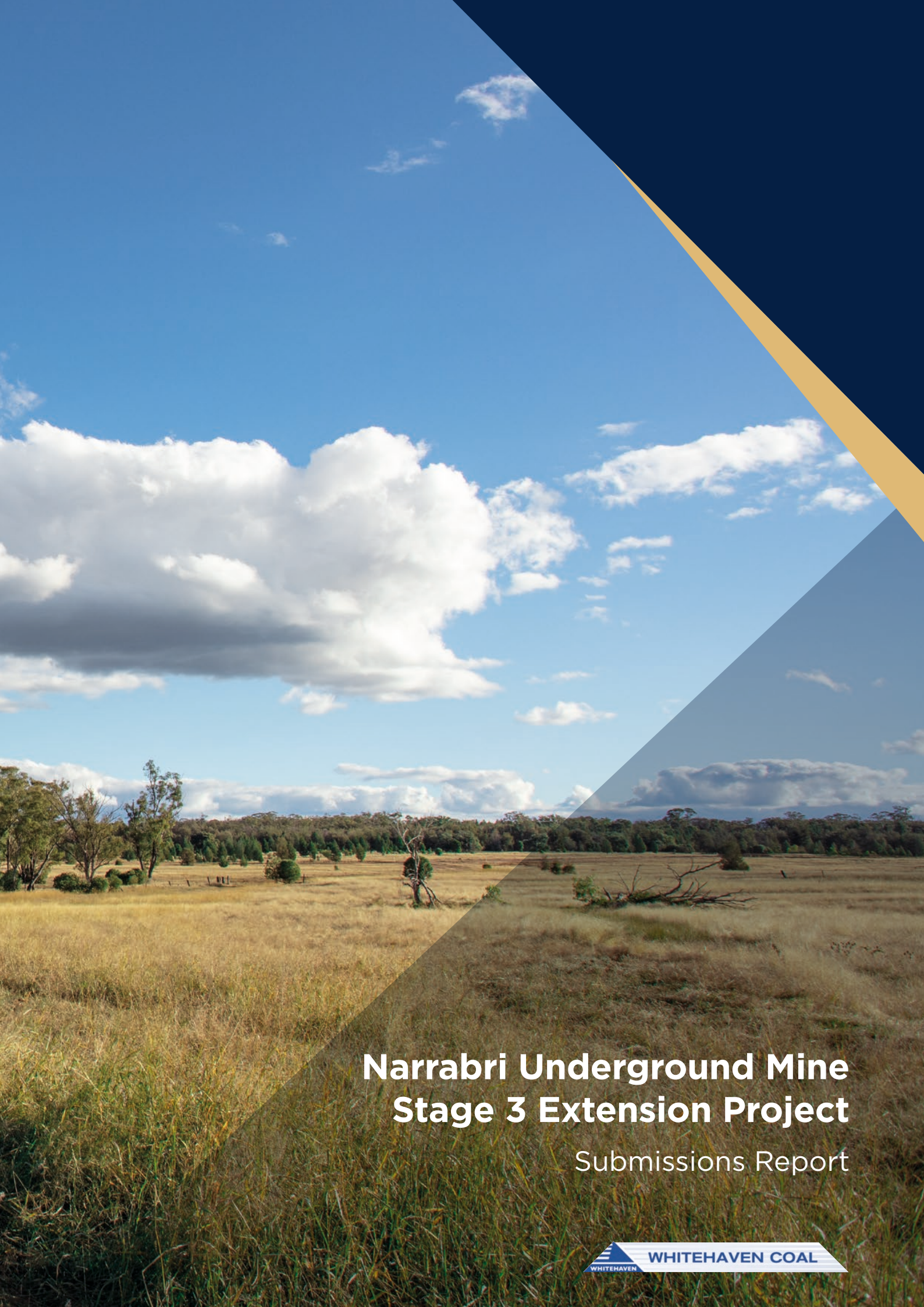

Narrabri Underground Mine Stage 3 Extension Project

Submissions Report

WHITEHAVEN COAL

EXECUTIVE SUMMARY

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

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

The EIS was placed on public exhibition by the Department of Planning, Industry and Environment (DPIE) from 5 November 2020 to 16 December 2020. During this period, government agencies, organisations and members of the public were invited to provide submissions on the EIS to DPIE. A total of 83 submissions on the Project were received from public authorities, organisations and members of the public. The following provides a breakdown of the submissions by submitter category:

- 61 submissions (73.5%) from members of the public;
- 16 submissions (19.3%) from public authorities; and
- 6 submissions from organisations (7.2%).

Of these submissions:

- 63 submissions (75.9%) were in support of the Project, 61 from members of the public and 2 from organisations;
- 17 submissions (20.4%) were comments, 16 from public authorities and 1 from an organisation; and
- 3 submissions (3.6%) objected to the Project, all from organisations.

Submissions in support of the Project cited the socio-economic benefits of the Project, including jobs, as being key to their support of the Project and were from the regional area (between 5 and 100 kilometres [km] from the Project) with a smaller portion from the broader community (greater than 100 km from the Project). Objectors to the Project typically cited groundwater, surface water, subsidence and traffic impacts.

This Submissions Report provides responses to issues raised by submissions from government agencies, local councils, organisations and members of the public during the exhibition period for the EIS and has been prepared in consideration of the Exhibition Draft *Preparing a Submissions Report State Significant Development Guide*. Technical subject matter experts such as Australasian Groundwater and Environmental Consultants, WRM Water & Environment Pty Ltd, The Transport Planning Partnership, Jacobs Pty Ltd and Dr Peter Hancock have contributed to the responses provided in this report.

Since lodgement of the Project EIS, NCOPL has continued to consult with community members, Councils, NSW government agencies and the Department of Planning, Industry and Environment regarding the Project. In particular, following a submission from the Boggabri Baan Baa Landowners group, NCOPL undertook direct consultation with members of this group to discuss concerns raised, which were mostly relating to groundwater. This included additional groundwater bore investigations to refine the assessment of impacts to groundwater bores and features of interest.

In addition, bores where the predicted drawdown exceeds the NSW *Aquifer Interference Policy* (AIP) minimal impact threshold were further appraised in order to better characterise impacts and assist with designing 'make good' measures. When used, these bores are for stock and domestic purposes. In summary, a total of nine privately-owned bores are predicted to exceed the AIP minimal impact threshold. Of these, six bores may experience drawdown which results in some impairment of water production from the bore. NCOPL has committed to these bore owners to:

- conduct a groundwater yield test (where allowed by the installed bore head works);
- monitor any drawdown as it develops; and
- implement 'make good' measures (such as installation of a deeper bore) during the operational phase of the Project.

In weighing up the main environmental impacts (costs and benefits) associated with the proposal as assessed and described in the EIS and the Submissions Report (incorporating the amended Project), the Project is, on balance, considered to be in the public interest.

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1 INTRODUCTION

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

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

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

NCOPL is seeking consent to develop the Project. NCOPL (2020a) prepared the Project Environmental Impact Statement (the EIS) to support the assessment process under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

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

On 22 December 2020, DPIE requested that NCOPL prepare and submit a Response to Submissions for the Project (herein referred to as the Submissions Report) in accordance with section 4.39 of the EP&A Act and with clause 82(2) of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

Additional submissions were provided by DPIE subsequent to the exhibition period closing, including submissions from DPIE – Water, Heritage NSW, Forestry Corporation of NSW, Siding Spring Observatory, and the Boggabri Baan Baa Landowners (BBBL) Group. These additional submissions have been considered in this Submissions Report. A number of other additional community representations were also received subsequent to the exhibition period closing, which are considered in this Submissions Report.

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

Section 1 Provides an introduction to the Project and overview of the planning process to date.

Section 2 Provides an analysis of the submissions received by DPIE during the public exhibition period.

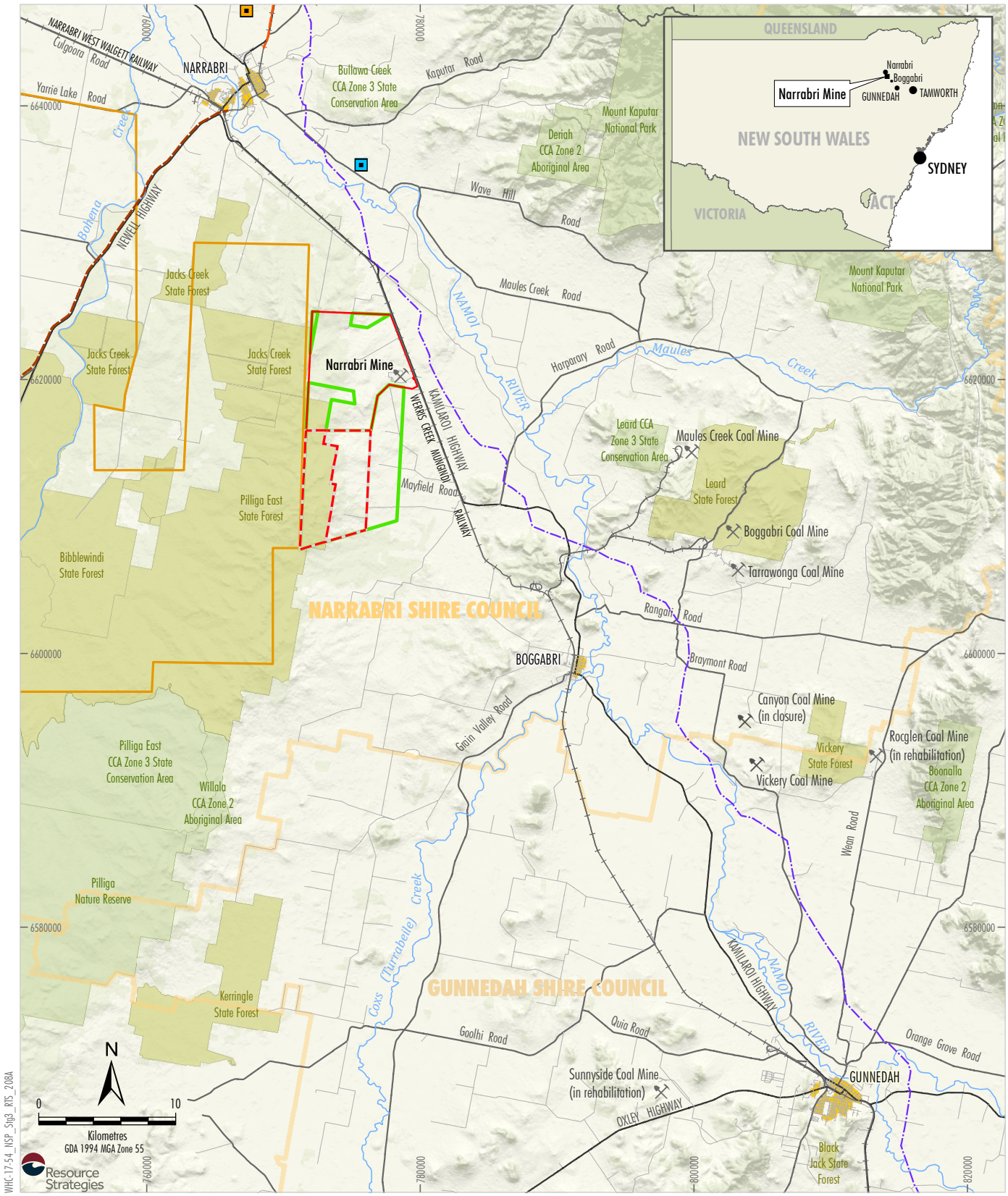
Section 3 Summarises the actions taken since lodgement of the EIS, including additional engagement activities and further refinements and assessment of the Project.

Section 4 Provides responses to the issues raised in the submissions.

Section 5 Provides an updated evaluation of the Project.

Section 6 Lists the documents referenced in the Submissions Report.

It is noted that a number of organisations, agencies and members of the public supported the Project (approximately 76% of total submissions). In the interest of brevity, these submissions have not been reproduced in this document. However, a summary of the key matters raised in these submissions is provided in Section 2.5.



LEGEND

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

Other Major Projects

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

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

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Regional Location

Figure 1

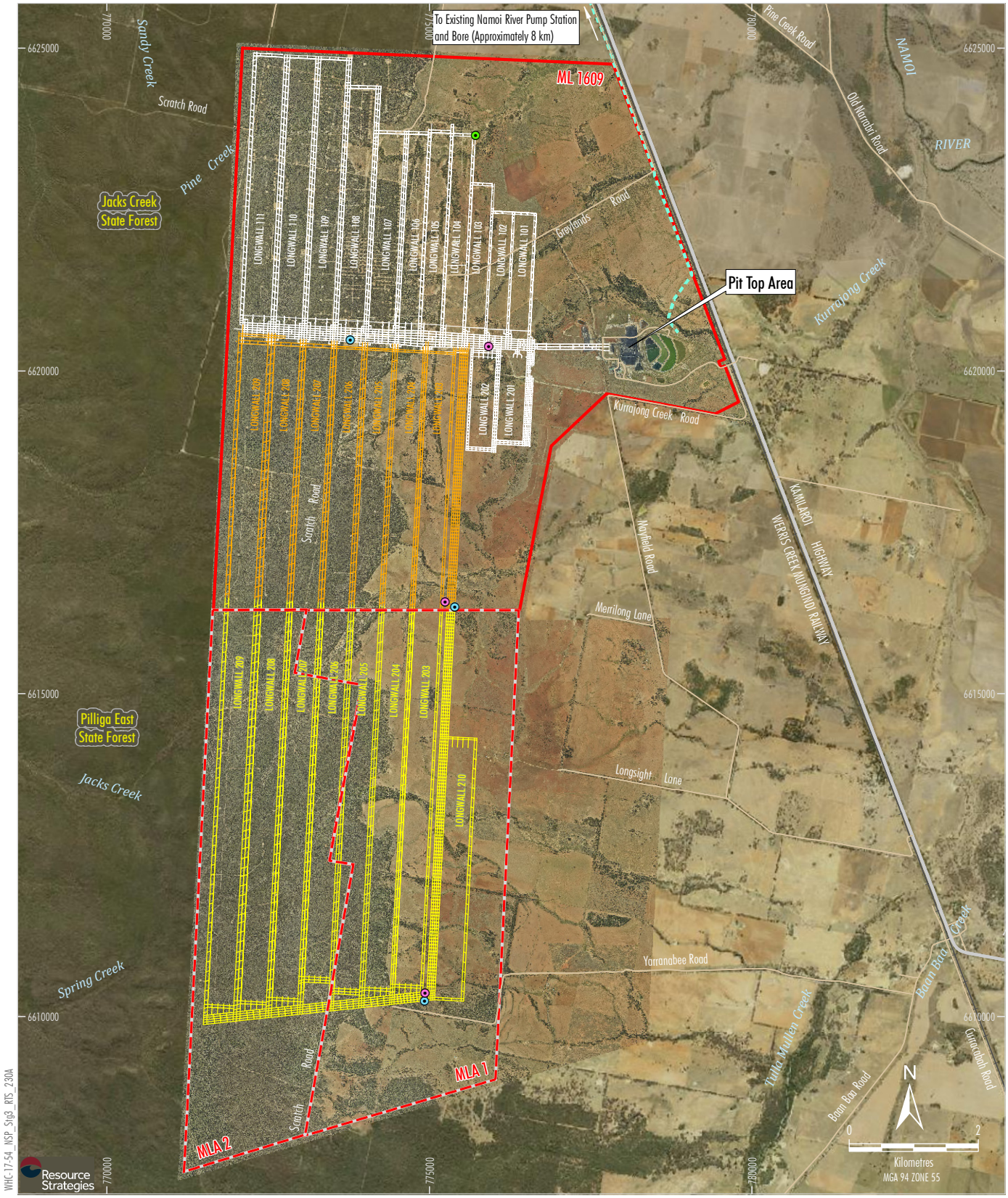
1.1 OVERVIEW OF THE PROJECT

The Project involves an extension to the approved underground mining area to gain access to additional coal reserves within MLAs 1 and 2 (Figure 2), an increase in the mine life to 2044, and development of supporting surface infrastructure. Table 1 provides a tabulated summary of the key characteristics of the Project and a comparison to the approved Narrabri Mine.

