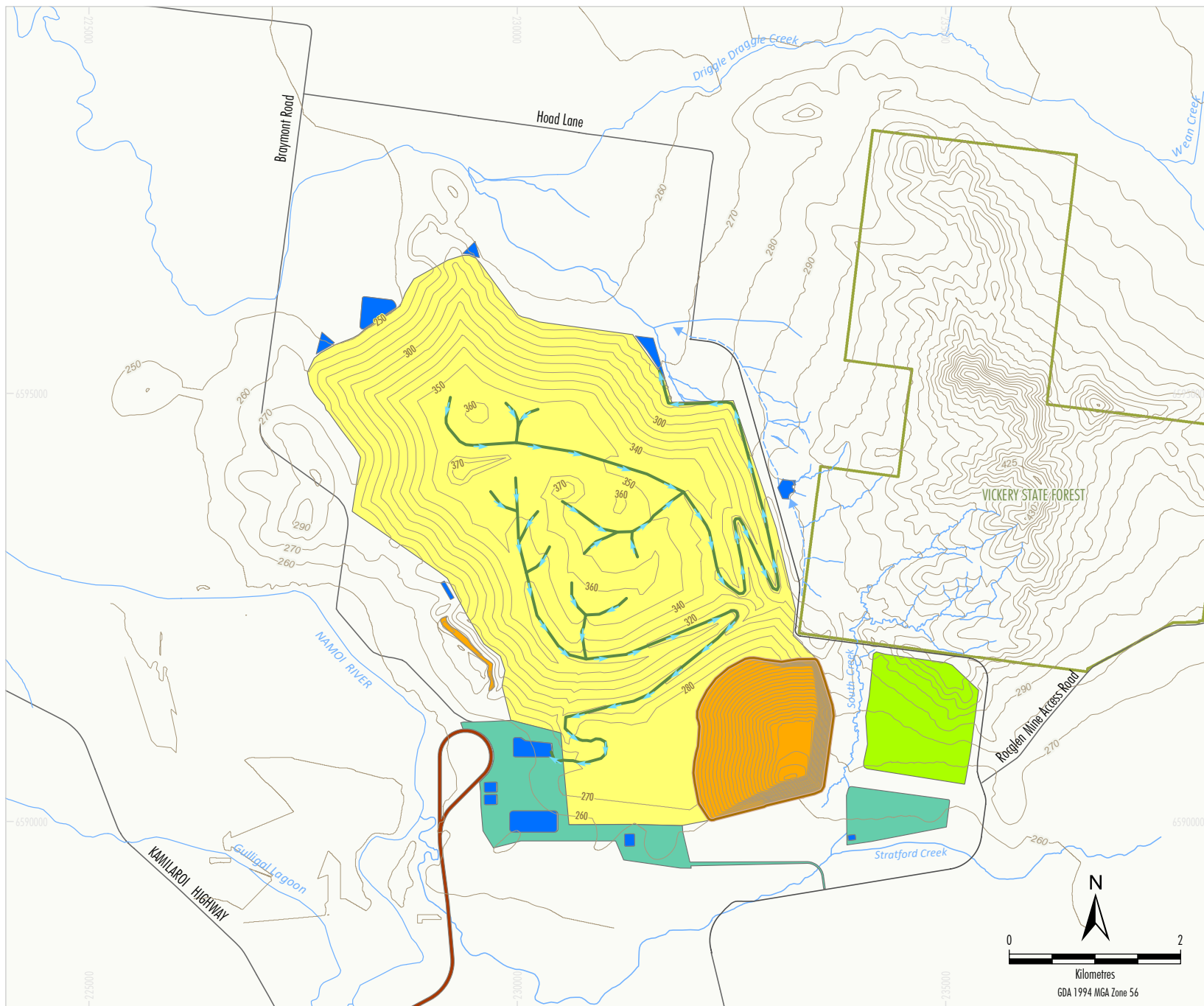
Note: \* Future detailed mine and rehabilitation planning design considerations may result in localised areas with steeper batter angles.

