

# Agricultural Impact Assessment





# **Agricultural Impact Assessment for Gateway Application**

**Narrabri Underground Mine Stage 3 Extension Project**

Prepared for  
**Narrabri Coal Operations Pty Ltd**

5 February 2019

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# Abbreviations

Abbreviation	Description
AIP	Aquifer Interference Policy
ASC	Australian Soil Classification
BSAL	Biophysical strategic agricultural land
CHPP	Coal handling and preparation plant
DPI	Department of Primary Industries
DP&I	Department of Planning and Infrastructure
EIS	Environmental Impact Statement
EL	Exploration licence
ha	Hectare
km	Kilometre
LGA	Local Government Area
LSC	Land and Soil Capability
ML	Mining Lease
Mt	Million tonnes
Mtpa	Million tonnes per annum
New South Wales	NSW
NCOPL	Narrabri Coal Operations Pty Ltd
Gateway Certificate Application Area	Narrabri Underground Mine Stage 3 Extension Project Gateway Certificate Application Area
ROM	Run-of-mine
SRLUP Potential BSAL	Strategic Regional Land Use Plan Potential Biophysical Strategic Agricultural Land
t/ha	Tonnes per hectare
The Mining SEPP	The State Environmental Planning Policy (Mining, Petroleum and Extractive Industries)
The Project	Narrabri Underground Mine Stage 3 Extension Project
U95%CL	Upper 95% confidence limit

# Executive Summary

## *Report Purpose*

The New South Wales (NSW) Government has implemented a 'Gateway Process' to assess Coal Seam Gas and Coal Mine developments that might impact on Strategic Agricultural Land. Narrabri Coal Operations Pty Ltd (NCOPL) is seeking to expand the current underground coal mining operation to the south in a project called the Narrabri Underground Mine Stage 3 Extension Project (the Project). The Narrabri Underground Mine Stage 3 Extension Project Gateway Certificate Application Area (Gateway Certificate Application Area) contains land that has been mapped by the NSW Government as including biophysical strategic agricultural land (BSAL), which has been verified by detailed soil resource fieldwork, and hence the Gateway Process has been triggered and a Gateway Certificate Application is required.

This report represents the Agricultural Impact Assessment required for the Gateway Certificate Application. The Gateway Certificate Application is also supported by detailed studies of: likely mine impacts through subsidence modelling and impact assessment; soil resource verification and impact assessment; and groundwater modelling and impact assessment. These reports also provided core input to support the decision-making and impact assessment outlined in this report.

## *Proposed Project*

NCOPL has proposed the Project to provide continuity of mining with the existing Narrabri Mine that lies immediately north of the Gateway Certificate Application Area. The Project includes the extension of the currently approved Longwalls (LW) 112 to LW119 in the Hoskissons Seam by 6.1 to 6.4 kilometres (km). In addition, a 3.7 km long longwall is proposed within the Gateway Certificate Application Area to the east of the extended longwalls. The modified longwalls will be renamed LW203 to LW209 and the additional longwall will be named LW210. The Gateway Certificate Application will involve a new mining lease(s) of approximately 3,789 hectares (ha). This will increase total mine output to 280 million tonnes (Mt) and increase mine life until 2045. Mining will be carried out using longwall mining techniques with similar mine geometry, geology, landscape and land use as the currently operating Narrabri Mine.

## *Gateway Certificate Application Area*

Land use and land production capability was assessed through: interviews with property managers within the Gateway Certificate Application Area; interviews with local agricultural consultants/suppliers; review and analysis of NSW Government agricultural resource mapping data; and assessment of local and regional agricultural data and summaries.

Land use within the Gateway Certificate Application Area consists of a combination of grazing (cattle and sheep), small areas of cropping and a State Forest with selective silvicultural harvesting (predominately white cypress). Cropping is generally restricted to fodder crops for livestock and is opportunistic, based on favourable soil moisture conditions and weather forecasts. There is no irrigated agriculture in the Gateway Certificate Application Area. Surface water is the main water source for stock and domestic use. Groundwater is seldom, if ever, used and is of poor quality.

The land surface is moderately to gently undulating with slopes generally less than 10 degrees. Land capability is generally moderate (Land and Soil Capability Classes 4 or 5) with small areas of higher land capability (Classes 2 or 3).

Detailed soil investigation, including extensive field sampling, conducted by and under the direction of Dr David McKenzie, has mapped 107 ha of verified BSAL on the eastern edge of the Gateway Certificate Application Area. A further 95 ha of Strategic Regional Land Use Plan Potential Biophysical strategic agricultural land (SRLUP Potential BSAL) was mapped by the NSW Government, however, restricted field access prevented in-field verification. For this Project both the verified and SRLUP Potential BSAL (which was unable to be verified) were considered to be BSAL, giving a conservative combined area of 202 ha.

#### *Potential Impacts*

Given the nature of the Project, subsidence of up to 2.8 metres (m) is expected for each longwall panel. The main expected surface impact from subsidence would be small areas of ponding along existing creek lines including an area of approximately 1.5 ha of BSAL. Based on experience drawn from the existing Narrabri Mine, there is expected to be minimal to no impact on other agricultural resources if routine maintenance is undertaken as required through the Land Management Plan.

Surface mining infrastructure is expected to occupy approximately 374 ha in total although the majority of these areas will only be required for a temporary period. An area of 11.2 ha of BSAL is expected to be used for mine infrastructure development. All areas used for surface mining infrastructure will be rehabilitated to the pre-existing land capability prior to mine closure.

Groundwater assessment and modelling by HydroSimulations (2019) found no significant groundwater resources within the Gateway Certificate Application Area. The highly productive Namoi Alluvium to the east of the Gateway Certificate Application Area is not expected to be significantly impacted by the Project.

#### *Impacts to BSAL and Agricultural production*

With appropriate management and rehabilitation, no significant impacts on BSAL or local or regional agricultural production are likely as a result of the Project.

# 1 Introduction

The Narrabri Mine is an existing underground coal mining operation situated in the Gunnedah Coalfield. The 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) (Figure 1-1), in the New England North West Region of New South Wales (NSW).

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 wholly owned subsidiary Narrabri Coal Pty Ltd (70 percent [%]), Upper Horn Investments (Australia) Pty Ltd (7.5%), J-Power Australia Pty Limited (7.5%), EDF Trading Australia Pty Limited (7.5%), and Posco Daewoo Narrabri Investment Pty Limited and Kores Narrabri Pty Limited (7.5%).

NCOPL is seeking a new Development Consent to extend the underground mining areas at the Narrabri Mine to gain access to additional areas of run-of-mine (ROM) coal reserves within Exploration Licence (EL) 6243. This extension would also include development of supporting infrastructure, continued use of existing infrastructure and an extension to the mine life. The proposal is herein referred to as the Narrabri Underground Mine Stage 3 Extension Project (the Project).

The Project would require the issue of a new mining lease(s) as the mining area would be outside the existing Narrabri Mine mining lease (Mining Lease [ML] 1609). Therefore, Part 4AA of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) applies.

As part of the *Strategic Regional Land Use Policy*, the NSW Government introduced a 'Gateway Process' for upfront assessment of the impacts of State Significant mining and coal seam gas proposals on Strategic Agricultural Land (NSW Government 2012). The Strategic Regional Land Use Policy and the 'Gateway Process' apply to new State Significant Development applications or modifications for mining projects located outside of existing mining lease areas (NSW Government 2012) (e.g. the Project).

Clause 50A of the *NSW Environmental Planning and Assessment Regulation, 2000* requires that a development application for consent to mine on certain land (including land shown on the *Strategic Agricultural Land Map* in the Mining SEPP) must be accompanied by a gateway certificate or a site verification certificate (that certifies that the land on which the proposed development is to be carried out is not biophysical strategic agricultural land [BSAL]).

The *Strategic Agricultural Land Map* in the Mining SEPP maps BSAL within the Project area and Soil Management Designs (2019) has confirmed that areas of the Project area meet the BSAL criteria. No Critical Industry land is identified near the Project on the *Strategic Agricultural Land Map* in the Mining SEPP.

Accordingly, NCOPL would lodge an application for a gateway certificate with the Mining and Petroleum Gateway Panel for the Project area to the south of the existing mining lease within EL 6243 (herein referred to as the Gateway Certificate Application Area) (Figure 1-2) in accordance with Division 4 of the Mining SEPP.

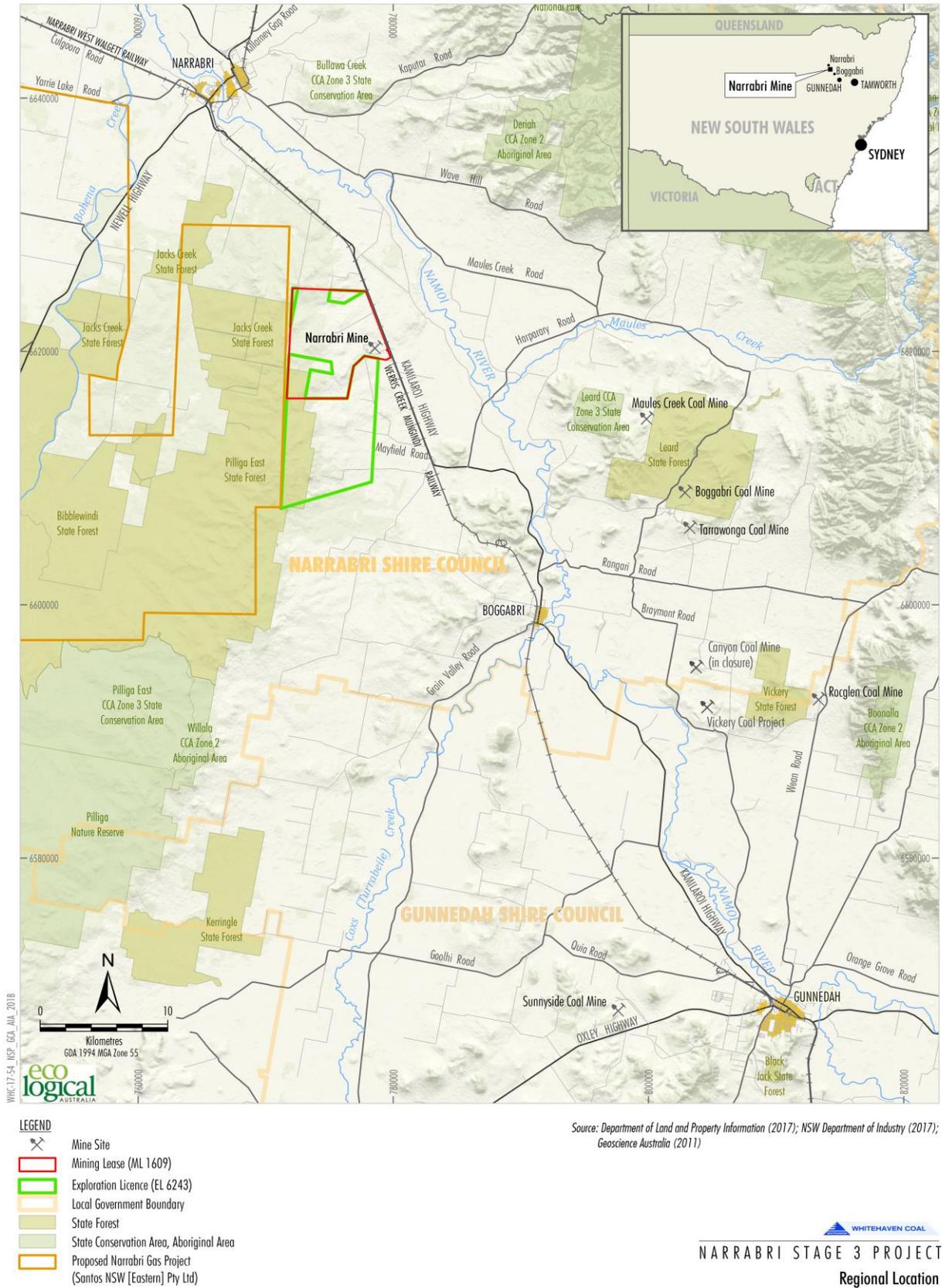


Figure 1-1

Figure 1-1: Regional Location



Figure 1-2: Gateway Certificate Application Area

## 1.1 Purpose of Assessment

The purpose of this Agricultural Impact Assessment is to support the Gateway Certificate Application for the Project. This report was prepared in accordance with:

- The Mining SEPP.
- *New England North West Strategic Regional Land Use Plan*, September 2012 by the Department of Planning & Infrastructure (DP&I) (DP&I 2012a).
- *Strategic Regional Land Use Policy Guideline for Gateway Applicants*, Fact Sheet, September 2013 (the Guideline) by DP&I (DP&I 2013).
- *Strategic Regional Land Use Policy Guideline for Agricultural Impact Statements*, October 2012 by DP&I (DP&I 2012b).
- *Agricultural Impact Statement technical notes: A companion to the Agricultural Impact Statement guideline*, April 2013 by the Department of Primary Industries (DPI) (DPI 2013).
- *Interim protocol for site verification and mapping of biophysical strategic agricultural land* (the Interim Protocol), by the Office of Environment & Heritage (OEH) and the Office of Agricultural Sustainability & Food Security (OAS&FS) (OEH and OAS&FS 2013).

### 1.1.1 Addressing the Relevant Criteria

This report addresses relevant Gateway assessment criteria contained in Clause 17H4(a) of the Mining SEPP (Table 1-1). In addition, Table 1-2 describes how this report addresses the Guideline.

