APPENDIX 2
Mine Plan Options Report

MANGOOLA OPEN CUT

GLENCORE

Mine Plan Options Report

Mangoola Coal Continued Operations Project

Prepared by: Mangoola Coal Operations Pty Limited

Date: June 2019

Executive Summary

Mangoola Coal Mine is an existing open cut coal mine located approximately 20 kilometres (km) west of Muswellbrook and 10 km north of Denman in the Upper Hunter Valley of NSW. Mangoola Coal Operations Pty Limited (Mangoola) has operated the Mangoola Coal Mine in accordance with NSW Project Approval (PA) 06_0014 since mining commenced at the site in September 2010.

The Mangoola Coal Continued Operations (MCCO) Project will allow for the continuation of mining at Mangoola Coal Mine into a new mining area to the immediate north of the existing operations. The Project is classed as State Significant Development (SSD 8642) and requires approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

This mine plan options report discusses the mine design and final void studies undertaken by the MCCO Project to determine the proposed conceptual mine plan and the resulting proposed conceptual final landform for the MCCO Project. This report has been prepared by Mangoola and forms part of an Environmental Impact Statement (EIS) to accompany an application for development consent under Division 4.1 and 4.7 of Part 4 of the EP&A Act for the MCCO Project.

Concept and pre-feasibility mine design studies have been ongoing since 2014 for the MCCO Project to optimise the Project's final design. These studies identified potential mine design options, evaluating each option to identify the preferred mine design, with environmental, economic and community impacts key considerations.

The key issues considered in assessing the viability and feasibility of various alternatives and developing the proposed conceptual mine plan and final landform for the MCCO Project were as follows:

- optimise resource recovery with financial viability
- mining efficiency coupled with safe mining practices
- optimisation of product coal quality from the various seams within the resource
- minimising the overall number and size of the proposed final voids
- minimising noise, dust and visual impacts on the surrounding community
- minimising impacts on biodiversity and water resources
- minimising social impacts
- establishing the future final landform to be safe, stable and non-polluting, consistent with the current design and rehabilitation principles of the existing operation

The outcome of these studies was the development of a preliminary MCCO Project mine plan which was further refined over time by a detailed iterative design and environmental constraints modelling and impact assessment process. This process resulted in the development of the mine plan that is proposed, and has been assessed, in the MCCO Project EIS.

Throughout the detailed iterative design and environmental constraints modelling and impact assessment process, final void/final landform design were integral considerations during development of the mine plan for the MCCO Project. Once the mine plan for the MCCO Project was determined, further refinement was undertaken of final landform options, specifically related to final voids, balancing the design inputs and expectations surrounding the establishment of a final landform. These inputs and expectations include:

- maximising resource recovery with financial viability
- surrounding constraints such as topography and boundaries
- available material post coal mining completion for use in rehabilitation activities
- long term stability and safety
- visual considerations

The final landform studies focussed on the range of options that could be achieved in regard to final landform and considered economic, mine planning, geotechnical, environmental and social factors. The studies have defined the proposed conceptual final landform for the MCCO Project.

As part of the MCCO Project, as mining progresses, it is proposed to haul some of the overburden from the MCCO Additional Mining Area south for emplacement in the mining void in the approved mining area, reducing the size of the final void that would otherwise remain. It is proposed that a final void would also remain in the MCCO Additional Mining Area to the north of Wybong Road. After the completion of coal extraction in the MCCO Additional Mining Area, some emplaced overburden would be rehandled and placed back into this void to reduce the size and improve the shape of the void providing the conceptual final landform as presented in the EIS. While two final voids would remain, emplacing overburden from the MCCO Additional Mining Area in both voids to reduce their size and improve the shape of each was determined by Mangoola to be the preferred case.

A number of final void options and final landforms have been considered through the feasibility phase of the MCCO Project. This report will focus discussion on the primary cases and includes a description of each case and the differential economic, social and environmental outcomes when compared to the baseline case. A summary of the final void options that have been considered in this report are presented in **Table ES1**.

The option of backfilling both voids was found to be uneconomic and would result in the MCCO Project not proceeding. The option of backfilling one void (in the existing approved mining area) was achievable, however it would have resulted in a poorer landform outcome with a much larger void and visually poorer outcome in the MCCO Additional Mining Area and is therefore not proposed.

The proposed conceptual final landform, including the potential rehandle of 5Mbcm of material in the MCCO Additional Mining Area, is more costly to achieve than other landform options that were viable, however it is considered by Mangoola to achieve an appropriate balanced outcome.

A summary of the final void assessment outcomes that have been considered in this report are presented in **Table ES2**. All cost estimates provided in **Table ES2** relate to the baseline case (Case 1) of the MCCO Project which was considered to be the most cost-effective mining outcome. The indicative costs and timeframes to complete each of the other options (Case 2 to 7) relate incrementally to Case 1 (i.e. the baseline scenario).

The MCCO Project (Case 3) as selected provides the following benefits:

- provides a balanced outcome that achieves economic viability whilst minimising the size of the final voids
- reduces the overall size and improves the visual appearance of the MCCO Project Additional Mining Area void by making the void smaller and softening the void ends
- achieves and improves upon the existing commitments regarding the establishment of the approved conceptual final landform including the re-establishment of Anvil Creek
- both voids (non-backfilled mine areas) act as long-term groundwater sinks, capturing salt and avoiding impacts on surrounding water quality
- there will be limited public vantage points from which the remnant highwalls will be visible (particularly once vegetation has been established on adjacent areas)
- requires minimal (6 months) time to complete following the completion of coal mining

The MCCO Project (Case 3) as presented and assessed in the MCCO Project EIS strikes an appropriate balance between mine planning, economic, environmental and social outcomes.

Table ES1 Summary of Mine Plan Options Considered

Description	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Case Description	Business Baseline Case – All Overburden emplaced in the MCCO Additional Project Area	Initial Integrated Project Case	MCCO Project Case (as included in the EIS)	Non preferred case – One Void in the North	Non preferred case – No Voids	Non preferred case – Partial fill of Final Voids	Non preferred case – No MCCO Project Case
Overburden Emplacement Strategy	Overburden is hauled to additional, larger and higher overburden dumps in the MCCO Additional Project Area of up to approximately RL220	Haul approximately 50Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area	As per Case 2 along with additional 5Mbcm rehandle to improve the overall shape and size of the void in the MCCO Additional Mining Area	As per Case 2 along with additional 33Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area to fill the existing approved mining area void to approximately RL150 - RL160	As per Case 4 however at the completion of coal mining, remove approximately 100Mbcm (394 ha) of established rehabilitation to fill the MCCO Additional Mining Area void.	As per Case 2 with an additional 6Mbcm from the MCCO Additional Mining Area to the existing approved mining area and rehandle approximately 8Mbcm of overburden from the MCCO Additional Mining Area	Mining continues as per current approved operations
Volume of Rehandle (Estimated Mbcm)	Nil	Nil	5	Nil	100	8	N/A
Number of Voids at completion of mining	2	2	2	1	0	2	1
Additional Time to complete	Nil	Nil	6 months	Nil	4.5 years	9 months	N/A
Indicative Total Cost (compared to baseline)	Baseline Costs	$53M	$75M	$114M	$526M	$95M	Economic benefits of the MCCO Project are lost

Table ES 2 Final Void Assessment Outcomes

Case Identification	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Void Options	**All Overburden emplaced in the MCCO Additional Mining Area**	**Initial Integrated Project Case**	**MCCO Project Case (as included in the EIS)**	**One Void in the North** **No void in the existing mining area**	**No Final Voids**	**Partial fill of Final Voids**	**No MCCO Project Case**
Reasonable & Feasible Mine Design?	Yes	Yes	Yes	Yes	No	Yes	-
Reasonable & Feasible Engineering Design?	Yes	Yes	Yes	Yes	No	Yes	-
Economically Feasible?	Yes	Yes	Yes	Possibly feasible	No	Feasible	No as the economic benefits of Project will be lost
Proposed	No	No	Yes	No	No	No	No
Comments	Most economical case however not proposed due to larger and higher emplacement areas in the MCCO Additional Mining Area, associated environmental impacts	Less costly than Case 3 however would result in a larger final void in the MCCO Additional Mining Area	The proposed final landform seeks to strike the balance between mine planning, economic, environmental and social outcomes	Unbalanced outcome	No perceived benefit	Not proposed as the total area of void doesn't reduce in line with the significant costs	Would result in the early closure of Mangoola Mine

**Option considered to address MSC input to SEARs*

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1 Introduction

1.1 Background

Mangoola Coal Mine is an existing open cut coal mine located approximately 20 kilometres (km) west of Muswellbrook and 10 km north of Denman in the Upper Hunter Valley of NSW (refer **Figure 1**). Mangoola Coal Operations Pty Limited (Mangoola) has operated the Mangoola Coal Mine in accordance with NSW Project Approval (PA) 06_0014 since mining commenced at the site in September 2010.

The Mangoola Coal Continued Operations (MCCO) Project will allow for the continuation of mining at Mangoola Coal Mine into a new mining area to the immediate north of the existing operations. The Project is classed as State Significant Development (SSD 8642) and requires approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

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The development of the Mangoola site was initiated with exploration that began in 1999 by Powercoal and Centennial Coal where a resource of approximately 180 million tonnes (Mt) of coal at a relatively shallow depth was identified. NSW Project Approval (PA 06_0014) was originally granted in June 2007 for the construction of an open cut mine and related infrastructure to access approximately 150 million tonnes of ROM coal. In 2009, Mangoola Open Cut (then the Anvil Hill Project) was acquired by Xstrata Coal (now Glencore). Mining activities began in September 2010 with the first coal produced in February 2011.

Mining at Mangoola is completed utilising truck and shovel mining methods to handle overburden, interburden (to be referred to as overburden for the remainder of this document) and coal with a run of mine (ROM) coal extraction rate of up to 13.5 Mt per annum. Mangoola is a thermal coal mine which produces for both the domestic and exports markets. Coal is taken to the local Power Stations or the Port of Newcastle via the existing Hunter Valley rail network.

Following exploration within Mangoola's Assessment Lease (AL) 9, Mangoola has identified further coal resources to the north of the existing Mangoola Coal Mine and north of Wybong Road. Mangoola is seeking approval to extract these further coal resources by continuing the existing mine into this new mining area. The MCCO Project would provide access to approximately 52 Mt of additional coal resources which represents approximately eight years of mining in the additional resource.

The focus of this report is on the outcomes of the assessments that were undertaken to develop the proposed concept mine plan for the MCCO Project that was assessed and is detailed in the EIS. This included the assessment of a range of mine plan options against geological, economic, environmental and social factors to identify the proposed concept mine plan.

The resultant stage mine plans for Years 1, 3, 5 and 8 for the MCCO Project are included in the Project Description of the EIS and reproduced on **Figure 2**.

This report also identifies the key factors considered in mine plan development and the key aspects that have been considered in developing the conceptual final landform for the MCCO Project.