The Project would include the following activities:

- continued longwall mining of the Hoskissons Coal Seam involving a southern extension including:
  - an extension of Longwalls 203 to 209 into MLAs 1 and 2; and
  - an additional longwall (Longwall 210) within MLA 1;
- continued development of underground roadways within the Hoskissons Coal Seam and adjacent strata to access mining areas;
- continued use of existing underground roadways and drifts for personnel and materials access, ventilation, dewatering and other ancillary activities;
- continued production of up to 11 million tonnes per annum (Mtpa) of ROM coal (i.e. no change compared to the approved Narrabri Mine);
- continued use of the existing surface facilities (with minor upgrades and extension) and development of additional surface infrastructure associated with roadways, mine ventilation, gas management, exploration, services, water management areas and other ancillary infrastructure above the extended underground mining area;
- continued development of mine safety pre-conditioning areas;
- continued use of the existing coal reject emplacement area;
- disposal of drilling waste products within the reject emplacement area, including receipt and disposal of similar drilling waste products from off-site;
- continued transport of product coal from site by rail;
- continued use and progressive development of the sumps, pumps, pipelines, water storages and other water management infrastructure and development of additional water management infrastructure associated with the extended underground mining areas;
- continued use of the Namoi River pump station, alluvial production bore and pipeline (including potential development of a second approved pipeline);
- continued employment of up to approximately 520 full-time equivalent personnel and additional contractors;
- continued monitoring, rehabilitation and remediation of subsidence effects and surface disturbance areas; and
- other associated minor infrastructure, plant, equipment and activities.

The Development Application for the Project seeks to consolidate and replace the existing Narrabri Mine Project Approval 08_0144.



LEGEND

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

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

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Project General Arrangement - Indicative Underground Mining Layout

Figure 2

Table 1
Summary Comparison of the Existing/Approved Narrabri Mine and the Project

Project Component	Existing/Approved Narrabri Mine	The Project^
Mining Method and Resource	▪ Longwall mining of the Hoskissons Coal Seam.	▪ Unchanged.
Underground Mine Geometry	▪ Twenty longwall panels (Longwalls 101 to 111 and Longwalls 201 to 209). ▪ 295 metres (m) wide longwall panels for Longwalls 101 to 106. ▪ 400 m wide longwall panels for Longwalls 107 to 111 and Longwalls 201 to 209.	▪ Twenty-one longwall panels (Longwalls 101 to 111 and 201 to 209 and Longwall 210). ▪ No change to Longwalls 101 to 111 and 201 and 202. ▪ Extension of Longwalls 203 to 209 into MLAs 1 and 2. ▪ Additional longwall panel within MLA 1 (Longwall 210), which is approximately 410 m wide.
Tenements	▪ Mining operations conducted within Mining Lease (ML) 1609.	▪ Continued mining operations conducted within ML 1609. ▪ Mining operations conducted within MLAs 1 and 2.
Mine Life	▪ Mining operations approved until July 2031.	▪ Extension of mining operations to 2044.
ROM Coal Production	▪ Approved total ROM coal production of approximately 170 million tonnes (Mt)*.	▪ Total ROM coal production increased to approximately 252 Mt.
ROM Coal Production Rate	▪ ROM coal production of up to 11 Mtpa.	▪ Unchanged.
Underground Mine Surface Infrastructure	▪ Ventilation shafts, pre-drainage and post-drainage sites, mine safety pre-conditioning sites, access roads and electricity transmission lines.	▪ Augmentation of the existing gas drainage, mine safety pre-conditioning, mine ventilation system, services corridors and boreholes, access tracks and electricity transmission lines within MLAs 1 and 2.
Underground Mine Access	▪ Via three drifts at the box cut.	▪ Unchanged.
Coal Washing	▪ Coal Handling and Preparation Plant (CHPP) and secondary crusher/screen.	▪ Continued use of existing facilities, with replacement or upgrades of components as required.
Coal Handling and Stockpiling	▪ ROM coal stockpile capacity of approximately 700,000 tonnes (t). ▪ Product coal stockpile capacity of approximately 500,000 t.	▪ Unchanged.
Reject Management	▪ CHPP rejects placed in reject emplacement area.	▪ Continued disposal of coal reject waste in the reject emplacement area. ▪ Disposal of exploration drilling waste in the reject emplacement area, including potential receipt and disposal of exploration drilling waste products from off-site.
Product Coal Transport	▪ Product coal transported from site by rail. ▪ Average of four trains per day. ▪ Peak of eight trains per day.	▪ Unchanged.
Water Management	▪ Conducted in accordance with the Water Management Plan (including discharge under the conditions of Environment Protection Licence [(EPL)] 12789 and Project Approval 08_0144).	▪ Water management generally unchanged. ▪ Development of Southern Mine Water Storage within MLA 1.
Water Supply	▪ Make-up water demand to be met from mine dewatering, runoff recovered from operational areas, and licensed extraction from Namoi River and Namoi Alluvium.	▪ Unchanged.

Table 1 (Continued)
Summary Comparison of the Existing/Approved Narrabri Mine and the Project

Project Component	Existing/Approved Narrabri Mine	The Project^
Power	▪ Permanent mains power supplied via a spur line from a 66 kilovolt (kV) powerline located to the east of Kamilaroi Highway. ▪ Power converted from 66 kV to 11 kV on-site and reticulated, using progressively developed 11 kV powerlines.	▪ No change to key power supply infrastructure; however, demand for mains power would increase. ▪ Continued progressive development of electricity transmission lines to service the extended underground mining area and associated surface infrastructure.
Hours of Operation	▪ 24 hours per day, seven days per week.	▪ Unchanged.
Employment	▪ Operational workforce (employees and contractors) of approximately 520 full-time equivalent personnel.	▪ Continued employment of up to approximately 520 full-time equivalent personnel. ▪ Possible short-term increases in employment for development activities and potential additional development requirements.
Site Access	▪ Primary access via a sealed mine access road connected to the Pit Top Area.	▪ Unchanged.
Surface Development Footprint	▪ Approximately 210.5 hectares (ha) of woodland/forest native vegetation clearance.	▪ Approximately 609 ha of additional surface development footprint to support underground mining.
Gas management	▪ Gas currently vented to the atmosphere; however, investigation of developments in flaring technology to determine if flaring is a viable gas management option.	▪ Generally unchanged, however, pre-drainage gas from the Hoskissons Coal Seam in some parts of the underground mine footprint (where the methane and gas content are sufficient and oxygen content permits safe flaring) would be flared to reduce greenhouse gas emissions.
Rehabilitation Strategy	▪ Conducted in accordance with the Mining Operations Plan (MOP).	▪ Unchanged.
Capital Investment Value	▪ Not applicable.	▪ $404 million.

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

^ Includes the amendments to the Project described in the Amendment Report (NCOPL, 2021).

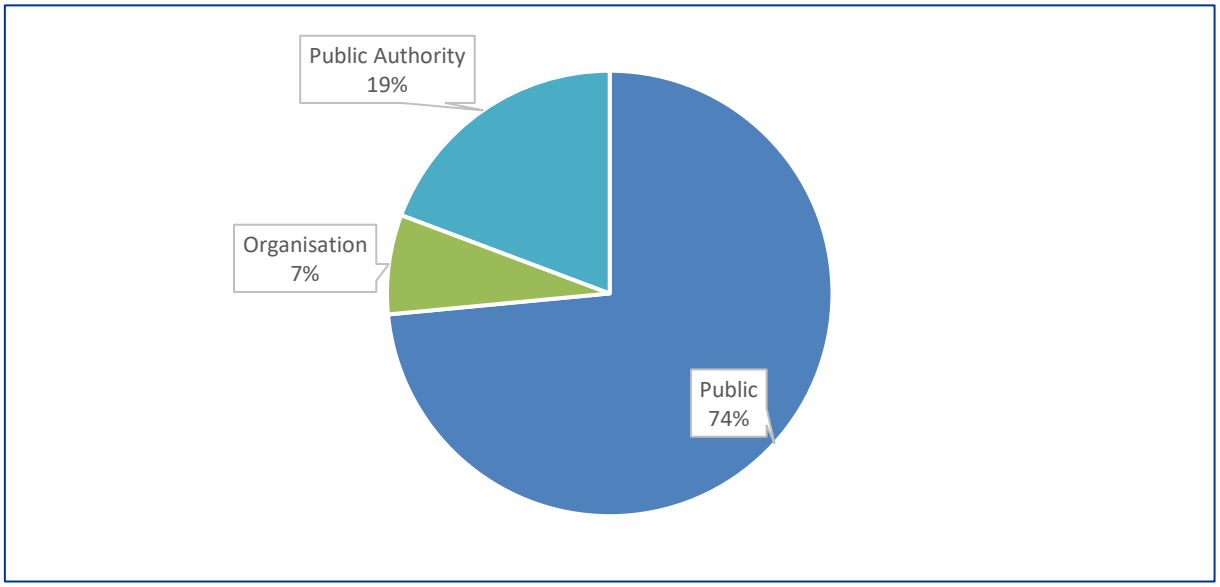
2 ANALYSIS OF SUBMISSIONS

2.1 NUMBER OF SUBMISSIONS

A total of 83 submissions on the Project were received from public authorities, organisations and members of the public. The following provides a breakdown of the submissions by submitter category (Chart 1):

- 61 submissions (73.5%) from members of the public;
- 16 submissions (19.3%) from public authorities; and
- 6 submissions from organisations (7.2%).

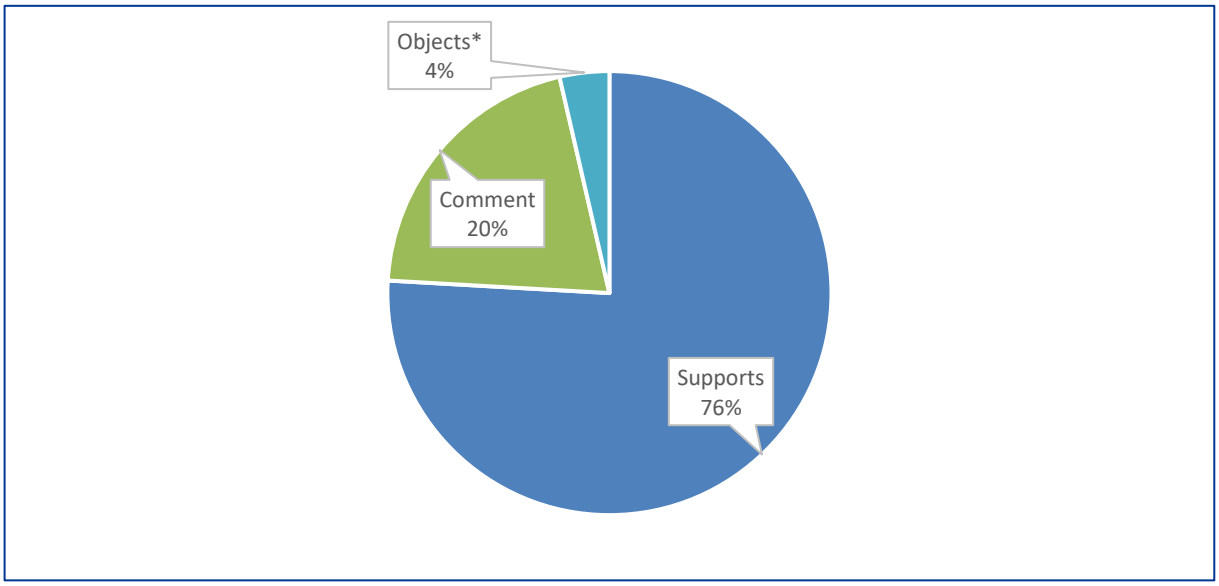
Chart 1
Summary of All Submissions



Of these submissions (Chart 2):

- 63 submissions (75.9%) were in support of the Project, 61 from members of the public and 2 from organisations;
- 17 submissions (20.4%) were comments, 16 from public authorities and 1 from an organisation; and
- 3 submissions (3.6%) objected to the Project, all from organisations.

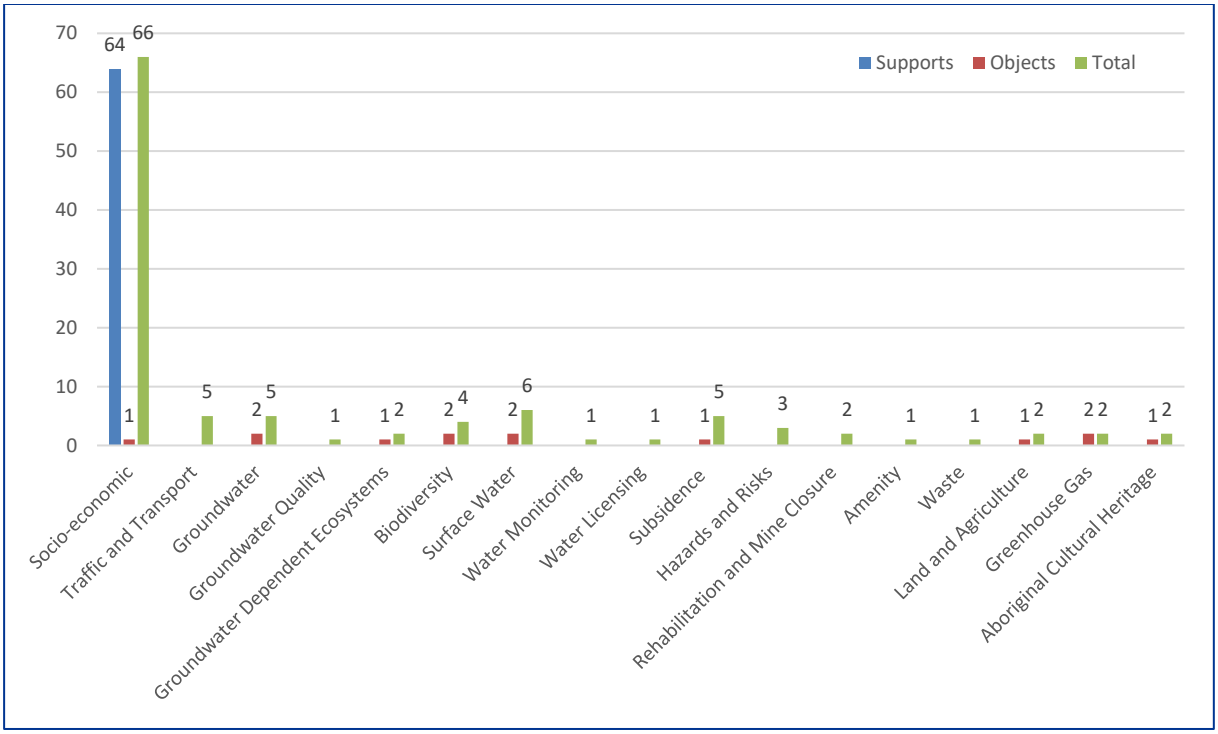
Chart 2
Summary of Submission Types for All Submissions



*Note: the objection from the BBBL included 16 signatories.