Refer to Figure 5-2 for locations of cross-sections



VICKERY EXTENSION PROJECT  
Conceptual Cross-Sections of the  
Project Final Landform

**Figure 5-5**

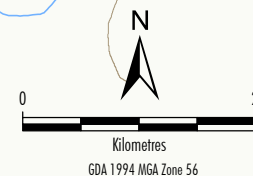


- LEGEND**
- State Forest
  - Indicative Up-catchment Diversion
  - Indicative Constructed Channels
  - Indicative Final Void Perimeter Bund
  - Indicative Domain 1A
  - Indicative Domain 2A
  - Indicative Domain 3B
  - Indicative Domain 4B/4C
  - Indicative Domain 5B
  - Indicative Domain 6D

Source: Department of Land and Property Information (2014);  
Department of Industry (2015)



**VICKERY EXTENSION PROJECT**  
Conceptual Final Landform -  
Rehabilitation Domains



**Figure 5-6**



Waste rock material used in the outer layer of the waste rock emplacement would be sampled to identify sodic materials. Unless appropriately ameliorated, sodic materials would not be used to construct the vegetated drainage paths.

The drainage paths would meander between macro-relief (i.e. 10 to 20 m hills similar to those found in the Vickery State Forest) along the top of the waste rock emplacement and down the waste rock emplacement batters.

Larger drainage paths would flow into sediment dams (adjacent to the waste rock emplacement) constructed to manage runoff on part of mine operations (Domain 4B/4C described below). This would provide an opportunity to allow for flow velocities to decrease before flowing to the surrounding environment.

It may be decided with future landowners/leaseholders that the sediment dams are not required to be retained (and it has been demonstrated they are no longer required), and as such, the sediment dams may be removed.

The conceptual batters of the waste rock emplacement, shown on Figure 5-2, have an overall slope of up to approximately 10% (i.e. approximately 6°). Design considerations to improve geotechnical performance, stability and hydrological function of the final landform (e.g. micro-relief and macro-relief) may result in localised areas with batter angles steeper than 10%.

Consistent with the NSW Mineral Council's *Rehabilitation by Design Practice Notes* (2007) and DECCW's *Managing Urban Stormwater Soils and Construction Volume 2E Mines and Quarries* (2008), benches are not expected to be required to control the velocity of runoff from the batters where the waste emplacement slopes are less than 10%.

#### *Revegetation*

To the east of the Project is the Vickery State Forest, which contains native woodland vegetation, and to the west of the Project is a patch of remnant vegetation along Braymont Road that is contiguous with the Namoi River.

The waste rock emplacement would be revegetated with native tree, shrub and grass species, between the existing native vegetation in the Vickery State Forest and the Namoi River (Figures 5-3 and 5-4).

Approximately 2,385 ha (within Domains 1A and 2A) is proposed to be revegetated to one or more of the native woodland/forest vegetation types that occur in the surrounding sub-region (Section 5.4.4).

The final landform would be designed to avoid or minimise as far as possible the requirement for rock-lined drop structures, with preference given to developing drainage paths rehabilitated with grass/vegetation.

#### ***Domain 2A: Northern Part of Secondary Infrastructure Area***

The Approved Mine Eastern Emplacement would not be constructed for the Project and would instead be used as an extended secondary infrastructure area.

This northern part of the secondary infrastructure area would be revegetated with native tree, shrub and grass, as described above for the waste rock emplacement (Figure 5-3).

#### ***Domain 3B: Mine Infrastructure Area and Southern Part of Secondary Infrastructure Area***

Infrastructure would be removed at the end of the Project life, unless otherwise agreed with the relevant government agencies and landholders (e.g. concrete hardstands, site access roads, sheds, buildings and sediment dams may provide for alternate post-mining uses).

During the decommissioning phase, the priority would be to dismantle fixed equipment and infrastructure for removal from site and re-use at another location, or for recycling.