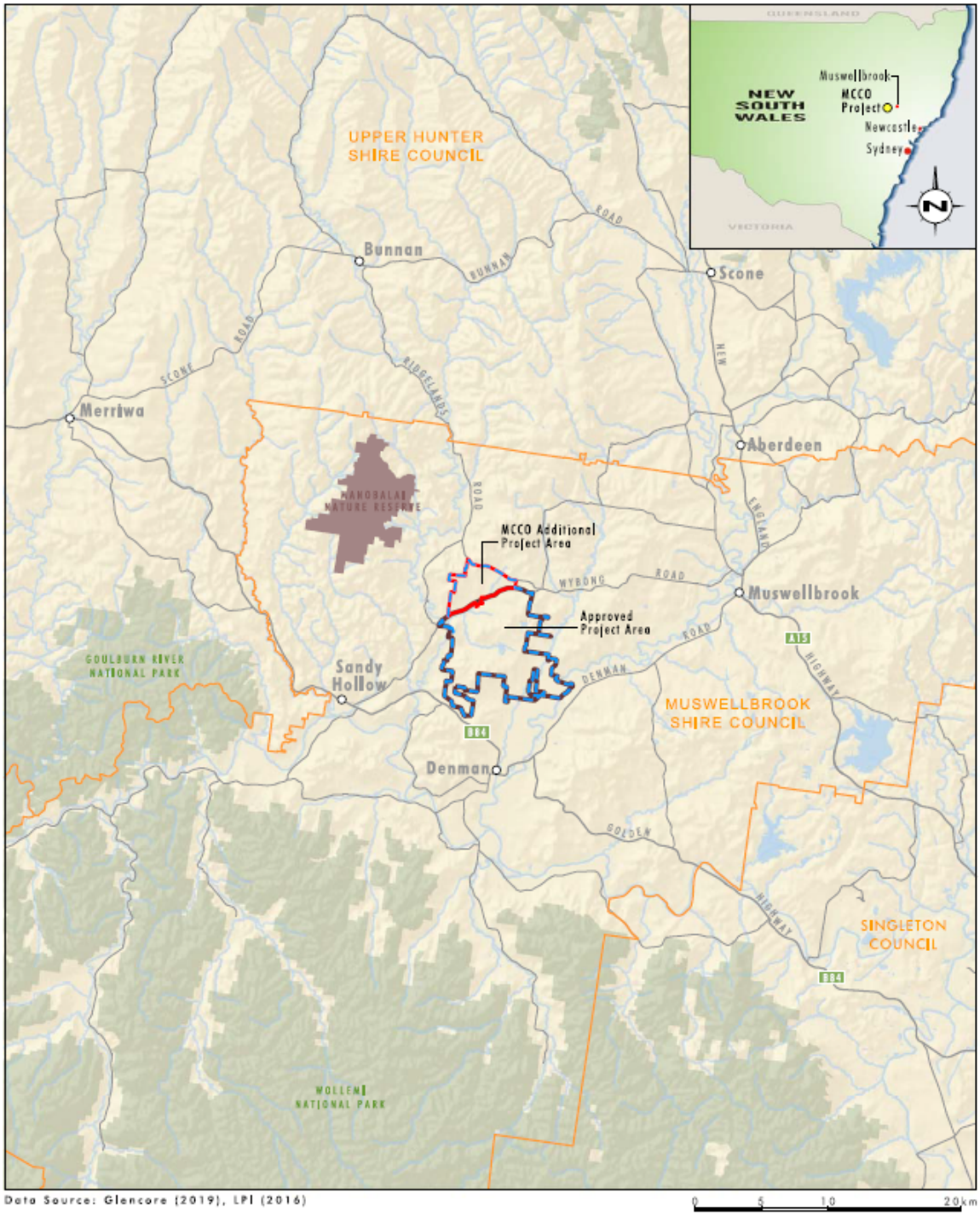

Figure 1: Regional Locality Plan

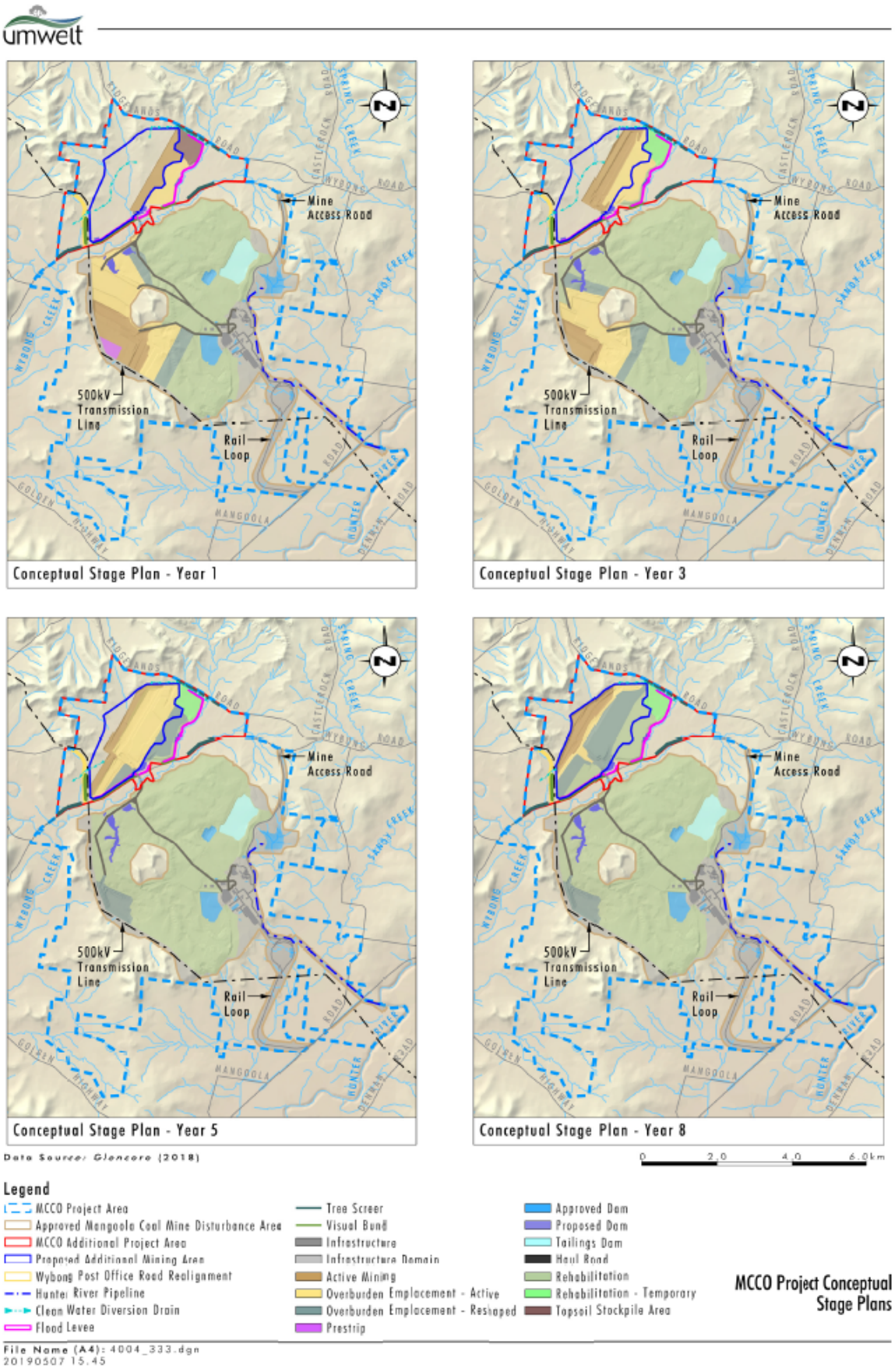

Figure 2: MCCO Project Conceptual Stage Plans

1.2 Document Structure

This report has been prepared to support the MCCO Project EIS and includes:

- an overview of the approach and key drivers for the mine design for the MCCO Project (**Section 2**)
- mine plan options assessed and why they were or were not selected as the go-forward case (**Section 3**)
- final void options assessed and why they were or were not selected as the go-forward case (**Section 4**)
- the final void assessment outcome (**Section 5**)
- an assessment of the void design (**Section 6**)
- A conclusion and list of key references (**Section 7** and **Section 8**)

1.3 Report Assumptions & Limitations

This report has been prepared with consideration of the following assumptions:

- The mine shell as discussed in **Section 3.2** reflects the extent of the preferred mine plan at the present time. Further coal resources may be located within AL9 and subject to future exploration drilling to further define this resource
- As Mangoola is an existing and established open cut mining operation the continued use of the existing infrastructure and equipment is the preferred mining process
- Detailed planning and assessment has only been completed on the preferred case for the MCCO Project. Alternative mine plan options contained within this report are conceptual in nature and have been used as a guide in order to arrive at the preferred case and are for landform and indicative comparison purposes only
- The assessment of economic differences in each mine plan option has primarily considered the truck haulage and rehandle costs associated with each option. Actual costs to implement each of the options may be greater than quoted depending on the timing of the work to be conducted and the degree of interaction with other mining and rehabilitation activities.
- Alternative mine plan options contained within this report focus on the end of mining stage plan.

2 Mine Design Approach

2.1 Key Mine Design Considerations

The MCCO Project has been designed to optimise resource recovery and operational efficiencies between the proposed MCCO Additional Mining Area and the existing approved mining area south of Wybong Road, whilst minimising environmental and social impacts. The mine design process has been iterative since the commencement of the MCCO Project pre-feasibility phase exploration program in early 2014.

The MCCO Project will allow for significant operational efficiencies and continued utilisation of existing mining equipment and infrastructure, as well as maximising efficient recovery of coal resources. The MCCO Project will allow for the continuation of mining at Mangoola Coal Mine into a new mining area to the immediate north of the existing operations and will extend the life of the existing operation providing for ongoing employment opportunities for the Mangoola workforce. The MCCO Project will provide employment opportunities for a workforce up to approximately 400 employees rising up to approximately 480 employees.

As mining operations in the existing approved mining area become more constrained due to the reduced operating area and the location of permanent natural features including Anvil Hill, the commencement of the MCCO Project will enable the existing operation to re deploy some of the mobile equipment to the MCCO Project Additional Mining Area. As the MCCO Project is not increasing the total ROM coal production no upgrades to the primary infrastructure items such as the CHPP or rail facilities are anticipated and the existing truck fleet can largely be utilised.

The introduction of the MCCO Project as a combined operation with the existing operation provides significant improvement in final landform outcomes by utilising void space in the existing operation to accommodate overburden material from the MCCO Additional Mining Area that would otherwise necessitate the construction of larger and/or higher overburden emplacement areas. Limiting the height of emplacement areas has the added effect of reducing noise and visual impacts to private receivers.

The volume of overburden material is one of the key inputs into mine design and the size and location of overburden emplacement areas. Through the mining process of blasting and excavating, the solid ground is broken into smaller pieces, therefore adding “space” between the particles of the excavated material, resulting in a greater volume of material after excavation. This increase in volume can be described as the “swell factor” of material once it has been excavated from the ground from its confined (in situ) state.

The existing Mangoola Coal Mine operations and the proposed MCCO Additional Mining Area depth of ground cover from the surface to the lowest excavated level ranges from approximately 16 m near the seam crop line areas down to 125 m. A low strip ratio and with a typical swell factor for an excavator and truck operation, means that when the coal seams are excavated there is an overall deficit of material when compared to pre mining conditions.

The MCCO Project has been designed as far as practicable to reduce the overall size of the final voids. Typically in many open cut operations to initially create the mining pit, overburden material removed is placed ‘out of pit’ in an emplacement area. The mine then progresses to the pit bottom (lowest mining level) and once the pit is large enough to efficiently accommodate the mobile equipment, the overburden can be put back within the pit as the mine progresses. This results in an area of out of pit emplacement that is usually near where the pit starts and a void at the end where the pit finishes. The cost of re-excavating the out of pit emplacement area at the end of mining and backfilling the void, may or may not be cost prohibitive for a particular project and depends on the amount of material placed out of pit and the size of the void at the end of the mine life. Further discussion regarding why final voids are proposed is included in **Section 4.3**.

The MCCO Project has been developed to direct haul a large portion of ‘out of pit’ material to the currently approved mining area, thus improving landform outcomes in this area. Whilst the MCCO Project will have an out of pit emplacement area that is significantly smaller, than would have occurred if it was a standalone mining operation. In total the MCCO Project will result in the transportation of approximately 50Mbcm of overburden to within the existing approved mining area to assist in reducing the size of the final void that would otherwise occur and improving the final landform outcome. Further

discussion in regard to the emplacement strategy associated with the MCCO Project mine plan is provided in **Section 3.3.5**.

Other primary design considerations in developing the MCCO Project mine plan include establishing the features of the currently approved final landform at the existing Mangoola Coal Mine. Relevant mine plan design features applicable to establishing the final landform and development of the MCCO Project mine plan include:

- re-establishment of Anvil Creek (shown conceptually on **Figure 3**)
- decommissioning / capping of the Tailings Decant Dam and Tailings Dam 4 (TD4) – the existing and MCCO Project tailings storage facility
- establishment of a rehabilitated landform, constituting a mixture of woodland and grassland areas, using natural landform design principles and revegetation techniques that are widely recognised as industry leading.

Once the key elements of the MCCO Project were established, the MCCO Project implemented a detailed design, stakeholder engagement, and environmental and social assessment process. This process allowed stakeholder's views and the findings of the technical studies to inform the MCCO Project design and thereby further minimising impacts. This process has resulted in a range of reasonable and feasible impact avoidance measures being incorporated into the MCCO Project design including:

- measures to minimise noise through mine design (e.g. addition of haul road bunding in key areas and haul road placement behind topographic barriers where practicable)
- minimising dust generation (e.g. consideration of mining equipment density, sequential rehabilitation and temporary rehabilitation to reduce windblown dust)
- minimising the disturbance footprint by:
    - an iterative design of clean water drains from outside the mine footprint, to largely within the mine footprint
    - a reduction in the out of pit emplacement area associated with the MCCO Additional Mining Area by removing the emplacement area between the two limbs of Big Flat Creek as originally proposed in the MCCO Project Preliminary Environmental Assessment (PEA)(Umwelt 2017)
- creating an improved site wide final landform while minimising the total void area (e.g. by removing the additional out of pit emplacement area described above and preferentially placing this material in the existing approved mining area).

The integrated design would result in an improved final void outcome for the existing approved mining area, reduces the need for disturbance of new areas, limits overburden emplacement height levels and enables proactive response to noise and dust issues through the availability of a greater range of emplacement locations for each mining area. The MCCO Project will allow for operational efficiencies and improved utilisation of existing mining equipment and infrastructure, as well as maximising the efficient recovery of coal resources at Mangoola Coal Mine whilst aiming to minimise environmental and social impacts.

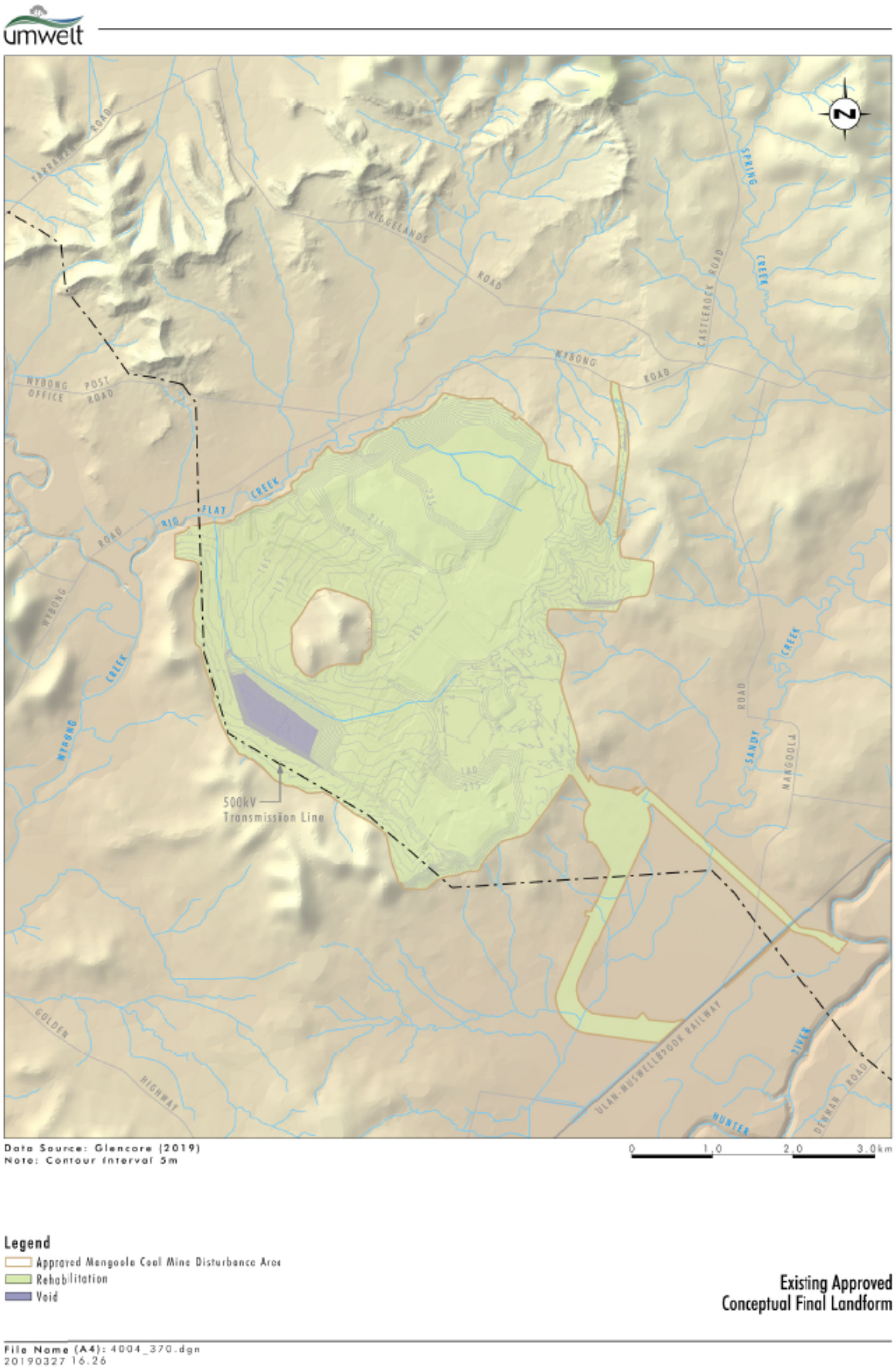

Figure 3: Existing Approved Conceptual Final Landform

2.2 Mine Planning Drivers

2.2.1 Introduction

In addition to the consideration of balancing the physical site constraints, environmental, social, geological, safety and legislative requirements, a key driver for the mine design was achieving a mine plan that provides a financial investment return for the MCCO Project. All of these factors have been considered in an iterative manner to determine the proposed mine plan for the MCCO Project, however without an economic return on investment, the MCCO Project would not proceed.

The following discussion provides further information regarding some of the key mine planning drivers for the MCCO Project including initial alternatives considered throughout the development of the final mine plan.

2.2.2 Geological Setting

The mine planning studies focussed on selecting the area to be mined, the seams to be mined, the mining method and the direction of mining/the progression of the mining operation. Once these key features were determined, further work was then undertaken to refine the mine plan including detailed assessment and consideration of environmental and social constraints.

The coal seams and overburden layers within the MCCO Project area are well known due to the existing approved operation and through an extensive exploration program that has occurred most notably since 2014. The exploration program has confirmed that the seams within the MCCO Additional Mining Area are consistent with those of the existing approved mining area in quality, thickness, depth and interval separation. **Figure 4** represents the typical stratigraphy and target seams in the MCCO Additional Mining Area and within the existing approved Mangoola mine area.

The preferred MCCO Project mine plan was determined following a number of mine scheduling iterations that were used to derive the highest value within constraint boundaries while maximising resource recovery and minimising environmental and social impacts. A consideration was designing the mine plan to deliver continual economic value during the life of the MCCO Project in a market that has had fluctuating coal prices.

Strip ratios, that is the cubic metre volume of overburden required to be removed to recover a tonne of ROM coal, is a factor in assessing economic value. The more overburden required to be removed to recover a tonne of coal, the less economic the mine is depending on the nature and the quality of the resource. In general terms, the lower the strip ratio and the earlier access is gained to coal, the more economic value can be extracted from a resource. The proposed depth of mining was determined by the economic coal to overburden strip ratio and the product quality of the coal seams.

The annual coal mining rate planned for the MCCO Project was determined by a range of factors, but a prime consideration was to maintain and not surpass the approved annual capacity of the Mangoola Coal, coal preparation plant of 13.5 Mt ROM. The coal preparation plant will process coal from both the MCCO Project Additional Mining Area and the approved Mangoola Coal operations, with mining equipment transitioning over time from the existing approved mining area to the MCCO Project Additional Mining Area. Another key consideration is the utilisation of the existing mining fleet in the most efficient manner both from a productivity perspective and a life cycle perspective.

