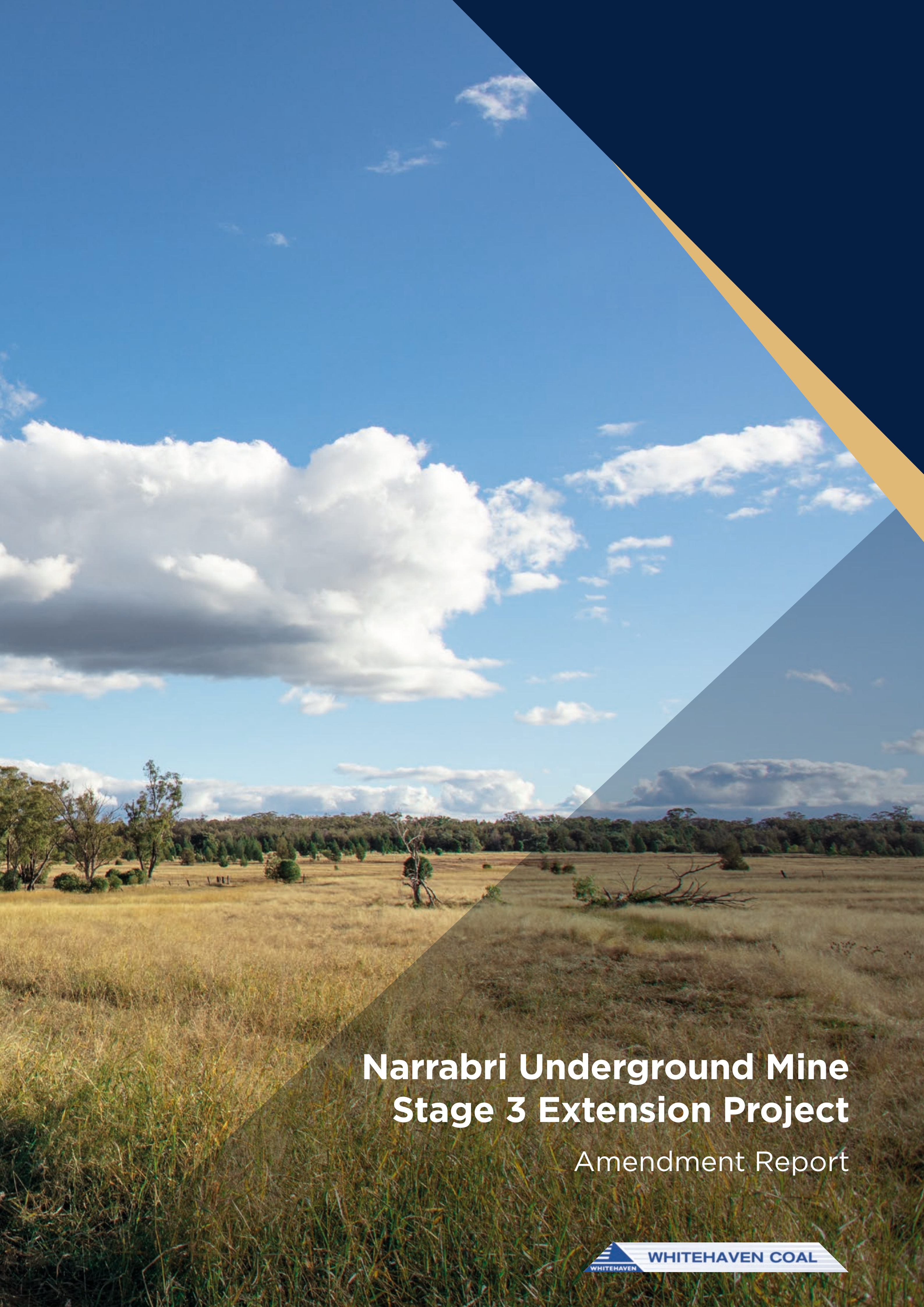


Narrabri Underground Mine Stage 3 Extension Project

Amendment Report

WHITEHAVEN COAL

EXECUTIVE SUMMARY

The Narrabri Underground Mine Stage 3 Extension Project (the Project) would involve a southern extension of the existing/approved underground mining areas at the Narrabri Mine to gain access to additional areas of run-of-mine (ROM) coal reserves within Mining Lease Applications (MLAs) 1 and 2, which are located within Exploration Licence (EL) 6243. This extension would also include an extension to the mine life, development of additional supporting infrastructure and continued use of existing infrastructure.

Narrabri Coal Operations Pty Ltd (NCOPL) is seeking development consent for the Project. NCOPL (2020) prepared the *Narrabri Underground Mine Stage 3 Extension Project Environmental Impact Statement* (the EIS) for the Project to support the assessment process under the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act).

The EIS was placed on public exhibition by the Department of Planning, Industry and Environment (DPIE) from 5 November 2020 to 16 December 2020. During this period, government agencies, organisations and members of the public were invited to provide submissions on the EIS to DPIE.

Since lodgement of the Project EIS, NCOPL has refined the Project design to reduce the environmental impacts of the Project and respond to particular comments raised in submissions on the EIS.

In summary, when compared to the EIS, the proposed amendments to the Project design would:

- remove some components of the indicative Surface Development Footprint that are no longer required by the revised Project design;
- incorporate flaring of pre-drainage gas in particular parts of the underground mining area which would reduce Scope 1 greenhouse gas emissions by approximately 1 percent compared to unabated emissions; and
- relocate some components of the indicative Surface Development Footprint to reduce impacts on Coolabah Bertya.

The changes to the indicative Surface Development Footprint presented in the EIS would reduce the overall surface disturbance by approximately 31 hectares, reduce impacts on threatened species, and reduce the Scope 1 greenhouse gas emissions by approximately 1 percent.

Therefore, the proposed amendments to the Project would result in a reduction in environmental impacts presented in the EIS. Accordingly, the conclusion in the EIS that, on balance, the Project has merit on the basis of the positive social and economic outcomes to the local region and NSW, remains unchanged.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

The Narrabri Mine is an existing underground coal mining operation situated in the Gunnedah Coalfield. The Narrabri Mine is located approximately 25 kilometres (km) south-east of Narrabri and approximately 60 km north-west of Gunnedah, within the Narrabri Shire Council (NSC) Local Government Area (LGA), in the North West Slopes and Plains region of New South Wales (NSW) (Figure 1).

The Narrabri Mine is operated by Narrabri Coal Operations Pty Ltd (NCOPL), on behalf of the Narrabri Mine Joint Venture, which consists of Whitehaven Coal Limited's (Whitehaven's) wholly owned subsidiaries Narrabri Coal Pty Ltd (NCPL) (70 per cent [%]) and Narrabri Coal Australia Pty Ltd (7.5%), Upper Horn Investments (Australia) Pty Ltd (7.5%), J-Power Australia Pty Limited (7.5%), Posco International Narrabri Investment Pty Ltd (5%) and Kores Narrabri Pty Limited (2.5%).

NCOPL (ABN 15 129 850 139) is the proponent for the Project. The contact details for NCOPL are:

Narrabri Coal Operations Pty Ltd
Locked Bag 1002
Narrabri NSW 2390
Phone: (02) 6794 4755

The Narrabri Mine is located at 10 Kurrajong Creek Road, Baan Baa, NSW, 2390.

Whitehaven is the parent company of NCPL, which has 70% ownership of NCOPL. Further information on Whitehaven and its mining operations can be found at:

http://www.whitehavencoal.com.au/

1.2 OVERVIEW OF THE PROJECT

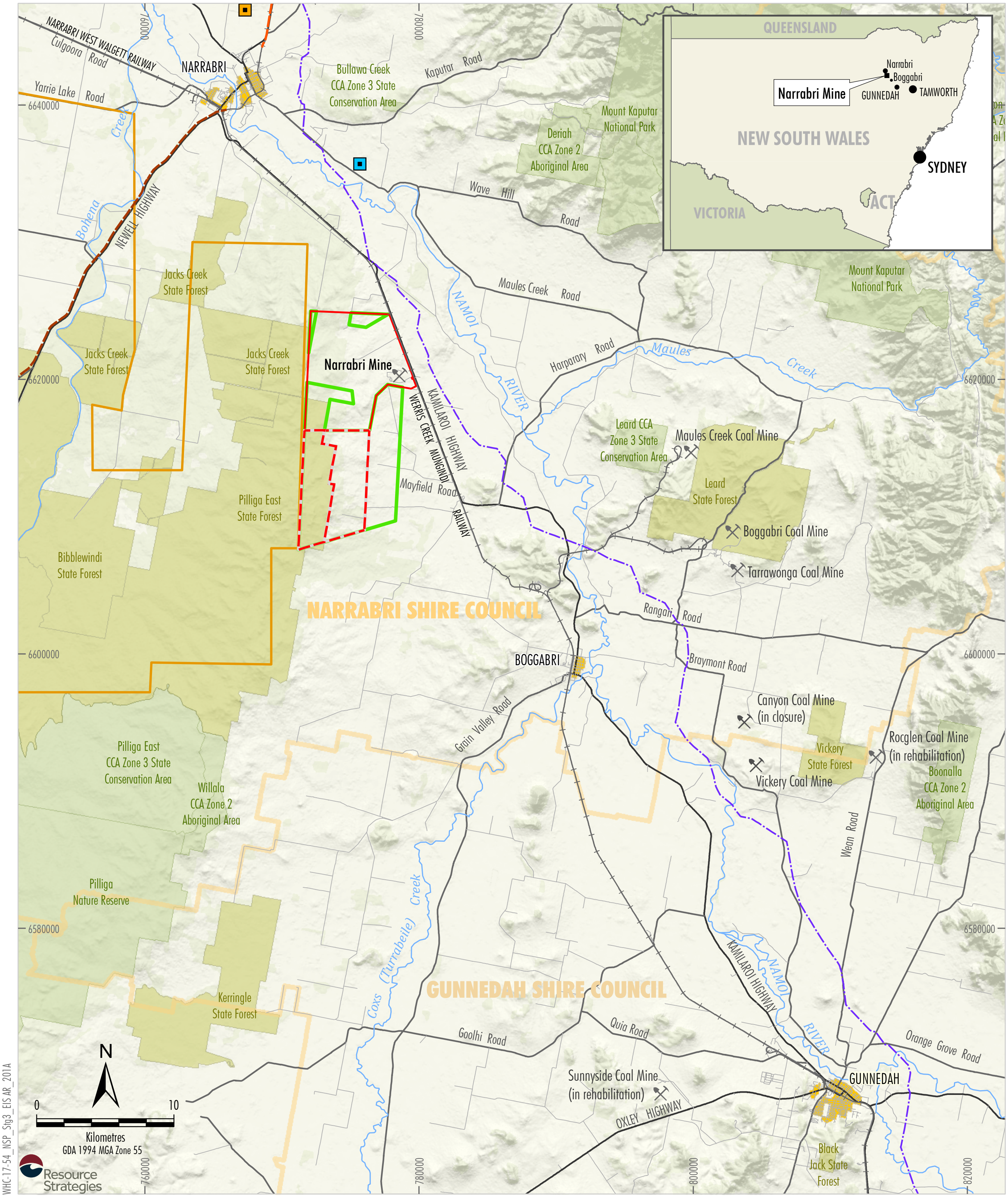
The Narrabri Underground Mine Stage 3 Extension Project (the Project) would involve a southern extension of the existing/approved underground mining areas at the Narrabri Mine to gain access to additional areas of run-of-mine (ROM) coal reserves within Mining Lease Applications (MLAs) 1 and 2 (Figure 2), which are located within Exploration Licence (EL) 6243. This extension would also include an extension to the mine life, development of additional supporting infrastructure and continued use of existing infrastructure.

1.3 PREVIOUS STEPS IN THE ASSESSMENT

NCOPL is seeking development consent for the Project. NCOPL (2020) prepared the Narrabri Underground Mine Stage 3 Extension Project Environmental Impact Statement (the EIS) for the Project to support the assessment process under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The EIS was placed on public exhibition by the Department of Planning, Industry and Environment (DPIE) from 5 November 2020 to 16 December 2020. During this period, government agencies, organisations and members of the public were invited to provide submissions on the EIS to DPIE.

NCOPL has prepared a Submissions Report which addresses the matters raised in the government agency, organisation and public submissions on the Project EIS.



LEGEND

- Mine Site
- Exploration Licence (EL 6243)
- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Local Government Boundary
- State Forest
- State Conservation Area, Aboriginal Area

Other Major Projects

- Narrabri South Solar Farm
- Proposed Silverleaf Solar Farm
- Narrabri Gas Project (Santos NSW [Eastern] Pty Ltd)
- Inland Rail (Narrabri to North Star - Phase 1)
- Proposed Inland Rail (Narromine to Narrabri)
- Queensland Hunter Gas Pipeline

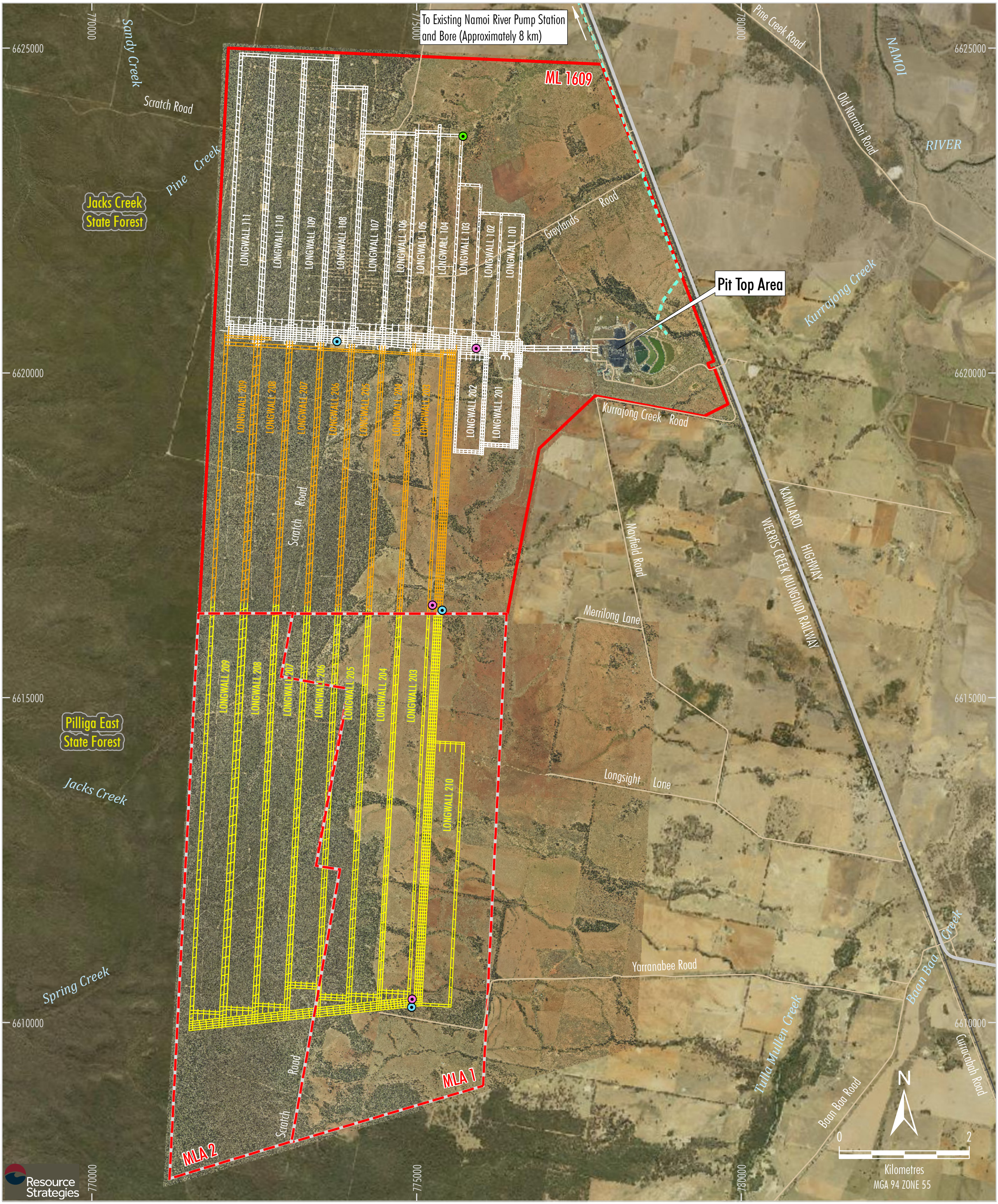
Source: Geoscience Australia (2011); NSW Spatial Services (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Regional Location

Figure 1



Source: NCOPL (2019); NSW Spatial Services (2019)

LEGEND

- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Existing Namoi River Pipeline (Buried)
- Approved Underground Mining Layout
- Indicative Underground Mining Layout to be Extended for Project
- Indicative Underground Project Mining Layout
- Indicative Ventilation Complex (Downcast)
- Indicative Ventilation Complex (Upcast)
- Indicative Ventilation Complex (Upcast - Decommissioned)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project General Arrangement - Indicative Underground Mining Layout

Figure 2

1.4 PROPOSED AMENDMENTS

Since lodgement of the Project EIS, NCOPL has refined the Project design to reduce the environmental impacts of the Project and respond to particular comments raised in submissions on the EIS.

In summary, when compared to the EIS, the proposed amendments to the Project design would:

- remove some components of the indicative Surface Development Footprint that are no longer required by the revised Project design;
- incorporate flaring of pre-drainage gas in particular parts of the underground mining area which would reduce Scope 1 greenhouse gas emissions by approximately 1 percent (%) compared to unabated emissions; and
- relocate some components of the indicative Surface Development Footprint to reduce impacts on Coolabah Bertya.

The changes to the indicative Surface Development Footprint presented in the EIS would reduce the overall surface disturbance by approximately 31 hectares (ha), reduce the impacts on threatened species, and reduce the Scope 1 greenhouse gas emissions by approximately 1%.

1.5 STRUCTURE OF THIS DOCUMENT

The Amendment Report has been prepared in consideration of the Exhibition Draft *Preparing an Amendment Report State Significant Development Guide* (DPIE, 2020b). The structure of the document is as follows:

Section 1	Provides an introduction to the Project, an overview of the planning process to date and the amendments to the Project presented in the EIS.
Section 2	Details the strategic context of the amended Project.
Section 3	Provides a detailed description of the proposed amendments.
Section 4	Details the statutory context of the amended Project.
Section 5	Describes the engagement undertaken in relation to the amended Project.
Section 6	Details the assessment of impacts of the amended Project.
Section 7	Describes the updated mitigation measures for the amended Project.
Section 8	Provides an evaluation of the amended Project merits.
Section 9	Lists the documents referenced in the Amendment Report.

2 STRATEGIC CONTEXT

2.1 REGIONAL STRATEGIC CONTEXT

The Project is located in the New England North West region of NSW, which comprises the following LGAs: Armidale Regional, Glen Innes Severn, Gunnedah, Gwydir, Inverell, Liverpool Plains, Moree Plains, Narrabri, Tamworth Regional, Tenterfield, Uralla and Walcha (Department of Planning and Environment [DP&E], 2017).

The region includes river valleys dominated by agricultural land uses and elevated vegetated country typically managed as State Forests and National Parks.

The region includes strong broadacre cropping and grazing sectors, and emerging intensive agriculture and food processing sectors. The key agricultural commodities produced in the region (by value) include beef cattle, cereal grains, cotton, poultry and wool (DP&E, 2017).

The region is also rich in a variety of other resources such as coal, coal seam gas (CSG) and other minerals (DP&E, 2017). The Gunnedah Coalfield is host to a number of major coal mine developments in the region.

The key population centres of the region include the two major regional centres of Armidale and Tamworth, and the five major towns of Narrabri, Gunnedah, Glen Innes, Inverell and Moree. These key population centres contain a number of industries and services ranging from professional services to manufacturing (DP&E, 2017).

The region is located between Sydney/Newcastle and Brisbane, which provide access to domestic and international markets and services. The existing road (e.g. Kamilaroi, Newell and New England Highways) and rail (e.g. Werris Creek Mungindi Railway) networks provide access from the region to these markets and services.

The regional strategic context of the Project, which includes the benefits of the Project to NSW and the local region relative to the Narrabri Mine, are provided in Section 3.1 of the Project EIS. The conclusions of Section 3.1 of the Project EIS are summarised above and remain unchanged for the amended Project.

2.2 PROJECT STRATEGIC CONTEXT

The Project is located approximately 25 kilometres (km) south-east of Narrabri and approximately 60 km north-west of Gunnedah (Figure 1). Baan Baa is located approximately 10 km to the south-east of the Pit Top Area and is the closest community to the Project.

Existing land uses in the vicinity of the Narrabri Mine are characterised by a combination of coal mining, agricultural enterprises, rural dwellings and forestry operations (Pilliga East and Jacks Creek State Forests).

The approved Narrabri Gas Project proposed by Santos NSW (Eastern) Pty Ltd will be located in the Gunnedah Basin approximately 20 km south-west of Narrabri (GHD, 2017), and is adjacent to the Project.

The Narrabri Mine is located to the immediate west of the Kamilaroi Highway and the Werris Creek Mungindi Railway (Figure 2). The Kamilaroi Highway provides road access to the Narrabri Mine, and product coal from the Narrabri Mine is transported via the Werris Creek Mungindi Railway to the Port of Newcastle for export.

The Project would involve the extension of the underground mining areas at the Narrabri Mine to gain access to additional areas of ROM coal reserves within MLAs 1 and 2 (Figure 2), which are located within EL 6243. This extension would also include additional mine life to 2044, development of additional supporting infrastructure and continued use of existing infrastructure.

The use of existing/approved Narrabri Mine infrastructure for the Project maximises the potential benefits of previous NCOPL investment and minimises the need for new surface development areas in comparison to a greenfield mine proposal.

In the absence of approval for the Project, this existing infrastructure would be decommissioned at the cessation of the approved Narrabri Mine and the potential benefits of its use would be forgone.

The strategic context of the Project, which includes the benefits of the Project to NSW and the local region relative to the Narrabri Mine, is provided in Section 3.2 of the EIS. The conclusions of Section 3.2 are summarised above and remain unchanged for the amended Project.

2.3 STRATEGIC PLANNING DOCUMENTS

Section 3 of the EIS also includes consideration of cumulative interaction with other projects, key engagement outcomes, the strategic need and potential benefits of the Project and various strategic planning documents and government policies in the context of the Project including:

- development control plans;
- *Strategic Statement on Coal Exploration and Mining in NSW* (NSW Government, 2020);
- *New England North West Regional Plan 2036* (DP&E, 2017);
- *Narrabri Shire Community Strategic Plan 2017 – 2027* (NSC, 2016);
- *North West Local Land Services – Local Strategic Plan 2016-2021* (North West Local Land Services, 2016);
- *Paris Agreement*;
- *NSW Climate Change Policy Framework* (NSW Office of Environment and Heritage [OEH], 2016);
- *Net Zero Plan Stage 1: 2020-2030* (DPIE, 2020a);
- NSW *Aquifer Interference Policy* (AIP) (DPI – Office of Water, 2012); and
- *Voluntary Land Acquisition and Mitigation Policy* (NSW Government, 2018).

The strategic context of the Project, which includes the benefits of the Project to NSW and the local region relative to the Narrabri Mine, are provided in Section 3 of the EIS. The conclusions of Section 3 of the EIS remain unchanged for the amended Project.

3 DESCRIPTION OF AMENDMENTS

3.1 OVERVIEW

Table 1 provides a summary of the amended Project compared to the Project as presented in the EIS.

Table 1
Project Summary Comparison Table

Project Component	Summary of the Project as Presented in the EIS	Summary of the Amended Project
Mining Method and Resource	▪ Longwall mining of the Hoskissons Coal Seam.	▪ Unchanged from the Project EIS.
Underground Mine Geometry	▪ Twenty-one longwall panels (Longwalls 101 to 111 and Longwalls 201 to 210). ▪ 295 metres (m) wide longwall panels for Longwalls 101 to 106. ▪ 400 m wide longwall panels for Longwalls 107 to 111 and Longwalls 201 to 209. ▪ 410 m wide longwall panel for Longwall 210.	▪ Unchanged from the Project EIS.
Tenements	▪ Mining operations conducted within Mining Lease (ML) 1609 and MLAs 1 and 2.	▪ Unchanged from the Project EIS.
Mine Life	▪ Mining operations until 2044.	▪ Unchanged from the Project EIS.
ROM Coal Production	▪ Total ROM coal production of approximately 252 million tonnes (Mt)*.	▪ Unchanged from the Project EIS.
ROM Coal Production Rate	▪ ROM coal production of up to 11 Mtpa.	▪ Unchanged from the Project EIS.
Underground Mine Surface Infrastructure	▪ Ventilation shafts, pre-drainage and post-drainage sites, mine safety pre-conditioning sites, access roads and electricity transmission lines.	▪ Types of underground mine surface infrastructure are unchanged from the Project EIS, however fewer infrastructure locations are required for the amended Project.
Underground Mine Access	▪ Via three drifts at the box cut.	▪ Unchanged from the Project EIS.
Coal Washing	▪ Continued use of existing facilities (e.g. Coal Handling and Preparation Plant and secondary crusher/screen), with replacement or upgrades of components as required.	▪ Unchanged from the Project EIS.
Coal Handling and Stockpiling	▪ ROM coal stockpile capacity of approximately 700,000 tonnes (t). ▪ Product coal stockpile capacity of approximately 500,000 t.	▪ Unchanged from the Project EIS.
Reject Management	▪ Coal rejects, exploration drilling waste from on-site and off-site placed in reject emplacement area.	▪ Unchanged from the Project EIS.
Product Coal Transport	▪ Product coal transported from site by rail. ▪ Average of four trains per day. ▪ Peak of eight trains per day.	▪ Unchanged from the Project EIS.

Table 1 (Continued)
Project Summary Comparison Table

Project Component	Summary of the Project as Presented in the EIS	Summary of the Amended Project
Water Management	▪ Conducted in accordance with the Water Management Plan (including discharge under the conditions of Environment Protection Licence [EPL] 12789 and Project Approval 08_0144). ▪ Development of Southern Mine Water Storage within MLA 1.	▪ Unchanged from the Project EIS.
Water Supply	▪ Make-up water demand to be met from mine dewatering, runoff recovered from operational areas, and licensed extraction from Namoi River and Namoi Alluvium.	▪ Unchanged from the Project EIS.
Power	▪ Permanent mains power supplied via a spur line from a 66 kilovolt (kV) powerline located to the east of Kamilaroi Highway. ▪ Power converted from 66 kV to 11 kV on-site and reticulated, using progressively developed 11 kV powerlines to service the underground mining area.	▪ Unchanged from the Project EIS.
Hours of Operation	▪ 24 hours per day, seven days per week.	▪ Unchanged from the Project EIS.
Employment	▪ Operational workforce (employees and contractors) of approximately 520 full-time equivalent personnel. ▪ Possible short-term increases in employment for development activities and development requirements.	▪ Unchanged from the Project EIS.
Site Access	▪ Primary access via a sealed mine access road connected to the Pit Top Area.	▪ Unchanged from the Project EIS.
Surface Development Footprint	▪ Approximately 640 ha of additional surface development footprint to support underground mining.	▪ Approximately 609 ha of additional surface development footprint to support underground mining (i.e. a reduction of 31 ha compared to the EIS).
Gas Management	▪ Gas currently vented to the atmosphere, however investigation of developments in flaring technology to determine if flaring is a viable gas management option would be undertaken.	▪ Generally unchanged, however, pre-drainage gas from the Hoskissons Coal Seam in some parts of the underground mine footprint (where the methane and gas content are sufficient and oxygen content permits safe flaring) would be flared to reduce greenhouse gas emissions.
Rehabilitation Strategy	▪ Conducted in accordance with the Mining Operations Plan (MOP).	▪ Unchanged from the Project EIS.
Capital Investment Value	▪ $404 million.	▪ Unchanged from the Project EIS.

* Based on current mine planning, the approved Narrabri Mine is expected to produce a total of approximately 145 Mt of ROM coal (i.e. approximately 25 Mt less than the approved limit of 170 Mt).

Note that the proposed amendments would not change or increase the following components of the Project:

- total ROM coal production (252 Mt);
- peak ROM coal production rate (i.e. 11 million tonnes per annum [Mtpa]);
- mine life;
- water management;
- water supply;
- hours of operation; or
- workforce.

The Project Description (Section 2 of the Project EIS) has been updated to incorporate the amendments described above and is provided as Appendix A.

3.2 AMENDMENT TO SURFACE DEVELOPMENT FOOTPRINT

Since the lodgement of the Project EIS, NCOPL has continued to review the Project design and has identified opportunities to reduce the indicative Surface Development Footprint. The reductions include removal of exploration and service boreholes that are no longer required, narrowing of some access tracks and post-drainage corridors (Figure 3) and amendments to reduce the Project's impact on Coolabah Bertya (a threatened plant species) (Figure 4).

The indicative Surface Development Footprint for the amended Project is presented in Figure 5.

3.2.1 Surface Development Footprint Reductions

Exploration Boreholes

Approximately 28 exploration boreholes presented in the EIS are no longer considered to be required where they were previously proposed within approximately 400 m of the main headings and the mine sequence allows for the main headings to be in place before the sampling is required (Figure 3). In these areas, NCOPL would sample gas via underground in-seam techniques rather than from the surface.

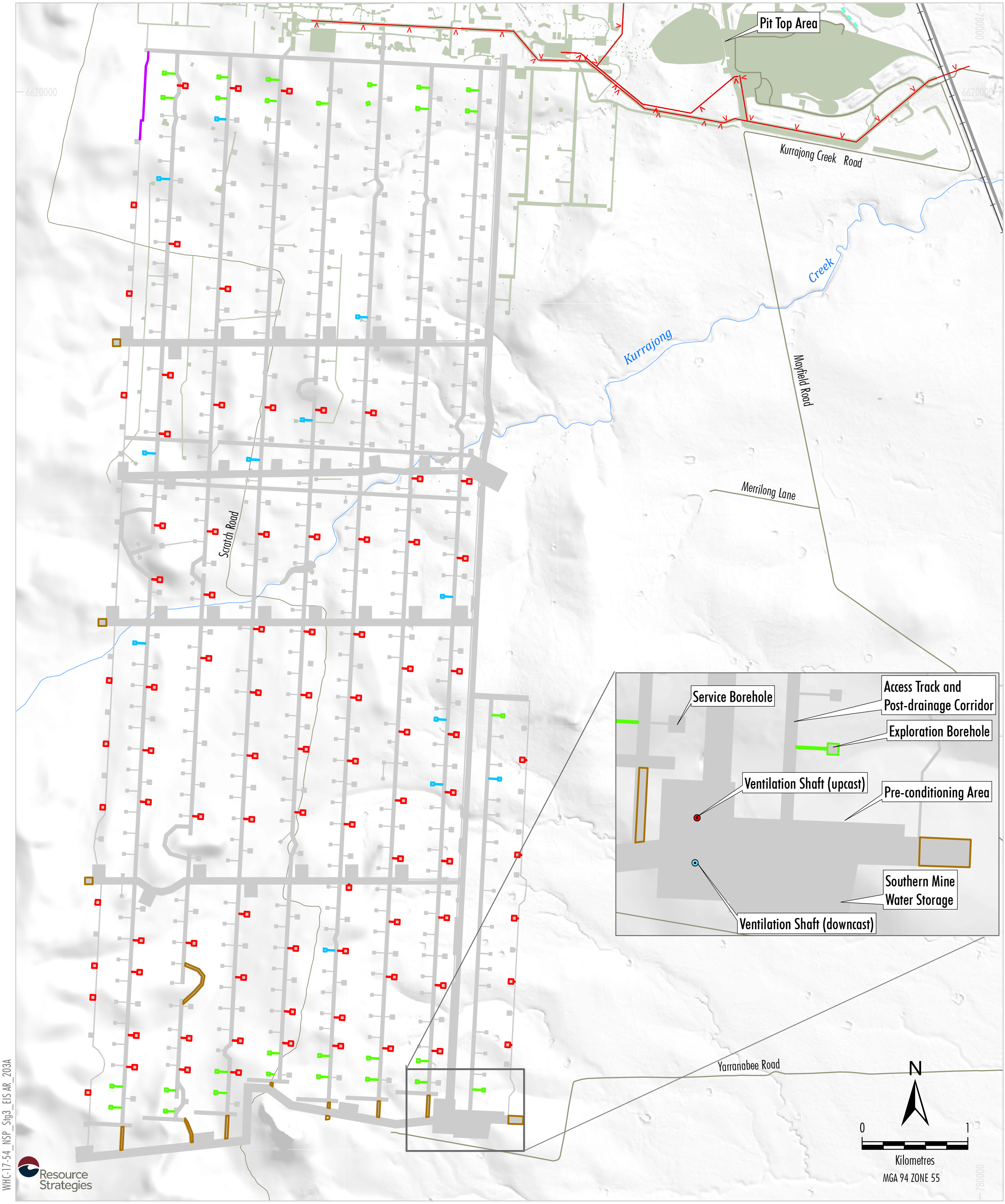
Approximately 12 exploration boreholes have also been removed as the analysis of exploration information from previous NCOPL exploration campaigns has been finalised. Where this additional exploration information was obtained from locations close to proposed exploration boreholes and therefore indicative of geological considerations at the proposed locations, NCOPL has removed the proposed boreholes.

The removal of the 40 exploration boreholes that are no longer considered to be required would reduce the indicative Surface Development Footprint by approximately 5 ha.

Service Boreholes

Additional gas management analysis undertaken by NCOPL has identified that in-seam gas volumes are expected to be lower in some areas compared with the estimates used for the Project design. NCOPL has confirmed that less pre-drainage underground in-seam drilling would be required to manage the gas volumes in some areas of the Narrabri Mine. The reduced pre-drainage drilling means that fewer service boreholes that connect the underground in-seam drilling to the surface are required. As a result, the number of service boreholes has been reduced substantially (i.e. by over 80 boreholes) (Figure 3) compared with the EIS.

The removal of the services boreholes that are no longer considered to be required would reduce the indicative Surface Development Footprint by approximately 19 ha.



LEGEND

- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Electricity Transmission Line (Constructed)
- Existing Namoi River Pipeline (Buried)
- Existing/Approved Surface Development
- Indicative Surface Development Footprint Presented in EIS

Amended Project

- Exploration Borehole - Removed as Sampling via Underground
- Exploration Borehole - Removed Due to Gas Data Finalisation
- Service Borehole - Removed Due to Low Gas Level
- Reduction in Width of Access Track and Post-drainage Corridor
- Access Track or Service Corridor Removed

Source: NCOPL (2019; 2021); NSW Spatial Services (2019); Unity Power Engineers (2021)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project General Arrangement - Indicative Surface Development Footprint - Amended Project Reductions

Figure 3

WHC-17-54_NSP_Stg3_EIS AR_206A

Resource Strategies

LEGEND

- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Electricity Transmission Line (Constructed)
- Existing Namoi River Pipeline (Buried)
- Existing/Approved Surface Development
- Indicative Surface Development Footprint Presented in EIS

Amended Project Coolabah Bertya Amendments

- Indicative Surface Development Footprint Amendment
- Indicative Surface Development Footprint Removed

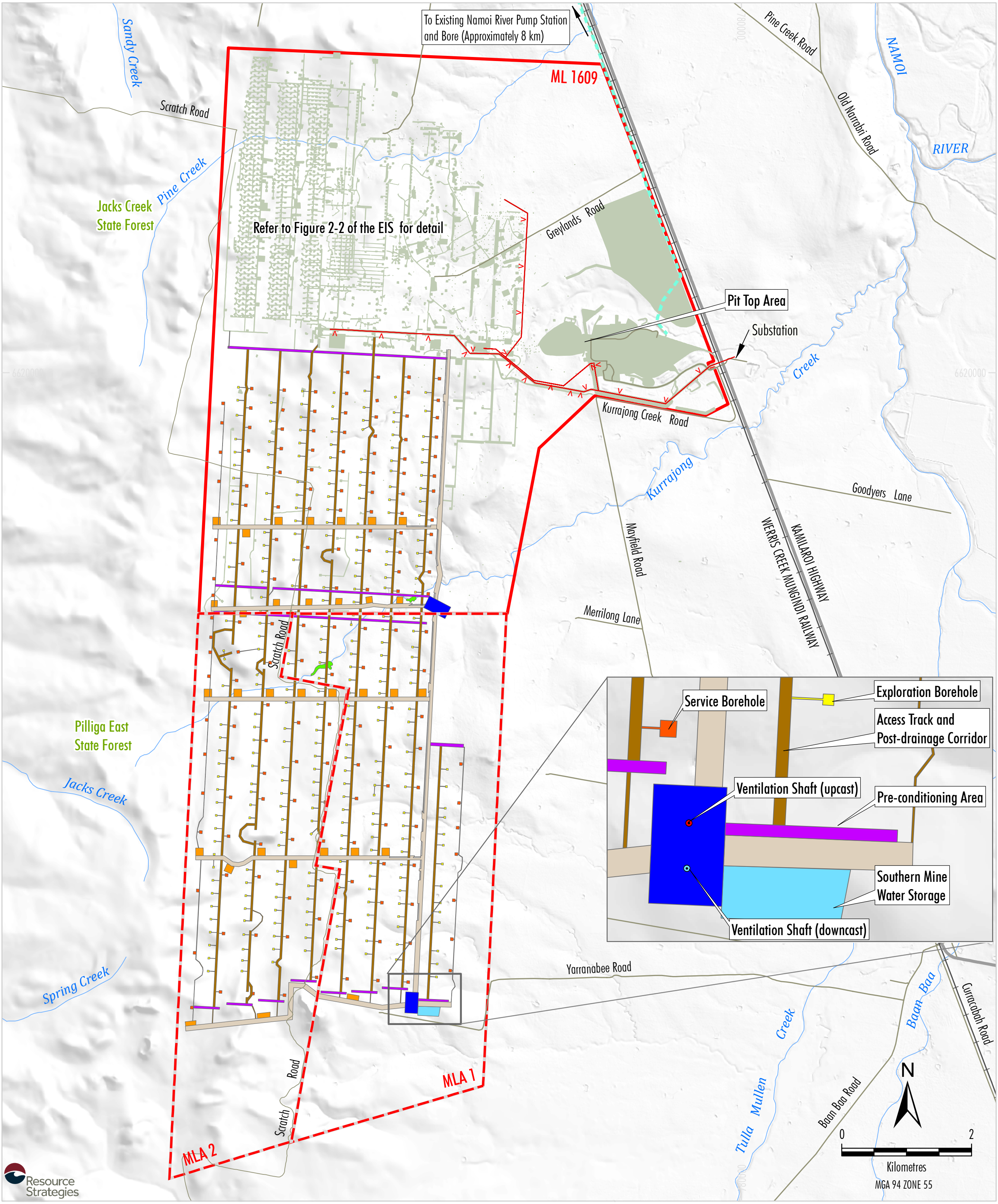
Source: NCOPL (2019; 2021); NSW Spatial Services (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project General Arrangement - Indicative Surface Development Footprint - Amended Project Reductions to Coolabah Bertya Impact

Figure 4



Source: NCOPL (2019; 2021); NSW Spatial Services (2019)

LEGEND

- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Electricity Transmission Line (Constructed)
- Existing Namoi River Pipeline (Buried)
- Existing/Approved Surface Development*
- Services Corridor
- Service Borehole
- Exploration Borehole
- Access Track and Post-drainage Corridor
- Pre-conditioning Area
- Service Borehole and Power Reticulation
- Southern Mine Water Storage
- Ventilation Complex
- Farm Dam Decommissioning Works

*Excludes the Impact Reduction Area (Refer to Figure 2-12 of the EIS)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Amended Project General Arrangement - Indicative Surface Development Footprint

Figure 5

Access Track and Post-drainage Corridor and Services Corridor

Clearing requirements for electricity transmission lines have been reduced based upon updated engineering design (Unity Power Engineers, 2021).

Portions of the access track and post-drainage corridors have been narrowed from approximately 30 m to 10 m where goaf gas drainage is not required (Figure 3).

NCOPL has narrowed post-drainage corridors located outside of the longwall blocks from approximately 30 m to 10 m as goaf gas drilling is no longer required within those areas (Figure 3) (i.e. access is still required to be maintained in these areas however drilling is not required).

3.2.2 Reduction in Coolabah Bertya Impact

NCOPL has revised the Project design to reduce the potential impacts on Coolabah Bertya (a threatened plant species). NCOPL also commissioned AMBS Ecology & Heritage (AMBS) to undertake further surveys of Coolabah Bertya to identify potential areas where infrastructure could be relocated to further avoid potential impacts on Coolabah Bertya.

The following amendments have been made to reduce potential impacts on Coolabah Bertya:

- the northern portion of the westernmost access track has been removed;
- two access tracks have been realigned; and
- a service borehole and exploration borehole have been relocated to reduce the impact to Coolabah Bertya.

The amended Project would reduce the proposed disturbance to Coolabah Bertya by approximately 2.3 ha compared to the Project EIS.

3.3 REDUCTION IN GREENHOUSE GAS EMISSIONS

3.3.1 Flaring of the Pre-drainage Gas

Low methane levels of approximately 5% methane have been encountered in the gas extracted from the Hoskissons Coal Seam at the Narrabri Mine to date (Palaris Australia Pty Ltd [Palaris], 2021a). As methane levels of greater than 30% are required to flare pre-drainage gas from the Hoskissons Coal Seam (Palaris, 2021a), pre-drainage gas has been vented directly to the atmosphere.

As described in Section 2.6.7 of the EIS, NCOPL committed to ongoing monitoring of gas volumes and composition and investigation of developments in flaring technology to determine whether flaring of pre-drainage and post-drainage gas is a viable option to reduce greenhouse gas emissions associated with the Project.

As part of ongoing Project design studies, Palaris has conducted a further review of the feasibility of flaring pre-drainage and post-drainage gas. As a result of the ongoing review of gas volumes and composition, Palaris (2021a) concluded that some areas of the underground mining area have methane content and gas composition levels which are suitable for flaring of the pre-drainage gas (Appendix B). Post-drainage gas was reviewed and it was identified that flaring of post-drainage was not possible due to the amount of oxygen within the gas stream being too high to safely flare (Palaris, 2021a). Accordingly, as part of the amended Project, NCOPL commits to flaring pre-drainage gas when the gas stream from the pre-drainage has a methane content of greater than 30%, and an oxygen content of less than 6%. Pre-drainage would only generally take place when the *in-situ* gas content of the Hoskissons Coal Seam is greater than 3.5 cubic metres per tonne of coal (m^3/t of coal) (Palaris, 2021a). The approximate areas within the underground mine where these gas conditions are expected to occur are shown on Figure 6.