Non-salvageable/non-recyclable infrastructure would be disposed of at suitable off-site disposal areas, or on-site, subject to demonstration that no land contamination risk would be posed and relevant approvals are obtained.

Land contamination assessments would be conducted and any contaminated soil would be remediated in accordance with the relevant guidelines.

Once all the equipment and infrastructure components have been removed and any land contamination has been remediated, the mine infrastructure areas would be ripped, covered with soil and seeded with grass species to return the area to land suitable for cattle grazing, consistent with the existing Agricultural Suitability of these areas (i.e. Class 3 and 4 Agricultural Suitability land).

#### **Domain 4B/4C: Water Management Dams**

Mine water dams, coal contact water dams and sediment dams would be required as part of the Project Water Management System (Section 2.10.1).

Following closure, the two mine water dams and three coal contact water dams (Figure 2-2) would be removed and the area rehabilitated to land suitable for cattle grazing, consistent with the existing Agricultural Suitability of these areas (i.e. Class 3 and 4 Agricultural Suitability land).

Following the establishment of self-sustaining, stable final landforms, key elements of the operational sediment control structures would be removed unless otherwise agreed with the relevant government agencies and landholders (e.g. the sediment dams may be retained for agricultural purposes or as passive water control storages) (Section 5.4.6).

#### **Domain 5B: Rail Spur Corridor**

The Project rail spur and rail loop infrastructure would be dismantled and removed following closure of the Project unless otherwise agreed with the relevant government agencies and landholders.

Once removed, the area would be re-profiled to form a free draining landform and the area ripped, covered with soil and seeded with grass species. It is expected the land within the Project rail spur corridor could be returned to its existing Agricultural Suitability (i.e. Class 2 and 3 Agricultural Suitability land).

#### **Domain 6D: Final Voids**

The mine plan for the Project allows for progressive emplacement of waste rock within the footprint of the open cut. The final landform would include a rehabilitated final void with a depth of approximately 235 m below the pre-mining surface level. The existing Blue Vale final void would also remain in the final landform (Figure 5-2).

A conceptual cross-section of the final void is provided as Section C-C<sup>1</sup> on Figure 5-5.

The final landform represents an improvement to the current landform (i.e. five existing voids [Figure 5-1]) and to the Approved Mine final landform, which includes three final voids (i.e. the Northern and Southern final voids as well as the existing Blue Vale final void).

A summary of the existing, approved and proposed final voids is provided in Table 5-3. Consideration of alternative Project final void options is presented in Section 6.1.9 of the EIS.

**Table 5-3  
Final Void Summary**

Final Voids	Ultimate Fate of Void	
	Approved Mine Final Landform	Project Final Landform
<b>Existing Final Voids</b>		
Canyon	Filled	Filled
Red Hill	Filled	Filled
Blue Vale	Open	Open
Greenwood	Filled	Filled
Shannon Hill	Filled	Filled
<b>Approved Final Voids</b>		
Northern	Open	Filled
Southern	Open	Open
Number of Final Voids at Mine Closure	3	2

The final void within the perimeter bund would be bounded by highwalls on its eastern, northern and southern sides, with shallower slopes (i.e. 10 to 15°) on the western side (Figure 5-2). A Preliminary Geotechnical Assessment of the final void has been undertaken by Lambert Geotech (2016). The Preliminary Geotechnical Assessment indicates maximum highwall slopes in the order of 30 to 50° (depending on water recovery levels in the final void) would maintain a suitable factor of safety for long-term stability of the final void highwalls (Lambert Geotech, 2016).

The highwalls for the final voids would be designed to be geotechnically stable in the long-term. If required, additional works would be undertaken following the completion of mining to improve their long-term geotechnical stability.



Once mining operations cease, groundwater inflows to the final void would no longer be collected and pumped out, and as a result, it would gradually begin to fill with water. Water in other on-site operational storages may also be transferred to the final void to facilitate decommissioning and rehabilitation.