**Table 1-1: Assessment Criteria Contained in Clause 17H4(a) of the Mining SEPP and Where They are Addressed in This Report**

Relevant Criteria	Where Addressed
Any impacts on the land through surface area disturbance and subsidence	Sections 5.2.1 and 5.3, Ditton Geotechnical Services (2019)
Any impacts on soil fertility, effective rooting depth or soil drainage	Sections 5.2.1 and 5.3, Soil Management Designs (2019)
Increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH	Sections 5.2.1 and 5.3, Ditton Geotechnical Services (2019), Soil Management Designs (2019)
Any impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy [AIP])	Sections 5.2.2 and 5.3, HydroSimulations (2019)
Any fragmentation of agricultural land uses	Section 5.3
Any reduction in the area of BSAL	Section 5.3, Soil Management Designs (2019)

**Table 1-2: Complying with the Guideline**

Guideline Requirements for Supporting Documents	Where Addressed
Describes the proposal's impact in terms of relevant Gateway criteria and mitigation measures to address these impacts	Section 5
Provide high quality photographs, maps or figures that depict local and regional context	Throughout all reports
Explain why the site was chosen and discuss any alternatives considered	Sections 2 and 2.8
Present relevant technical investigations	Ditton Geotechnical Services (2019), Soil Management Designs (2019), HydroSimulations (2019), this report including Appendix A.
Supply maps and text to describe the areal extent of surface impacts	Throughout all reports
Describe land and soil capability (LSC) classes that will be affected	Section 4.2, Soil Management Designs (2019)
Estimate likelihood of full rehabilitation and how this might be achieved	Sections 5.1 and 5.2
Refer to the Interim Protocol	Soil Management Designs (2019), this report
Refer to the Agricultural Impact Statement	This report
Provide information in a tabular form that demonstrates the pre-development and post development LSC and soil fertility classes	Soil Management Designs (2019), Section 4.2
Estimate quantities of water likely to be taken from any water source on an annual basis	HydroSimulations (2019)
A strategy for obtaining appropriate water licence/s for the maximum predicted annual take	HydroSimulations (2019)
Establishment of baseline groundwater conditions	HydroSimulations (2019)
A strategy for complying with any water access rules	HydroSimulations (2019)
Estimates of potential water associated impacts on nearby water users	HydroSimulations (2019)
Estimates of potential water impacts on groundwater dependent ecosystems	HydroSimulations (2019)
Estimates of potential saline and contaminated water flow to aquifers and river systems	HydroSimulations (2019)
Estimates of the potential to cause or enhance hydraulic connectivity between aquifers	HydroSimulations (2019)
Estimates of the potential for river bank instability, or high wall instability or failure	HydroSimulations (2019)
Outline method for disposing of water inflows	HydroSimulations (2019)
A strategy for moving to groundwater modelling using more site-specific data should the proposal progress	HydroSimulations (2019)
Assess groundwater impacts against the AIP	HydroSimulations (2019)
Indicate whether the proposal will result in significant fragmentation of agricultural land use in terms of: area; critical farm and regional infrastructure; change in land use (agricultural intensity or to another land use); use of mine buffer land	Section 5.3
Quantify any potential reductions in the area of BSAL	Soil Management Designs (2019), Sections 4.3 and 5.3

## 1.2 Supporting Studies

Three supporting studies were undertaken for the Project to support the Gateway Certificate Application:

- **Agricultural Literature Review and Stakeholder Consultation Report** – Eco Logical Australia (2019). This report is presented in Appendix A.
- **Agricultural Resources Assessment** – Soil Management Designs (2019) *Agricultural Resource Assessment for Gateway Certificate Application: “Narrabri Underground Mine Stage 3 Extension Project” Narrabri, NSW*. A report prepared for NCOPL by Soil Management Designs, Orange NSW; January 2019. This report is presented in Appendix B.
- **Subsidence Modelling and Impact Assessment** – Ditton Geotechnical Services (2019) *Mine Subsidence Assessment in Support of a Gateway Certificate Application for the Narrabri Underground Mine Stage 3 Extension Project, Narrabri Mine, DGS Report No. NAR-005/1*. This report is presented in Appendix C.
- **Groundwater Modelling and Impact Assessment** – HydroSimulations (2019) *Narrabri Underground Mine Stage 3 Extension Project: Gateway Application Preliminary Groundwater Assessment, Report HS2017/45*. January 2019. This report is presented in Appendix D.

## 2 Project Description and Rationale

### 2.1 Overview of the Narrabri Mine

Stage 1 of the Narrabri Mine was approved under Part 3A of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) in 2007 and involved initial site establishment activities and continuous miner mining operations.

Project Approval 08\_0144 for Stage 2 of the Narrabri Mine was issued under Part 3A of the EP&A Act in 2010 and allowed the mine to convert to a longwall mining operation.

The Narrabri Mine extracts coal from the Hoskissons Seam. Project Approval 08\_0144 allows for the production and processing of up to 11 million tonnes per annum (Mtpa) of ROM coal until July 2031. ROM coal is processed at the Narrabri Mine coal handling and preparation plant (CHPP) to produce thermal and pulverised coal injection product coal. Product coal is then transported from site by rail.

Coarse CHPP rejects are placed in a dedicated rejects emplacement.

The Narrabri Mine comprises 20 longwall panels, Longwalls (LW) 101 to LW120. Longwall mining is currently being undertaken in the approved LW108, with extraction of LW101 to LW107 complete. It should be noted that LW112 to LW120 will be renamed LW201 to LW209 should the Project proceed.

The pit top area incorporates the majority of the Narrabri Mine surface infrastructure, including the box cut, CHPP, ROM and product coal stockpiles, rail loop and product coal load-out infrastructure.

### 2.2 Project Overview

The Project includes an extension of the southern longwall panels at the Narrabri Mine to gain access to additional coal reserves within EL 6243 (Figure 1-2). This extension would also include development of supporting infrastructure and an extension to the approved surface operations.

The Project would provide continued employment of the existing Narrabri Mine workforce, with some short-term increases possible (for construction and additional development requirements).

The Project would include the following activities:

- Continued longwall mining of the Hoskissons Seam including a southern extension of the existing underground mining area.
- Development of roadways within the Hoskissons Seam and adjacent strata to access mining areas.
- Continued use of existing roadways and drifts for personnel and materials access, ventilation, dewatering and other ancillary activities.
- Increased production of up to 13 Mtpa of ROM coal (increased from 11 Mtpa).
- Continued use of the existing surface facilities (with minor upgrades and extensions) and development of additional surface infrastructure associated with mine ventilation and gas management, and other ancillary infrastructure above the extended underground mining area.
- Continued use and extension of the existing coal reject emplacement area.
- Continued transport of product coal from site by rail.

- Continued use and progressive development of the Namoi River water pipeline, sumps, pumps, pipelines, water storages and other water management infrastructure.
- Continued employment of the existing residentially based workforce.
- Continued monitoring, rehabilitation and remediation of subsidence and other mining effects.
- Development associated with exploration in EL 6243.
- Other associated minor infrastructure, plant, equipment and activities.

Table 2-1 provides a comparative summary of activities associated with the Project and the existing approved Narrabri Mine.

**Table 2-1: Summary Comparison of the Approved Narrabri Mine and the Project**

Project Component	Approved	Project
Mining Method	<ul style="list-style-type: none"> <li>• Longwall mining of the Hoskissons Seam.</li> </ul>	<ul style="list-style-type: none"> <li>• Unchanged.</li> </ul>
Underground Mine Geometry	<ul style="list-style-type: none"> <li>• Twenty longwall panels (LW101 to LW120).</li> <li>• 295 metres (m) wide longwall panels for LW101 to LW106.</li> <li>• 400 m wide longwall panels for LW107 to LW120.</li> </ul>	<ul style="list-style-type: none"> <li>• Additional and/or longer longwall panels within EL 6243.</li> <li>• Variable longwall panel widths of approximately 400 m.</li> </ul>
Tenement	<ul style="list-style-type: none"> <li>• Mining operations conducted within ML 1609.</li> </ul>	<ul style="list-style-type: none"> <li>• Continued mining operations conducted within ML 1609.</li> <li>• Mining operations conducted within new Mining Lease Application (MLA) areas to the south in EL 6243.</li> </ul>
Mine Life	<ul style="list-style-type: none"> <li>• Mining operations approved until July 2031.</li> </ul>	<ul style="list-style-type: none"> <li>• An extension in mine life to 2045.</li> </ul>
ROM Coal Production	<ul style="list-style-type: none"> <li>• Total ROM coal production of approximately 170 million tonnes (Mt).</li> <li>• ROM coal production of up to 11 Mtpa.</li> </ul>	<ul style="list-style-type: none"> <li>• Total ROM coal production increased to approximately 280 Mt.</li> <li>• ROM coal production rate increased to 13 Mtpa.</li> </ul>
Underground Mine Surface Infrastructure	<ul style="list-style-type: none"> <li>• Ventilation shafts, pre-drainage and post-drainage sites, mine safety pre-conditioning sites (LW101 to LW120), access roads and electricity transmission lines.</li> </ul>	<ul style="list-style-type: none"> <li>• Augmentation of the existing gas drainage, mine safety pre-conditioning and mine ventilation system.</li> </ul>
Coal Washing	<ul style="list-style-type: none"> <li>• CHPP and secondary crusher/screen capable of processing approximately 2,000 tonnes (t) per hour.</li> </ul>	<ul style="list-style-type: none"> <li>• Unchanged.</li> </ul>
Coal Handling and Stockpiling	<ul style="list-style-type: none"> <li>• ROM coal stockpile capacity of 700,000 t.</li> <li>• Product coal stockpile capacity of 500,000 t.</li> </ul>	<ul style="list-style-type: none"> <li>• Unchanged.</li> </ul>
Coal Reject Management	<ul style="list-style-type: none"> <li>• CHPP rejects placed in rejects emplacement area.</li> </ul>	<ul style="list-style-type: none"> <li>• Total rejects production increased.</li> <li>• Increased rejects emplacement capacity.</li> </ul>

Project Component	Approved	Project
Product Coal Transport	<ul style="list-style-type: none"> <li>• Average of four trains per day.</li> <li>• Product coal transported from site by rail.</li> <li>• Peak of eight trains per day.</li> </ul>	<ul style="list-style-type: none"> <li>• Average increased to five trains per day.</li> <li>• No change to peak number of trains per day.</li> </ul>
Subsidence Commitments and Management	<ul style="list-style-type: none"> <li>• The subsidence impact performance measures listed in Conditions 1 and 2, Schedule 3 of Project Approval 08_0144.</li> </ul>	<ul style="list-style-type: none"> <li>• To be determined through Environmental Impact Statement (EIS) process.</li> </ul>
Water Management	<ul style="list-style-type: none"> <li>• Conducted in accordance with the Water Management Plan (including discharge under the conditions of Environment Protection Licence 12789).</li> </ul>	<ul style="list-style-type: none"> <li>• Water management strategy generally unchanged.</li> </ul>
Water Supply	<ul style="list-style-type: none"> <li>• Make-up water demand to be met from mine dewatering, runoff recovered from operational areas, and licensed extraction from Namoi River and Namoi River Alluvium.</li> </ul>	<ul style="list-style-type: none"> <li>• Unchanged.</li> </ul>
Power	<ul style="list-style-type: none"> <li>• Permanent mains power supplied via a spur line from a 66 kilovolt (kV) power-line located to the east of Kamilaroi Highway.</li> <li>• Power converted from 66 kV to 11 kV on-site and reticulated using progressively developed 11 kV powerlines.</li> </ul>	<ul style="list-style-type: none"> <li>• No change to key power supply infrastructure, however demand for mains power may increase.</li> <li>• Continued progressive development of powerlines to service the extended underground mining area.</li> </ul>
Hours of Operation	<ul style="list-style-type: none"> <li>• 24 hours per day, seven days per week.</li> </ul>	<ul style="list-style-type: none"> <li>• Unchanged.</li> </ul>
Employment	<ul style="list-style-type: none"> <li>• Residential operational workforce (employees and contractors) of approximately 370 employees.</li> </ul>	<ul style="list-style-type: none"> <li>• Operational workforce unchanged.</li> <li>• Possible short-term increases in employment for construction activities and additional development requirements.</li> </ul>
Surface Development Footprint	<ul style="list-style-type: none"> <li>• Approximately 750 hectares (ha).</li> </ul>	<ul style="list-style-type: none"> <li>• Additional surface development areas to support underground mining, similar to the existing Narrabri Mine.</li> </ul>
Rehabilitation Strategy	<ul style="list-style-type: none"> <li>• Conducted in accordance with the Landscape Management Plan.</li> </ul>	<ul style="list-style-type: none"> <li>• Unchanged.</li> </ul>
Capital Investment Value	<ul style="list-style-type: none"> <li>• Not applicable.</li> </ul>	<ul style="list-style-type: none"> <li>• To be determined through the EIS process.</li> </ul>

## **2.3 Project Activities**

### **2.3.1 Underground Mining Operations**

The Project involves longwall mining operations in ML 1609 and new MLA areas (within EL 6243) to extract coal within the Hoskissons Seam.

### **2.3.2 Ancillary Surface Infrastructure**

The locations of underground mine surface infrastructure would be refined through detailed mine planning, environmental assessment outcomes and consideration of alternatives, and would be documented in the EIS.

### **2.3.3 Coal Processing, Handling and Transport Infrastructure**

The Project would include the use of the existing Narrabri Mine surface facilities (Section 2.2) for handling, processing and transportation of coal for the life of the Project.

The Project may incorporate minor upgrades and extensions to existing infrastructure, which would be documented in the EIS.

### **2.3.4 Water Management**

The site water management strategy for the Narrabri Mine is based on the containment and re-use of mine water while diverting upstream water around the Narrabri Mine. The approved water management system includes:

- Up-catchment diversion structures.
- Raw water storage dams.
- Saline water storage dams.
- Filtered water storage dams.
- Brine storage dams.
- Sediment dams.
- Reverse osmosis plant.
- Namoi River water pipeline and pump station.
- Any groundwater supplementary supply and associated infrastructure.
- Namoi River licensed discharge point.
- Other water transfer infrastructure (i.e. tanks, pumps and pipelines).

The water management system is progressively developed subject to its ongoing performance, prevailing climatic conditions and actual underground mine inflows.

The Project would involve the use of the existing/approved infrastructure with minor augmentations and extensions, including the progressive development of sumps, pumps, pipelines, water storages and other water management infrastructure. Water supply and release requirements for the Project would be subject to the outcomes of a detailed water balance that would be presented in the EIS.

### **2.3.5 Other Activities**

Other activities that would be conducted as a component of the Project include development associated with exploration in EL 6243 and development of other associated minor infrastructure, plant, equipment and activities.

### **2.3.6 Rehabilitation Activities and Remediation Works**

The Project would include the continued monitoring, rehabilitation and remediation of subsidence and other mining effects.

### **2.3.7 Hours of Operation**

The Narrabri Mine would continue to be operated on a continuous basis (24 hours per day, seven days per week) during the Project.

## **2.4 Employment**

The Narrabri Mine currently employs approximately 370 personnel (employees and contractors). The number of employees (particularly contractors) fluctuates according to requirements at the time. The Project would facilitate continued employment of the existing residential workforce and would also result in the extension of existing economic opportunities for NCOPL's suppliers and service providers.

Possible short-term increases in employment would be generated by Project construction activities and additional development requirements. This additional employment would be quantified and assessed in the EIS.

## **2.5 Conceptual Project Schedule**

Longwall extraction in LW111 at the Narrabri Mine (i.e. the final longwall in the northern series of longwall panels) is scheduled for completion in 2023. The longwall miner would be installed in a southern longwall block thereafter (i.e. to allow development of the Project). First workings development would be required to commence in 2021 to facilitate continuity of mining.

## **2.6 Environmental Management Commitments**

The environmental management approach used at the existing Narrabri Mine is also proposed for the Project. It is anticipated that any new Development Consent would require a contemporary Extraction Plan process for the Project to mitigate, remediate, monitor, manage and offset potential impacts associated with subsidence.

## **2.7 Project Rationale**

The extraction of coal from the Narrabri Mine provides benefits at national, state and local levels.

Benefits from the Narrabri Mine occur through employment, expendable income, export earnings and government revenue. NCOPL provides local jobs for its direct employees and contract workforce, suppliers and service providers with flow-on benefits for the Narrabri region.

The Project would facilitate the continuation of benefits derived from the Narrabri Mine and would also result in increased coal production.