Chart 3 presents a summary of the key issues raised by submitter category. The register of submitters is provided in Attachment 1.

Chart 3
Key Issues Raised by Submission



2.2 GOVERNMENT AGENCY SUBMISSIONS

A total of 16 submissions were received from public authorities, which include NSW Government agencies, local councils and the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). These submissions were all in the form of comments.

2.3 ORGANISATION AND PUBLIC SUBMISSIONS

A total of six submissions were received from organisations. Two of these submissions were from organisations who supported the Project, one organisation provided comments and three organisations objected to the Project.

A total of 61 submissions were received from members of the public, all of which supported the Project. The majority of the submissions in support of the Project were from the regional area (between 5 and 100 km from the Project with a smaller portion from the broader community (greater than 100 km from the Project). No submissions were received from the near local area (i.e. within 5 km of the Project).

2.4 KEY MATTERS RAISED IN SUBMISSIONS

The most commonly raised matters in relation to the Project are illustrated in Chart 3. The following key matters were raised in the submissions:

- socio-economic benefits;
- Aboriginal cultural heritage;
- biodiversity;
- subsidence;
- surface water;
- groundwater;
- groundwater dependent ecosystems (GDEs);
- amenity;
- cumulative impacts;
- greenhouse gas emissions;
- hazards and risk;
- land resources and agriculture; and
- rehabilitation and mine closure.

3 ACTIONS TAKEN SINCE LODGEMENT OF THE PROJECT EIS

3.1 ENGAGEMENT ACTIVITIES

Since the lodgement of the EIS, NCOPL has continued to engage with key stakeholders, including government agencies, local organisations and community members regarding the Project. The consultation with each of these stakeholders is summarised in the following sections.

3.1.1 Consultation with Government Agencies

Subsequent to the lodgement of the EIS, NCOPL met with DPIE on 11 December 2020 to discuss the Project Impact Reduction Area component of the Biodiversity Development Assessment Report (BDAR), and the potential groundwater impacts on properties in the area. NCOPL invited DPIE to an on-site meeting to discuss the key matters raised in the submissions and to provide a tour of the site.

NCOPL met with DPIE – Biodiversity Conservation and Science (BCS) on 26 February 2021 to discuss the Impact Reduction Area and ecological rehabilitation components of the BDAR as well as other matters raised by BCS in their submission. In addition, BCS officers attended the Narrabri Mine site on 13 May 2021 for a site visit. NCOPL has also consulted with the Biodiversity Conservation Trust regarding biodiversity offsets for the Project, including the process to form Biodiversity Stewardship Agreements.

NCOPL hosted a teleconference on 11 May 2021 with the Department of Planning, Industry and Environment – Water (DPIE – Water) to discuss the comments received on the EIS. NCOPL outlined the general approach to addressing DPIE – Water comments.

In addition, NCOPL has provided regular updates to DPIE during the preparation of this Submissions Report.

3.1.2 Consultation with Councils

NCOPL has consulted with the NSC and Gunnedah Shire Council (GSC) on various occasions regarding Voluntary Planning Agreements including:

- four meetings with NSC on 12 October, 13 and 14 December 2020 and 18 February 2021; and
- four meetings with GSC on 14 October, 11 November and 15 December 2020 and 16 February 2021.

3.1.3 Drop-in Session

NCOPL hosted a drop-in session at the Baan Baa Hall on 28 November 2020 which gave the public an opportunity to discuss the outcomes presented in the EIS with NCOPL employees (Plate 1). Approximately 20 members of the public attended the drop-in session.

Some further information from some attendees was requested during the drop-in session, which was provided in the following week and during follow-up consultation with landholders (Section 3.1.4).

3.1.4 Consultation with Surrounding Landowners

Landholders and licensees immediately surrounding the existing Narrabri Mine and the Project were provided with flyers notifying them of public exhibition of the EIS and the drop-in session (Section 3.1.3). Where the landholders were at home at the time, NCOPL personnel discussed the EIS process and encouraged attendance at the drop-in session.

Source: NCOPL (2020)

WHC-17-54_NSP_Stg3_EIS RTS_001A

Resource Strategies

WHITEHAVEN COAL

NARRABRI STAGE 3 PROJECT

Baan Baa Community Hall Drop in Session

Plate 1

NCOPL also discussed the issues raised by nearby individual landholders regarding the Project.

In addition, the following measures notifying nearby landowners of the drop-in session were undertaken:

- flyers notifying the community of the drop-in session were left at the Railway Hotel, Baan Baa and delivered to immediate neighbours in the Turrawan and Baan Baa areas; and
- advertisements of the drop-in session were included in two newspapers over two editions.

NCOPL consulted with landholders regarding the implementation of round 3 of the bore census (rounds 1 and 2 were conducted during preparation of the EIS). This included initial discussions regarding site access, in-person discussions regarding groundwater access and use at the property (in conjunction with conduct of the census) and subsequent discussions regarding the bore census results. Where relevant, participating landholders received a property report detailing the data obtained and the relevant outcomes. Importantly, for properties where groundwater drawdown associated with the development of the Project is predicted to potentially impair groundwater use, NCOPL has committed to 'make good' measures, which would be identified in consultation with the landholders and implemented during the operational phase of the Project. Next steps including further monitoring and groundwater yield tests have been outlined to affected landholders.

In addition, following a submission from the BBBL, NCOPL undertook direct consultation with members of this group to discuss concerns raised, which were mostly relating to groundwater. Further detail regarding consultation with the BBBL is provided in Section 4.1.1. In total, approximately 20 meetings have been held with these landholders as part of the Submissions Report.

3.1.5 Other Community Consultation

Subsequent to the lodgement of the EIS, NCOPL gave notice of a Development Application for consent to carry out the Project under Part 4 of the EP&A Act and in accordance with clauses 6 and 7 of the EP&A Regulation. This notice was published in the *Northern Daily Leader* (30 October 2020), *Namoi Valley Independent* (30 October 2020) and *Namoi Courier* (3 November 2020).

DPIE separately published advertisements of the EIS exhibition in the *Daily Telegraph* (4 November 2020), *Narrabri North West Courier* (5 November 2020), *Sydney Morning Herald* (4 November 2020), *The Australian* (5 November 2020) and *The Land* (5 November 2020).

NCOPL advised all Registered Aboriginal Parties (RAPs) from the Aboriginal Cultural Heritage Assessment (ACHA) on 13 November 2020 that the EIS was on exhibition and provided details on how to access a copy of the EIS and final Aboriginal Cultural Heritage Assessment.

On 16 December 2020, NCOPL met with the Narrabri Mine Community Consultative Committee (CCC). The meeting provided an update following lodgement of the EIS and advised CCC members of the next steps of the assessment process. Further, on 10 March 2021, NCOPL presented the results of the Groundwater Assessment to the CCC and requested that CCC members provide details of any bores that they believe to have not been subject to impact assessment. NCOPL also provided a breakdown of submissions received on the EIS at this meeting.

On 19 January 2021, NCOPL met with Nous Group who are currently working with the Department of Regional NSW on the Narrabri Special Activation Precinct (SAP). The meeting provided information on the status of the Project and discussed the direction for the development of the Narrabri SAP.

NCOPL has also updated their website (https://whitehavencoal.com.au/our-business/our-assets/narrabri-mine/), providing a newsletter, fact sheet and a short video summarising the outcomes of the EIS, and a link to the EIS along with an explanation on how feedback on the Project can be given.

Further consultation is proposed to occur by early June 2021 including posting a Project update flyer and groundwater information sheet to residences within approximately 10 km from the Project.

3.2 ON-SITE ACTIVITIES

Of relevance to the Project, the following activities have been undertaken:

- ongoing subsidence monitoring and management (e.g. surface crack filling) within the existing mining areas, including trials of crack filling in limited access areas (i.e. dense native vegetation);
- additional event-based surface water monitoring has been undertaken on Pine Creek and Kurrajong Creek;
- submission of a revised Water Management Plan, which proposed increased frequency in the surface water and groundwater monitoring programs;
- ongoing rehabilitation works of agricultural and native woodland end land use areas;
- livestock grazing trials and monitoring on previously completed mining areas (i.e. Longwalls 101 to 104) to demonstrate meeting final end land use completion criteria;
- upgraded dust sprays on product discharge conveyers to further reduce dust emissions;
- commencement of installation of stock proof fencing around all Aboriginal cultural heritage sites identified for the Project to avoid inadvertent impacts from the Project and ongoing stock damage;
- purchase of two upgraded bulldozers to be used on coal stockpiles to minimise noise emissions; and
- implementation of algae and odour control measures on the brine dams, which has included aeration and algaecide dosing, as well as ongoing monitoring and algae analysis.

3.3 FURTHER ENVIRONMENTAL ASSESSMENT AND REFINEMENT OF THE PROJECT

Subsequent to the public exhibition of the Project EIS, NCOPL has continued biodiversity surveys for potential land-based offset areas. Biodiversity surveys have focused on NCOPL-owned land which is adjacent to or in the vicinity of the Project, as well as some non-NCOPL owned land with potential to provide specific biodiversity credit requirements for the Project.

NCOPL engaged AMBS Ecology and Heritage Pty Ltd (AMBS) to undertake further Coolabah Bertya surveys (a threatened plant species), and has identified components of the indicative Surface Development Footprint which could be relocated components now reduced the Project's impact on Coolabah Bertya. Subsequently, the amended Project would reduce the potential impacts on Coolabah Bertya by approximately 2.3 ha.

In addition, since lodgement of the EIS, NCOPL has identified some infrastructure components no longer required. As a result, NCOPL has reduced the indicative Surface Development Footprint by approximately 31 ha compared to the Project EIS. Further information regarding these reductions is provided in the Amendment Report (NCOPL, 2021).

NCOPL engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE), Ditton Geotechnical Services, Jacobs, The Transport Planning Partnership (TTPP) and WRM Water & Environment (WRM) to review and respond to matters raised in the submissions. NCOPL also commissioned Dr Peter Hancock to further assess the potential impacts to stygofauna from groundwater drawdown resulting from the Project. The outcomes of Dr Hancock's assessment are incorporated into the responses to submissions (Section 4).

Review of the matters raised in the submissions has resulted in no change to the mitigation measures presented in Attachment 4 of the EIS (NCOPL, 2020a), except for refining the proposed groundwater monitoring regime to include indicative locations of monitoring bores following input from AGE.

4 RESPONSES TO SUBMISSIONS

Responses to issues raised by public authorities and organisations are provided in the sub-sections below. Responses to public submissions do not require specific responses given all submissions were in support of the Project.

The following organisations had no specific queries or concerns regarding the Project and, therefore, do not require any specific response:

- Siding Spring Observatory;
- WesTrac NSW; and
- Projence Pty Ltd.

In accordance with the Draft Exhibition *Preparing a Submissions Report State Significant Development Guide* (DPIE, 2020a), the issues raised in submissions have been categorised into the Project in general, procedural matters, the economic, environmental and social impacts of the Project, the evaluation of the Project and issues beyond the scope of the Project.

No issues were identified relating to the Project in general, the evaluation of the Project and issues beyond the scope of the Project, and, therefore, the Project category has not been included below.

4.1 PROCEDURAL MATTERS

4.1.1 Groundwater

Make Good Agreements

Issue

DPIE – Water and two organisations raised concern regarding the potential implementation of 'make good' provisions (where appropriate measures are put in place for potential Project-related drawdown of greater than 2 m), particularly where impacts are predicted to occur following completion of mining at the Project. It was also expressed that there may be potential future groundwater extraction opportunities on private properties which may not be available due to the Project's impacts. It was further suggested that properties where bores are predicted to be impacted should be afforded acquisition rights, and in circumstances where these landowners decide to forego these rights, a make good agreement should be formed prior to the commencement of the Project.

Response

Appropriate make good provisions for a Project-related groundwater drawdown greater than 2 m at a groundwater bore may include:

- deepening the affected groundwater bore (including lowering pump set and/or provision of new pump set and power supply if required);
- construction of a new groundwater bore (including provision of a new pump set and power supply if required); and/or
- provision of an alternative water supply of suitable quality and quantity.

These contingency measures would be assessed on a case-by-case basis (including an assessment of the bore construction details and viability of any proposed measures), and implemented during the operational phase of the Project in consultation with the affected landholder and relevant regulators prior to drawdown exceeding the AIP minimal impact threshold.

Further, ongoing groundwater monitoring, as well as any updates to the groundwater model, would also be used to confirm the predicted drawdown at these bores. Any groundwater monitoring at the bores would be described in the Water Management Plan (subject to agreement with the landholder).

As required under the AIP (DPI – Office of Water, 2012), additional take from groundwater sources which feature in Water Sharing Plans have been assessed and are presented in Section 7.7 of the Groundwater Assessment (AGE, 2020). The assessment concludes that NCOPL already holds sufficient licences to account for the predicted groundwater take from the Upper and Lower Namoi Regulated River Water Sources, the Upper Namoi Zone 5 and the GAB Southern Recharge Zone. As explained in Section 7.10.1 of the Groundwater Assessment (AGE, 2020) this reflects the fact that the predicted impacts of the Project on the Namoi River, Quaternary Alluvium and GAB Southern Recharge Zones are less than previously predicted and approved. Furthermore, since the predicted total take from the Namoi Alluvium (up to 65 ML/year) is substantially less than previously predicted (260 ML/year), the Project is also considered to align with the *Namoi Catchment Action Plan 2010-2020* threshold for alluvial aquifers (i.e. to never exceed historical maximum drawdown levels [Namoi Catchment Management Authority, 2011]).

The groundwater assessment also notes that the majority of the licensed take would be required under the Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources (i.e. for the Gunnedah-Oxley Basin MDB Groundwater Source). This groundwater source is significantly under-allocated and has had several controlled allocation periods of interest between 2017 and 2020. Most recently, the Controlled Allocation Order (Various Groundwater Sources) 2020 is offering 4,043 shares of the Gunnedah-Oxley Basin MDB Groundwater Source. Whitehaven has excess entitlements in this groundwater source across its operations which would be used for the Project (Table 2).