Inflows into the final void would comprise groundwater and incident rainfall runoff within the final void catchment area. The catchment area of the final void would be defined by a permanent perimeter bund (Figure 5-2). The direct catchment area has been minimised as far as practicable, at approximately 250 ha (Appendix B).

Final void water recovery analyses have been conducted as part of the Surface Water Assessment (Appendix B). The assessment incorporates predicted groundwater inflows determined by the Groundwater Assessment (Appendix A).

The final void is not predicted to spill under any of the simulated climatic sequences, with the water level remaining at least 140 m below the crest of the final void under the wettest climate scenario (Appendix B).

The final void water recovery analyses include simulations of the long-term salinity of the final void waterbody (Appendix B). Salinity is expected to increase through accumulation of salt, primarily from groundwater inflows, and evaporation from the final void lake.

Following closure, any water in the Blue Vale final void would be removed (e.g. transferred to the Project final void) and the Blue Vale final void rehabilitated consistent with existing rehabilitation condition (i.e. rehabilitated to grassland) (Section 5.1.2).

#### **Other Areas**

Following mine closure and subject to no further ongoing use for the infrastructure being identified, the Project borefield would be decommissioned and the disturbed land would be rehabilitated to land suitable for agricultural use unless otherwise agreed with the relevant government agencies and landholders. It is expected the land within the Project borefield could be returned to its existing Agricultural Suitability (i.e. Class 2 Agricultural Suitability land).

The Project would also involve the construction of permanent infrastructure that would not require rehabilitation post-mining (e.g. the Blue Vale Road realignment [Section 2.12.3] and permanent up-catchment diversion system [Section 2.4.4]).

## **5.4 GENERAL REHABILITATION MEASURES**

The following sub-sections summarise the general rehabilitation practices and measures that would be implemented for the Project.

The success of progressive rehabilitation activities would be regularly evaluated throughout the Project life and the results would be used to inform future rehabilitation initiatives.

### **5.4.1 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 would be required to accommodate projected development activities for the next 12 months.

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

Potential fauna habitat (e.g. logs/hollows) salvaged during pre-clearance surveys would be relocated to the woodland/forest rehabilitation areas.

Further detail on management of potential impacts on flora and fauna during clearing is provided in Section 4.11.

## 5.4.2 Soil Management

### Soil Management Strategies

The following management measures would be implemented during the stripping of soils at the Project:

- areas of disturbance would be stripped progressively, as required, to reduce the potential for erosion and sediment generation, and to minimise the extent of soil stockpiles and the period of soil storage;
- areas of disturbance requiring soil stripping would be clearly defined following vegetation clearing;
- soil stripping during periods of high soil moisture content (i.e. following heavy rain) would be avoided, wherever practicable, to reduce the likelihood of damage to soil structure; and
- in preference to stockpiling, stripped soil would be directly replaced on completed sections of the final landforms wherever practicable.

Any long-term soil stockpiles would be managed to maintain long-term soil viability through the implementation of relevant management practices as listed below:

- Soil stockpiles would be retained at a height of up to 3 m, with slopes no greater than 1:2 (V:H) and a slightly roughened surface to minimise erosion.
- Soil stockpiles would be constructed to minimise erosion, encourage drainage, and promote revegetation.
- Ameliorants such as lime, gypsum and fertiliser would be applied to stockpiles where needed to improve the condition of stripped soil.
- Wherever practicable, soil would not be trafficked, deep ripped or removed in wet conditions to avoid breakdown in soil structure.
- All soil stockpiles would be seeded with a non-persistent cover crop to reduce erosion potential as soon as practicable after completion of stockpiling. Where seasonal conditions preclude adequate development of a cover crop, stockpiles would be treated with a straw/vegetative mulch to improve stability.

- Soil stockpiles would be located in positions to avoid surface water flows. Silt stop fencing would be placed immediately down-slope of stockpiles until stable vegetation cover is established.
- An inventory of soil resources (available and stripped) on the Project site would be maintained and reconciled annually with rehabilitation requirements.
- Weed control programs would be implemented on soil stockpiles if required.