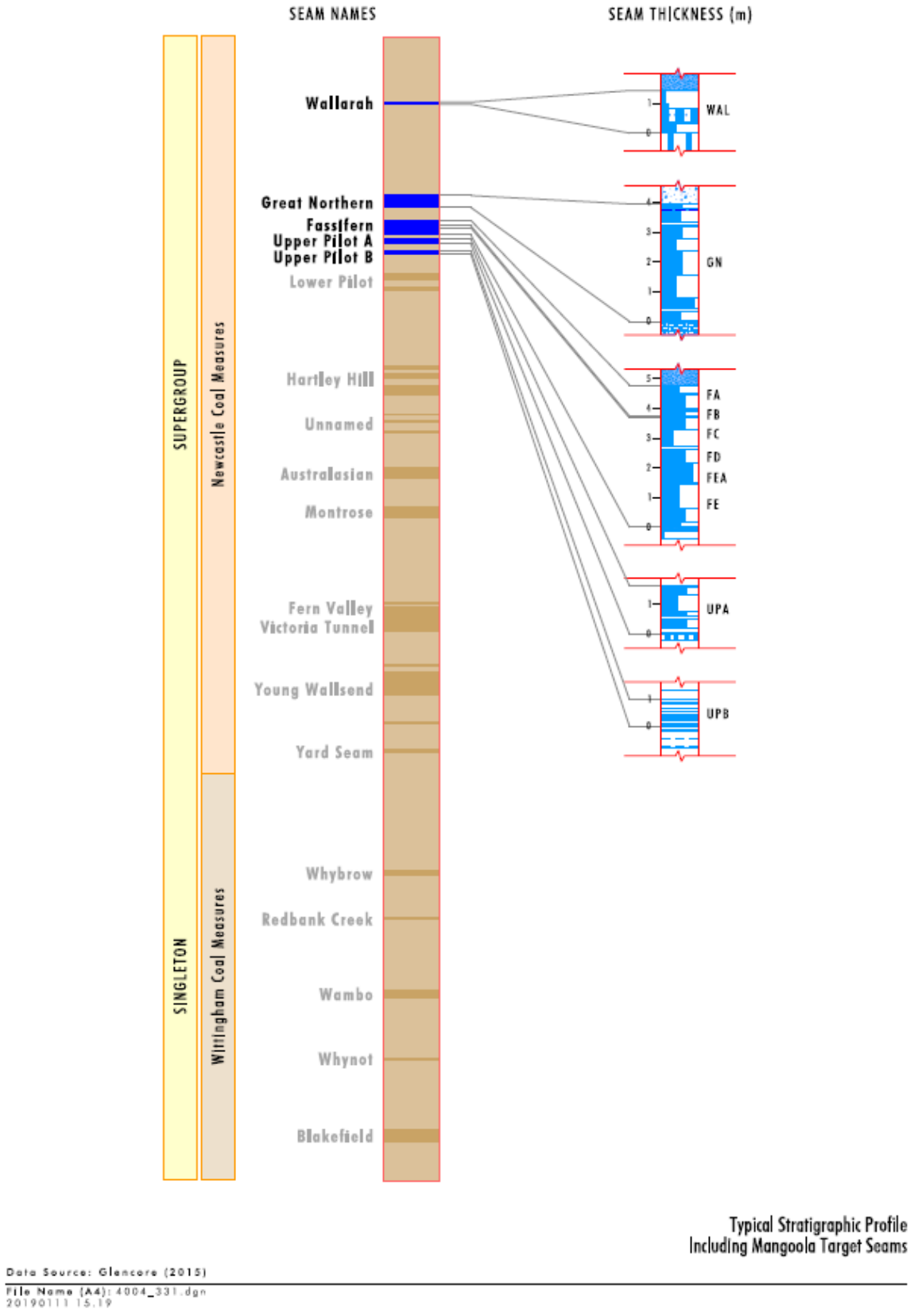

Figure 4: Typical stratigraphic profile including Mangoola target seams

2.2.3 Preliminary Project Assessment

Glencore have a thorough internal project assessment process by which all major projects are planned and assessed. Each phase has progressive and increasing expectations on the mine planning process and an increasing definition of the mine plan and the scope of the project. It is in the Feasibility phase that fine detailed mine planning is completed, the project is evaluated and accompanied by a comprehensive EIS to the NSW Government for assessment.

The preferred mine plan as developed and selected for the MCCO Project has been based on the outcomes of deposit characterisation, constraints analysis, social and environmental impact assessment and economic analysis. Deposit characterisation considers coal seam structure and coal quality through exploration drilling of open and cored sample holes and analysis of those holes and samples. Constraints analysis considers physical, tenement, environmental (preliminary air quality and noise modelling) and social constraints. Economic analysis considers inputs such as the mining schedule, staffing levels, coal product quality, capital costs, operational costs, transport costs, taxes and royalties.

The MCCO Project mine plan development considered several options over time:

- An initial mine plan targeting seams deeper than those currently mined at Mangoola Coal Mine, down to the Montrose seam and/or to the Upper Pilot seams, with a mining progression generally from an east to west orientation
- This initial mine plan (to the Montrose seam) was discounted due to poor economic outcomes related to a higher strip ratio, lower energy seams (in the seams lower than the current target seams) and equipment replacement capital required due to the longer life mining sequence with the additional coal seams
- The east/west orientation mining to the Upper Pilot seams was also discounted due to less than desirable economic outcomes related to an initial higher strip ratio and minor wash outs of the coal seams in the eastern extent of the proposed mining area
- The mine plan target was then refined to the upper seams (Wallarah to the Upper Pilot A (UPA)) in general alignment with the existing Mangoola Coal Mine operational area (noting that the existing operation extracts coal to the UPB seam at times dependant on quality), with mining commencing generally from the southeast, aligning with the seam crop lines, progressing to the northwest and deeper areas of the resource
- This re-alignment of mining progression generally southeast to northwest, improved the economic outcomes due to the commencement of mining where the coal seams are shallowest, targeting the higher value shallow seam coals and by lower capital expenditure, by matching and optimising the existing mining fleet projected life expectancies
- Therefore the mine plan and schedule seeks to utilise the current mining fleet with the staged transition from the current approved mining area to the MCCO Additional Mining Area with a minor addition of haul trucks to accommodate longer truck haul lengths for overburden emplacement

In addition, MCCO Project mine planning considered a number of constraints which included:

- The existing mining lease and tenement boundaries
- The existing biodiversity offset areas to the east
- Big Flat Creek located between the existing mining operation and the MCCO Additional Project Area
- The Big Flat Creek conservation area located between the existing operation and the MCCO Additional Project Area and which generally aligns with a significant portion of Big Flat Creek
- Wybong Road located between the existing mining operation and the MCCO Additional Project Area
- The location of known threatened flora species including *Acacia pendula*, *Diuris tricolor* and *Prasophyllum petilum*
- Wybong Post Office Road located in the central portion of the MCCO Additional Project Area

- Ridgeland's Road located north of the MCCO Additional Project Area
- The rising topography to the north/northwest, which results in increasing strip ratios
- The existing 500kV TransGrid powerlines located to the west
- ROM coal and product coal, strip ratios
- Overburden dumping constraints, including limiting out-of-mine overburden emplacement, avoiding disturbance of the existing mine rehabilitation areas and maintaining the approved number of voids in the existing approved Mangoola Coal operations
- Wybong Creek to the west
- Results from preliminary air quality and noise constraints modelling

The consideration of the above mine planning design drivers was critical to designing an economically feasible mine design. The rigorous pre-feasibility phase for the MCCO Project occurred over the period from 2014 through to the commencement of detailed feasibility planning in 2017. In the ensuing period since the commencement of the feasibility phase of the MCCO Project the mine plan has been refined to optimise a single mine plan to support a robust investment case, meet legislated expectations and provide reasonable and feasible avoidance or mitigation measures for environmental and social factors.

Through this iterative design process the potential environmental impacts of the MCCO Project have been significantly reduced with the physical components shown on **Figure 5** in relation to the proposed MCCO Project layout. Items shown in green shading represent areas of land that were either considered for future mining or infrastructure however have been altered or ruled out at this stage as discussed throughout this chapter. Details regarding the alternatives considered for the MCCO Project are provided in **Section 3**.

In total, the changes to the physical components of the MCCO Project has resulted in an overall reduction of approximately 400 ha to the total MCCO Additional Disturbance Area when compared to the future mining or infrastructure that have either been altered or ruled out at this stage (as shown on **Figure 5**). This reduction in impacts has occurred in parallel with additional exploration drilling, and an increase in the forecast ROM coal tonnes from approximately 45 million tonnes (as nominated in the MCCO Project PEA, Umwelt 2017), to approximately 52 million tonnes.

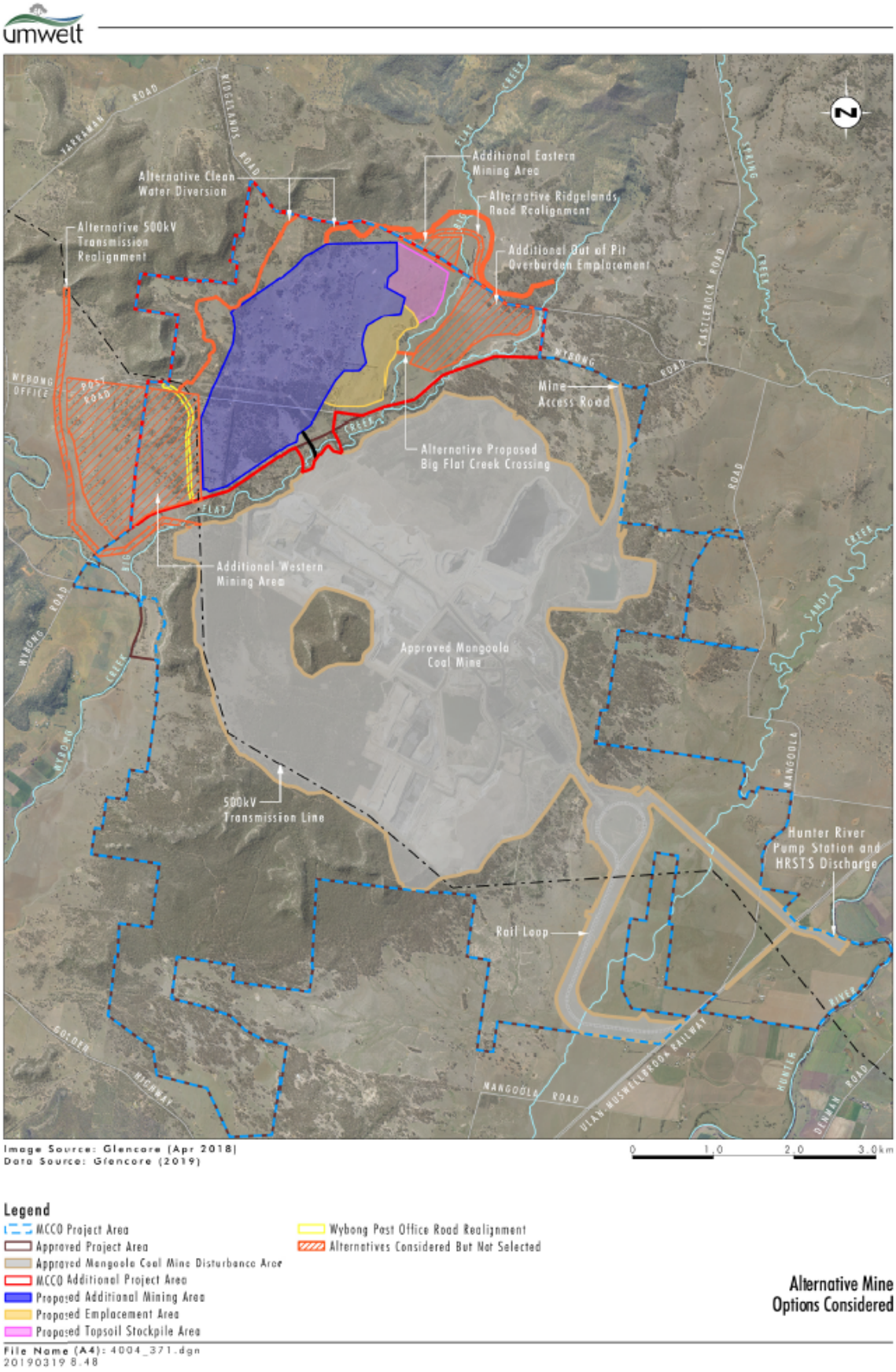

Figure 5: Alternative MCCO Project Design Elements Considered

3 Mine Design Options Assessed

3.1 Introduction

The following sections outline the evolution of the MCCO Project design and discuss the various mine designs and features that were considered and ultimately found either not to be feasible, or desirable, or able to form part of, the preferred project design.

3.2 Preferred Mine Plan Development

The following section summarises the evolution of the MCCO Project mine plan having regard to:

- financial viability
- resource recovery efficiency
- efficient use of existing infrastructure and equipment fleet
- minimising noise and dust emissions on the surrounding community
- minimising impacts on biodiversity and water resources
- minimising social impacts
- the future final landform including development and minimisation of final voids.

Throughout the period 2014 - 2017 ongoing exploration drilling within AL9 and geological assessment continued to assist in increasing the knowledge of the MCCO Project Additional Mining Area resource. During this time the mine shell continued to be refined for the purposes of providing an indication of the mining footprint for the pre-feasibility phase environmental and infrastructure studies with an assumption of mining in a generally east to west direction. Initially, three options for the target seams were considered and included the Upper Pilot seams, the Montrose seam and the Young Wallsend seam to estimate the reserves within the mine shells, including an area west of the 500kV power lines and a small area north of Ridgeland's Road. **Figure 6** illustrates the mine shell under consideration at this point in time.

Mining schedules were assessed with coal production as a target up to the existing 13.5 Mtpa ROM approval limit (and CHP capacity) to determine the effect of the higher strip ratio within the MCCO Additional Mining Area. These initial schedules indicated that the quantity of material to be mined as overburden to achieve the production target was too significant. This was due to the restricted work areas with the width of the mine and the relatively high strip ratios. In addition, the generally east to west orientation of this schedule was identified as not feasible or practical, both from an equipment fleet quantity perspective and a safe operational area/mining equipment interaction perspective, or from an environmental perspective due to increased air quality, noise and visual impacts. The option of mining to the deeper Montrose and Young Wallsend seams was discontinued at this stage.

Consideration was made of an alternative mine plan where no overburden was transported from the MCCO Additional Mining Area into the existing approved mining area. This option is considered the most economical however due to larger and higher overburden emplacement areas in the MCCO Additional Mining Area and associated increased air quality, noise and visual impacts along with the size of the resultant final voids this option was not considered suitable. Further discussion regarding this outcome is provided in **Section 4.4.2**.