## 2.8 Project Alternatives

The following is a description of the Project alternatives in relation to location, surface facilities, production scale, mining method and extent:

- **Project Location** – the location of the Project is determined by the presence of coal seams able to be economically mined. Consideration is also given to minimising impacts by using existing mining infrastructure associated with the current Narrabri Mine and to minimise potential impacts on BSAL that exists in the eastern side of the Gateway Certificate Application Area.
- **Surface Facilities** – existing facilities associated with the current Narrabri Mine would be used where possible to minimise potential impacts on BSAL that exists in the eastern side of the Gateway Certificate Application Area.
- **Scale** – the Project coal yield is estimated at approximately 110 Mt of ROM coal, extending the currently approved Narrabri Mine yield from 170 Mt to 280 Mt. The proposed Project longwall panels maximise the recovery of economically viable coal resources.
- **Mining Method** – the Applicant has considered alternate methods of mining, however the depth of cover means that the coal resource is amenable to underground mining methods and therefore open cut mining is not proposed. Longwall extraction has been determined to be the most efficient method of mining the coal resource relative to other underground mining methods (e.g. bord and pillar mining) and has reduced impacts relative to open cut mining methods.
- **Longwall Extraction Limits** – the Applicant has considered longwall extraction limits with regard to surface subsidence impacts. The longwall layout and mine geometry has been configured to minimise impacts on the surface landscape and also minimise potential impacts on BSAL.

## 3 Overview of Agriculture in the Region

The Project is located in the Narrabri Shire LGA, which lies within the New England North West Region of NSW. Information relating to agricultural resources and production within the New England North West Region is summarised below, with more detail focused on the Narrabri LGA.

### 3.1 New England North West Region

The New England North West Region comprises an area of 9.9 million ha and includes the Northern Tablelands to the east, and the North West Slopes and Plains to the west. The region includes the LGAs of Armidale Regional, Glen Innes Severn, Gunnedah, Gwydir, Inverell, Liverpool Plains, Narrabri, Tamworth Regional, Tenterfield, Uralla and Walcha (Figure 3-1) (DP&I 2012a). The New England North West Region is split into four agricultural-geographical sub-regions:

1. Southern Plains (Liverpool Plains and Gunnedah LGAs).
2. Northern Plains (Moree Plains and Narrabri LGAs).
3. Slopes (Tamworth Regional, Gwydir and Inverell LGAs).
4. Tablelands (Armidale Regional, Uralla, Walcha, Glen Innes Severn and Tenterfield LGAs).

The New England North West Region generates more than \$2 billion per annum of agricultural product. Almost a quarter of the gross value of all crops in NSW is produced in the region (NSW Trade & Investment 2015). The agricultural sector is the region's largest industry, with a 15% share of both regional output and employment (NSW Trade & Investment 2015). Main contributors are sheep and cattle grazing, broad acre cereal crops, irrigated cotton, intensive livestock and plant agriculture, and poultry production (DP&I 2012a).

Almost half the regional production (about 45%) occurs in the Northern Plains; however, on a per unit of area of agricultural land basis, the Northern and Southern Plains contribute similar values of \$312 and \$310 per ha each to agricultural production (Short and Thomson 2014). Production in the Northern Plains is dominated by irrigation on predominately grey cracking clay soils along the Namoi, Gwydir, and Macintyre Rivers. Irrigated agriculture, of which cotton is the major crop, is possible due to water availability from Pindari, Copeton, Keepit and Split Rock Dams and highly productive aquifers. The cattle industry is supported by artesian bores (DP&I 2012a).

The Project is located in the Northern Plains sub-region of the New England North West Region.

The Mining SEPP includes mapping of lands identified as potential BSAL. Figure 3-1 shows this Mining SEPP Potential BSAL in the New England North West Region.

Approximately 40% of the Mining SEPP Potential BSAL in the New England North West Region is mapped to occur in the Northern Plains sub-region, with the greater proportion in the Moree Plains LGA. Most of the Mining SEPP Potential BSAL occurs on the floodplains of the Namoi and Gwydir Rivers (Figure 3-1).

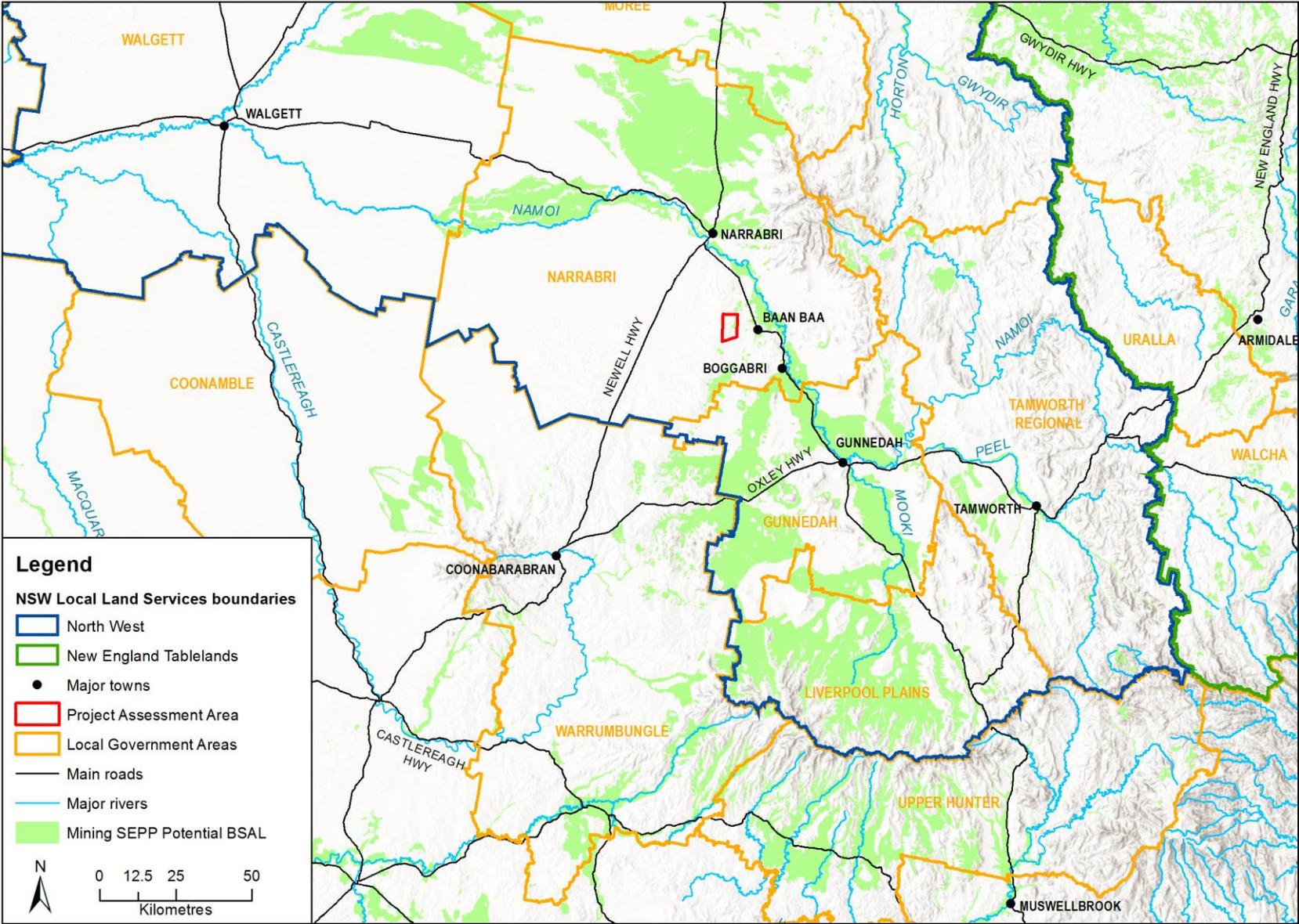


Figure 3-1: Mining SEPP Potential BSAL in the New England North West Region

The coal industry is rapidly developing in the region and becoming a more prominent industry and driver of the local economy, particularly in the Liverpool Plains, Gunnedah and Narrabri Shires (DP&I 2012a). EL 6243 (encompassing the existing Narrabri Mine and the Project) is identified in the *Strategic Regional Land Use Plan: New England North West* (DP&I 2012a) as an area with the potential for future coal resource development.

### 3.2 Narrabri Shire

The Narrabri Shire covers an area of 13,056 square kilometres and supports a population of approximately 14,000 people (NSC 2016). Narrabri is the largest town in the Narrabri Shire and is the administrative centre. Other towns and villages include Boggabri, Wee Waa, Baan Baa, Bellata, Edgeroi, Gwabegar and Pilliga. The landscape of the shire consists of flat open plains to the west and steep land that is associated with Mount Kaputar and the accompanying ranges to the east (EDGE Land Planning 2009).

#### 3.2.1 Local Geography

Narrabri Shire forms part of the Namoi River catchment, 'bounded by the Nandewar Range in the north, the New England Plateau in the north-east, the Liverpool Plains in the south-east and the Warrumbungle Range in the south-west' (DPI Water 2017). The Namoi River system is subject to extensive flooding and is regulated with several dams, the largest being Lake Keepit which provides major water storage for the catchment. The Great Artesian Basin is also a key source of water (Askland *et al.* 2016).

Narrabri has an average annual rainfall of 661 millimetres (mm) and rainfall is summer dominant (Figure 3-2). Maximum mean temperature is 26.5 degrees Celsius (°C) and mean minimum is 11.7°C (Figure 3-3) (BOM 2016).

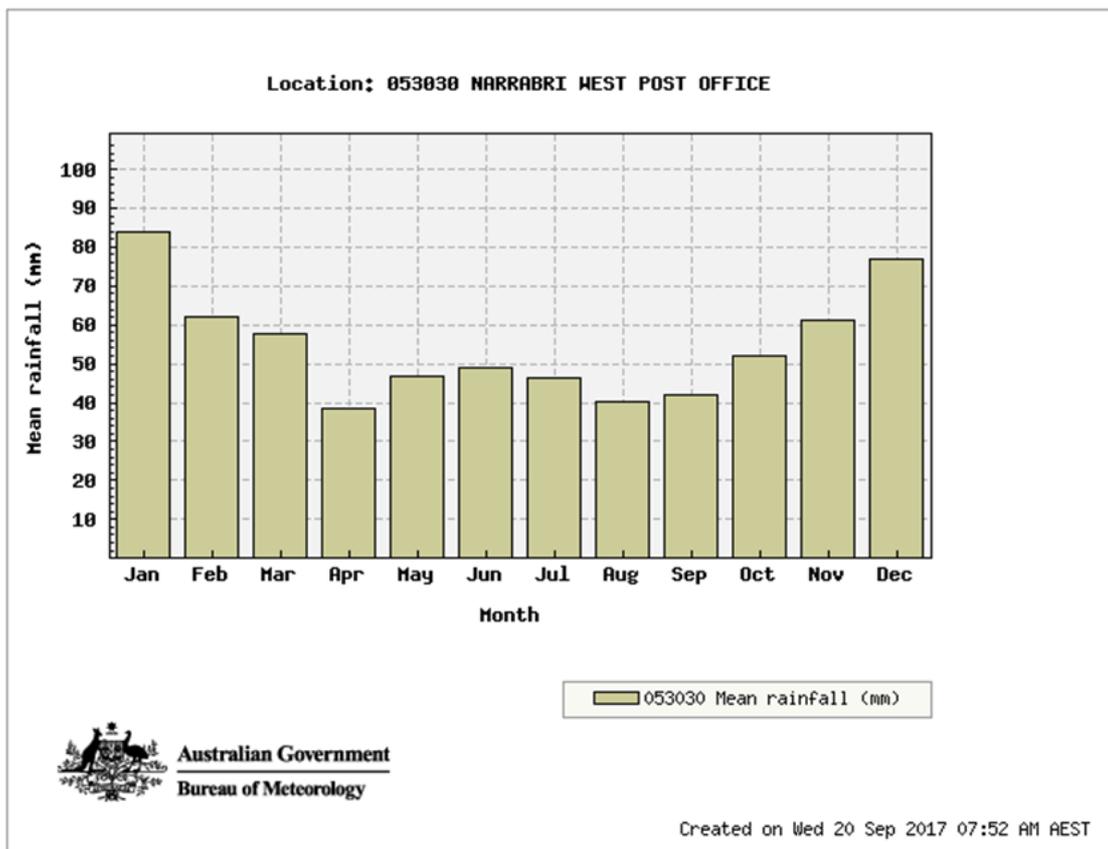


Figure 3-2: Mean Rainfall at Narrabri West Post Office (Source: BOM 2016)

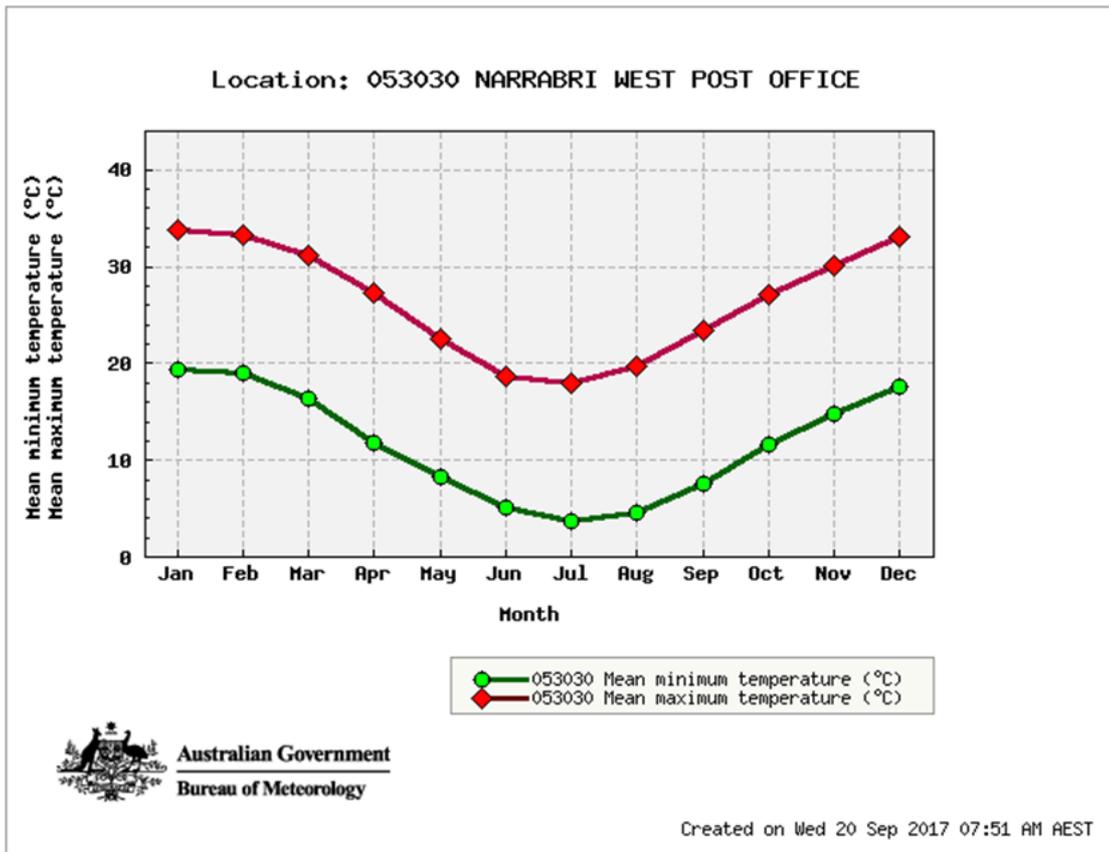


Figure 3-3: Mean Maximum and Minimum Temperatures at Narrabri West Post Office (Source: BOM 2016)

Mt Kaputar National Park is 50 km east of Narrabri and is comprised of more than 36,000 ha of forested mountainous country in the Nandewar Ranges. The Pilliga East State Forest is dominated by extensive cypress pine and ironbark woodlands. The Pilliga is the largest remaining dry sclerophyll forest west of the Great Dividing Range (Askland *et al.* 2016).