The MOP would describe soil management measures relevant to the various stages of mine development (i.e. stripping, stockpiling and rehabilitation). The management measures would include identification of soil constraints and use of appropriate amelioration measures.

### Soil Reserves

A preliminary soil material balance has been developed to determine the quantity of soil available for rehabilitation (Appendix H).

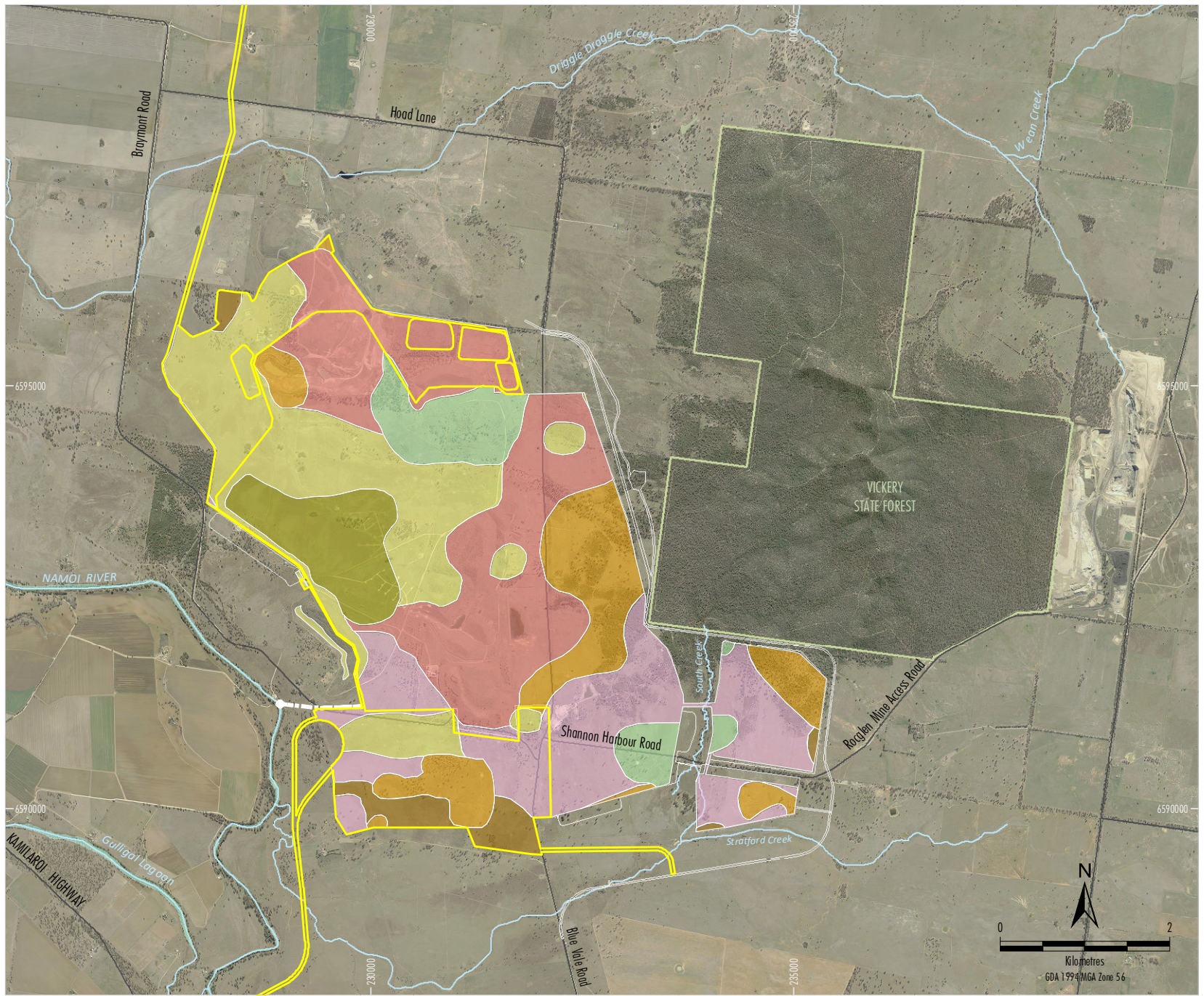
The balance indicates that, based on the recommended soil stripping depths shown on Figure 5-7, approximately 8,681,691 cubic metres (m<sup>3</sup>) of soil would be available for rehabilitation in the Project mining area (Table 5-4).