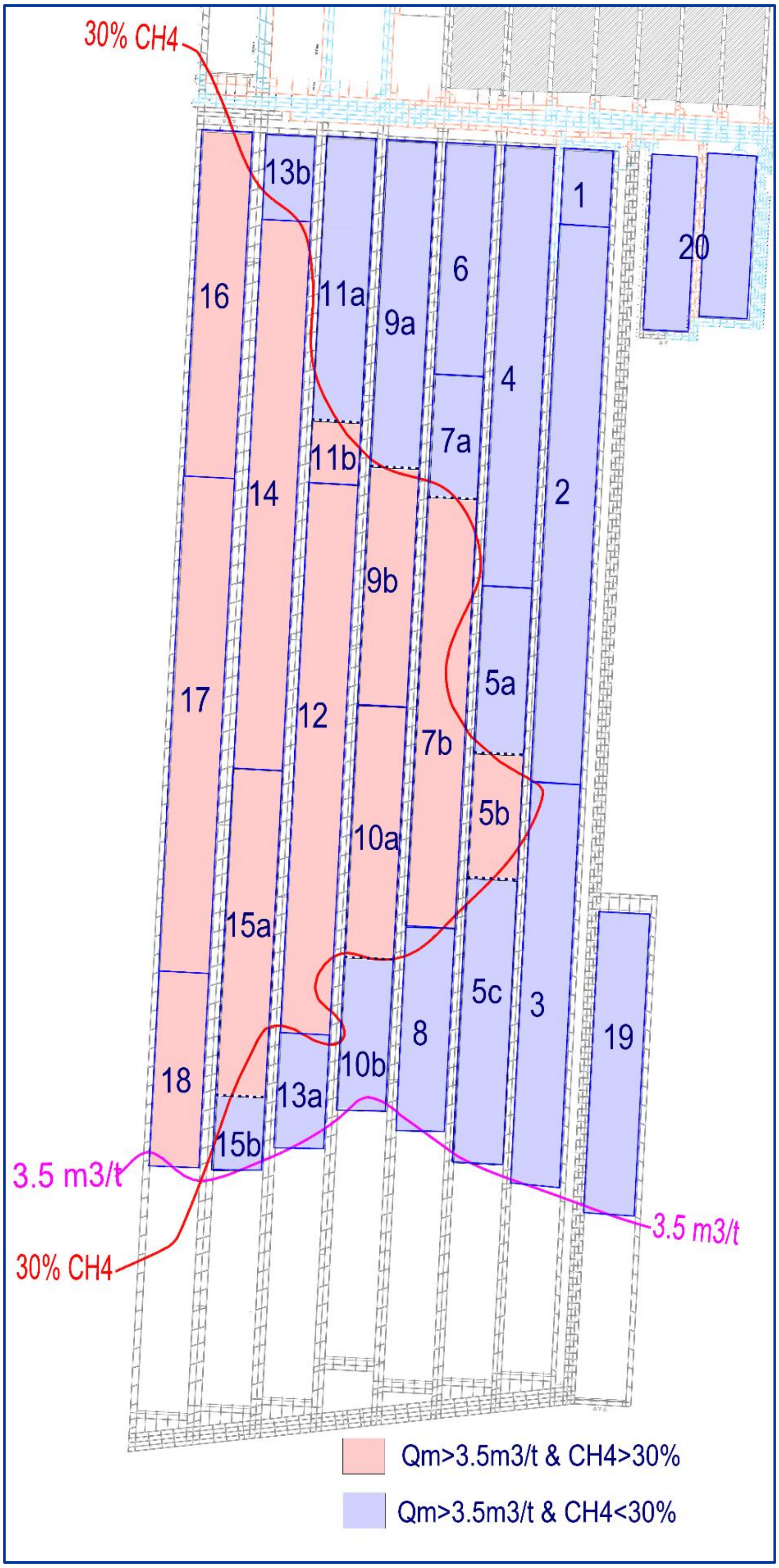


Figure 6
Pre-drainage Gas Zones (Source: Palaris [2021a])

Each flare is expected to be connected to a number of pre-drainage boreholes. Consequently, it is expected that up to approximately three flaring units could be in operation at any one time when mining within the areas where gas conditions support flaring (Palaris, 2021b).

Consistent with the Project EIS, flaring infrastructure would be constructed within the indicative Surface Development Footprint (Figure 5) (i.e. no additional disturbance to that presented for the amended Project would be required for flaring) and would be constructed via the enclosed flare method, which is described as (NSW Environment Protection Authority [EPA], 2015):

> *An enclosed flare surrounds the burner head with a refractory shell that is internally insulated. The shell helps to reduce noise, luminosity and heat radiation. Enclosed flares allow better combustion by maintaining temperature, air flow and more stable combustion conditions, maximising the conversion of methane to carbon.*

Gas monitoring systems would be implemented for the Project to monitor gas composition of the air in the underground workings (e.g. carbon dioxide [CO_2] and methane levels) to maintain a safe underground working environment.

Flaring infrastructure has been costed at approximately $2 million (M) of capital expenditures (CAPEX) and an operating expenditure (OPEX) of $0.3M per annum (or $5.6M over 12 years) (NCOPL pers comms, 2021).

A description of the greenhouse gas abatement that would be achieved by the proposed flaring is included in Section 6.3 and Appendix C.

3.3.2 Consideration of Alternative Greenhouse Gas Abatement Opportunities

NCOPL commissioned Palaris (2021b) to investigate the viability of alternative greenhouse gas abatement measures (other than flaring of pre-drainage gas) (Appendix D). Palaris (2021b) considered the following greenhouse gas abatement technologies:

- Ventilation Air Methane Abatement (VAM);
- VAM (partial flow);
- low gas concentration power generation; and
- methane gas enrichment (i.e. increasing the proportion of methane in the flaring stream).

Ventilation Air Methane Abatement

All underground mines use ventilation to ensure safe working conditions.

VAM is a greenhouse gas abatement measure typically used with low concentrations of methane. VAM greenhouse gas abatement can occur either by flaring or with power generation, however, at ventilation air concentrations of 0.2% to 0.5% methane (which is the case for the Project), it is economically and technically more efficient to install VAM without power generation (Palaris, 2021b).

The CAPEX of VAM is approximately $95M and the OPEX is approximately $9M per annum (Palaris, 2021b). NCOPL has assumed that two VAM units would be required at a CAPEX of $190M and operated over a seven year period (OPEX of $76M). The total estimated abatement is approximately 3 Mt of carbon dioxide equivalent (CO_2-e) over the life of the Project (NCOPL pers comms, 2021) (i.e. a reduction of approximately 9.6% of total Scope 1 emissions).

NCOPL does not consider the VAM abatement measure to be viable given the high CAPEX and OPEX costs and relatively low total abatement, however would continue to review the ability to utilise this abatement measure over the life of the Project.

Ventilation Air Methane Abatement (Partial Flow)

The VAM (partial flow) is similar to the VAM, however with a lower ventilation flow rate compared to VAM (500 m^3/s flow rate for VAM per VAM unit and 125 m^3/s for VAM [partial flow] per VAM unit).

The CAPEX of VAM (partial flow) is approximately $32M and the OPEX is approximately $2.5M per annum (Palaris, 2021b). NCOPL has assumed that two VAM units would be required at a CAPEX of approximately $64M and operated over a seven year period (OPEX of approximately $24M). The estimated abatement would be approximately 0.758 Mt of CO_2-e over the life of the Project (NCOPL pers comms, 2021) (i.e. a reduction of approximately 2.2% of total Scope 1 emissions).

NCOPL does not consider the VAM (partial flow) abatement measure to be viable given the high CAPEX and OPEX costs, however would continue to review the ability to utilise this abatement measure over the life of the Project.

Gas Enrichment with Flaring

Gas enrichment with flaring diverts more methane into the flaring stream by stripping other waste gases. The CAPEX of gas enrichment with flaring is approximately $15M and the OPEX is approximately $2M per annum (Palaris, 2021b).

There is a high level of unknown operational risk associated with gas enrichment plants as there are no plants which are currently operating in the Australian coal industry (NCOPL pers comms, 2021). Notwithstanding, NCOPL would continue to review the ability to utilise gas enrichment over the life of the Project.

Low Gas Concentration Power Generation

Where the methane content in the pre-drainage gas is high enough (over 25%) the methane can be used for power generation.

Given that the period of time of mining where the gas content is suitable for gas generation (above 25% methane) is short, the costs associated with a power station would not be viable in consideration of the potential payback benefit (Palaris, 2021b).

Solar Power

NCOPL is currently investigating the use of solar power for specific site applications (e.g. pumps and gas drainage mobile extraction units). This may lead to a reduction in Scope 2 greenhouse gas emissions (i.e. emissions associated with power generation), should these investigations lead to solar being used instead of diesel or off-site generated power.

3.3.3 Research Program

In addition to the above, given Scope 1 emissions are forecast to generally increase over the life of the Project (i.e. to a peak in 2040 [Jacobs, 2021]), NCOPL would prepare and implement a Research Program for the Project to the satisfaction of the Secretary, and allocate funds towards the implementation of the program. This program would:

(a) be prepared in consultation with DPIE:

(b) be submitted to the Secretary for approval within three years of approval of the Project;

(c) be targeted at genuine research, as opposed to implementing the matters required by the Project; and

(d) be directed at encouraging research into improving the abatement of direct Scope 1 greenhouse gas emissions by:

- enrichment of methane content in gas streams to be burnt by flares (i.e. by stripping methane from waste streams);
- flaring or power generation of gas with low methane content (less than 30% methane);
- use of VAM at relatively low methane contents (0.2% to 0.5% methane);
- capture of carbon dioxide for beneficial re-use or sequestration; and
- other potential abatement options that may be identified.

4 STATUTORY CONTEXT

The statutory approvals required for the Project, as outlined in Section 4 and Attachment 7 of the EIS, are unchanged by the proposed amendments to the Project. In light of the proposed amendments to the Project, certain requirements of the *Biodiversity Conservation Act 2016* (BC Act), *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) and *State Environmental Planning Policy (Koala Habitat Protection) 2020* (2020 Koala Habitat Protection SEPP) are addressed in the sub-sections below.

An updated statutory compliance table for the amended Project is provided in Appendix E.

4.1 BIODIVERSITY CONSERVATION ACT 2016

The BC Act provides the legislative framework for biodiversity conservation in NSW.

Section 7.9 of the BC Act provides that an application for development consent under Part 4 of the EP&A Act for State Significant Development (SSD) must be accompanied by a Biodiversity Development Assessment Report (BDAR) unless it is determined that the proposed development is not likely to have any significant impact on biodiversity values.

A BDAR was prepared and submitted in support of the Project EIS. As the amended Project would change the indicative Surface Development Footprint presented in the Project EIS, the BDAR will be modified pursuant to section 6.14 of the BC Act and the modified BDAR will be submitted to DPIE.

4.2 STATE ENVIRONMENTAL PLANNING POLICY (MINING, PETROLEUM PRODUCTION AND EXTRACTIVE INDUSTRIES) 2007

The Mining SEPP regulates mining development in NSW.

Clauses 2, 7, 12AB to 17 and 17B of the Mining SEPP were considered in the Project EIS. Further to this commentary, clause 14 of the Mining SEPP is reconsidered below in light of the amendments to the Project.

4.2.1 Clause 14

Clause 14(1) of the Mining SEPP requires that, before granting consent for development for the purposes of mining, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following:

> *(a) that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable,*
>
> *(b) that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable,*
>
> *(c) that greenhouse gas emissions are minimised to the greatest extent practicable.*

In addition, clause 14(2) requires that, without limiting subclause (1), in determining a development application for development for the purposes of mining:

> *…the consent authority must consider an assessment of the greenhouse gas emissions (including downstream emissions) of the development, and must do so having regard to any applicable State or national policies, programs or guidelines concerning greenhouse gas emissions.*

The potential impacts of the Project on groundwater and surface water resources are discussed in Sections 6.4 and 6.5 of the EIS and Appendices B and C of the EIS, including measures to minimise potential impacts. The potential impacts on groundwater and surface water resources are generally unchanged for the amended Project.

The amended Project would result in reduced potential biodiversity impacts (because of the reduced surface disturbance). The revised potential impacts of the amended Project on threatened species and biodiversity will be described in the modified BDAR, including measures to minimise potential impacts. The modified BDAR will also include a biodiversity offset strategy that has been developed in consideration of the requirements of the BC Act.

Because of the commitment to flare pre-drainage gas, the amended Project would result in fewer Scope 1 (direct) greenhouse gas emissions. The amended Project's greenhouse gas emissions and greenhouse gas abatement measures are described in Section 6.3 and Appendix D. This demonstrates that the Scope 1 greenhouse gas emissions of the Project have been minimised to the greatest extent practicable (based on the existing knowledge of gas quantity and content).

Accordingly, the Minster or Independent Planning Commission (IPC) can be satisfied as to these matters.

4.3 STATE ENVIRONMENTAL PLANNING POLICY (KOALA HABITAT PROTECTION) 2020

State Environmental Planning Policy (Koala Habitat Protection) 2019, which was considered in the Project EIS, was repealed by the 2020 Koala Habitat Protection SEPP on 30 November 2020.

The 2020 Koala Habitat Protection SEPP currently applies to land within the Narrabri LGA which is zoned as RU1 Primary Production, RU2 Rural Landscape and RU3 Forestry (Zones RU1 and RU3 are the relevant zones for the Project): clause 5. The other current Koala Habitat Protection SEPP, *State Environmental Planning Policy (Koala Habitat Protection) 2021*, does not apply to such land (and also does not apply with respect to a development application made in relation to land, but not finally determined before *State Environmental Planning Policy (Koala Habitat Protection) 2021* applied to the land).

The aims of the 2020 Koala Habitat Protection SEPP are as follows:

> *This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline—*
>
> *(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and*
>
> *(b) by encouraging the identification of areas of core koala habitat, and*
>
> *(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones.*

Most relevantly, Part 2 of the 2020 Koala Habitat Protection SEPP provides for development controls relating to Koala habitats. Clause 7 states that Part 2 applies to land:

> *(a) that is land to which this Policy applies, and*
>
> *(b) that is land in relation to which a development application has been made, and*
>
> *(c) that, whether or not the development application applies to the whole, or only part, of the land—*
>
> > *(i) has an area of more than 1 hectare, or*
> >
> > *(ii) has, together with adjoining land in the same ownership, an area of more than 1 hectare.*

Clauses 8 to 10 in Part 2 establish three steps which condition the power of a local council to grant development consent for development on land to which Part 2 applies (clause 11 also requires a local council to take certain guidelines into consideration).

Since the Project is SSD under the EP&A Act, the Minister or IPC is the consent authority rather than the local council. Notwithstanding, Part 2 does not apply in circumstances where the consent authority is the Minister or IPC, an updated assessment of Koala habitat which has regard to the 2020 Koala Habitat Protection SEPP will be included in the modified BDAR.

5 ENGAGEMENT

Since the lodgement of the EIS, NCOPL has continued to engage with key stakeholders, including government agencies, local organisations and community members regarding the Project.

5.1 RELEVANT GOVERNMENT AGENCIES

NCOPL has continued to consult with DPIE regarding the Project. DPIE officers visited the Narrabri Mine for a site visit on 24 February 2021. On 5 May 2021, NCOPL hosted a videoconference with DPIE to discuss various components of the Project, including the proposed amendments described in this report.

NCOPL consulted with the BCS on 13 May 2021 regarding the reduction of impact on the Coolabah Bertya, as part of the BCS's site visit to the Narrabri Mine.

NCOPL continues to consult with relevant NSW State Government agencies on a regular basis in relation to the Project and the current operations at the Narrabri Mine.

5.2 OTHER RELEVANT STAKEHOLDERS

A Project update flyer, which provides an update on the Project, will be distributed to members of the public in early June 2021. A separate flyer will describe the potential impacts of the Project on groundwater resources.

5.3 OTHER PROJECT CONSULTATION

Since lodgement of the EIS, NCOPL has undertaken the various engagement regarding the Project, including:

- consulting with relevant government agencies, including DPIE, BCS, DPIE-Water and Forestry Corporation of NSW;
- consulting with relevant councils including the Narrabri Shire Council and Gunnedah Shire Council;
- consulting with nearby landholders directly;
- hosting a 'drop in' session which gave the public an opportunity to discuss the outcomes presented in the EIS;
- providing an update on the Project at two Community Consultative Committee meetings; and
- notified the public of EIS exhibition in four newspapers.

Further detail regarding engagement activities since lodgement of the Project EIS is provided in the Submissions Report.

6 ASSESSMENT OF IMPACTS

6.1 IDENTIFICATION OF ISSUES

NCOPL has undertaken a review of the potential environmental impacts of the amended Project to identify key potential environmental issues requiring additional assessment compared to the impacts presented in the EIS.

The key environmental issues identified are summarised in Table 2 and addressed in Sections 6.2 to 6.4 and Appendix C.

Table 2
Summary of Key Potential Environmental Issues/Impacts of the Amended Project

Environmental Aspect	Key Potential Environmental Issues/Impacts	Section Addressed
Biodiversity	A reduction in the indicative Surface Development Footprint for the amended Project and further avoidance of Coolabah Bertya has resulted in a reduction in biodiversity impacts. A modified BDAR is being prepared to reflect the amended Project.	Sections 4.1 and 6.2
Greenhouse Gas	The potential changes in greenhouse gas emissions as a result of the amended Project, including consideration of the reduced greenhouse gas emissions as a result of flaring is provided in Section 6.3 and Appendix C.	Section 6.3
Economic Effects	The amended Project would result in: ▪ A minor reduction in estimated social costs associated with a reduction in total Scope 1 emissions; and ▪ A minor increase in CAPEX and OPEX associated with the flaring infrastructure.	Section 6.4.1
Visual	As described in Section 6.10.3 of the Project EIS, visual impacts associated with flares would be limited. This conclusion is expected to continue to be the case for the amended Project.	Section 6.4.2
Social and Community Infrastructure	The Project would not materially change the existing workforce at the Narrabri Mine. The amended Project would not change the proposed workforce; therefore, these impacts remain unchanged.	Section 6.4.3
Air Quality	Jacobs (2021) concluded that the potential air quality impacts from flaring pre-drainage gas would be minimal.	Section 6.4.4
Land and Agricultural Resources	A minor reduction in potential impact to land and agricultural resources as a result of the reduced indicative Surface Development Footprint for the amended Project is anticipated.	N/A
Aboriginal Cultural Heritage	As presented in the Project EIS, none of the identified Aboriginal cultural heritage sites would likely be directly impacted by surface disturbance. Given the amended Project is proposing a reduction in the indicative Surface Development Footprint presented in the EIS, the amended Project would result in less than or equal to the potential impacts presented in the Project EIS.	N/A
Historical Heritage Subsidence Groundwater Surface Water Noise Road and Rail Transport Hazards and Risks Groundwater Dependent Ecosystems	The amended Project is not expected to change the potential impacts presented in the EIS.	N/A

6.2 BIODIVERSITY

The amended Project would reduce the indicative Surface Development Footprint presented in the EIS by approximately 31 ha. In addition, as part of the amended Project, NCOPL has proposed to relocate some elements of the indicative Surface Development Footprint to avoid impacts on Coolabah Bertya. Therefore, the amended Project would result in a reduction in biodiversity impacts compared with those described in the EIS.

As described in Section 4.1, a modified BDAR which reflects the amended Project would be submitted to DPIE.

6.3 GREENHOUSE GAS

Potential air quality and greenhouse gas impacts of the Project were assessed as part of the EIS (Jacobs, 2020). NCOPL has since commissioned further review of gas volumes and composition in order to further review the potential to flare a proportion of the gas and reduce the overall greenhouse gas emissions (Palaris, 2021a). As a result of further analysis of gas content within the Project area, a forecast increase in total fugitive (Scope 1) emissions was identified. The gas density applied for the EIS was also revised to align with the *Estimating emissions and energy from coal mining guideline* (Clean Energy Regulator, 2020). The resulting total Scope 1 greenhouse gas emission calculations have changed from 23.9 Mt CO_2-e in Jacobs (2020) to 31.19 Mt CO_2-e (abated) in Jacobs (2021).

6.3.1 Flaring of Pre-drainage Gas

An Air Quality and Greenhouse Gas Assessment was prepared by Jacobs (2020) as part of the Project EIS (Appendix I of the Project EIS). The Air Quality and Greenhouse Gas Assessment conservatively assumed that NCOPL would vent all gas extracted by the Project (i.e. no flaring would be undertaken). Notwithstanding, as described in Section 2.6.7 of the Project EIS, ongoing monitoring of gas volumes and composition and investigation of developments in flaring technology would determine whether flaring of pre-drainage gas is a viable option to manage gas associated with the Project.

Palaris (2021a) indicates that some areas of the underground mine, where the methane content is high enough, can accommodate flaring of the pre-drainage gas (Appendix B). Accordingly, NCOPL would flare pre-drainage gas with a methane content of greater than 30%, oxygen content of less than 6% and a gas content of 3.5 m^3/t of coal.

As part of ongoing Project design studies, Palaris has conducted a further review of the feasibility of flaring pre-drainage gas. As a result of the ongoing review of gas volumes and composition, Palaris (2021a) concluded that some areas of the underground mining area have methane and gas composition levels which are suitable for flaring of the pre-drainage gas (Appendix B). Accordingly, as part of the amended Project, NCOPL commits to flaring pre-drainage gas with a methane content of greater than 30%, oxygen content of less than 6% and a gas content of 3.5 m^3/t of coal (Palaris, 2021a). The approximate areas within the underground mine where these gas conditions are expected to occur are shown on Figure 6.

As a result of the proposed flaring of the pre-drainage gas, a reduction in Scope 1 greenhouse gas emissions of approximately 1% is predicted. A comparison of the total Scope 1 emissions for the Project EIS and the amended Project is presented in Table 3. The amended Project would not change the estimated Scope 2 or 3 emissions associated with the Project (Jacobs, 2021).

Table 3
Summary of Greenhouse Gas Emissions of the Project Without Abatement and the Amended Project

Type of Greenhouse Gas Emissions	Without Proposed Abatement Measures	Amended Project
Scope 1 (Mt CO_2-e)	31.41	31.19

Source: Jacobs (2021).

For comparison, Jacobs (2021) estimates the Narrabri Mine Scope 1 emissions from 2022 at 12.81 Mt CO_2-e, meaning that the incremental emissions from the Project are estimated at 18.38 Mt CO_2-e.

6.4 OTHER

6.4.1 Economic

An Economic Assessment was prepared by AnalytEcon Pty Ltd (AnalytEcon) (2020) as part of the Project EIS (Appendix L of the Project EIS). The Economic Assessment (Appendix L of the Project EIS) considered a valuation of greenhouse gas emissions from the Project, with the incremental social costs (i.e. the NSW share of the incremental GHG emissions attributable to the Project) estimated as approximately $860,000 in Net Present Value (NPV) terms.

In addition, a valuation of greenhouse gas emissions for 'central', 'high' and 'low' carbon prices (e.g. a sensitivity analysis of incremental social costs of greenhouse gas emissions) was undertaken by AnalytEcon (2020). AnalytEcon (2020) predicted a range from approximately $590,000 to $1.69M for social costs associated with the Project's greenhouse gas emissions (NPV terms).

The amended Project would reduce the incremental social costs of greenhouse gas emissions in proportion with the estimated reduction of emissions (in the order of approximately 1%). In addition, the costs associated with flaring are estimated at approximately $2M of CAPEX and an OPEX of $0.3M per annum (or $5.6M over 12 years) (NCOPL pers comms, 2021).

The reduced incremental social costs of greenhouse gas emissions and increased CAPEX/OPEX are considered minimal given the predicted net benefits of the Project to NSW is in the order of approximately $599M (AnalytEcon, 2020). The reduction would also be minimal in consideration of the sensitivity analysis of the incremental social costs of greenhouse gas emissions.

In addition, the amended Project would not change the net benefits of coal royalties compared to the Project EIS (i.e $259M in NPV terms).

6.4.2 Visual

An assessment of the potential visual impacts was presented in Section 6.10 of the Project EIS. The assessment concluded:

> *The visual character of the area surrounding the Project would not be significantly altered by the Project, as the Project involves underground mining, and does not propose significant modifications to the visibility of the existing Pit Top Area (i.e. the key surface infrastructure area).*

The amended Project would remove some components of the indicative Surface Development Footprint (e.g. services and exploration boreholes and access tracks), resulting in a minor reduction in potential visual impact.

Flaring

The potential visual impacts of flaring for the Project were considered in Section 6.10.3 of the Project EIS. The predicted visual impacts of flaring were anticipated to be limited (Section 6.10.3 of the Project EIS).

Consistent with Section 6.10.3 of the Project EIS, flares for the amended Project would be constructed via the enclosed flare method (EPA, 2015) and internally insulated to reduce luminosity.

Flaring for the amended Project is considered to result in minimal potential visual impacts as:

- flaring is approved for the Narrabri Mine;
- the potential impacts of the flaring were considered as part of the Project EIS, and impacts were predicted to be limited;
- a maximum of approximately three flaring units would be in operation at any one time; and
- the flares would be constructed via the enclosed flare method (EPA, 2015) and internally insulated to reduce luminosity.

6.4.3 Social

A Social Impact Assessment was undertaken for the Project (CDM Smith, 2020). Given the Project would not materially change the existing workforce at the Narrabri Mine, impacts on the community and social infrastructure and services were found to be limited. The amended Project would not change the proposed workforce, therefore, these impacts remain unchanged.

6.4.4 Air Quality

Flaring of pre-drainage gas, which contains methane, has the potential to produce oxides of nitrogen (NO_x) emissions. The impacts of NO_x emissions on the local air quality environment are expected to be minimal based on (Jacobs, 2021):

- a maximum of three flaring units would be used at any one time;
- the infrastructure would be located away from any sensitive receptors;
- prevailing winds are generally from the south-west (i.e. not in the direction from flaring infrastructure to sensitive receptor locations); and
- opportunities for flaring are limited by the availability of suitable pre-drainage gas.

No other changes to potential air quality impacts are anticipated for the amended Project.

7 UPDATED MITIGATION MEASURES

A summary of the proposed mitigation measures for the Project was presented in Attachment 4 of the EIS.

The amended Project would not change the mitigation measures presented in the Project EIS, except pre-drainage gas in areas of the Hoskissons Coal Seam would be flared where the methane content is above 30%, oxygen content of less than 6% and the gas composition is 3.5 m^3/t of coal, resulting in reduced greenhouse gas emissions (Section 6.3).

There are updated mitigation measures proposed as part of the Submissions Report. These updated mitigation measures are described in the Submissions Report.

8 EVALUATION OF MERITS

The Project is a continuation of the Narrabri Mine that would comply with relevant strategic planning policy objectives and applicable statutory requirements (Section 4 and Appendix E).

The Project would allow for continued employment of the existing operational workforce (up to approximately 520 full-time equivalent personnel) at the Narrabri Mine until 2044. In addition, there would be multiple, short periods of development activity throughout the Project life as infrastructure development occurs, which would require an additional 20 full-time equivalent personnel.

Engagement with members of the public and key regulatory agencies in NSW and at a Commonwealth level has informed NCOPL's design of the Project.

Potential environmental, social and economic impacts of the Project have been assessed against established thresholds of acceptability contained in relevant guidelines and policies, including for groundwater, surface water, biodiversity, noise and air quality.

Potential impacts have been avoided or minimised as far as is reasonable or feasible. Mitigation measures and offset strategies are proposed where residual impacts are predicted.

The site is suitable for the proposed Project use, as underground coal mining by longwall methods is compatible with the existing, approved or likely preferred uses of land in the vicinity of the Project.

Economic benefits potentially forgone if the Project does not proceed amount to a net benefit of $599M in NPV terms to the State of NSW. This includes an estimated $259M in royalties and $177M in company tax in NPV terms.

The Project would be consistent with the *Strategic Statement on Coal Exploration and Mining in NSW* (NSW Government, 2020) as it:

- is an extension to the existing Narrabri Mine to gain access to additional areas of ROM coal reserves that would provide significant benefits to the State and facilitate continued and additional local and regional employment and economic development opportunities;
- utilises existing/approved Narrabri Mine infrastructure to maximise the potential benefits of previous NCOPL investment and minimises the need for new surface development areas in comparison to a greenfield mine proposal; and
- includes environmental, social and economic impact avoidance, minimisation, mitigation and offsets (for residual impacts).

Since lodgement of the Project EIS, NCOPL has refined the Project design to reduce the environmental impacts of the Project and respond to particular comments raised in submissions on the EIS.

In summary, when compared to the EIS, the proposed amendments to the Project design would:

- remove some components of the indicative Surface Development Footprint that are no longer required by the revised Project design;
- incorporate flaring of pre-drainage gas in particular parts of the underground mining area which would reduce Scope 1 greenhouse gas emissions by approximately 1% compared to unabated emissions; and
- relocate some components of the indicative Surface Development Footprint to reduce impacts on Coolabah Bertya.

The changes to the indicative Surface Development Footprint presented in the EIS would reduce the overall surface disturbance by approximately 31 ha, reduce impacts on threatened species, and reduce the Scope 1 greenhouse gas emissions by approximately 1%.

Therefore, the proposed amendments to the Project would result in a reduction in environmental impacts presented in the EIS. Accordingly, the conclusion in the EIS that, on balance, the Project has merit on the basis of the positive social and economic outcomes to the local region and NSW, remains unchanged.

9 REFERENCES

AnalytEcon (2020) *Economic Assessment – Narrabri Underground Mine Stage 3 Extension Project*. Prepared for Narrabri Coal Operations Pty Ltd.

CDM Smith (2020) *Narrabri Underground Mine Stage 3 Extension Project Social Impact Assessment.* Prepared for Narrabri Coal Operations Pty Ltd.

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New South Wales Government (2018) *Voluntary Land Acquisition and Mitigation Policy*.

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Palaris Australia Pty Ltd (2021b) *Narrabri South – Abatement Technology Assessment.*

Unity Power Engineers (2021) *Whitehaven Coal Narrabri Coal Operations Extension Project Overhead Line Design*.

APPENDIX A

UPDATED PROJECT DESCRIPTION

NARRABRI UNDERGROUND MINE STAGE 3 EXTENSION PROJECT

AMENDMENT REPORT

UPDATED PROJECT DESCRIPTION

MAY 2021

ID: 01081018

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

2 PROJECT DESCRIPTION

This section describes the Project, incorporating amendments as described in the Narrabri Stage 3 Extension Project Amendment Report (refer blue text).

2.1 DESCRIPTION OF THE APPROVED NARRABRI MINE

The following subsections describe activities associated with the Narrabri Mine (Plate 2-1) that are currently approved under Project Approval 08_0144. The Development Application for the Project seeks to consolidate and replace the existing Project Approval 08_0144 (i.e. subject to approval of the Project [which includes the ongoing operation of existing approved operations], Project Approval 08_0144 would be surrendered and all relevant approved activities transferred to the Development Consent for the Project).

2.1.1 Underground Mining Operations

Development of the Narrabri Mine commenced in 2008 and production using continuous miner mining methods commenced in 2010 following the issuing of Project Approval 05_0102 (Stage 1 of the Narrabri Mine). Longwall mining operations commenced in 2012 following the issuing of Project Approval 08_0144 (Stage 2 of the Narrabri Mine).

The Narrabri Mine is approved to extract coal at a rate of up to 11 Mtpa of ROM coal until July 2031[1]. Mining operations are undertaken 24 hours per day, seven days per week.

The approved underground mining area consists of 20 longwall panels. Longwalls 101 to 106 are approximately 295 metres (m) wide and range from approximately 1.8 km to 2.9 km long. Longwalls 107 to 111 and Longwalls 201 to 209 are approximately 400 m wide and range from approximately 1.6 km to 4 km long (Figure 2-1).

Start and finish dates for longwalls extracted to date at the Narrabri Mine are provided in Table 2-1. At the time of writing, longwall mining is being undertaken in Longwall 109.

Table 2-1
Start and Finish Dates for Completed Longwalls to Date

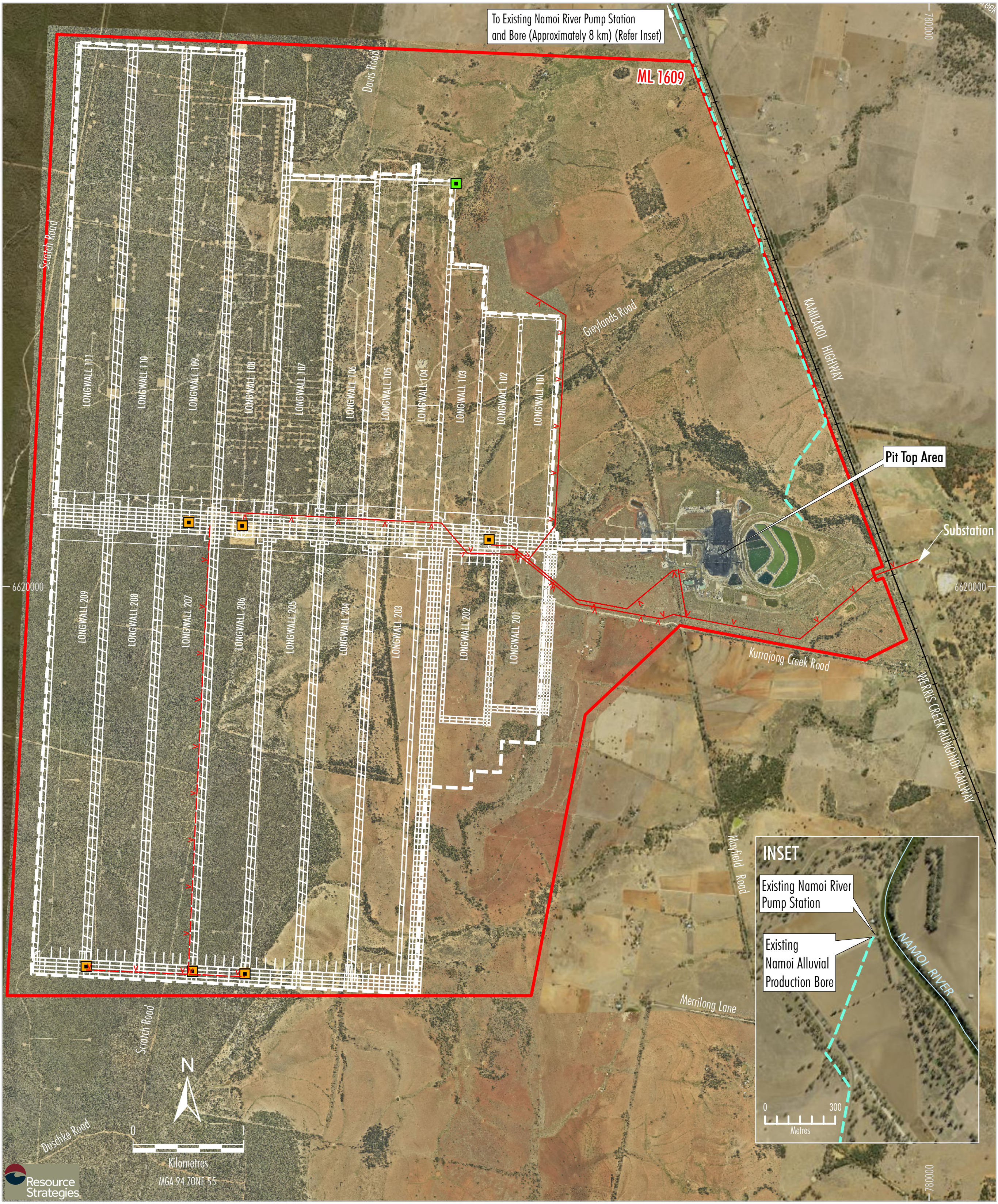
Longwall	Start Date	Finish Date
LW101	June 2012	June 2013
LW102	July 2013	January 2014
LW103	March 2014	October 2014
LW104	December 2014	July 2015
LW105	September 2015	May 2016
LW106	June 2016	March 2017
LW107	April 2017	July 2018
LW108[2]	September 2018	November 2019
LW109	January 2020	-

Source: NCOPL (2019b).

Plate 2-1 Narrabri Mine Box Cut and Drifts

[1] The Narrabri Coal Mine Stage 2 Longwall Project Environmental Assessment (R.W. Corkery & Co, 2009) described a 28-year mine life (i.e. until 2037); however, Condition 5, Schedule 2 of Project Approval 08_0144 restricts mining operations to July 2031.

[2] Longwall 108 was segregated by installing additional gate roads due to geology considerations. The panel is now known as Longwall 108a (fully extracted) and Longwall 108b (not yet extracted).



LEGEND

Mining Lease (ML 1609)

Approved Narrabri Mine

Underground Mine Footprint

Underground Mining Layout

Electricity Transmission Line (Constructed)

Electricity Transmission Line (Not Yet Constructed)

Existing Namoi River Pipeline (Buried)

Indicative Ventilation Complex

Indicative Ventilation Complex - Decommissioned

Source: NCOPL (2019); NCOPL (2015); NSW Spatial Services (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Approved Narrabri Mine
Indicative Underground Mining Layout

Figure 2-1

Underground Mine Access

Access to the underground mining area is via three drifts from the box cut, as shown on Plate 2-1. The box cut is located in the Pit Top Area (Figure 2-2). The current layout of the Pit Top Area is shown on Figure 2-3.

A conveyor to transfer ROM coal to the surface is located in one of the drifts. The other drifts allow for employee, machine and material access and services including ventilation, water and electricity.

Major Underground Equipment and Mobile Fleet

The existing major underground equipment and mobile fleet comprises (after NCOPL, 2019a):

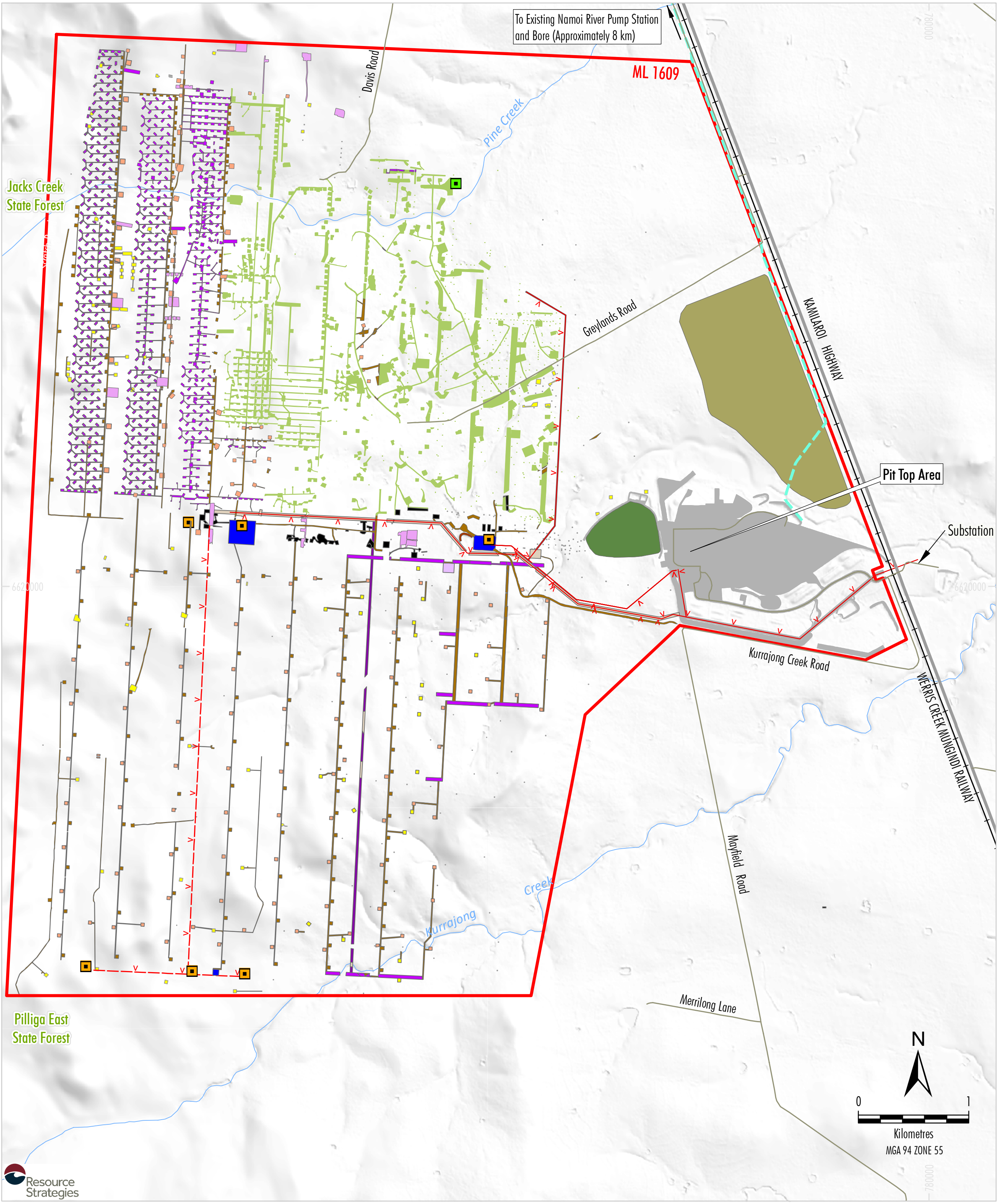
- a longwall mining unit;
- continuous miners;
- shuttle cars;
- feeder breakers;
- load/haul/dump vehicles;
- personnel transport vehicles;
- panel conveyor belts;
- underground loaders; and
- underground drill rigs.

2.1.2 Pit Top Area

The Pit Top Area is shown on Plate 2-2 and includes the following surface infrastructure (Figure 2-3):

- box cut;
- CHPP (Section 2.1.3);
- ROM coal stockpile and product coal stockpile (Plate 2-3) and associated coal handling infrastructure (Section 2.1.3);
- rail loop and product coal load-out infrastructure (Section 2.1.3);
- reject emplacement area (Section 2.1.4);
- site water management infrastructure (e.g. water storages, water treatment facilities, brine storage area, sediment dams and associated pumps, pipelines and drainage infrastructure) (Section 2.1.9);
- administration, workshop, store and bathhouse buildings;
- range of service facilities (e.g. potable water, sewage treatment facilities, electricity distribution, waste management facilities) (Section 2.1.10);
- longwall unit assembly area;
- access roads;
- car parking; and
- amenity bunds.

Plate 2-2 Existing Pit Top Area



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Resource Strategies

LEGEND

- Mining Lease (ML 1609)
- Approved Narrabri Mine
- Electricity Transmission Line (Constructed)
- Electricity Transmission Line (Not Yet Constructed)
- Existing Namoi River Pipeline (Buried)
- Indicative Ventilation Complex
- Indicative Ventilation Complex - Decommissioned
- Existing Rehabilitation and Subsidence Remediation Areas
- Reject Emplacement Area
- Additional Brine Storage Area
- Exploration Borehole
- Access Track and Post-drainage Corridor
- Bund
- Pre-conditioning Area
- SIS Pre-Drainage Borehole
- Service Borehole
- Services Corridor
- Pit Top Area Infrastructure
- Ventilation Complex
- Other

Source: NCOPL (2019) ; NSW Spatial Services (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Approved Narrabri Mine
Indicative Surface Disturbance Footprint

Figure 2-2

WHC-17-54_NSP_Stg3_EIS AR AttA Sect2_202C

Source: Orthophoto: NCOPL (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Existing Pit Top Layout

Figure 2-3

Plate 2-3 Existing Product Coal Stockpile

The existing major surface mobile fleet includes (after NCOPL, 2019a):

- dozers;
- trucks;
- water carts;
- excavators;
- graders; and
- drill rigs.

2.1.3 Coal Handling, Processing and Transport

Coal Handling and Preparation

ROM coal is transferred to the ROM coal stockpile on the surface via the drift conveyor. The ROM coal is then either fed to a rotary breaker or to a secondary bypass crusher.

The rotary breaker reduces the size of the ROM coal before it is transferred to the CHPP. Waste generated from the rotary breaker is transferred to the reject emplacement area.

The CHPP produces the following main streams:

- combined (partly washed) thermal coal;
- washed PCI coal;
- coarse coal reject material; and
- coal fines.

Product coal from the CHPP is transferred to the product coal stockpile via conveyor in conjunction with dozers.

The product coal from the secondary bypass crusher is blended with thermal coal from the CHPP on the product coal stockpile or during train loading. No waste is generated from the secondary bypass crusher except for minor amounts of tramp material.

Coarse coal reject material generated from the CHPP is disposed of in the reject emplacement area. Coal fines are either blended with thermal coal, or disposed in the reject emplacement area.

Product Coal Transport

Product coal is loaded via conveyor onto trains 24 hours per day, seven days per week using train load-out infrastructure at the Pit Top Area (Figure 2-3).

An average of four trains are loaded each day and a maximum of eight trains per day are loaded during peak periods.

Product coal is transported via the Werris Creek Mungindi Railway to the Port of Newcastle for export.

2.1.4 Reject Management

The Narrabri Mine allows for disposal of up to approximately 8 Mt of coal reject material in the reject emplacement area (Figure 2-2) over the life of the mine.

The approved reject emplacement area was originally designed with a significant excess capacity, because at the time, coal quality in the southern and western mining areas was not extensively tested (R. W. Corkery & Co., 2009).

Approximately 0.4 Mt of coal reject has been disposed in the reject emplacement area to date (NCOPL, 2019c).

The reject emplacement area has been constructed with a compacted floor with a permeability of less than $1x10^{-9}$ metres per second (m/s) and a surface water runoff management system (NCOPL, 2019c).

2.1.5 Ventilation Infrastructure

The ventilation system is progressively established to maintain a safe underground working environment.

Ventilation complexes include ventilation shafts, site access, sediment control infrastructure and other associated ancillary infrastructure. Each ventilation shaft is operated as an upcast (return to the atmosphere) or downcast (intake to the mine) ventilation shaft, and is steel or concrete-lined. In addition to the above, ventilation complexes with upcast ventilation shafts also include fans, power supply and electrical infrastructure, as well as ventilation gas management infrastructure. The majority of ventilation complexes include a single shaft and fan; however, the initial ventilation complex developed for the Narrabri Mine included one shaft and three fans. The initial ventilation complex is show on Plate 2-4.