Overall, as described above, the predicted additional take from groundwater resources due to the Project has either already been accounted for, and licensed, or would occur from a significantly under-allocated source. Furthermore, NCOPL has committed to implementing 'make good' provisions during the Project, as opposed to if/when the impact is realised as is required by the AIP. Furthermore, additional production bores on private property would need to be established in accordance with the various rules of the relevant Water Sharing Plans and additional take from groundwater source(s) would need to be licensed appropriately by relevant landowners.

Table 2
Whitehaven's *Gunnedah-Oxley Basin MDB Groundwater Source* Water Access Licences

Site	Water Access Licence	Allocation (ML)	Whitehavens' 2019 Take (ML)
Narrabri Mine	29549	818	380
	43017	403	0
Werris Creek Mine	32224	211	53
	29506	50	0
Sunnyside Mine	29537	120	26.76
Canyon Mine	29548	50	0
Maules Creek Mine	29467	306	333
	36641	800	50
Rocglen Mine	29461	120	0
	36758	700	30
Tarrawonga Mine	31084	250	58
Vickery Mine	36576	600	0
Whitehaven (total)	-	4,428	904

As discussed in Section 7.6.1 of the Groundwater Assessment (AGE, 2020) and in the groundwater impact addendum (Attachment 7), maximum predicted drawdown at the majority of the bores identified as potentially exceeding the 2 m drawdown threshold only marginally exceeds 2 m. Hence, even in a worst-case scenario where these bores become no longer useable, replacement groundwater supplies should be obtainable by extending existing bore depths by up to several metres. Accordingly, predictions indicate that sterilisation (i.e. widespread loss of water supply) of the properties served by these bores due to lack of ongoing access to groundwater is considered unlikely to occur.

As discussed in Section 8.2 of the Groundwater Assessment (AGE, 2020), further monitoring of the Mayfield, Hardys and Eather Springs and at two locations close to Tulla Mullen Creek tributary is also proposed if the Project is approved. Proposed locations for the Tulla Mullen Creek tributary sites are described in Section 4.2.1 and have been selected based, in part, on proximity to the potential GDE areas shown.

Landholder Concern Regarding Bore Census Participation and Potential Impacts on their Properties

Issue

The BBBL raised concern that they did not participate in the bore census and/or that material impacts might occur to the property.

Response

Responses to specific concerns raised are provided in Table 3 with further details provided below. Further details including identification of potential 'make good' measures are provided in Attachment 7.

Insufficient Consultation with Groundwater-affected Landholders

Issue

An organisation raised concern that many residents and farmers living within the identified groundwater-affected zones have had little or no contact with NCOPL.

Response

All of the landowners where bores are predicted to be impacted have now been consulted by NCOPL. Including consideration of the Groundwater impact assessment addendum (Attachment 7), nine privately-owned stock and domestic water supply bores are predicted to experience drawdowns exceeding the AIP minimal harm impact criterion (i.e. 2 m). Six of these bores may experience some impairment of supply due to these impacts. These bores and a description of consultation that has been conducted with their owners are described in Table 4 below.

Advertisement of Consultation Activities and the Information Session

Issue

An organisation raised concern that consultation/information sessions have been poorly advertised.

Response

NCOPL hosted a drop-in session at the Baan Baa Hall on 28 November 2020, which provided the public an opportunity to discuss the outcomes presented in the EIS with NCOPL (Section 3.1.3). It is noted that many of the members of the BBBL attended this session.

Landholders immediately surrounding the existing Narrabri Mine and the Project were provided with flyers notifying them of public exhibition of the EIS and the drop-in session (Section 3.1.4).

Table 3
Responses to Concerns Raised Regarding Potential Impacts by the BBBL

Landholder	BBBL Concern Raised			NCOPL Response		
	Did WHC Undertake a Bore Survey on your bore?	Do you have GDEs or springs?	Is your house listed as a 'Sensitive Receiver'	Impacts on groundwater?[1,2]	Impacts on GDEs or springs?[3]	Air Quality, Noise and Visual Impacts
A	No	Yes	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
B	No	Yes	Yes	Mentone bore predicted to exceed 2 m of drawdown (*Aquifer Interference Policy* Threshold). Property was included as part of round 1 of the bore census mail out. It is understood that a new bore has been installed since this was undertaken. This bore is now assessed in Attachment 7.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
C	No	Yes	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
D	N/A	No	Yes	No bores located on the property – confirmed by the landholder.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Included in air quality, noise modelling and in visual impact assessment (Section 6.10 of the EIS). No exceedances of air quality or noise criteria were predicted and visual impact was assessed to be 'very low'.
E	?	Yes	No	House bore to exceed 2 m of drawdown (*Aquifer Interference Policy* Threshold). Bore was included as part of round 2 of the bore census.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.

Table 3 (Continued)
Responses to Concerns Raised Regarding Potential Impacts by the BBBL

Landholder	BBBL Concern Raised			NCOPL Response		
	Did WHC Undertake a Bore Survey on your bore?	Do you have GDEs or springs?	Is your house listed as a 'Sensitive Receiver'	Impacts on groundwater?[1,2]	Impacts on GDEs or springs?[3]	Air Quality, Noise and Visual Impacts
F	No	No	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
G	No	Yes	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
H	No	No	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
I	Yes/No	Yes	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
J	No	No	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.
K	No	Yes	No	No exceedance of 2 m drawdown.	No mapped facultative or high-priority GDEs located within 2 m drawdown areas on the property.	Nil impacts expected - receiver too distant from Narrabri Mine.

[1] AGE (2020).

[2] Attachment 7.

[3] Refer to Figures 6-29b and 6-30b of the EIS.

Table 4
Summary of Consultation Conducted with Owners of Potentially Affected Bores

Bore	Included in Bore Census	Landowner Consulted Regarding Impact and 'Make Good' Commitments	Bore Impairment
House Bore	✓	✓	Unlikely
257_Bore	✓	✓	Unlikely
GW008634	✓	✓	Unlikely
GW013858	✓	✓	Likely
GW026121	✓	✓	Likely
South Caloola	✓	✓	Likely
GW903687	✓	✓	Likely
Mentone Bore	✓	✓	Likely
Windmill Bore	✓	✓	Likely

Source: Attachment 7.

Where the landholders were at home at the time, NCOPL personnel discussed the EIS process and encouraged attendance at the drop-in session.

In addition, flyers notifying the community of the drop-in session were left at the Railway Hotel in Baan Baa (which is a method often used to notify members of the public of community events).

The Narrabri Mine's CCC was notified of the drop-in sessions on 18 November 2020 via email, members without email access were provided with hard copies of the email.

The drop-in session was advertised twice in two local papers on 19 November 2020 resulting in a total of four advertisements.

During the preparation of the Submission Report, the following further consultation with the BBBL has occurred:

- A letter was sent from NCOPL to the signatories of the BBBL requesting details of any groundwater bores which were not considered as part of the EIS.
- Some of the landholders who were signatories to the BBBL submission were included as part of the bore census round 3 and were consulted in person as part of this process.
- All other landholders who were signatories to the BBBL submission and have not been identified as part of the bore census round 3 were contacted (via phone) with the offer of an in-person briefing where required.
- Where relevant, landowners with bores who were involved in round 3 of the bore census (Attachment 6) received detailed individual property reports including information on their bores, including the relevant groundwater sources, potential impacts and proposed monitoring.
- Landholders with potentially affected bores were provided with a detailed information package prepared by AGE as part of initiating consultation with landholders for the 'make good' agreements.

Further details regarding round 3 of the bore census are provided in Section 4.2.1.

4.1.2 Land Resources and Agriculture

Consultation for the Agricultural Impact Statement

Issue

Concern was raised regarding the extent of consultation undertaken to support the Agricultural Impact Statement (AIS) (2rog, 2020) and that consultation undertaken was inadequate as it included consultees who are land managers of NCOPL land.

Response

Land managers interviewed for the AIS (2rog, 2020) were for the purpose of understanding the productivity of land within the Project area. The interviews covered the following aspects:

- Property history.
- Land manager local experience.
- Key agricultural systems.
- Typical yield/production.
- Major suppliers of materials and services.
- Number of employees.
- Property limitations.
- Water sources.
- Main markets.
- Key agricultural infrastructure.

This information can most accurately be obtained from the land managers of the specific properties that are subject to direct disturbance from the Project or subsidence-related impacts. Although most of the properties within the Project area have been acquired by NCOPL, the land managers (lessees) are generally long-term managers of the land who previously sold their property to NCOPL. It was considered appropriate to interview the previous landholders (now lessees) as they are able to provide the historical productivity information relevant to the properties, which can be more accurate than the alternative of making assumptions based on Geographic Information System-based and regional assessment information.

Further, Section 3 of the AIS (2rog, 2020) describes that the landholders/managers that were contacted for interview (Table 3-1). Of note is that Table 3-1 (which outlines the consultees for the AIS) of the AIS includes two privately-owned properties.

4.2 ECONOMIC, ENVIRONMENTAL AND SOCIAL MATTERS

4.2.1 Groundwater

Modelling Accuracy

Issue

The IESC and DPIE – Water raised concern regarding the accuracy of modelling of potential impacts on the Namoi River and alluvium, particularly that there may be uncertainty in regard to the extent and parameterisation of the hydrogeological units between the Project and the Namoi River. Further, consideration of drawdown in the model layer 11 (Pamboola and older Formations) and its potential impacts on the directly overlying alluvium to the east of the Project was requested.

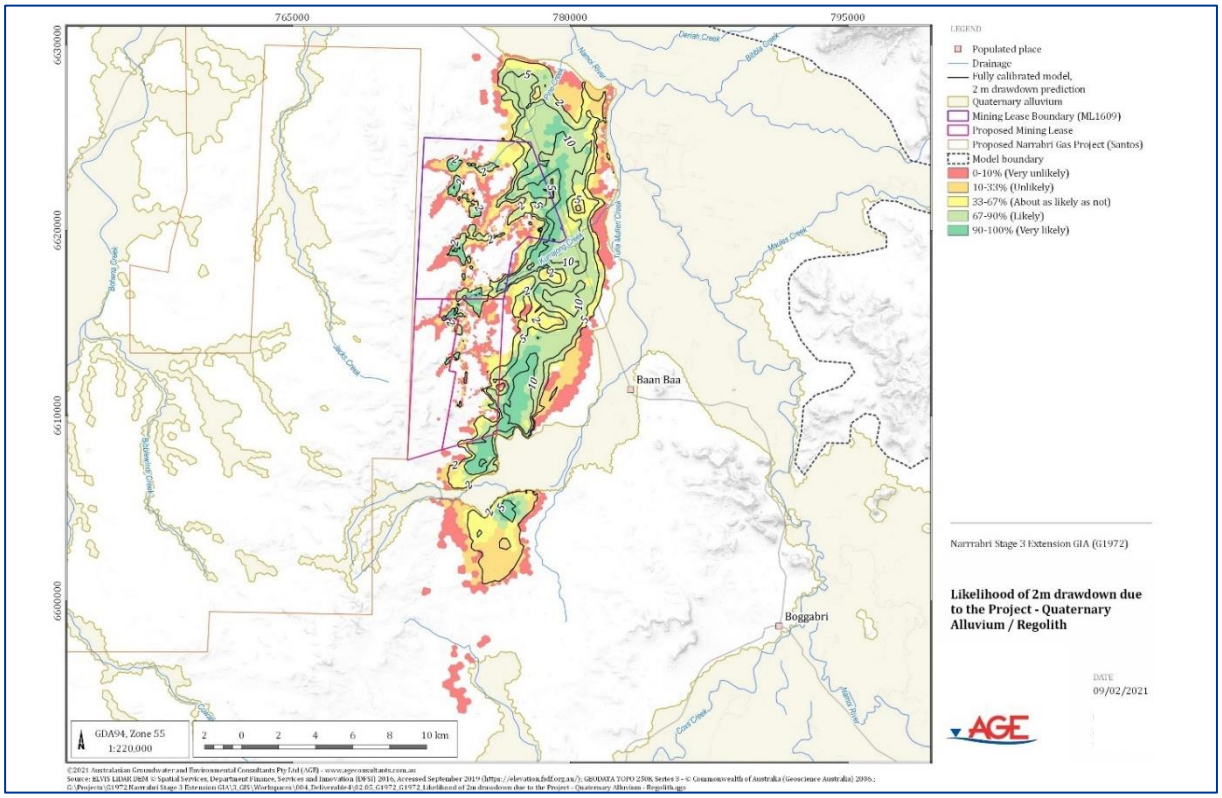
Response (prepared with assistance from AGE)

Predictive uncertainty has been quantified using a stochastic Null Space Monte Carlo based methodology in a manner which is consistent with the current IESC guidance on uncertainty analyses of this type (Middlemis and Peeters, 2018). The sensitivity of model predictions to the parameterisation of all hydrogeological units present between the proposed longwall panels and the Namoi River has therefore been assessed using the most rigorous of the three types of methods identified by Middlemis and Peeters (2018) as being appropriate.

Predictive uncertainty can also arise from a number of other sources including conceptual uncertainties such as the extent of key strata. In keeping with most, if not all, studies of this type, the contribution of other types of uncertainty has been assessed qualitatively, rather than quantitively. Conceptual uncertainty is discussed in Section D 2.4.3 of Appendix D in the Groundwater Assessment. As discussed in this section, key controls on the development of impacts between the Narrabri Mine and the Namoi River include the extent of the Hoskissons Coal Seam and the Namoi Alluvium to the east of the Project. The extent of both of these units is considered to be known with a high degree of accuracy. In addition to geological mapping of the area, produced by the Geological Survey of NSW, which typically involves ground truthing using shallow augur holes, further ground truthing of the extent of these strata is provided via 1,600 mine exploration bores and over 1,000 licensed water supply bores in the model domain. Accordingly, no further ground truthing of the extent of these strata was, or is considered, necessary. However, monitoring of groundwater levels and groundwater quality in these and other areas around the Narrabri Mine would continue, in accordance with the Water Management Plan, to confirm impact predictions and update the Project groundwater model and predictions where necessary.

The sensitivity of model predictions to parameter uncertainty was assessed via completion of a predictive uncertainty analysis (Appendix D of AGE, 2020). Hence, in addition to the 'best estimate' predictions of drawdown in Quaternary Alluvium/regolith drawdowns shown in Figure 7.8 of the Groundwater Assessment and predictions for a further 100 realisations can be analysed statistically to assess the likelihood of the 2 m drawdown contour extending further into the Namoi Alluvium. The results of this statistical analysis are presented in Figure 3.

As shown in Figure 3, uncertainty analysis results suggest that impacts of more than 2 m are very unlikely to occur within the Namoi Alluvium at any point in the future. This is because the indirect loss of groundwater from the base of the alluvium to the depressurised underlying Permian strata is less than the recharge rate to the alluvial groundwater system for all of the model realisations. The unconsolidated nature of the Namoi Alluvium means that it is characterised by substantially higher recharge, hydraulic conductivity and storage properties than the underlying consolidated Permian strata, such that the relatively minor drawdowns predicted towards the limit of the Permian strata reduce rapidly at the boundary of the alluvium.