**Table 5-4**  
**Estimate of Soil Volume for Rehabilitation in the Project Mining Area**

Recommended Stripping Depth (m)	Approximate Stripping Area (ha)	Soil Volume Estimate (m <sup>3</sup> )
0	383	0
<15	536	804,320
15-20	746	1,491,711
20-30	99	296,565
30-50	627	3,136,990
50-60	199	1,196,991
60-90	195	1,755,114
<b>Total</b>		<b>8,681,691</b>

Source: Appendix H.





**LEGEND**

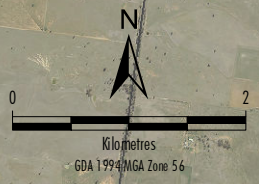
- State Forest
- Approximate Extent of Approved Mine
- Approximate Extent of Vickers Extension Project Additional Area
- Indicative Namoi River Pump Station and Pipeline

**Soil Stripping Depths**

- 0cm
- <15cm
- 15-20cm
- 20-30cm
- 30-50cm
- 50-60cm
- 60-90cm

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); Department of Industry (2015); McKenzie Soil Management (2012); SESL (2015; 2018)

  
**WHITEHAVEN COAL**  
**VICKERY EXTENSION PROJECT**  
**Recommended Soil Stripping Depths**



**Figure 5-7**



A nominal soil re-application depth of approximately 0.2 m to 0.3 m would be used for areas rehabilitated to native woodland/forest (McKenzie Soil Management, 2012; Thackway and Freudenberger, 2016), and a nominal re-application depth of 0.9 m would be used for areas rehabilitated to land suitable for agricultural uses (McKenzie Soil Management, 2012) (to be refined during the Project life based on operational experience and mine progression and extent).

The areas to be rehabilitated to native woodland/forest and agricultural use are shown on Figure 5-3.

As the final landform would change land use in some areas (i.e. from existing agricultural land to woodland/forest post-mining), the soil re-application depth for rehabilitation would not be equivalent to the stripping depth in some areas.

Based on the nominal re-application depths above, the amount of soil used to rehabilitate the Project mining area would be approximately 8,266,500 m<sup>3</sup>. Accordingly, the results of the material balance indicate there would be a surplus of soil available to meet the Project rehabilitation concepts described in this EIS (Appendix H).

Further to the soil resource described above, McKenzie Soil Management (2012) identified that deeper soil resources could also be used for rehabilitation if ameliorated through gypsum treatment. However, the preliminary assessment of the soil resource indicates this would not be required.

If soil is stripped to a depth deeper than that nominated on Figure 5-7, this additional material would be separately stockpiled and either treated and used as part of the soil resource available for rehabilitation, or placed (untreated) as an intermediate layer between soil and waste rock.

The process of stripping, stockpiling and re-application of soil resources would be reviewed and refined over the life of the Project.

#### 5.4.3 Stages of Rehabilitation

Once mine landform areas are no longer active, these areas would be rehabilitated to native woodland/forest.

Initial rehabilitation involves the stabilisation of the area, the application of soil and the application of seed/cover crops following an area becoming available for rehabilitation.

Following the application of seed/cover crops, the rehabilitated areas would generally require approximately two years to establish self-sustaining vegetation, however, this may be influenced by the climatic conditions at the time.

Established rehabilitation represents areas with established vegetation, which would only require minor maintenance (e.g. weed control). The landforms would be safe and stable, with adequate, geomorphically stable drainage features.