### 3.2.2 Local Land Use

Agricultural industries have existed in the Narrabri Shire since European settlement in the 1830's when early settlers were attracted by rich grazing land, and have remained a key part of the Narrabri Shire's socio-economic characteristics (Askland *et al.* 2016).

The Narrabri Shire's current agricultural uses include sheep and cattle grazing, grain crops, cotton, piggeries, feedlots, vineyards and forestry. The open flat floodplains located in the west of the Narrabri Shire provide areas which are used for irrigated agriculture, particularly cotton. These crops rely heavily on water from the Namoi River and groundwater. Grazing of sheep and cattle is the primary form of agriculture to the south-east of the Narrabri Shire (EDGE Land Planning 2009).

A land use survey carried out by EDGE Land Planning (2009) found that extensive agriculture made up 54.7% of the Narrabri Shire's primary land use, irrigated plants (11.1%) and intensive animal keeping (0.2%). This amounted to 66% of the Narrabri Shire's land use devoted to agriculture.

Coal mining is a growth industry in the Narrabri Shire. The Gunnedah Basin, in which the Narrabri Shire is located, is estimated to contain 12% of NSW's available coal reserves. Extraction of coal seam gas is an emerging industry (Askland *et al.* 2016).

### 3.2.3 Key Agricultural Infrastructure

Narrabri Shire is positioned halfway between Sydney and Brisbane, with easy access to road and rail transportation and therefore ports; allowing for global transportation. There are many large agricultural organisations that have facilities within the Narrabri Shire. These companies include Cargill, Louis Dreyfus, Viterro, Queensland Cotton and Australia Milling. National organisations with facilities in the Narrabri Shire include Namoi Cotton, Auscott Limited, Cotton Seed Distributors, Graincorp, CLASS Harvest Centre, McGregor Gourlay, and Kenway and Clark (NSC 2016). Seed production and ginning facilities are also located within the Narrabri Shire (Askland *et al.* 2016).

The IA Watson Grains Research Centre (which incorporates the University of Sydney and Australian Grain Technologies) and the Australian Cotton Research Institute (which incorporates the DPI, Cotton Research and Development Corporation and the Commonwealth Scientific and Industrial Research Organisation) are also located in Narrabri Shire (NSC 2016).

# 4 Gateway Certificate Application Area Agricultural Analysis

## 4.1 Agricultural Land Use and Productivity

There are six agricultural enterprises that fall within the Gateway Certificate Application Area (Table 4-1, Figure 4-1 and Appendix A). In addition, there is an area of Pilliga East State Forest on the western edge of the Gateway Certificate Application Area. The Pilliga East State Forest area supplies native timbers that are routinely harvested by the Forestry Corporation of NSW.

**Table 4-1: Landholders within the Gateway Certificate Application Area**

Landholding	Landowner	Land Manager	Area (ha)	Area within Gateway Certificate Application Area (ha)
Merrilong	NCOPL	Peter Lennox	985	434
Longsight	Clarke	Clarke	513	356
Yarranbee	Hudson	Hudson	793	344
Uambi	Ward	Ward	526	213
Kinka	Murray	Murray	570	504
The Bulga*	RK Martin	RK Martin	735	192
Pilliga East State Forest	NSW Government	NSW Forestry Corporation	132,021	1,705
Crown Land	NSW Government	Dept of Industry (Crown Land)		41

\*The Bulga is subject to a perpetual lease agreement with Crown Lands

Three methods were used to assess and describe the agricultural production systems and productivity within the Gateway Certificate Application Area: interviews with land managers and local experts; literature review and GIS-based assessment of agricultural and natural resources datasets and high-resolution imagery (Appendix A).

Agricultural land uses and productivity within the Gateway Certificate Application Area can be summarised as:

- Grazing for beef cattle and sheep is the dominant land use.
- Some dryland cropping of cereal crops is undertaken generally to support grazing production. Yields can reach 2 to 2.5 tonnes per hectare (t/ha) (personal communication Dave Hudson [Yarranabee Property]).
- Water for livestock is sourced from overland flow. Bores were reported by land managers to have provided poor quality water and to be currently disused and not maintained.
- There is no irrigated land use.

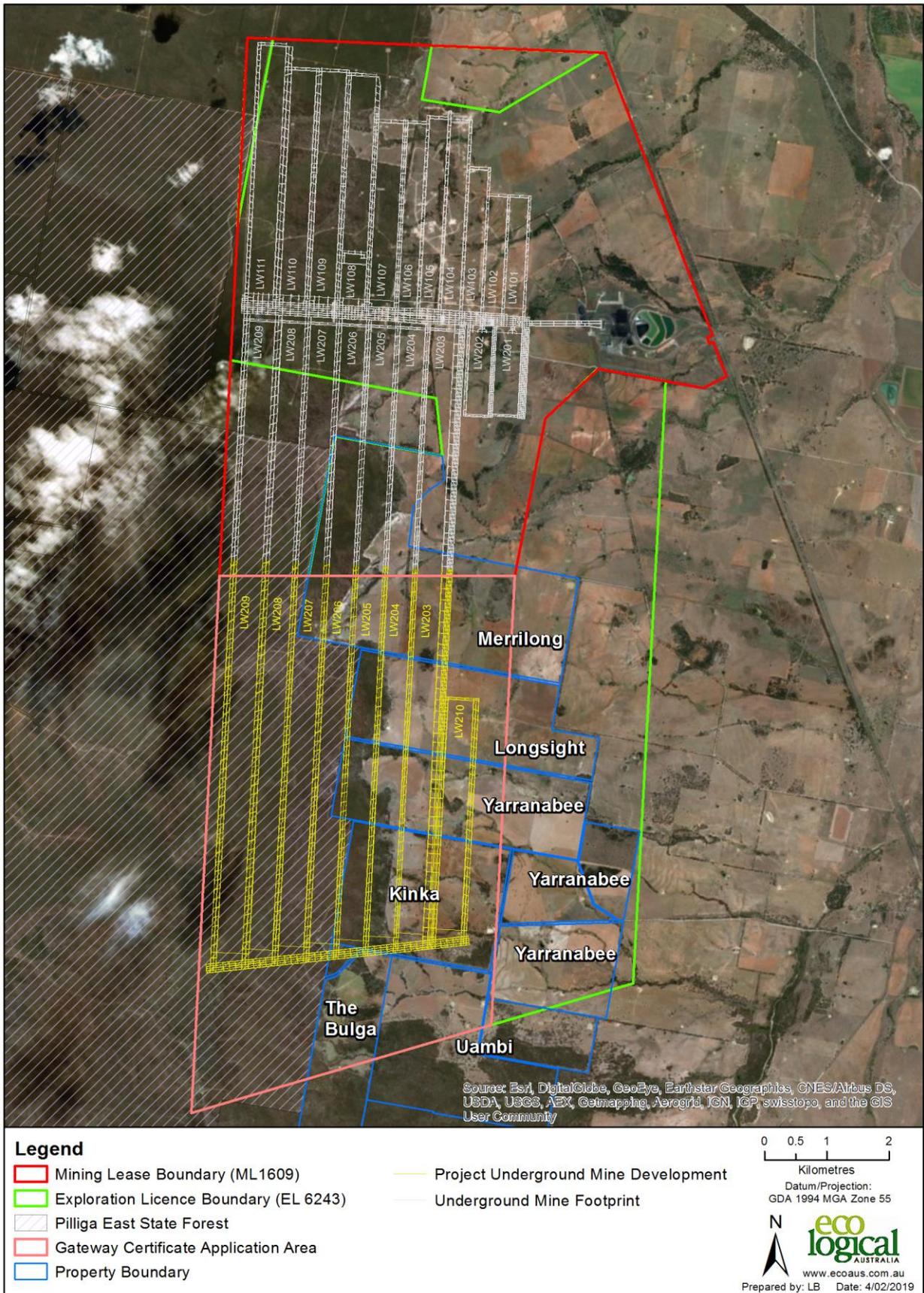


Figure 4-1: Property Names within the Gateway Certificate Application Area

- Pilliga East State Forest supports limited commercial harvesting. The area has not been subject to recent harvesting but adjacent areas have been selectively harvested for: white cypress and iron bark sawlog, iron bark residue and *Melaleuca* spp. fencing brush.

## 4.2 Soil and Land Capability

Soil Management Designs (2019) provides a detailed assessment of soil and land capability within the Gateway Certificate Application Area and includes a review of existing soil, land and geological information from:

- Soil Profile Attribute Data Environment (SPADE) soil profiles (part of the NSW Natural Resource Atlas).
- Gunnedah Coalfield (north) Regional 1:100,000 Geology Map (Pratt 1998).
- Regional Australian Soil Classification (ASC) mapping.
- Regional LSC mapping.
- Regional BSAL mapping.
- Critical Industry Cluster mapping.

### 4.2.1 Soil Survey

Soil Management Designs (2019) conducted a soil survey in May, June and September 2017 in the Gateway Certificate Application Area and surrounds.

The main aim of the soil survey was to identify any BSAL within the Gateway Certificate Application Area. BSAL verification within the Gateway Certificate Application Area was conducted in accordance with the Interim Protocol.

In order to identify the potential impact on agricultural resources and the appropriate level of soil survey required, an evaluation of potential risks to agricultural resources and enterprises was undertaken by Soil Management Designs (2019) in accordance with the Interim Protocol.

The risk assessment concluded that the Project was considered to pose a low risk to agricultural resources in the western section of the Gateway Certificate Application Area (Soil Management Designs 2019).

For the eastern section of the Gateway Certificate Application Area, the risk assessment concluded that the Project was considered to pose a moderate to high risk to agricultural resources (in the context of the Interim Protocol) (Soil Management Designs 2019).

In consideration of the above risk rankings, and in consideration of the Interim Protocol, a sampling density of one site per 400 ha was considered appropriate in the western section of the Gateway Certificate Application Area, and a sampling density of one site per 20 ha was considered appropriate in the eastern section of the Gateway Certificate Application Area (Soil Management Designs 2019).

In total, 69 pits, to a depth of approximately 1.4 m were excavated with a backhoe (Figure 4-2). Soils were described using the 'Australian Soil and Land Survey Field Handbook' (National Committee on Soil and Terrain 2009) and the 'Guidelines for Surveying Soil and Land Resources, Chapter 29' (McKenzie *et al.*, 2008) (Table 4-2). The soil profiles were classified according to the ASC (Isbell 2002) (Table 4-3).



Figure 4-2

Figure 4-2: Soil Pit Locations (Source: Soil Management Designs 2019)

**Table 4-2: Soil Landscape Units and Associated Soil Types (Source: Soil Management Designs 2019)**

Soil Landscape Unit	Number of Detailed Sites	Map Code	Dominant or Co-dominant Soil Types	Sub-Dominant Soil Types	Additional Comments
Pilliga Sandstone	9	<b>P</b>	Orthic Tenosol	Sodosol, Dermosol	Acidic sandy soil – poor fertility for agricultural crops.
Garawilla Volcanics - Calcic	3	<b>GV-C</b>	Vertosol	Dermosol	High quality clay-rich soil that is suitable for a broad range of agricultural crops and pasture.
Garawilla Volcanics - Intermediate	19	<b>GV-I</b>	Dermosol	Chromosol, Kandosol, Rudosol	High quality soil that is suitable for a broad range of agricultural crops and pasture following amelioration.
Garawilla Volcanics - Sodic	24	<b>GV-S</b>	Sodosol	Dermosol, Kandosol, Leptic Tenosol, Calcarosol	Poor root growth in subsoil due to sodicity.
Garawilla Volcanics – Sodic/Vertosols	8	<b>GV-S/V</b>	Vertosol	N/A	Poor root growth in subsoil due to sodicity, but a favourable ability to regenerate soil structural form through shrink-swell processes.
Napperby Siltstone	6	<b>N</b>	Sodosol	Rudosol	Poor root growth in subsoil due to sodicity.

**Table 4-3: Soil Types Identified; Classified According to the ASC and Great Soil Groups (Source: Soil Management Designs 2019)**

ASC Soil Type	Number of Detailed Sites	Great Soil Group Equivalent
Dermosol	17	Red and yellow podzolic soils
Sodosol	15	Solodized solonetz and Solodic Soils
Vertosol	10	Grey, Brown and Red Clays
Orthic Tenosol	7	Lithosols
Chromosol	6	Red-Brown Earths, Non-calcic brown soils
Kandosol	6	Calcareous Red Earths
Leptic Tenosol	4	Lithosols
Rudosol	2	Alluvial Soils
Calcarosol	2	Red calcareous soils

The soil types in Table 4-3 have the following characteristics (Isbell 2002):

- Dermosols have structured B2 horizons and lack strong texture contrast between A and B horizons.
- Sodosols have strong texture contrast between the A and B horizons, and the B horizon is sodic (ESP of 6 or greater).
- Vertosols are clay soils with shrink-swell properties that exhibit strong cracking when dry.
- Tenosols have only weak pedological development; at this location, they are either deep sandy soil (Orthic) or with hard rock close to the surface (Leptic).
- Chromosols have strong texture contrast between the A and B horizons, and a non-sodic subsoil with  $\text{pH}_{\text{water}}$  greater than 5.5.
- Kandosols lack strong textural contrast and have a massive or only weakly structured B horizon.
- Rudosols are derived from recently deposited materials that have only minimal profile development.
- Calcarosols are usually calcareous throughout the profile, often highly so.

Soil survey data were used to refine existing soil land mapping within the Gateway Certificate Application Area (Figure 4-3).

#### 4.2.2 Land and Soil Capability

The LSC Assessment Scheme uses the biophysical features of the land and soil including landform position, slope gradient, drainage, climate, soil type and soil characteristics to derive detailed rating tables for a range of land and soil hazards (OEH 2012). The LSC class gives an indication of the land management practices that can be applied to a parcel of land. The LSC classes are outlined in Table 4-4.

LSC mapping was prepared for the Gateway Certificate Application Area based on the results of the soil survey conducted by Soil Management Designs (2019) in accordance with *The Land and Soil Capability Assessment Scheme – Second Approximation* (OEH 2012) (Figure 4-4 and Table 4-5).

LSC assessment found that LSC Classes 4 and 5 (moderate land capability) dominate the eastern side of the Gateway Certificate Application Area (Figure 4-4). LSC 4/5 is moderate capability land and has moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture. The area of Class 5 land is considered to have limited agricultural potential because of topsoil with acidity and poor buffering capacity.

LSC Class 6/7 dominates the western side of the Gateway Certificate Application Area and has severe erosion hazards associated with the steep slopes (Figure 4-4).

The relatively small zones with LSC Classes 2 and 3 are considered to be capable of a wide variety of land uses, including cropping, grazing, horticulture, forestry and nature conservation. Areas categorised as these classes generally coincide with the BSAL areas (Figure 4-4). Whilst classed as high capability, these areas are excluded from being BSAL as they are classified as having moderately low fertility (Soil Management Designs, 2019).