A number of ventilation shafts in the mains and an additional four ventilation shafts at the rear of the longwall panels are approved to be constructed for the Narrabri Mine (Figure 2-1).

In addition to providing access for personnel and materials, the three drifts at the Pit Top Area also act as intake airways to the underground mine.

The requirement for each ventilation complex is subject to ongoing detailed mine planning (i.e. some ventilation infrastructure may not be required).

Ventilation fans, electrical infrastructure and other associated infrastructure are upgraded, replaced or decommissioned and removed during the life of the Narrabri Mine subject to this detailed mine planning.

Ventilation shafts may also be converted between upcast and downcast as required.

2.1.6 Gas Management Infrastructure

Pre-mining gas drainage and goaf gas drainage is required in some locations to reduce the gas content in the coal seams to levels suitable for safe underground mining operations.

Pre-mining gas drainage of the coal seam is progressively conducted ahead of longwall and underground development mining operations through a combination of surface to in-seam (SIS) boreholes and conventional underground in-seam drainage methods.

Goaf gas drainage is conducted behind the progressing longwall mining operations using goaf drainage boreholes. Goaf drainage boreholes are established along each longwall panel in consideration of gas quantity and content.

Plate 2-4 Existing Upcast Ventilation Infrastructure

The existing and indicative future locations of gas management areas for the approved Narrabri Mine are shown on Figure 2-2. The exact locations of future gas management areas may change subject to further detailed mine planning during development and operation, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts on biodiversity, heritage and surface features.

Given the low methane levels in the gas extracted from the Hoskissons Coal Seam to date, gas has been vented to the atmosphere and flaring (although approved for the Narrabri Mine) has not been required to date.

Decommissioning and rehabilitation of gas management areas occurs progressively (Section 2.1.12).

2.1.7 Exploration Drilling

Exploration drilling is conducted at the Narrabri Mine to inform coal and strata characteristics and gas quantity within ML 1609 and EL 6243.

More than 100 exploration boreholes have been drilled within EL 6243.

Rehabilitation of exploration areas occurs progressively (Section 2.1.12).

2.1.8 Mine Safety Pre-conditioning

Mine safety pre-conditioning of the strata overlying the Hoskissons Coal Seam (i.e. the Digby Conglomerate and other adjacent strata) is undertaken to ensure that the roof collapses (or 'goafs') in a regular fashion thereby limiting the risk of strata spanning behind the longwall and reducing the risk of wind blast.

Mine safety pre-conditioning is undertaken by drilling a borehole from the surface into the rock and injecting water under pressure, causing the rock to fracture and cave.

The Narrabri Mine includes development of a series of boreholes at both ends of each longwall panel to allow for mine safety pre-conditioning to occur.

More intensive pre-conditioning is generally required above longwall panels where the Digby Conglomerate thickens to greater than approximately 20 m.

The Digby Conglomerate is typically 15 to 20 m thick in ML 1609; however, the conglomerate is thickest in the north-west of ML 1609 (i.e. thicker than 20 m).

As a result, more intensive pre-conditioning has been undertaken above Longwalls 107 and 108a. More intensive pre-conditioning would be required above Longwalls 108b, 109 to 111.

The existing and indicative future locations of pre-conditioning areas for the approved Narrabri Mine are shown on Figure 2-2. The exact locations of future pre-conditioning areas may change subject to further detailed mine planning during development and operation, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts on biodiversity, heritage and surface features.

Decommissioning and rehabilitation of pre-conditioning areas is conducted progressively (Section 2.1.12).

2.1.9 Site Water Management

Site Water Management System

The site water management strategy for the Narrabri Mine is based on the containment and re-use of mine water and diversion of upstream water around the Pit Top Area.

The approved Narrabri Mine water management system includes:

- up-catchment diversion structures;
- raw water storage dams (Storage D and Containment Bund);
- mine water storage dams (Storages A1 to A3);
- Pit Top Area storages (SB1 to SB4);
- a filtered water storage dam (Storage B1);
- brine storage dams (Storages B2, C and BR1 to BR5[3]);
- sediment dams (SD1 to SD4 and SD6 to SD8[4]);

[3] Brine storages BR1 to BR5 have not been constructed. The construction of BR1 to BR5 is described in Section 2.5.10.

[4] SD7 has not been constructed.

- water treatment facilities;
- the Namoi River pump station, alluvial production bore and pipeline; and
- other water transfer infrastructure (i.e. tanks, pumps and pipelines).

Existing water management dams at the Pit Top Area are shown on Figure 2-3.

The water management system is progressively developed subject to its ongoing performance, prevailing climatic conditions and actual underground mine inflows. The water management system is managed in accordance with the Water Management Plan (NCOPL, 2017a) (or the latest approved version).

A detailed description of the Narrabri Mine site water management system is provided in Appendix C.

Water Demand and Supply

Water is required for underground mining, CHPP operations, washdown requirements, dust suppression, drilling and potable water supply.

The main water sources for the Narrabri Mine are:

- groundwater inflows into the underground workings;
- captured runoff from disturbed areas;
- raw water imported to site from the Namoi River pump station and alluvial production bore; and
- potable water trucked to site, as required.

The existing water treatment facilities treat groundwater inflows and disturbed area runoff to produce filtered water and a brine waste product. The filtered water is used in underground mining operations, or transferred to the Namoi River for controlled release. NCOPL may also investigate options for the beneficial re-use of excess water such as internal use (e.g. irrigation) or provision of water to other water users in the region.

Brine (generated from the water treatment facilities) and groundwater inflows are used for dust suppression. Brine is approved to be stored in Brine Storage Ponds at the Pit Top Area (Figure 2-2). Towards the end of mining, brine will be re-injected into the longwall goaf through the disused goaf gas drainage holes.

Disturbed area runoff and groundwater inflows are used in the CHPP.

Raw water is used to supplement underground mining and CHPP demand and to supply a separate water treatment facility used to produce potable water. If required, potable water is also transported via truck to the Narrabri Mine to supplement the potable water supply from the water treatment facility.

The water balance of the system fluctuates with water demand, the magnitude of groundwater inflows and climatic conditions over time.

Mine Dewatering

Groundwater inflows to the underground workings are pumped to a sump in the box cut before being transferred to the site water management system.

Namoi River Pump Station, Alluvial Production Bore and Pipeline

A pump station and production bore has been developed at the Namoi River to allow for supplementary water supply (Plate 2-5). A pump station and associated infrastructure has been developed to allow for the transfer of water from the Namoi River to the Narrabri Mine. The production bore has been constructed to allow groundwater extraction from the Namoi alluvium (Upper Namoi Zone 5, Namoi Valley [Gin's Leap to Narrabri] Groundwater Source).

Water is preferentially extracted from the Namoi River in accordance with Water Access Licences (WALs) held by NCOPL. When low or no flow conditions in the Namoi River prevent the extraction of water from the river (or other circumstances such as the pump station not being operational), groundwater is extracted from NCOPL's bore to provide a supplementary water supply, in accordance with WALs held by NCOPL.

The Narrabri Mine includes the development of two approved buried pipelines between the Narrabri Mine and the Namoi River (Figure 2-1). One pipeline has been constructed to date, and the second approved pipeline may be constructed in the future (Section 2.10.5).

The existing pump, bore and pipeline may be upgraded or replaced over the life of the approved Narrabri Mine as required.

Plate 2-5 Existing Namoi River Pump Station and Production Bore

Licensing requirements for extraction of water from the Namoi River and the Namoi alluvium are described in Sections 6.4 and 6.5, the Groundwater Assessment (Appendix B) and the Surface Water Assessment (Appendix C).

Controlled Releases

The Narrabri Mine has the potential to receive groundwater and surface water inflows in excess of its consumption requirements.

The Narrabri Mine allows for excess filtered water to be transferred via the approved Namoi River pipelines for controlled release to the Namoi River in accordance with Project Approval 08_0144 and Environment Protection Licence (EPL) 12789, which include the following water quality criteria:

- 50th percentile of all samples (volume-based) are below 250 milligrams per litre (mg/L) of Total Dissolved Solids (TDS);
- 100th percentile of all samples (volume-based) are below 350 mg/L of TDS; and
- pH values of all sampled water to be between 6.5 and 8.5.

To date, no water has been released to the Namoi River.

2.1.10 Other Infrastructure and Supporting Systems

Site Access, Services Corridors and Access Tracks

Access to the Pit Top Area from the Kamilaroi Highway is via Kurrajong Creek Road, which connects to an internal sealed mine access road.

For environmental monitoring, general land management, exploration activities and other ancillary activities, alternative access points to the Narrabri Mine area are also used as required.

Services corridors and access tracks are constructed across the underground mining area and Pit Top Area. Services corridors and access tracks generally include roadways, pipelines, pumps, telecommunication infrastructure, power transmission infrastructure and sediment controls.

Electricity Supply and Distribution

The Narrabri Mine receives electricity via a spur line from a 66 kilovolt (kV) supply system adjacent to the Kamilaroi Highway (Figure 2-1). Transformers in the Pit Top Area step down the 66 kV supply to 11 kV for distribution by overhead cable or underground cable, where necessary.

The 11 kV electricity transmission line will be progressively extended as ventilation complexes (Figure 2-1) and the Narrabri Mine is developed.

Dangerous Goods and Waste Management

Hydrocarbon Storages

Hydrocarbons used on-site include fuels (i.e. diesel), oils, greases, degreaser and kerosene.

Hydrocarbon storage facilities are constructed and operated in accordance with Australian Standard (AS) 1940:2017 *The Storage and Handling of Flammable and Combustible Liquids* and the NSW *Work Health and Safety Regulation 2017*.

Liquid and Non-liquid Wastes

Waste management at the Narrabri Mine is conducted in accordance with the Waste Management Plan (NCOPL, 2015a) (or the latest approved version).

Solid and hazardous waste generated by the mine is typically removed from the site and disposed of by a licensed contractor. Drilling cuttings from exploration, gas drainage and service boreholes are disposed in the reject emplacement area, or consolidated with excavated soil to backfill the sump at the exploration site.

Waste materials are collected and sorted for recycling of paper, cardboard, metals, glass, air filters and oil filters.

Sewage is treated in an on-site sewage treatment plant which is serviced by a licensed contractor.

2.1.11 Workforce

The existing operational workforce (employees and contractors) is up to approximately 520 full-time equivalent personnel.

Contractor numbers vary based on operational requirements and/or to address short-term staffing constraints.

Surface development activities at the Narrabri Mine (when required) are restricted to 7.00 am to 10.00 pm up to seven days a week.

Operations occur 24 hours per day, seven days per week. The current operational shift arrangements at the Narrabri Mine are:

- Administration personnel – 8.00 am to 5.00 pm weekdays.
- Operations day shift personnel – 6.30 am to 4.00 pm.
- Operations afternoon shift personnel – 2.30 pm to 12.00 am.
- Operations night shift personnel – 10.30 pm to 8.00 am.

Shift configurations may be amended from time to time to meet operational and industry best-practice requirements.

A description of NCOPL's approach to local employment is provided in Section 6.16. This approach includes policies and strategies to:

- prioritise recruitment of personnel from the NSC and Gunnedah Shire Council (GSC) LGAs; and
- recruit operational employees from outside the underground mining sector, supported by appropriate workforce training and development.

2.1.12 Rehabilitation and Remediation Activities

The approved Mining Operations Plan (MOP) (SLR Consulting Australia Pty Ltd [SLR], 2020a), the Rehabilitation Management Plan (RMP) (Eco Logical Australia Pty Ltd [ELA], 2017a) and the Mine Closure Plan (MCP) (SLR, 2016) describe the approved Narrabri Mine activities and progress toward rehabilitation outcomes required under ML 1609 and Project Approval 08_0144.

The Narrabri Mine final landform will generally approximate the pre-mining landscape with the exception of the reject emplacement area and surface impacts from subsidence in the underground mining area (SLR, 2020a).

The following final land uses are approved at the Narrabri Mine (SLR, 2020a):

- water management;
- pasture;
- woodland;
- State Forest; and
- biodiversity offset areas.

In addition, surface infrastructure may be retained post-mining where agreed with the relevant regulatory authorities and landholders.

Progressive rehabilitation activities have been conducted at the Narrabri Mine since 2008 and the rehabilitation of approximately 130 hectares (ha) of disturbed areas has commenced to date. Rehabilitation has been undertaken in areas that are available for rehabilitation (principally the area above Longwalls 101 to 107) (NCOPL, 2020).

NCOPL considers that the current rehabilitation performance at the Narrabri Mine indicates good progress towards achieving the relevant rehabilitation objectives and completion criteria with the continued application of adaptive rehabilitation management.

2.1.13 Environmental Monitoring and Management

The Narrabri Mine environmental management system includes various environmental management plans and programs that have been developed and implemented since operations commenced including the following (or the latest approved version):

- Environmental Management Strategy (NCOPL, 2015b).
- Noise Management Plan (NCOPL, 2018).
- Air Quality Monitoring Program (NCOPL, 2015c).
- Water Management Plan (NCOPL, 2017a) incorporating the following:
  - Site Water Balance;
  - Subsidence Monitoring Program;
  - Erosion and Sediment Control Plan;
  - Surface Water Monitoring Plan;
  - Groundwater Monitoring Program; and
  - Surface and Groundwater Response Plan.
- Aboriginal Cultural Heritage Management Plan (ACHMP) (NCOPL, 2019a).
- Energy Savings Action Plan (Advitech, 2014).
- Greenhouse Gas Minimisation Plan (SLR Consulting, 2012).
- Waste Management Plan (NCOPL, 2015a).
- Landscape Management Plan (ELA, 2017b) incorporating the following:
  - RMP (ELA, 2017a); and
  - MCP (SLR Consulting, 2016).
- Biodiversity Management Plan (ELA, 2017c).
- Biodiversity Offset Strategy (ELA, 2019a).
- Extraction Plan (NCOPL, 2017b).

The existing environmental monitoring locations at the Narrabri Mine is presented on Figure 2-4.

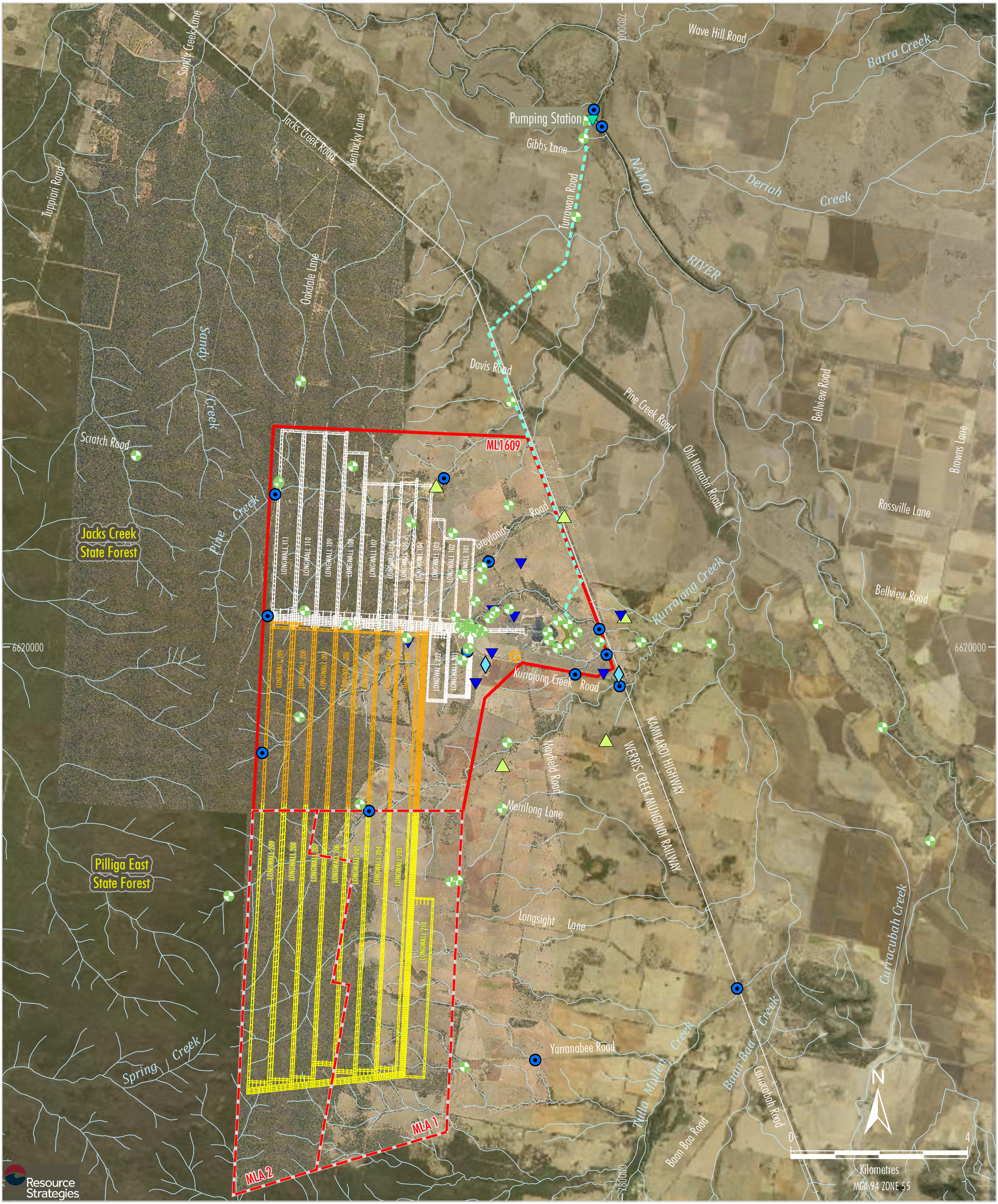
Further details of the existing content and/or revision of these plans and programs for the Project is provided under the relevant environmental aspect headings in Section 6.

2.2 PROJECT GENERAL ARRANGEMENT

The Project involves an extension to the approved underground mining area to gain access to additional coal reserves within MLAs 1 and 2 (Figure 2-5), an increase in the mine life to 2044, and development of supporting surface infrastructure (Figure 2-6). The Development Application for the Project seeks to consolidate and replace the existing Project Approval 08_0144.

The Project would include the following activities (Figures 2-5 and 2-6):

- continued longwall mining of the Hoskissons Coal Seam involving a southern extension including:
  - an extension of Longwalls 203 to 209 into MLAs 1 and 2; and
  - an additional longwall (Longwall 210) within MLA 1;
- continued development of underground roadways within the Hoskissons Coal Seam and adjacent strata to access mining areas;



LEGEND

Mining Lease (ML 1609)
Provisional Mining Lease Application Area
Existing Namoi River Pipeline (Buried)
Approved Underground Mining Layout
Indicative Underground Mining Layout to be Extended for Project
Indicative Underground Project Mining Layout

Surface Water Monitoring Site*
Groundwater Monitoring Site
Noise Monitoring Site
Deposited Dust Monitoring Site
PM_{10} Monitoring Site
Meteorological Station
Pumping Station

** Does not include on-site water storage monitoring locations.*

Source: NCOPL (2019); NSW Spatial Services (2019)

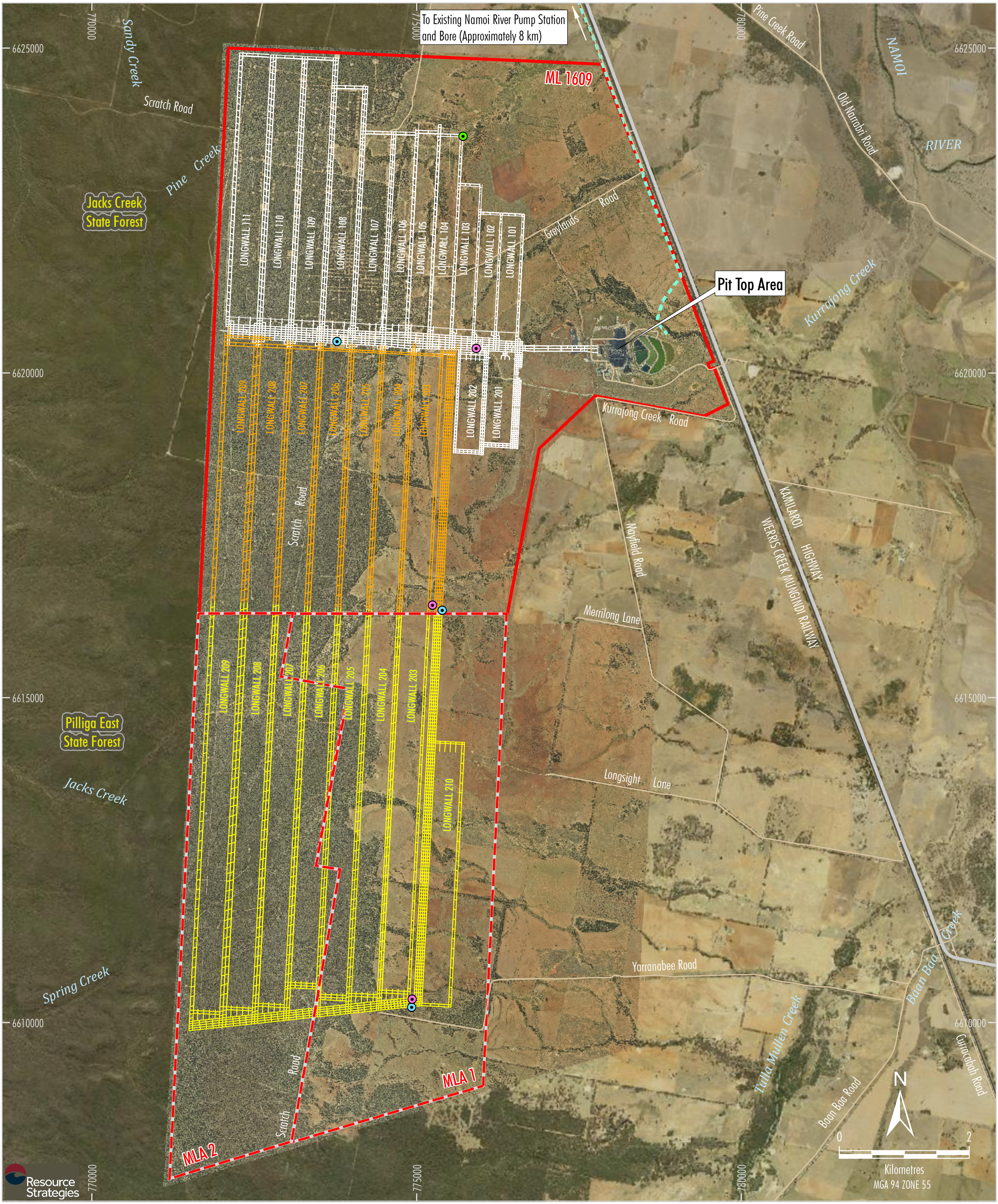
WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Current Environmental Monitoring Locations

Figure 2-4

DRAFT



LEGEND

- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Existing Namoi River Pipeline (Buried)
- Approved Underground Mining Layout
- Indicative Underground Mining Layout to be Extended for Project
- Indicative Underground Project Mining Layout
- Indicative Ventilation Complex (Downcast)
- Indicative Ventilation Complex (Upcast)
- Indicative Ventilation Complex (Upcast - Decommissioned)

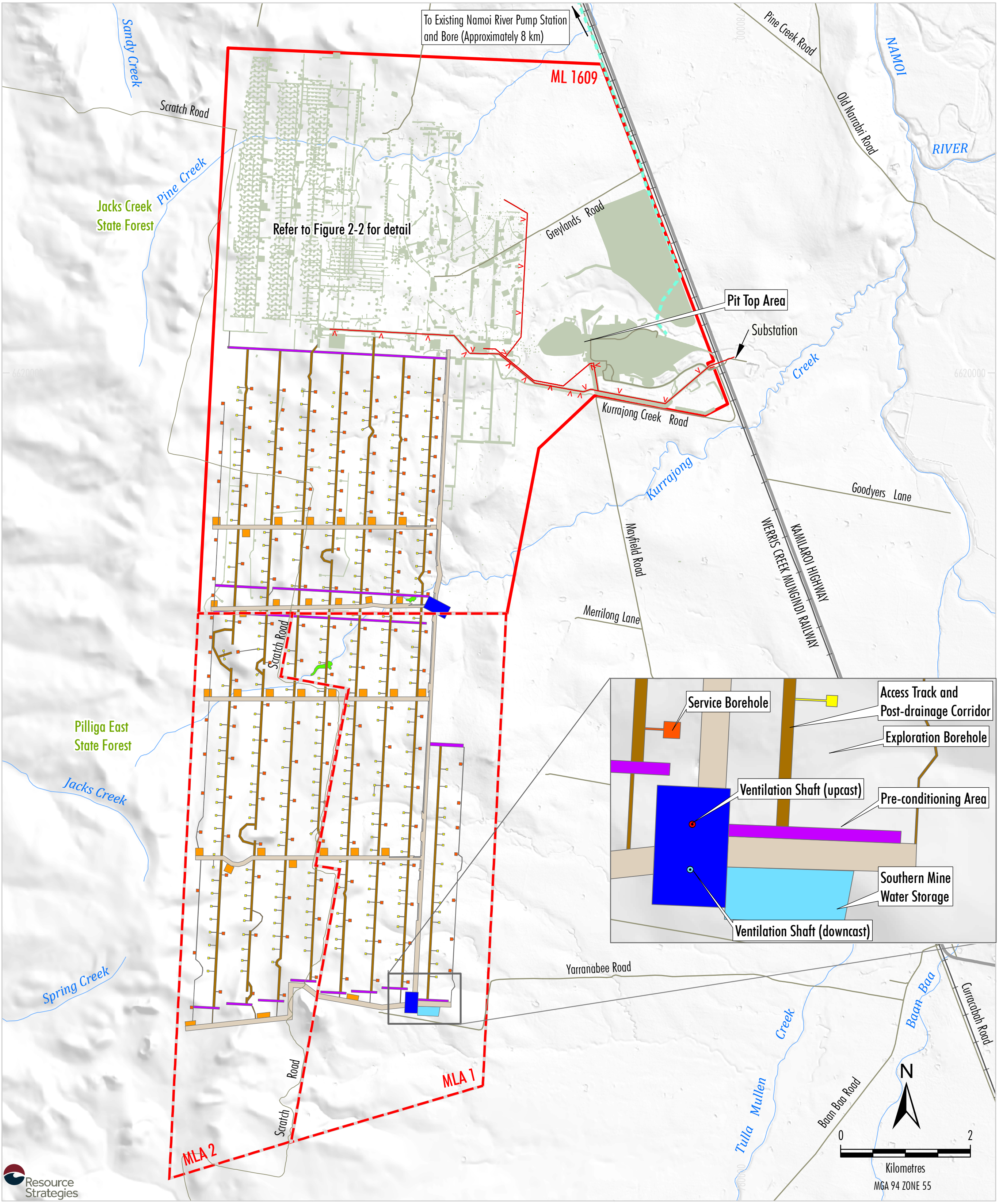
Source: NCOPL (2019); NSW Spatial Services (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project General Arrangement -
Indicative Underground Mining Layout

Figure 2-5



LEGEND

- Mining Lease (ML 1609)
- Provisional Mining Lease Application Area
- Electricity Transmission Line (Constructed)
- Existing Namoi River Pipeline (Buried)
- Existing/Approved Surface Development*
- Services Corridor
- Service Borehole
- Exploration Borehole
- Access Track and Post-drainage Corridor
- Pre-conditioning Area
- Service Borehole and Power Reticulation
- Southern Mine Water Storage
- Ventilation Complex
- Farm Dam Decommissioning Works

*Excludes the Impact Reduction Area (Refer to Figure 2-12)

Source: NCOPL (2019; 2021); NSW Spatial Services (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project General Arrangement - Indicative Surface Development Footprint

Figure 2-6

- continued use of existing underground roadways and drifts for personnel and materials access, ventilation, dewatering and other ancillary activities;
- continued production of up to 11 Mtpa of ROM coal (i.e. no change compared to the approved Narrabri Mine);
- continued use of the existing surface facilities (with minor upgrades and extension) and development of additional surface infrastructure associated with roadways, mine ventilation, gas management, exploration, services, water management areas and other ancillary infrastructure above the extended underground mining area;
- continued development of mine safety pre-conditioning areas;
- continued use of the existing coal reject emplacement area;
- disposal of drilling waste products within the reject emplacement area, including receipt and disposal of similar drilling waste products from off-site;
- continued transport of product coal from site by rail;
- continued use and progressive development of the sumps, pumps, pipelines, water storages and other water management infrastructure and development of additional water management infrastructure associated with the extended underground mining areas;
- continued use of the Namoi River pump station, alluvial production bore and pipeline (including potential development of a second approved pipeline);
- continued employment of up to approximately 520 full-time equivalent personnel and additional contractors;
- continued monitoring, rehabilitation and remediation of subsidence effects and surface disturbance areas; and
- other associated minor infrastructure, plant, equipment and activities.

Table 2-2 provides a tabulated summary of the key characteristics of the Project and a comparison to the approved Narrabri Mine.

Table 2-2
Summary Comparison of the Existing/Approved Narrabri Mine and the Project

Project Component	Existing/Approved Narrabri Mine	The Project
Mining Method and Resource	▪ Longwall mining of the Hoskissons Coal Seam.	▪ Unchanged.
Underground Mine Geometry	▪ Twenty longwall panels (Longwalls 101 to 111 and Longwalls 201 to 209). ▪ 295 m wide longwall panels for Longwalls 101 to 106. ▪ 400 m wide longwall panels for Longwalls 107 to 111 and Longwalls 201 to 209.	▪ Twenty-one longwall panels (Longwalls 101 to 111 and 201 to 209 and Longwall 210). ▪ No change to Longwalls 101 to 111 and 201 and 202. ▪ Extension of Longwalls 203 to 209 into MLAs 1 and 2. ▪ Additional longwall panel within MLA 1 (Longwall 210), which is approximately 410 m wide.
Tenements	▪ Mining operations conducted within ML 1609.	▪ Continued mining operations conducted within ML 1609. ▪ Mining operations conducted within MLAs 1 and 2.
Mine Life	▪ Mining operations approved until July 2031.	▪ Extension of mining operations to 2044.
ROM Coal Production	▪ Approved total ROM coal production of approximately 170 Mt*.	▪ Total ROM coal production increased to approximately 252 Mt.
ROM Coal Production Rate	▪ ROM coal production of up to 11 Mtpa.	▪ Unchanged.
Underground Mine Surface Infrastructure	▪ Ventilation shafts, pre-drainage and post-drainage sites, mine safety pre-conditioning sites, access roads and electricity transmission lines.	▪ Augmentation of the existing gas drainage, mine safety pre-conditioning, mine ventilation system, services corridors and boreholes, access tracks and electricity transmission lines within MLAs 1 and 2.
Underground Mine Access	▪ Via three drifts at the box cut.	▪ Unchanged.

Table 2-2 (Continued)
Summary Comparison of the Existing/Approved Narrabri Mine and the Project

Project Component	Existing/Approved Narrabri Mine	The Project
Coal Washing	▪ CHPP and secondary crusher/screen.	▪ Continued use of existing facilities, with replacement or upgrades of components as required.
Coal Handling and Stockpiling	▪ ROM coal stockpile capacity of approximately 700,000 t. ▪ Product coal stockpile capacity of approximately 500,000 t.	▪ Unchanged.
Reject Management	▪ CHPP rejects placed in reject emplacement area.	▪ Continued disposal of coal reject waste in the reject emplacement area. ▪ Disposal of exploration drilling waste in the reject emplacement area, including potential receipt and disposal of exploration drilling waste products from off-site.
Product Coal Transport	▪ Product coal transported from site by rail. ▪ Average of four trains per day. ▪ Peak of eight trains per day.	▪ Unchanged.
Water Management	▪ Conducted in accordance with the Water Management Plan (including discharge under the conditions of EPL 12789 and Project Approval 08_0144).	▪ Water management ~~strategy~~ generally unchanged. ▪ Development of Southern Mine Water Storage within MLA 1.
Water Supply	▪ Make-up water demand to be met from mine dewatering, runoff recovered from operational areas, and licensed extraction from Namoi River and Namoi Alluvium.	▪ Unchanged.
Power	▪ Permanent mains power supplied via a spur line from a 66 kV powerline located to the east of Kamilaroi Highway. ▪ Power converted from 66 kV to 11 kV on-site and reticulated, using progressively developed 11 kV powerlines.	▪ No change to key power supply infrastructure; however, demand for mains power would increase. ▪ Continued progressive development of electricity transmission lines to service the extended underground mining area and associated surface infrastructure.
Hours of Operation	▪ 24 hours per day, seven days per week.	▪ Unchanged.
Employment	▪ Operational workforce (employees and contractors) of approximately 520 full-time equivalent personnel.	▪ Continued employment of up to approximately 520 full-time equivalent personnel. ▪ Possible short-term increases in employment for development activities and potential additional development requirements.
Site Access	▪ Primary access via a sealed mine access road connected to the Pit Top Area.	▪ Unchanged.
Surface Development Footprint	▪ Approximately 210.5 ha of woodland/forest native vegetation clearance.	▪ Approximately ~~640~~ **609** ha of additional surface development footprint to support underground mining.
Gas Management	▪ **For mine safety purposes, gas is either vented to the atmosphere or flared.**	▪ **Generally unchanged, however, pre-drainage gas from the Hoskissons Coal Seam in some parts of the underground footprint (where the methane and gas content are sufficient and oxygen content permits safe flaring) would be flared to reduce greenhouse gas emissions.**
Rehabilitation Strategy	▪ Conducted in accordance with the MOP.	▪ Unchanged.
Capital Investment Value	▪ Not applicable.	▪ $404 million.

* Based on current mine planning, the approved Narrabri Mine is expected to produce a total of approximately 145 Mt of ROM coal (i.e. approximately 25 Mt less than the approved limit of 170 Mt).

2.3 COAL RESOURCE AND GEOLOGICAL FEATURES

The Narrabri Mine currently extracts coal from the Hoskissons Coal Seam (Figures 2-7a and 2-7b).

More than 100 exploration boreholes have been drilled within EL 6243 (Section 2.1.7). Further mineable areas of the Hoskissons Coal Seam have been identified within MLAs 1 and 2 (Figures 2-7a and 2-7b). These areas would be targeted for extraction for the Project.

The lower portion of the Hoskissons Coal Seam contains low-ash coal suitable for thermal applications, whilst the upper section contains high-ash coal and tuffaceous claystone that will remain in the roof where the seam thickness exceeds 4.3 m (the target **maximum** mining height).

The Project would continue to produce a combination of thermal and PCI product coal, consistent with the approved Narrabri Mine.

2.3.1 Stratigraphy and Seam Characteristics

The Narrabri Mine is located near the northern and western boundaries of the Gunnedah Basin and the eastern margin of the Surat Basin.

The stratigraphy of the Narrabri Mine is characterised by two main geological basins:

- Surat Basin Units of Jurassic age which include Pilliga Sandstone, Purlawaugh Formation and Garrawilla Volcanics; and
- Gunnedah Basin Units, comprising:
  - Napperby and Digby Formations of Triassic age; and
  - Permian coal measures within the Black Jack Group which include Hoskissons Coal Seam, Melvilles Seam, and Arkarula and Pamboola Formations. Locally, these coal measures are characterised by an east (shallowest) to west (deepest) gradient (or dip).

Typical depths of cover from the surface to the Hoskissons Coal Seam range from approximately 180 to 420 m within MLAs 1 and 2 (Appendix A).

2.3.2 Geological Features

Geological features identified in the target underground mining area and surrounds include the Digby Formation Conglomerate, a dolerite sill intruding into the Napperby Formation and the Boggabri Ridge.

The Digby Conglomerate is typically approximately 15 to 20 m thick within ML 1609. Sandstone palaeochannels present in the north-west of ML 1609 thicken the Digby Conglomerate to greater than approximately 20 m.

The Digby Conglomerate is generally less than 20 m thick within MLAs 1 and 2.

The Boggabri Ridge, comprising Early Permian volcanic rocks, forms the basement of the Gunnedah Basin and divides the Basin into two parts, the Maules Creek Sub-basin to the east, and the Mullaley Sub-basin to the west.

The alluvium associated with the floodplains of the Namoi River is located approximately 5 km east of the Project underground mining area (Figures 2-7a and 2-7b).

Geological features in the Project area are described and considered further as part of the Subsidence Assessment (Appendix A) and the Groundwater Assessment (Appendix B).

2.3.3 Coal Resource and Resource Recovery

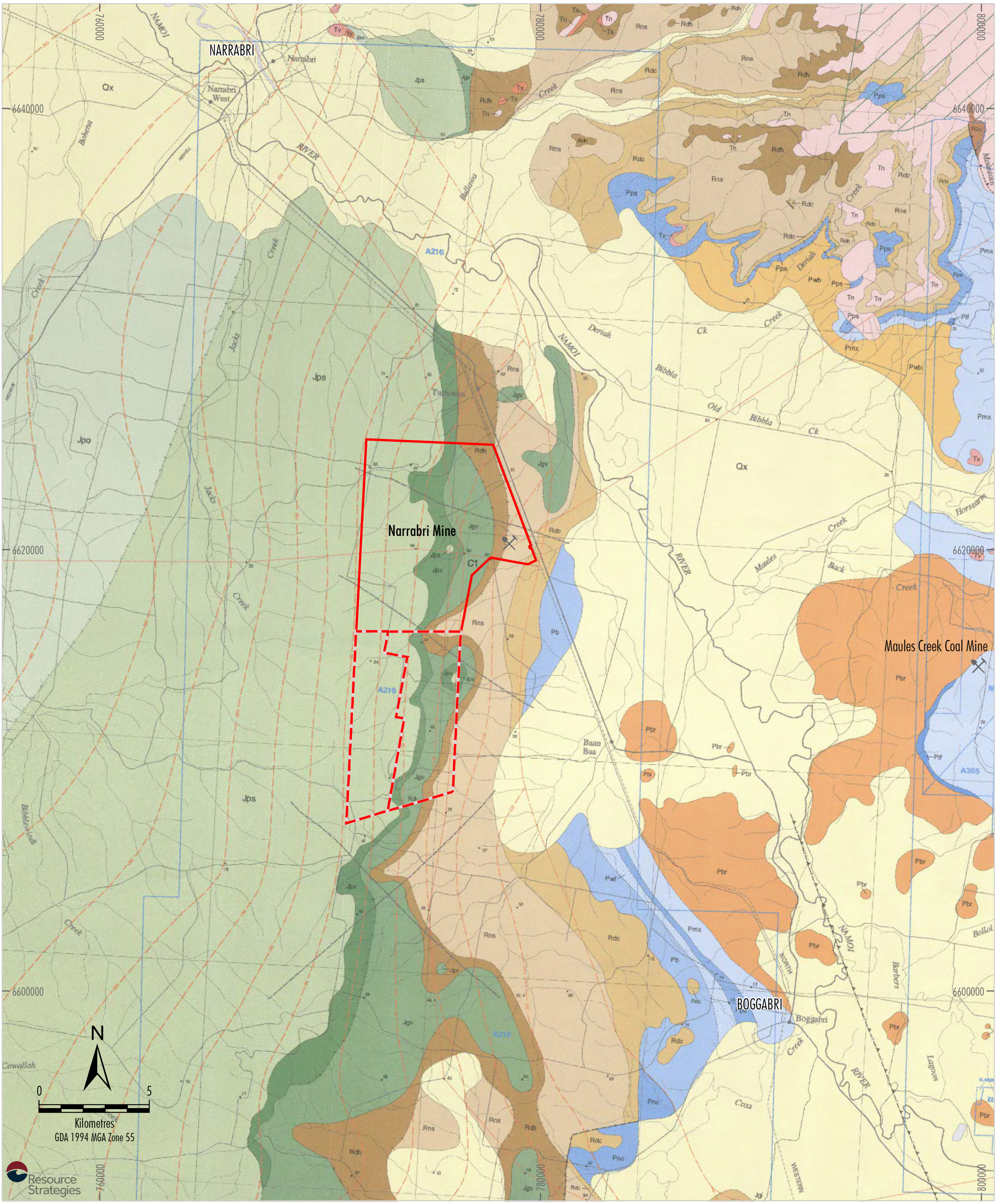
The Project would involve the extraction of approximately 252 Mt of ROM coal over the life of the Project (inclusive of historical and approved mining operations).

The Hoskissons Coal Seam strikes generally north-south and dips gently to the west.

The southern extent of the Hoskissons Coal Seam is constrained by a split in the Hoskissons Coal Seam south of Longwalls 203 to 209.

The Hoskissons Coal Seam has a maximum working section thickness of up to approximately 4.5 m (Appendix A).

Thickness and quality characteristics of the coal seams present in MLAs 1 and 2 are such that only the Hoskissons Coal Seam is currently considered to contain coal resources with mining potential.



LEGEND

Mine Site

Mining Lease (ML 1609)

Provisional Mining Lease Application Area

Source: NSW Resources & Geoscience (2017)

Note: Refer Figure 2-7b for Regional Geology Legend

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Regional Geology

Figure 2-7a

Era		Period		Stratigraphy: Group		Stratigraphy: Formation	Symbol	Lithology
CAINOZOIC		QUATERNARY				undifferentiated sediments	Qx	Undifferentiated alluvial deposits; includes Holocene alluvial channels and overbank deposits of sand silt and clay. Generally does not include residual and veneer colluvial deposits
CAINOZOIC		TERTIARY				undifferentiated sediments	Ts	Sand, sandstone, pebble sandstone, pebble to cobble gravels, and tuffs
CAINOZOIC		TERTIARY				Nandewar Volcanic Complex	Tn	Basalt, dolerite, teschenite, nephelinite or trachyte sills, dykes, plugs and flows
CAINOZOIC		TERTIARY				undifferentiated volcanics	Tv	Basalt, dolerite, teschenite, nephelinite or trachyte sills, dykes, plugs and flows
MESOZOIC	Surat Basin Units	JURASSIC				Orallo Formation	Jpo	Fine to coarse grained labile to sub-labile clayey sandstone with interbedded siltstone and mudstone
MESOZOIC	Surat Basin Units	JURASSIC				Pilliga Sandstone	Jps	Quartz pebble and quartzose sandstone with minor lithic sandstone and siltstone
MESOZOIC	Surat Basin Units	JURASSIC				Purlawaugh Formation	Jpx	Thin bedded lithic labile sandstone interbedded with siltstone and mudstone
MESOZOIC	Surat Basin Units	JURASSIC				Glenrowan Intrusives	Jgi	Sills and dykes of alkali dolerite and micro-syenodolerite
MESOZOIC	Surat Basin Units	JURASSIC				Garrawilla Volcanics	Jgv	Vesicular and non-vesicular, alkali olivine basalt, alkali basalt, hawaiite, mugearite, soda trachyte and interbedded pyroclastics
PALAEOZOIC	Gunnedah Basin Units	TRIASSIC	MIDDLE			Deriah Formation	Rdh	Fine to medium grained lithic sandstone rich in volcanic fragments with common mudstone clasts overlain by off-white lithic sandstone and dark grey mudstone
PALAEOZOIC	Gunnedah Basin Units	TRIASSIC	MIDDLE			Napperby Formation	Rns	Coarsening-up sequences of dark-grey siltstone/sandstone laminite overlain by parallel bedded or low-angle crossbedded quartzose sandstone
PALAEOZOIC	Gunnedah Basin Units	TRIASSIC	EARLY			Digby Formation	Rdc	Poorly sorted volcanic-lithic pebble orthoconglomerate overlain by massive, parallel or cross bedded coarse to fine grained quartz-lithic and then quartzose sandstone
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Black Jack Group	Nea Subgroup	Trinkey Formation	Pnc	Claystone, siltstone and fine grained sandstone intercalated with tuff, carbonaceous claystones and tuffaceous stony coal seams
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Black Jack Group	Nea Subgroup	Wallala Formation	Pnc	Fining up sequence of dominant lithic conglomerate, sandstone, siltstone, claystone and coal with minor tuff and tuffaceous sediments.
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Black Jack Group	Coogal Subgroup	Clare Sandstone	Pnc	Medium bedded, cross stratified medium to coarse grained quartzose sandstone. Quartzose conglomerate locally developed
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Black Jack Group	Coogal Subgroup	Benelabri Formation	Pnc	Interbedded claystone, siltstone and fine grained quartzose sandstone and coal
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Black Jack Group	Coogal Subgroup	Hoskissons Coal	Pnc	Coal with subordinate layers of fine grained sandstone, carbonaceous siltstone and claystone, and tuff
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Black Jack Group	Brothers Subgroup	Brigalow Formation / Arkarula Formation	Pb	Fining-up sequence of medium grained quartzose sandstone and siltstone. Fining-up sequence of fine-medium lithic sandstone and siltstone with worm burrows
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Black Jack Group	Brothers Subgroup	Pamboola Formation	Pb	Lithic sandstone, siltstone, claystone, conglomerate and intercalated coals in generally coarsening-up and sporadic fining-up sequences
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Millie Group		Watermark Formation	Pwf	Fining-up sequence of intensely bioturbated silty sandstone to sandstone/claystone laminite with marine fossils overlain by finely laminated siltstone/claystone with little bioturbation, then by coarsening-up sequences of strongly bioturbated silty to sandy laminite
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	LATE	Millie Group		Porcupine Formation	Pps	Basal conglomerate passing upward into bioturbated silty sandstone and minor siltstone with dropped pebbles
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	EARLY	Bellata Group		Maules Creek Formation	Pmx	Basal carbonaceous claystone, pelletoidal clay sandstone, passing into fining-up cycles of sandstone, siltstone and coal. Conglomerate dominant towards top
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	EARLY	Bellata Group		Goonbri Formation	*	Carbonaceous siltstone and thin coal grading upwards to fine to medium sandstone
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	EARLY			Leard Formation	Plf	Buff coloured flint (pelletoidal)claystone, conglomerate, sandstone and siltstone
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	EARLY			Werrie Basalt	Pwb	Basaltic lavas with intervening palaeosols and local thin coals
PALAEOZOIC	Gunnedah Basin Units	PERMIAN	EARLY			Boggabri Volcanics	Pbr	Rhyolitic to dacitic lavas and ashflow tuffs with interbedded shale. Rare trachyte and andesite
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS	LATE			Currabubula Formation	Cbc	Paraconglomerate, orthoconglomerate, crossbedded feldspathic and lithic sandstone, siltstone, mudstone and minor limestone. Felsic ashflow and airfall tuff, rhyolitic to andesitic crystal and vitric tuff.
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS	LATE			Lark Hill Formation	Cls	Feldspathic arenite, litharenite, subordinate orthoconglomerate and paraconglomerate, siltstone, rhyodacite, and dacitic ashflow and airflow tuff
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS	LATE			Rocky Creek Conglomerate	Crc	Orthoconglomerate, minor feldspathic arenite and litharenite, siltstone and intermediate ashflow tuff
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS	LATE			Plagyan Rhyodacite Tuff Member	Crpr	Multiple beds of rhyolitic to andesitic crystal and vitric tuff
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS	LATE			Clifden Formation	Ccs	Crossbedded feldspathic and lithic sandstones, subordinate conglomerate, shale, rhyodacitic and dacitic airfall tuffs
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS	EARLY			Caroda Formation: Barneys Spring Andesite Member	Cabb	Porphyritic andesite
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS	EARLY			Caroda Formation	Cas	Crossbedded sandstone, minor lenticular oolitic limestone and magnetite sandstone, succeeded by coarse fluvial litharenite, conglomerate, shale, thin coal
PALAEOZOIC	New England Orogen Units	DEVONIAN	LATE	Parry Group		Mostyn Vale Formation	Dpmx	Pebbly lithic wacke, diamictite, lithic wacke, orthoconglomerate, olistostromal volcanic breccia, rhyodacitic to basaltic lavas, tuffs, agglomerates, rare limestones

* Known only from borehole data

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Resource Strategies

Source: NSW Resources & Geoscience (2017)

Note: Refer Figure 2-7a for Regional Geology Mapping.