Indicative progressive areas of Initial and Established Rehabilitation for Project Years 3, 7, 13 and 21 (and following mine closure) are shown on Figures 2-4 to 2-7 and Figure 5-2. Table 5-5 shows the approximate areas of disturbance and progressive rehabilitation for the Project. These areas are subject to the further detailed mine planning that would be presented in the MOP.

Descriptions of the stages of rehabilitation, and the associated areas and timing, would be described in the Annual Reviews for the Project.

#### 5.4.4 Selection of Native Plant Species for Revegetation

As part of the Biodiversity Offset Strategy for the Project (Appendix F), woodland/forest vegetation is to be established on the post mine landforms to enable ecosystem credits to be generated under the NSW Offset Policy.

Approximately 2,385 ha of the Project landforms is proposed to be revegetated to one or more of the native woodland/forest vegetation types that occur in the surrounding sub-region, and are the same vegetation class as required to be provided as part of the Biodiversity Offset Strategy.

The woodland/forest would be a recognisable vegetation type that is self-sustaining and listed in the *NSW Vegetation Information System: Classification* (OEH, 2016d) as required by the NSW Offset Policy (OEH, 2014b). Native species to be planted in revegetation areas would be selected on a site by site basis depending on pre-existing vegetation, nearby remnant vegetation associations, soil types, aspect and site conditions (Appendix F).



**Table 5-5  
Approximate Areas of Disturbance and Progressive Rehabilitation for the Project**

Project Years	Disturbed Area (ha)*	Rehabilitated Area (ha)*		
		Initial Rehabilitation	Established Rehabilitation	Total
Year 3	719	0	0	0
Year 7	1,571	25	0	25
Year 13	1,607	75	531	606
Year 21	1,721	131	961	1,092
Following mine closure	156^	0	2,727	2,727

\* These areas are subject to further detailed mine and rehabilitation planning that would be presented in the MOP.

^ Area associated with the final void pit lake and highwall, and sediment dams (Figure 5-2).

#### 5.4.5 Re-establishment of Agricultural Land

The assessment of the physical and chemical properties of the soils within the Project area for the Approved Mine EIS established that the soils generally within the western part of the Project area would be a suitable rehabilitation medium for agricultural uses post-mining as:

- they have favourable pH values;
- they are non-saline;
- their exchangeable sodium percentage values are low enough to be treated easily with coarse-grade gypsum;
- their cation exchange capacity allows for natural decompaction through shrink-swell processes; and
- the favourable properties of these soils would not be modified greatly during stripping, stockpiling and re-spreading.

The mine infrastructure area, part of the secondary infrastructure area and Project rail spur corridor would be rehabilitated to land suitable for agricultural uses, generally consistent with the current Agricultural Suitability classifications of those areas (Appendix H).

The soils in the volcanic zones in the western part of the Project area are highly suitable medium for rehabilitation. These soils would be selectively handled and used for rehabilitation of the mine infrastructure areas and rail corridor.

The areas to be rehabilitated to agricultural land uses would be prepared with a nominal total soil profile depth of approximately 0.9 m (to be refined based on operational experience). This soil profile would provide root zone chemical and physical conditions that are at least as favourable for grazing as the existing agricultural land in the Project mining area (i.e. Class 3 or 4 Agricultural Suitability) (Whitehaven, 2013).

Approximately 342 ha of land suitable for agricultural purposes would be re-established through rehabilitation of the Project (of which 256 ha would be located in the Project mining area).

#### 5.4.6 Erosion and Sediment Control Works

The site sediment and erosion control system would be managed through a Water Management Plan to be developed for the Project. The sediment and erosion control system would be updated periodically to address changes over the Project life. The effectiveness of the system would be assessed through regular monitoring.

The operational sediment and erosion control works would be retained and maintained during initial rehabilitation. Following the establishment of self-sustaining, stable final landforms, key elements of the operational sediment control structures would either be removed unless otherwise agreed with the relevant government agencies and landholders (e.g. the sediment dams may be retained for agricultural purposes or as passive water control storages).