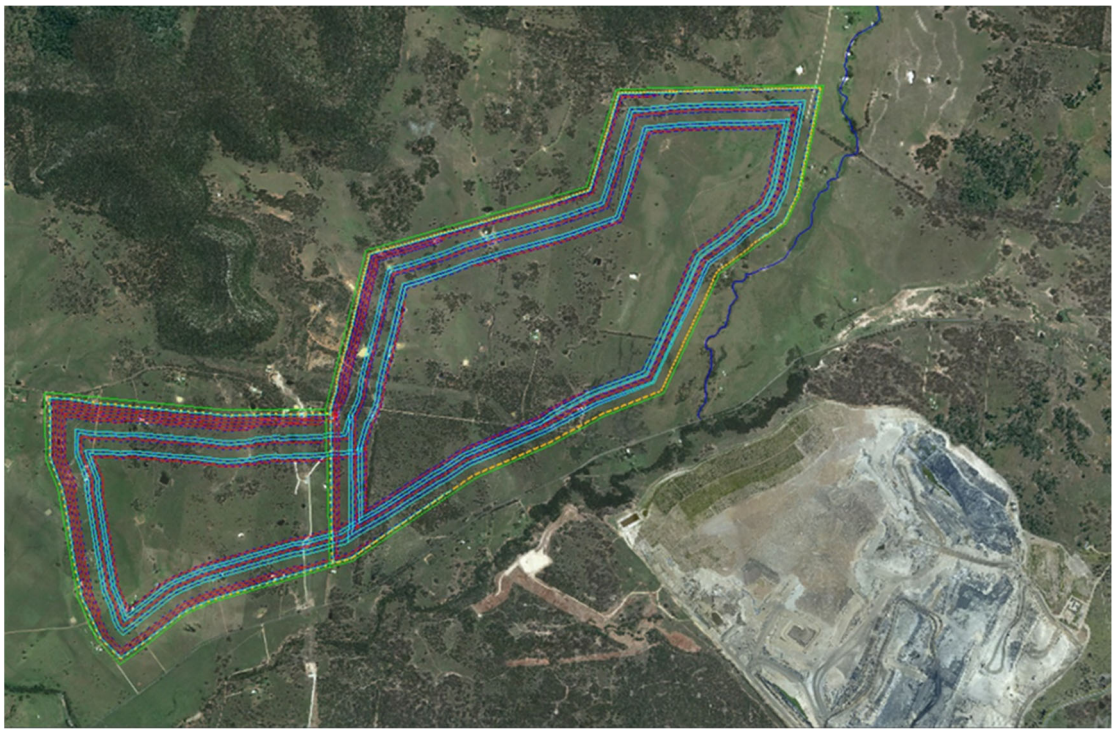

Figure 6: Preliminary Mine Shell

Outcomes from ongoing review and assessment found that the capital cost and environmental impact of mining through Ridgelands Road in the eastern extent was seen as not being viable, with a significant road diversion and clean water drain being required for a relatively small quantity of coal extracted. Further, it was identified that Ridgelands Road is a key road for the local community and would cause excessive impacts for limited resource gain and was subsequently discounted.

At this stage the mine plan was refined to target the upper seams (Wallarah to UPA) consistent with the existing mining operation and in order to utilise the existing fleet and infrastructure. The mining progression was changed to a generally southeast to northwest orientation, targeting the seam crop lines initially, to provide improved economic outcomes with an initial lower strip ratio and by targeting shallower and better quality coal seams. Also the revised mine plan would make better use of the current mining fleet to the full extent of the equipment operating life and provided a more productive staged integration of the MCCO Additional Mining Area into the existing operations.

Mining to the west of the 500 kV Electrical Transmission Line (ETL) in its current position was discounted at this time primarily due to the capital required to relocate the ETL or the constraints of mining in this area if the ETL was left in its current position. This should not rule out further assessment of this area and other areas within AL9 in the future, subject to a number of factors.

From late 2015 the MCCO Project Additional Mining Area mine plan has been refined and assessed based on the following criteria:

- Mine shell constraints limited by Ridgelands Road to the east, Wybong Road to the south, the 500kV power line to west, Exploration Licence (EL) 8064 and rising topography, together with downward dipping coal seams, to the north and northwest
- Economic seam determination targeting the same coal seams as that of the existing approved Mangoola mining operation, being the Wallarah, the Great Northern, the Fassifern and the Upper Pilots (to the UPAB ply in this instance)
- Minimising impacts to the local community particularly in relation to noise, air quality and visual amenity
- Minimising disturbance areas and avoiding impacts where possible, to threatened orchid species including *Prasophyllum petilum*
- Minimising overburden emplacement areas external to the mine shell

- Maximising the backfill of the current mining operations to minimise the size of the final void and to provide an improved landform outcome
- Minimise disturbance of any existing rehabilitated mining area
- A staged transition from the current mining lease to the MCCO Additional Mining Area for two of the three mining waste excavator fleets and one of the two coal and parting fleets whilst maintaining production levels up to the currently approved 13.5 Mtpa
- Coal Handling and Preparation plant capacity is unchanged from the current capacity
- All other site infrastructure is continued to be used with the proposed MCCO Additional Project Area integrated into the existing site systems

Exploration drilling in 2017 and early 2018 identified an area of loss of coal reserves from the geological model in the east of the MCCO Additional Mining Area.

To offset these losses in the coal resource the planned limit of mining was extended to the north and straightened to increase the strike length (the available mining area and therefore the mining rate) in the later years of the MCCO Project. This provided options to optimise the final landform, to reduce the size of final voids through access to additional overburden material volume and the scheduling of overburden emplacement to within the existing approved mining area (see **Section 4.4.2**). **Figure 7** illustrates the contemporary mine shell developed for the MCCO Project, referred to in the EIS as the MCCO Project Additional Mining Area. The crop line in the east and southeast of the pit shell may be subject to further refinements based on future operational crop line drilling.

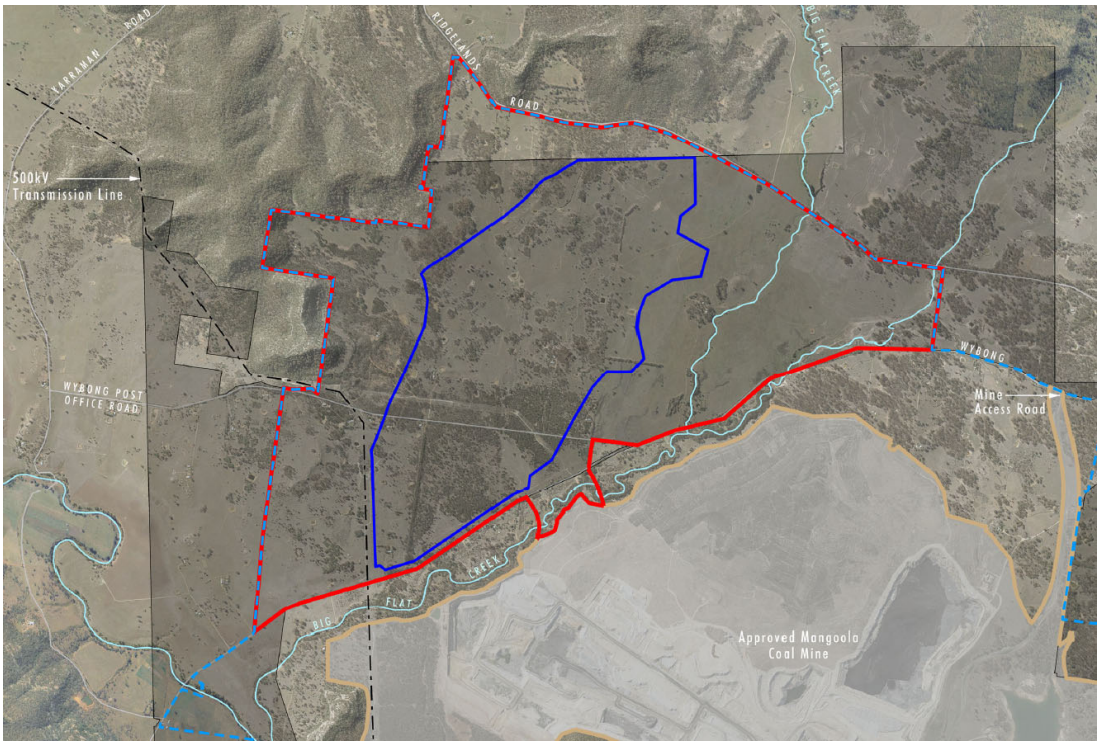

Figure 7: MCCO Project Additional Mining Area

As a result of the increase in overburden volume associated with this change, the completion of the MCCO Additional Mining Area also extended the mine life to approximately 2029 (assuming a 2022 start date for the MCCO Project).

At this stage three overburden mining excavators and two coal and parting excavator fleets (the total Mangoola fleet) were included in the mining schedule for the MCCO Additional Mining Area as the reshaped mine shell was considered to provide adequate strike length for the scheduling of the entire truck and excavator fleet until 2027. The additional overburden volume allowed the size of final voids to be minimised while maintaining the recoverable coal reserves despite the geological losses resulting from the latest exploration results.

Ongoing geological updates and noise constraints modelling was completed and changes to the mine plan were made to further minimise noise impacts to near neighbours. This redesign had the mine schedule consider mining equipment intensity, by utilising two only (vs. three) overburden excavators for overburden removal and one only coal mining excavator (vs. two) in the MCCO Additional Mining Area.

This reduction in the total number of overburden and coal excavators used in the MCCO Additional Mining Area added approximately seven months to the MCCO Project life, with last coal now scheduled to be mined in 2030 (assuming the same start date as the previous schedule). The reduction in overburden and coal mining excavators and the resultant reduction in truck numbers reduced the overall noise impacts to the near neighbours, particularly to the north through to the west of the MCCO Additional Mining Area. (It must be noted that the equipment not being utilised may be kept for operational use during maintenance periods on the primary use excavators or during periods where environmental and operational conditions permit their use.) The preferred mine plan and schedule was now established for the MCCO Project and ongoing final landform outcomes refined (see **Section 4.4**).

The work described above has led to a balanced, achievable and feasible mine design that has been refined to support a robust investment case, meet legislated expectations and provide reasonable and feasible mitigation or avoidance measures for environmental and social factors. Final stage mine plans for Years 1, 3, 5 and 8 developed for the MCCO Project are included on **Figure 2** and described in detail in the Project Description of the EIS.

3.3 Alternatives Considered

A fundamental objective in the MCCO Project's concept and pre-feasibility mine planning stage was to identify potential alternatives for mining the identified coal resources that were viable within the existing AL 9 exploration areas. As Mangoola is an existing and established open cut mining operation the continued use of existing infrastructure and equipment was logically considered to be the preferred method of mining. Various open cut mining configurations were considered as part of the planning to optimise the MCCO Project's environmental and economic outcomes.

The key issues considered in assessing the viability and feasibility of various alternatives and developing the final design at pre-feasibility were as follows:

- financial viability
- resource recovery efficiency
- efficient use of existing infrastructure and equipment fleet
- minimising noise and dust emissions on the surrounding community
- minimising impacts on biodiversity and water resources
- minimising social impacts
- the future final landform including development and minimisation of final voids.

To date, limited exploration has been completed specifically targeting the deeper coal seams within AL9 that may have underground mining potential. Subject to further detailed geological investigation and future market conditions, there may be the potential for further mining operations to be proposed at a future date for the remaining coal resources within AL9.

Studies of all key issues were undertaken as part of the project planning process so that environment, heritage and social values and constraints could be considered in project decision making. This included various iterations of quantitative noise and air quality modelling, which was undertaken as part of the mine plan assessment process, including consideration of the additional mining areas and out of pit overburden emplacement arrangements. As described in the following sections this modelling assisted in identifying areas of higher impacts and ensured these were considered in the project design as well as guiding the implementation of reasonable and feasible mitigation as part of project design to reduce the impacts of the MCCO Project.

3.3.2 Additional Western Mining Area

A key alternative to the MCCO Project was to mine additional coal resources to the west of the existing 500 kV ETL. This option would have resulted in the mining of an additional 12 Mt of coal and disturbance an additional 246 ha of land. As shown on **Figure 5** this mine plan option would have required the realignment of a section of the existing 500 kV ETL in a location closer to Yarraman Road to the west. Constraints analysis also indicated that it would result in increased noise and air quality impacts to private receivers.

The Additional Western Mining Area was considered uneconomic under current market conditions largely due to the cost associated with the realignment of the 500 kV ETL, replacement mining fleet equipment costs and was less desirable due to increased environmental and social impacts particularly with regard to noise, air quality and biodiversity impacts.

3.3.3 Additional Eastern Mining Area

Another mining area was also considered to the north east of Ridgelands Road to mine an additional 1 Mt of coal. As shown on **Figure 5** this mine plan option would have required the realignment of a small section of Ridgeland Road and the construction of an extensive clean water diversion drain to the north of the realigned road. This option would have resulted in an increased disturbance footprint of 17 ha (inclusive of the required realignment of Ridgeland's Road). Constraints analysis also indicated that it would result in increased noise and air quality impacts to private receivers.

It was also identified early during community consultation that Ridgelands Road is a key road that is used by the local community.

The Additional Eastern Mining Area was considered uneconomic under current market conditions and less desirable due to increased environmental and social impacts particularly with regard to noise and air quality emissions and impacts on travel for the local community.

3.3.4 Mining of Deeper Seams

A mine plan was considered included targeting coal seams deeper than those currently mined at Mangoola Coal Mine, down to the Montrose and Young Wallsend seams. The mining of deeper seams option was discounted due to poor economic outcomes related to a higher strip ratio, lower energy content in these deeper seams (lower than the current target seams) and equipment replacement capital required due to the longer mine life associated with mining the additional coal resources.

This plan would have resulted in larger and higher overburden emplacement areas and a larger final void.

3.3.5 Additional Out of Pit Overburden Emplacement

A feasible mine planning option that was considered was the development of a second overburden emplacement area within the MCCO Additional Project Area as an alternative to hauling overburden to the south for disposal within the existing Mangoola mining area (see **Figure 5**).

The Muswellbrook Shire Council (MSC) input into the Secretary Environmental Assessment Requirements (SEARs), noted *"the location of the out of pit emplacement shown in Fig 6.3* (MCCO Project PEA, Umwelt 2017) *has operations closer to non-mine owned residents in Castlerock Road than has ever occurred with the existing operation. This could result in additional noise and dust impacts on the residents of Castlerock Road. To avoid this, all efforts should be explored in the EA for material to be preferentially placed in the existing approved mine void. This is not located near any non mine-owned residences."*

In alignment with the above comment the MCCO Project has developed a final mine plan schedule that removes this element and developed a conceptual mine plan that removes the requirement for the previously proposed additional out of pit overburden emplacement by scheduling the emplacement of additional overburden to within the existing mining area, generating the following benefits:

- further reduces the overall disturbance of the MCCO Project by 75 ha

- removes the requirement for an additional culvert across Big Flat Creek to connect the MCCO Additional Mining Area to the eastern OEA
- anticipated to provide an incremental reduction in impacts associated with air quality, noise, visual and surface water
- reduces the size of the void in the existing mining area

Removing the additional OEA was considered an improvement to the integrated final landform planning perspective and desirable due to decreased environmental impacts and was incorporated into the final MCCO Project as a result.

3.3.6 Proposed Wybong Road and Big Flat Creek Overpass

The haul road overpass location of the crossing of Wybong Road and Big Flat Creek was determined by a combination of factors and considerations including:

- minimising the area impacted within the previously proposed biodiversity and Aboriginal archaeological offset corridor adjacent to Big Flat Creek (the haul road alignment was placed to avoid or reduce impacts on threatened species and known Aboriginal archaeological sites)
- achieving a location that is relatively central to the MCCO Proposed Additional Mining Area in order to maximise the efficiency of haulage routes
- limiting disturbance at the existing Mangoola Coal Mine to within the Approved Mangoola Coal Mine Disturbance Area
- alignment with and maximising truck haulage efficiency to, the existing or planned haul roads in the Approved Project Area
- site lines along Wybong Road for traffic using this road.

The design and location selected has avoided impacts on 68 threatened plants (including 11 *Acacia pendula*, 39 *Prasophyllum petilum* and 18 *Diuris tricolour*) and 5 known Aboriginal archaeological sites.

Although not centrally located to the MCCO Project Additional Mining Area, the haul road crossing of Wybong Road and Big Flat Creek is the most appropriate location based on the factors and constraints considered above.

3.3.7 Clean Water Diversions

Two extensive clean water diversions were originally designed to be located to the north of the MCCO Project Additional Mining Area in order to manage water inflows to the proposed Additional Mining Area (refer to **Figure 5**). As originally proposed, the construction of these diversion drains would have increased the disturbance footprint of the project by 23.5 ha, impacted on 99 threatened orchids (including 2 *Prasophyllum petilum* and 97 *Diuris tricolour*) and 2 known Aboriginal archaeological sites.

The preferred alternative of constructing staged clean water diversion drains, largely within the proposed Additional Mining Area footprint has resulted in these impacts being avoided. Further, in some areas the land now not utilised for clean water diversion drains has been included in the Biodiversity Offset Strategy for the MCCO Project.