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Regional Geology - Legend

Figure 2-7b

NCOPL would seek to maximise resource recovery within geological, environmental and infrastructure constraints via continued use of the existing longwall mining method. At this stage, the Project would not be expected to have a significant impact on future extraction or recovery of other coal resources (e.g. beneath the Hoskissons Coal Seam).

Further exploration (Section 2.5.7) or technical assessment may result in changes to the recoverable coal resource. NCOPL also recognises that mining technology will advance over the life of the Project, influencing the ultimate coal reserves.

2.3.4 Spontaneous Combustion Potential

The Hoskissons Coal Seam has a high intrinsic spontaneous combustion propensity (Beamish, 2006).

The Narrabri Mine would continue to implement the following spontaneous combustion management measures to the physical layout and design of the Project:

- ventilation shaft design to reduce a pressure differential across goaves and, therefore, reduce potential for spontaneous combustion;
- pre-mining and goaf gas drainage systems would be implemented for gas management purposes, minimising ventilation pressures that would result if the ventilation system were only used to maintain gas concentration to acceptable levels;
- installation of high standard ventilation control devices such as stopping, regulators and overcasts;
- installation, operation and maintenance of a dual ventilation monitoring system (telemetric and tube bundle);
- on-site gas chromatograph; and
- on-site inertisation capability including:
  - pipework and valves fitted to goaf seals to allow the injection of inert gas;
  - potential utilisation of in-seam drainage ranges; and
  - a nitrogen generating plant is located on-site and reticulated underground via a dedicated pipeline.

Spontaneous combustion at the Narrabri Mine is further managed during operations in accordance with the Spontaneous Combustion Management Plan (NCPL, 2007) (or the latest approved version).

Other management measures to minimise the potential for spontaneous combustion for coal stockpiles are described in Section 6.18.3.

Coarse reject comprises predominately broken rock (sandstone/siltstone material), which is not carbonaceous; therefore, the propensity of reject for spontaneous combustion is considered very low (NCOPL, 2019a).

2.4 PROJECT SCHEDULE

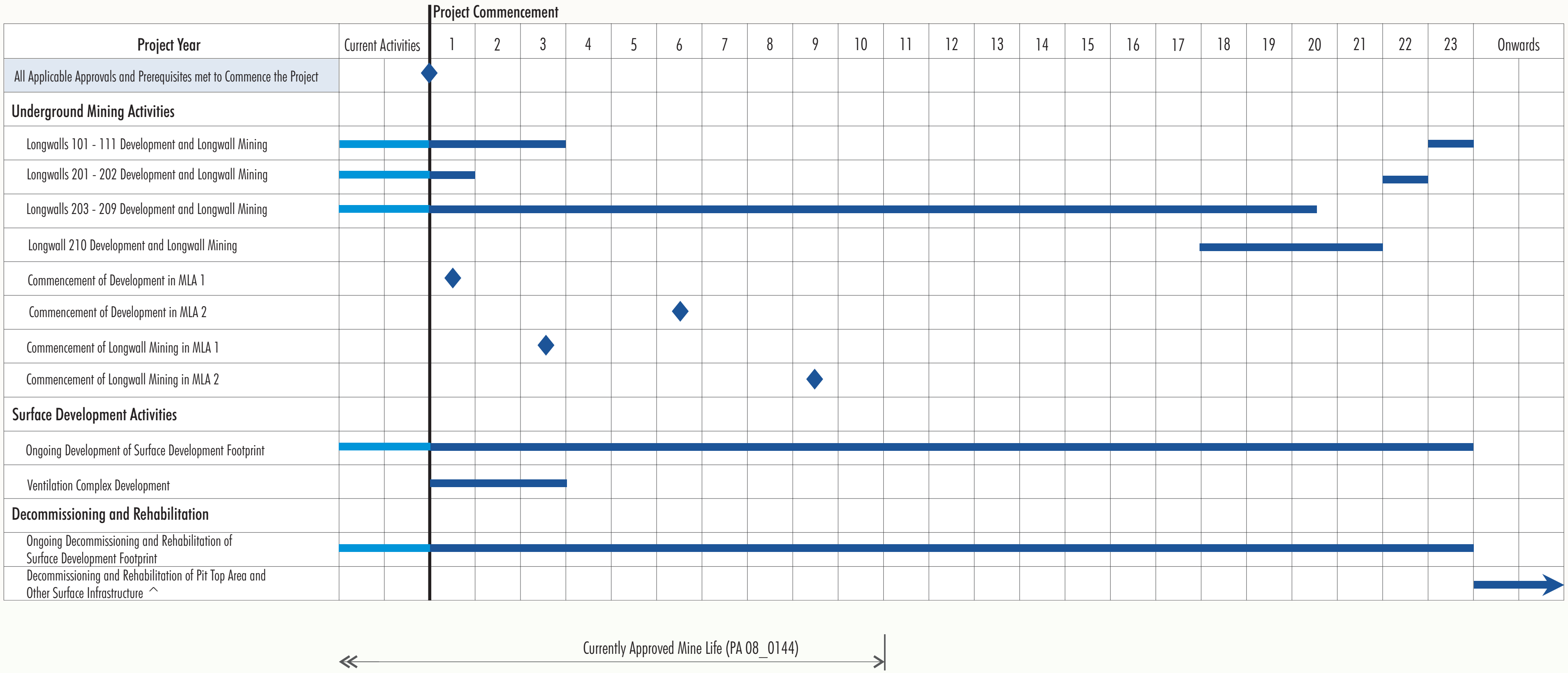
An indicative Project schedule is shown on Figure 2-8. The Project is assumed to commence in 2022.

2.5 PROJECT DEVELOPMENT ACTIVITIES

The Project would use the existing and approved Pit Top Area and supporting infrastructure described in Section 2.1.

Additional infrastructure and upgrades to existing infrastructure that are required to support the Project would be progressively developed in parallel with ongoing mining operations, including:

- development of underground roadways, coal clearance infrastructure and other ancillary infrastructure required to access and support Project underground mining areas (Section 2.5.2);
- underground mining machinery replacement and upgrades (Section 2.5.3);
- development of services corridors and access tracks to surface infrastructure (Section 2.5.4);
- development of mine ventilation infrastructure (Section 2.5.5);
- development of gas management infrastructure (Section 2.5.6);
- development of exploration boreholes (Section 2.5.7);
- development of service boreholes (Section 2.5.8);



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LEGEND

Approved Narrabri Mine Activities *

Project Activities

* Approved Narrabri Mine activities would occur within ML 1609 only and under Development Consent PA 08_0144.

^ Subject to consultation with relevant stakeholders.

NARRABRI STAGE 3 PROJECT

Indicative Project Schedule

Figure 2-8

- development of pre-conditioning areas (Section 2.5.9);
- water management system upgrades (Section 2.5.10);
- CHPP upgrades (Section 2.5.11); and
- minor augmentations and upgrades of other surface facilities.

Surface construction and development would generally occur 7.00 am to 6.00 pm, seven days per week. Activities undertaken outside of these hours would include:

- excavation of ventilation shafts, and other drilling activities, which may be conducted 24 hours per day, seven days per week;
- activities that cause equivalent continuous noise level over a sample period of 15 minutes ($L_{Aeq(15\ minute)}$) of no more than 35 decibels (dB) at any privately-owned residence, or at a higher level that has been agreed with the resident;
- the delivery of construction materials of which delivery is required, by the NSW Police or the NSW Roads and Maritime Services (RMS), to be undertaken for safety reasons outside the normal construction hours; and
- emergency work to avoid the loss of life, damage to property or to prevent environmental harm.

The existing mobile equipment including drill rigs, mobile cranes, excavators, loaders and delivery trucks, would generally be required for ongoing development activities. During periods of more intense development, additional mobile equipment may be required.

The number and type of equipment would vary, depending on the development activity being undertaken.

Additional infrastructure required for the Project would be developed within the indicative Surface Development Footprint shown on Figure 2-6 and described below.

2.5.1 Indicative Surface Development Footprint

The indicative Surface Development Footprint is the area of land proposed to be directly impacted by the Project based on the current mine design (Figure 2-6). Some flexibility in the indicative Surface Development Footprint is needed over the life of the Project to allow for further detailed mine planning during development and operations, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts.

Any such changes are expected to be minor and, therefore, would not have an increased impact on the biodiversity values identified in the EIS. Throughout the life of the Project, NCOPL would track actual native vegetation/habitat clearance against the indicative Surface Development Footprint and the allowance included in the calculation of biodiversity credits (Section 6.7.6). Any proposed native vegetation/habitat clearance outside of the indicative Surface Development Footprint or beyond the allowance, should it be required, would trigger a review of the proposed activities, the relevant Project approval documentation and MOP and the impact on biodiversity values.

To facilitate this review, Vegetation Zones (Plant Community Types in broad condition states) and habitat for species credit species (i.e. those species which a species polygon is required to be determined by the area of habitat) have been mapped in and surrounding the indicative Surface Development Footprint. This mapping is provided in the BDAR (Appendix D).

There is a single species credit species recorded, namely Coolabah Bertya, for which the credit requirement is required by the DPIE to be determined by a count of the number of individual plants within the indicative Surface Development Footprint. For this species, the credit requirement was based on a conservative estimate of the density of Coolabah Bertya individuals for each Vegetation Zone (which exceeded the count of the number of individual plants). NCOPL would track the clearance of the number of Coolabah Bertya plants by applying the density to the area of habitat to be cleared.

The development of key surface infrastructure components required for the Project (and for the approved Narrabri Mine) that form the indicative Surface Development Footprint are discussed in the subsections below. The locations of surface infrastructure components have been selected in consideration of avoiding or minimising impacts to surface features (e.g. infrastructure would avoid significant features such as rock outcrops to minimise impacts, where practicable). Furthermore, Palaris (2020a) has reviewed the indicative disturbance footprints of individual key surface infrastructure components for the Project against other comparable underground coal mines in NSW and Queensland. Palaris (2020a) concludes the disturbance footprints of individual infrastructure components proposed for the Project are below the industry averages.

As part of the Amendment Report, NCOPL has refined the Project design to reduce the indicative Surface Development Footprint, and to reduce the Project's impact on Coolabah Bertya (a threatened plant species).

Impacts during clearing would be minimised through the implementation of a vegetation clearance protocol (Section 6.7.4).

Areas of approved surface disturbance that are no longer proposed for the Project are described in Section 2.15.

2.5.2 Development of Access and Supporting Infrastructure for Underground Mining Areas

Underground roadways would continue to be developed to access and support the Project underground mining areas (i.e. for access, ventilation and coal clearance).

Coal clearance infrastructure and other ancillary infrastructure would be developed for the Project underground mining areas. The existing coal clearance infrastructure would also be upgraded and augmented progressively throughout the life of the Project through replacement or upgrades of conveyors, sizers, drives, winders and supporting systems.

Other ancillary infrastructure required to support the Project underground mining areas includes infrastructure for electricity distribution, communication systems, water management, services and service delivery (e.g. boreholes to the surface).

2.5.3 Mining Machinery Replacement and Upgrades

Over the life of the Project, it is anticipated that a range of the current underground mining equipment (Section 2.1.1) and surface mobile fleet (Section 2.1.2) would be replaced or upgraded as a component of general maintenance, or to increase efficiency.

2.5.4 Services Corridors and Access Tracks

Services corridors and access tracks would continue to be progressively developed for the Project to provide access from the Pit Top Area to surface infrastructure components.

The indicative locations of services corridors and access tracks for the Project are shown on Figure 2-6. The exact locations may change subject to further detailed mine planning, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts (Section 2.5.1).

As part of the Amendment Report, NCOPL would remove components of the indicative Surface Development Footprint including:

- **a reduction in clearing associated with electricity transmission lines based on updated engineering design;**
- **portions of the access tracks and post drainage corridor would be removed where goaf gas is not required; and**
- **post drainage corridors located outside of longwall blocks would be narrowed as no drilling is required in those areas.**

Minor amendments to access tracks were also undertaken to further avoid impacts on Coolabah Bertya.

Project services corridors would generally include roadways, pipelines, pumps, telecommunication infrastructure, power transmission infrastructure, sediment controls and other ancillary infrastructure.

Project access tracks would generally include roadways, pipelines, pumps, sediment controls, goaf gas drainage infrastructure (Section 2.5.6) and other ancillary infrastructure. Narrower access tracks would also be developed where goaf gas drainage is not required.

Small borrow areas may be developed within the corridors and access tracks to provide material for development activities (e.g. roadbase).

Services corridors, access tracks and other infrastructure would utilise fords or culverts to traverse drainage lines in accordance with the Fisheries NSW *Policy and Guidelines for Fish Habitat Conservation and Management* (Department of Primary Industries [DPI], 2013a).

2.5.5 Mine Ventilation Infrastructure

The Project would involve the continued use of existing upcast (return) and downcast (intake) ventilation shafts.

The Project would also continue to use the existing drifts as intake airways.

In addition, the Project would involve the progressive establishment of two additional ventilation complexes.

The indicative locations of the ventilation complexes potentially required for the Project are shown on Figure 2-5. The exact locations may change subject to further detailed mine planning, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts (Section 2.5.1).

The requirement for each ventilation complex is subject to detailed mine planning (i.e. some ventilation infrastructure may not be required).

The development area for each ventilation complex would generally include:

- drilling areas;
- laydown and parking areas;
- soil and spoil stockpile areas;
- sediment dam and sump areas;
- construction offices and amenities;
- generators, compressors, lighting and fuel storage area;
- nitrogen plant areas; and
- areas for other associated infrastructure and works.

Development of each ventilation complex would generally include:

- development of two concrete-lined or steel-lined shafts, typically approximately 6 m in diameter;
- installation of ventilation fans and associated power supply (for the upcast ventilation shaft);
- development of other boreholes as required (e.g. dewatering, gas monitoring, power reticulation, concrete and ballast boreholes);
- installation of a power supply and transmission and associated electrical switchroom, transformer and ancillary infrastructure for the ventilation fans (for the upcast ventilation shaft);
- installation of Personal Emergency Device (PED) cables to facilitate emergency transportation to/from underground mining operations;
- installation of erosion and sediment control infrastructure;
- construction of temporary in-ground or above-ground sumps for the containment of drilling process water;
- installation of appropriate security (i.e. fencing) and development or improvement of access where required (Section 2.5.4); and
- other minor associated infrastructure and works.

Cut-throughs (development between two underground roadways) may be required during the development to facilitate enhanced ventilation.

It is expected that the ventilation shafts would be constructed using either the "blind bore" or conventional shafts sinking methods (from the surface down to the underground) or a "raise bore" (from the underground up to the surface) or using other construction methods identified through the detailed design process. Using the blind bore method, the shaft development would take place in advance of development workings, with material from the excavation being removed from the top of the shaft. The raise bore method involves using a pilot hole for guidance to develop the bore from the underground working to the surface.

It may be necessary to initiate small blasts within the shafts, particularly when harder volcanic units are encountered. Such blasts are routine for shaft development and cause few effects because of their small size and depth below the surface.

The mined rock from the development of ventilation shafts would be used as fill material for the development of Southern Mine Water Storage, sediment dams and/or other infrastructure construction activities. Any excess material would be stockpiled at the ventilation complex, temporarily revegetated and used for future rehabilitation of the shaft sites upon decommissioning.

Excavation of the shafts would occur 24 hours per day, seven days per week.

Ventilation fans, electrical infrastructure and other infrastructure may be upgraded, converted between upcast and downcast, replaced or decommissioned and removed during the life of the Project subject to detailed mine planning.

Development of ventilation shafts would be documented in the MOP and relevant Annual Reviews.
The operation and decommissioning of ventilation infrastructure is described in Section 2.6.6.

2.5.6 Gas Management Infrastructure

Pre-mining gas drainage and goaf gas drainage would continue to be progressively developed for the Project to reduce the gas content in the coal seam to levels suitable for safe underground mining operations.

The indicative locations of gas management infrastructure areas are shown on Figures 2-2 and 2-6. The exact locations may change subject to further detailed mine planning, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts (Section 2.5.1).

Gas management operations are described in Section 2.6.7.

Underground In-Seam Pre-drainage

Conventional underground in-seam pre-drainage would continue to be undertaken by drilling into the coal seam from gate roads, with gas collected and then pumped to the surface for venting at service boreholes using mobile extraction units (Section 2.5.8).

Underground in-seam pre-drainage does not involve surface disturbance (except for infrastructure on the surface where gas is transferred to).

Surface to In-Seam Pre-drainage

SIS pre-drainage would continue to be progressively undertaken where conventional underground in-seam drainage is not feasible (e.g. where gas or water content is too high, or pre-drainage is required prior to establishment of the underground gate roads).

The existing and indicative future locations of SIS pre-drainage borehole areas for the Project are shown on Figure 2-2. The exact locations of future SIS pre-drainage borehole areas may change, subject to further detailed mine planning during construction and operation, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts (Section 2.5.1).

The development area for each SIS borehole would generally include:

- drilling areas;
- laydown and parking areas;
- soil and spoil stockpile areas;
- sediment management measures; and
- areas for other minor associated infrastructure and works.

SIS pre-drainage borehole development activities would generally include:

- development of a small-diameter borehole;
- construction of in-ground or above-ground sumps for the containment of drilling process water;
- installation of erosion and sediment control infrastructure;
- installation of gas management infrastructure (including flaring infrastructure, if required);
- installation of appropriate security (i.e. fencing) and development or improvement of access where required (Section 2.5.4); and
- other minor associated works.

It is expected that the SIS pre-drainage boreholes would be constructed from the surface down to the underground (i.e. conventional drilling methods) with casing being installed where required, but may be constructed using other methods subject to further detailed mine planning.

The operation and decommissioning of SIS pre-drainage boreholes is described in Section 2.6.7.

Goaf Gas Drainage

Goaf gas boreholes would continue to be developed for the Project to drain gas from the goaf. Goaf gas drainage boreholes would generally be developed within the access track corridors or, in the case of approved (but not constructed) goaf gas boreholes, on discrete pads.

The indicative locations of goaf gas boreholes areas for the Project are shown on Figures 2-2 and 2-6. The exact locations may change subject to further detailed mine planning, operational/mine safety requirements for specific siting of infrastructure to minimise impacts (Section 2.5.1). **NCOPL has narrowed post-drainage corridors located outside of the longwall blocks as drilling is not expected to be required within those areas.**

The development area of each goaf gas drainage borehole would generally include:

- drilling area;
- laydown and parking areas;
- soil and spoil stockpile areas;
- sediment management measures; and
- areas for other associated infrastructure and works.

Goaf gas borehole development activities would generally include:

- drilling of small-diameter hole(s);
- development of in-ground or above-ground sumps for the containment of drilling process water;
- installation of erosion and sediment control infrastructure;
- installation of gas management infrastructure;
- installation of appropriate security (i.e. fencing) and development or improvement of access where required (Section 2.5.4); and
- other minor associated works.

It is expected that the goaf gas boreholes would be constructed from the surface down to the underground, with casing being installed where required, but may be developed using other methods subject to further detailed mine planning.

The operation of goaf gas drainage sites is described in Section 2.6.7.

2.5.7 Exploration Boreholes

Exploration boreholes would continue to be developed for the Project to inform coal, strata characteristics and gas quantity for ongoing mine planning.

The indicative locations of exploration borehole areas for the Project are shown on Figures 2-2 and 2-6. The exact locations may change subject to further detailed mine planning, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts (Section 2.5.1).

As part of the Amendment Report, a number of exploration boreholes were removed where they were previously proposed within approximately 400 m of the main headings and the mine sequence allows for the main headings to be in place before the sampling is required, NCOPL would sample gas via underground in-seam techniques and not from the surface.

In addition, as part of the Amendment Report, a number of other exploration boreholes have been removed since the EIS design of the indicative Surface Development Footprint additional drilling information has been finalised. Where this additional information was obtained in close proximity to the proposed exploration borehole, NCOPL has removed the proposed borehole.

The development area for each exploration borehole would generally include:

- drilling area;
- laydown and parking areas;
- soil and spoil stockpile area;

- sediment management measures; and
- areas for other associated infrastructure and works.

Exploration borehole development activities would generally include:

- development of small-diameter hole(s);
- development of in-ground or above-ground sumps for the containment of drilling process water;
- installation of erosion and sediment control infrastructure;
- installation of appropriate security (i.e. fencing) and development or improvement of access where required (Section 2.5.4); and
- other minor associated works.

It is expected that the exploration boreholes would be constructed from the surface down to the underground, with casing being installed where required, but may be developed using other methods subject to further detailed mine planning.

2.5.8 Service Boreholes

Service boreholes would continue to be developed for the Project to provide water, gas and electricity to the underground mining area.

The indicative locations of service borehole areas for the Project are shown on Figures 2-2 and 2-6. The exact locations may change subject to further detailed mine planning, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts (Section 2.5.1).

Based upon additional gas management work undertaken by NCOPL, NCOPL has confirmed that the reduced in-seam gas would result in less pre-drainage underground in-seam drilling requirements. As the reduced pre-drainage means that less service bores that connect the underground in-seam drilling to the surface is required, the number of service boreholes has been reduced substantially in the Amendment Report (i.e. by over 80 boreholes).

The development area for most service boreholes would generally include:

- drilling area;
- laydown and parking areas;
- soil and spoil stockpile areas;
- sediment dam and sump areas;
- construction offices and amenities; and
- areas for other associated infrastructure and works.

Some service boreholes would provide power reticulation along with the other services to the underground mining areas. These sites require a larger area for transformers, generators, compressors, gas extractors, lighting and fuel storage.

Service borehole development activities would generally include:

- development of a large-diameter hole;
- installation of a power supply and transmission and associated electrical switchroom, transformer and ancillary infrastructure (where power reticulation is required);
- installation of erosion and sediment control infrastructure;
- construction of in-ground or above-ground sumps for the containment of drilling process water;
- installation of appropriate security (i.e. fencing) and development or improvement of access where required (Section 2.5.4); and
- other minor associated works.

It is expected that the service boreholes would be constructed from the surface down to the underground, with casing being installed where required (to control the borehole), but may be constructed using other methods subject to further detailed mine planning.

The operation and decommissioning of service boreholes is described in Section 2.11.4.

2.5.9 Mine Safety Pre-conditioning

The Project would include the progressive development of mine safety pre-conditioning of the Digby Conglomerate or other large strata units at both ends of each longwall and in the middle of some longwalls to mitigate the potential for wind blast events occurring underground (Figure 2-6).

As described in Section 2.1.8, more intensive pre-conditioning (i.e. along the entire longwall panel length) is typically required along the longwall panels where the Digby Conglomerate thickens to greater than approximately 20 m.

Based on available geological data, intensive mine safety pre-conditioning would be required for the Project consistent with the approved Narrabri Mine (i.e. above the approved Longwalls 108b, and 109 to 111 [Section 2.1.8]).

Based on available geological data, the Digby Conglomerate thickness within MLAs 1 and 2 generally ranges between 12 and 19 m, and therefore intensive mine safety pre-conditioning is not expected to be required for Longwalls 201 to 210. However, the need for intensive mine safety pre-conditioning would continue to be evaluated.

Notwithstanding, pre-conditioning would be required at both ends of Longwalls 203 to 210, and two additional rows in the middle of Longwalls 203 to 209.

The indicative locations of pre-conditioning areas for the Project are shown on Figures 2-2 and 2-6. The exact locations may change subject to further detailed mine planning, operational/mine safety requirements and for specific siting of infrastructure to minimise impacts (Section 2.5.1).

The development area for each pre-conditioning area would generally include:

- drilling area;
- hydraulic pump areas;
- laydown and parking areas;
- soil and spoil stockpile areas;
- sediment management measures; and
- areas for other associated infrastructure and works.

Development within pre-conditioning areas would generally include:

- development of several small-diameter hole(s) at variable intervals across the pre-conditioning area;
- development of in-ground or above-ground sumps for the containment of drilling process water;
- installation of erosion and sediment control infrastructure;
- installation of hydraulic pumps, clean water dams and gas testing equipment;
- installation of appropriate security (i.e. fencing) to prevent unauthorised access;
- development of access; and
- other minor associated works.

The operation of pre-conditioning areas is described in Section 2.6.8.

2.5.10 Water Management System

Southern Mine Water Storage

Additional water management infrastructure would be required directly south of Longwall 210 to store water from mine dewatering activities.

Development of the additional water management infrastructure area would generally include:

- installation of a lined Mine Water Storage (herein referred to as the Southern Mine Water Storage) (Figure 2-6);
- installation of electric pumps, clean water dams or tanks and gas-testing equipment;
- installation of erosion and sediment control infrastructure;
- installation of appropriate security (i.e. fencing) and development or improvement of access where required (Section 2.5.4); and
- other minor associated works.

The Southern Mine Water Storage would utilise mined rock from the development of ventilation shafts as fill material.

Pipelines between the Southern Mine Water Storage area and the Pit Top Area would be installed to facilitate transfer of clean water and mine water. The pipelines would be installed within services corridors and other cleared areas.

Brine Storage Ponds

NCOPL would progressively construct Brine Storage Ponds (BR1 to BR5) within the approved Brine Storage Area, as required. This would comprise:

- progressive installation of lined ponds within the approved Brine Storage Area;
- installation of erosion and sediment control infrastructure;
- installation of appropriate security (i.e. fencing) and development or improvement of access where required (Section 2.5.4); and
- other minor associated works.

The Brine Storage Pond walls would be constructed with a slope of no greater than 1:3 (vertical [V]:horizontal [H]) or other slopes delivering the same factors of safety. A sequential process of topsoil removal would be adopted, with subsoil recovered from the floor of each Brine Storage Pond used to construct the perimeter walls.

The topsoil would be used to stabilise the outer slopes of the cell walls (which form the perimeter of the Brine Storage Area).

Surplus topsoil would be stored in dedicated stockpiles around the perimeter of the Brine Storage Area.

The Brine Storage Ponds would be lined with a low permeability high-density polyethylene (HDPE) with a permeability of less than $1x10^{-14}$ m/s to minimise the potential for seepage.

Water Management for Underground Mining Area Surface Infrastructure

Sediment dams would typically be constructed within ventilation complex and service borehole pads.

These sediment dams would typically be lined with a low-permeability HDPE. Each ventilation complex and gas management infrastructure pad would be designed and constructed such that any overflow from sediment dam would be retained on the pad itself (i.e. no runoff would be discharged to local drainage or impact on undisturbed vegetation).

2.5.11 Coal Handling and Preparation Facility

Over the life of the Project, a range of equipment within the CHPP and its associated infrastructure would be replaced or upgraded as a result of general maintenance or to increase efficiency.

2.6 UNDERGROUND MINING OPERATIONS

The Project involves the continuation of longwall mining operations within ML 1609 and extension into MLAs 1 and 2 to extract coal from the Hoskissons Coal Seam. The Project (including the approved Narrabri Mine) would involve extraction of approximately 252 Mt of ROM coal.

Based on current mine planning, the approved Narrabri Mine is expected to produce a total of approximately 145 Mt of ROM coal (i.e. approximately 25 Mt less than the approved limit). Therefore, the Project would result in an additional ROM coal production of 107 Mt compared to the currently approved Narrabri Mine, or 82 Mt relative to the approved limit.

Consistent with the approved Narrabri Mine, underground mining operations would be conducted on a continuous basis, 24 hours per day, seven days per week.

2.6.1 Mining Method

Longwall mining methods and equipment would continue to be employed for the Project.

Longwall mining involves the extraction of rectangular panels of coal defined by underground roadways constructed around each longwall. The longwall shearer travels back and forth across the width of the coal face, progressively removing coal in slices from the panel. Once each slice of coal is removed from the longwall face, the hydraulic roof supports are moved forward, allowing the roof and a section of the overlying strata to collapse behind the longwall machine (referred to as forming a 'goaf') (Figure 2-9).

Subsidence-related monitoring and remediation activities for the Project are discussed in Section 2.14.1 and described in detail in Attachment 4.

2.6.2 Longwall Mining Layout

The approved Narrabri Mine allows for extraction of 20 longwall panels (101 to 111, and 201 to 209).

The approved Longwalls 101 to 111 are located north of the existing underground main headings (Figure 2-1). The mining layout of these panels described in Section 2.1.1 (i.e. overall void widths, lengths and extraction heights) would remain generally unchanged for the Project. The approved Longwalls 201 and 202 would similarly remain generally unchanged for the Project.

The approved Longwalls 203 to 209 are located south of the existing underground main headings and would be extended into MLAs 1 and 2 for the Project (Figure 2-5). The southern longwalls would have overall lengths of between approximately 1.3 km and 10.2 km (i.e. an extension of up to approximately 6.2 km for some panels). Consistent with the approved Narrabri Mine, the southern longwall panels would have overall void widths of approximately 400 m (including first workings), and an ~~average~~ extraction height of **up to** approximately 4.3 m.

The southern extent of Longwalls 204 and 205 incorporates a setback from the Bulga Hill, which is a known topographic feature within MLA 2. The setback distance has been developed in consideration of potential subsidence effects and biodiversity impacts. Further detail regarding the setback from Bulga Hill is provided in the Subsidence Assessment (Appendix A) and the BDAR (Appendix D).

The Project would also include mining of a new longwall panel (i.e. Longwall 210) located within MLA 1 (Figure 2-5). Longwall 210 would have a length of approximately 4.0 km, an overall void width of approximately 410 m (including first workings), and an extraction height of up to approximately 4.3 m.

The Project seeks to maximise resource recovery within geological, environmental and infrastructure constraints via the extension of Longwalls 203 to 209.

The conceptual layout of Longwalls 203 to 209 is depicted in Figure 2-5. However, the final layout and mining order of the longwalls would depend on a number of factors, including:

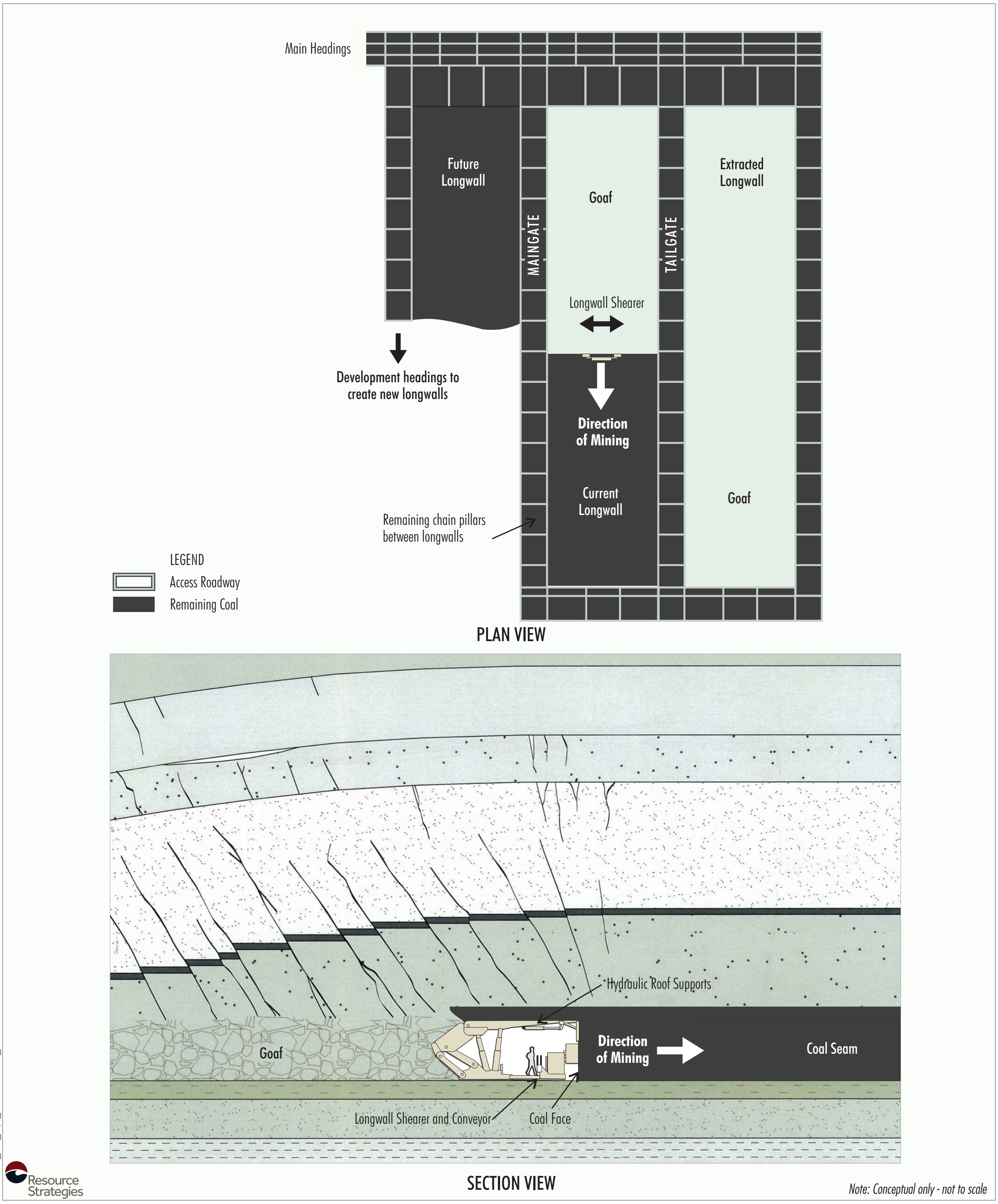
- localised geological features;
- detailed mine design; and/or
- adaptive management requirements.

The final layout of Longwalls 203 to 209 and mining order would be subject to review and approval as a component of future Extraction Plans.

The final layout and mining order of the longwalls approved under future extraction plans may include installation of additional gate roads in Longwalls 203 to 209 as currently approved (Figure 2-1) and/or installing additional gate roads due to geology considerations (similar to Longwall 108 [Section 2.1.1]). If appropriate, these additional workings would result in longwall panels being spilt into two (or more) continuous panels, which would be described in the relevant future Extraction Plans.

An alternative underground mining layout reflecting these changes is shown in Figure 2-10. Potential changes in key impacts associated with the alternative layout are assessed in Attachment 11.

As the conceptual underground mine geometry maximises resource recovery within the underground mining area, such adaptations to the conceptual mine geometry are expected to result in reduced subsidence effects and consequential environmental impacts, as would be detailed in the relevant future extraction plans.



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Resource Strategies

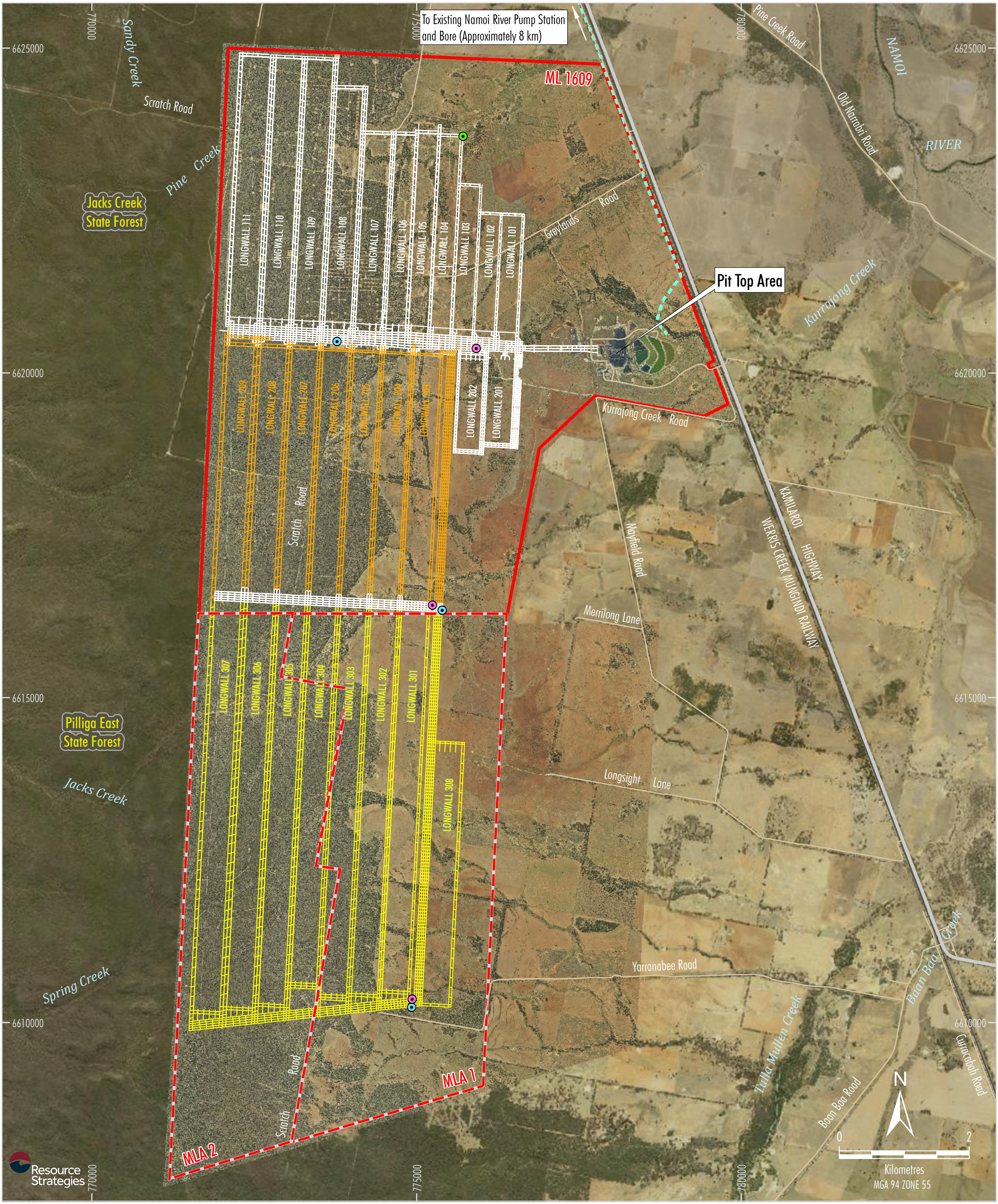
Source: After Hansen Consulting (2008)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Longwall Mining Method - Conceptual Cross-section and Plan

Figure 2-9



LEGEND

Mining Lease (ML 1609)

Provisional Mining Lease Application Area

Existing Namoi River Pipeline (Buried)

Approved Underground Mining Layout

Indicative Underground Mining Layout to be Extended for Project

Indicative Underground Project Mining Layout

Indicative Ventilation Complex (Downcast)

Indicative Ventilation Complex (Upcast)

Indicative Ventilation Complex (Upcast - Decommissioned)

Source: NCOPL (2019); NSW Spatial Services (2019)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project General Arrangement - Indicative Alternative Underground Mining Layout

Figure 2-10

2.6.3 Indicative Mining Schedule

An indicative mining schedule for the Project is presented in Table 2-3. The maximum amount of ROM coal produced in any one year would be 11 Mt.

The existing Narrabri Mine has involved the extraction of approximately 50.6 Mt of ROM coal to the end of June 2020.

The actual timing, mining sequence and annual coal production profile may vary to take account of localised geological features, coal quality characteristics, detailed mine design, mine economics, market volume requirements, and/or adaptive management requirements.

Table 2-3
Indicative Mining Schedule

Project Year	ROM Coal Production (Mt)	Coarse Reject Material (Mt)	Product Coal (Mt)
2021 (Year 0)	6.4	0.02	6.4
1	7.7	0.09	7.6
2	7.1	0.06	7.0
3	6.6	0.03	6.6
4	10.9	0.25	10.7
5	10.9	0.25	10.7
6	9.4	0.17	9.2
7	10.8	0.24	10.6
8	9.0	0.15	8.9
9	10.4	0.22	10.2
10	8.4	0.12	8.3
11	10.3	0.22	10.1
12	9.4	0.17	9.2
13	8.3	0.12	8.2
14	9.4	0.17	9.2
15	8.1	0.11	8.0
16	9.2	0.16	9.0
17	9.2	0.16	9.0
18	7.7	0.09	7.6
19	8.4	0.12	8.3
20	7.5	0.08	7.4
21	9.1	0.16	8.9
22	6.1	0.00	6.1
23	1.3	0.00	1.3

2.6.4 Underground Mine Access

The existing underground mine personnel, materials and coal access (Section 2.1.1) would remain unchanged for the Project (Figure 2-1).
PED cables would also be installed at ventilation complexes to facilitate emergency transportation to/from the underground mining operations.

Underground main headings would be developed to access and support the Project underground mining areas (i.e. for access, ventilation and coal clearance).

Each longwall would be formed by developing gate roads (the tailgate and maingate roads). To construct the gate roads, underground roadways (headings) would be driven parallel to each other using continuous miners.

The headings that form the gate roads would be connected by driving a “cut-through” from one heading to another at regular intervals (Figure 2-9). This leaves a series of pillars of coal along the length of the gate road that support the overlying strata.

In some cases, additional gate roads may be required within the longwall panel footprint due to geology and mine planning considerations (similar to Longwall 108 [Section 2.1.1]).