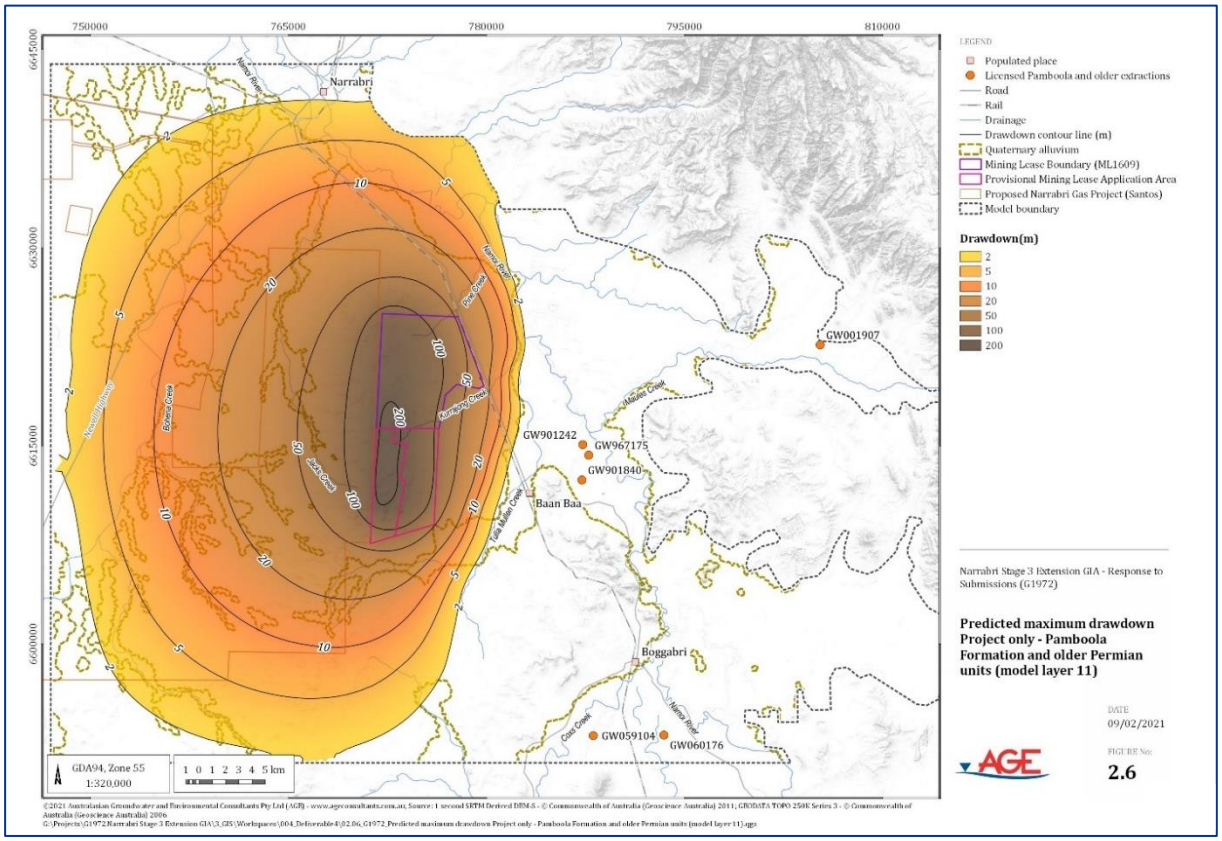
Source: AGE (2021).

Figure 3
Likelihood of 2 m Drawdown Due to the Project – Quaternary Alluvium/Regolith

Predicted maximum drawdown in model layer 11 (Pamboola and older formations) and the location of the six third-party bores (GW060176, GW059104, GW901840, GW967175, GW901242, GW001907) which have been attributed to this layer based on bore depths is shown in Figure 4. As shown in Figure 4, all six of these bores are situated well outside of the predicted 2 m drawdown contour for this unit. This is because the Pamboola Formation strikes to the east of the Narrabri Mine (i.e. these bores are up-dip of the Narrabri Mine). It should also be noted that:

- as shown in Figure 4, all six bores are located within areas where Quaternary Alluvium is present at outcrop;
- the depth of each bore, which varies from 61 to 132 m, only marginally exceeds the estimated depth of the Quaternary Alluvium; and
- the licensed volumes for five of the six bores are in the range 2,546 to 5,504 megalitres per year (ML/year) and are considered to be unusually high for bores in consolidated Permian age units.

It is, therefore, considered most likely that these bores draw most, if not all, of their supply from the Namoi alluvium aquifer and that the attribution of these bores to the Pamboola Formation over-estimates the significance of this unit as a water supply. As discussed previously, drawdown impacts of more than 2 m are not expected in any part of the Namoi alluvium and hence impacts of substantially less than 2 m are also expected in the Quaternary Alluvium and the underlying Permian age units at these six locations.



Source: AGE (2021).

Figure 4
Predicted Maximum Drawdown Project-only – Pamboola Formation and Older Permian Units (model layer 11)

Groundwater Modelling Parameters

Issue

The IESC and one organisation raised concern that the Groundwater Assessment does not consider all relevant parameters, which may result in an underestimation of potential impacts. Comparison of reported model to measurement 'mis fits' were cited as potential evidence of this. It was also noted that information on where in the geological sequence bores take water are key inputs to the impact assessment on these bores.

Response (prepared with assistance from AGE)

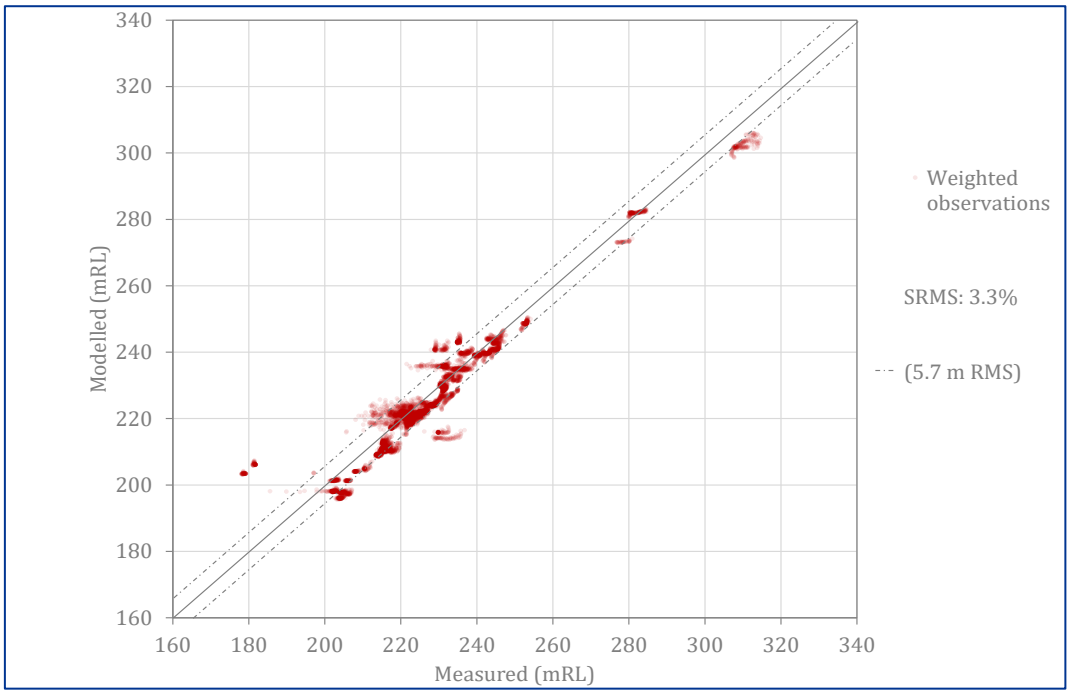
The sensitivity of model predictions to all relevant parameters including hydraulic conductivity, storage, boundary condition conductance and other parameters have been assessed and reported in Appendix D5 of the Groundwater Assessment (AGE, 2020). It is, therefore, unclear which 'relevant parameters' the comment is referring to.

The final sentence of the IESC submission (which relates to model-to-measurement misfits) also fails to recognise that any numerical model of this type represents a simplification of a substantially more complex reality or that the purpose of the numerical model is to predict the impacts of the proposed development. Modelled-to-measurement misfits are inevitable in a model of this type, rather, predicted water levels at monitoring points should be assessed on the ability of the model to predict observed trends and impacts, rather than on whether or not the calculated ranges of uncertainty encompass all of the actual measured values.

Consistent with its stated aim, the model does not seek to exactly match system stresses and other hydrogeological features which affect groundwater levels but which have little or no bearing on the ability of the model to predict impacts. For instance, groundwater level data are available from over 100 monitoring bores completed into the Namoi Alluvium and have been used for calibration of the numerical model. As shown in Figure 5, the overall statistical fit to these data is very good, as evidenced by the scaled root mean square error of 3.3%, which suggests that the overall model parameterisation of the Namoi Alluvium is appropriate.

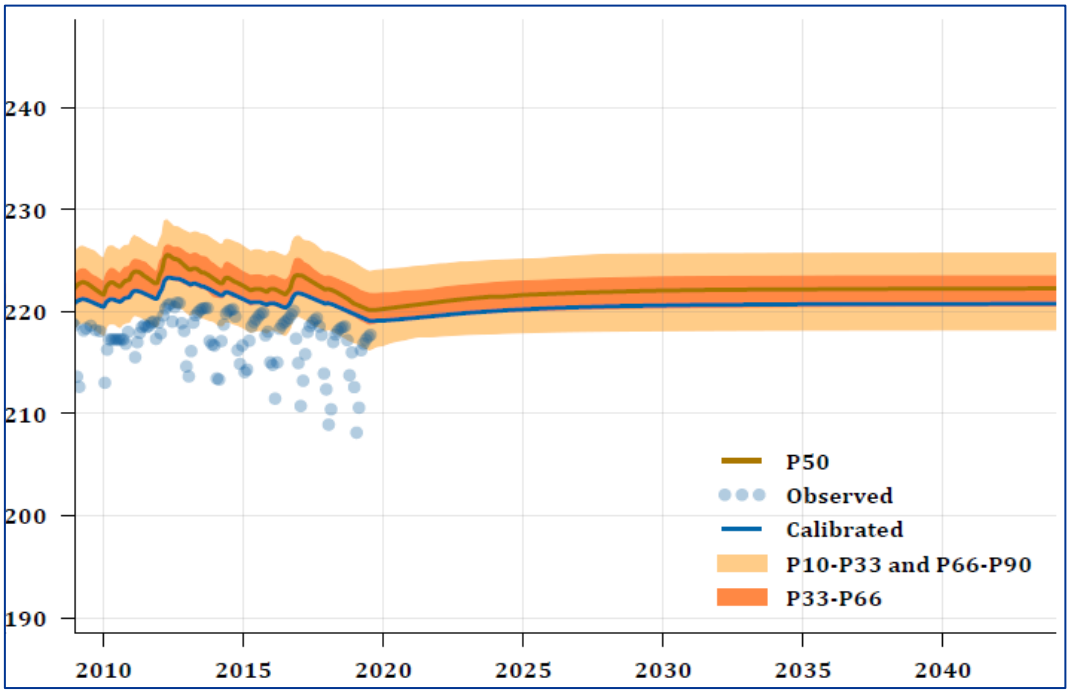
Nevertheless, as shown in Figure 6 the model cannot accurately replicate observed groundwater levels at all locations. In this case the model is able to accurately replicate the longer-term observed seasonal fluctuations and minor observed drawdown (i.e. the observed impact) over the monitored period. On the other hand, modelled groundwater levels at some alluvial bores are higher than observed and short-term fluctuations, which are likely to be related to nearby pumping from the Namoi Alluvium, are also not replicated in the model. In this case, the modelled fit to the observed data would most likely be improved by adding resolution and/or adjusting the elevation of surficial boundary conditions and collecting more detailed pumping records for nearby bores (i.e. to simulate the influence of pumping from these bores). However, such changes would have little or no benefit in terms of the model's ability to predict the indirect impact of the Narrabri Mine on the Namoi Alluvium. In fact, by adding complexity into the model, these changes would limit the capability of the model to assess Project impacts by increasing model run times and limiting the opportunities to optimise the calibration and assess predictive uncertainty.

A further example which relates to a nested monitoring facility in the Napperby Formation close to the existing mine workings is provided in Figure 7. In this example, the model is able to very closely match the water level trends and observed impact at this point, suggesting that the model is a close to perfect predictor of drawdown impact in this case, despite the fact that the absolute modelled levels are around 10 m lower than predicted.



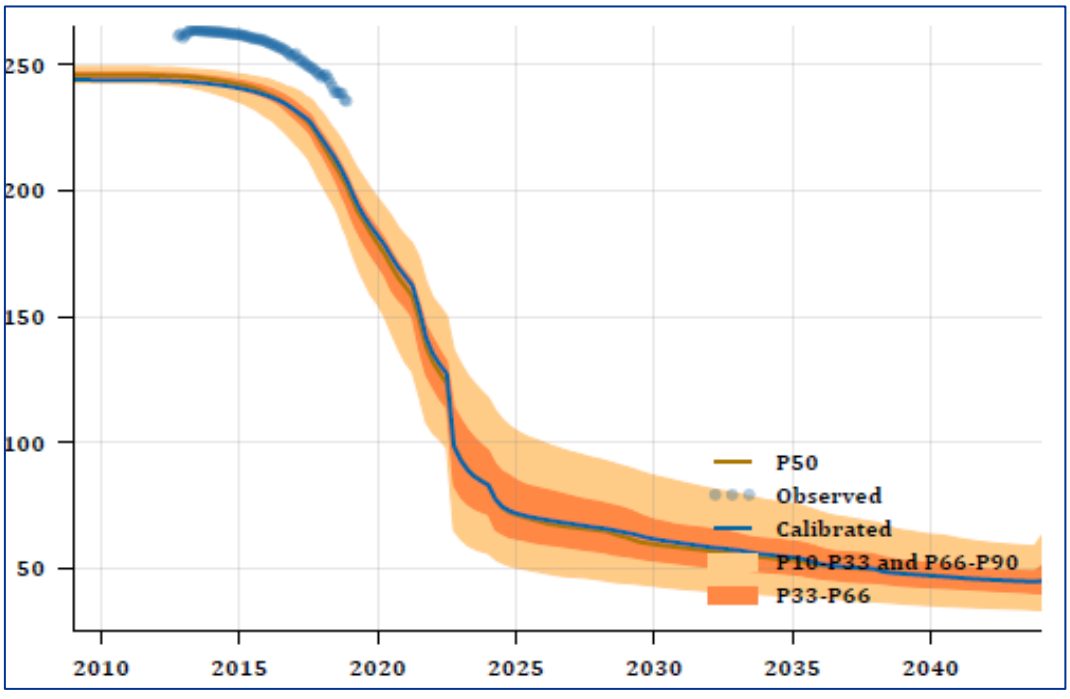
Source: AGE (2021).

Figure 5
Transient Calibration – Modelled versus Observed Groundwater Levels, Namoi Alluvium



Source: AGE (2021).

Figure 6
Modelled versus Observed Groundwater Levels, Namoi Alluvium, Monitoring Bore 030233.1.3



Source: AGE (2021).