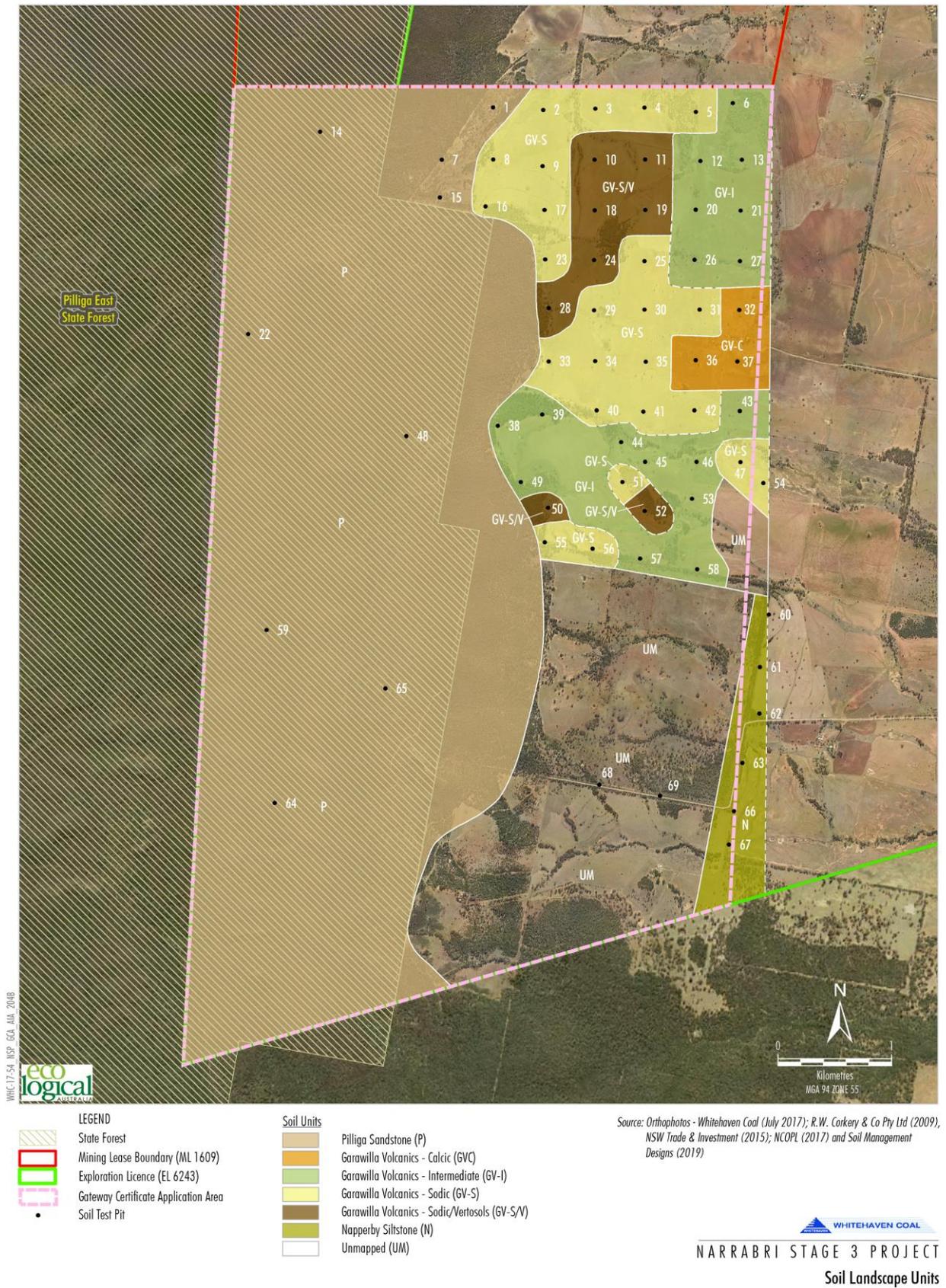
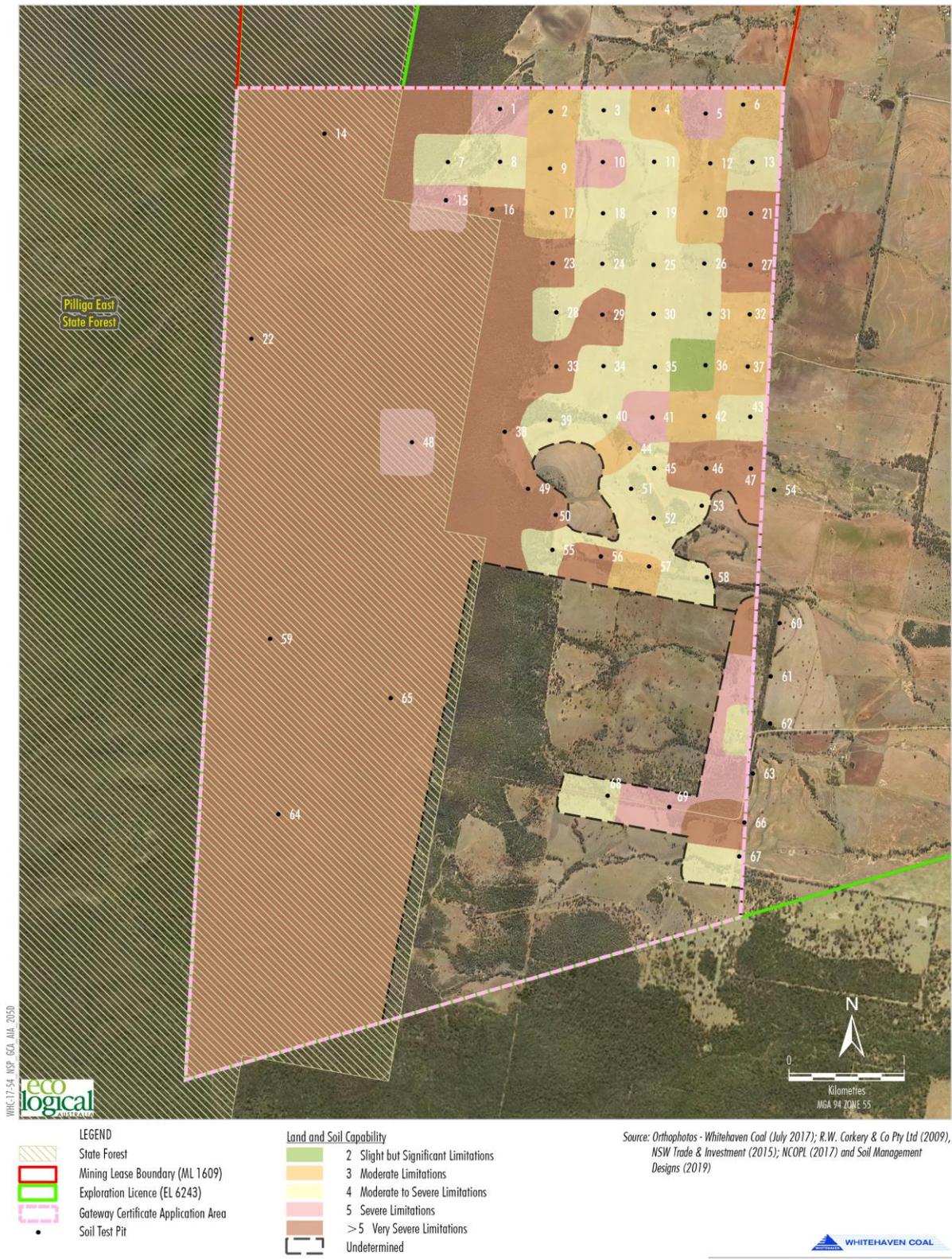


Figure 4-3

Figure 4-3: Soil Landscape Units (Source: Soil Management Designs 2019)



WHITEHAVEN COAL  
 NARRABRI STAGE 3 PROJECT  
 Land and Soil Capability  
 Classes within the Gateway Certificate  
 Application Area

Figure 4-4

Figure 4-4: Land and Soil Capability Classes within the Gateway Certificate Application Area (Source: Soil Management Designs 2019)

**Table 4-4: Land and Soil Capability Classes (OEH 2012)**

LSC class	General Definition
<b>Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)</b>	
1	Extremely high capability land: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	High capability land: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
<b>Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)</b>	
4	Moderate capability land: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	Moderate–low capability land: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
<b>Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)</b>	
6	Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
<b>Land generally incapable of agricultural land use (selective forestry and nature conservation)</b>	
7	Very low capability land: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	Extremely low capability land: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

**Table 4-5: Land and Soil Capability within the Gateway Certificate Application Area**

Landholding	Land and Soil Capability Classes					
	2	3	4	5	6 and 7	No Data
Kinka	0	9	33	41	31	389
Longsight	18	56	154	8	121	0
Merrilong	0	137	150	65	83	0
The Bulga	0	0	0	0	0	192
Uambi	0	0	26	11	12	165
Yarranabee	0	20	103	8	140	73
Pilliga East State Forest	0	0	0	36	1,623	45
Crown Land	0	4	14	5	10	7
<b>TOTAL</b>	<b>18</b>	<b>226</b>	<b>480</b>	<b>174</b>	<b>2020</b>	<b>871</b>

### 4.3 Biophysical Strategic Agricultural Land (BSAL)

Soil Management Designs (2019) identified 202 ha of BSAL (verified BSAL and Mining SEPP Potential BSAL) within the Gateway Certificate Application Area (Table 4-6, Figure 4-5). Field survey was used to verify 107 ha of BSAL and a further 95 ha was assessed through desktop methods as field access was not possible. The BSAL areas are located mainly on the eastern edge of the Gateway Certificate Application Area and are generally outside of the area likely to be impacted by the Project.

**Table 4-6: BSAL Area within Landholdings within the Gateway Certificate Application Area**

Landholding	Verified BSAL	Mining SEPP Potential BSAL
Merrilong	57	0
Longsight	50	0
Yarranabee	0	0
Kinka	0	95
Uambi	0	0
The Bulga*	0	0
State Forest	0	0

\*The Bulga is subject to a perpetual lease agreement with Crown Lands

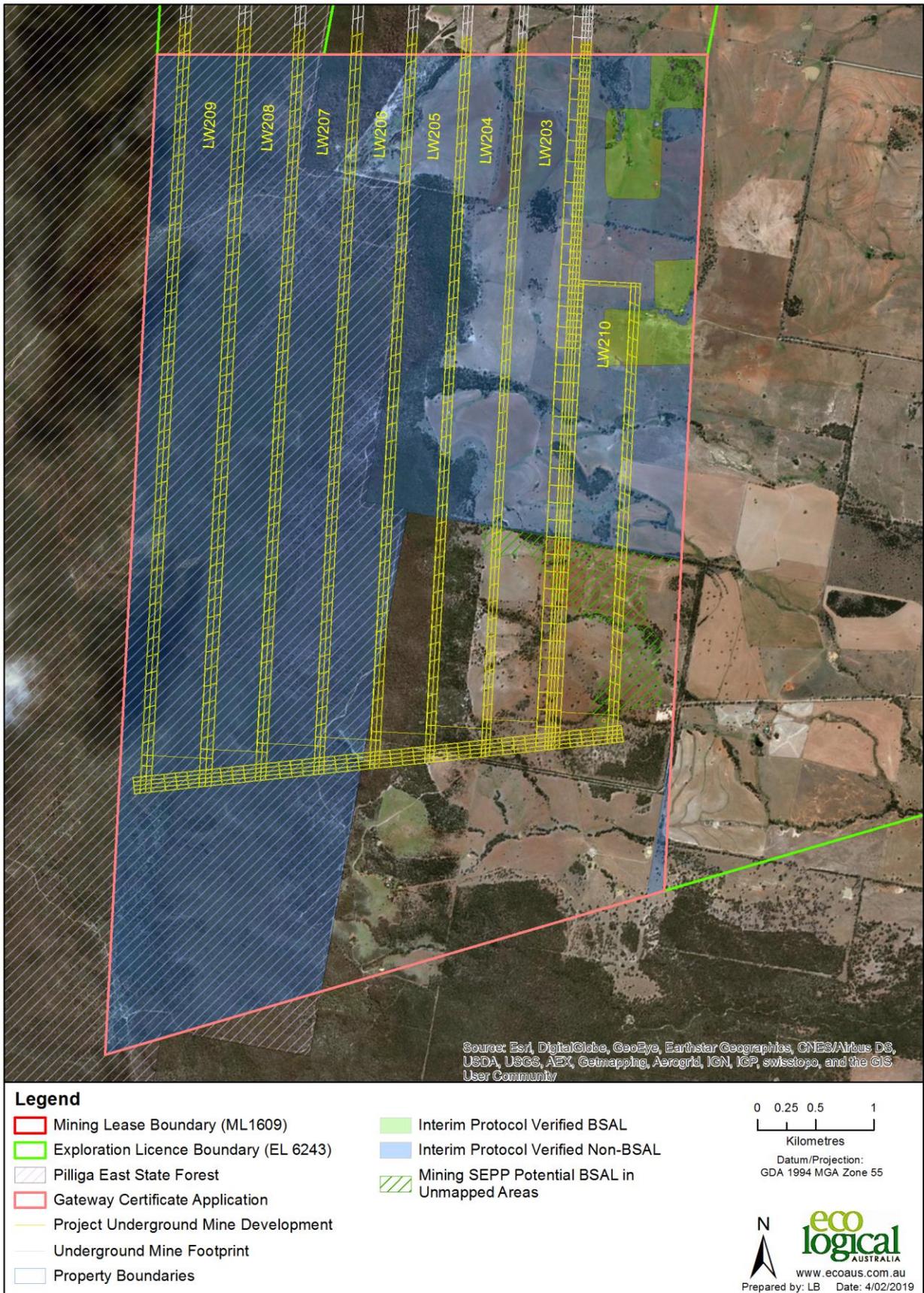


Figure 4-5: BSAL within the Gateway Certificate Application Area

#### 4.4 Groundwater Systems

The Gateway Certificate Application Area is located within the Permo-Triassic Gunnedah Basin, which forms the central part of the north-south elongate Sydney-Gunnedah-Bowen Basin system. The Gateway Certificate Application Area is located near the northern and western boundaries of the Gunnedah Basin and the eastern margin of the Surat Basin, a sub-basin of the larger Great Artesian Basin.

The geology has been described in GHD (2007), Aquaterra (2009) and HydroSimulations (2019). In summary, the stratigraphy in the Gateway Certificate Application Area is characterised by deposits in two main basins:

- Surat Basin Units of Jurassic age which includes Pilliga Sandstone, Purlawaugh Formation and Garrawilla Volcanics; and
- the Gunnedah Basin Units:
  - Napperby and Digby Formations of Triassic age; and
  - Permian coal measures within the Black Jack Group which includes Hoskissons Seam, and Arkarula and Pamboola Formations.

Adjacent to the Gateway Certificate Application Area (i.e. to the east) are alluvial sediments of Quaternary age (Narrabri Formation and Gunnedah Formation) within the upper Namoi Valley.

The Digby Formation Conglomerate is about 15 to 20 m thick. A dolerite sill intrudes into the Napperby Formation about 40 m above the roof of the Digby Formation Conglomerate.

The coal resource of the Project is contained within the Hoskissons Coal Seam which strikes generally north-south, and dips gently to the west. The seam is 8 to 10 m thick over the western half of ML 1609.