2.6.5 Major Underground Equipment and Mobile Fleet

The existing underground equipment and mobile fleet (Section 2.1.1) is expected to remain unchanged for the Project. The equipment and mobile fleet may be revised over the life of the Project as operational requirements change.

Over the life of the Project, a range of underground mining equipment would be replaced or upgraded as a component of general maintenance or to increase efficiency (Section 2.5.3).

2.6.6 Mine Ventilation Systems

The existing, approved and additional Project ventilation complexes would continue to ventilate the Project underground areas. The ventilation system would continue to be progressively established for the Project (including the development of the proposed additional ventilation complexes) to maintain a safe working environment and reduce the potential for spontaneous combustion.

The additional ventilation complexes would be constructed progressively, ahead of mine development.

Each ventilation complex would include ventilation shafts which could be upcast or downcast. The upcast ventilation component would include a shaft and fans with a cumulative flow rate of up to approximately 250 cubic metres per second (m^3/s) at each complex.

The downcast ventilation shafts (including the drifts) would draw fresh air underground through the pressure differential created by fans located at the upcast ventilation shafts.

The requirement for each ventilation complex is subject to detailed mine planning (i.e. some ventilation infrastructure may not be required).

Ventilation fans, electrical infrastructure and other infrastructure may be upgraded, converted between upcast and downcast, replaced or decommissioned and removed during the life of the Project subject to detailed mine planning.

Ventilation complexes would be progressively decommissioned and sealed where no further beneficial use is identified. Ventilation shafts would be backfilled with mined rock from development of the shafts, which would be stored at the ventilation complexes during operations.

Further detail of ventilation complex decommissioning and rehabilitation is provided in Section 2.14.

2.6.7 Mine Safety Gas Management

Pre-mining gas drainage and goaf gas drainage would be required for the Project, to reduce the gas content in the coal seams to levels suitable for safe underground mining operations. The progressive development of gas drainage infrastructure is described in Section 2.5.6.

Gas extracted from the Hoskissons Coal Seam associated with the Project is expected to have a higher methane content than the approved mine area, but a lower volume than for the existing Narrabri Mine (Palaris, 2020b).

Gas from the Narrabri Mine is currently vented to the atmosphere (Section 2.1.6).

~~Ongoing monitoring of gas volumes and composition and investigation of developments in flaring technology would determine whether flaring is a viable option to manage gas associated with the Project. Accordingly, depending on localised gas volumes and composition, there may be opportunities to flare gas for the Project.~~

~~Ongoing monitoring of gas volumes and composition and investigation of developments in flaring technology would determine whether flaring is a viable option to manage gas associated with the Project.~~

There are areas of the Hoskissons Coal Seam where the pre-drainage gas content is suitable for flaring (i.e. the methane content is above 30% and the gas content is above 3.5 cubic metres per tonne of ROM coal [m^3/t ROM coal]) (Palaris, 2021). Accordingly, NCOPL would flare pre-drainage gas with a methane content above 30%, oxygen content of less than 6% and gas content of 3.5 m^3/t ROM coal, resulting in a reduction of approximately less than 1% in Scope 1 emissions of the Project.

~~If required for the Project,~~ **F**laring infrastructure would be constructed within the indicative Surface Development Footprint shown on Figure 2-6. Any flares constructed for the Project would be constructed via the enclosed flare method, which is described as (NSW Environment Protection Authority [EPA], 2015):

> *An enclosed flare surrounds the burner head with a refractory shell that is internally insulated. The shell helps to reduce noise, luminosity and heat radiation. Enclosed flares allow better combustion by maintaining temperature, air flow and more stable combustion conditions, maximising the conversion of methane to carbon.*

Gas monitoring systems would be implemented for the Project to monitor gas composition of the air in the underground workings (e.g. carbon dioxide [CO_2] and methane levels) to maintain a safe working environment.

Pre-mining and goaf gas drainage development for the Project would occur ahead of longwall development (i.e. typically approximately one to six months or approximately 500 m ahead of longwall development).

Pre-mining gas drainage infrastructure would be decommissioned after the longwall has passed or where no further beneficial use is identified. Goaf gas drainage infrastructure would be decommissioned as required, or where no further beneficial use is identified (i.e. typically commencing within approximately 2.5 years after the longwall has passed the location).

Further detail of pre-mining gas drainage and goaf gas drainage decommissioning and rehabilitation is provided in Section 2.14.

2.6.8 Mine Safety Pre-conditioning

Pre-conditioning of the Digby Conglomerate and other geological units would be required for the Project to mitigate the potential for wind blast events occurring underground. The progressive development of pre-conditioning areas is described in Section 2.5.9.

Pre-conditioning is conducted at the Narrabri Mine by injecting water under pressure into a section of the strata overlying the coal seam through vertical holes. This practice would be continued for the Project.

Pre-conditioning for the Project would occur approximately one to six months ahead of longwall development as required.
The pre-conditioning areas would be rehabilitated and decommissioned as required, or where no further beneficial use is identified (i.e. typically commencing within approximately 12 months after the longwall has passed the location).

Further detail of mine safety pre-conditioning decommissioning and rehabilitation is provided in Section 2.14.

2.6.9 Water Management

Water would be supplied to the underground mining operations for equipment cooling and dust suppression.

Groundwater and operational water that accumulates in the underground workings would be pumped to the surface via underground sumps, access drifts and/or boreholes. Overlying and adjacent workings may also be dewatered, if required for safety reasons.

Further discussion on the site water management system is provided in Section 2.10.

2.6.10 Other Supporting Infrastructure

Other infrastructure and activities associated with underground mining operations would include:

- infrastructure at the Pit Top Area, such as administration, bathhouse and parking facilities (Section 2.11.1);
- infrastructure for servicing of underground mining equipment;
- infrastructure for electricity distribution and communication systems; and
- storage and handling of materials used by underground mining equipment (e.g. hydraulic fluids, roof bolts, wear plates, miscellaneous consumables and safety equipment).

2.7 ROM COAL HANDLING AND PREPARATION

The Project would use the existing coal handling and processing infrastructure located at the Narrabri Mine.

An indicative coal handling and processing schematic is provided as Figure 2-11.

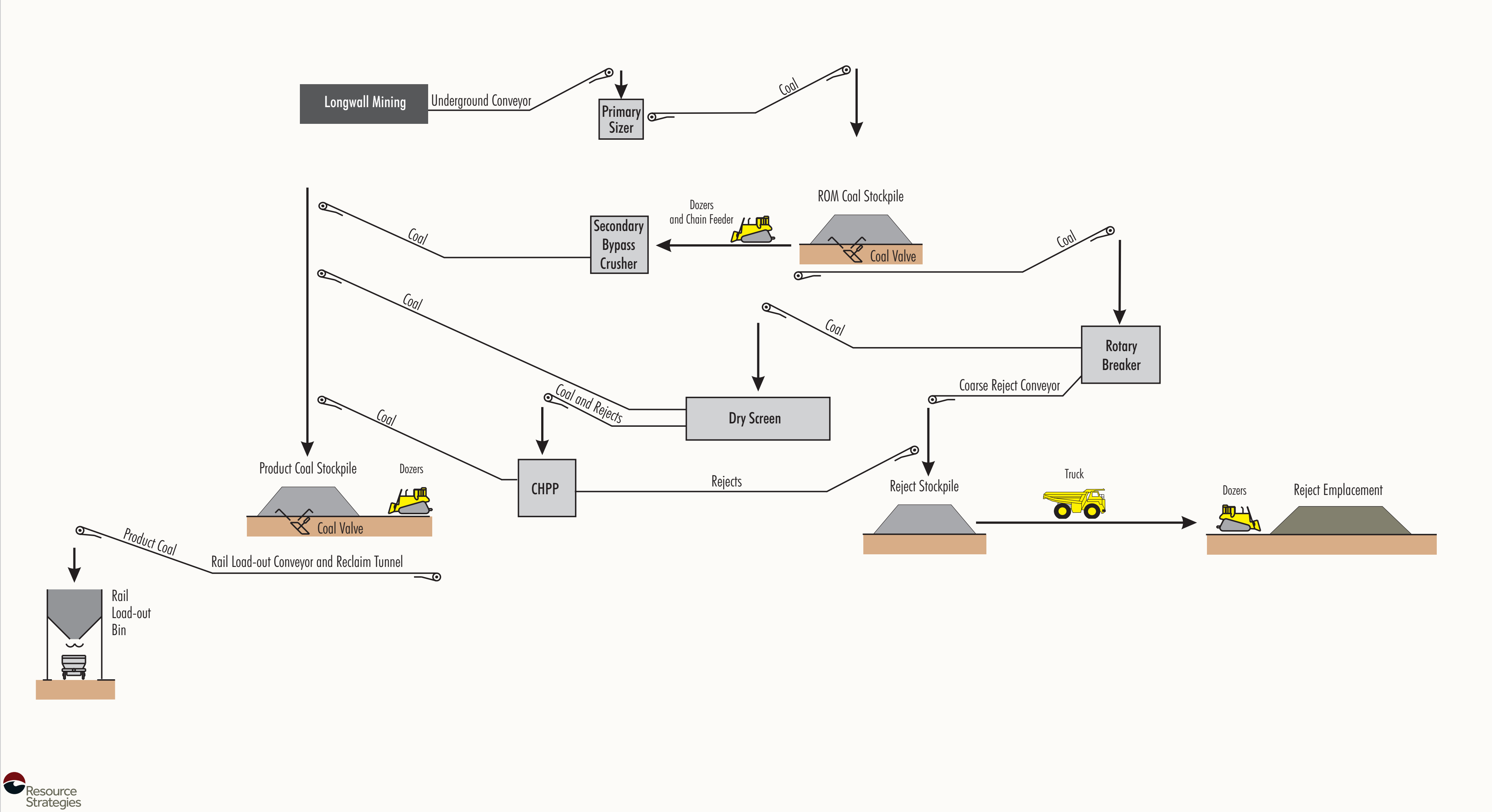
Over the life of the Project, a range of equipment within the CHPP and its associated infrastructure would be replaced or upgraded as a component of general maintenance or to increase efficiency.

2.7.1 ROM Coal Sizing, Stockpiling and Transport

ROM coal is generally primary sized underground before it is transferred to the ROM coal stockpile on the surface via the drift conveyor. A reversible tripper stacks the ROM coal on the ROM coal stockpile in conjunction with dozers.

The ROM coal is then either fed via reclaim valves to a rotary breaker or by dozer push to a chain feeder which feeds a secondary bypass crusher.

The rotary breaker reduces the size of the ROM coal before it is either transferred to the CHPP, or directly to the product coal stockpile.



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Resource Strategies

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Indicative Coal Handling Schematic

Figure 2-11

2.7.2 Coal Handling and Preparation Plant

The CHPP would produce the following main streams:

- combined (partly washed) thermal coal;
- washed PCI coal;
- coarse coal reject material; and
- coal fines.

The existing CHPP comprises a range of components that can be generally classified into three major circuits; the coarse coal, small coal and coal fines circuits. Each of these circuits includes components that separate coal materials on the basis of size (e.g. screens) and on the basis of material type (e.g. cyclones, flotation cells, jig/drum). Each circuit has links to each of the other circuits for recycling of undersize or oversize material.

The small coal and fine coal circuits also include components that are used to dewater coal products (e.g. centrifuges) and the fine coal circuit includes components that are used to dewater coal and coal fines (e.g. thickeners, filters and tailings presses).

Product coal from the CHPP is transferred to the product coal stockpile via conveyor in conjunction with dozers.

The product coal from the secondary bypass crusher is blended with the thermal coal from the CHPP on the product coal stockpile or during train loading. No waste is generated from the secondary bypass crusher except for minor amounts of tramp material.

Further details on product coal handling and transportation and CHPP reject material management are provided in Section 2.8.

2.8 PRODUCT COAL HANDLING AND TRANSPORTATION

An indicative schedule for product coal production is provided in Table 2-3.

Consistent with existing operations, product coal would typically be transported from the Narrabri Mine via the Werris Creek Mungindi Railway to the Port of Newcastle.

Product coal would be loaded onto trains 24 hours per day, seven days per week. Consistent with the approved Narrabri Mine, an average of four trains are loaded each day and a maximum of eight trains each day are loaded during peak coal transport periods.

Product coal would continue to be transported via the Werris Creek Mungindi Railway to the Port of Newcastle for export.

2.9 MANAGEMENT OF REJECT AND EXPLORATION WASTE MATERIAL

2.9.1 CHPP Reject Material Production

Coal reject generated during coal preparation at the Narrabri Mine would include coarse reject and coal fines. Consistent with the approved Narrabri Mine, coarse coal reject generated from the CHPP is disposed of in the reject emplacement area and coal fines are either blended with the unwashed (thermal) coal or disposed in the reject emplacement area.

Approximately 3.53 Mt of coarse reject material would be produced over the life of the Project (including the existing and approved Narrabri Mine). An indicative CHPP reject material production schedule is provided in Table 2-3. The actual quantity produced in any one year may vary with ROM coal production and product coal specifications.

The expected quantity of reject material disposed within the reject emplacement area would continue to be significantly less than the approved reject emplacement area capacity of 8 Mt (Section 2.1.4).

2.9.2 Geochemical Characteristics of CHPP Reject Material

An assessment of the geochemical characteristics of the coarse rejects associated with the Project has been undertaken in the Environmental Geochemistry Assessment (Appendix N) prepared by GEM. A summary of the assessment is provided below.

The Environmental Geochemistry Assessment (Appendix N) concluded that the coarse rejects would be slightly to highly saline.

The Environmental Geochemistry Assessment (Appendix N) concluded that the coarse reject would be predominately non-acid forming (NAF) with a small amount of potentially acid forming – low capacity material and that mixing during disposal would result in an overall NAF material.

Results of the test work on the coarse rejects indicated enrichment of Arsenic (As), Antimony (Sb), Molybdenum (Mo) and Selenium (Se). The contained Se would be readily soluble and the As would be relatively insoluble (Appendix N).

The management of coarse reject is described in Section 2.9.4 and Appendix N.

2.9.3 Exploration Waste from Other Whitehaven Exploration Activities

The Project would involve the co-disposal of up to approximately 15,000 cubic metres of exploration drilling waste (over the life of the Project) from other Whitehaven exploration activities in the area.

Exploration drilling waste would be transported to site by heavy vehicles (e.g. a 11,000 L hydro-excavation vacuum truck) between 7.00 am and 10.00 pm, seven days a week.

The typical geochemical characteristics of exploration waste has been assessed in the Environmental Geochemistry Assessment (Appendix N), which concludes the material would typically be NAF.

Given the minor quantities of drilling waste from other Whitehaven exploration activities proposed to be disposed, the Narrabri Mine reject emplacement area would not require a change to the approved footprint, maximum height or batter angles.

2.9.4 Reject Management

The reject emplacement area is shown on Figure 2-2. The progressive reject emplacement design has been reviewed and updated by ATC Williams (2019) based on the expected quantity and geochemical characterisation of reject and exploration waste to be disposed for the Project.

The reject emplacement area has been designed with specific design criteria such that there is a low risk of geotechnical failure (ATC Williams, 2019).

2.10 WATER MANAGEMENT

The Project would involve the use of the existing/approved water management infrastructure with minor augmentations and extensions, including the progressive development of pumps, pipelines, water storage and other water management infrastructure.

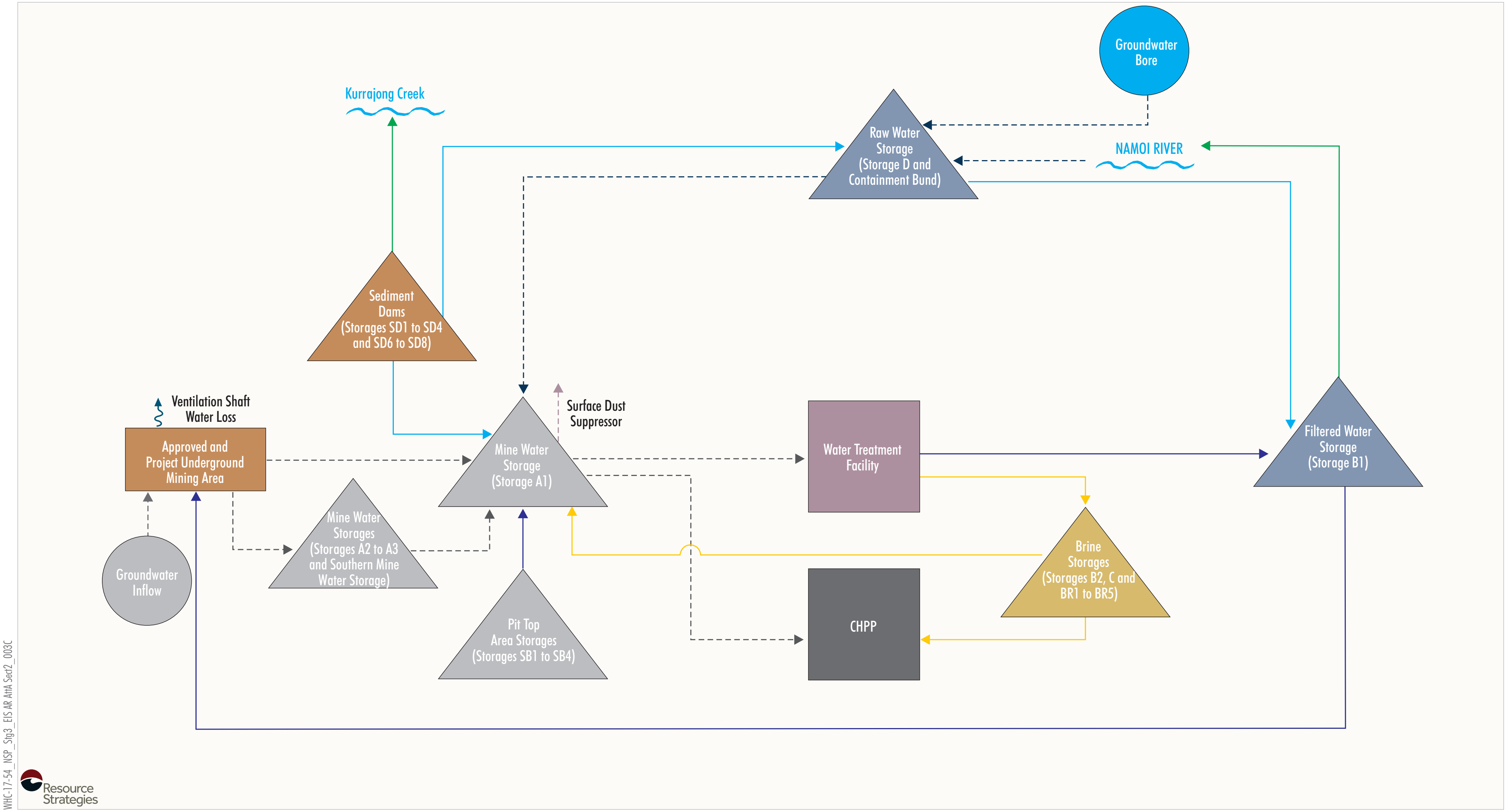
An indicative Project water management schematic is presented as Figure 2-12.

A detailed description of the operation and predicted performance of the Project site water management system is provided in the Surface Water Assessment (Appendix C), prepared by WRM (2020).

2.10.1 Project Site Water Management System

The objectives and design criteria of the Project site water management system would be to:

- protect the integrity of local and regional water resources;
- separate runoff from undisturbed, rehabilitated and mining-affected areas;
- design and manage the system to operate reliably throughout the life of the Project in all seasonal conditions, including both extended wet and dry periods;
- provide water for use in mining and CHPP operations that is of sufficient volume and quality, including during periods of extended dry weather;
- provide sufficient storage capacity in the system to store, treat and discharge runoff as required, including during periods of extended wet weather; and
- maximise the re-use of water on-site.



LEGEND
- Controlled Off-site Discharge or Overflow Due to Rainfall in Excess of Design Storm
- Mine Water / Pit Top Runoff Transfer
- Disturbed Area Runoff Transfer
- Raw Water Transfer
- Filtered Water Transfer
- Brine Water Transfer

Notes:
1. All dams are subject to direct rainfall and evaporation.
2. The Southern Mine Water Storage would be constructed as mining progresses south of mains.
3. BR1 to BR5 would be constructed as required.
4. SD7 has not been constructed.

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Indicative Water Management Schematic

Figure 2-12

To effectively develop a site water management system that addresses the above objectives and design criteria, runoff has been classified into the following categories for the Project:

- Undisturbed Area Runoff – runoff from catchments that have not been disturbed by mining activities. Undisturbed area runoff may be diverted around mining activities to downstream receiving waters.
- Rehabilitated Mine Area Runoff – runoff from rehabilitated mine areas that have established stable vegetation cover. This runoff is expected to have similar water quality characteristics to undisturbed area runoff. The Project site water management system has been designed to allow runoff from these areas to be discharged without control.
- Disturbed Area Runoff – runoff from disturbed areas and areas under active rehabilitation that may contain silt and sediment. The Project site water management system has been designed to capture this runoff in sediment dams or managed in accordance with *Managing Urban Stormwater – Soils and Construction* (Landcom, 2004). Water captured in sediment dams would be:
  - transferred to the Project site water management system for re-use in mine operations; and/or
  - released via licensed discharge points, in accordance with the conditions of EPL 12789 following rainfall events that exceed sediment dam design capacity.
- Pit Top Area Runoff – runoff from Pit Top Areas that may contain silt, sediment and other pollutants (e.g. chemicals and hydrocarbons). The Project site water management system has been designed to contain and re-use this water on-site.

Water would be required for underground mining operations (e.g. for cooling and underground dust suppression), CHPP operations, washdown usage, dust suppression on roads, stockpile dust suppression, and other minor non-potable uses.

The main water sources for the Project would be:

- groundwater inflows to underground workings (mine water);
- catchment runoff and infiltration (refer to runoff types above);
- supplementary licensed extraction from the Namoi River and/or Namoi River alluvium (raw water); and
- potable water transported to site.

The water treatment facilities would treat mine water, disturbed area runoff and Pit Top Area runoff to produce filtered water and a brine waste product. The filtered water would be used in mining operations and the brine would be used for stockpile dust suppression. NCOPL may also investigate options for the beneficial re-use of excess water such as internal use (e.g. irrigation) or provision of water to other water users in the region.

Untreated disturbed area and Pit Top Area runoff would be used in CHPP operations.

Raw water would be used to supplement mining and CHPP operations demand and/or to supply a separate water treatment plant used to produce potable water. Potable water would also be transported to site to supplement the potable water supply from the water treatment plant.

Post-mining water management would incorporate some aspects of the site water management system (i.e. some storages and water management structures would be retained as permanent features) (Attachment 5).

Consistent with the current post-mining water management strategy, brine from the Brine Storage Ponds would be re-injected into the longwall goaf through the disused goaf gas drainage holes or via the underground infrastructure.

Up-catchment Runoff Control

Temporary and permanent up-catchment diversion structures would be constructed over the life of the Project to divert runoff from undisturbed areas around disturbed areas.

Stabilisation of up-catchment diversions would be achieved by the design of appropriate channel cross-sections and gradients and the use of channel lining materials, such as grass or rock fill.

Water Storages

The Project would continue to use existing and approved water storages including (Figure 2-12):

- raw water storage dams (Storage D and Containment Bund);
- mine water storages (Storages A1 to A3);
- Pit Top Area storages (Storages SB1 to SB4);
- a filtered water storage dam (Storage B1);
- brine storage dams (Storages B2, C and BR1 to BR5[5]); and
- sediment dams (SD1 to SD4 and SD6 to SD8[6]).

An additional mine water storage would be constructed south of Longwall 210 (Figure 2-6) as described in Section 2.5.10. This mine water storage would be used for mine dewatering of the southern longwall panels, and to transfer water to the Pit Top Area, as required.

The Pit Top Area storages would capture runoff from the Pit Top Area (e.g. CHPP). The water captured in the Pit Top Area storages would be transferred to the mine water storages.

Water contained in the mine water storages would be transferred to the water treatment facilities for treatment and/or re-used on-site (e.g. CHPP operations, washdown and/or dust suppression).

The filtered water and brine produced from the water treatment facilities would be stored in the filtered water storage and brine storages, respectively, prior to re-use.

Brine storages would be lined with a low permeability HDPE with a permeability of less than 1×10^{-14} m/s to minimise the potential for seepage.

Evaporator spray systems may be installed on water storages to increase evaporation of mine water and brine to remove excess water from the Project site water management system, consistent with the approved Narrabri Mine.

The Pit Top Area, mine water and brine storages have been designed to contain and re-use water on-site. This would involve operating the storages with a maximum operating level to provide freeboard for storm runoff storage. The freeboard for storm storage would be maintained by transferring excess water to other contained storages.

Periodic reviews of the site water balance would be conducted to enable the Project site water management system to be adjusted as necessary.

Water Treatment

The Project would include the continued use of water treatment facilities (and/or other suitable water treatment technologies) to treat water for supply to underground mining operations and potable water.

The capacity of the water treatment facilities would be reviewed as part of the periodic site water balance reviews and the capacity of the water treatment facilities may be adjusted as necessary.

Sedimentation Control

Sedimentation control for the Project would be implemented using sediment dams. Sediment dams would contain runoff from disturbed areas and areas under active rehabilitation that may contain silt and sediment.

Sediment dam storage capacity would be restored through transfer of water to other water storages or through controlled release via licensed discharge points, in accordance with the requirements of an EPL following rainfall events that exceed sediment dam design capacity.

Sediment dams would be maintained until runoff from catchment areas reporting to the sediment dams has similar water quality characteristics to areas that are undisturbed by mining activities (i.e. when vegetation successfully establishes on partially rehabilitated areas), at which point they would be decommissioned and rehabilitated (Section 2.14.2).

[5] BR1 to BR5 have not been constructed. The construction of BR1 to BR5 is described in Section 2.5.10.

[6] SD7 has not been constructed.

Transfer of Water

The transfer of water between water storages is integral to the Project site water management system.

Water transfer infrastructure would include storage tanks, pumps, pipelines and associated power supply. This infrastructure would be developed and relocated progressively over the life of the Project and, as such, this minor ancillary infrastructure is not shown on Figure 2-6.

Farm Dam Decommissioning

As part of the Project, NCOPL would decommission two existing farm dams on Kurrajong Creek prior to longwall mining occurring in those areas. Decommissioning activities would occur generally in accordance with Landcom (2004).

2.10.2 Groundwater Inflows

Groundwater and operational water that accumulates in the underground workings would be pumped to the surface via underground sumps, access drifts and/or boreholes. Groundwater would also be extracted as part of ongoing mine safety management activities.

Predicted groundwater inflows to the underground workings over the life of the Project are predicted to be up to approximately 6.7 megalitres per day (ML/day) (Appendix B).

Licensing of the predicted groundwater inflows for the Project is assessed and described in Section 6.4.4, Attachment 7 and the Groundwater Assessment (Appendix B).

2.10.3 Water Consumption

The main water requirements for the Project would be for mining operations, CHPP operations, washdown usage, dust suppression on roads, stockpile dust suppression, and other minor uses.

Water required for the Project would be preferentially sourced from groundwater inflows to underground workings and catchment runoff and infiltration. Supplementary water supply required over the life of the Project would be sourced from the Namoi River and/or Namoi River alluvium.

The water consumption requirements and water balance of the system would fluctuate with climatic conditions, production rate and as the extent of the mining operation changes over time.

Supplementary water supply from the Namoi River and/or Namoi River alluvium is predicted to range from 0 megalitres per year (ML/year) to 30 ML/year (Appendix C).

Consistent with current practice, water would be preferentially extracted from the Namoi River in accordance with WALs held by NCOPL. When low or no-flow conditions in the Namoi River prevent the extraction of water from the river (or other circumstances such as the Namoi River pump station not being operational), groundwater would be extracted from NCOPL's bore to provide a supplementary water supply, in accordance with WALs held by NCOPL.

A summary of the estimated Project water demands is provided below.

Underground Mining Operations

Treated water used in underground mining operations is predicted to peak at approximately 1.9 ML/day (Appendix C).

Coal Handling and Preparation Plant Make-up Demand

Water used in the CHPP would be recycled with any necessary make-up water obtained from water contained on-site.

The CHPP make-up demand is related directly to the rate of ROM coal feed to the CHPP, the amount of coal bypassed around the coal processing plant, and the rate of production and moisture content of CHPP rejects. The estimated make-up demand is predicted to peak at approximately 1.2 ML/day (Appendix C).

Dust suppression would be required for surface activities and for ROM and product coal stockpiles.

Dust suppression usage would be in the order of approximately 0.5 ML/day (Appendix C).

2.10.4 Namoi River Discharge

Under some climactic conditions, the Project has the potential to receive groundwater and surface water inflows in excess of its consumption requirements.

In the event that excess water accumulates at the Project, consistent with Project Approval 08_0144 and EPL 12789, filtered water that meets the following water quality criteria would be pumped to the Namoi River (Figure 2-1) for release:

- 50th percentile of all samples (volume-based) are below 250 mg/L of TDS;
- 100th percentile of all samples (volume-based) are below 350 mg/L of TDS; and
- pH values of all sampled water to be between 6.5 and 8.5.

In addition, NCOPL would investigate options for the beneficial re-use of excess filtered water with other water users in the Project area (e.g. irrigation) or passing the water to local landholders.

Lastly, consideration would also be given to the injection of excess mine water of suitable quality into the longwall goaf through the disused goaf gas drainage holes or via the underground infrastructure. Any beneficial re-use or underground injection of excess water would be undertaken in accordance with an updated Water Management Plan.

2.10.5 Simulated Performance of the Site Water Management System

A simulated site water balance based on 129 years of climatic data has been prepared by WRM (2020), to simulate the performance of the site water management system over the life of the Project.

The site water balance modelling demonstrates that the proposed site water management system has sufficient capacity and flexibility to accommodate a wide range of groundwater inflows and climate scenarios while (Appendix C):

- providing security of supply for Project operations;
- containing brine on-site, with no uncontrolled off-site release; and
- maintaining a low risk of uncontrolled off-site release of mine water and Pit Top Area water.

2.11 INFRASTRUCTURE AND SERVICES

The Project would involve the continued use of existing and approved surface infrastructure at the Narrabri Mine for the life of the Project, as required.

2.11.1 Surface Facilities

The Project would use the existing surface facilities (such as administration buildings, bathhouses, workshops and storage areas) described in Section 2.1 with minor upgrades and extensions as required.

The Project would use the existing major mobile fleet described in Section 2.1.2. Additional detail of the indicative surface mobile equipment fleet, which would be used during periods of typical operations, is provided in Appendix J.

Additional surface fleet may be present for short periods, for example during longwall change-outs, scheduled plant shutdowns or other maintenance programs over the life of Project.

2.11.2 Site Access

The existing primary access to the Narrabri Mine site from the Kamilaroi Highway is via Kurrajong Creek Road and an internal sealed mine access road connecting to the Pit Top Area (Figure 2-3), which would be retained for the Project.

For environmental monitoring (Figure 2-4), general land management, exploration activities and other ancillary activities, alternative access points to the Narrabri Mine area would also be used as required, consistent with the current access arrangements to the approved Narrabri Mine.

2.11.3 Electricity Supply and Distribution

The existing Narrabri Mine receives electricity via a spur line from a 66 kV supply system adjacent the Kamilaroi Highway (Figure 2-1). Transformers in the Pit Top Area step down the 66 kV supply to 11 kV for distribution by overhead cable or underground cable where necessary.

The 66 kV electricity transmissions would continue to supply most of the electricity requirements of the Project.

The 66 kV electricity transmission line would be progressively extended as ventilation complexes and the mine is developed (Figure 2-5). The Project would involve the development of additional service boreholes for electricity supply to the underground workings (Section 2.11.4). The Project is expected to result in an increased demand for electricity due to additional infrastructure and extension of the underground mining area. **As part of the Amendment Report, clearing associated with electricity transmission lines has been reduced based upon updated engineering design (Unity Power Engineers, 2021).**

In addition, supplementary diesel fuel generations would also be used as required.

2.11.4 Service Boreholes, Access Tracks and Services Corridors

Services such as compressed air, diesel, electricity, nitrogen and water required for the advancing longwall and development operations or ventilation would be delivered from the surface via the drifts and service boreholes. The development of service boreholes is described in Section 2.5.8.

Service boreholes for the Project would be progressively installed approximately one month or 500 m ahead of longwall development.

Service boreholes would be progressively decommissioned as required, or where no further beneficial use is identified (i.e. typically commencing approximately 2.5 years after the longwall has passed the location).

Services corridors would be progressively constructed over the life of the Project. Construction of the main services corridor running north-south would most likely commence in Year 1 of the Project. Services corridors would typically be decommissioned following mine closure or when no longer required.

Access tracks and post-drainage corridors would be constructed ahead of longwall development (i.e. typically approximately one to six months or 500 m ahead of longwall development). Access tracks and post-drainage corridors would be progressively decommissioned once goaf gas drainage areas have been decommissioned and rehabilitated (i.e. typically commencing approximately 2.5 years after the longwall has passed the location), or otherwise when no longer required.

Further detail of surface infrastructure decommissioning and rehabilitation is provided in Section 2.14.

2.11.5 Site Security and Communications

Existing site security measures would be retained for the Project with upgrades as necessary. Additional security fencing for the Project may be erected where necessary (for example at ventilation complex sites).

The existing communications systems at the surface facilities and underground mining operations would be retained for the Project with augmentations as necessary.

2.11.6 Namoi River Pump Station, Production Bore and Pipeline

The Namoi River pump station, alluvial production bore and pipeline are described in Sections 2.1.9 and 2.10.

2.12 WASTE MANAGEMENT

The Project would generate waste streams of a similar nature to current waste generation at the Narrabri Mine, which can be categorised as production and non-production wastes (NCOPL, 2015a):

- Production wastes:
  - Mined rock from development of ventilation shafts.
  - Drill cuttings (e.g. from development of gas management infrastructure, exploration boreholes and service boreholes).
  - Reject generated by the CHPP and underground areas.
  - Brine.
- Non-production wastes:
  - General waste.
  - Hydrocarbons.
  - Treated sewage and effluent.
  - Minor quantities of other waste from mining and workshop activities (e.g. worn tyres and used oil filters) as well as hazardous wastes.

An overview of the waste types likely to be generated by the Project is presented to Table 2-4. Further details on the management of waste is provided below.

2.12.1 Production Wastes

Mined rock from the development of ventilation shafts would be used as fill material for the Southern Mine Water Storage, sediment dams and/or other infrastructure construction activities. Any excess material would be stockpiled at the ventilation complex, temporarily revegetated and used for future rehabilitation of the shaft sites upon decommissioning.

Drill cuttings would be excavated from sumps and disposed of in the reject emplacement area, or consolidated with excavated soil to backfill the sump (where minor amounts of cuttings are present). An area at the reject emplacement area has been established to allow excess water from drill cuttings to decant off prior to cuttings being incorporated into the reject emplacement area (NCOPL, 2019c).

Management of rejects and the receipt of exploration drilling waste from other Whitehaven exploration activities is described in Section 2.9. Management of brine is described in Section 2.10.1.

The *Waste Classification Guidelines Part 1: Classifying Waste* (EPA, 2014) classifies production waste as general solid waste (non-putrescible).

2.12.2 General Waste

Consistent with the NSW waste hierarchy (EPA, 2017a), general waste produced by the Project would be deposited into waste bins segregated to separate general, hydrocarbon and recyclable waste. General waste bins would then be transported to an off-site approved waste handling facility for further segregation.

EPA (2014) classifies general waste as general solid waste (non-putrescible and putrescible).

Table 2-4
Waste Types Likely to be Generated by the Project

Waste Stream	Indicative Waste Class	Management Method
CHPP Reject	-	Refer to Section 2.9.1.
Brine	-	Refer to Section 2.10.1.
Exploration waste	-	Refer to Section 2.9.3.
Worn tyres	Special	Worn tyres would be segregated and collected for either repair (if possible) or disposal by licensed waste contractor(s).
Sewage and effluent	Liquid	The existing wastewater treatment plant would continue to be used to treat effluent on-site, with the treated water discharged to a rehabilitation area.
Excess hydrocarbon material	Liquid	Stored in bunded areas within the workshop or at the waste oil depot prior to collection by licensed contractor(s) for processing off-site.
Asbestos (if identified)	Special	Further assessment and advice would be sought regarding waste classification, handling, treatment, disposal and reporting requirements prior to appropriate disposal.
General solid waste such as Timber, cardboard, paper, steel, scrap metal, food waste, etc.	General Solid Waste (non-putrescible and putrescible)	Transported to an approved waste handling facility and recycled or disposed.
Other general solid waste, such as used oil filter, used particulate filters, and workshop wastes (e.g. rags and oil-absorbent materials that only contain non-volatile hydrocarbons and do not contain free liquids)	-	Temporary storage on-site in designated bins prior to removal from site by appropriately licensed waste contractors.

Waste quantities would vary from year to year and would continue to be reported in Annual Reviews. In 2019, approximately 2,296 tonnes (t) of general waste was generated (NCOPL, 2019b). In addition, approximately 14 t of cardboard/paper, 252 t of timber and 397 t of steel were recycled (NCOPL, 2019b).

2.12.3 Hydrocarbons

Any excess hydrocarbon material that is collected during maintenance activities or through the waste separator would be stored in bunded areas within the workshop or at the waste oil depot prior to removal by a licensed waste oil recycler.

EPA (2014) classifies hydrocarbons as general solid waste (non-putrescible and putrescible).

2.12.4 Sewage and Effluent

At the Pit Top Area, the existing wastewater treatment plant would continue to be used to treat effluent on-site, with the treated water discharged to a rehabilitation area. Treated effluent would be irrigated in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (Department of Environment and Conservation, 2004), and managed in accordance with the Water Management Plan (NCOPL, 2017a) (or the latest approved version).

The sludge waste process generated from the wastewater treatment plant would continue to be collected and transported offsite by licensed contractors. Waste quantities would vary from year to year and would continue to be reported in Annual Reviews. Approximately 556,200 litres (L) of waste sludge was collected and transported off-site in 2019 (NCOPL, 2019a).

EPA (2014) classifies sewage and effluent as liquid waste.

2.12.5 Hazardous Waste

Hazardous waste as classified by EPA (2014), including explosives, lead-acid or nickel-cadmium batteries and containers that have not been cleaned containing residue of dangerous goods would be temporarily stored on-site in a designated area prior to removal from the site by licensed contractors.

2.12.6 Other Waste

Other general solid waste, such as used oil filter, used particulate filters, and workshop wastes (e.g. rags and oil-absorbent materials that only contain non-volatile hydrocarbons and do not contain free liquids) would be temporarily stored on-site in designated bins prior to removal from site by appropriately licensed waste contractors.

Used tyres would be segregated and collected for either repair (if possible) or disposal by a licensed waste contractor. Tyres are classified as special waste in EPA (2014).

Further assessment and advice would be sought regarding handling, treatment, disposal and reporting requirements for any asbestos found on site, prior to appropriate disposal. EPA (2014) classifies asbestos waste as special waste

2.13 MANAGEMENT OF DANGEROUS GOODS

The transportation, handling and storage of all dangerous goods for the Project would be conducted in accordance with the requirements of the NSW *Work Health and Safety Regulation 2017*.

The dangerous goods stored for the Project would include compressed gases, flammable and combustible liquids, and corrosive substances.

Based on the quantities proposed to be stored for the Project, it is not anticipated that a Dangerous Goods Licence would be required.

2.13.1 Transport

Dangerous goods required for the Project would be transported in accordance with the appropriate State legislation.

2.13.2 Hydrocarbon Storage

Hydrocarbons used on-site for the Project would be consistent with current operations and would include fuels (i.e. diesel), oils, greases, degreaser and kerosene.

Hydrocarbon storage facilities are constructed and operated in accordance with AS 1940:2017 *The Storage and Handling of Flammable and Combustible Liquids* and the NSW *Work Health and Safety Regulation 2017*.

2.13.3 Explosives Storage

Explosives may be used during development of ventilation shafts and boreholes as well as underground development. Explosives storage would be conducted in accordance with the NSW *Explosives Act 2003* and *Explosives Regulation 2013* (or their latest versions). The *Explosives Regulation 2013* details the requirements for the safe storage, land transport and handling, and disposal of the explosive, with reference to AS 2187.2:2006 *Explosives – Storage and Use – Use of Explosives* for specific guidelines.

Explosives would continue to be stored at the Pit Top Area in an existing licensed explosives magazine in accordance with Workcover requirements and applicable Australian Standards.

2.13.4 Other Dangerous Goods

The management and storage of chemicals for the Project would be conducted in accordance with NCOPL's prescribed management procedures, and relevant Australian Standards and Codes.

Spill kits would be available onsite and contaminated soil would be rehabilitated in accordance with NCOPL procedures.

NCOPL would continue to assess new substances before their use on-site by completing a substance evaluation and risk assessment. Safety Data Sheets and substance evaluations would be available to site personnel.

2.14 REHABILITATION AND REMEDIATION ACTIVITIES

Rehabilitation is currently undertaken at the Narrabri Mine as described in Section 2.1.12.

The Project would require the progressive rehabilitation of surface development areas and the remediation of subsidence impacts in the underground mine area.

The Project would be rehabilitated to a safe, stable and non-polluting landform of a similar character to surrounding areas.

Rehabilitation would be undertaken progressively as soon as reasonably practicable as areas become available following mining operations.

A summary of the key components is provided below. Further details of the Project rehabilitation and mine closure activities are provided in Attachment 5.

2.14.1 Conceptual Final Landform Design

The Project would not require significant changes to the approved final landform design (Section 2.1.12). The conceptual final landform for the Project would continue to generally approximate the pre-mining landscape with the exception of the reject emplacement area and surface impacts from subsidence in the underground mining area.

Following the completion of mining, mine entrances in the box cut would be sealed in accordance with the requirements of *MDG6001 Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams* (NSW Trade and Investment, 2012). Consistent with the approved final landform, the box cut would then be backfilled with material recovered from the amenity bund and other areas on-site before being re-profiled to be consistent with the surrounding landscape.

Following the dewatering of the Brine Storage Ponds (Section 2.10.1), accumulated salts would be removed from the brine storage pond floor and walls and placed in the box cut. Brine Storage Pond liners would be removed from site by an appropriately licensed waste contractor. The Brine Storage Pond walls would then be pushed in and re-profiled to be consistent with the surrounding landscape (Attachment 5).

The rehabilitated reject emplacement area would be approximately 15 m high with batter slopes of generally 1:5 (V:H) with a maximum grade of 1:4 (V:H) on the north-east batter. An approximate 400 millimetre (mm) clay capping layer would be placed over the final landform prior to revegetation (ATC Williams, 2019).

Landform changes would occur as a result of subsidence in the underground mining area. Surface impacts from subsidence would be progressively remediated in accordance with the procedures referenced in Section 6.3. Post-mining subsidence monitoring would continue for a period of time detailed within the Extraction Plans, and any observed surface impacts would continue to be remediated by NCOPL in accordance with the Extraction Plan.

2.14.2 Post-mining Land Use

For the purposes of rehabilitation and mine closure planning for the Project, NCOPL proposes the post-mining land use of the Project would continue to comprise a combination of native vegetation, agricultural (pasture) and forestry (State Forest) land uses.

Project infrastructure (e.g. rail loop, site access roads, water storages) may be retained for alternate post-mining uses (where agreed with relevant regulatory authorities and landholders).

2.15 IMPACT REDUCTION AREA DEVELOPMENT FOOTPRINT

The indicative Surface Development Footprint (Figure 2-6) excludes some areas of surface development associated with the approved Narrabri Mine (Figure 2-1).

The approved Narrabri Mine surface development areas that are not required for the Project would be foregone subject to approval of the Project. The indicative Impact Reduction Area for the Project is shown on Figure 2-13.

Further detail is provided in the BDAR (Appendix D).

2.16 WORKFORCE

The Project would allow for the continued employment of up to approximately 520 full-time equivalent personnel at the Narrabri Mine.

In addition to ongoing coal mining operations, the existing operational workforce would undertake the following development activities, which would occur throughout the life of the Project:

- Development of underground roadways to access Project underground mining areas.
- Development of coal clearance infrastructure and other ancillary infrastructure required to support Project underground mining areas.
- Development of ventilation complexes and associated infrastructure.
- Gas management works.
- Minor maintenance, replacement or upgrades to areas and infrastructure at the Pit Top Area.

Operations would continue to occur 24 hours per day, seven days per week. The current shift arrangements described in Section 2.1.11, which may be amended from time to time, would continue for the Project.