Figure 7
Modelled versus Observed Groundwater Levels, Napperby Formation, Monitoring Bore P40_307

Table 5 presents a comparison of maximum total observed and modelled drawdown at all monitoring points with:

- more than one year of data (i.e. sufficient observed groundwater level data to establish longer-term trends); and
- located close to the Project (i.e. in areas where impacts are likely at this relatively early stage of mine development).

It should be stressed that the values shown in Table 5 represent total observed and modelled drawdown relative to the first recorded value and may, therefore, include drawdown related to climate and other influences, as well as drawdown related to operation of the Narrabri Mine. As shown in Table 5, observed drawdown impacts at 45 out of 69 monitoring locations are over-predicted by the model and hence the model appears to be slightly biased towards over-prediction of impacts at most locations, rather than under-estimating impacts (as asserted by the IESC). This makes the model a conservative tool suitable for impact assessment and decision-making.

Presented Groundwater Contours

Issue

The IESC raised concern that the groundwater contours for each modelled layer should be presented at more refined values to show drawdown less than 2 m, and that drawdown of 0.5 m may substantially alter spring discharge rates.

Response (prepared with assistance from AGE)

Regional drawdown maps for aquifers intended for use in assessing impacts at water supply bores (e.g. Figures 7.3 to 7.8 in the Project Groundwater Assessment) show 2 m, 5 m, 10 m, 20 m, 50 m, 100 m and 200 m drawdown contours. However, all maps which present water table drawdown at potential GDE sites (e.g. Figures 7.25 and 7.26 in the Groundwater Assessment) also show predicted 0.2 m, 0.5 m and 1 m drawdown contours. Furthermore, recognising that some GDEs can be significantly affected by relatively small drawdowns, drawdowns shown in Section 7.6.2 of the Groundwater Assessment (AGE, 2020) are provided to the nearest centimetre (cm).

In addition, Dr Peter Hancock assessed the information presented in the EIS relating to potential impacts to stygofauna (Attachment 4). Three springs were identified in the vicinity of the Project (Eather, Hardys and Mayfield Springs). Drawdown at Eather and Hardys Springs is predicted to be 0.01 and 0.05 m, respectively. This level of drawdown is likely to have a negligible impact on the ecology of these two springs. Likewise, the modelled drawdown of 0.02 m at Mayfield Spring would have negligible impact on the ecology of this spring (Attachment 4).

Table 5
Comparison of Observed and Predicted Maximum Drawdowns by Hydrostratigraphic Unit

Formation	Monitoring Point Count	Observed Maximum Drawdown Range	Predicted Maximum Drawdown Range	No. of Bores where Predicted Maximum Drawdown Exceeds Observed
Pilliga Sandstone	7	0.01 – 2.27	0 – 0.72	4 (57%)
Purlawaugh Formation	6	0 – 7.84	0.01 – 0.4	1 (17%)
Garrawilla Volcanics	9	0.06 – 26.88	0.01 – 21.1	5 (56%)
Napperby Formation	15	0 – 35.58	0.08 – 74.68	14 (93%)
Digby Formation	7	0 – 63.91	0.08 – 108.95	4 (57%)
Hoskissons Coal Seam	15	3.05 – 196.33	0.06 – 168.86	11 (73%)
Arkarula Formation	5	0 – 193.27	0.06 – 94.62	2 (40%)
Pamboola Formation	5	0 – 19.44	0.3 – 48.34	4 (80%)
Total	**69**	**0 – 196.33**	**0 – 168.86**	**45 (65%)**

Source: AGE (2021).

In the unlikely event that stygofauna were living beneath the springs, a fall of 1 to 5 cm in the underlying aquifer would have no significant impact on the community (Attachment 4).

Depth of Cracking Prediction Inconsistency

Issue

The IESC requested clarification regarding a potential inconsistency between the depth of cracking predictions made in the Subsidence Assessment and the conservative assumptions on changes in hydraulic parameters made in the Groundwater Assessment. One organisation also raised concern that cracking of the Pilliga Sandstone is possible.

Response (prepared with assistance from AGE)

The A-zone height values adopted in the Groundwater Assessment are consistent with those reported in the Subsidence Assessment (Ditton Geotechnical Services, 2020). However, in relation to the depth of the surface cracking zone beneath the ground surface (the D Zone), the Groundwater Assessment adopts a more conservative D-Zone calculation of ten times the panel height, based on previous work by Guo *et al*. (2007). Accordingly, the Groundwater Assessment effectively assumes potential seam-to-surface cracking over larger parts of the mining area than are reported in the Subsidence Assessment.

As discussed in Sections 5.2.11 and D 2.5.6.1 (in Appendix D) of the Groundwater Assessment (AGE, 2020) site-specific data, in the form of groundwater data for the nested monitoring facility (P57) installed above Longwall 108A, has already been used to estimate potential heights of fracturing and calibrate the groundwater model. Modelled hydraulic parameters in the A and D-Zones are, therefore, already constrained by site-specific data. Furthermore, as summarised in Section D 5 in Appendix D of the Groundwater Assessment, a range of possible alternative parameters for functions affecting both hydraulic conductivity and storage above longwall panels have been assessed as part of the predictive uncertainty analysis. Further data collection above future longwall panels is also proposed. Additional data from these further sites would be considered as part of future re-calibration of subsidence predictions.

Modelling Commitments

Issue

The IESC included a recommendation that the groundwater model should be updated bi-annually and that additional regional monitoring of groundwater in a number of different geological units should be undertaken.

Response (prepared with assistance from AGE)

It is assumed that 'bi-annually' in this case means every two years (biennial) rather than every six months. Six-monthly updates would require a near-continuous rolling program of data collection, processing, model re-calibration and predictions. Consistent with Project Approval 08_0144, the current site Water Management Plan for the Narrabri Mine (NCOPL, 2017) includes a commitment to re-calibrate the Project groundwater model two years after commencement of longwall extraction and every five years thereafter. A similar commitment in the updated Water Management Plan for the Project is proposed, whereby the groundwater model would be updated two years after approval of the Project and every five years thereafter. This commitment is consistent with other contemporary projects in NSW (e.g. Vickery Extension Project). The Water Management Plan would also identify a number of other circumstances, which may trigger further development and/or re-calibration of the model as follows:

- a significant change to the mine plan;
- acquisition of new hydrogeological information, such as groundwater levels and aquifer properties (i.e. hydraulic conductivity), which are different to calibrated values used in the model; and
- groundwater drawdown and inflows which significantly exceed model predictions for that stage of mining.

Additional monitoring recommendations are provided in Section 8.2 of the Project Groundwater Assessment (AGE, 2020) and include the installation of additional groundwater level and quality monitoring facilities at six locations upstream and downstream of the site on Kurrajong, Pine and Tulla Mullen Creeks (Figure 8). In addition to installing standpipe piezometers in the Quaternary alluvium and immediately underlying bedrock strata (as recommended by AGE [2020]), NCOPL proposes to install a further six VWP monitoring nests at each of these locations. Each VWP nest would include monitoring in each stratigraphic present above the Hoskissons Coal Seam. As shown in Figure 8, since a number of the proposed sites are above proposed longwall panels this would also provide additional data on actual height of fracturing. This data would then be used to re-calibrate the model (as part of future model updates).

Issue

The IESC showed support towards the recommendations made for additional groundwater monitoring by AGE (2020). The IESC and DPIE – Water further recommended that the resulting data be incorporated into the groundwater model.

DPIE – Water requested additional monitoring to the south and east (VWPs to provide an 'early warning' of potential impacts) and in the alluvium and Tulla Mullen Creek and its tributaries to the immediate east, south-east and south of the Project and in the vicinity of Spring Creek to the immediate west was recommended.

DPIE – Water also requested that additional sites upstream and downstream of proposed infrastructure be installed. It was further recommended to include a number of geological units for water quality analysis (Hoskissons Coal Seam, Arkarula Formation, Digby Formation, Purlawaugh Formation and Pamboola Formation).

Response (prepared with assistance from AGE)

NCOPL supports the recommendations for the expanded groundwater monitoring program described in Section 8.2 of the Groundwater Assessment (AGE, 2020) and Attachment 4 of the EIS. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan.

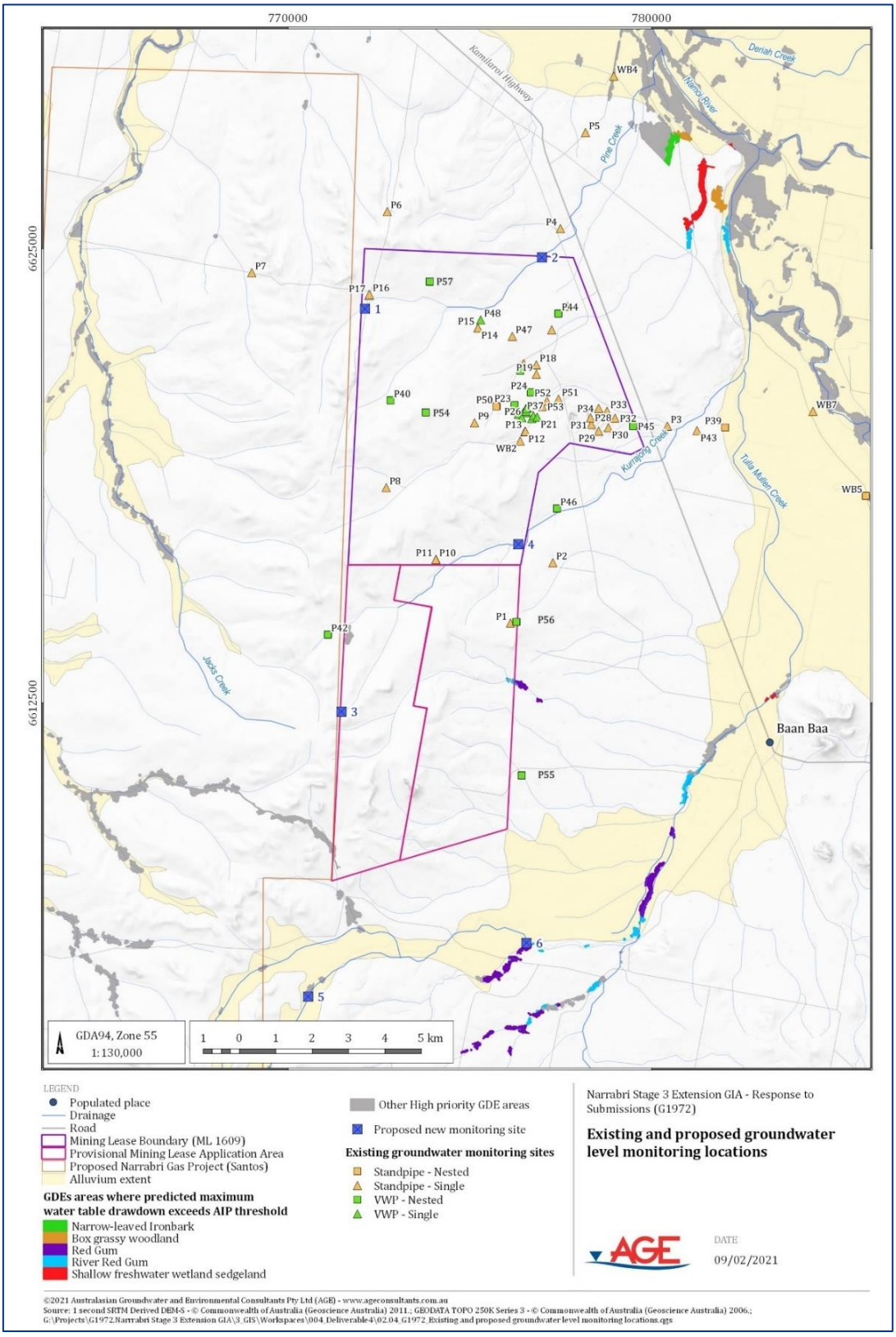
As discussed in the response above, additional monitoring is proposed at six locations shown in Figure 8. Each site would comprise standpipe monitoring bores installed into the Quaternary alluvium and immediately underlying bedrock and VWP nests monitoring groundwater levels in underlying units. These additional facilities would be installed as soon as possible after approval is received such that they could provide significant additional groundwater level data into future updates of the groundwater model.

Groundwater monitoring at the six additional sites shown in Figure 8. Each site would comprise:

- two shallow standpipe monitoring bores monitoring groundwater levels and water quality in the Quaternary Alluvium and the immediately underlying bedrock; and
- a nested VWP facility including monitoring of all groundwater levels in consolidated units from the Hoskissons Coal Seam to the ground surface.

Additional monitoring of water quality reporting to the underground mine workings and of groundwater levels and groundwater quality at three potential spring sites is also proposed in the Groundwater Assessment (AGE, 2020).

Existing and proposed shallow groundwater monitoring facilities in and around surface infrastructure would be identified in an update to the Water Management Plan for the Project.



Source: AGE (2021).

Figure 8

Existing and Proposed Groundwater Monitoring Locations

Existing Groundwater Quality Monitoring Program and Data

Issue

The IESC and DPIE – Water requested additional information on the existing groundwater quality monitoring program, along with water quality data for a wider range of parameters (i.e. additional to salinity, which is included in the EIS). In addition, a request was made to assess water quality impacts under the NSW *Aquifer Interference Policy* (AIP) (Department of Primary Industries [DPI] – Office of Water, 2012) using other indices (other than salinity) and for all parameters to be presented as time-series. Lastly, it was requested that the water quality analysis consider other water quality objectives, benchmarks and trigger levels.

Response (prepared with assistance from AGE)

NCOPL supports the recommendations for the expanded groundwater monitoring program described in Section 8.2 of the Groundwater Assessment (AGE, 2020) and Attachment 4 of the EIS. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan.

Further details of the Narrabri Mine groundwater quality monitoring program (i.e. in addition to salinity) are presented in the current site Water Management Plan (NCOPL, 2017). Groundwater level and quality data collected from the network of monitoring bores is summarised in a series of annual environmental reports, including in the 2019 Annual Review (NCOPL, 2020b). These reports also provide a summary of environmental performance over the preceding year in relation to groundwater inflows, groundwater levels and groundwater quality. A revised version of the current Water Management Plan to address regulator comments is currently being assessed by DPIE – Water. This document would be updated to incorporate the Project.

As documented in Appendix E of the 2019 Annual Review (NCOPL, 2020b), groundwater samples taken from the Narrabri Mine are regularly tested to confirm arsenic and cobalt concentrations and are typically at or close to detection limits. Testing for antimony, molybdenum and selenium has not routinely been undertaken historically but would be added to the Project WMP following approval.

In accordance with the AIP (DPI – Office of Water, 2012), which does not include minimal impact considerations for other indices, the Groundwater Assessment (AGE, 2020) focuses on impacts on groundwater salinity or total dissolved solids (TDS).