##### 4.4.1 Infrastructure

There are 87 registered bores belonging to other groundwater users within 10 km of the Gateway Certificate Application Area. The mean and median depths are 42 and 40 m, respectively. Except for two bores in the deepest part (Pamboola Formation) of the geological section, the bores are distributed in the shallower formations as shown below:

- |                                 |                             |
|---------------------------------|-----------------------------|
| • Alluvium and regolith         | 44 bores;                   |
| • Pilliga Sandstone             | 28 bores;                   |
| • Purlawaugh Formation          | 11 bores;                   |
| • Garrawilla Volcanics          | 1 bore;                     |
| • Napperby Formation            | 1 bore (above basalt sill); |
| • Digby Formation               | Nil;                        |
| • Hoskissons Coal Seam          | Nil; and                    |
| • Arkarula, Pamboola Formations | 2 bores.                    |

Of these groundwater systems, it is the aquifers contained in the alluvium-derived Narrabri and Gunnedah formations that are the most important to agriculture. The Narrabri formation, where present, is typically above the Gunnedah formation. Deeper aquifers rapidly trend to highly saline conditions, making them unsuitable for irrigation or other agricultural use.

The Gunnedah Formation is the primary (highest yielding, most utilised) aquifer in the region. Groundwater from the Gunnedah Formation is used extensively for irrigation, stock and domestic use and for the town water supply.

## 5 Assessment of Agricultural Impacts to BSAL

### 5.1 Review of the Documented Impacts of Longwall Mine Subsidence on Agricultural Landscapes

A literature review was undertaken to describe the documented impacts of planned longwall mine subsidence on agricultural production. Particular attention was given to papers that presented measured impacts in agricultural regions with landscapes (topography and soils) and climatic regimes similar to those in the Gateway Certificate Application Area.

#### 5.1.1 Physical Effects of Planned Longwall Mine Subsidence

This section describes the key features of longwall mine subsidence with a particular focus on impacts that may affect agricultural activities and production.

The primary and secondary impacts of longwall mine subsidence are well studied and described by multiple authors (e.g. Bell & Genske 2001; Bell *et al.* 2000; Palamara *et al.* 2006). Following extraction of the selected coal seam, subsidence can form a shallow depression (i.e. trough), generally within days of mining, settling over weeks to months (Bell *et al.* 2000).

With alteration to surface topography it follows that surface runoff patterns and soil moisture patterns may also be altered. Areas of increased surface slopes can increase erosion risk, especially along areas of concentrated water flow, including pre-existing drainage lines. Likewise, areas of decreased slope may retain water and form temporary ponds following rainfall. In areas with shallow water tables, ponding from groundwater can also occur.

Depending on the nature of the longwall mine, surface cracking can result from planned subsidence. Surface cracks generally appear in tensile zones parallel to longwall edges or the longwall end. Bedrock with fractures and joints can also influence the pattern of cracking. As the extraction face progresses, transient cracks can develop, opening and closing as the area moves from tensile to compressive phases. Larger cracks that may require remediation are usually located around the perimeters of the longwall. Large, isolated cracks can also develop along steep slopes.

Cracking at the surface or subsurface can alter or create new flow paths altering surface and groundwater flow. Cracking can also provide erosion initiation points. The amount of change in surface and subsurface water flows will be dependent on the overlying strata and nature of the subsidence (Booth 2006; Sidle *et al.* 2000). In a landscape which is undulating and of high relief, subsidence impacts may be harder to recognise, whereas in flatter landscapes of low relief and higher water tables, the impacts of subsidence can be much more obvious (Asadi *et al.* 2004).

#### 5.1.2 Impacts on Agricultural Landscapes and Production

Worldwide there have been few studies that have sought to quantify the impacts of longwall mine subsidence on agricultural landscapes and production. An ongoing program of research is being undertaken by the Illinois Mine Subsidence Research Program (including Darmody *et al.* 1989; Darmody 1995; Darmody 1998), and these studies conclude that soil erosion and surface ponding are key factors that may impact productivity. The Illinois Mine Subsidence Research Program studies landscapes which are very flat with rich agricultural soil. Soil erosion has been found to be negligible with surface ponding considered the most important potential impact to productivity. However, land forming mitigation through ditch creation (drainage) or fill has been shown to successfully ameliorate any negative impacts.

In Australia, Beltana Mine in the lower Hunter Valley and Kestrel Mine in central Queensland have been subject to several studies that sought to quantify the impact of longwall mine subsidence on agricultural crop and pasture production and soil parameters (Trotter and Frazier 2009; Thompson *et al.* 2010; Frazier *et al.* 2010; Frazier 2015). These mine sites have similarities with the Gateway Certificate Application Area, in that subsidence ranges from 1 to 3 m and the surface topography is moderately sloping (generally <10 degrees [°]). Erosion control structures, such as contour banks, have been used as part of historical agricultural management and soils range from sandy alluvial soils to black cracking clays (vertisols).

### 5.1.3 Beltana Mine

Beltana Mine has been the subject of several key studies to examine the impacts of subsidence on agricultural/viticultural production (Trotter and Frazier 2009; Thompson *et al.* 2010).

Beltana Mine is located approximately 16 km south-west of Singleton in the Hunter Valley, NSW. Agricultural land use consists of cattle grazing (native and improved), lucerne cropping, viticulture and olive farming (Frazier *et al.* 2010). The landform is gentle to undulating, with vineyards and other cropping located mainly on alluvium and toe-slopes. Soils include alluvial soils, yellow podzols and chocolate soils with the alluvial soils occupying lower parts of the landscape (Kovac and Lawrie 1991). The climate is warm-temperate with hot wet summers and cool mild winters. For Singleton, the mean maximum temperature is 30°C in December to January and 18°C in June to July. The mean annual rainfall is 722 mm. Following extraction, subsidence of up to 2 m was measured (Thompson *et al.* 2010) with associated changes in surface slope and cracking recorded.

Trotter and Frazier (2009) studied the impact of subsidence on irrigated lucerne and native pasture production above the underground Beltana Mine. They sampled total biomass using traditional field sampling methods, proximal crop sensing and remote sensing methods. In addition, soils were sampled via cores and EM38 soil conductivity surveys. Sampling was conducted across longwall panels and in control areas to cover a range of likely impacts.

No significant impacts in production or soil characteristics were found that could be associated with longwall mine subsidence.

Thompson *et al.* (2010) conducted a detailed study of the impact of longwall mine subsidence on wine grape production from 2003 to 2008. Sampling included key grape and vine parameters to capture quality and quantity parameters at scales from individual vines to the vineyard block and vineyard region scale. Sampling was undertaken prior to subsidence and following subsidence and across longwall panels to examine changes in potential impacts over time or across the vineyard. Key changes in yield were found to be more associated with changes in seasonal climatic conditions rather than subsidence and they concluded that any impacts were likely to be highly localised rather than affecting productivity more broadly.

### 5.1.4 Kestrel Mine

The Kestrel Mine has also been subject to several studies that aimed to quantify the impact of subsidence on agricultural production.

The Kestrel Mine is located 50 km north-east of Emerald in central Queensland. The site is very gently to gently sloping with maximum gradients of 5%. The vertisol topsoil varies in depth from 0.5 to 2 m and is underlain by a highly dispersible subsoil which is prone to erosion. Numerous erosion control measures, including contour banks and grassed waterways, were implemented prior to any mining activity (Trotter and Frazier 2009).

The agricultural land use at the site is primarily pastoral and cropping. Kestrel leases the property 'Gordon Downs' to the Northern Australian Pastoral Company as a background grazing property. There are areas of permanent pastures, both improved and unimproved and forage crops which were used for grazing purposes. The area has also been used for cereal crop production.

The climate of the area has characteristics intermediate between those of tropical and temperate climatic types. It is also transitional between humid and semi-arid, and is regarded as sub-humid (Winders, Barlow & Morrison 1985). The mean annual rainfall for the area (data obtained for Emerald, Queensland) is 536 mm. This area experiences an average of 60 days of rain per year, with the highest recorded annual rainfall being 883 mm and the lowest recorded rainfall being 284 mm. The mean maximum daily temperature for the area (data obtained for Emerald, Queensland) is 30°C, and the mean minimum daily temperature for the area is 16°C. This area experiences extremes in temperature, with the highest temperature of 47°C and low temperatures of 10°C.

Hinchliffe *et al.* (2003) studied the impact of longwall mine subsidence on wheat and soybean crops at the Kestrel mine site in 2000 and 2001. They compared subsided areas with unsubsided areas, measuring key aspects of plant germination and yield as well as soil parameters. There was no apparent difference in crop or soil parameters that would imply a negative impact from longwall mine subsidence. They concluded that while impacts such as soil cracking and change in slope are apparent, these impacts are highly localised and ameliorated through normal agricultural management practices.

Further study over the site was undertaken across the 2007 and 2008 seasons (Trotter and Frazier 2009). Sampling was undertaken to assess forage sorghum, sown pasture and soil parameters at subsided and unsubsided (control) sites. Field sampling examined plant biomass, species composition, plant height, soil electrical conductivity, soil pH and soil moisture. Techniques commonly used in precision agriculture, including EM38 conductivity survey, hand/machine mounted crop sensors and satellite remote sensing were used to provide a broader, landscape view. The study concluded there were no negative impacts on plant or soil parameters that could be attributed to subsidence.

Frazier (2015) further studied an established pasture paddock over the Kestrel mine. The paddock had been subject to several years of conservation grazing practices that aimed to re-establish Queensland Bluegrass (*Dichanthium sericium*). This study targeted several longwall areas to determine if impact patterns over time could be found; that is, if there was a recovery following subsidence or any impacts that compound over time. Samples were taken for plant cover and diversity using field samples and satellite imagery. No significant negative impact was found across any of the zones above any of the longwall panels in comparison to a control area. Further, it was found that conservative grazing practices had substantially increased the presence of Bluegrass.

#### **5.1.5 Narrabri Mine**

The Project is an extension of the existing Narrabri Mine, a longwall coal mining operation directly adjacent to the Gateway Certificate Application Area, and shares similar mine geometry and expected surface impacts (Sections 1 and 2 of this report) (Figure 1-2).

Longwalls at the existing Narrabri Mine underlie agricultural land comprising grazing, dryland crops, contour banks and ephemeral streams.

Whitehaven Coal has prepared End of Panel Reports for LW101 to LW105 at the existing Narrabri Mine describing subsidence impacts, including surface cracking (Figure 5-1) and monitoring results following the completion of mining of each longwall (Whitehaven Coal 2013, 2014, 2015a, 2015b, 2016).

With respect to impacts to agricultural production, the End of Panel Reports describe:

- The only area affected by subsidence, with regards to agricultural suitability, was where water ponded at an ephemeral creek. The ponded water is currently pumped downstream when required. The ephemeral nature of the creek system is such that any ponding that does occur is for relatively short periods only, and on this basis, has negligible effect on agricultural use or agricultural suitability.
- Contour banks, or parts thereof, were undermined during the extraction of LW101 to LW105. The subsidence impacts to the contour banks did not affect their structural stability or functionality.
- Ploughing of the land overlying LW103 was able to be undertaken during the extraction of LW103, however, the ploughing was limited due to poor climatic conditions.

Several farm dams have been undermined during extraction of LW101 to LW105. No structural damage to these dams has been noted at any site following subsidence.



**Figure 5-1: Examples of Surface Cracks above Narrabri Mine (Longwalls 101 to 103) (Source: Whitehaven Coal [2013, 2014 and 2015a])**

Detailed monitoring of the agricultural landscape has also been undertaken for LW101 to LW105 and reported since 2012 (ELA 2012b, 2012a, 2013, 2014, 2015a, 2015b, 2016). The Land Management Plan (ELA 2012a) outlines an approach to agricultural landscape monitoring that incorporates:

- Multi-spectral remote sensing of land cover.
- EM38 and EM31 sensing of soil conductivity.
- Lidar sensing of surface topography.
- Field soil sampling.
- Field pasture biomass and pasture weed percentage measurement.
- Channel stability and ponding assessment.
- Visual assessment of the landscape in general.

Sampling and analysis is undertaken within the predicted potential impact zones which include the zone of maximum subsidence, zone of maximum change in surface slope and unmined control zones.

Systematic analysis has found no statistically significant difference between any of the sampling zones for soil or pasture characteristics. Channel stability along creek-lines is similar to that found in unsubsidised control areas, and ponding along watercourses is consistent with that predicted in the Environmental Assessment.

#### **5.1.6 Literature Review Conclusions**

Planned longwall mine subsidence has a definite impact on the surface landscape with lowering of the surface above the longwall panels. Secondary impacts including surface cracking, altered surface flow patterns with potential ponding or increased erosion risk, can be predicted with a high degree of certainty at the paddock scale.

Several studies from within Australia and worldwide show that localised impacts, such as that caused by an individual crack do occur as a result of longwall mining. However, none of the studies have shown widespread impacts that have significantly reduced agricultural productivity over the short- or long-term during or following longwall mining. Further, common agricultural maintenance practices such as cultivation, ripping or minor land forming (such as restoring contour banks or small channel formation) have proven effective in managing short-term impacts.

Case studies at the Narrabri, Beltana and Kestrel Mines have demonstrated that agricultural production can continue above longwall mining with little or no impact to productive capacity. At these sites detailed examination of yield and soil qualities have shown no impact from planned subsidence.

## **5.2 Nature of Proposed Mining Activities**

The Project proposes to use longwall coal mining methods. The conceptual mine layout indicates the extension of eight longwall panels (LW203 to LW210) from the existing Narrabri Mine (Figure 1-2). Within the Gateway Certificate Application Area, 107 ha of verified and 95 ha of Mining SEPP Potential BSAL has been found (Figure 4-5). With longwall mining, subsidence is the primary factor that may affect agricultural productivity. Smaller areas will also be needed for infrastructure development, such as roads and mine ventilation.