3.3.8 No Wybong Post Office Road Relocation Mine Plan

As requested by MSC, an assessment was undertaken of the implications on the mine plan should Wybong Post Office Road not be relocated and remain in place. It was requested that "*Where any Council local road (Post Office Road) is sought to be closed (including any realignment of a road outside its reserve), the assessment should include an alternate mine plan and final landform plan in the event that Council does not resolve to close that road in accordance with the Roads Act 1993.*"

The MCCO Project has considered this request and has completed a concept level assessment of retaining Wybong Post Office Road in its current alignment. In the assessed case the MCCO Project Additional Mining Area is split by the retention of the existing Wybong Post Office Road and would result two separate mining areas north of Wybong Road (three mining areas in total). A conceptual mine plan of this option is provided on **Figure 8**.

Another option exists where a significant loss of resource occurs by restricting mining in the MCCO Project Additional Mining Area to the northern side of Wybong Post Office Road only. This option has not been assessed due to the significant loss of approximately 14.2 Mt of ROM coal or 27% of the planned 52 Mt of ROM coal in the EIS assessed plan.

In the assessed case, to access the mining areas an additional haul road crossing is required to be constructed over Wybong Post Office Road in addition to the planned crossing of Wybong Road, to enable access from the existing approved mining area and then consequently from one mining area to the other mining area of the revised MCCO Project Additional Mining Area.

With the extra road crossing, elevated haul roads associated with the road crossings would be extended to access both the north and south side of Wybong Post Office Road with significant increased visual impact when compared to the proposed case assessed in the EIS. Although not modelled, this elevated haul road arrangement would likely add to the noise impacts to northern and western receivers along with additional road closures and reduced operational efficiency due to more constraints around blasting.

This option would generally reflect the EIS assessed case as the MCCO Project would haul overburden from the MCCO Additional Mining Area to the existing approved mining area however, conceptually three final voids would likely remain at the completion of operations. Should one of the three voids be removed by backfilling post mining (in order to achieve the same number of voids and a similar landform to the MCCO Project mine plan) then the logical choice is the smaller of the three voids, located in the north area of the smaller mining area in the south west of the MCCO Additional Mining Area and south of Wybong Post Office Road. This void would require approximately 8.8Mbcm of overburden rehandled from an established overburden dump post the completion of mining.

From a construction perspective additional disruption to the public would occur with the construction of the additional crossing over the existing Wybong Post Office Road and it would not be proposed to upgrade any portion of Wybong Post Office Road as proposed (refer to the EIS for further details) as there is no direct impact with the road remaining on its current alignment.

In summary this option is not preferred due to the following reasons:

- Would result in the loss (and potentially the sterilisation) of coal resource from the coal proposed to be extracted from the MCCO Additional Mining Area affecting the commercial viability of the project.
- Whilst the existing Wybong Post Office Road would remain, the construction of a new and improved standard of road as proposed by the MCCO Project (as discussed in EIS) would not be required to be constructed
- Would result in additional impacts to local road users due to the increased frequency of blasting and road closures
- Would be anticipated to provide an incremental increase in impacts associated with air quality, noise and visual
- Is not the most efficient mine plan or means to extract the known coal resource and would decrease overall operational efficiency
- May result in three final voids (or require significant overburden rehandle to reduce to two as proposed by the MCCO Project)
- Would require increased capital associated with the construction of an additional haul road overpass and coupled with the loss of coal would impact on the overall economic benefits of the project.

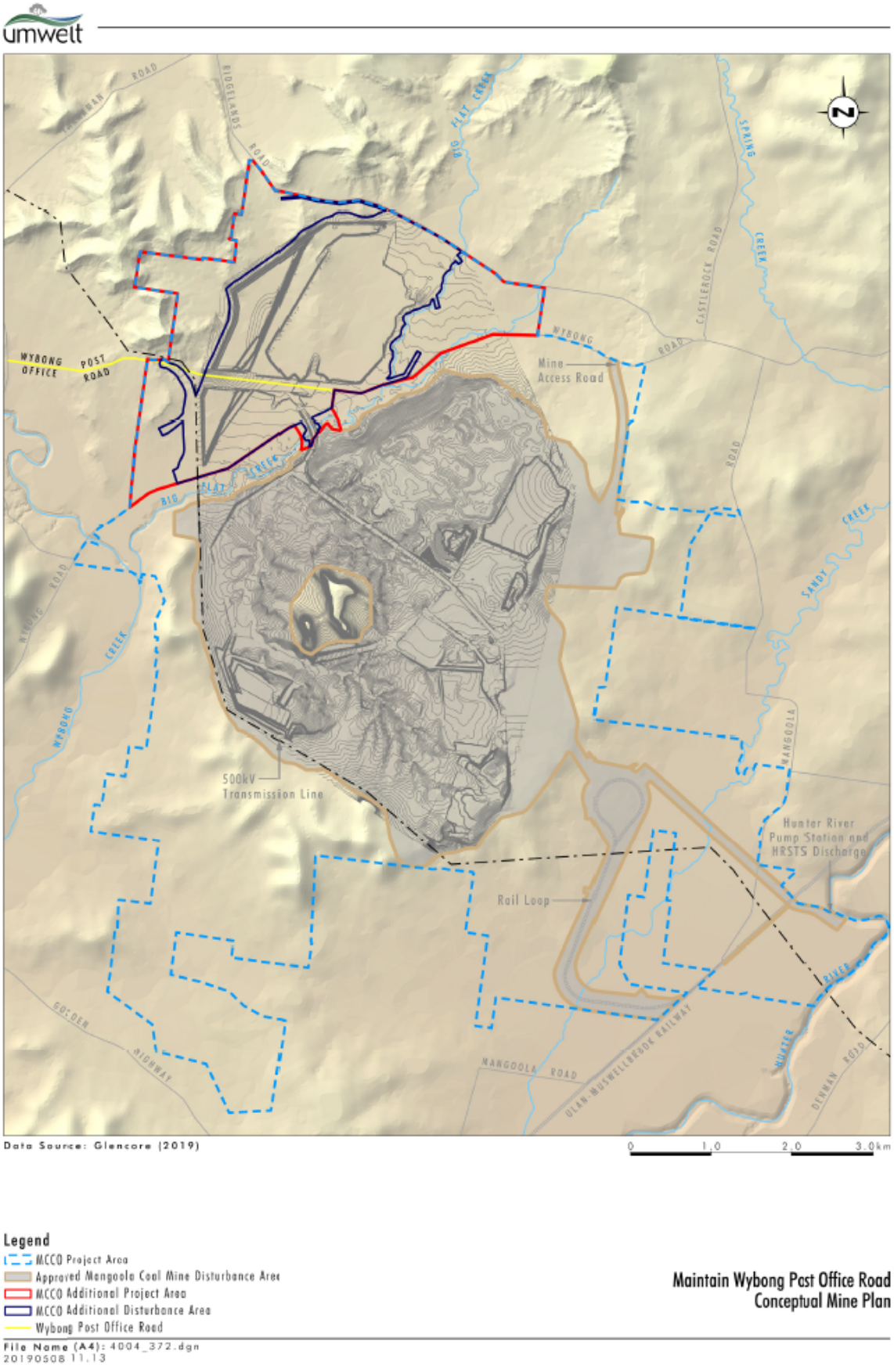

Figure 8: Maintain Wybong Post Office Road Conceptual Mine Plan

3.3.9 Alternative of not proceeding with the Project

The option of not proceeding with the Project was also considered by Mangoola. Not proceeding with the Project would mean the cessation of mining at Mangoola in approximately 2025. Whilst rehabilitation and closure works would continue for some years following the cessation of mining, such operations would be at a much lower intensity than the current mining operations and there would be a subsequent significant reduction in employee numbers. The employment opportunities for up to approximately 480 employees would be lost as would the significant flow on effect to the local, regional and state economy.

The Project will extract approximately 52 Mt of ROM coal during the life of the Project. The impacts of supplying this coal from an existing mining operation (i.e. a 'brownfields' development) are significantly reduced when compared to supply from a new 'greenfields' mine development if such a new mine was developed in an area that had not been previously subject to mining.

The extraction of the MCCO Project ROM coal now, while there is existing mining equipment operating at the site and available mining infrastructure, is substantially more efficient than seeking to mine the resource at some future date following closure of the existing operations. Not proceeding with the Project will make it considerably more expensive to extract the coal in the future, with commensurate reductions to taxation and royalty revenue. Such future operations may not be commercially feasible as the current benefit of being able to utilise existing Mangoola infrastructure may not be available if the MCCO Project does not proceed.

As outlined in EIS proceeding with the MCCO Project will provide a range of economic and social benefits at local, regional and State levels (Cadence Economics, 2019). Some of the key economic benefits include:

- provide ongoing employment opportunities for the Mangoola workforce of approximately 400 employees, rising to a peak of approximately 480
- ongoing opportunities for local businesses and service providers
- provide a net benefit to the Upper Hunter region of $92.6M in net present value terms
- provide a net benefit of $408.6M to NSW over the life of the MCCO Project in present value terms
- provide a royalty revenue stream flowing to the NSW government estimated to be $121M over the life of the MCCO Project.

These and other economic and social benefits would not be realised should the MCCO Project not proceed.

Not progressing with the MCCO Project would have some potential benefits to the local community and environment in terms of avoiding some of the impacts from mining. However, these potential benefits need to be balanced against the economic and social benefits of the MCCO Project. Further discussion in regard to the potential impacts and benefits is contained within the EIS.

With the implementation of appropriate management, mitigation and offset measures, the EIS concluded that the Project would result in a net benefit to the NSW community. Mangoola therefore considers that not proceeding with the Project is not a desirable alternative.

4 Final Void Options Assessed

Final voids has been identified as a key consideration for the MCCO Project and therefore an assessment of final void options was undertaken to identify the proposed final void arrangement. This section outlines the options assessed and the key determinants of the proposed final void arrangement for the MCCO Project.

The development of the preferred mine plan described in **Section 3.2** above has led to a balanced, achievable and feasible mine design that has been refined to support a robust investment case, meet legislated expectations and provide reasonable and feasible mitigation or avoidance measures for environmental and social factors. In addition to the detail provided in **Section 3.3** the following section describes the particular details associated with the MCCO Project final void including alternative final void outcomes considered for the MCCO Project.

4.2 What is a Final Void

Open cut mining involves the displacement of material to access a resource within the ground, which often results in the formation of large pits or 'voids' where that material has been removed. Where a void is left after mining, it is typically referred to as a 'final void' (DPE 2017).

For the purposes of this report the ‘final void’ is considered to be the area within the crest of the final highwall circumnavigating the predicted long term water recovery level of the pit lake and excluding the lowwall/endwalls. The lowwalls/endwalls have been excluded from the definition of a final void due to the reduced slopes compared to mining conditions, combined with the ability for rehabilitation opportunities as described within this report. It is important to note that not all areas defined as a final void render the land unusable and further, final voids may have future value beyond the scope of this report.

4.3 Why Are Final Voids Required

As discussed in **Section 3**, the MCCO Project has been designed to optimise resource recovery and operational efficiencies between the proposed MCCO Additional Mining Area and the existing approved mining area south of Wybong Road, whilst minimising environmental and social impacts. A key feature of the Mangoola Mine, when compared to other large open cut mining operations, is the relatively low strip ratio. The existing Mangoola Mine operations and the proposed MCCO Additional Mining Area depth of ground cover from the surface to the lowest excavated level ranges from approximately 16m near the seam crop line areas at the northeast extent down to 125m as the topography rises and the seams dip lower in the northwest. One of the effects of this low strip ratio is that when the coal seams are excavated, the ability to re-establish a final landform without leaving a void, or at best re-establishing the topographical landform is diminished, as there is limited material remaining post the coal seam removal to re-establish the pre-mining landform as part of the mining process.

During the entire life of mining at Mangoola Coal Mine including the MCCO Additional Mining Area, with the forecast total volume of material removed from the ground and if hypothetically all the overburden and loose reject material from the CPP is placed back into the mined area and there is no overburden placed in the out of pit area, and considering swell factor, there is a net volume deficit. Therefore it is not possible to reinstate the topography to pre mining levels across all previously mined areas. As previously described, the mining process at the commencement of mining also dictates that “out of pit” overburden emplacement areas are required to provide for the initial start-up operating area, before backfilling of the mining void (known as in-pit/or in-mine overburden emplacement) can commence. This means that for the emplaced material to be put back into the mine shell at the completion of mining it must be rehandled (effectively it must be mined twice). This would significantly affect the economics, and the environmental and social impacts of the mine depending on the volume of material requiring rehandle.

As discussed throughout this report the introduction of the MCCO Project as a combined operation with the existing operation, provides significant improvement in overburden emplacement efficiency by:

- providing an integrated emplacement strategy

- making more efficient use of available space
- minimising the size of the final void
- reducing the need for the disturbance of new areas
- limiting overburden emplacement height levels
- enabling proactive responses to noise and dust issues through the availability of a greater range of available emplacement locations for each mining area.

The Surface Water Impact Assessment completed for the MCCO Project EIS (HEC 2019) has found that the final pit lake water levels will gradually recover over time until an equilibrium state is reached. It is anticipated that the long term pit lake recovery levels would fluctuate with time and conditions however are predicted to generally stabilise at approximately RL112 in the existing mining area and approximately RL110 in the MCCO Additional Mining Area (HEC 2019).

The MCCO Project Groundwater Impact Assessment (AGE 2019) has found that in both mining areas the final void pit lakes are predicted to equilibrate at a lower level than under pre-mining conditions, with the final voids (non-backfilled mine areas) acting as long term groundwater 'sinks'. By acting as a long-term groundwater sinks naturally occurring salt that is captured within these pit lakes and avoids impacts on surrounding water quality.

4.4 Void Options Assessed

4.4.1 Introduction

Following the establishment of the MCCO Project Additional Mining Area mine plan (which also considered resultant final voids) the next phase of options assessment was to review the landform with a view of further reducing the potential for final voids to occur and reducing the size and improving the design of any voids that are proposed to remain. It should be noted that this process utilises the same mining shell, equipment and mining schedule however varies the sequence, location and/or timing for overburden material emplacement.

A number of final void options and final landforms have been assessed over time. This report will focus discussion on seven of those cases, having been considered as reasonable options to explore with the other options considered similar iterations of those described below.

The assessments completed on the final void options discussed below have been completed at a concept level to determine their feasibility, key impacts and high level costs. The mine plan models of each option were developed to derive the incremental differences in costs of material moved or rehandled. This level of detail is considered sufficient to provide a relative comparison of each option to determine the proposed final void arrangements for the MCCO Project and to support the assessment in this report.

The assessment of economic differences in each mine plan option has primarily considered the truck haulage and rehandle costs associated with each option. Actual costs to implement each of the options may be greater than quoted depending on the timing of the work to be conducted and the degree of interaction with other mining and rehabilitation activities.

The costs quoted were calculated to provide an indication of economic feasibility and to differentiate between options and should not be considered to necessarily represent the total cost of each option.

The relative differences in costs, as discussed below, are presented as both the total cost (undiscounted) and the total net present cost (discounted at 4%).

A summary description of the seven cases considered is provided in **Table 1** and following, each case is discussed in further detail. The figures shown in each case below (unless stated otherwise elsewhere) is reflective of the landform at the completion of mining. Further work would then have to be completed to rehabilitate the landform to a "mine closure" standard (e.g. to establish a more natural looking landform consistent with the techniques used by Mangoola at the existing mine). It should also be noted that any dates or timeframes discussed are based on determination of the MCCO Project in mid-2020.

Case 1 for the purposes of this report is considered the baseline case as it reflects the most cost effective mining outcome. All other cases discussed are compared in a relative sense to this case.