Monitoring of inflows to the current mine workings and water held within the current storage facilities is limited to pH, electrical conductivity (EC), TDS, grease, and total organic carbon (TOC). Accordingly, no information is available on likely concentrations of metals or other indices. However, impacts on beneficial use or other receptors or users are also likely to be negligible for all constituents since:

- the load of metals and other constituents in the water to be re-injected originated in the Hoskissons Coal Seam in the first place;
- numerical model predictions indicate flow towards the goaf areas for around 200 years after mining ceases; and
- longer term once groundwater levels fully recover then numerical model predictions indicate downward flow within the mining area from the Hoskissons Coal Seam to the underlying Arkarula Formation, which is already saline (12,884 milligrams per litre [mg/l] TDS on average).

Accordingly, there are no known mechanisms by which brine re-injected to the goaf could migrate to potential receptors which include existing water supply bores and surficial GDEs.

Expanded Groundwater Monitoring Program

Issue

The IESC and DPIE - Water showed support towards a number of recommendations for additional monitoring, including groundwater and subsidence monitoring as well as geological mapping and hydraulic parameterisation in proximity to the Namoi River.

Response

NCOPL supports the recommendations for the expanded groundwater monitoring program described in Section 8.2 of the Groundwater Assessment (AGE, 2020) and Attachment 4 of the EIS. This would include monitoring sites to the south and west of the Project area. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan.

Further, NCOPL supports the recommendations in the Subsidence Assessment (Ditton Geotechnical Services, 2020) for further subsidence monitoring to be undertaken. It is envisaged that subsidence-related monitoring and management would be developed as part of a revised Extraction Plan.

Further details regarding additional monitoring recommended are provided below (prepared with the input of Ditton Geotechnical Services and AGE).

Subsidence

Detailed mapping of surface cracking impacts would allow on-going review of predicted versus measured surface cracking impacts in Annual Reviews and to demonstrate that adaptive management procedures are in place at Narrabri Mine. The effectiveness of crack remediation should also be reviewed to establish that the materials used to repair the cracks aren't dispersive and won't allow piping to the surface to occur into rock-head cracks. It is noted that Subsidence Monitoring and Impact Management Plans are now in place at the Narrabri Mine and cracks are being backfilled with available spoil. It is considered that the spoil used should be fine- to coarse-grained, well graded sandy soils with non-dispersive clay fines (Emerson Class 4 or higher) to facilitate 'filtering' of stormwater seepages and not erode or disperse into deeper cracks in shallow rock (if present). Available spoil that is deemed dispersive should be treated with gypsum or an alternative non-dispersive material used.

On-going review of the height of continuous fracturing above selected panels (Longwalls 110 to 111 and some of Longwalls 201 to 210) would provide additional prediction points to allow for (i) wider longwalls, (ii) multiple panel effects, and (iii) geological interaction and allow groundwater models to be re-calibrated if necessary. Nests of deep borehole piezometers (greater than 30 m depth) and shallow standpipe piezometers (less than 30 m depth) and deep wireline extensometers to aid with interpretation of nearby piezometer data should be installed above selected longwall centrelines at distances greater than 300 m (0.7 x cover depth or panel width) from the panel ends.

Groundwater

The position of the lithological boundary between alluvium and porous rock is known with a high degree of accuracy and further ground truthing is not considered as necessary to provide a model that can be used for decision-making purposes. The position of the modelled boundary is supported by geological mapping of the area, produced by the Geological Survey of NSW, which is likely to have been ground-truthed to some extent. Further ground truthing of the extent of these strata is provided via 1,600 mine exploration bores and over 1,000 licensed water supply bores in the model domain.

Existing and proposed monitoring locations are shown in Figure 8. Installation of six additional nested VWP installations are proposed to the west, south and east of the Project. The additional VWPs would be installed as soon as practicable, following determination of the Project as part of the updated Water Management Plan.

Further details of the Narrabri Mine groundwater quality monitoring program are presented in the current site Water Management Plan (NCOPL, 2017). Groundwater level and quality data collected from the network of monitoring bores is summarised in a series of annual environmental reports, including the 2019 Annual Review (NCOPL, 2020b). These reports also provide a summary of environmental performance over the preceding year in relation to groundwater inflows, groundwater levels and groundwater quality. A revised version of the draft Water Management Plan to address regulator comments is currently being assessed by DPIE – Water. This document, which identifies a range of site-specific triggers and related management actions, would be further revised following approval of the Project.

Water Access Licences in the NSW Gunnedah Oxley Basin Water Source and Lower Namoi Alluvium

Issue

The IESC and DPIE – Water raised concern that NCOPL holds insufficient licenses in the NSW Gunnedah Oxley Basin Murray-Darling Basin (MDB) Water Source to cater for the predicted peak flows, as well as for the Lower Namoi Groundwater Source. In addition, DPIE – Water raised concern regarding any proposal to transfer water entitlements between Whitehaven operations.

Response

NCOPL currently holds sufficient licences to cover the predicted maximum licensing requirements for the Project with the exception of the following water sources:

- Gunnedah Oxley Basin Murray-Darling Basin (MDB) Groundwater Source regulated by the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*; and
- Lower Namoi Groundwater Source regulated by the Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020.

To address the identified shortfall in Gunnedah-Oxley Basin MDB groundwater source, allocation would be transferred from other Whitehaven operations to meet the Project requirements. The current excess entitlements which are available from other Whitehaven operations are shown in Table 2.

For the predicted licensing requirements in the Lower Namoi Groundwater Source, NCOPL would seek and obtain the appropriate entitlements on the open market in accordance with the appropriate trading rules of the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020*. Based on recent water trading statistics, there is sufficient market depth in the Lower Namoi Groundwater Source to accommodate the very small allocation required for the Project (i.e. up to 1 ML per annum).

Potential Groundwater Impacts for Agricultural Purposes, Bore Census and the 'Less Productive' Hydrogeological Units

Issue

Two organisations raised concern regarding the potential groundwater impacts, including impacts on bores used for agricultural purposes and that these bores may be impacted quicker than expected. Further, concern was expressed regarding a number of bores that were not inspected as part of the bore census, and that these bores may also be impacted. In addition, concern was expressed regarding the designation of 'less productive' hydrogeological units in the Groundwater Assessment. Lastly, concern was raised that NCOPL-owned bores were not assessed.

Response (prepared with assistance from AGE)

NCOPL considers the Groundwater Assessment (AGE, 2020) provides a comprehensive assessment of the baseline conditions and potential impacts of the Project. This is confirmed through the peer review conducted by Mr Brian Burnett (Attachment 6 of the EIS). As described in Section 6.4.2 of the EIS, the Groundwater Assessment (AGE, 2020) used the following baseline geological and groundwater information:

- regional geology mapping (Gunnedah Coalfield [north] Regional Geology 1:100 000, 1st Edition [Pratt W., 1998]) and state-wide seamless geology [Colquhoun *et al*., 2020]);
- NCOPL exploration geological data, logs and site geological model;
- publicly available geological and hydrogeological reports for the region, including the Narrabri Gas Project Groundwater Impact Assessment (CDM Smith, 2016);
- NSW Office of Water (now DPIE – Water) PINNEENA Groundwater Works Database and the National Groundwater Information System (NGIS);
- groundwater level and pressure data from groundwater monitoring programs and investigations undertaken for the Narrabri Mine and surrounding projects/operations (Figure 6-4 of the EIS);
- groundwater quality and chemistry data from the above monitoring programs, investigations and studies;
- previous groundwater assessments for the Narrabri Mine;
- results of a bore census of privately-owned bores, wells and other groundwater features of interest in the vicinity of the Project;
- regional GDE mapping (Commonwealth Bureau of Meteorology [BoM], 2020) as well as high priority GDE mapping provided in Water Sharing Plans; and
- other additional geological and regional topographic mapping data.

Further, the bore census undertaken as part of the baseline data collection for the groundwater assessment included:

- a desktop review of registered groundwater bore records and potential groundwater features of interest;
- landholder property maps to support site inspections (summary of available contact details, boundaries, access routes, and potential groundwater bore sites);
- site inspections to meet with landholders and inspect relevant features; and
- development of a bore census database.

The bore census site inspections were initially completed over two rounds (between 15 August to 11 October 2019, and between 18 May and 20 May 2020). Importantly, the second bore census site inspections were undertaken following preliminary groundwater monitoring results, whereby potential impacts on groundwater bores were predicted in some areas that did not form part of the first bore census site inspections.

Site inspections during rounds 1 and 2 were conducted across 33 private properties, and NCOPL-owned land, which identified:

- 73 present groundwater bores;
- three potential groundwater features;
- nine features of interest which had no identifiable interaction with groundwater at the time of inspection; and
- three sampling sites on Tulla Mullen Creek and a tributary of Kurrajong Creek tributary.

Bore census database records were provided to landholders.

Section 5.2.1 of the Groundwater Assessment (AGE, 2020) provides the following description of the groundwater monitoring network used to develop the groundwater model:

> *Groundwater level data for monitoring bores in and around the Project Area are available from three monitoring networks associated with the Narrabri Mine, the Narrabri Gas Project and the State groundwater monitoring network. Groundwater monitoring bore locations are shown in Figure 5.2 of the Groundwater Assessment (AGE, 2020) and a summary of the number of monitoring bores for which data was collated is presented in Table 5.1 of the Groundwater Assessment (AGE, 2020).*
>
> *Data have been collated for 262 monitoring points, around 40% of which are thought to be monitoring groundwater levels in the Quaternary alluvium associated with the Namoi River and its major tributaries. Since information on the formation monitored for the State monitoring bores are not included in the NGIS (BoM, 2019), this has been estimated by intersecting the bore screen with surfaces developed for groundwater modelling purposes. Accordingly, data for 43 state monitoring bores for which no screen information or subsurface information is available have not been used for conceptualisation and/or model development since the formation monitored cannot be estimated. For the most part the monitoring networks generally comprise standpipe monitoring bores for shallow installations and vibrating wire piezometers (VWPs) for monitoring of deeper formations.*
>
> *Data were collated and analysed for a substantially larger network of monitoring points than that assessed as part of the Gateway Application Preliminary Groundwater Assessment (HydroSimulations, 2019). Of the 262 monitoring bores used for development of the current conceptual and numerical model 82, of the Narrabri Mine monitoring points were used in the Gateway Application Preliminary Groundwater Assessment.*
>
> *The dataset for the Project has therefore been significantly expanded through the use of data for NSW State Monitoring bores and the Narrabri Gas Project (Figure 5.2). Data are also available for a further 33 Narrabri Mine monitoring points in and around ML 1609 and MLAs 1 and 2. This includes a key nest of VWPs and extensometer installed immediately above Longwall 108A prior to mining this panel.*

Notwithstanding, in response to concerns raised in submissions on the EIS, NCOPL commissioned AGE to undertake a further round of the bore census (round 3) with a focus on collecting data on bores in an area to the south of the Project and also to undertake bore appraisals on bores noted in the EIS as potentially experiencing impacts greater than the 2 m drawdown threshold in the AIP. The data gathered and outcomes of round 3 of the bore census are presented in a report which is presented as Attachment 6.

Consistent with the two previous rounds of the bore census, the objectives of round 3 of the bore census was (Attachment 6):

- identify water supply bores and other potential groundwater features in the study area;
- where possible, conduct site inspections and meet with landholders to verify borehole conditions and how groundwater is used; and
- compile the bore census results to support the groundwater assessment process.

A total of 35 present groundwater bores and two groundwater features were inspected during the third round bore census (Attachment 6) (i.e. post-EIS) including the identification of several bores which were either newly constructed (i.e. since round 1 of the bore census) or are understood to be unregistered (Attachment 6).

As with previous stages, where relevant, landowners with bores who were involved in round 3 of the bore census received detailed individual property reports, including information on their bores, including:

- groundwater sources accessed by the bores;
- potential impacts; and
- proposed monitoring.

Subsequent to round 3 of the bore census, AGE also completed an impact assessment addendum to provide an update on the impacts on groundwater bores for the Project (Attachment 7).

The Groundwater Assessment (AGE, 2020) and impact assessment addendum (Attachment 7) report that drawdown of more than 2 m (i.e. the AIP threshold [DPI – Office of Water, 2012]) is not predicted in any existing privately owned water supply bores that extract water from either the highly productive Pilliga Sandstone or Namoi Alluvium aquifers. However, predictions suggest that drawdowns would continue to develop in the less productive Digby Formation, Napperby Formation, Garrawilla Volcanics and Purlawaugh Formation. Including consideration of the groundwater impact assessment addendum (Attachment 7), drawdown of more than the AIP threshold of 2 m for these aquifers is predicted at nine existing privately owned water supply bores. Predicted drawdowns at three of these bores represents less than 50% of the available 'headroom' (i.e. the distance between the observed standing water level in the bore and the uppermost water bearing horizon) and hence the yield and functionality of these bores may not be significantly impaired (Attachment 7).

Ultimately, the Groundwater Assessment (including the impact assessment addendum – Attachment 7) concluded that nine private bores currently in use are likely to experience drawdowns of more than 2 m. As documented in Appendix F of the Groundwater Assessment (AGE, 2020), this total excludes nine groundwater bores owned by NCOPL on the basis that they are seldom, if ever, used for agricultural water supply purposes (i.e. NCOPL accepts the potential impacts to these bores and would not 'make good' these impacts).

Many of these impacts are not expected to occur for some years. Notwithstanding, NCOPL would undertake further investigations of the potentially affected bores to confirm and determine the likely extent of affectation. Where further investigations confirm the findings in the Groundwater Assessment, 'make good' arrangements would be implemented during the Project operational phase through consultation and agreement with the relevant landholders.

In the event that other bores not identified or predicted to be affected in the Groundwater Assessment are impacted by more than 2 m, then these bores would also be eligible for 'make good' provisions. NCOPL would continue their engagement with the community to continuously monitor and manage groundwater impacts from the Project.

In relation to "highly productive" and "less productive" groundwater, the Groundwater Assessment (AGE, 2020) adopted the terminology from the AIP (DPI – Office of Water, 2012).

The AIP describes minimal impact considerations for aquifer interference activities based upon whether the water source is highly productive or less productive and whether the water source is alluvial or porous/fractured rock in nature.

A "highly productive" groundwater source is defined by the AIP as a groundwater source which has been declared in regulations and datasets, based on the following criteria:

a) has a TDS concentration less than 1,500 mg/L; and

b) contains water supply works that can yield water at a rate greater than 5 L per second.

Highly productive groundwater sources are further grouped by geology into alluvial, coastal sands, porous rock and fractured rock. "Less productive" groundwater sources are all other aquifers that do not satisfy the "highly productive" criteria for yield and water quality.

DPIE – Water has mapped areas of groundwater productivity across NSW, showing areas classified as either highly or less productive.

Water Level Measurements of Bores

Issue

An organisation raised concern that a static standing water level measurement at a bore is not a satisfactory means of assessing /benchmarking the yield of a bore or well.

Response

A bore census (i.e. rounds 1 and 2) was conducted by ENRS in 2019 and 2020 to confirm the location and use of groundwater bores in the vicinity of the Project and surrounds. The results of the bore census confirmed that groundwater use near the Project is predominantly stock and domestic. The Bore Census Report is provided in Appendix G of the Groundwater Impact Assessment (AGE, 2020). A further round of the bore census was conducted by AGE in 2021 and is presented as Attachment 6.