### 5.2.1 Surface Subsidence and Potential Impacts

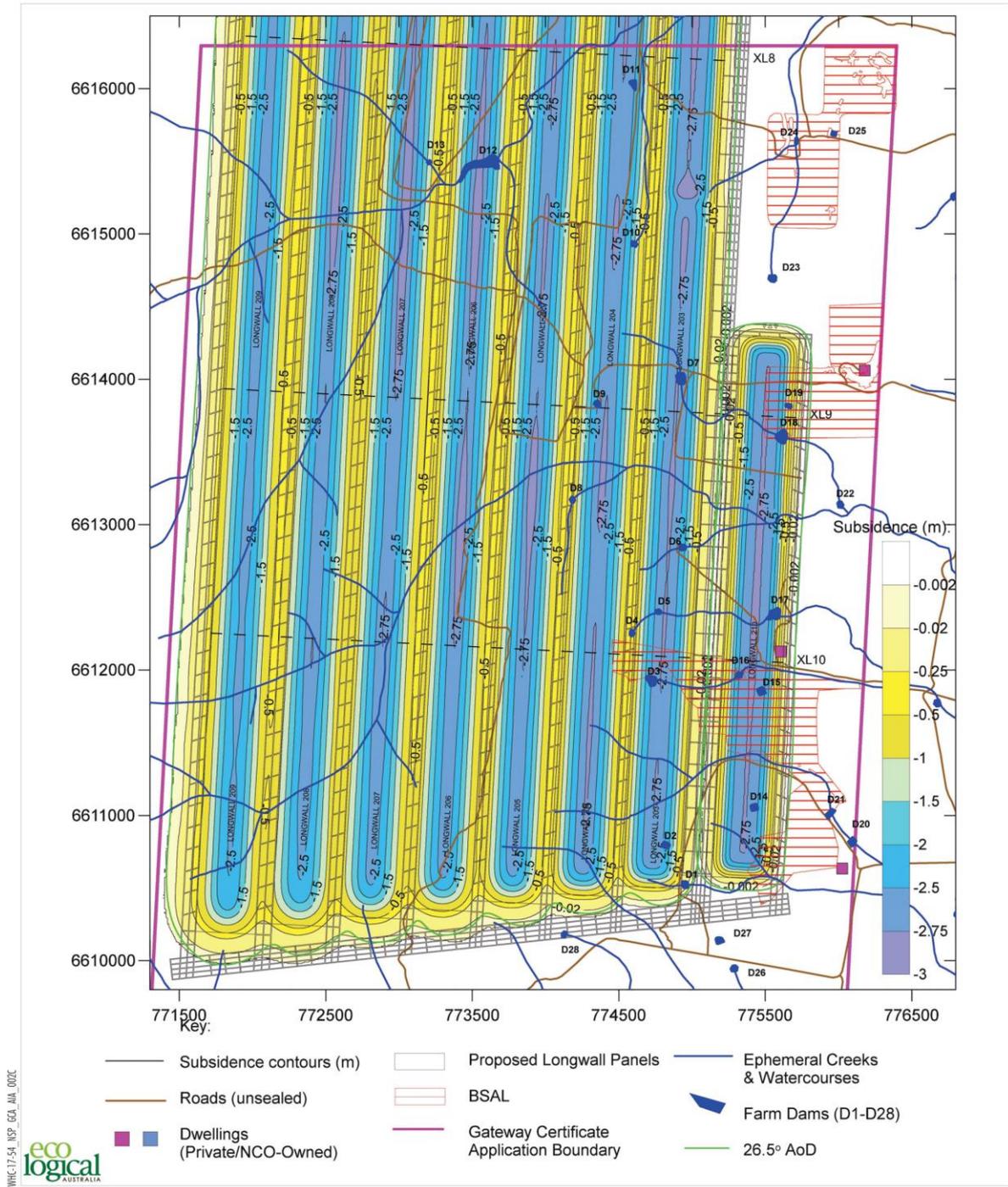
The extent and nature of subsidence is related to: extracted panel thickness; depth of cover; overlying geology and surface topography (Ditton Geotechnical Services 2019). Ditton Geotechnical Services (2019) modelled the likely extent and nature of subsidence associated with the Project and assessed related secondary impacts on other land resources. This section provides a summary of the findings presented in Ditton Geotechnical Services (2019).

Ditton Geotechnical Services (2019) modelled the likely surface subsidence (horizontal and vertical movement along with associated stresses and strains) and assessed the likely subsidence-related consequences on the landscape and land use (Table 5-1). They used several modelling approaches, along with the current mine design information, to predict the likely (mean) subsidence and also estimated the upper 95% confidence limit (U95%CL) to provide a likely upper estimate of subsidence and related impacts. For this report, the U95%CL information has been used to assess impacts as it provides a likely maximum impact scenario. It should be noted that the U95%CL limit by definition may be exceeded 5% of the time. The data modelled by Ditton Geotechnical Services (2019) was also supported by measured observations in the existing Narrabri Mine LW101 to LW107. These observations are particularly relevant as they are nearby, have similar mine design and overlying geology and have similar land use. Ditton Geotechnical Services (2019) also assessed the likely impacts based on their previous experiences of measured impacts in the Hunter Valley and Southern Coalfields of NSW.

Surface subsidence above the panels is expected to reach a maximum of 2.8 m (vertical change) for all panels (Table 5-1, Figure 5-2). Total depth of cover increases from 170 m above LW210 to 390 m above LW209. The predicted maximum tilt varies from 67 mm/m over LW210 to 24 mm/m over LW209. Subsidence above the chain pillar areas is expected to be much lower, ranging from 0.13 to 0.54 m. As a result of the uneven subsidence, the post mining landform will contain a series of broad undulations. The angle of draw (AOD), which helps define the likely extent of subsidence beyond the mine footprint, ranges from 25° to 34° (Ditton Geotechnical Services 2019).

**Table 5-1: Summary of Predicted Subsidence**

Panel No.	Depth of Cover (m)	Mining Height (m)	Predicted Max. Subsidence (m)	Max. Tilt (mm/m)
203	190-210	4.3	2.8	58
204	210-240	4.3	2.8	52
205	240-280	4.3	2.8	44
206	270-300	4.3	2.8	38
207	300-320	4.3	2.8	32
208	320-350	4.3	2.8	30
209	340-390	4.3	2.8	26
210	170-180	4.3	2.8	67



WHRC17-54\_IJSP\_GCA\_AIA\_001C



Source: Ditton Geotechnical Services (2019)

**NARRABRI STAGE 3 PROJECT**
  
 Predicted Subsidence Contours

Figure 5-2

**Figure 5-2: Predicted Subsidence Contours (Source: Ditton Geotechnical Services 2019 [Figure 13b])**

As a result of subsidence, a range of likely consequences on the surface landscape and land use have been predicted by Ditton Geotechnical Services (2019).

### **Surface cracking**

Surface cracking usually develops within several days of longwall face retreat. Some compressive cracks will close once the subsidence trough is fully developed. New cracks in the tensile zone may develop along and inside the panels 2 to 3 weeks later. Tensile zone cracks will probably be tapered and range from 5 to 10 m in depth. Cracks in the compressive zone are generally low-angle shear cracks.

Modelling and cracking observed in the Narrabri Mine and mines in the Hunter region allows prediction of cracks of 20 mm to a maximum of 240 mm (U95%CL) in the tensile zones.

Management strategies for cracking include:

- Inspection and mapping.
- Repair large cracks (potentially construct temporary fencing).
- Ripping, tyning or grouting, particularly on watercourses as required.

### **Subsurface cracking**

Ditton Geotechnical Services (2019) predicted sub-surface fracturing heights of 149 m above LW210 to 297 m above LW209. The Geology and Geometry Pi-Term models predict discontinuous sub-surface cracks are likely to interact with surface cracks where the depth of cover is <300 m (above 306 m wide longwall panels) and where the depth of cover is <390 m (above the wider longwall panels). In these areas, creeks could be re-routed to below surface pathways and re-surface downstream.

Observed tree stress in LW101 to LW103 indicates B-Zone interaction with tree roots. Direct impacts to tree roots is expected to decrease as cover above the longwall increases in thickness (i.e. in the western section of the Gateway Certificate Application Area). As predicted the lighter soils (less clay) and thicker cover above LW104 to LW106 reduced likely shear stress on tree roots and tree health has remained unaffected. Since the Pilliga East State Forest is located in areas with thicker cover and light soils than those found over LW101 to LW103, it is expected that there will be no significant impact on harvestable timber.

Subsurface crack management strategies include:

- Repair cracks when they occur.
- Decrease mine height or panel width.

### **Slope stability and erosion**

Surface topography in the Gateway Certificate Application Area is gently to moderately undulating and generally <15°. There is extremely low likelihood of mass movement or landslips. In areas with dispersive soils and slope >10°, any soil exposure is likely to increase erosion. Areas with slopes <10° are anticipated to have low erosion rates, except for creek channels which are expected to undergo re-adjustment following subsidence.

Erosion management strategies include:

- Slope change monitoring along subsidence cross-lines.
- Repair surface cracking.
- Maintain high levels of ground cover.
- In extreme areas, design and implement mitigation works such as regrading, revegetation, etc.
- Ongoing appraisal of significant changes to surface slopes.

### ***Ponding***

Surface slopes in the elevated areas between creeks range between 0.9 to 7% and indicate a net fall across the panels of 2.5 to 10 m prior to mining. With predicted maximum subsidence at 2.8 m, closed depressions could form, especially across panels with flatter surface topography, altering natural drainage pathways to watercourses and farm dams (Figure 5-3).

Maximum change to ponding depths is expected to be up to 0.6 m, with 12 potential ponding areas predicted within the Gateway Certificate Application Area. There are nine existing surface dams that may have their inflow affected. The majority of potential ponding areas will develop along watercourses and are likely to remain within watercourse channels. Ditton Geotechnical Services (2019) identified three small areas of potential ponding upon BSAL.

Ponding management strategies should include monitoring of changes in surface drainage in areas of pond development. Based on the final landscape surface and future land use a site-specific management plan should be designed that may include earthworks to reinstate the channel and/or dam inflow regime.

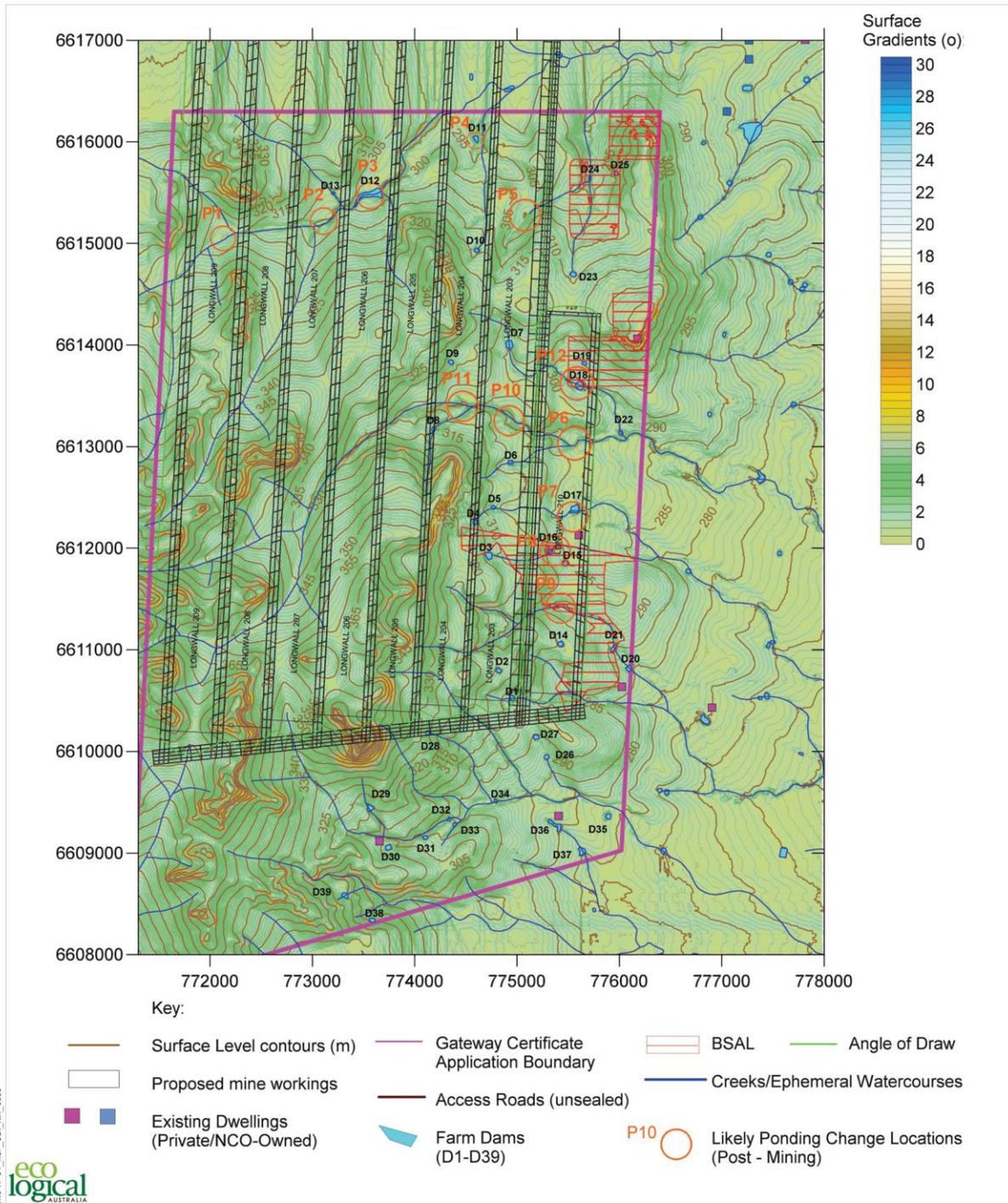
### ***Water storage dams and soil conservation banks***

A total of 39 dams currently exist above the predicted impact area (Figure 5-3), nine of which may have their inflows affected by upstream ponding due to the proposed longwalls (Ditton Geotechnical Services 2019). At Narrabri Mine several dams above LW101 to LW105 have already been undermined and subjected to subsidence. These dams did not require any remedial work following subsidence and have remained as functioning farm dams. It could be expected that phases of tensile and compressive strain may result in damage to a dam wall or floor with related water loss. Dam storage areas may be increased or decreased due to tilting of the land surface.

Impact management should include: dam specific appraisal prior to subsidence; suitable works pre-mining if required; and ongoing monitoring during and following mining with remedial works if required.

### ***Property fences and livestock***

It is possible that some farm infrastructure may be affected by subsidence and cracking. Ongoing monitoring during and after subsidence should be undertaken with appropriate repair work for infrastructure as required. Livestock should be removed from the mining area until subsidence is complete, and any required amelioration of the surface or infrastructure is undertaken.



Source: Ditton Geotechnical Services (2019)

WHITEHAVEN COAL  
NARRABRI STAGE 3 PROJECT  
Predicted Areas of Potential Ponding  
and the Locations of Farm Dams

Figure 5-3

Figure 5-3: Predicted Areas of Potential Ponding and the Locations of Farm Dams (Source: Ditton Geotechnical Services 2019 [Figure 19b])

### ***Dwellings and sheds***

There are five private dwellings within the Gateway Certificate Application Area, one of which is located over LW210, the other four are outside the 26.5° AOD and it is unlikely that they will be impacted by mine subsidence effects.

Existing buildings should be assessed prior to subsidence and preventative measures put in place if required. All buildings should be vacant during subsidence and then checked by a qualified inspector. Once inspected, the building should either be declared safe or made safe through works prior to being re-used or re-inhabited. Some structures may need to be demolished and reinstated if required.

### **5.2.2 Groundwater Resources**

Potential impacts on highly productive aquifers within the meaning of the AIP are discussed in Section 6 of HydroSimulations (2019). A summary is provided below.

#### *Impacts on highly productive groundwater (within the meaning of the AIP)*

The AIP (NSW Government 2012) establishes minimal impact considerations for highly productive and less productive groundwater. From review of NSW Office of Water mapping of highly productive groundwater in the vicinity of the Project, it is understood that the Namoi Alluvium and Southern Recharge Groundwater Source (part of the Great Artesian Basin) are highly productive groundwater sources.

Potential impacts on groundwater systems, including highly productive groundwater within the meaning of the AIP, have been determined (Table 5-2, Table 5-3 and Table 5-4).

HydroSimulations (2019) identified two bores (GW067626 [privately-owned] and GW966836 [NCOPL-owned]) within the Purlawaugh formation and the Garrawilla Volcanics that are predicted to experience a drawdown effect of >2 m. These bores are predominately impacted by the existing Narrabri Mine, however, there may be some additional drawdown due to the Project. While these bores are in less productive groundwater sources, they have been conservatively assigned by HydroSimulations (2019) to the NSW Great Artesian Basin Groundwater Sources Water Sharing Plan. One of these bores is owned by NCOPL, whilst NCOPL would implement “make good” provisions on the privately-owned bore.