Table 1: Summary of Final Void Cases

Case	Features
1.	**Baseline case – All Overburden emplaced in the MCCO Additional Mining Area** No overburden is transported from the MCCO Additional Mining Area into the existing approved mining area Reduced mining intensity applied in the MCCO Additional Mining Area Overburden is hauled to additional, larger and higher overburden dumps in the MCCO Additional Mining Area of approximately RL220 (vs. RL180 in the preferred case) and RL175 (additional dump to the preferred case). As this case is not supported no work has been completed to assess post mining rehandle of overburden into the void in the Additional Mining Area The void in the existing approved mining area is not improved when compared to that proposed with the MCCO Project
2.	**Initial Integrated Project Case** Haul approximately 50Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area for the purpose of establishing the approved final landform Reduced mining intensity applied in the MCCO Additional Mining Area Two final voids remain at the completion of operations Void in the existing approved mining area commensurate with the approved final landform however improved due to the application of natural landform design and shallower slopes on the low wall Void low walls in the MCCO Additional Mining Area shaped at the completion of mining Remaining high walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons
3.	**MCCO Project Case (as included in the EIS)** Refer to Case 2, with the addition of nominally 5Mbcm overburden rehandle at the completion of mining in the MCCO Additional Mining Area, to improve the overall shape and reduce the total void area
4.	**Non preferred case – One Void in the North** Haul minimum required (approximately 50Mbcm) plus an additional 33Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area for the purpose of filling the existing approved mining area void to approximately RL150 / RL160 Reduced mining intensity applied in the MCCO Additional Mining Area One final void remains at the completion of operations, being the void in the MCCO Additional Mining Area The void low walls are shaped at the completion of mining, however limited (if any) filling of the sharp looking ends post mining is completed, as there is insufficient overburden material to complete any further works (other than rehandling overburden already rehabilitated from the existing Mangoola Coal Mine)

Case	Features
	Remaining high walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons
5.	**Non preferred case – No Voids** Haul minimum required (approximately 50Mbcm) plus an additional 33Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area for the purpose of filling the existing approved mining area void to approximately RL150 / RL160 At the completion of coal extraction, remove approximately 100Mbcm from the existing rehabilitated mining area of the existing approved Mangoola Coal Mine to fill the MCCO Additional Mining Area void Disturbs approximately 394 hectares of existing rehabilitated land Approximate 4 year extension of site works post mining completion to rehandle the approximately 100Mbcm of material and associated additional rehabilitation with additional impacts Nil final voids remains at the completion of operations. Pre-mining topography is unable to be achieved due to an overall net deficit of material. Remaining remnants of high walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons
6.	**Non preferred case – Partial fill of Final Voids** Haul minimum required (approximately 50Mbcm) plus an additional 6Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area for the purpose of partially filling the existing approved mining area void to approximately RL130 to establish a “depression” and an expectation that a pit water lake would still form Rehandle approximately 8Mbcm of overburden from the MCCO Additional Mining Area overburden emplacement dumps, post mining completion, to partially fill the void and therefore only reduce the depth in the MCCO Additional Mining Area void to approximately RL111 considering the available overburden material remaining on the emplacement dump Nominal 7 month extension of site works post mining completion to rehandle the approximately 8Mbcm of material and associated rehabilitation with additional impacts In this case, two partial final voids or depressions remain at the completion of operations, being a revised void or depression in the MCCO Project Additional Mining Area and in the existing approved mining area The void low walls are shaped at the completion of mining Remaining high walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons
7.	**Non preferred case – No MCCO Project Case** No MCCO Additional Mining Area case Mining completed at the end of mining in the existing approved mining area Mining is not carried out in the MCCO Additional Mining Area Proceeding with the MCCO Project will provide a range of economic and social benefits at local, regional and State levels. These benefits would not be realised should the MCCO Project not proceed and would result in the loss of: • ongoing employment opportunities for the Mangoola workforce of approximately 400 employees, rising to a peak of approximately 480

Case	Features
	• ongoing opportunities for local businesses and service providers • a net benefit to the Upper Hunter region of $92.6M in net present value terms • a net benefit of $408.6M to NSW over the life of the MCCO Project in present value terms • royalty revenue stream flowing to the NSW government estimated to be $121M over the life of the MCCO Project Not progressing with the MCCO Project would have some potential benefits to the local community and environment in terms of avoiding some of the impacts from mining. However, these potential benefits need to be balanced against the economic and social benefits of the MCCO Project. Further discussion in regard to the potential impacts and benefits is contained within the EIS The void in the existing approved mining area is not improved when compared to that proposed with the MCCO Project

4.4.2 Business Baseline (Case 1) - All Overburden emplaced in the MCCO Additional Mining Area

This case considers not transporting overburden from the MCCO Additional Mining Area into the existing approved mining area. Case 1 was considered the 'baseline' scenario of the MCCO Project which, for comparison purposes, as it reflects the most cost effective mining outcome however did not achieve the final landform objectives discussed in **Section 2.1**. In this case overburden would be hauled to an additional overburden emplacement area and result in larger and higher overburden emplacement areas in the MCCO Additional Mining Area of approximately RL200 (vs. RL180 as in the preferred case) and RL175 (being an additional overburden emplacement area to the preferred case). A conceptual Case 1 final landform is presented on **Figure 9**.

The final landform in the MCCO Additional Mining Area would consist of higher than Case 2 overburden emplacement areas which would elevate the noise, dust and visual profile of the mining operation in this area. The final landform visual aspect would be less than ideal when compared to the Case 2 final landform, with likely steep sided overburden emplacement walls (without significant rehandle of overburden), considering the base footprint is relatively small to fit the additional overburden into.

This case is considered the best value option as it is based on the relatively shorter truck cycle times for the MCCO Additional Mining Area to the overburden emplacement areas. However this case is not supported due to the anticipated greater impacts of noise, dust, visual profile and larger final voids at the completion of the mining operation.

For the purposes of this case there has been no assessment of rehandling overburden to reduce the size of the void in the MCCO Additional Mining Area.

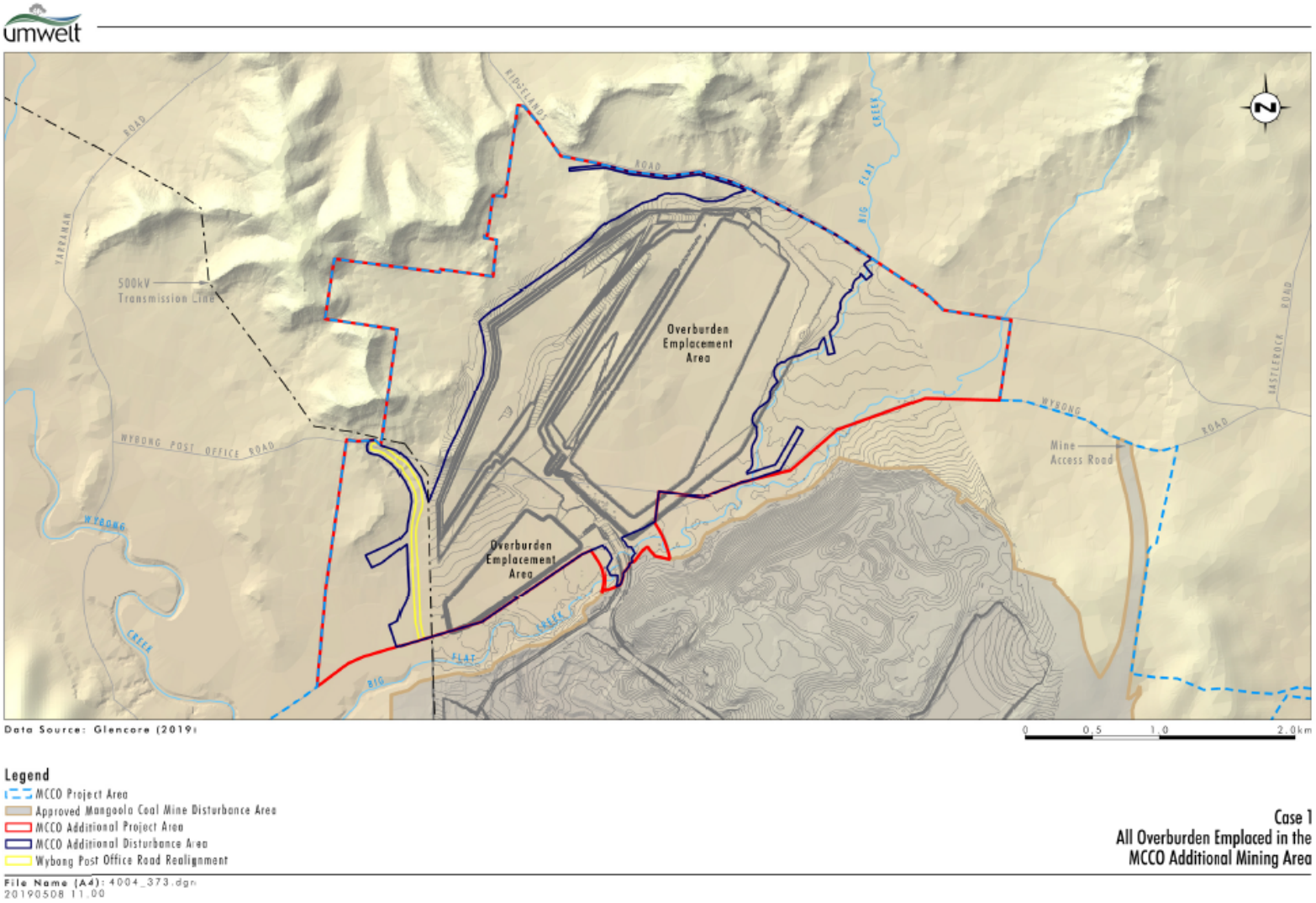

Figure 9: Case 1 – All Overburden emplaced in the MCCO Additional Mining Area

4.4.3 Case 2 – Initial Integrated Project Case

Case 2 was the first integrated project case developed in detail as part of the planning and design process and considers all constraints and assessed impacts with particular emphasis on noise, air quality, mining intensity, visual aspects and biodiversity.

As discussed in **Section 3**, the existing mining operations would transition from the existing approved mining area once the MCCO Project is approved and construction and preparation works are complete. Through the mining process over time, from the MCCO Additional Mining Area, approximately 50Mbcm of overburden would be trucked to the existing approved mining area for the purpose of establishing the final landform.

A reduced mining intensity has been applied in the MCCO Additional Mining Area in consideration of a reduction in noise impacts, with a reduced equipment fleet size relative to the existing mining operation south of Wybong Road. As stated above, two final voids remain at the completion of the Mangoola Coal operation. The void in the existing approved mining area would be commensurate with the approved final landform however improved due to the application of natural landform design and shallower slopes on the low wall and includes the commitment for the re-establishment of Anvil Creek as discussed in **Section 2.1**. Void low walls in both the existing approved mining area and the MCCO Additional Mining Area would be shaped at the completion of mining.

Remaining high walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons. This is dependent on any further geotechnical assessments or any further detailed exploration and geotechnical highwall stability studies as the operation nears the completion of mining and as the highwall is progressively exposed for inspection and assessment.

In addition the existing commitments regarding the establishment of the approved conceptual final landform are maintained including:

- re-establishment of Anvil Creek
- decommissioning/capping of the Tailings Decant Dam and TD4
- establishment of a rehabilitated landform using natural landform design principles and revegetation techniques

The incremental total cost commitment associated with Case 2 to Mangoola Coal is estimated at $53M. (The Net Present Cost is estimated at $30M when discounted at 4%).

This option would leave a larger and more angular void in the north of the MCCO Additional Mining Area as shown on **Figure 10** and resulting in an improved final void at the existing Mangoola Coal Mine due to the application of natural landform design and shallower slopes on the low wall.

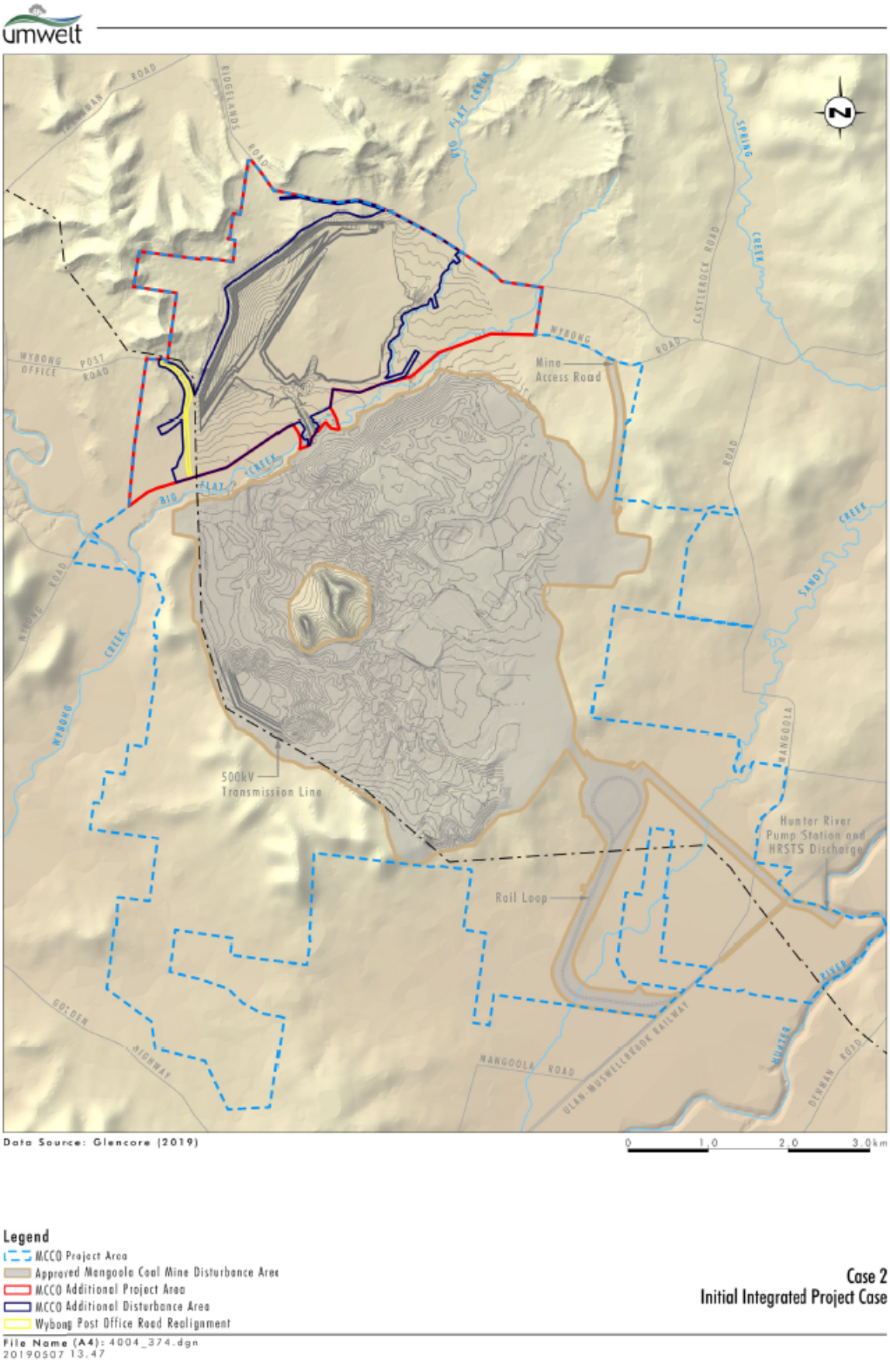

Figure 10: Case 2 – Initial Integrated Project Case

4.4.4 Case 3 - MCCO Project Case

Case 3 reflects the submitted EIS case contained with the Development Application. This option is the preferred MCCO Project case as described in Case 2 with the addition of overburden material rehandle at the completion of the coal mining extraction, in the MCCO Additional Mining Area. This case recognises the angular nature of the Case 2 final landform void, with the intent to remove and soften the sharp looking ends.

This case allows for the rehandle of approximately 5Mbcm of overburden from the adjacent MCCO Project overburden emplacement area post mining completion. The requirement to reclaim the 5Mbcm would continue the operation for approximately 6 months with a fleet size of one overburden excavator, associated truck fleet and associated support equipment such as dozers, graders and water carts and does not factor in rehabilitation timeframes.

The additional total cost to Mangoola Coal is estimated at $75M, including the rehandle of approximately 5Mbcm of overburden post mining and all aspects of Case 2. (The Net Present Cost is estimated at $44M when discounted at 4%).

All other aspects of this case are consistent with Case 2. The MCCO Project Case conceptual final landform is shown on **Figure 11**.