The operational workforce would continue to predominantly reside locally (e.g. within the NSC and GSC LGAs).

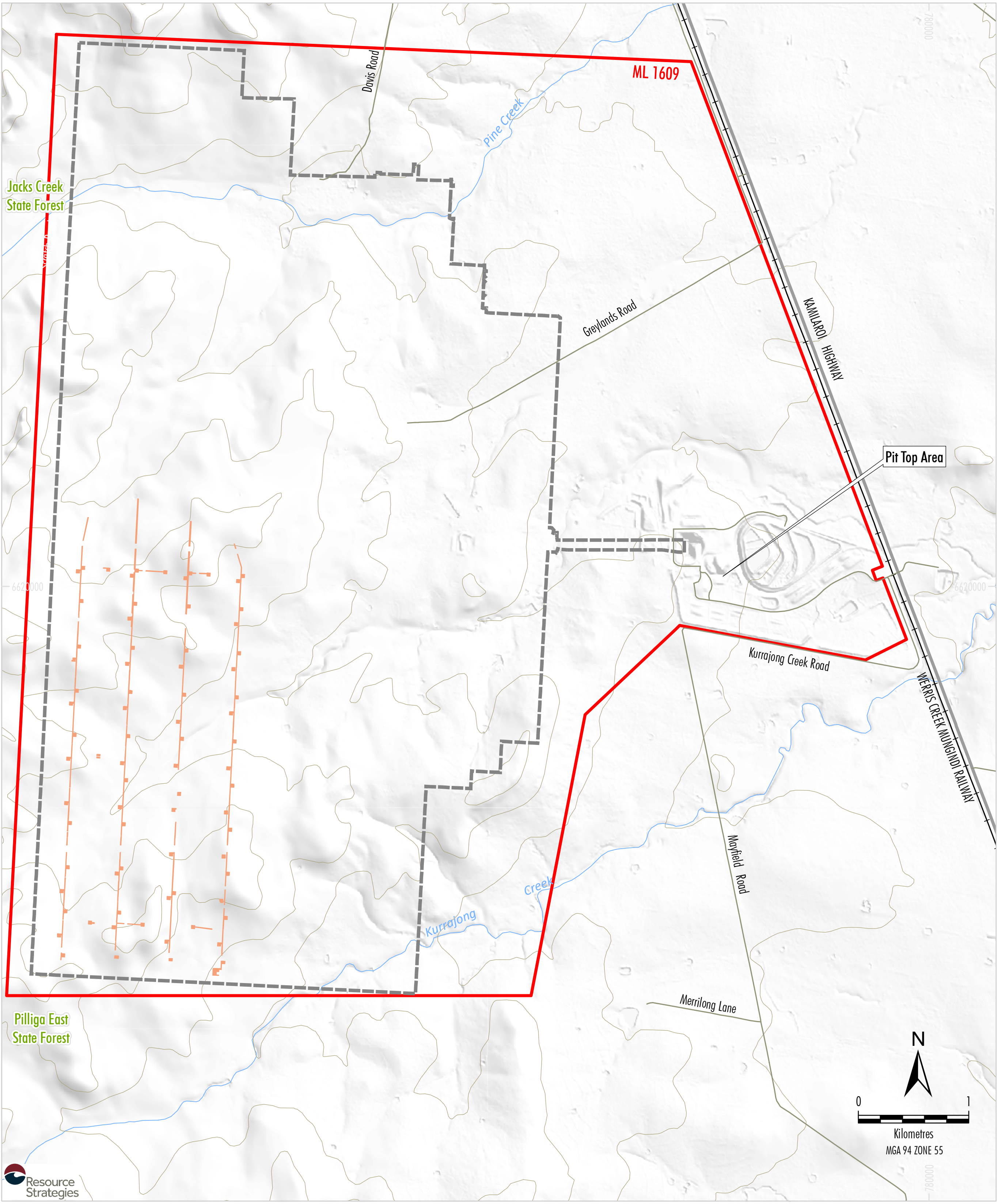
There would be multiple, short periods of development activity throughout the Project life as infrastructure development occurs, which would require additional personnel (Section 2.5). Activities would include longwall change-outs, periods of higher underground development activities, drilling programs, ventilation shaft development, scheduled plant shutdowns or other maintenance programs.

These activities would require approximately 20 full-time equivalent personnel (in addition to the current operational workforce) for multiple, short periods throughout the Project life.

These activities would generally occur 7.00 am to 6.00 pm Monday to Sunday. Activities undertaken outside of these hours would include:

- activities that cause $L_{Aeq(15\ minute)}$ of no more than 35 dB at any privately-owned residence, or at a higher level that has been agreed with the resident;
- the delivery of materials of which delivery is required, by the NSW Police or RMS, to be undertaken for safety reasons outside the normal construction hours; and
- emergency work to avoid the loss of life, damage to property or to prevent environmental harm.

Some development works (e.g. drilling and underground development activities) would occur on a 24-hour-per-day basis.



Source: NCOPL (2019); NSW Spatial Services (2019)

LEGEND

Mining Lease (ML 1609)

Approved Underground Mine Footprint

Indicative Approved Surface Development (Impact Reduction Area)

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project Impact Reduction Area

Figure 2-13

APPENDIX B

GREENHOUSE GAS EMISSION FORECAST

Report

Narrabri Underground Mine Stage 3 Extension Project GHG Emission Forecast

Client	Whitehaven Coal Limited
Site	NSW
Date	May 21
Doc No.	WHC5824-06d

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Version Management

Process	Name	Date	Version
Author	Dane Traeger, Eugene Yurakov	03-05-2021	03
Peer Review By	John Pala	12-05-2021	
Draft Issued To	David Ellwood	12-05-2021	06
Final Review By	Dane Traeger	25-05-2021	
Final Issued To	David Ellwood	25-05-2021	06d

Contents

1 EXECUTIVE SUMMARY

The objective of this study was to estimate volumes of gas and subsequent greenhouse gas (GHG) emissions produced from mining the Hoskissons (HSK) Seam for the Narrabri Underground Mine Stage 3 Extension Project (the Project). The GHG sources attributable to mining were assessed separately by contribution stream, namely gas pre-drainage, development, longwall and outbye sealed areas.

The GHG estimate is underpinned by a detailed gas reservoir and emission assessment conducted for the Project by Palaris in 2019. Reservoir and emission modelling undertaken in the 2019 study has been leveraged to provide the GHG estimate, based on Narrabri Coal Operations Pty Ltd's proposed mine schedule, operational activities, and gas management strategies.

Across the life of the Project (2022-2043) the total GHG emission is estimated to be in the order of 27 Mt carbon dioxide equivalent (CO_2-e) with an average of 1.2 Mt CO_2-e per financial year (Figure 1.1). The highest yearly emissions occur during FY33-38 (1.6-1.8 Mt CO_2-e), which align to the longwall's location in both the highest gas emission and highest CH_4 seam composition areas of the Project domain.

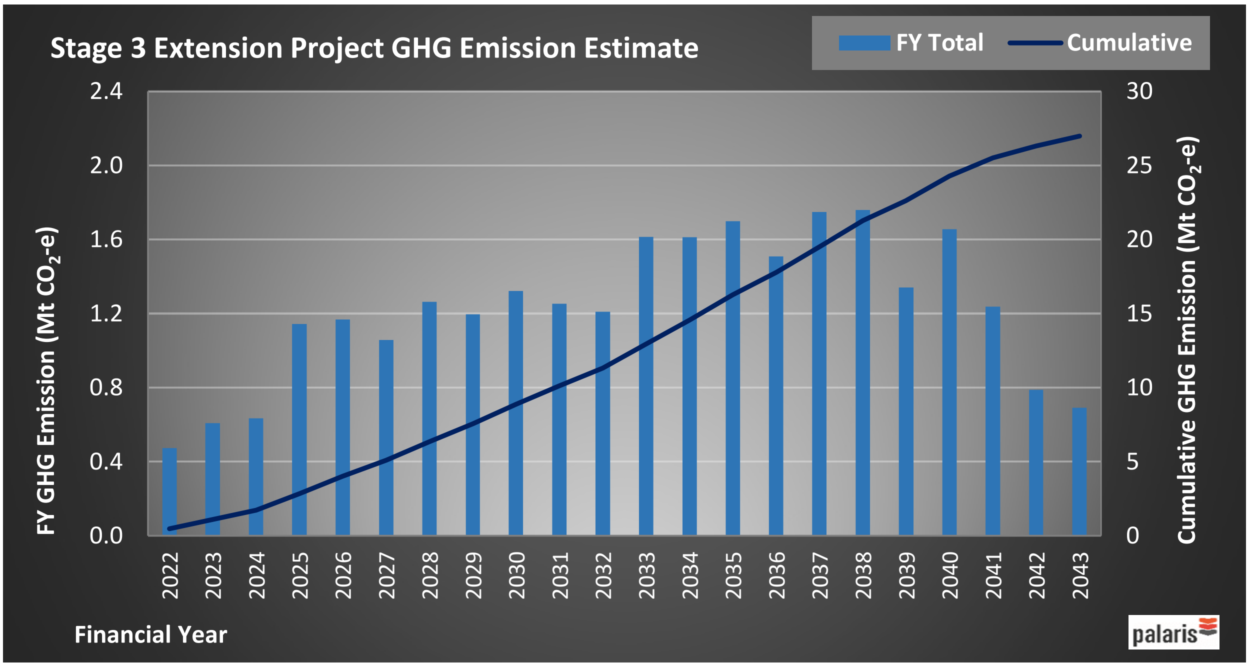


Figure 1.1 – Stage 3 Extension Project GHG Emission Estimate (abated case) – per FY and cumulative

Compared to the historical GHG emissions for the existing Narrabri Mine (~0.4-0.5 Mt CO_2-e per FY), the moderate to low virgin gas contents (2.5 - 5 m^3/t) and an increase in methane (CH_4) gas composition (from 5% up to 40%) of the HSK Seam across the Project area has a significant impact to the GHG emission forecast.

With current technology, gas pre-drainage and the ability to flare the pre-drainage gas are limited in effect for the Project. Previous analysis for the existing Narrabri Mine suggests the remaining gas content after pre-drainage currently is in the order of 3-4 m^3/t. This information combined with a minimum CH_4 composition of 30% for flaring results in low volumes of pre-drainage gas, firstly able to be captured and then destructed.

It is estimated that the gas pre-drainage stream accounts for 2.3% of the total GHG emissions (Figure 1.2), of which 0.2 Mt CO_2-e can be abated from flaring.

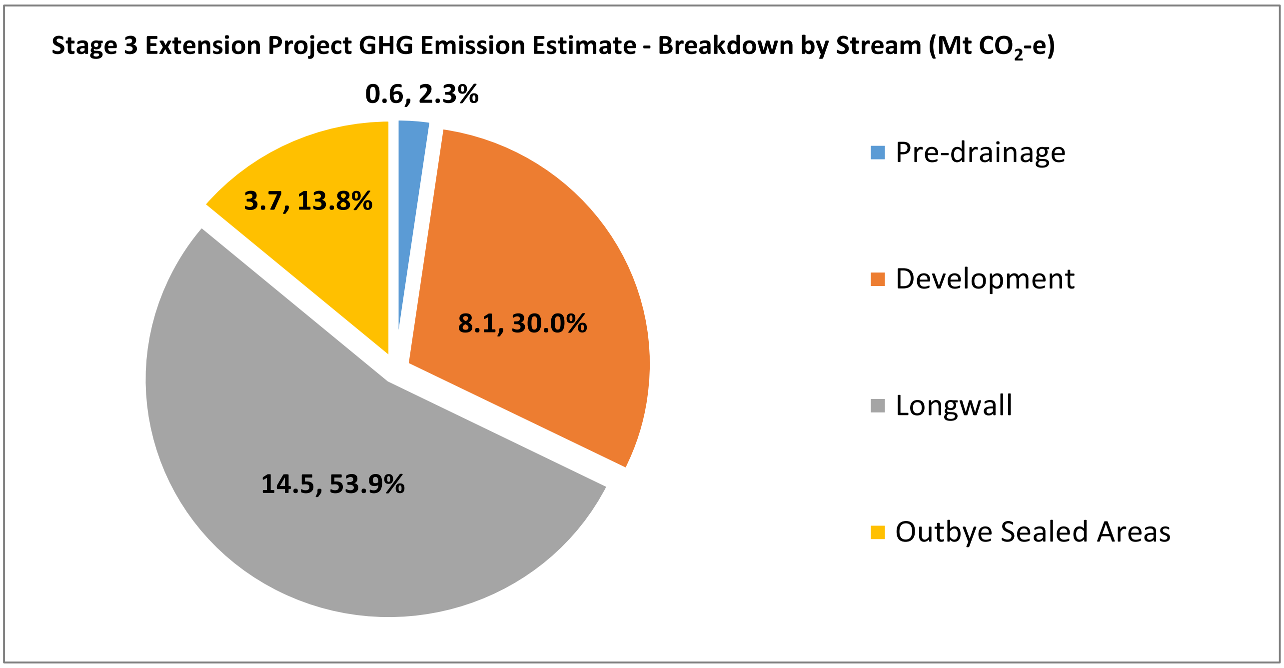


Figure 1.2 - Stage 3 Extension Project GHG Emission Estimate (abated case) - Breakdown by Stream

Longwall mining is identified as the largest contributor to both total volumes of gas and GHG emissions over the life of the Project, accounting for 54% of the total GHG estimate. On a financial year basis, the longwall GHG proportion ranges from 35-77% of the total, the variance reflective of its location in the Project domain.

No abatement of longwall emissions post drainage gas has been included in the GHG estimate. Historically, the oxygen content within the post-drainage stream for the mining operation has been in excess of 10%, meaning that it is unlikely that the post drainage gas could be flared as a discreet flow due to safety constraints (recommended oxygen trip level for flaring set at 6% to maintain adequate levels of safety).

2 BACKGROUND

The Narrabri Underground Mine Stage 3 Extension Project plans to mine the HSK Seam, with the Project area located to the south of the current 100 Panel Mains. The mine plan consists of ten north-south orientated longwall blocks with blocks up to 10 km in length (Figure 2.1). Longwall production is planned to commence in FY24 and cease in FY43, with weekly longwall production forecast to range from 180,000 – 215,000 tonnes per week.

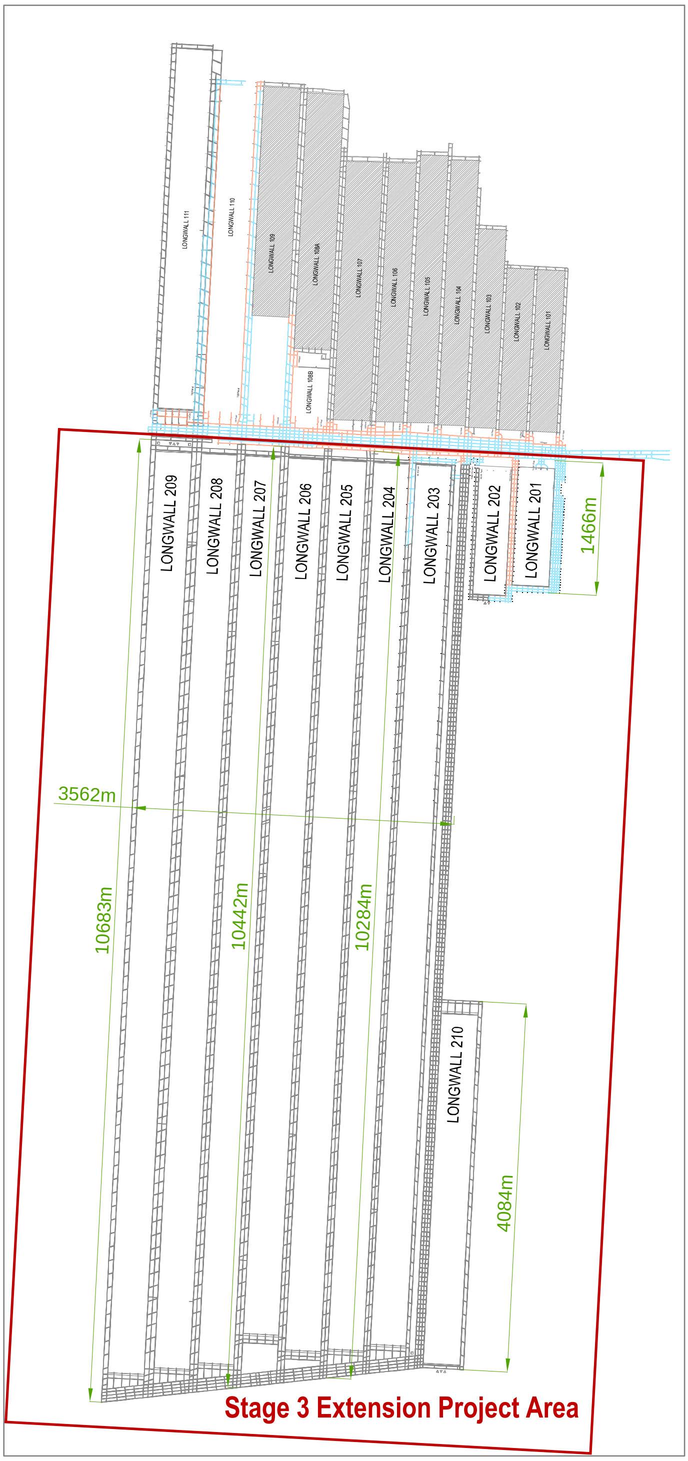


Figure 2.1 Narrabri Underground Mine Stage 3 Extension Project Area

The gas reservoir properties of the Stage 3 Extension Project Area are distinctly different from the current mining area in the North. The key differences are:

- Lower virgin gas contents (2.5-5 m^3/t) for the South compared to the North (5-9 m^3/t) (Figure 2.2)
- Increase in CH_4 composition of the HSK Seam, from ~5% in the North to 30-40% across the south and western areas of Narrabri South (Figure 2.3)
- The presence of the Caroona and Trinky coal formations overlying the HSK Seam which will contribute to longwall gas emissions

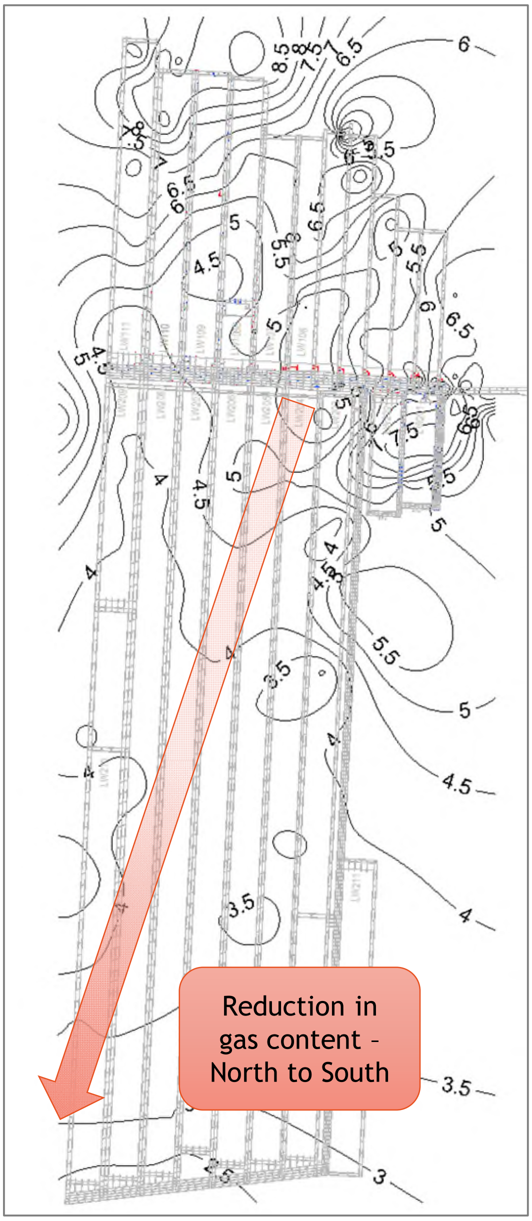


Figure 2.2 HSK Seam Gas Content (m^3/t @ seam ash)

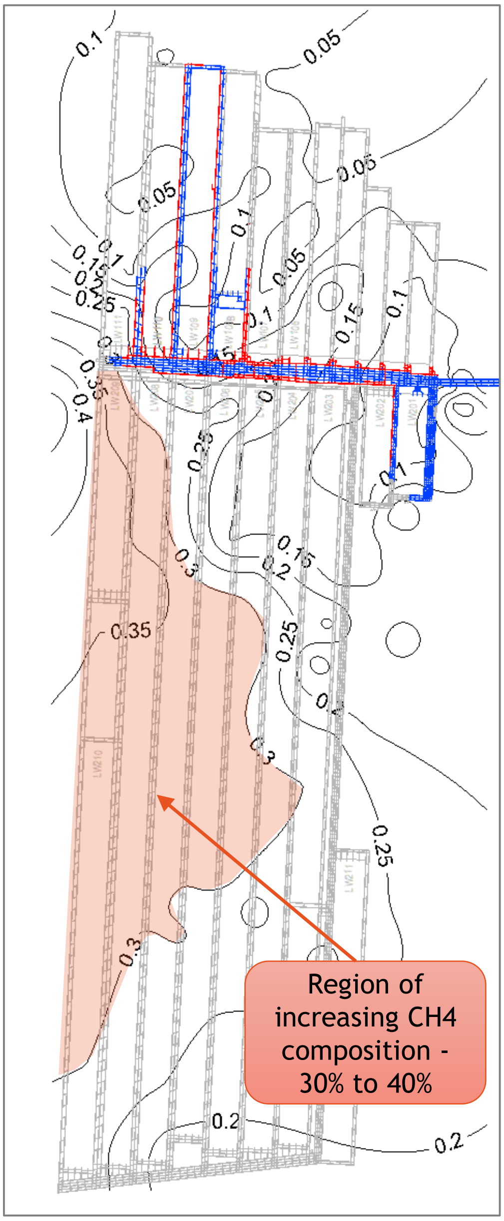


Figure 2.3 HSK Gas Composition ($CH_4/(CH_4+CO_2)$)

The change in gas reservoir properties, in conjunction with 10 km long blocks will result in a different GHG emission profile compared to the North. The contribution streams of gas pre-drainage, development, longwall and outbye emissions have been assessed independently and then collated to build up the total GHG emission estimate for Narrabri South.

3 GAS PRE-DRAINAGE STREAM

3.1 Assumptions

- Gas pre-drainage across Narrabri South consists of:
  - Pre-drainage of the HSK Seam (working seam)
  - Pre-drainage of longwall blocks only
  - Pre-drainage where the gas content of the HSK Seam is greater than 3.5 m^3/t (@ seam ash)
  - Targeting a remaining gas content of 3.5 m^3/t (@ seam ash). The pre-drainage threshold of 3.5 m^3/t is supported by previous analysis for the existing Narrabri Mine (Palaris Report Number WHC4940-01) which identified that across Longwall 108, the remaining gas content after pre-drainage was in the order of 3-4 m^3/t
- Pre-drainage gas volumes have been estimated using a mass balance of the gas in place. With lower virgin gas contents in the Stage 3 Extension Project Area compared to the current mining are in the North (Figure 2.2), the amount of pre-drainage required and resultant volumes of pre-drainage gas will be reduced compared to the North
- Pre-drainage gas can be flared where the HSK Seam gas composition is greater than 30% CH_4 – refer to Appendix A for an excerpt of WHC5733-01 Narrabri Gas Flare Position Report outlining gas flaring potential for Narrabri South
- A flaring efficiency factor of 0.98 is used for flaring of coal mine waste gas
- Pre-drainage gas volumes are reported one financial year (FY) prior to when the longwall will mine the pre-drained area (assumption that boreholes will be online for one year prior to longwall extraction)
- An exception to the above will occur for Longwalls 201 and 202, whereby:
  - The volume of pre-drainage gas will be applied pro-rata from FY24 to FY42 to reflect the continuance of gas drainage for this area across the life of the Project

3.2 Methodology

Table 3.1 below steps out the methodology undertaken and reference material used to estimate:

- The volumes of gas (m^3) from pre-drainage
- The volumes of gas (m^3) from pre-drainage that can be flared
- The fugitive emissions (t CO_2-e) from the extraction of coal (vented gas pre-drainage)
- The emissions (t CO_2-e) from the flaring of the drained coal mine waste gas (flared gas pre-drainage)

Table 3.1 Gas Pre-Drainage GHG Estimate Methodology

Step	Description	Reference Documentation
1	Identify the locations across Narrabri South where: ▪ Gas pre-drainage will occur (>3.5 m^3/t) ▪ The pre-drainage gas can be flared (composition >30% CH_4)	▪ WHC5175 Narrabri South Gas Reservoir and Emission Assessment
2	Overlay the longwall FY mining location (Figure 3.1) on the HSK Seam gas content and composition contouring to establish FY pre-drainage sub-zones (Figure 3.2) delineated by: ▪ Longwall location ▪ Composition (<30% or >30% CH_4)	▪ WHC5175 Narrabri South Gas Reservoir and Emission Assessment ▪ Mine schedule WHC 2019 FEA P3X02 G08 R16 S10 ▪ Stage 3 EIS Period plot.dwg
3	For each pre-drainage sub-zone (Figure 3.2), estimate the average gas content, composition, seam thickness and ash	▪ WHC5175 Narrabri South Gas Reservoir and Emission Assessment
4	Calculate the area of each pre-drainage sub zone	N/A
5	Calculate the volume of gas above 3.5 m^3/t for each pre-drainage sub zone (volume of pre-drainage gas)	N/A
6	Synthesise the data to calculate the volume of pre-drainage gas, flared and unflared for each FY	N/A
7	For each FY: a. Calculate the fugitive emissions (t CO_2-e) from the vented gas pre-drainage b. Calculate the emissions (t CO_2-e) from the flared gas pre-drainage c. Combine (a) and (b) to determine the total emissions (t CO_2-e) from gas pre-drainage - 'base case' d. Establish a 'no flaring case' to calculate the abatement of GHG emissions (t CO_2-e) from flaring	▪ Section 3.6 - Method 4, National Greenhouse and Energy Reporting (Measurement) Determination 2008, Compilation 12, July 20 ▪ Section 3.15 - Method 2, National Greenhouse and Energy Reporting (Measurement) Determination 2008, Compilation 12, July 20 ▪ GWP of CH_4 kept at 25

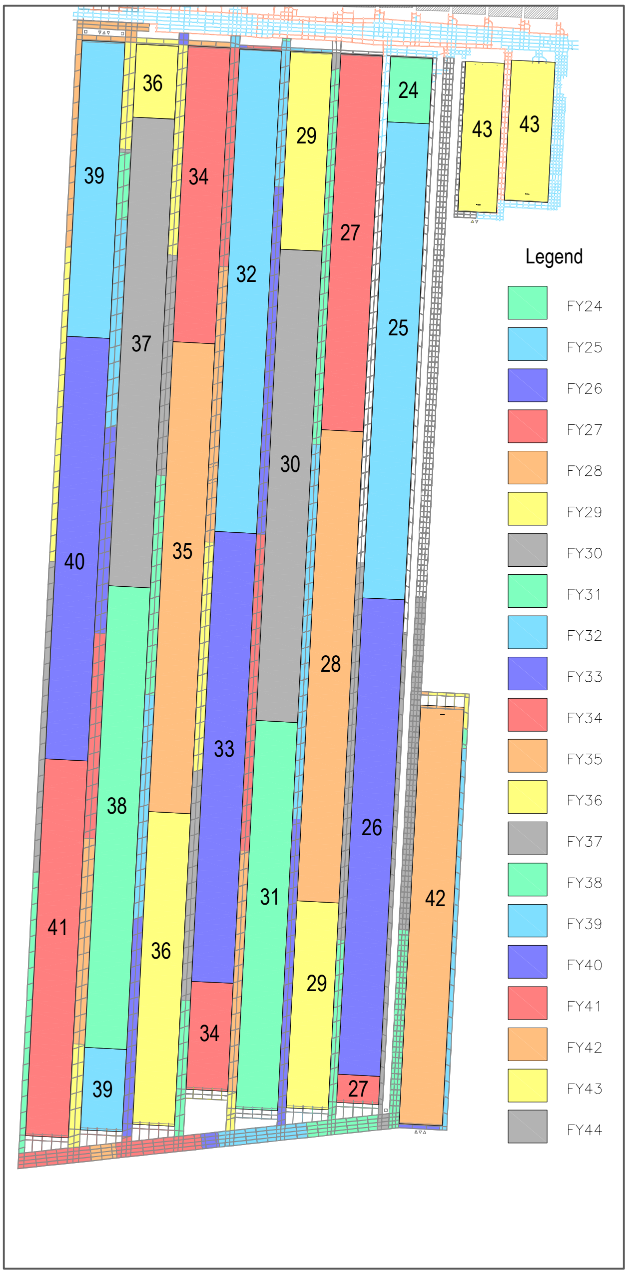


Figure 3.1 Longwall FY Location

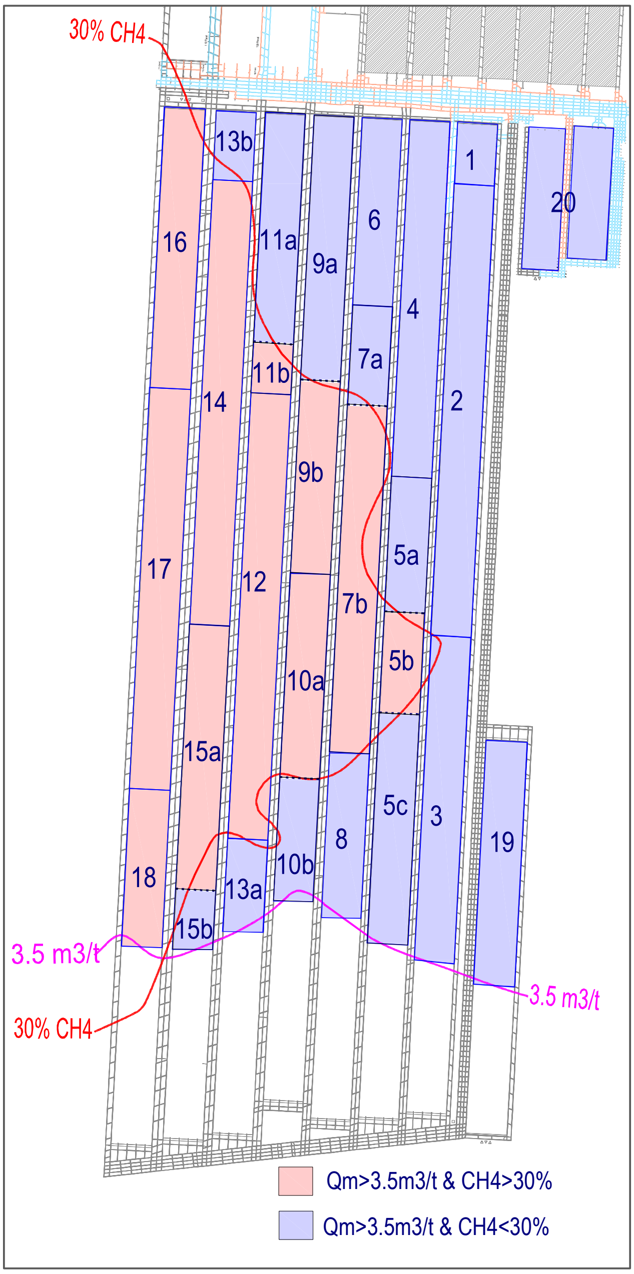


Figure 3.2 Gas Pre-Drainage Sub Zones

3.3 Outcomes

The volumes of gas and GHG emissions resulting from gas pre-drainage are summarised by financial year in Table 3.2. The overall GHG contribution from gas pre-drainage is estimated at 0.6 Mt CO_2-e. It is estimated that flaring will abate approximately 0.2 Mt CO_2-e.

Table 3.2 Gas Pre-Drainage GHG Estimate

LW Mining FY	Gas Drainage Reporting FY	Flared						Unflared						'Base Case (Flared)'	'No Flaring Case'
		Total Pre-drainage Gas (m^3)	Pre-drainage Gas CH_4 (m^3)	Pre-drainage CO_2 Gas (m^3)	Pre-drainage Gas CH_4 Composition (%)	Pre-drainage GHG CH_4 (t CO_2-e)	Pre-drainage GHG CO_2 (t CO_2-e)	Total Pre-drainage Gas (m^3)	Pre-drainage Gas CH_4 (m^3)	Pre-drainage CO_2 Gas (m^3)	Pre-drainage Gas CH_4 Composition (%)	Pre-drainage GHG CH_4 (t CO_2-e)	Pre-drainage GHG CO_2 (t CO_2-e)	Total Pre-drainage GHG emission (t CO_2-e)	*Assume all unflared Total Pre-drainage GHG emission (for comparison) (t CO_2-e)*
2024	2023	-	-	-	-	-	-	3,330,338	339,052	2,991,286	10	5,750	5,567	11,317	*11,317*
2025	2024	-	-	-	-	-	-	20,759,004	4,389,626	16,369,377	21	74,448	30,463	104,911	*104,911*
2026	2025	-	-	-	-	-	-	7,230,738	1,765,396	5,465,341	24	29,941	10,171	40,112	*40,112*
2027	2026	-	-	-	-	-	-	13,856,204	1,871,655	11,984,548	14	31,743	22,303	54,047	*54,047*
2028	2027	1,946,580	603,440	1,343,140	31	1,101	2,500	4,281,773	910,511	3,371,262	21	15,442	6,274	25,316	*34,450*
2029	2028	-	-	-	-	-	-	15,014,396	1,897,301	13,117,095	13	32,178	24,411	56,589	*56,589*
2030	2029	1,694,489	525,292	1,169,198	31	958	2,176	4,948,522	983,006	3,965,516	20	16,672	7,380	27,186	*35,136*
2031	2030	-	-	-	-	-	-	2,143,164	325,298	1,817,866	15	5,517	3,383	8,900	*8,900*
2032	2031	2,706,135	920,086	1,786,049	34	1,678	3,324	14,976,875	2,573,054	12,403,821	17	43,639	23,084	71,724	*85,651*
2033	2032	3,428,798	1,097,215	2,331,582	32	2,001	4,339	2,505,566	442,348	2,063,218	18	7,502	3,840	17,682	*34,290*
2034	2033	1,290,383	425,826	864,557	33	777	1,609	11,047,478	2,640,419	8,407,059	24	44,782	15,646	62,813	*69,258*
2035	2034	5,711,967	1,884,949	3,827,018	33	3,438	7,122	1,364,265	122,784	1,241,481	9	2,082	2,310	14,953	*43,484*
2036	2035	-	-	-	-	-	-	3,818,388	809,938	3,008,450	21	13,737	5,599	19,335	*19,335*
2037	2036	3,980,937	1,433,137	2,547,800	36	2,614	4,741	1,364,265	122,784	1,241,481	9	2,082	2,310	11,748	*33,440*
2038	2037	3,668,107	1,173,794	2,494,312	32	2,141	4,642	1,870,642	269,633	1,601,008	14	4,573	2,979	14,335	*32,102*
2039	2038	6,497,341	2,404,016	4,093,325	37	4,384	7,618	1,364,265	122,784	1,241,481	9	2,082	2,310	16,395	*52,783*
2040	2039	9,167,245	3,025,191	6,142,054	33	5,517	11,430	1,364,265	122,784	1,241,481	9	2,082	2,310	21,341	*67,130*
2041	2040	2,942,842	971,138	1,971,704	33	1,771	3,669	1,364,265	122,784	1,241,481	9	2,082	2,310	9,833	*24,533*
2042	2041	-	-	-	-	-	-	4,608,238	933,777	3,674,461	20	15,837	6,838	22,675	*22,675*
2043	2042	-	-	-	-	-	-	1,364,265	122,784	1,241,481	9	2,082	2,310	4,393	*4,393*

Total:	**615,605**	**834,536**

4 DEVELOPMENT STREAM

4.1 Assumptions

- Rib emission models developed as part of WHC5175 Narrabri South Gas Reservoir and Emission Assessment are used for estimating development rib emissions (all emissions are in the ventilation stream)
- A permeability of 10 millidarcy (mD) has been used for all rib emission models, corresponding to the average value of insitu permeability tests completed across Narrabri South
- The gas pre-drainage target of 3.5 m^3/t as outlined in Section 3.1 has been used to inform the gas content levels in the rib emission models

4.2 Methodology

Table 4.1 below steps out the methodology undertaken and reference material used to estimate the volumes of gas (m^3) and GHG emissions (t CO_2-e) resulting from development mining.

Table 4.1 Development GHG Emission Estimate Methodology

Step	Description	Reference Documentation
1	Calculate the average advance rate for each gateroad	▪ Mine schedule WHC 2019 FEA P3X02 G08 R16 S10
2	Update development rib emission models for the HSK Seam to reflect: ▪ Eastern longwall block (in reference to the gateroad being mined) drained to 3.5 m^3/t ▪ Virgin gas content of the gateroad and the western longwall block ▪ Permeability of 10 mD (average from measured data)	▪ Development emission models developed as part of WHC5175 Narrabri South Gas Reservoir and Emission Assessment
3	For each FY identify: ▪ Development panel(s) being mined (Figure 4.1) ▪ Mid-point distance of the FY from the start of the gateroad panel	▪ Mine schedule WHC 2019 FEA P3X02 G08 R16 S10 ▪ Stage 3 EIS Period plot.dwg
4	Calculate the average rib emission for each FY for each development panel being mined using the mid-point distance in (3) and the rib emission models in (2)	N/A
5	Identify gateroads that are standing from the completion of development to the start of longwall mining	▪ Mine schedule WHC 2019 FEA P3X02 G08 R16 S10 ▪ Stage 3 EIS Period plot.dwg
6	Calculate the standing gateroads duration and apply an emission per FY based on the rib emission modelling in (2)	N/A
7	Synthesise the data to calculate the total volumes of gas (CH_4 and CO_2) for each FY	N/A
7	Calculate the GHG emissions (t CO_2-e) from the extraction of coal (development) using Method 4 from NGERS (2008)	▪ Section 3.6 - Method 4, National Greenhouse and Energy Reporting (Measurement) Determination 2008, Compilation 12, July 2020 ▪ GWP of CH_4 kept at 25

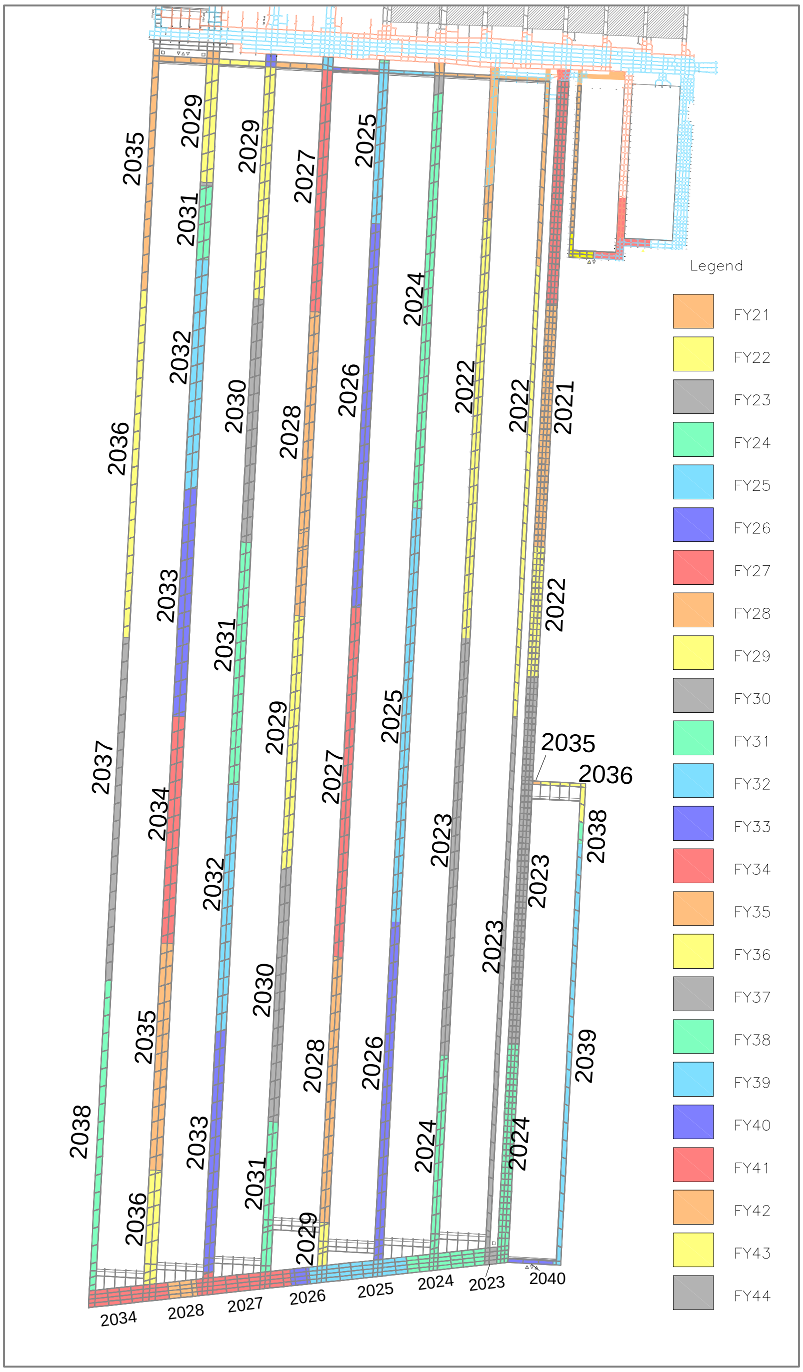


Figure 4.1 Development FY Location

4.3 Outcomes

The volumes of gas and GHG emissions from development mining are summarised by financial year in Table 4.2. In total, approximately 8.1 Mt CO_2-e (~30% of total) of GHG emissions are attributable to development, averaging 0.4 Mt CO_2-e per financial year.

Table 4.2 Development GHG Emission Estimate

Development Mining FY	Panel	Total Development Emission (l/s)	Total Development CH_4 Emission (l/s)	Total Development CO_2 Emission (l/s)	Total Development Emission (m^3)	Total Development CH_4 Emission (m^3)	Total Development CO_2 Emission (m^3)	Development CH_4 Composition (%)	Total Development GHG (t CO_2-e)	Development GHG CH_4 (t CO_2-e)	Development GHG CO_2 (t CO_2-e)
2022	MH200, TG203, MG203	1,841	767	1,074	58,057,776	24,188,112	33,869,664	42	473,262	410,230	63,031
2023	MH200, TG203, MG203	2104	1020	1084	66351744	32,166,720	34,185,024	48	609,166	545,548	63,618
2024	MH200, MG203, MG204, MH201	1746	695	1051	55061856	21,917,520	33,144,336	40	433,403	371,721	61,682
2025	MG204, MG205, MH201, MG203, MH200	1673	693	980	52759728	21,854,448	30,905,280	41	428,166	370,651	57,515
2026	MG204, MG205, MH201, MG203, MH200	1760	780	980	55503360	24,598,080	30,905,280	44	474,698	417,183	57,515
2027	MG205, MG206, MH201, MG204, MH200	1595	777	818	50299920	24,503,472	25,796,448	49	463,586	415,579	48,007
2028	MG205, MG206, MH201, MG204, MH200	1633	824	809	51498288	25,985,664	25,512,624	50	488,196	440,717	47,479
2029	MG205, MG206, MG207, MG208, MH200	1926	1013	913	60738336	31,945,968	28,792,368	53	595,386	541,804	53,583
2030	MG206, MG207, MG205, MH200	1604	869	735	50583744	27,404,784	23,178,960	54	507,921	464,785	43,136
2031	MG206, MG207, MG208, MG205, MH200	1869	1002	867	58940784	31,599,072	27,341,712	54	586,803	535,920	50,883
2032	MG207, MG208, MG206, MH200	1466	823	643	46231776	25,954,128	20,277,648	56	477,919	440,182	37,737
2033	MG207, MG208, MG206, MH200	1416	783	633	44654976	24,692,688	19,962,288	55	455,938	418,788	37,150
2034	MG208, MH201, MG207, MH200	1086	588	498	34248096	18,543,168	15,704,928	54	343,719	314,492	29,227
2035	MG208, MG209, MG207, MH200, MH201	1265	714	551	39893040	22,516,704	17,376,336	56	414,221	381,883	32,337
2036	MG209, MG208, TG210, MH200, MH201	1167	661	506	36802512	20,845,296	15,957,216	57	383,233	353,536	29,696
2037	MG209, MG208, MH200, MH201	1084	596	488	34185024	18,795,456	15,389,568	55	347,411	318,771	28,640
2038	MG209, TG210, MG208, MH200, MH201	1149	633	516	36234864	19,962,288	16,272,576	55	368,844	338,560	30,283
2039	TG210, MH200, MH201	319	151	168	10059984	4,761,936	5,298,048	47	90,622	80,762	9,860
2040	TG210, MH200, MH201	334	156	178	10533024	4,919,616	5,613,408	47	93,883	83,437	10,447
2041	MH200, MH201	150	64	86	4730400	2,018,304	2,712,096	43	39,278	34,230	5,047
2042	MH200	100	43	57	3153600	1356048	1797552	43	26,344	22,999	3,345
2043											
								Total:	**8,101,997**	**7,301,780**	**800,218**

5 LONGWALL STREAM

5.1 Assumptions

- Weekly average longwall gas emission data is used for estimating the volumes of gas from longwall operations for the purpose of GHG calculations
- The longwall production rates used to calculate the longwall weekly average emission are as per Table 5.1 below:

Table 5.1 Stage 3 Extension Project Longwall Weekly Production Rate

Longwall	Production Rate (tpw)
201	200,000
202	200,000
203	215,000
204	215,000
205	205,000
206	200,000
207	195,000
208	190,000
209	180,000
210	215,000

- No abatement of longwall emissions post drainage gas will be included in the GHG estimate. This is due to historical data identifying that the oxygen content within the post drainage stream for Narrabri North has been in excess of 10% (recommended oxygen trip level for flaring is 6% to maintain adequate levels of safety) – refer to Appendix A for WHC5733-01 Narrabri Gas Flare Position Report regarding gas flaring potential for Narrabri South
- With no abatement, the GHG emissions attributable to longwall mining are reported as the total (include both the ventilation emissions and post drainage stream combined)

5.2 Methodology

Table 5.2 below steps out the methodology undertaken and reference material used to estimate the volumes of gas and GHG emissions resulting from longwall mining.