Reduction in pressure at these two bores, which are not in highly productive groundwater, is considered not significant within the context of this Agricultural Impact Assessment.

### **5.2.3 Surface Infrastructure**

In the order of 374 ha will be progressively developed for mine infrastructure within the Gateway Certificate Application Area. The Project will use the CHPP and rail loop and administration buildings and other infrastructure already developed as part of the existing Narrabri Mine. However, additional areas will need to be developed for roads, mine ventilation and survey lines, etc.

During mining, the majority of these areas will be effectively temporarily taken out of agricultural production. Once the infrastructure is no longer required, it is expected that all of the surface infrastructure in these areas would be decommissioned and the area rehabilitated to agricultural or forestry land use. An infrastructure access corridor and ventilation shaft are proposed for construction and use throughout the mine operations. In addition, some minor, temporary infrastructure would also be developed. These will occupy approximately 11.2 ha of BSAL (1.8 ha of verified BSAL and 9.4 ha of SRLUP Potential BSAL). These areas would be rehabilitated following the cessation of mining operations (i.e. in 2045), whilst temporary infrastructure would be progressively developed and then rehabilitated as mining progresses.

**Table 5-2: Summary of Highly Productive Alluvial Aquifer – Minimal Impact Considerations**

<b>Aquifer</b>	Upper and Lower Namoi Groundwater Sources – Upper Namoi Zone 5 Namoi Valley (Gin’s Leap to Narrabri) Groundwater Source
<b>Type</b>	Alluvial Aquifer
<b>Category</b>	Highly Productive
<b>Level 1 Minimal Impact Consideration</b>	<b>Assessment</b>
<b>Water Table</b>	Level 1 minimal impact consideration classification
<b>Water Pressure</b>	Level 1 minimal impact consideration classification
<b>Water Quality</b>	Level 1 minimal impact consideration classification

Source: after HydroSimulations, 2019.

**Table 5-3: Summary of Highly Productive Great Artesian Basin Aquifer – Minimal Impact Considerations**

<b>Aquifer</b>	NSW Great Artesian Basin Groundwater Sources Southern Recharge Groundwater Source
<b>Type</b>	Porous Rock Water Sources (Great Artesian Basin) Aquifer
<b>Category</b>	Highly Productive
<b>Level 1 Minimal Impact Consideration</b>	<b>Assessment</b>
<b>Water Table</b>	Level 1 minimal impact consideration classification
<b>Water Pressure</b>	Level 2 minimal impact consideration classification (bores predicted for impact are in less productive groundwater conservatively assigned to this groundwater source)
<b>Water Quality</b>	Level 1 minimal impact consideration classification

Source: after HydroSimulations, 2019.

#### **5.2.4 Changes to Agricultural Land Use**

The Project will cause changes to the topography of the landscape with subsidence of up to 2.8 m likely in some areas. Subsidence will lead to some surface cracking, changes to surface water drainage patterns and some impacts to built features (e.g. buildings, dams, roads, fences, etc.). In addition, approximately 374 ha of land (11.2 ha of BSAL) will need to be developed to support surface mine infrastructure. For the period of active mining and remediation it may be necessary to remove discrete areas from agricultural production to ensure the safety of people and livestock. During this time, it is recommended that high levels of ground cover are maintained and cultivation avoided to improve surface soil stability and minimise erosion risk. Grazing of livestock land can largely continue as usual with temporary removal of livestock from areas undergoing active subsidence until the area is deemed stable to ensure animal safety. As there are no irrigated areas and water for domestic and stock use is not from groundwater, there is no impact expected on groundwater use.

In general, it is expected that impacts to agricultural land use will be short-term with minimal impacts to production in areas of BSAL. Upon the completion of mining, all areas of BSAL required for mining infrastructure will be return to BSAL.

### 5.3 Agricultural Impacts against Criteria

Evidence from modelling and assessment undertaken specifically for the Project (Ditton Geotechnical Services 2019, Soil Management Designs 2019, HydroSimulations 2019) and from assessment of similar projects in Australia and worldwide show that, given appropriate management and rehabilitation, there is likely to be insignificant impact to agricultural production as a result of the Project (Table 5-4 and Table 5-5). Monitoring undertaken at the existing Narrabri Mine with a similar mining approach, landscape and land use has shown no significant change to the agricultural resource (soil, water, pasture, farm infrastructure) when compared to nearby unmined areas over five years since mining commenced. Surface ponding has resulted in small areas of potential pasture adjacent to creek channels being temporarily unavailable for grazing, however, management through draining can minimise this impact. Soil cracking following mining is largely self-ameliorating but larger cracks have required rehabilitation treatment.

It is expected that the Project will require an Extraction Plan that incorporates a Land Management and Rehabilitation Management Plan. With appropriate development and implementation of these plans, it is expected that there will be no significant impact on the agricultural resources within the Gateway Certificate Application Area.

It is expected that there will be no significant impact to the area of permanent BSAL, given that:

- The total area of BSAL (verified and SRLUP Potential BSAL) within the Gateway Certificate Application Area is approximately 202 ha (with approximately 75 ha within the proposed mining footprint).
- Mining infrastructure will be constructed on only approximately 11.2 ha of BSAL, with some of this being temporary.
- All areas of surface infrastructure are planned for removal and rehabilitation to the pre-existing land capability upon the completion of mining.

**Table 5-4: Summary of Agricultural Impact Assessment**

Agricultural Resource, Practice or Infrastructure	Potential Impact	Management or Mitigation	Consequence to Agricultural Productivity
<i>Resource</i>			
BSAL	<p><i>Approximately 202 ha of BSAL (verified and SRLUP Potential BSAL) in the Gateway Certificate Application Area.</i></p> <p>Subsidence impacting BSAL through:</p> <ul style="list-style-type: none"> <li>• ponding; and</li> <li>• erosion or degradation.</li> </ul> <p>Loss of BSAL through infrastructure development.</p>	<p>Ponding management strategies include monitoring of changes in surface drainage in areas of pond development and development of site-specific management approaches such as draining or integration into the agricultural landscape.</p> <p>Land management planning and action to minimise erosion through retention of high levels of ground cover, minimising cultivation, repairing residual soil cracks and managing areas or poor drainage (ELA 2015c) (or latest approved version).</p> <p>Land management actions to ameliorate erosion/degradation should it occur (ELA 2015c).</p> <p>Rehabilitation of surface disturbance areas to agricultural land use.</p>	No significant impact
Soil	<p>Subsidence impacting soil quality through:</p> <ul style="list-style-type: none"> <li>• ponding; and</li> <li>• erosion.</li> </ul> <p>Loss of agricultural soil through infrastructure development.</p>	<p>Minimal ponding expected along existing creek lines.</p> <p>Land management planning and action to minimise erosion through retention of high levels of ground cover, minimising cultivation, repairing residual soil cracks and managing areas or poor drainage (ELA 2015c) (or latest approved version).</p> <p>Land management actions to ameliorate erosion should it occur (ELA 2015c) (or latest approved version).</p> <p>Limited infrastructure to be developed over the site. Rehabilitation upon closure to reinstate previous or other agreed land use.</p>	No significant impact
Surface water	<p>Altered topography/catchment through subsidence.</p> <p>Ponding along creek lines.</p> <p>Altered dam storage or damage to dam wall or floor.</p>	<p>Catchment area will remain almost the same for all water courses.</p> <p>Draining or incorporation of ponded areas into land management.</p> <p>Inspect dams before and after subsidence to ensure no damage or change to productivity. Dam repairs or augmentation made as required (ELA 2015c) (or latest approved version).</p>	No significant impact

Agricultural Resource, Practice or Infrastructure	Potential Impact	Management or Mitigation	Consequence to Agricultural Productivity
Groundwater	<p>No highly productive groundwater associated with the Namoi alluvium aquifer exists within the Gateway Certificate Application Area.</p> <p>Highly productive groundwater associated with the Namoi alluvium aquifer will not be impacted significantly.</p>	N/A.	No significant impact
<i>Practice</i>			
Grazing	<p>Small areas unavailable to grazing in discrete areas of current mining until made safe for livestock and personnel.</p> <p>Loss of pasture areas:</p> <ul style="list-style-type: none"> <li>• ponding; and</li> <li>• soil degradation.</li> </ul>	<p>Temporary exclusion of livestock and personnel.</p> <p>Minimal ponding expected along existing creek lines.</p> <p>Land management planning and action to minimise erosion through retention of high levels of ground cover, minimising cultivation, repairing residual soil cracks and managing areas or poor drainage (ELA 2015c) (or latest approved version).</p>	No significant impact
Cereal cropping	<p>Cropping areas unavailable in the area of current mining until made safe for vehicles and personnel.</p> <p>Loss of cropping area:</p> <ul style="list-style-type: none"> <li>• ponding; and</li> <li>• soil degradation.</li> </ul>	<p>Temporary exclusion of personnel.</p> <p>Minimal ponding expected along existing creek lines.</p> <p>Land management planning and action to minimise erosion through retention of high levels of ground cover, minimising cultivation, repairing residual soil cracks and managing areas or poor drainage (ELA 2015c) (or latest approved version).</p>	No significant impact
<i>Infrastructure</i>			
Fences and gates	Damage to fences and gates.	Monitor and repair as required.	No significant impact
Buildings and sheds	Damage to buildings and sheds.	<p>Exclude personnel during active subsidence.</p> <p>Inspect following subsidence to determine safety. Repair if required or demolish and replace if unrepairable.</p>	No significant impact

Agricultural Resource, Practice or Infrastructure	Potential Impact	Management or Mitigation	Consequence to Agricultural Productivity
Dams	Loss of dam volume. Damage to dam wall or floor.	Inspect dam prior to undermining. Monitor post subsidence to determine any impacts. Alter dam configuration if required. Repair dam wall or floor if required.	No significant impact
Contour banks and other erosion control works	Damage to banks or alteration to function.	Monitor post subsidence to determine any impacts. Repair banks if required.	No significant impact

**Table 5-5: Assessment Against Relevant Criteria**

Relevant Criteria (from Clause 17h4(a) Mining SEPP)	Impact Assessment
Any impacts on the land through surface area disturbance and subsidence	<p>The area would be subject to longwall mine subsidence and approximately 374 ha of temporary surface disturbance for mining related infrastructure. All surface infrastructure will be rehabilitated to the pre-existing land capability at, or prior to, the completion of mining. The majority of this infrastructure would be temporary in nature and would be progressively rehabilitated. Subsidence of up to 2.8 m is predicted with minimal impact on the surface agricultural resources.</p>
Any impacts on soil fertility, effective rooting depth or soil drainage	<p>Evidence from the existing Narrabri Mine, other sites within Australia and the Agricultural Resource Assessment (Soil Management Designs 2019) undertaken for the Project indicate that there will be no significant impact to soil fertility or soil rooting depth.</p> <p>There would be some changes to the landscape topography that would result in small areas of ponding along existing water courses and creek lines. These ponds could be drained to reinstate the previous soil drainage patterns or incorporated into the landscape as an environmental or agricultural resource.</p>
Increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH	<p>There would be some changes to the landscape topography that will result in localised increases and decreases in land slope. With appropriate management, including maintaining cover and rehabilitation of any cracking that may form, these changes are expected to be insignificant.</p>
Any impacts on highly productive groundwater (within the meaning of the AIP)	<p>There are no highly productive groundwater sources within the Gateway Certificate Application Area. The highly productive Namoi Alluvium aquifer to the east of the Gateway Certificate Application Area has been assessed (HydroSimulations 2019) and shown to be unaffected or only affected within the limits set out in the AIP.</p>
Any fragmentation of agricultural land uses	<p>Throughout the mine life the majority of the Gateway Certificate Application Area will be suitable for agricultural production under the current land use intensity. Therefore, there will be insignificant fragmentation of agricultural land use.</p>
Any reduction in the area of BSAL	<p>The total area of BSAL (verified and Potential BSAL) within the Gateway Certificate Application Area is approximately 202 ha, with approximately 75 ha lying within the proposed mining footprint. A surface infrastructure corridor, ventilation shaft and some minor, temporary infrastructure are proposed to be constructed on approximately 11.2 ha of BSAL. These areas will be rehabilitated to BSAL at the completion of mining operations, whilst temporary infrastructure would be progressively developed and then rehabilitated as mining progresses.</p> <p>There will be insignificant impact to the area of BSAL within the Gateway Certificate Application Area.</p>

## 6 Conclusions and Recommendations

Detailed assessment of the impacts of the Project on agricultural production and BSAL has forecast no significant impact on agriculture.

Soil Management Designs (2019) reviewed and refined soil mapping in the Gateway Certificate Application Area, verifying 107 ha of BSAL and documenting another 95 ha of Mining SEPP Potential BSAL that could not be verified as site access was restricted. BSAL areas are largely confined to the eastern extremity of the Gateway Certificate Application Area and the majority fall outside of the proposed mine footprint. A surface infrastructure corridor, ventilation shaft and other minor infrastructure are proposed to be constructed upon approximately 11.2 ha of BSAL for the period of mining operations.

Ditton Geotechnical Services (2019) modelled the potential subsidence based on the mine design and undertook impact assessment for the potential consequences of subsidence in the area. They also drew upon experience from measured subsidence and associated impacts from other mines in Australia and the existing Narrabri Mine. As the Project is an extension of the existing Narrabri Mine, they have very similar mine geometry, geology, landscape and land use and measured impacts are highly likely to be similar to those that might be experienced by the Project. Modelling showed a likely maximum subsidence of 2.8 m for each of the proposed panels with resulting consequences of soil cracking, ponding, increased erosion risk, infrastructure disturbance and changes to farm dams. Based on the modelling and experience from the existing Narrabri Mine, Ditton Geotechnical Services (2019) found that there was little to no significant risk of detrimental consequences to agricultural resources if land management and rehabilitation was applied in a similar manner to that undertaken at the existing Narrabri Mine. Creek line ponding is the most likely possibly detrimental consequence, however, ponding can be drained through channel creation and/or creek channel works or incorporated into the working agricultural landscape.

Groundwater assessment and modelling by HydroSimulations (2019) found no significant groundwater resources within the Gateway Certificate Application Area. The highly productive Namoi Alluvium to the east of the Gateway Certificate Application Area is not expected to be significantly impacted by the Project.

The Gateway Certificate Application Area is moderately productive. Grazing of sheep and cattle is the dominant land use with high returns in favourable seasons. Cropping is generally for livestock fodder production. There is no irrigated cropping. Given the nature of the production systems and the nature of the impacts predicted for the Project, it is likely that agricultural production can continue throughout the Project's operation, with small areas being excluded temporarily while subsidence and rehabilitation are taking place. It is estimated that 374 ha of land, including 11.2 ha of BSAL, will be required for infrastructure development. Surface infrastructure required for the project is largely temporary and will be rehabilitated to agricultural land use, in a progressive manner, as it is no longer required. All non-temporary surface infrastructure will be rehabilitated to agricultural land use upon mine closure.

This report represents the Agricultural Impact Assessment undertaken to support the Gateway Certificate Application for the Project. As such, it has drawn upon regional and local datasets and relied upon modelling and assessment based on a defined Gateway Certificate Application Area and planned mine footprint. Further assessment will be required in support of a full EIS should the proposal progress beyond the Gateway Stage.

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