## 5.5 REHABILITATION AND REVEGETATION TRIALS AND MONITORING

The rehabilitation monitoring program for the Project would be designed to track the progress of revegetation and to determine the requirement for intervention measures, such as alternate species or species mix, thinning to reduce the density of revegetated areas, or additional plantings in areas where vegetation establishment has been sub-optimal.

The Project rehabilitation monitoring program would be documented in the MOP and would describe the methods that would be used to:

- evaluate the coverage and application of soil prior to seeding;
- monitor drains and assess water quality to determine whether substantial silting of inverts and/or any localised failure of drain embankments has occurred;
- evaluate areas recently covered with soil after rain events (particularly on sloping ground) to assess whether significant rilling or loss of soil has occurred;
- evaluate the behaviour of placed soil over time (i.e. erosion or dispersion, compaction, salting or hard setting);
- assess the initial germination success in revegetation areas (including recording of diversity and abundance);
- monitor revegetation success over time (e.g. survival rate, plant growth, species diversity, weed content, fauna usage);
- evaluate potential threats to rehabilitated areas (e.g. weed invasion, pest species, dispersive soils or potentially acid forming-low capacity materials, erosion); and
- record key rehabilitation information (e.g. photographic records, surveys, file notation).

Revegetation surveys would be undertaken by an appropriately qualified and experienced person to identify the success of rehabilitation and identify any additional measures required to achieve ongoing rehabilitation success. The frequency of surveys would be annually initially, with the frequency reviewed based on monitoring results. A detailed monitoring report would be prepared that includes a summary of previous monitoring reports, results of the current year's monitoring and planned remedial works, if required.

The specific rehabilitation parameters and completion criteria would be determined in consultation with relevant government agencies and documented in the MOP.

Trials and experience at other Whitehaven operations would also inform the development of Project rehabilitation measures and final land use.

## 5.6 INTEGRATION WITH REHABILITATION AT OTHER MINES

### 5.6.1 Canyon Coal Mine

Rehabilitation at the Canyon Coal Mine has been successful and the mine is in closure (Section 5.1.1).

Rehabilitation of the northern extent of the waste rock emplacement for the Project would be conducted to integrate with and complement the existing rehabilitated landform at the Canyon Coal Mine.

### 5.6.2 Rocglen Coal Mine

The Rocglen Coal Mine is located to the east of the Vickery State Forest (Figure 1-2).

The rehabilitation strategy for the Rocglen Coal Mine includes the establishment of native vegetation on the western side of the site to connect with the vegetation in the Vickery State Forest (GSS Environmental, 2011).

The rehabilitation objectives of the Project and the Rocglen Coal Mine would extend the woodland of the Vickery State Forest east towards the foothills of Boonalla Coordinated Conservation Area Zone 2 Aboriginal Area and west towards the Namoi River.



## 5.7 MINING OPERATIONS PLAN

A MOP describes how rehabilitation is undertaken, provides rehabilitation performance and completion criteria and addresses aspects of rehabilitation including mine closure, final landforms and final land use.

The MOP would be prepared for the Project in consultation with the relevant government agencies, and in accordance with the relevant NSW rehabilitation and mine closure guidelines.

Consistent with the *ESG3: Mining Operations Plan (MOP) Guidelines, September 2013* (DRE, 2013), the MOP would include:

- details of the proposed activities during the MOP term;
- environmental and rehabilitation risk identification and management methods;
- a detailed description of the post-mining land use and rehabilitation principles and objectives;
- rehabilitation domains, objectives and phases;
- performance indicators and completion criteria relevant to the rehabilitation domains;
- details of the rehabilitation activities to be implemented during the MOP term;
- rehabilitation monitoring and research; and
- intervention and adaptive management methods to be implemented relevant to identified rehabilitation risks.

## 5.8 PLANNING FOR MINE CLOSURE

Planning for mine closure would be conducted over the life of the Project, in consultation with the Gunnedah Shire Council, Narrabri Shire Council, DP&E and the local community, and would consider the amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.