Table 5.2 Longwall GHG Emission Estimate Methodology

Step	Description	Reference Documentation
1	Update longwall emission models for the HSK Seam pre-drained to 3.5 m^3/t (@ seam ash). Where the longwall gas zone is less than 3.5 m^3/t (Zones 4 and 10) models ran at virgin gas content	▪ Longwall emission models developed for WHC5175 Narrabri South Gas Reservoir and Emission Assessment
2	Obtain the specific gas emission (SGE) curves and goaf gas composition from the longwall emission models	▪ Longwall emission models developed for WHC5175 Narrabri South Gas Reservoir and Emission Assessment
3	Overlay the longwall FY locations (Figure 5.1) on the longwall gas zones (Figure 5.2) and establish longwall gas emission sub zones delineated by: ▪ Longwall location (production rate) ▪ Longwall gas zone	▪ Mine schedule WHC 2019 FEA P3X02 G08 R16 S10 ▪ Stage 3 EIS Period plot.dwg
4	Calculate the volume of gas for each longwall gas emission sub zone	N/A
5	Synthesise the gas volume data using a weighted average from the lengths of each longwall emission sub zone and the length of each longwall FY location	N/A
6	Calculate the GHG emissions (t CO_2-e) from the extraction of coal (longwall) using Method 4 from NGERS (2008)	▪ Section 3.6 - Method 4, National Greenhouse and Energy Reporting (Measurement) Determination 2008, Compilation 12, July 2020 ▪ GWP of CH_4 kept at 25

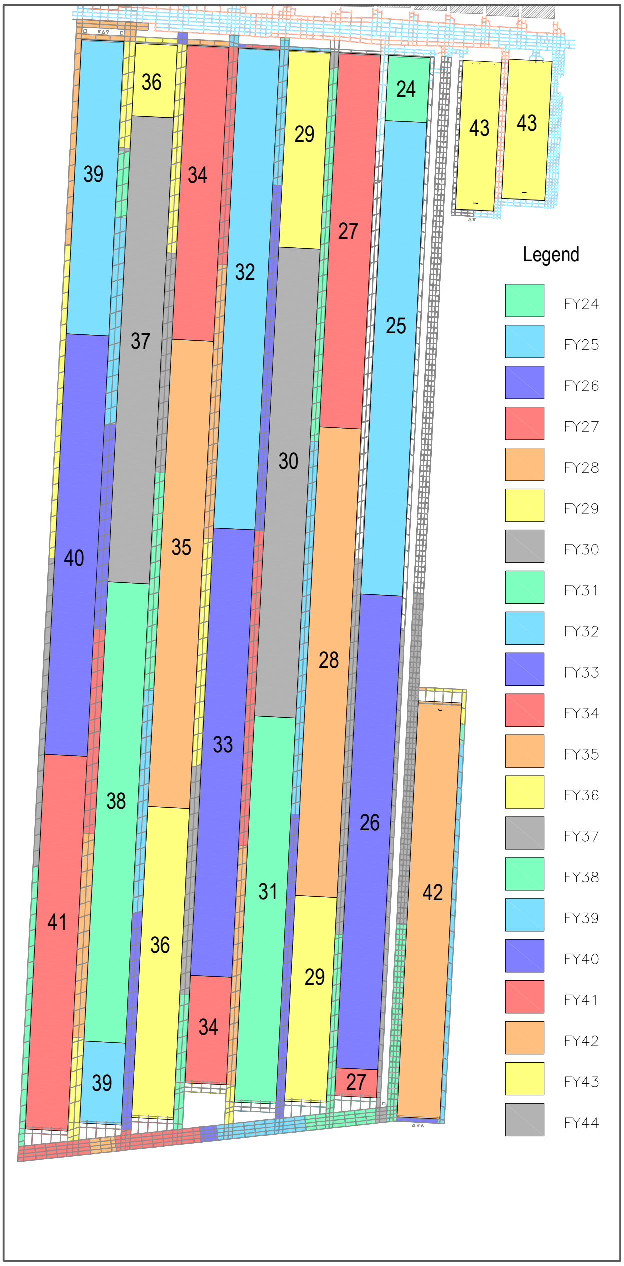


Figure 5.1 Longwall FY location

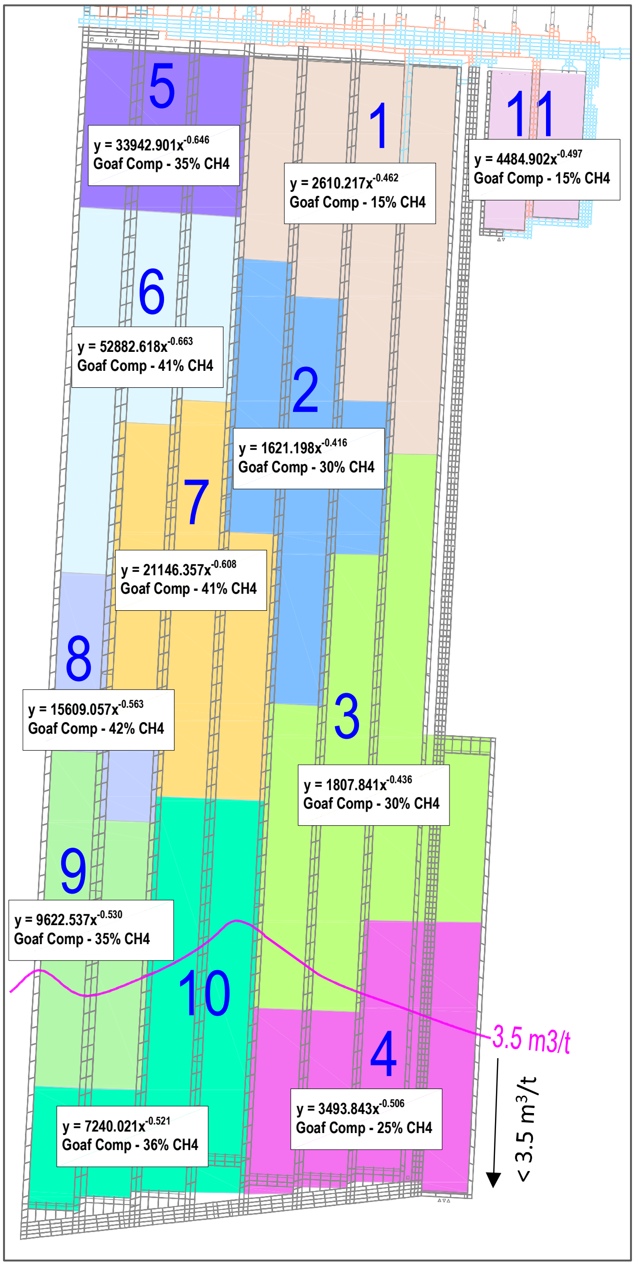


Figure 5.2 Longwall Gas Zones with SGE Curves And Goaf Composition

5.3 Outcomes

The volumes of gas and GHG emissions resulting from longwall mining are summarised by FY in Table 5.3. The overall GHG contribution from longwall mining is estimated at 14.5 Mt CO_2-e, 54% of the total GHG estimate.

Table 5.3 Longwall GHG Emission Estimate

Longwall Mining FY	Longwall	Longwall Production (kilotonnes)	Weighted Average Longwall Emission (l/s)	Longwall Total Gas (m^3)	Longwall CH_4 (m^3)	Longwall CO_2 (m^3)	Longwall CH_4 Composition (%)	Total Longwall GHG (t CO_2-e)	Longwall GHG CH_4 (t CO_2-e)	Longwall GHG CO_2 (t CO_2-e)	Outbye Sealed Areas GHG (t CO_2-e)
2024	LW203	215	3,191	16,817,456	2,522,618	14,294,838	15	69,386	42,784	26,603	120,000
2025	LW203	215	3,136	98,896,816	20,276,399	78,620,417	21	490,200	343,888	146,313	120,000
2026	LW203	215	2,799	88,257,356	24,540,888	63,716,468	28	534,790	416,213	118,576	120,000
2027	LW203, LW204	215	3,187	92,258,100	16,405,127	75,852,972	18	419,393	278,231	141,162	120,365
2028	LW204	215	3,125	98,545,273	29,563,582	68,981,691	30	629,773	501,398	128,375	120,365
2029	LW204, LW205	215, 205	2,863	82,867,112	17,157,629	65,709,483	21	413,279	290,993	122,285	130,382
2030	LW205	205	3,321	104,737,612	30,548,866	74,188,746	29	656,174	518,109	138,065	130,382
2031	LW205	205	2,745	86,553,632	24,202,694	62,350,938	28	526,513	410,478	116,035	130,382
2032	LW206	200	3,288	95,155,217	23,262,823	71,892,394	24	528,329	394,537	133,792	132,997
2033	LW206	200	4,163	131,291,082	50,469,140	80,821,942	38	1,006,366	855,957	150,410	132,997
2034	LW206, LW207	200, 195	4,575	132,423,693	49,549,267	82,874,426	37	994,585	840,356	154,229	210,773
2035	LW207	195	4,215	132,937,502	53,655,645	79,281,858	40	1,057,543	910,000	147,544	210,773
2036	LW207, LW208	195, 190	4,104	118,775,149	42,530,945	76,244,205	36	863,215	721,325	141,890	242,945
2037	LW208	190	4,602	145,121,845	58,056,350	87,065,495	40	1,146,665	984,636	162,029	242,945
2038	LW208	190	4,764	150,231,453	56,519,499	93,711,953	38	1,132,969	958,571	174,398	242,945
2039	LW208, LW209	190, 180	4,485	129,809,832	48,716,476	81,093,356	38	977,146	826,231	150,915	257,500
2040	LW209	180	5,082	160,268,623	65,219,027	95,049,596	41	1,283,002	1,106,115	176,887	257,500
2041	LW209	180	4,473	129,471,312	45,695,214	83,776,098	35	930,898	774,991	155,907	257,500
2042	LW210	215	2,699	78,127,693	21,022,174	57,105,519	27	462,809	356,536	106,273	276,738
2043	LW201, LW202	200	3,440	99,567,548	14,935,132	84,632,416	15	410,801	253,300	157,501	276,738
								Total:	**11,784,647**	**2,749,190**	**3,734,226**

6 OUTBYE SEALED AREAS STREAM

The GHG emissions for outbye sealed areas historically, has not been measured or assessed for Narrabri North to ascertain a baseline in which future projections can be applied.

Across other underground mines in NSW, outbye sealed areas emissions can represent up to 50% of the total GHG estimate, being a function of the age of the mine, extent of sealed areas and the way emissions from the sealed environments are managed.

Using real time / tube bundle gas monitoring data of outbye ventilation splits and at the fan site over several longwall blocks, it may be possible to assess the contribution of outbye sealed areas. The intention of such an assessment would be twofold. Firstly, it would be to identify the increase in contribution as longwalls are sealed, and secondly it would be to understand the decline in emissions over time from the sealed panels. These insights would then be able to be used to predict the GHG emissions more accurately from outbye sealed areas going forward.

Given the relative simplicity of the Narrabri Mine Plan, few overlying/underlying coal seams across most of the mining area and seam gas composition in Narrabri North being predominately CO_2, it is unlikely that GHG emissions from outbye sealed areas will ever be in the order of 50%, rather more likely in the range of ~10-30% of the total GHG estimate.

To consider the changes in CH_4 composition across Narrabri South and the increase in longwall GHG emissions across the western panels, 25% of the longwall GHG emissions has been assumed for outbye sealed areas GHG emission contribution (Table 5.3).

Outbye sealed areas GHG emissions have been included from FY24, the year longwall mining commences in Narrabri South. In total, it is estimated that 3.7 Mt CO_2-e of GHG emissions occur from outbye sealed areas, increasing per financial year across the life of the project and accounting for approximately 14% of the total GHG estimate.

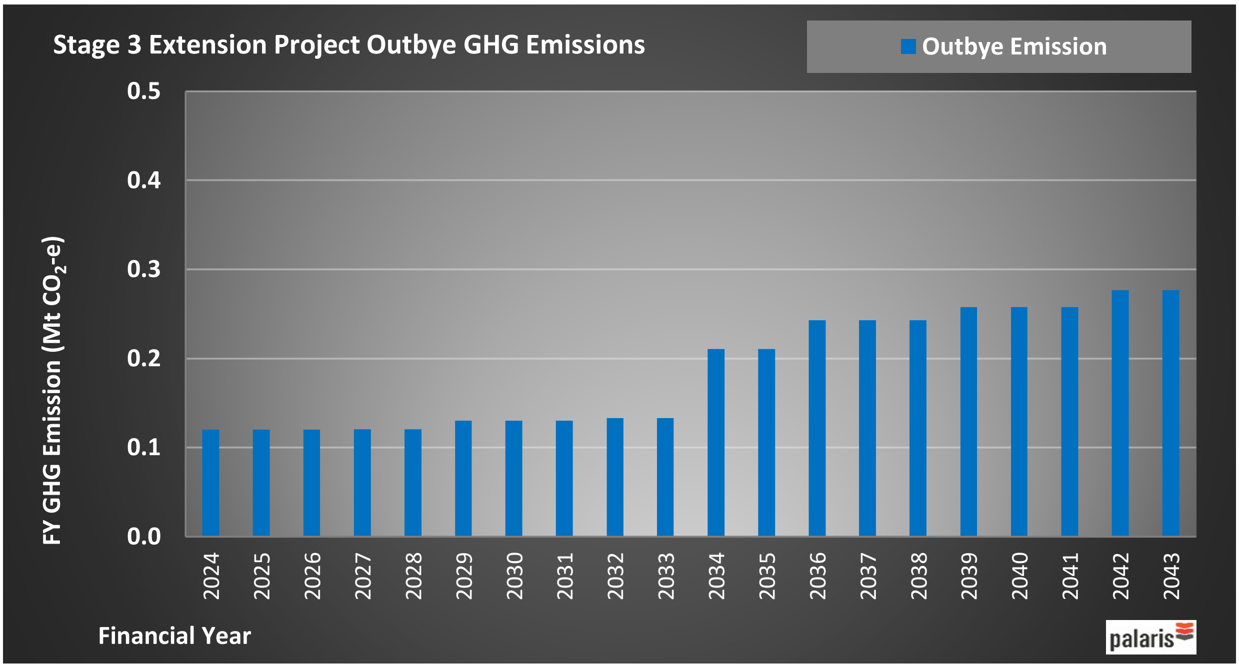


Figure 6.1 Stage 3 Extension Project Outbye Sealed Areas GHG Emission Estimate - per FY

7 TOTAL GHG EMISSIONS

Combining the streams, the total GHG emission for Narrabri South is estimated to be in the order of 27 Mt CO_2-e with an average of 1.2 Mt CO_2-e per financial year (Figure 7.1).

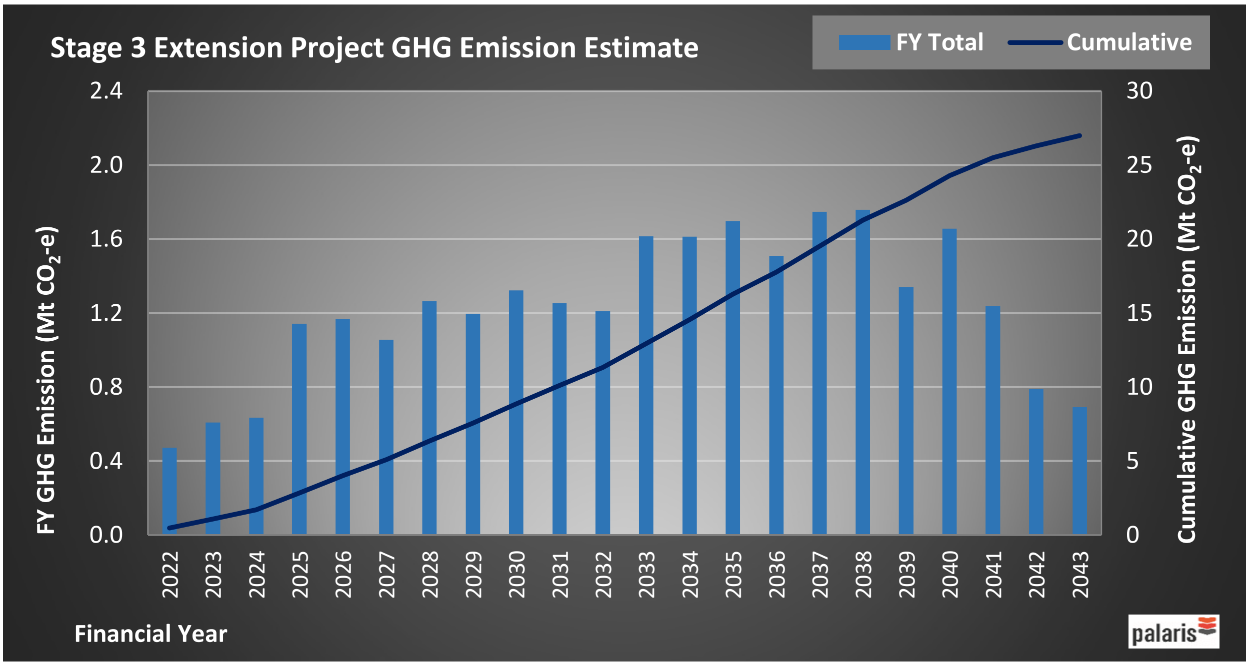


Figure 7.1 Stage 3 Extension Project GHG Emission Estimate (abated case) - per FY and cumulative

Breaking the streams down by source (Figure 7.2) shows:

- Development GHG emissions are a significant contributor in the first 10 years of the Project (0.4-0.6 Mt CO_2-e per FY)
- Longwall GHG emissions double in FY33 to 1.0-1.3 Mt CO_2-e as a result of the longwall entering higher emission and higher CH_4 Seam composition areas of the Project domain

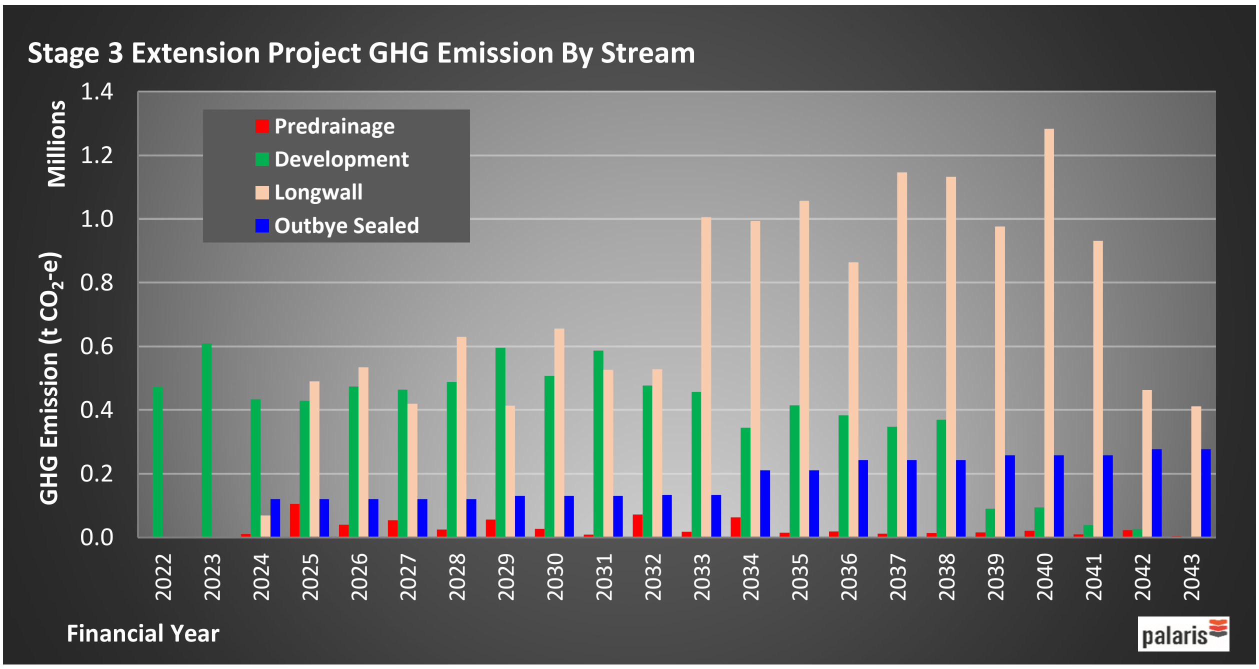


Figure 7.2 Narrabri South GHG Emission Estimate (abated case) - by Stream

Table 7.1 Total GHG Emission Estimate (abated case) - Delineated by Stream and FY

FY	Pre-drainage GHG (t CO_2-e)	Development GHG (t CO_2-e)	Longwall GHG (t CO_2-e)	Outbye Sealed Areas GHG (t CO_2-e)	Total GHG (t CO_2-e)
2022		473,262			473,262
2023		609,166			609,166
2024	11,317	433,403	69,386	120,000	634,106
2025	104,911	428,166	490,200	120,000	1,143,278
2026	40,112	474,698	534,790	120,000	1,169,600
2027	54,047	463,586	419,393	120,365	1,057,391
2028	25,316	488,196	629,773	120,365	1,263,651
2029	56,589	595,386	413,279	130,382	1,195,636
2030	27,186	507,921	656,174	130,382	1,321,662
2031	8,900	586,803	526,513	130,382	1,252,598
2032	71,724	477,919	528,329	132,997	1,210,969
2033	17,682	455,938	1,006,366	132,997	1,612,983
2034	62,813	343,719	994,585	210,773	1,611,890
2035	14,953	414,221	1,057,543	210,773	1,697,490
2036	19,335	383,233	863,215	242,945	1,508,728
2037	11,748	347,411	1,146,665	242,945	1,748,769
2038	14,335	368,844	1,132,969	242,945	1,759,093
2039	16,395	90,622	977,146	257,500	1,341,663
2040	21,341	93,883	1,283,002	257,500	1,655,725
2041	9,833	39,278	930,898	257,500	1,237,509
2042	22,675	26,344	462,809	276,738	788,566
2043	4,393		410,801	276,738	691,931
Total:	**615,605**	**8,101,997**	**14,533,837**	**3,734,226**	**26,985,666**

8 REFERENCES

National Greenhouse and Energy Reporting (Measurement) Determination 2008, Compilation 12, 1 July 2020, viewed 30 April 2021, <https://www.legislation.gov.au/Details/F2020C00600>

Palaris 2021, Narrabri Gas Flare Position Paper, Consultants Report WHC5733

Palaris 2019, Narrabri Longwall 109 Gas Management, Consultants Report WHC4940-01

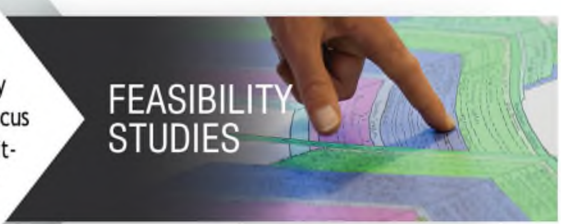
Palaris 2019, Narrabri South Project Gas Management Assessment, Consultants Report WHC5175

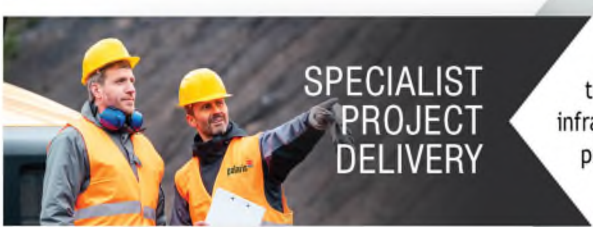
9 OUR SERVICES

With our deep understanding of the resource industry's business and financial performance, we offer a unique solution by integrating qualified business improvement professionals with mining technical specialists. Having completed over 300 business improvement projects, our clients value our co-design/ co-execute approach. We consistently deliver more value for our clients in complex and challenging environments.

Our vast resource industry experience and capability is leveraged for our clients from having completed over 200 due diligence, independent technical engineer (debt) and valuation projects. We integrate technical expertise with financial acumen to deliver accurate and valuable reports that provide our clients with confidence. Our in-house databases allow us to benchmark and apply an additional lens in order to provide insightful analysis.

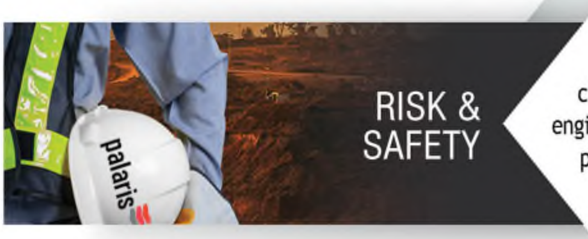
Having completed over 50 feasibility studies on coal, metals and other bulk commodity projects globally, our experience ensures a tailored study approach which is both technically feasible and financially accurate. We have an unrelenting focus on margin optimisation and a commitment to delivering a fit-for-purpose outcome. Our mining and engineering in-house capability provides an integrated approach to our studies.





We know that on-time and on-budget project delivery of critical infrastructure can add significant value to a resource asset. We have delivered over 50 critical infrastructure projects for our clients by providing a strong project management team who seamlessly interface with the client's existing systems. Our success comes from using our integrated owner's team model.

Our clients understand that extra resource value is unlocked by seamless optimised performance. Our engineering specialists are extensively experienced with the full range of the life cycle requirements having completed over 650 equipment/infrastructure projects. We have the right combination of engineering know how and operational experience and have a track record of delivering fit-for-purpose solutions.



Our focus on materiality extends into how we have delivered value in over 300 risk related projects for our clients. Our approach, whilst underpinned by deep technical engineering risk analysis, has an unrelenting focus on delivering practical insights into material risk and safety issues for our clients. Our recommendations are underpinned by our commitment to improve operational performance.

Appendix A WHC5733-01 Narrabri Gas Flare Position Paper

LOW METHANE CONCENTRATION FLARING

Narrabri are considering the use of enclosed flares at the mine during the extraction of the Narrabri South project. Concerns have been raised over the technical validity of flaring in very low composition methane environments. The following report discusses the technical merits of flaring at low levels of methane (CH_4).

Australian Coal Mining Industry Enclosed Flares

Enclosed flares have been installed and operating at Australian coal mines since the early 2000's, with the following mines currently operating enclosed flares:

- Tahmoor
- Mandalong
- Bulga complex
- United
- Integra
- Appin
- Oaky Creek
- Grasstree
- Grosvenor
- Moranbah

Candlestick flares are in operation at many Queensland mines and are not commonly utilised in NSW due to environmental and community considerations.

Principle of Methane Flaring

Flaring occurs when a mixture of methane and oxygen is ignited for combustion to occur, typically with enclosed flares a mixing tube allows gas under pressure containing methane to be mixed with sufficient oxygen to allow initial combustion to occur. Gas pressure regulation and control of inlet air, via automatically adjusted louvres, allows combustion to be controlled within the flume stack of the enclosed flare.

Typically, operating temperatures between 950 – 1100 degrees Celsius are maintained. With most enclosed flares operating within the Australian mining industry having a thermal capacity of between 40 – 60MW and depending on the gas composition each flare flow capacity can be in the order of 2200 – 2800 l/sec.

Candlestick flares rely on an exit velocity of gas being ignited just above the outlet stack of the flare where the gas mixture meets the external oxygen environment, the open flame varying due to gas (pressure, flow, and composition).

Flaring is generally used on pre and post mining gas flows (depending on composition) and cannot be utilised to manage methane within the main ventilation of the mine.

About Methane Gas Compositions & Ignition

As a rule, the higher the CH_4 composition the more oxygen is required to optimise combustion, equally lower compositions require less air to maintain combustion, typically in Australian coal mining gas compositions the CH_4 component can vary largely depending on the source of the stream of gas being either (SIS, UIS or Goaf) or a combination.

Additionally, a large portion of Australian mines have CH_4 mixtures of between 35 – 80% CH_4 depending on the gas stream and in the case of UIS and SIS streams only compositions as high as 95% can occur.

There are several key aspects of operating a high efficiency flare. The first is the need to maintain the composition of the gasses being burnt. When operating with higher methane percentages the ability for the flare maintain combustion when there are changes to the composition and flow is easily controlled within a range by adjusting the air inlet louvres. When composition moves outside of the design criteria the flare will shut down as there is risk with burning too hot and high where the flame propagates outside of the flare enclosure.

The ability to maintain a constant flow of gas is also desirable, sudden changes in flow can cause the difficulties in managing the flame, when dealing with higher methane content the ability to manage changes in flow is considered less problematic as the gas compositions (in particular the oxygen percentage) remain well outside of the explosive range.

A relatively consistent composition gas stream is also required to maintain the safety at the mine. A major risk associated with the combustion of methane gas when flaring is associated with the amount of oxygen contained within the gas stream.

From the chart below (Figure A.1) you can see that providing the oxygen concentration is less than 12 %vol. the gas mixture is not explosive (red zone). It is recommended setting the trip level at 6 %vol. to maintain sufficient safety margins.

A further compounding characteristic of mine waste gas is the moisture content, often this can lead to problems associated with the pilot ignition and gas inlet system clogging.

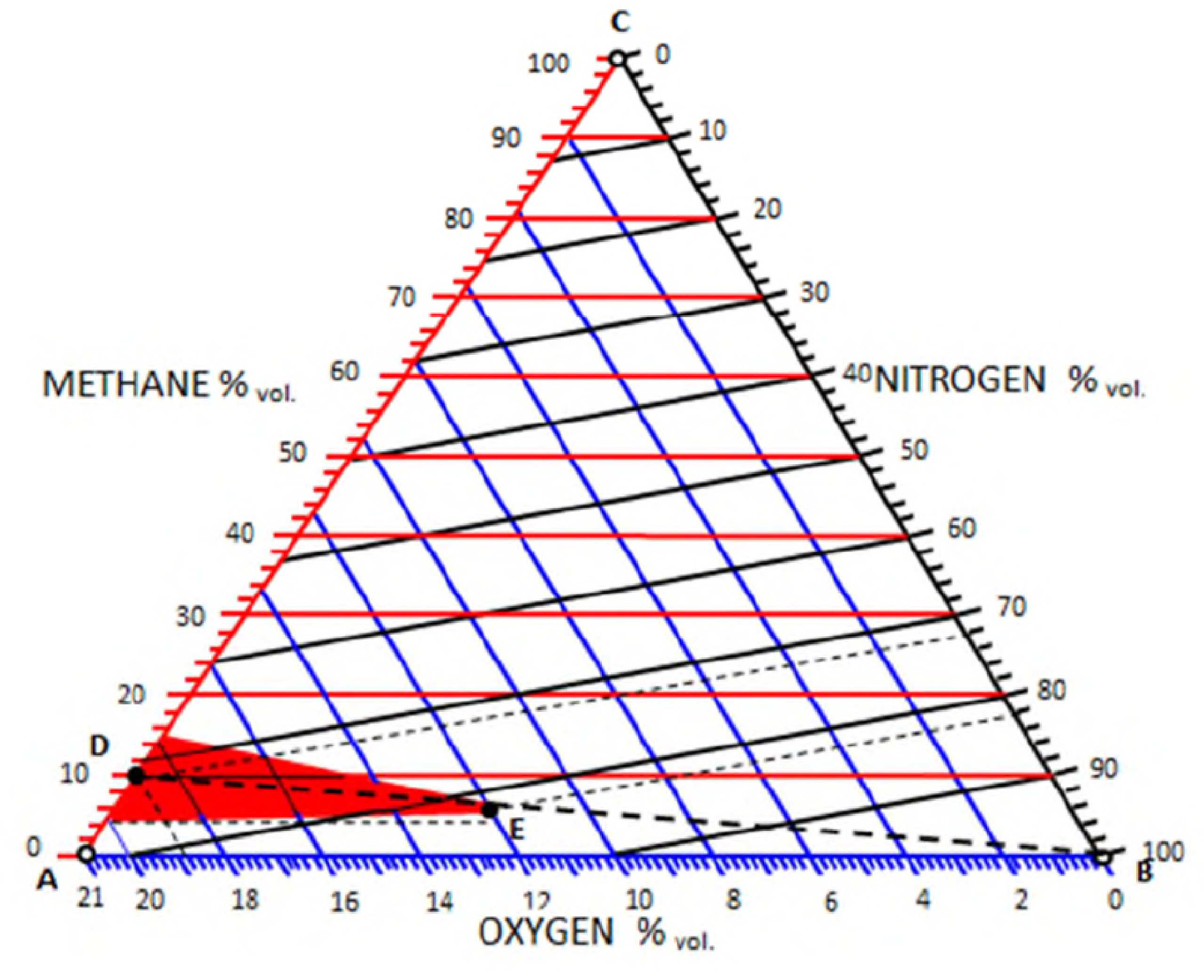


Figure A.1 Chart highlighting the explosive range of gas compositions at low CH_4 percentages

Methane – less than 30%

Within the Australian coal mining industry, it is uncommon for mines to flare when methane contents are less than 30%, this is primarily due to the inability to maintain a stable atmosphere with fluctuating flows and composition.

When dealing with a methane composition of less than 30% and high flows that are produced in coal mines the need to carefully assess the risk by the engineering team is paramount. There is a risk that the control system to maintain the flame cannot operate with sufficient accuracy or speed to manage the fine adjustments required to maintain a safe mixture of gasses.

Another key difference with the low calorific flare design is that a “constant pilot” is required to be maintained, meaning the pilot flame used to initially ignite the main burners within the flare is continuously burning. Commonly a flame out is the result of low CH_4 composition, inert gases or low flow gas “pockets” in the gas stream with the pilot flame used to reignite the flare automatically once ignition conditions are met.

The pilot flame gas supply is via a “natural gas or propane” supply, this may be problematic in a coal mine application due to the higher flow and volumes required to maintain a constant pilot.

It would require a significant amount of engineering assessment for there to be confidence in “Lowcal” technology flares being introduced into a coal mining application.

It is our opinion, that to achieve efficient and reliable combustion of waste mine gas constant compositions of greater than 30% CH_4 would be required (25% with a factor of safety).

Other Considerations

Generally speaking gas supply from an operating coal mine is inconsistent, with the majority of mines observing swings in flow of up to 100% during the life of a flare.

This variability in flow (realise at the flare in the form of pressure) becomes problematic at low percentages of methane with the flares constantly flaming, as the flame reignites there is potential for detonation as the system may not have equalised and there is an explosive mixture still in the system.

Whilst not necessarily catastrophic on a single instance, repetitive loss of flame and detonation could result in eventual catastrophic failure of the flare internal infrastructure. Mine safety is protected by flame arrestors further down the intake system.

Additionally, as the flares are set to run within a specified range the increase and decrease in composition and flow results in damage to the internal systems of the flare increasing the maintenance requirements (down time) and eventual running costs.

Flaring at the Narrabri Mine

Historically the oxygen content within the post drainage gas stream at the Narrabri mine has varied between 10% and 15%, this means that it is unlikely that the post drainage gasses could be flared as a discreet flow due to safety constraints. As previously mentioned typically the oxygen trip level is set at 6% to maintain adequate levels of safety.

There are some areas within the southern extension area where in situ methane content increases too slightly above the identified 30% threshold. Due to the in-situ gas being so close to the 30% cut off and due to the inherent complexities of flaring at such low methane percentages.

When mining in the southern domain, it is recommended that the measured gas composition and flow is reviewed on an annual basis to assess if flaring is practicable at the mine.

References

i. Destruction of Low Purity Methane using Flaring Methods- memo – Water Gas Renew- Bob Dixon- 22nd January 2021
ii. Flaring of gas – 2564-gas-flaring-fact sheet – EPA NSW- December 2015

APPENDIX C

AMENDED GREENHOUSE GAS CALCULATIONS

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31 May 2021

Attention: David Ellwood
Narrabri Coal Operations Pty Limited

Project Name: Narrabri Underground Mine Stage 3 Extension Project
Project Number: IA217900

Dear David

Air Quality and Greenhouse Gas Assessment Response to Submissions

Thank you for the updated information relating to fugitive gas modelling carried out by Narrabri Coal Operations Pty Ltd (NCOPL) for the Narrabri Underground Mine Stage 3 Extension Project (the Project). The information has now been reviewed and incorporated into revised calculations of the overall greenhouse gas emissions from the Project.

Please see attached for the revised calculations for inclusion in the Submissions Report.

Yours sincerely

Shane Lakmaker
Principal (Air Quality)
+61 (0) 419 239 687
shane.lakmaker@jacobs.com

1. Background

Potential air quality and greenhouse gas impacts of the Narrabri Underground Mine Stage 3 Extension Project (the Project) have been assessed as part of the Environmental Impact Statement (EIS) (Jacobs, 2020). Narrabri Coal Operations Pty Ltd (NCOPL) has since commissioned further modelling of fugitive gas emissions and composition from the mine in order to reassess the potential to flare a proportion of the gas and reduce the overall greenhouse gas emissions.

This report provides an updated greenhouse gas emissions inventory for the Project that incorporates the most recent fugitive emission modelling data and shows the potential emission reductions that may be achieved from flaring these emissions.

2. Methodology

Consistent with the methodology described by Jacobs (2020), the greenhouse gas inventory in this document has been calculated in accordance with the principles of the Greenhouse Gas Protocol. This involved determining the sources of greenhouse gas emissions and reporting the calculated emissions as direct and indirect impacts of the Project. The greenhouse gas inventory for this assessment includes all significant sources associated with the Project and separated into Scopes 1, 2 and 3. Table 1 shows the key emission sources that have been considered in this assessment.

Table 1 Greenhouse gas emission sources

Activity	Description	Scope(s)
Diesel usage	Combustion of diesel fuel from mobile and stationary plant and equipment.	1, 3
Fugitive	Fugitive emissions from the extraction of coal including gas venting and drainage.	1
Post-mining	Fugitive emissions from post mining activities such as transportation and stockpiling of coal from the release of residual gases not released during the mining process.	1
Vegetation	Loss of carbon sink due to removal of vegetation.	1
Electricity	Electricity usage.	2, 3
Transport (rail)	Transport of product coal by rail to port.	3
Transport (shipping)	Transport of product coal by ship to market.	3
Energy production	Combustion of thermal coal in power generators by end users.	3
Coking coal	Combustion of coking coal by end users.	3

Table 2 outlines the greenhouse gas emission estimation methodologies for each activity.

Table 2 Greenhouse gas emission estimation methodologies

Activity	Emission estimation methodology
Diesel usage	Estimated from diesel used to ROM coal ratio from NGERS FY17, NGERS FY18 and NGERS FY19 reports (0.00089 kilolitres per tonne [kL/t]). Emission factors from NGA Factors (DEE, 2019).

Activity	Emission estimation methodology
Fugitive	Calculated by Palaris (2021). Additional resolution was incorporated into the calculations relative to the EIS (as presented by Jacobs, 2020). Total greenhouse gas emissions were modelled and calculated from four areas of the mine: - Pre-drainage. This is the gas extracted in front of mining and can be flared when gas volumes reach 3.5 m^3/tonne coal and the methane (CH_4) composition exceeds 30%. This gas is extracted through service boreholes. - Development. This is the gas generated when mining roadways. This gas is extracted through the ventilation of the mine. - Longwall. This is the gas from the longwall. This gas is extracted through goaf drainage and the ventilation of the mine. - Outbye longwall. This is the gas from completed, sealed longwalls and outbye areas. This gas is extracted through the ventilation of the mine. Full details on the calculated fugitive emissions are provided by Palaris (2021).
Post-mining	Emission factors from NGA Factors (DEE, 2019).
Vegetation	Calculated using “Carbon Gauge” developed by the Transport Authorities Greenhouse Group (TAGG, 2013) with total emissions distributed over the mine life in proportion to the ROM coal. Vegetation assumed to be “Class D Open woodlands”. Biomass class set to “Class 3:100-150 (tonnes of dry matter per hectare [t dry matter/ha])” based on Project location.
Electricity	Emission factors from NGA Factors (DEE, 2019).
Transport (rail)	Emission factors from the Department for Environment, Food and Rural Affairs (DEFRA) (2019), based on “Freighting goods / freight train”. 370 kilometres (km) assumed distance from mine to port.
Transport (shipping)	Emission factors from DEFRA (2019), based on “Freighting goods / cargo ship, bulk carrier”. 8,000 km assumed distance from port to market.
Energy production	Emission factors from NGA Factors (DEE, 2019). Assumed that 95% of coal produced by the Project will be thermal coal.
Coking coal	Emission factors from NGA Factors (DEE, 2019). Assumed that 5% of coal produced by the Project will be coking coal.

3. Greenhouse Gas Emissions

Table 3 shows the estimated emissions of greenhouse gases due to all identified greenhouse gas-generating activities for each mining year. Over the lifetime of the Project, Scope 1 and 2 emissions are now estimated to average 1.487 million tonnes of carbon dioxide equivalent (Mt CO_2-e) per year without flaring of pre-drainage gas and 1.477 Mt CO_2-e per year with flaring of pre-drainage gas. The increases in emissions relative to the EIS data reflect the increased resolution of sources in the fugitive gas emission modelling.

Appendix A provides more detailed breakdowns of the estimated emissions for each activity by mining year, including a comparison with estimated emissions for Stage 2 (as approved).