The MCCO Project EIS Case provides the following benefits:

- provides a balanced outcome that both achieves economic expectations whilst minimises the size of the final voids
- improves the visual appearance of the MCCO Project Additional Mining Area void by removing and softening the sharp looking ends
- achieves and improves upon the existing commitments regarding the establishment of the approved conceptual final landform including the re-establishment of Anvil Creek
- both voids act as a long-term groundwater sinks, capturing salt and avoiding impacts on surrounding water quality
- there will be limited public vantage points from which the remnant highwalls will be visible (particularly once vegetation has been established on adjacent areas)
- requires minimal (6 months) time to complete following the completion of coal extraction.

Based on the above the MCCO Project Case 3 was determined to be the preferred EIS case.

The conceptual final landform, as shown **Figure 11**, will predominantly consist of an undulating landform which has been designed to maintain consistency with the terrain in the local area and the existing established rehabilitation at the Mangoola Coal Mine. Further details regarding the key features of the final landform and rehabilitation strategy is discussed in the EIS.

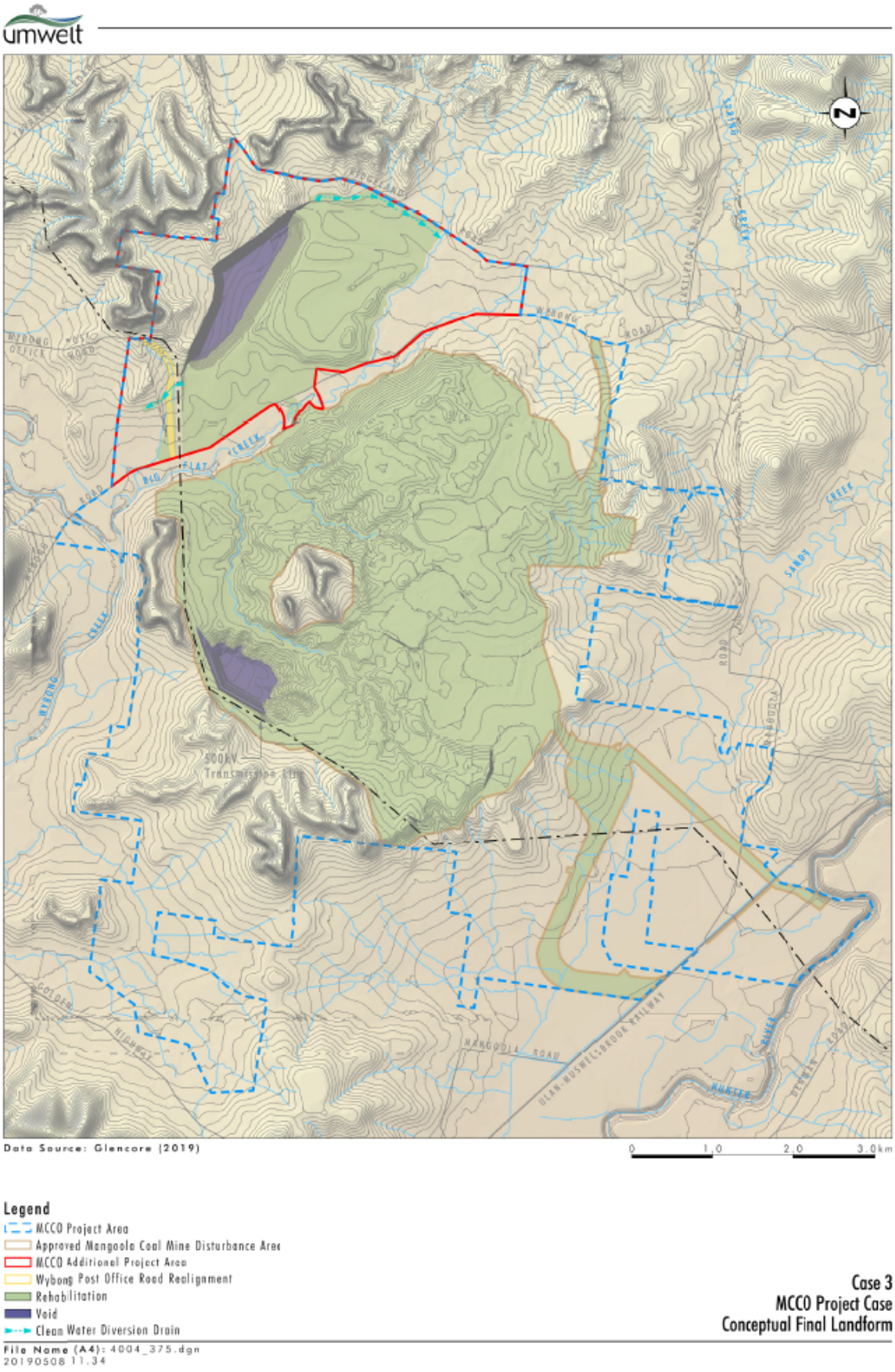

Figure 11: Case 3 – MCCO Project Case Conceptual Final Landform

4.4.5 Case 4 – Single Void in the MCCO Additional Mining Area / No Void in the Existing Approved Area

This case has been considered to assess the option of filling the existing approved mining area final void to a level consistent with the topography of an integrated rehabilitated landform and to maintain the existing approval commitment to re-establish Anvil Creek (see **Figure 12**).

As per Case 2 and 3 the minimum haul required of approximately 50Mbcm of overburden would be taken to the area surrounding the approved mining area final void, plus an additional 33Mbcm of overburden from the MCCO Additional Mining Area hauled as part of the mining process, which is then used to fill the existing approved mining area void to approximately RL150 to RL160, with RL150 the nominal elevation of Anvil Creek. Filling to RL150 would provide a landform level near to the rehabilitated topography level, with this level aimed at a free draining re-established Anvil Creek, noting that there will still be an exposed highwall at the completion of mining in this area. Again, remaining high walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons.

However the final void in the MCCO Additional Mining Area will not be able to have its ends softened as per Case 3 as there is insufficient overburden material remaining (above a free draining landform) to partially fill the ends of the void as per Case 3. The only way to achieve a final void as per Case 3 in the MCCO Additional Mining Area is to then rehandle overburden from the existing rehabilitated landform in the existing approved operation. This would then disturb a recognised industry leading rehabilitated site and result in additional cost, greater impacts and a potential poorer landform in the existing approved mining area where re-mining of some areas would be required.

Further to the above, the landform in the MCCO Additional Mining Area would form a generally flat landform as all overburden will be “in mine” dumping and aimed at enabling a free draining landform, with surface water movement away from the final void back towards Big Flat Creek.

Final exposed highwalls would be more visible due to the reduced shielding effect provided by the emplacement area in Case 3 (up to RL180).

In addition to the reasons discussed above, this case is not considered a preferred business case as it entails significantly greater trucking requirements early in the MCCO Project mine plan to fill the existing void.

The additional total haulage cost to Mangoola Coal is estimated at $114M (this does not include any rehandle associated with the northern void which would come at an additional cost). (The Net Present Cost is estimated at $65M when discounted at 4%).

For the above mentioned reasons Case 4 was determined not to be the preferred case.

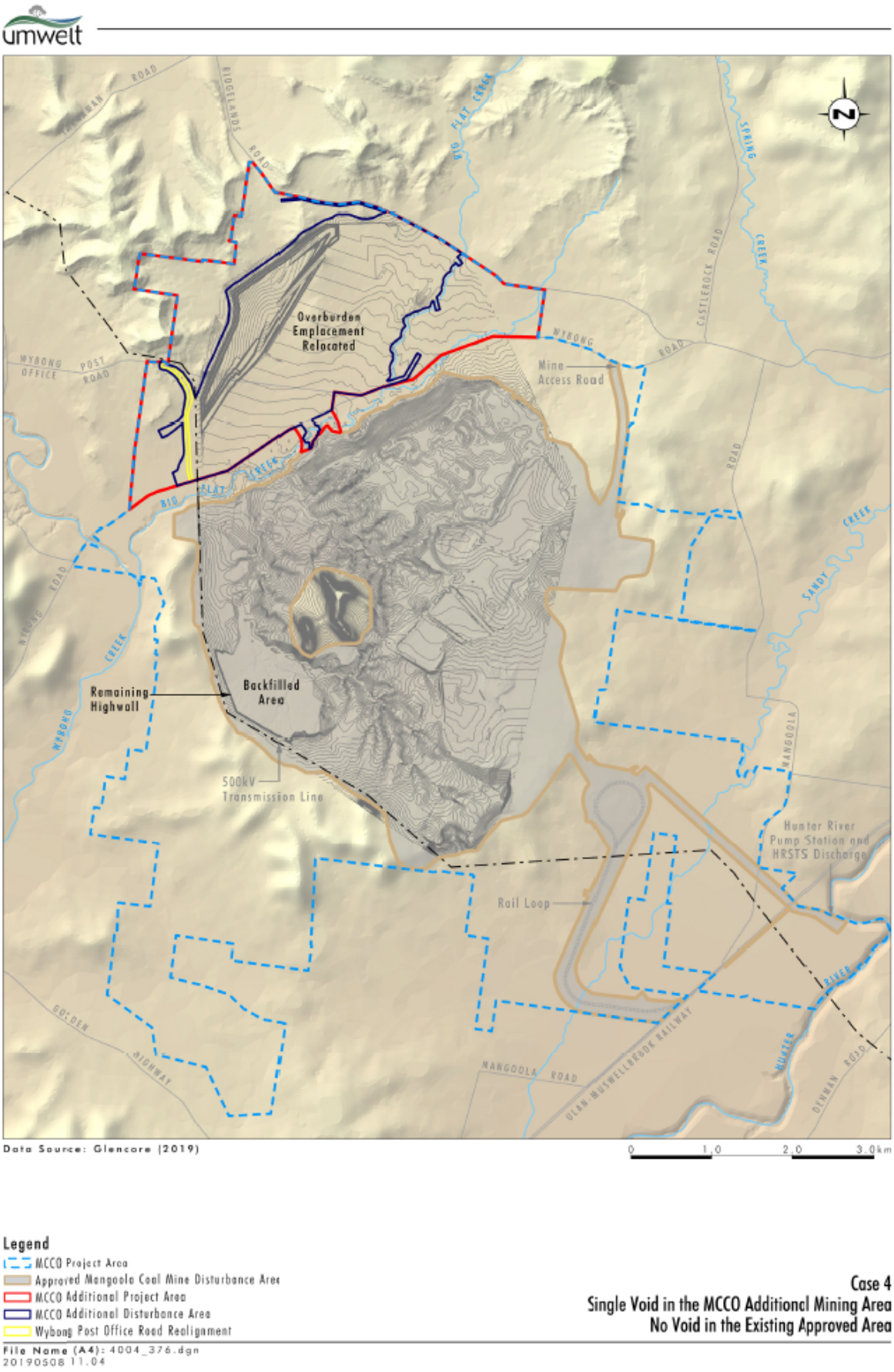

Figure 12: Case 4 – Single Void in the MCCO Additional Mining Area / No Void in the Existing Approved Area

4.4.6 Case 5 – No Voids

This case has been considered to address current stakeholder expectations and government direction including the *Improving Mine Rehabilitation in NSW Discussion Paper* (DPE, 2017) and requests for contemporary mining projects to demonstrate why all final voids cannot be filled with the aim of having no final voids in the final landform. As stated within this report it is not possible to reinstate the topography to pre mining levels across all previously mined areas, as following the extraction of coal there is a net deficit of overall material available.

In this case the mining schedule would be as per Case 4 whereby approximately 50Mbcm of overburden plus an additional 33Mbcm of overburden would be hauled from the MCCO Additional Mining Area to the existing approved mining area, for the purpose of filling the existing approved mining area void to approximately RL150/RL160.

At the completion of coal mining, the mine operations would continue and reclaim approximately 100Mbcm from the existing rehabilitated mining area, of the existing approved mine, to fill the MCCO Additional Mining Area void (see **Figure 13**). This would have a significant impact on the already rehabilitated areas of the existing approved mining area in the order of 394 hectares.

The requirement to reclaim the 100Mbcm would continue the operation for approximately 4 years with a fleet size of two overburden excavators, associated truck fleet and associated support equipment such as dozers, graders and water carts. For comparison purposes this is a similar fleet to that of the MCCO Project Case at the end of mining.

Any remaining remnants of high walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons.

The additional total cost to Mangoola Coal is estimated at $526M and the loss of economic value would see the MCCO Project not supported for execution. That is, the MCCO Project would not proceed. (The Net Present Cost is estimated at $317M when discounted at 4%).

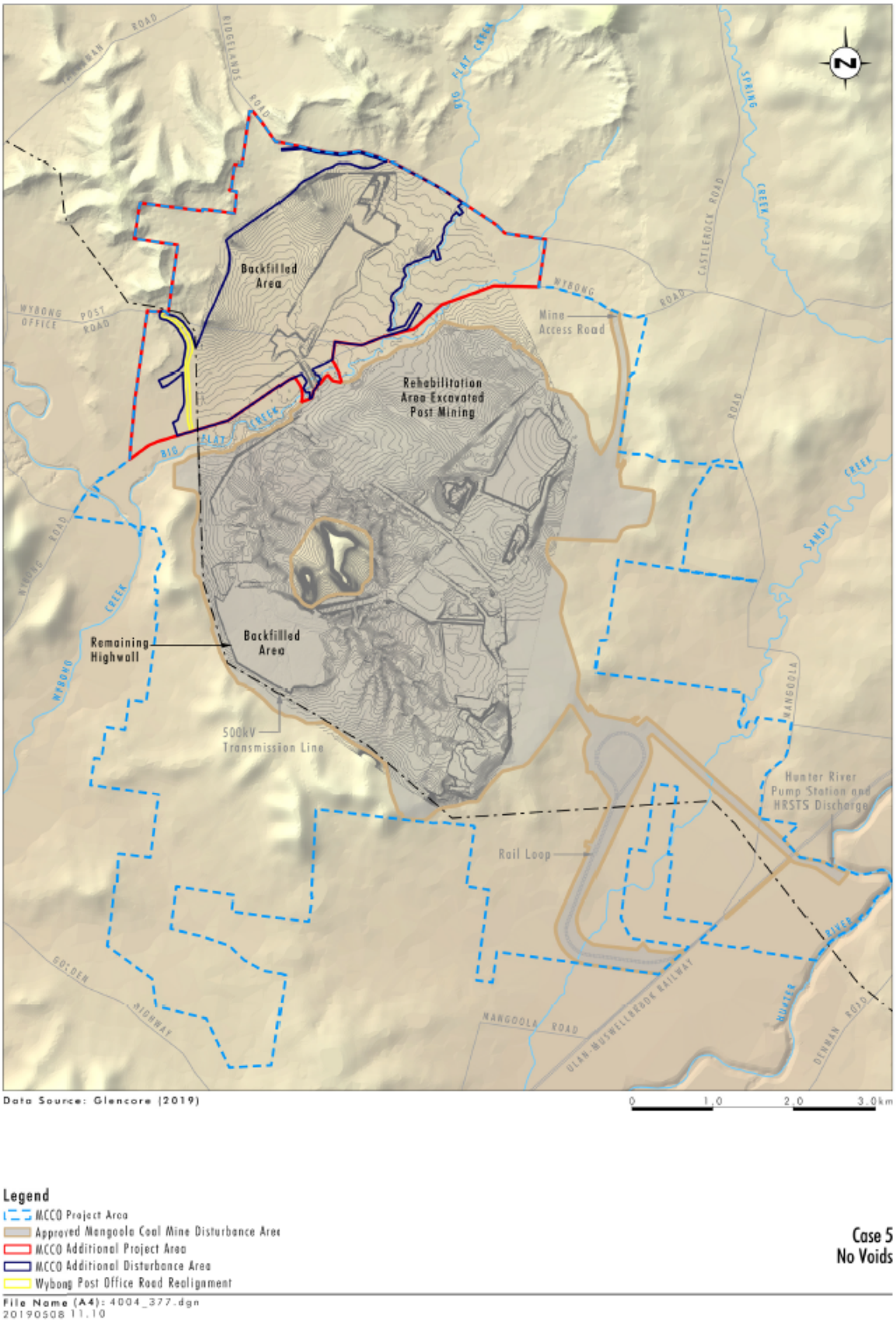

Figure 13: Case 5 – No Voids

4.4.7 Case 6 - Partial fill of Final Voids

This case was considered to represent a “mid-way” point between Case 3 and Case 5. In this case, overburden of approximately 50Mbcm, plus an additional 6Mbcm of overburden from the MCCO Project Additional Mining Area is hauled to the existing approved mining area for the purpose of partially filling the existing approved mining area void to approximately RL130. The aim of this case is to leave a depression rather than a void, with the intent maintained to re-establish Anvil Creek as per the existing conceptual final landform. There is an expectation that a water lake would still form within the depression, similar to a water lake in a “void” albeit at lower depth.

The case also assumes a rehandle of overburden from the out of pit overburden dump of the MCCO Additional Mining Area of approximately 8Mbcm into the void of the MCCO Additional Mining Area, post the completion of mining, to establish a floor level of nominally RL111 lifting the floor from the mined level of nominally RL85.

In this case two depressions/voids remain at the completion of operations, being a revised void or depression in the MCCO Additional Mining Area and in the existing approved mining area (see **Figure 14**).

Highwalls would remain in both cases and be treated as described in Case 3.

The requirement to reclaim the 8Mbcm would continue the operation for approximately 7 months with a fleet size of one overburden excavator, associated truck fleet and associated support equipment such as dozers, graders and water carts.

The void low walls are shaped at the completion of mining.

The additional cost to Mangoola Coal is estimated at $95M. (The Net Present Cost is estimated at $56M when discounted at 4%).

For the above mentioned reasons Case 6 was determined not to be the preferred case.

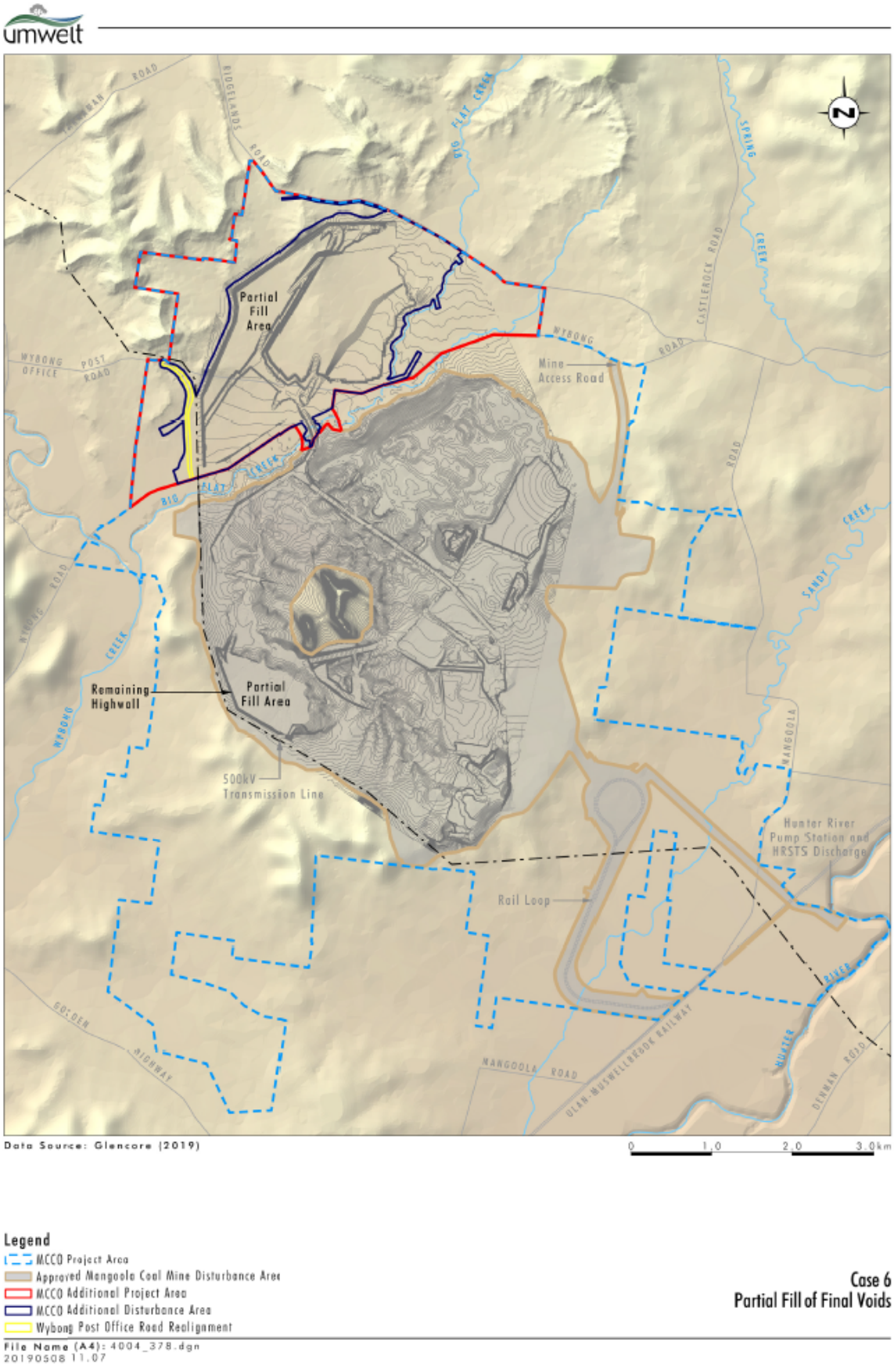

Figure 14: Case 6 – Partial Fill of Final Voids

4.4.9 Case 7 – No MCCO Project

This case considers no mining in the MCCO Additional Mining Area. The Mangoola Coal operation would cease at the end of mining in the existing approved mining area and this is currently forecast for 2025.

The reduction in mining in the existing approved mining area of ~1 year compared to the preferred case is based on maintaining the existing intensity of mining through to the end of mining, rather than decreasing the intensity as described in Cases 2 and 3 described above.

The earlier cessation of mining would result in the in the loss of:

- ongoing employment opportunities for the Mangoola workforce of approximately 400 employees, rising to a peak of approximately 480
- ongoing opportunities for local businesses and service providers
- a net benefit to the Upper Hunter region of $92.6M in net present value terms
- a net benefit of $408.6M to NSW over the life of the MCCO Project in present value terms
- royalty revenue stream flowing to the NSW government estimated to be $121M over the life of the MCCO Project.

Not progressing with the MCCO Project would have some potential benefits to the local community and environment in terms of avoiding some of the impacts from mining. However, these potential benefits need to be balanced against the economic and social benefits of the MCCO Project. Further discussion in regard to the potential impacts and benefits is contained within the EIS.

Should the MCCO Project not be approved, the Mangoola Coal operation would cease at the end of mining in the existing approved mining area in approximately 2025. The void in the existing approved mining area is not improved when compared to that proposed with the MCCO Project.

5 Final Void Options Assessment Outcome

A summary of the final void options that have been considered in this report and discussed above are presented in **Table 2**.

As discussed in **Section 4.4.1** all cost estimates provided in **Table 2** relate to the baseline cost of the MCCO Project and do not include all fixed costs (i.e. the costs to run the mine beyond the actual mining costs) and that actual costs to implement each of these options will be greater than quoted. The indicative costs and timeframes to complete each case relate incrementally to the 'baseline' scenario of the MCCO Project which, for comparison purposes, was considered to be Case 1 as it reflects the most cost effective mining outcome.

Table 2: Summary of Mine Plan Options Considered

Description	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Case Description	Business Baseline Case – All Overburden emplaced in the MCCO Additional Mining Area	Initial Integrated Project Case	MCCO Project Case (as included in the EIS)	Non preferred case – One Void in the North	Non preferred case – No Voids	Non preferred case – Partial fill of Final Voids	Non preferred case – No MCCO Project Case
Overburden Emplacement Strategy	Overburden is hauled to additional, larger and higher overburden dumps in the MCCO Additional Project Area of up to approximately RL220	Haul approximately 50Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area	As per Case 2 along with additional 5Mbcm rehandle to improve the overall shape and size of the void in the MCCO Additional Mining Area	As per Case 2 along with additional 33Mbcm of overburden from the MCCO Additional Mining Area to the existing approved mining area to fill the existing approved mining area void to approximately RL150 - RL160	As per Case 4 however at the completion of coal extraction, remove approximately 100Mbcm (394 ha) of established rehabilitation to fill the MCCO Additional Mining Area void.	As per Case 2 with an additional 6Mbcm from the MCCO Additional Mining Area to the existing approved mining area and rehandle approximately 8Mbcm of overburden from the MCCO Additional Mining Area	Mining continues as per current approved operations
Volume of Rehandle (Estimated Mbcm)	Nil	Nil	5	Nil	100	8	N/A
Number of Voids at completion of mining	2	2	2	1	0	2	1
Additional Time to complete	Nil	Nil	6 months	Nil	4.5 years	9 months	N/A
Indicative Total Cost (compared to baseline)	Baseline Costs	$53M	$75M	$114M	$526M	$95M	Economic benefits of the Project are lost

Table 3: Final Void Assessment Outcomes

Case Identification	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Void Options	**All Overburden emplaced in the MCCO Additional Mining Area**	**Initial Integrated Project Case**	**MCCO Project Case (as included in the EIS)**	**One Void in the North** **No void in the existing mining area**	**No Final Voids**	**Partial fill of Final Voids**	**No MCCO Project Case**
Reasonable & Feasible Mine Design?	Yes	Yes	Yes	Yes	No	Yes	-
Reasonable & Feasible Engineering Design?	Yes	Yes	Yes	Yes	No	Yes	-
Economically Feasible?	Yes	Yes	Yes	Possibly feasible	No	Feasible	No as the economic benefits of Project will be lost
Proposed	No	No	Yes	No	No	No	No
Comments	Most economical case however not proposed due to larger and higher emplacement areas in the MCCO Additional Mining Area, associated environmental impacts	Less costly than Case 3 however would result in a larger final void in the MCCO Additional Mining Area	The proposed final landform seeks to strike the balance between mine planning, economic, environmental and social outcomes	Unbalanced outcome	No perceived benefit	Not proposed as the total area of void doesn't reduce in line with the significant costs	Would result in the early closure of Mangoola Mine

** Option considered to address MSC input to SEARs*

6 Final Void Design

Mangoola takes a proactive approach to mine closure planning and has demonstrated and is recognised for the progressive implementation of rehabilitation works in conjunction with mining activity.

As discussed in this report, Mangoola has considered the option of not having voids as part of the MCCO Project and found that it is not economically feasible and in some aspects not sensible or practical.

Mangoola is committed to minimising risks to the community from any residual voids through effective mine planning and through the development of effective final void designs and the associated final landform and has committed to design final voids that are safe, stable and non-polluting.

Mangoola will consider the following factors throughout the life of the MCCO Project:

- the ongoing refinement of the life of mine plan to consider final void implications at each stage of planning
- there needs to be recognition that due to the dynamic nature of mining, mine plans may change through time in response to economic, geotechnical and environmental factors. As such, void positions/size/characteristics may change from that initially envisaged in the proposed mine plans, however, the design of the final voids in each mine plan iteration will meet acceptable outcomes
- final voids and rehabilitated mine sites need to consider opportunities for the economic diversification of an area following the cessation of mining and Mangoola will commit to considering such options should they arise as a part of the detailed mine closure planning process

These overarching commitments are further described as:

- Safe – associated with safe access and egress into voids by people and animals, and in the case of specific water quality issues, related to safe access and use of that water
- Stable – associated with the risk of geotechnical wall failures, slips and similar mass movement or high erosion rates
- Non-polluting – associated with geochemical risks and water quality impacts on important aquifers, creeks or surrounding ecosystems with the baseline and existing condition of the receiving waters to be considered when determining acceptable water quality standards
- Sustainable – associated with the ability to remain a stable system that supports some stabilising vegetation cover (where needed) and can satisfy the desired outcomes of safety, stability or that of not polluting into the future.

Mangoola has established design principles which will be applied to the final voids developed as part of the MCCO Project. These include:

- all final void rock slope angles will be determined by geotechnical investigations to ensure they are safe and stable
- within the void, the assumption is overburden (where feasible) will be placed against all exposed coal seams including those that will ultimately be covered by water within the void
- a safety berm will be established along the top of each highwall
- safety berms and associated drainage will be designed to prevent excessive runoff flowing over the face of the highwall
- the void slopes and highwall benches will be revegetated where practicable and appropriate
- the highwall benches will be revegetated with a suitable native vegetative mix using local species, where appropriate, above the predicted final void water level

As discussed in **Section 4.3** based on the MCCO Project (Case 3) landform the MCCO Project Surface Water Assessment (HEC 2019) has identified a pit lake will establish in the base of the final voids over time as shown on **Figure 11**. It is predicted that the long term water recovery levels forming a pit lake will reach approximately RL112 in the existing mining area and RL110 in the MCCO Additional Mining Area. When considering the final highwalls and the pit lake the total area considered final void is approximately 48 ha and 82 ha for the existing mining area and MCCO Additional Mining Area respectively.

There will be limited public vantage points from which the remnant highwall will be visible (particularly once vegetation has been established on adjacent areas). High walls may be selectively blasted and shaped for visual amenity and geotechnical stability reasons. This is dependent on any further geotechnical assessments or any further detailed exploration and geotechnical highwall stability studies as the operation nears the completion of mining and as the highwall is progressively exposed for inspection and assessment.

The design of the voids will be continually reviewed over the life of the mine as mining progresses in consideration of the above listed void design principles. The progressively updated final void and final landform designs will be provided in the MOP for the operation and will be subject to the approval of the department Division of Resources and Geoscience (DRG) or, if required, the relevant planning approval obtained.

7 Conclusion

Detailed concept and pre-feasibility mine design studies have been ongoing since 2014 for the MCCO Project to optimise the Project's final design. These studies identified potential mine design options, evaluating each option to identify the preferred mine design, with environmental and community impacts key considerations.

The outcome of these studies was the development of a preliminary MCCO Project mine plan which was further refined over time by a detailed iterative design and environmental constraints modelling and impact assessment process. This process resulted in the mine plan that is proposed and assessed in the MCCO Project EIS.

Once the mine plan for the MCCO Project was determined, further assessment was undertaken of final landform options, specifically related to final voids balancing the design inputs and expectations of mine voids. For Mangoola a key consideration in this assessment was the availability of overburden to backfill the mining area, both from a volume and sequencing perspective. The final landform studies focussed on the range of options that could be achieved in regard to final landform and considered economic, mine planning, geotechnical, environmental and social factors. The studies have defined the proposed final landform for the MCCO Project.

As part of the MCCO Project, as mining progresses, it is proposed to haul significant volumes of overburden south for emplacement in the mining void in the approved mining area, reducing the size of the final void that would otherwise occur and removal of an emplacement area shown in the MCCO Project PEA (Umwelt 2017). It is proposed that a second final void would occur in the proposed MCCO Additional Mining Area to the north of Wybong Road. After the completion of coal extraction in the MCCO Additional Mining Area, emplaced overburden would be rehandled and placed back into this void to reduce the size and improve the shape of the void.

While two final voids would remain, emplacing overburden in both void areas and within the voids, to reduce their size and improve the shape of each was determined by Mangoola to be the preferred case.

The options of backfilling one void or having no voids were assessed as part of the landform options studies. The option of backfilling both voids was found to be cost prohibitive and would result in the MCCO Project not proceeding. The option of backfilling one void (in the existing approved mining area) was achievable, however it would have resulted in a poorer landform outcome with a large and visually poorer outcome in the MCCO Additional Mining Area and is therefore not proposed.

The proposed final landform is more costly to achieve than other landform options that were viable, however it is considered by Mangoola to achieve an appropriately balanced outcome. The proposed final landform seeks to strike the balance between mine planning, economic, environmental and social outcomes.

8 References

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