Table 3 Summary of estimated greenhouse gas emissions as CO_2-e (Mt)

Year	Project emissions (EIS)*			Project emissions (revised gas modelling)					
				No flaring of pre-drainage gas			With flaring of pre-drainage gas		
Year	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2022#	0.625	0.110	17.977	0.625	0.110	17.977	0.625	0.110	17.977
2023#	0.581	0.102	16.760	0.581	0.102	16.760	0.581	0.102	16.760
2024	0.840	0.095	15.592	0.768	0.095	15.592	0.768	0.095	15.592
2025	0.926	0.156	25.698	1.363	0.156	25.698	1.363	0.156	25.698
2026	0.925	0.156	25.465	1.389	0.156	25.465	1.389	0.156	25.465
2027	0.951	0.134	21.987	1.246	0.134	21.987	1.246	0.134	21.987
2028	0.979	0.154	25.216	1.489	0.154	25.216	1.480	0.154	25.216
2029	1.002	0.128	20.890	1.376	0.128	20.890	1.376	0.128	20.890
2030	1.031	0.149	24.374	1.539	0.149	24.374	1.531	0.149	24.374
2031	0.992	0.120	19.618	1.422	0.120	19.618	1.422	0.120	19.618
2032	1.351	0.147	24.094	1.431	0.147	24.094	1.417	0.147	24.094
2033	1.332	0.134	21.807	1.818	0.134	21.807	1.801	0.134	21.807
2034	1.577	0.119	19.471	1.786	0.119	19.471	1.779	0.119	19.471
2035	1.598	0.134	21.805	1.915	0.134	21.805	1.886	0.134	21.805
2036	1.573	0.116	18.862	1.672	0.116	18.862	1.672	0.116	18.862
2037	1.711	0.132	21.448	1.956	0.132	21.448	1.934	0.132	21.448
2038	1.711	0.132	21.418	1.962	0.132	21.418	1.944	0.132	21.418
2039	1.711	0.110	17.858	1.532	0.110	17.858	1.496	0.110	17.858
2040	1.724	0.119	19.387	1.869	0.119	19.387	1.824	0.119	19.387
2041	1.708	0.108	17.558	1.404	0.108	17.558	1.389	0.108	17.558
2042	0.848	0.129	21.139	0.970	0.129	21.139	0.970	0.129	21.139
2043	1.068	0.086	14.210	0.814	0.086	14.210	0.814	0.086	14.210
2044#	0.481	0.018	2.986	0.481	0.018	2.986	0.481	0.018	2.986
Average	1.185	0.121	19.810	1.366	0.121	19.810	1.356	0.121	19.810
Total	27.246	2.787	455.620	31.408	2.787	455.620	31.189	2.787	455.620

** CO_2-e emissions for the EIS scenario have been recalculated using different gas densities applied to CH_4 and CO_2 for the fugitive gas calculations compared with Jacobs (2020). The densities used here are 0.68 kg/m^3 for CH_4 and 1.86 kg/m^3 for CO_2 (at 15°C and at standard atmospheric pressure), consistent with Palaris (2021) and NGERS (2020). The densities used in Jacobs (2020) were 0.554 kg/m^3 for CH_4 and 1.836 kg/m^3 for CO_2 (at 0°C and at standard atmospheric pressure).*

 # Fugitive emissions volumes for these years taken from Palaris (2020).

The fugitive emission estimates from Appendix A indicate that the reduction in greenhouse gas emissions from flaring suitable pre-drainage gas ranges from 0 to 2.7%, with an average reduction of 0.6% over the life of the mine.

Average scope 1 emissions per tonne of ROM coal mined for the Project is estimated at 0.16 t CO_2-e per tonne ROM coal. In comparison, selected Scope 1 emissions from other NSW underground coal mines are estimated at:

- 0.59 t CO_2-e per tonne ROM coal for the Tahmoor South Project.
- 0.07 t CO_2-e per tonne ROM coal for the Maxwell Project.
- 0.77 t CO_2-e per tonne ROM coal for the Dendrobium Mine Extension Project.

The Department of Agriculture, Water and the Environment provides a National Greenhouse Gas Inventory where statistics on emissions per annum are stored, and detailed analysis of sources can be determined. To develop the context for this assessment, the impacts of the emissions projected in this assessment have been compared with the latest emissions officially recorded on the National Greenhouse Gas Inventory. The latest available data through the Inventory is from 2019.

Table 4 presents these national and state figures in context with the projected emissions from the Project. The estimated annual average Scope 1 and 2 emissions from the Project (between 1.477 and 1.487 Mt CO_2-e) represent approximately 0.28% of Australia's 2019 emissions.

Table 4 Project operational greenhouse gas emissions in State and National context

National Greenhouse Gas Inventory	Value	
2019 Total Australia GHG emissions (Mt CO_2-e)	529.3	
2019 Total NSW GHG emissions (Mt CO_2-e)	136.6	
Project greenhouse gas emissions	No flaring of pre-drainage gas	Flaring of pre-drainage gas
Average projected emissions per year (Mt CO_2-e)	1.487	1.477
Proportion of 2019 total Australia emissions	0.28%	0.28%
Proportion of 2019 total NSW emissions	1.09%	1.08%

4. Oxides of Nitrogen Emissions

The burning of pre-drainage gas containing methane via the flaring operations has the potential to produce oxides of nitrogen (NO_x) emissions. The impacts of these NO_x emissions on the local air quality environment are expected to be minimal, considering:

- a maximum of three flaring units would be used at any one time;
- the infrastructure would be located well away from any nearby sensitive receptor locations;
- prevailing winds are from the southwest, and not in the direction from infrastructure to sensitive receptor locations; and
- opportunities for flaring are limited by the availability of suitable pre-drainage gas.

5. References

DEE (2019) “National Greenhouse Accounts Factors”. Department of Environment and Energy.

DEFRA (2019) “UK Government GHG Conversion Factors for Company Reporting”.

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Appendix A Greenhouse Gas Emissions by Activity

Diesel usage

Historical data

Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes
ROM Coal Production	t	6667232	7266601	6287535	6447561	
Saleable Coal	t	6237903				
Usage	kL	5939	5693	6626	5499	
Intensity	kL/t	0.00089	0.00078	0.00105	0.00085	

Stage 3 project

			Emission factor (kg CO2-e/kL)			Emissions (t CO2-e/year)		
Year	ROM coal (t)	Usage (kL)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2020	6,288,276	5,602	2709.72	0	138.96	15,180	-	778
2021	6,361,121	5,667	2709.72	0	138.96	15,355	-	787
2022	7,677,061	6,839	2709.72	0	138.96	18,532	-	950
2023	7,140,113	6,361	2709.72	0	138.96	17,236	-	884
2024	6,648,928	5,923	2709.72	0	138.96	16,050	-	823
2025	10,948,419	9,753	2709.72	0	138.96	26,429	-	1,355
2026	10,901,042	9,711	2709.72	0	138.96	26,315	-	1,349
2027	9,404,284	8,378	2709.72	0	138.96	22,701	-	1,164
2028	10,768,160	9,593	2709.72	0	138.96	25,994	-	1,333
2029	8,958,176	7,980	2709.72	0	138.96	21,625	-	1,109
2030	10,404,886	9,269	2709.72	0	138.96	25,117	-	1,288
2031	8,436,476	7,516	2709.72	0	138.96	20,365	-	1,044
2032	10,271,493	9,150	2709.72	0	138.96	24,795	-	1,272
2033	9,353,161	8,332	2709.72	0	138.96	22,578	-	1,158
2034	8,333,605	7,424	2709.72	0	138.96	20,117	-	1,032
2035	9,378,810	8,355	2709.72	0	138.96	22,640	-	1,161
2036	8,110,808	7,226	2709.72	0	138.96	19,579	-	1,004
2037	9,211,533	8,206	2709.72	0	138.96	22,236	-	1,140
2038	9,225,094	8,218	2709.72	0	138.96	22,269	-	1,142
2039	7,678,777	6,841	2709.72	0	138.96	18,536	-	951
2040	8,350,325	7,439	2709.72	0	138.96	20,157	-	1,034
2041	7,549,573	6,726	2709.72	0	138.96	18,224	-	935
2042	9,051,665	8,064	2709.72	0	138.96	21,850	-	1,121
2043	6,055,583	5,395	2709.72	0	138.96	14,618	-	750
2044	1,273,360	1,134	2709.72	0	138.96	3,074	-	158

Fugitive emissions

Historical data

Parameter	Units	Assumed valu	NGERS FY17	NGERS FY18	NGERS FY19	Notes
ROM Coal Production	t	6667232	7266601	6287535	6447561	
Saleable Coal	t	6237903				
Emission	t CO2-e	408976	412602	346068	468257	Includes venting and gas drainage
Intensity	t CO2-e/t	0.06134	0.05678	0.05504	0.07263	

Stage 3 project

		Emissions (t CO2-e/year) - no abatement				Emissions (t CO2-e/year) - flaring pre drainage			
Year	ROM coal (t)	Scope 1	Scope 2	Scope 3	Total	Scope 1	Scope 2	Scope 3	Total
2020	6,288,276	385,730	-	-	385,730	385,730	-	-	385,730
2021	6,361,121	390,198	-	-	390,198	390,198	-	-	390,198
2022	7,677,061	470,920	-	-	470,920	470,920	-	-	470,920
2023	7,140,113	437,983	-	-	437,983	437,983	-	-	437,983
2024	6,648,928	634,106	-	-	634,106	634,106	-	-	634,106
2025	10,948,419	1,143,277	-	-	1,143,277	1,143,278	-	-	1,143,278
2026	10,901,042	1,169,600	-	-	1,169,600	1,169,600	-	-	1,169,600
2027	9,404,284	1,057,392	-	-	1,057,392	1,057,391	-	-	1,057,391
2028	10,768,160	1,272,784	-	-	1,272,784	1,263,651	-	-	1,263,651
2029	8,958,176	1,195,635	-	-	1,195,635	1,195,636	-	-	1,195,636
2030	10,404,886	1,329,613	-	-	1,329,613	1,321,662	-	-	1,321,662
2031	8,436,476	1,252,597	-	-	1,252,597	1,252,598	-	-	1,252,598
2032	10,271,493	1,224,896	-	-	1,224,896	1,210,969	-	-	1,210,969
2033	9,353,161	1,629,591	-	-	1,629,591	1,612,983	-	-	1,612,983
2034	8,333,605	1,618,335	-	-	1,618,335	1,611,890	-	-	1,611,890
2035	9,378,810	1,726,021	-	-	1,726,021	1,697,490	-	-	1,697,490
2036	8,110,808	1,508,728	-	-	1,508,728	1,508,728	-	-	1,508,728
2037	9,211,533	1,770,461	-	-	1,770,461	1,748,769	-	-	1,748,769
2038	9,225,094	1,776,860	-	-	1,776,860	1,759,093	-	-	1,759,093
2039	7,678,777	1,378,051	-	-	1,378,051	1,341,663	-	-	1,341,663
2040	8,350,325	1,701,515	-	-	1,701,515	1,655,725	-	-	1,655,725
2041	7,549,573	1,252,208	-	-	1,252,208	1,237,509	-	-	1,237,509
2042	9,051,665	788,566	-	-	788,566	788,566	-	-	788,566
2043	6,055,583	691,931	-	-	691,931	691,931	-	-	691,931
2044	1,273,360	455,773	-	-	455,773	455,773	-	-	455,773

Post-mining activities								
Historical data								
Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes		
ROM Coal Production	t	6667232	7266601	6287535	6447561			
Saleable Coal	t	6237903						
Emission	t CO2-e	NA						
Factor	t CO2-e/t	0.01700						
Stage 3 project								
			Emission factor (t CO2-e/t CO2-e)			Emissions (t CO2-e/year)		
Year	ROM coal (t)	Emission (t CO2-e)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2020	6,288,276	106,901	1	0	0	106,901	-	-
2021	6,361,121	108,139	1	0	0	108,139	-	-
2022	7,677,061	130,510	1	0	0	130,510	-	-
2023	7,140,113	121,382	1	0	0	121,382	-	-
2024	6,648,928	113,032	1	0	0	113,032	-	-
2025	10,948,419	186,123	1	0	0	186,123	-	-
2026	10,901,042	185,318	1	0	0	185,318	-	-
2027	9,404,284	159,873	1	0	0	159,873	-	-
2028	10,768,160	183,059	1	0	0	183,059	-	-
2029	8,958,176	152,289	1	0	0	152,289	-	-
2030	10,404,886	176,883	1	0	0	176,883	-	-
2031	8,436,476	143,420	1	0	0	143,420	-	-
2032	10,271,493	174,615	1	0	0	174,615	-	-
2033	9,353,161	159,004	1	0	0	159,004	-	-
2034	8,333,605	141,671	1	0	0	141,671	-	-
2035	9,378,810	159,440	1	0	0	159,440	-	-
2036	8,110,808	137,884	1	0	0	137,884	-	-
2037	9,211,533	156,596	1	0	0	156,596	-	-
2038	9,225,094	156,827	1	0	0	156,827	-	-
2039	7,678,777	130,539	1	0	0	130,539	-	-
2040	8,350,325	141,956	1	0	0	141,956	-	-
2041	7,549,573	128,343	1	0	0	128,343	-	-
2042	9,051,665	153,878	1	0	0	153,878	-	-
2043	6,055,583	102,945	1	0	0	102,945	-	-
2044	1,273,360	21,647	1	0	0	21,647	-	-

Vegetation clearance								
Historical data								
Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes		
ROM Coal Production	t	6667232	7266601	6287535	6447561			
Saleable Coal	t	6237903						
Emission	kg	NA						
Intensity	kg/t	NA						
							from Carbon Gauge	
Stage 3 project								
			Emission factor (kg CO2-e/kg)			Emissions (t CO2-e/year)		
Year	ROM coal (t)	Emission (kg)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2020	6,288,276	4,292	1	0	0	4,292	-	-
2021	6,361,121	4,342	1	0	0	4,342	-	-
2022	7,677,061	5,240	1	0	0	5,240	-	-
2023	7,140,113	4,874	1	0	0	4,874	-	-
2024	6,648,928	4,539	1	0	0	4,539	-	-
2025	10,948,419	7,474	1	0	0	7,474	-	-
2026	10,901,042	7,441	1	0	0	7,441	-	-
2027	9,404,284	6,419	1	0	0	6,419	-	-
2028	10,768,160	7,350	1	0	0	7,350	-	-
2029	8,958,176	6,115	1	0	0	6,115	-	-
2030	10,404,886	7,103	1	0	0	7,103	-	-
2031	8,436,476	5,759	1	0	0	5,759	-	-
2032	10,271,493	7,011	1	0	0	7,011	-	-
2033	9,353,161	6,385	1	0	0	6,385	-	-
2034	8,333,605	5,689	1	0	0	5,689	-	-
2035	9,378,810	6,402	1	0	0	6,402	-	-
2036	8,110,808	5,537	1	0	0	5,537	-	-
2037	9,211,533	6,288	1	0	0	6,288	-	-
2038	9,225,094	6,297	1	0	0	6,297	-	-
2039	7,678,777	5,242	1	0	0	5,242	-	-
2040	8,350,325	5,700	1	0	0	5,700	-	-
2041	7,549,573	5,153	1	0	0	5,153	-	-
2042	9,051,665	6,179	1	0	0	6,179	-	-
2043	6,055,583	4,134	1	0	0	4,134	-	-
2044	1,273,360	869	1	0	0	869	-	-

Electricity usage									
Historical data									
Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes			
ROM Coal Production	t	6667232	7266601	6287535	6447561				
Saleable Coal	t	6237903							
Usage	kWh	88181842	84101399	86531000	93913127				
Intensity	kWh/t	13.226	11.574	13.762	14.566				
Stage 3 project									
			Emission factor (kg CO2-e/kWh)			Emissions (t CO2-e/year)			
Year	ROM coal (t)	Usage (kWh)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total
2020	6,288,276	83,169,710	0	0.81	0.09	-	67,367	7,485	74,853
2021	6,361,121	84,133,172	0	0.81	0.09	-	68,148	7,572	75,720
2022	7,677,061	135,350,146	0	0.81	0.09	-	109,634	12,182	121,815
2023	7,140,113	125,883,497	0	0.81	0.09	-	101,966	11,330	113,295
2024	6,648,928	117,223,686	0	0.81	0.09	-	94,951	10,550	105,501
2025	10,948,419	193,025,701	0	0.81	0.09	-	156,351	17,372	173,723
2026	10,901,042	192,190,430	0	0.81	0.09	-	155,674	17,297	172,971
2027	9,404,284	165,801,893	0	0.81	0.09	-	134,300	14,922	149,222
2028	10,768,160	189,847,651	0	0.81	0.09	-	153,777	17,086	170,863
2029	8,958,176	157,936,795	0	0.81	0.09	-	127,929	14,214	142,143
2030	10,404,886	183,442,970	0	0.81	0.09	-	148,589	16,510	165,099
2031	8,436,476	148,738,984	0	0.81	0.09	-	120,479	13,387	133,865
2032	10,271,493	181,091,180	0	0.81	0.09	-	146,684	16,298	162,982
2033	9,353,161	164,900,556	0	0.81	0.09	-	133,569	14,841	148,411
2034	8,333,605	146,925,319	0	0.81	0.09	-	119,010	13,223	132,233
2035	9,378,810	165,352,769	0	0.81	0.09	-	133,936	14,882	148,817
2036	8,110,808	142,997,301	0	0.81	0.09	-	115,828	12,870	128,698
2037	9,211,533	162,403,596	0	0.81	0.09	-	131,547	14,616	146,163
2038	9,225,094	162,642,680	0	0.81	0.09	-	131,741	14,638	146,378
2039	7,678,777	135,380,389	0	0.81	0.09	-	109,658	12,184	121,842
2040	8,350,325	147,220,098	0	0.81	0.09	-	119,248	13,250	132,498
2041	7,549,573	133,102,472	0	0.81	0.09	-	107,813	11,979	119,792
2042	9,051,665	159,585,052	0	0.81	0.09	-	129,264	14,363	143,627
2043	6,055,583	106,762,742	0	0.81	0.09	-	86,478	9,609	96,086
2044	1,273,360	22,449,926	0	0.81	0.09	-	18,184	2,020	20,205

Transport (Rail)								
Historical data								
Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes		
ROM Coal Production	t.km	6667232	7266601	6287535	6447561			
Saleable Coal	t	6237903						
Emission	kg CO2-e	NA						
Factor	kg CO2-e/t.km	0.03333				DEFRA 2019 - Freighting goods - Freight train		
Distance	km	370				Assumed distance to port		
Stage 3 project								
			Emission factor (kg CO2-e/kg CO2-e)			Emissions (t CO2-e/year)		
Year	ROM coal (t)	Emission (kg CO2-e	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2020	6,288,276	77,547,651	0	0	1	-	-	77,548
2021	6,361,121	78,445,985	0	0	1	-	-	78,446
2022	7,677,061	94,674,286	0	0	1	-	-	94,674
2023	7,140,113	88,052,585	0	0	1	-	-	88,053
2024	6,648,928	81,995,248	0	0	1	-	-	81,995
2025	10,948,419	135,016,999	0	0	1	-	-	135,017
2026	10,901,042	134,432,746	0	0	1	-	-	134,433
2027	9,404,284	115,974,576	0	0	1	-	-	115,975
2028	10,768,160	132,794,026	0	0	1	-	-	132,794
2029	8,958,176	110,473,123	0	0	1	-	-	110,473
2030	10,404,886	128,314,101	0	0	1	-	-	128,314
2031	8,436,476	104,039,468	0	0	1	-	-	104,039
2032	10,271,493	126,669,078	0	0	1	-	-	126,669
2033	9,353,161	115,344,113	0	0	1	-	-	115,344
2034	8,333,605	102,770,851	0	0	1	-	-	102,771
2035	9,378,810	115,660,425	0	0	1	-	-	115,660
2036	8,110,808	100,023,294	0	0	1	-	-	100,023
2037	9,211,533	113,597,547	0	0	1	-	-	113,598
2038	9,225,094	113,764,781	0	0	1	-	-	113,765
2039	7,678,777	94,695,441	0	0	1	-	-	94,695
2040	8,350,325	102,977,042	0	0	1	-	-	102,977
2041	7,549,573	93,102,090	0	0	1	-	-	93,102
2042	9,051,665	111,626,041	0	0	1	-	-	111,626
2043	6,055,583	74,678,060	0	0	1	-	-	74,678
2044	1,273,360	15,703,203	0	0	1	-	-	15,703

Transport (Shipping)								
Historical data								
Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes		
ROM Coal Production	t.km	6667232	7266601	6287535	6447561			
Saleable Coal	t	6237903						
Emission	kg CO2-e	NA						
Factor	kg CO2-e/t.km	0.00354				DEFRA 2019 - Freighting goods - Cargo ship,		
Distance	km	8000				Assumed distance to market		
Stage 3 project								
			Emission factor (kg CO2-e/kg CO2-e)			Emissions (t CO2-e/year)		
Year	ROM coal (t)	Emission (kg CO2-e	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2020	6,288,276	178,033,677	0	0	1	-	-	178,034
2021	6,361,121	180,096,069	0	0	1	-	-	180,096
2022	7,677,061	217,352,956	0	0	1	-	-	217,353
2023	7,140,113	202,150,874	0	0	1	-	-	202,151
2024	6,648,928	188,244,457	0	0	1	-	-	188,244
2025	10,948,419	309,971,641	0	0	1	-	-	309,972
2026	10,901,042	308,630,314	0	0	1	-	-	308,630
2027	9,404,284	266,254,102	0	0	1	-	-	266,254
2028	10,768,160	304,868,147	0	0	1	-	-	304,868
2029	8,958,176	253,623,880	0	0	1	-	-	253,624
2030	10,404,886	294,583,146	0	0	1	-	-	294,583
2031	8,436,476	238,853,514	0	0	1	-	-	238,854
2032	10,271,493	290,806,508	0	0	1	-	-	290,807
2033	9,353,161	264,806,685	0	0	1	-	-	264,807
2034	8,333,605	235,941,026	0	0	1	-	-	235,941
2035	9,378,810	265,532,874	0	0	1	-	-	265,533
2036	8,110,808	229,633,193	0	0	1	-	-	229,633
2037	9,211,533	260,796,924	0	0	1	-	-	260,797
2038	9,225,094	261,180,859	0	0	1	-	-	261,181
2039	7,678,777	217,401,522	0	0	1	-	-	217,402
2040	8,350,325	236,414,399	0	0	1	-	-	236,414
2041	7,549,573	213,743,513	0	0	1	-	-	213,744
2042	9,051,665	256,270,746	0	0	1	-	-	256,271
2043	6,055,583	171,445,678	0	0	1	-	-	171,446
2044	1,273,360	36,051,368	0	0	1	-	-	36,051

Energy Production								
Historical data								
Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes		
ROM Coal Production	t	6667232	7266601	6287535	6447561			
Saleable Coal	t	6237903						
Usage	t	5926008				95%	thermal coal	
Intensity	t/t	0.889				92-100% thermal coal		
Stage 3 project								
			Emission factor (kg CO2-e/t)			Emissions (t CO2-e/year)		
Year	ROM coal (t)	Usage (t)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2020	6,288,276	5,496,287	0	0	2436.21	-	-	13,390,109
2021	6,361,121	5,559,957	0	0	2436.21	-	-	13,545,224
2022	7,677,061	6,710,159	0	0	2436.21	-	-	16,347,355
2023	7,140,113	6,115,798	0	0	2436.21	-	-	14,899,367
2024	6,648,928	5,742,256	0	0	2436.21	-	-	13,989,342
2025	10,948,419	9,381,812	0	0	2436.21	-	-	22,856,065
2026	10,901,042	9,717,993	0	0	2436.21	-	-	23,675,071
2027	9,404,284	8,325,657	0	0	2436.21	-	-	20,283,048
2028	10,768,160	9,409,442	0	0	2436.21	-	-	22,923,376
2029	8,958,176	8,098,807	0	0	2436.21	-	-	19,730,395
2030	10,404,886	9,066,795	0	0	2436.21	-	-	22,088,617
2031	8,436,476	7,798,119	0	0	2436.21	-	-	18,997,856
2032	10,271,493	8,848,877	0	0	2436.21	-	-	21,557,723
2033	9,353,161	8,468,588	0	0	2436.21	-	-	20,631,258
2034	8,333,605	7,416,631	0	0	2436.21	-	-	18,068,471
2035	9,378,810	8,680,518	0	0	2436.21	-	-	21,147,565
2036	8,110,808	7,493,665	0	0	2436.21	-	-	18,256,140
2037	9,211,533	8,426,847	0	0	2436.21	-	-	20,529,569
2038	9,225,094	8,631,054	0	0	2436.21	-	-	21,027,060
2039	7,678,777	7,089,780	0	0	2436.21	-	-	17,272,192
2040	8,350,325	7,812,615	0	0	2436.21	-	-	19,033,170
2041	7,549,573	6,969,247	0	0	2436.21	-	-	16,978,550
2042	9,051,665	8,088,173	0	0	2436.21	-	-	19,704,488
2043	6,055,583	5,201,244	0	0	2436.21	-	-	12,671,322
2044	1,273,360	1,099,720	0	0	2436.21	-	-	2,679,149

Jacobs

31 May 2021

Coking coal use

Historical data

Parameter	Units	Assumed value	NGERS FY17	NGERS FY18	NGERS FY19	Notes	
ROM Coal Production	t	6667232	7266601	6287535	6447561		
Saleable Coal	t	6237903					
Usage	t	311895				5%	coking coal
Intensity	t/t	0.047				0-8% thermal coal	

Stage 3 project

			Emission factor (kg CO2-e/t)			Emissions (t CO2-e/year)			
Year	ROM coal (t)	Usage (t)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total
2020	6,288,276	387,062	0	0	2760.6	-	-	1,068,525	1,068,525
2021	6,361,121	391,546	0	0	2760.6	-	-	1,080,903	1,080,903
2022	7,677,061	472,546	0	0	2760.6	-	-	1,304,512	1,304,512
2023	7,140,113	564,535	0	0	2760.6	-	-	1,558,456	1,558,456
2024	6,648,928	478,521	0	0	2760.6	-	-	1,321,006	1,321,006
2025	10,948,419	861,595	0	0	2760.6	-	-	2,378,519	2,378,519
2026	10,901,042	481,089	0	0	2760.6	-	-	1,328,094	1,328,094
2027	9,404,284	473,049	0	0	2760.6	-	-	1,305,898	1,305,898
2028	10,768,160	665,314	0	0	2760.6	-	-	1,836,666	1,836,666
2029	8,958,176	282,517	0	0	2760.6	-	-	779,915	779,915
2030	10,404,886	668,080	0	0	2760.6	-	-	1,844,301	1,844,301
2031	8,436,476	95,099	0	0	2760.6	-	-	262,530	262,530
2032	10,271,493	761,194	0	0	2760.6	-	-	2,101,351	2,101,351
2033	9,353,161	282,286	0	0	2760.6	-	-	779,279	779,279
2034	8,333,605	380,340	0	0	2760.6	-	-	1,049,967	1,049,967
2035	9,378,810	94,353	0	0	2760.6	-	-	260,472	260,472
2036	8,110,808	94,857	0	0	2760.6	-	-	261,861	261,861
2037	9,211,533	191,519	0	0	2760.6	-	-	528,708	528,708
2038	9,225,094	-	0	0	2760.6	-	-	-	-
2039	7,678,777	94,530	0	0	2760.6	-	-	260,961	260,961
2040	8,350,325	-	0	0	2760.6	-	-	-	-
2041	7,549,573	94,179	0	0	2760.6	-	-	259,991	259,991
2042	9,051,665	380,620	0	0	2760.6	-	-	1,050,739	1,050,739
2043	6,055,583	464,397	0	0	2760.6	-	-	1,282,014	1,282,014
2044	1,273,360	91,643	0	0	2760.6	-	-	252,991	252,991

Table A1 Estimated greenhouse gas emissions for Stage 2 and Stage 3 as CO_2-e (Mt)

Year	Stage 2 emissions (revised gas modelling)			Stage 3 (Project) emissions (revised gas modelling)					
				No flaring of pre-drainage gas			With flaring of pre-drainage gas		
Year	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3
2022#	0.665	0.087	19.024	0.625	0.110	17.977	0.625	0.110	17.977
2023#	0.567	0.074	16.017	0.581	0.102	16.760	0.581	0.102	16.760
2024	0.600	0.069	14.856	0.768	0.095	15.592	0.768	0.095	15.592
2025	0.865	0.094	20.427	1.363	0.156	25.698	1.363	0.156	25.698
2026	0.985	0.091	19.731	1.389	0.156	25.465	1.389	0.156	25.465
2027	1.115	0.080	17.410	1.246	0.134	21.987	1.246	0.134	21.987
2028	1.021	0.081	17.642	1.489	0.154	25.216	1.480	0.154	25.216
2029	1.424	0.081	17.642	1.376	0.128	20.890	1.376	0.128	20.890
2030	1.665	0.080	17.410	1.539	0.149	24.374	1.531	0.149	24.374
2031	1.561	0.076	16.481	1.422	0.120	19.618	1.422	0.120	19.618
2032	1.497	0.063	13.696	1.431	0.147	24.094	1.417	0.147	24.094
2033	0.815	0.065	14.160	1.818	0.134	21.807	1.801	0.134	21.807
2034	0.033#	0.004#	0.929#	1.786	0.119	19.471	1.779	0.119	19.471
2035	-	-	-	1.915	0.134	21.805	1.886	0.134	21.805
2036	-	-	-	1.672	0.116	18.862	1.672	0.116	18.862
2037	-	-	-	1.956	0.132	21.448	1.934	0.132	21.448
2038	-	-	-	1.962	0.132	21.418	1.944	0.132	21.418
2039	-	-	-	1.532	0.110	17.858	1.496	0.110	17.858
2040	-	-	-	1.869	0.119	19.387	1.824	0.119	19.387
2041	-	-	-	1.404	0.108	17.558	1.389	0.108	17.558
2042	-	-	-	0.970	0.129	21.139	0.970	0.129	21.139
2043	-	-	-	0.814	0.086	14.210	0.814	0.086	14.210
2044#	-	-	-	0.481	0.018	2.986	0.481	0.018	2.986
Average	0.986	0.073	15.802	1.366	0.121	19.810	1.356	0.121	19.810
Total	12.813	0.947	205.423	31.408	2.787	455.620	31.189	2.787	455.620

 # Fugitive emissions volumes for these years taken from Palaris (2020).

APPENDIX D

ABATEMENT TECHNOLOGY ASSESSMENT

Report

Narrabri Underground Mine Stage 3 Extension Project - Abatement Technology Assessment

Client	Narrabri
Site	NSW
Date	25th May 2021
Doc No.	WHC5827-01

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Version Management

Process	Name	Date	Version
Author	Heath Shepherd, Bob Dixon, Rhys Brett	03/05/21	1
Peer Review By	Mick Barker	06/05/21	1
Draft Issued To	David Ellwood	18/05/21	4
Final Review By	Rhys Brett	24/05/21	5
Final Issued To	David Ellwood	25/05/21	5

1 ABATEMENT TECHNOLOGY ASSESSMENT

The Narrabri Mine is an existing underground coal mining operation, situated in the Gunnedah Coalfield of NSW. Greenhouse gases directly generated by Narrabri have averaged approximately 0.4 tonnes of carbon dioxide equivalent (Mt CO_2-e) per year over the last 5 years.

Narrabri Coal Operations Pty Ltd (NCOPL) have requested a report on the technical specifications and cost profiles of the following methane abatement technology:

i. Ventilation Air Methane Abatement (VAM)
ii. Methane Enrichment Plants
iii. Low gas concentration Power Generation

1.1 Ventilation Air Methane Abatement (VAM)

The Vocsidizer$_{TM}$ Regenerative Thermal Oxidizer (RTO) by Megtec/Durr is the most advanced VAM treatment equipment. The operating principles of RTO technology in application to VAM are summarised by Kallstrand (2019) and involve an exothermic oxidation of low concentrations of methane to form carbon dioxide and water vapour. The balance of fuel energy in energy recovered and energy exhausted is however, fundamental to the stable operation of any commercially available RTO technology.

At concentrations from 0.2% to 0.5% methane (CH_4), it is economically and technically more efficient to install VAM abatement only equipment without energy recovery. This conserves energy within the process chamber and maintains self-sustaining operating temperatures for VAM oxidation. Subject to the site-specific design optimisation described above, the plant is sized by simply dividing the total flow by the capacity of an abatement cube. The Narrabri Underground Mine Stage 3 Extension Project has several years where CH_4 concentrations are forecast to be in the lowest end of this range.

At concentrations from 0.5% to 0.8% CH_4, it is economically and technically more efficient to install VAM abatement equipment with energy recovery. Drainage gas support is preferred for energy recovery installations to stabilise input fuel conditions.

Longer term VAM concentrations above 0.8% $CH_{4,}$ are technically treated through the installation of additional VAM abatement cubes and utilising the fresh-air dilution control on all available cubes on a more permanent basis.

Currently the concept of four Vocsidizer^{TM} units combined to form a 'cube', each complete with two process fans, electrical, controls and instrumentation is proposed by Megtec-Durr for supply of multiple units for abatements plants. A configuration of the 'cube' concept is shown in Figure 1.1 below.

Given the wide range of potential VAM CH_4 concentrations, two cases of VAM abatement can be considered:

i. Case 1 - Full ventilation return air flow of ~500m^3/s, and
ii. Case 2 - Partial ventilation return air flow of ~125m^3/s

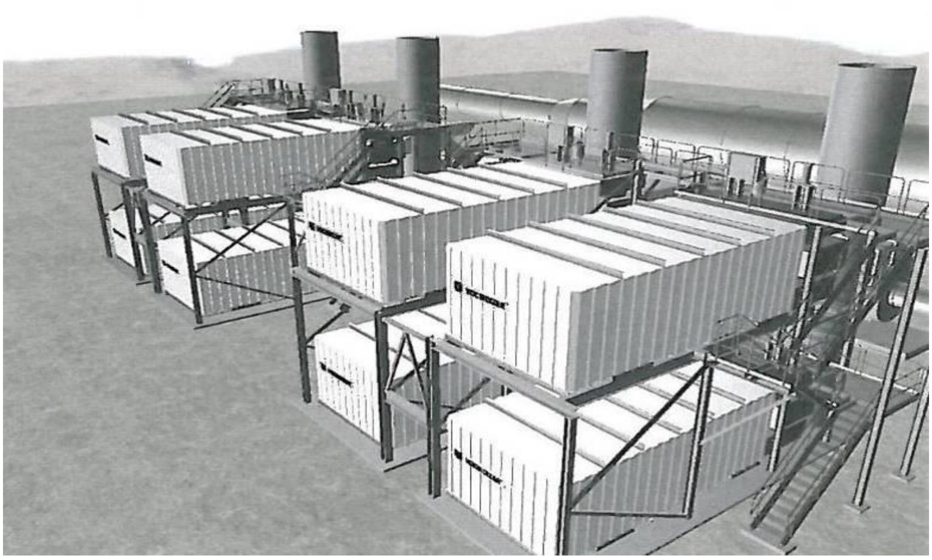

Figure 1.1 Vocsidizer™ 'Cube' Arrangement perspective (Courtesy: Megtec Systems AB)

1.2 Methane Enrichment Plants

Gas enrichment commonly uses an amine solution to absorb and separate the carbon dioxide from the mixed methane stream. Systems sizes used can capture and treat 500 litres per second (l/s) and 1000 l/s of the methane mixed gas resulting in 95-98% pure reinjected into the main methane line once treated. An example of this is utilising a 500 l/s enrichment plant for a 2000 l/s main gas stream of composition 21% methane and 79% carbon dioxide (CO_2), with an assumption of 98% efficiency, has the potential to increase the methane concentration to 26% when reinjected into the main gas stream.

Gas stream: Referring to the labelled process flow diagram in Figure 1.2. The 500 l/s mixed CO_2 and methane stream is redirected from the main feed pipeline. This is then passed through a heat exchanger and filter, removing most of the condensate and impurities in the gas stream before entering the absorption tower. The absorption tower scrubs the mixed methane stream with "lean amine", absorbing the CO_2 resulting in a "rich amine" solution which is processed. The purified CH_4 is then reinjected into the original stream source increasing the overall concentration of methane in the line. This purified stream also has a potential to use a portion of the purified gas to run a gas engine to supply heat for the plant.

Amine stream: Referring to Figure 1.2. Once the CO_2 has been absorbed and the "rich amine" captured it is then pumped into a regeneration tower. The regeneration tower uses steam heated from a gas engine or another form of heat source to convert the rich amine and capture both amine and CO_2 separately. The now lean amine is recirculated, cooled and topped up before being reinjected into the absorption tower and the separated CO_2 is captured for use elsewhere.

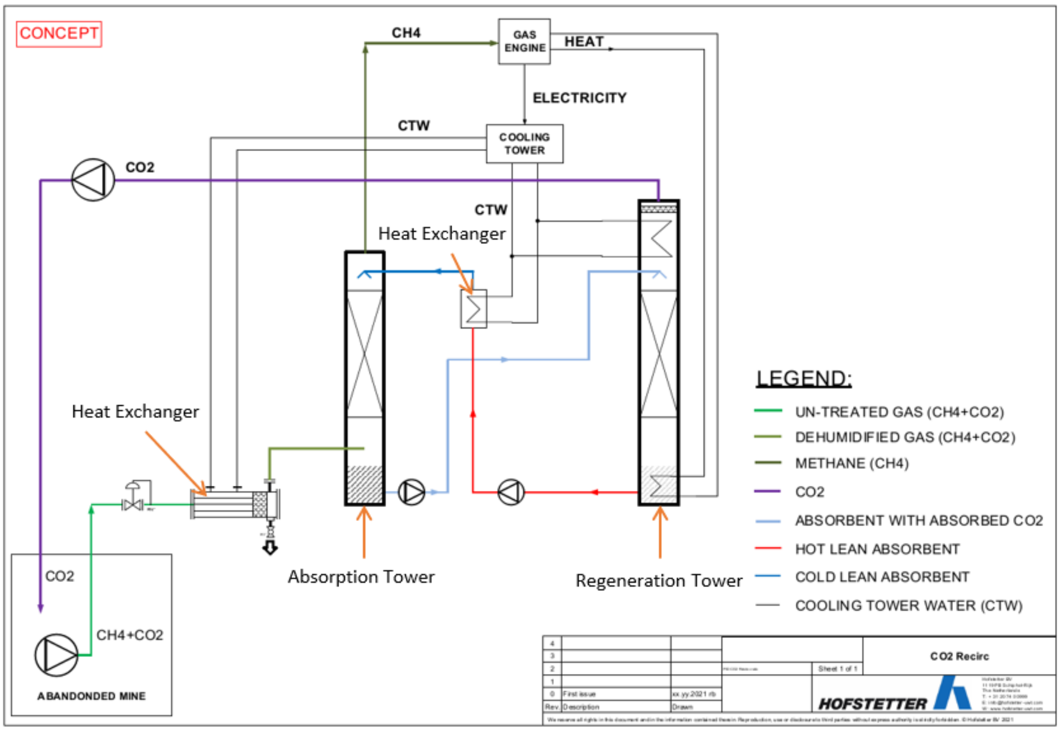

Figure 1.2: Gas Enrichment Process Flow Diagram [Courtesy of Hofstetter]

1.3 Low methane concentration power generation

Mine gas genset and combined power stations are commonly used throughout the Australian Mining industry. When assessing the viability of use in a mine site application the cost, operating life and concentration of the gas supplied are critical parameters. In the application of lower percentages of methane in the feed gas to the engine, the greater the flow required to maintain combustion of the engine. For example, an 3.3 mega watt (MW) gas genset supplied with 40% concentration methane consumes 2000 l/s of gas as per Jenbacher's specifications. The Jenbacher technical specifications note that the minimum operating gas concentration of CH_4 content of 25% volume (vol) and maximum O_2 content of 12%vol. Additional to this, an appropriately certified measurement device to measure methane concentration is required which will close the gas supply via a safety shut-off valve once the methane content goes below 25%vol or exceeds an O_2 concentration of 12%vol.

In the case for Narrabri, the period above the 25%vol methane for the life of mine (LOM) is only 3 years and the large expenditure for a power station would not be viable for the potential payback benefit.

Figure 1.3: 2G-energy 80-450kw biogas engine example

2 CONCEPTUAL COSTS

2.1 Assumptions and costs

Key assumptions in Table 2.1

Table 2.1 Key Assumptions

Area	Assumption
Order of Accuracy	Conceptual Analysis; ±40%
Base date for financial estimation	January 2021
Financials	All financials are in real 2021 dollars on a 100% ownership basis, with no allowance for structuring, joint venture or other commercial arrangements All financials are at the asset level and do not consider costs associated with financing or tax deductions for interest payments Sunk costs as at the valuation date and any expenditure to date have not been considered
Currency	Australian dollars, unless otherwise stated
Units	Quantities stated are metric (SI units)
Battery Limits	VAM and gas utilisation infrastructure costs only. All other costs including mobile extraction units, drilling and drainage, site mining costs (including gas and ventilation staff), overheads and all ex-mine costs are excluded from this analysis.

VAM total flow initial CAPEX investment of $95M and OPEX of approximately $9M per annum (totalling $88M over a 10-year period) for full ventilation return air flow of ~500m^3/s.

VAM partial flow initial CAPEX investment of $32M and OPEX of approximately $2.5M per annum (totalling $25M over a 10-year period) for partial ventilation return air flow of ~125m^3/s.

Table 2.2 VAM Conceptual Costs

Category	Unit	VAM - Total Flow	VAM - Partial Flow
Description	-	Total Ventilation Flow (including associated infrastructure) of 500m^3/s	Partial Ventilation Flow (including associated infrastructure) of 125m^3/s
CAPEX			
VAM abatement cubes	$M	40	10
Site connection	$M	15	8
Other	$M	5	2
Indirect	$M	16	6
Contingency	$M	19	7

Category	Unit	VAM - Total Flow	VAM - Partial Flow
Total CAPEX	**$M**	**95**	**32**
OPEX			
Power cost	$M	56^	15^
Labour	$M	2^	1^
O&M	$M	30^	10^
Total OPEX	**$M**	**88^**	**25^**

Note:^Total OPEX over a 10 year period for cost estimation

Gas enrichment and flares initial CAPEX of $15M and OPEX averaging approximately $2M per annum (totalling $14M over a 7-year period).

Gas generators CAPEX of $1.2M and OPEX averaging approximately $0.2M per annum (totalling $1M over a 5-year period).

Table 2.3 Gas Enrichment and Flares Conceptual Costs

Category	Unit	Gas Enrichment & Flares	Gas Generators
Description	-	CH_4 Enrichment Plant (up to 500 l/s) (including associated infrastructure)	Gas generators (low flow/low CH_4 content) (including associated infrastructure)
CAPEX			
Flares & other	$M	11	-
Power generators	$M	-	1
Gas enrichment plant	$M	3	-
Contingency	$M	2	<1
Total CAPEX	**$M**	**15**	**1**
OPEX			
Flares & other	$M	10^	-
Power generators	$M	-	1*
Gas enrichment plant	$M	5^	-
Total OPEX	**$M**	**14^**	**1***

Note:^Total OPEX over a 7 year period for cost estimation, *Total OPEX over 5 year period for cost estimation

The associated infrastructure for the CH_4 enrichment plant includes 3 x 2000 l/s enclosed flares (with small PLC control room), a filtration water knock out system and installation, 2 x 3000 l/s ventilation stacks, 4 x 2000 l/s vacuum skids and an allowance for pipes and valves.

APPENDIX E

UPDATED STATUTORY COMPLIANCE TABLE

Table E-1
Statutory Compliance for the Amended Project

Relevant Statute	Section Addressed	Amended Project Compliance
Commonwealth Legislation		
Environment Protection and Biodiversity Conservation Act 1999	Sections 4, 7 and A7.4.9 of the EIS	✓
National Greenhouse and Energy Reporting Act 2007	Sections 4, 6.18, 7 and A7.4.10 of the EIS	✓
Native Title Act 1993	Sections 4 and A7.4.11 of the EIS	✓
NSW Legislation		
Environmental Planning and Assessment Act 1979	Sections 4, 7 and A7.1 of the EIS	✓
Mining Act 1992	Sections 4 and A7.4.1 of the EIS	✓
Protection of the Environment Operations Act 1997	Sections 4, 6.5, 6.9, 6.10 and A7.4.2 of the EIS	✓
Water Management Act 2000	Sections 4, 6.4, 6.5 and A7.4.3 and Appendices B and C of the EIS	✓
Dams Safety Act 2015	Sections 4 and A7.4.4 and Appendix C of the EIS	✓
Biodiversity Conservation Act 2016	Section 4.1 of this document	✓
Forestry Act 2012	Sections 4 and A7.4.6 of the EIS	✓
Roads Act 1993	Sections 4 and A7.4.7 of the EIS	✓
Coal Mine Subsidence Compensation Act 2017	Sections 4, 6.3 and A7.4.8 and Appendix A of the EIS	✓
Other legislation	Section A7.4.12 of the EIS	✓
NSW Planning Policies		
State Environmental Planning Policy (State and Regional Development) 2011	Sections 4 and A7.2.1 of the EIS	✓
State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007	Section 4.2 of this document	✓
State Environmental Planning Policy No. 33 – Hazardous and Offensive Development	Sections 4 and A7.2.3 of the EIS	✓
State Environmental Planning Policy (Koala Habitat Protection) 2020	Section 4.3 of this document	✓
State Environmental Planning Policy No.55 – Remediation of Land	Sections 4 and A7.2.5 and Appendix M of the EIS	✓
State Environmental Planning Policy (Infrastructure) 2007	Sections 4 and A7.2.6 of the EIS	✓
Narrabri Local Environmental Plan 2012	Sections 4 and A7.3 of the EIS	✓

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