The scope of work for the bore census comprised the following tasks:

- conduct a desktop review of registered groundwater bore records and potential groundwater features of interest;
- prepare landholder property maps to support site inspections (summary of available contact details, boundaries, access routes, and potential groundwater bore sites); and
- conduct site inspections to meet with landholders and inspect relevant features (including obtaining water level and quality data where available).

WaterNSW work summary reports is typically available for each registered bore and can include information on bore construction, water bearing zones and lithological information from drillers' logs, and water level data collected as part of the bore census. These data were used to assist to determine the aquifer(s) or model layer(s) that are intersected by each bore. The water level data were not used to determine bore yield.

Further detailed bore appraisals have also commenced at landholder bores identified as exceeding the 2 m AIP minimal harm drawdown criteria in the Groundwater Impact Assessment (AGE, 2020) and impact assessment addendum (Attachment 7). The aims of the detailed bore appraisal are to confirm:

- the strata targeted by each bore;
- the significance of the predicted drawdown in each location; and
- identify suitable make good solutions.

Data gathering during this phase included:

- undertaking manual water level measurements; and
- taking water samples.

The results to date have been provided to the relevant landholder.

Where the results of the initial bore appraisal tend to confirm that the potential for impairment of bore yields exist, then further field work would be undertaken. NCOPL would commission yield tests in each bore to provide information on baseline maximum bore yields and aquifer and well potential losses for future reference purposes. These tests could then be repeated as part of the groundwater monitoring program following commencement of operations. The availability of these tests would depend on the head works installed at the bore.

Make good measures would be put in place during the operational stage of the Project, prior to exceeding the AIP minimal impact threshold (Section 4.1.1).

Long-term Loss of Baseflow in Namoi River

Issue

One organisation raised concern regarding the predicted long-term loss of baseflow from the Namoi River.

Response

The potential impacts on baseflow of the Namoi River are described in Section 8.3 of the Surface Water Assessment (WRM, 2020), and concludes that the Project would not measurably affect baseflow in the Namoi River during operations or post-mining. Section 8.3 of the Surface Water Assessment is provided below:

> *The potential impact of the Project on baseflow in the Namoi River and its tributaries has been assessed by AGE (Appendix C). The assessment concluded that there would be negligible changes to baseflow during the Project life. Baseflow impacts to the Namoi River and its tributaries of up to approximately 200 ML/yr are predicted to be lost post-mining (Appendix C, AGE, 2020). The Namoi River would not be subject to direct subsidence effects (Appendix A, Ditton Geotechnical Services 2020). Flows in the Namoi River are regulated by releases from the upstream Chaffey, Split Rock and Keepit dams. Mean flow rates in the Namoi River at Gunnedah (upstream of the Project) are maintained at about 1,900 ML/day. In the context of the Namoi River regulated system, a baseflow loss of 200 ML/yr (or approximately 0.03% of the mean Namoi River flow) is minor. Hence, the Project would not measurably affect baseflow in the Namoi River post mining. During operations, the water balance modelling showed that there could be releases of filtered water of up to 6 ML/day (Section 7.5.3), which is insignificant in comparison to the regulated flows of 1,900 ML/day. Hence, the Project would not measurably affect low flows in the Namoi River during mining. The reduction in Namoi River flows due to catchment incision is insignificant, given the catchment area of the Namoi River is 24,500 km.*

Extent of Interactions with Kurrajong and Tulla Mullen Creek and Extent of Saturation of Tulla Mullen Creek Alluvium

Issue

One organisation queried the extent of groundwater interactions with Kurrajong Creek and Tulla Mullen Creek, along with queries of the extent of saturation of Tulla Mullen Creek alluvium.

Response (prepared with assistance from AGE)

Impacts on groundwater discharge to all major creeks have been assessed as described in Section 7.5 of the Groundwater Assessment (AGE, 2020). The uncertainty associated with these predictions has also been quantified using the most robust of the three methodologies identified as being appropriate in the IESC guidance note (Middlemis and Peeters, 2018). Further groundwater monitoring is proposed along the Kurrajong, Pine and Tulla Mullen Creeks. Data for these sites would be used to update the numerical groundwater flow model and predicted impacts prior to commencement of the Project in approximately 2023.

Numerical model results and field observations suggest that the Quaternary Alluvium associated with Tulla Mullen Creek is partially saturated and that groundwater discharge to the alluvium is occurring from the underlying bedrock. Hence, potential impacts on the volume of groundwater discharging the alluvium are predicted. As described above, further groundwater monitoring is proposed along Kurrajong, Pine and Tulla Mullen Creeks to confirm groundwater levels in strata underlying these creeks.

Potential Impacts of Methane Migration

Issue

One organisation queried the potential risks of methane migration to groundwater.

Response (prepared with assistance from AGE)

Naturally occurring methane and other gases are present within the Hoskissons Coal Seam in the area. Some of this gas is also likely to discharge naturally to the surface towards the east of the mine lease area, in areas, where coal is present relatively close to the surface and the gases are not captured by the existing Narrabri Mine operations. Evidence from the eastern part of the Surat Basin suggests that coal seams within around 150 m of the ground surface are largely devoid of gas (Office of Groundwater Impact Assessment, 2019) due to natural 'drainage' into overlying units. Gas could also be encountered in any groundwater bores which are deep enough to tap into the coal seams in the area.

In response to the presence of gas in the coal seams the existing Narrabri Mine operations incorporate a number of gas control measures which would be extended as the mine develops. As described in Section 2.5.6 of the EIS Project gas management infrastructure would include:

- pre-drainage infrastructure (underground in-seam and surface to in-seam wells) to reduce methane and other gas concentrations to safe levels prior to mining each longwall panel; and
- goaf gas drainage boreholes to prevent gas build up in goaf areas after completion of mining in each longwall panel.

Post-closure risks are also considered to be minimal since the Hoskissons Coal Seam in the area could be de-gassed and both de-gassed and removed in the Narrabri Mine area. Long-term, it is possible that natural gas may start to build up again in the Hoskissons Coal Seam, however, impacts would likely be limited to a possible minor change to the pathways via which this gas can discharge to the surface. As discussed above, prior to development of the Narrabri Mine, some gas is likely to have naturally discharged to the surface via fractures and minor faults in areas where the Hoskissons Coal Seam is closer to the surface (i.e. towards the east of the mine lease areas). Post-development, assuming that gas does eventually build up in the Hoskissons Coal Seam, then some of this gas may discharge to surface directly above the Narrabri Mine via goafing induced fracturing of the strata overlying the mine, as well as to the east of the Narrabri Mine.

With regard to potential risks of methane migration into surrounding groundwater bores, experience from the Surat Basin in Queensland (Wu *et al*., 2018; APLNG, 2010) suggests that landholder bores may be affected by gas migration where they are:

- within the zone of influence of CSG operations and screened into the same coal seams targeted by local CSG wells; and
- situated up-dip of CSG fields, downdip migration is unlikely due to buoyancy effects.

In this case, however, the Hoskissons Coal Seam dips towards the west and, as shown in Figure 9, is largely not present to the east of the Mining Lease Boundary (ML 1609) and MLAs 1 and 2. Accordingly, as shown in Figure 9, none of the water supply bores to the east of these lease areas are considered to be at risk of gas migration, since the Hoskissons Coal Seam is not present in this area. Similarly, gas migration is also considered unlikely to existing water supply bores within the mine lease areas, since none of these bores is deep enough to penetrate into the coal seam.

Timing of Potential Drawdown

Issue

DPIE – Water raised concern that the timing of potential drawdown has not been described in the EIS.

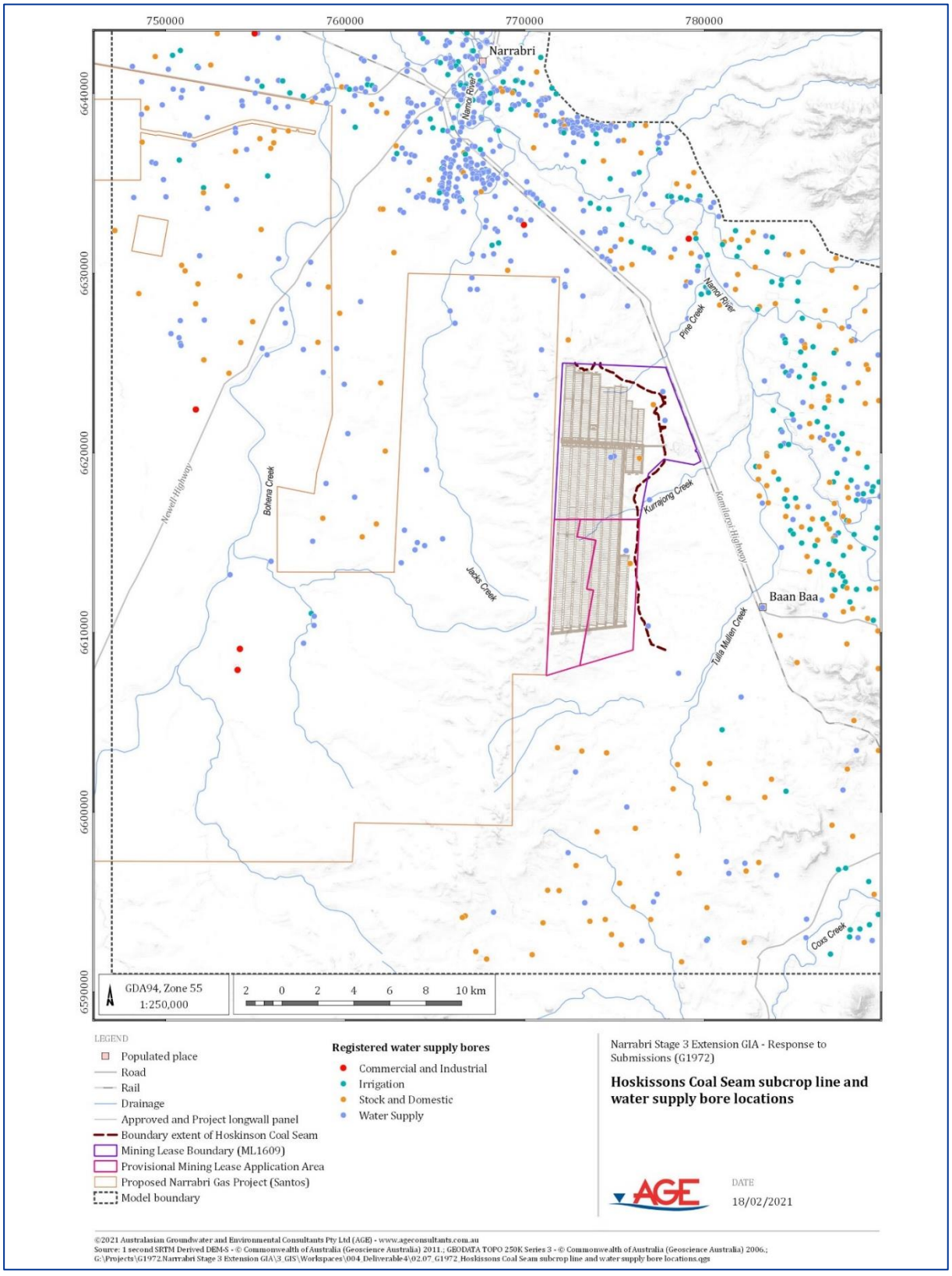
Response (prepared with assistance from AGE)

Additional maps showing the year in which predicted maximum drawdown occurs in each aquifer are provided in Attachment 2. Note that only those areas where the predicted maximum drawdown exceeds 2 m are shown.

Brine Re-injection Volume Inconsistency

Issue

DPIE – Water raised concern regarding the volume and quality of brine predicted to be reinjected for the Project and that the quantum of total dissolved salts assumed in the Groundwater Assessment may differ from the Surface Water Assessment.



Source: AGE (2021).

Figure 9
Hoskissons Coal Seam Subcrop Line and Water Supply Bore Locations

Response (prepared with assistance from AGE)

Brine re-injection impacts have been assessed assuming a total inflow volume of 2,830 ML and TDS concentration of 76,554 mg/L (Table 7.8 of the Groundwater Assessment). Final site water balance results presented in the Surface Water Assessment (WRM, 2020) present a range of predictions. Critically, however, as shown in Table 6 the predicted average long-term concentration in the goaf depends on the total load of dissolved solids (i.e. the product of the volume and the concentration). Hence adoption of any of the final values summarised in the Surface Water Assessment would result in lower predicted concentrations since the load in each of the four scenarios is lower than that used in the Project Groundwater Assessment. Accordingly, the predictions in the Groundwater Assessment are considered to be conservative. Loads and hence impacts under the 99th percentile scenario presented in the Surface Water Assessment would be lower than modelled in the Groundwater Assessment.

Table 6
Predicted Long-Term Average Brine Concentrations in the Goaf for Different TDS Re-injection Load Scenarios

Scenario Source	Volume (ML)	TDS (mg/L)	Load (t)	Predicted Average Goaf Concentration (mg/L)
Groundwater Assessment (AGE, 2020)	2,830	76,554	216,648	10,157
Surface Water Assessment (WRM, 2020) - 20th percentile	2,657	67,770	180,065	9,894
Surface Water Assessment (WRM, 2020) - 50th percentile	2,832	64,110	181,560	9,904
Surface Water Assessment (WRM, 2020) - 80th percentile	3,098	57,767	178,962	9,882
Surface Water Assessment (WRM, 2020) - 99th percentile	3,895	46,004	179,186	9,888

Source: After AGE (2021).

DPIE – Water/NRAR Comments on the Groundwater Model

Issue

DPIE – Water provided advice regarding the groundwater model used for assessment of groundwater impacts of the Project.

Response

On 19 April 2021, DPIE – Water/NRAR provided additional comments on the groundwater model adopted in the Groundwater Assessment (AGE, 2020). NCOPL and AGE discussed these comments with DPIE – Water on 11 May 2021. Responses to the specific matters raised in this submission have been prepared by AGE and is provided in Attachment 5.

All water level and quality data supplied by NCOPL was subject to the following sampling protocol (NCOPL, 2013):

- Depth to water table will be measured using a calibrated water level meter.
- Collection of groundwater samples will be undertaken following the purging of each bore.
- For groundwater sample, sampling devices will be dedicated and/or disposable for each sample or otherwise decontaminated between sampling locations. If rinsing is used, rinsate samples should be included in the QA/QC program as appropriate.
- Groundwater samples will be collected in laboratory supplied sampling containers that will be appropriately dosed with the preservative for the analysis required.

- The samples will be submitted for analysis to a NATA accredited laboratory within the relevant holding times with completed chain of custody documentation.
- All sampling events will have a QA/QC program and the QA/QC sample analysis will be checked to validate the integrity of the collected data.

Technical Aspects of the Groundwater Model and Model Uncertainties

Issue

DPIE – Water raised concern regarding some technical aspects of the groundwater model, including whether the hydrogeological parameters and other underpinning data (e.g. VWP data) have been scrutinised for error, consistency in the apportionment of geological layers and evidence to support the premise that geological faults are not conduits for water flow.

Response (response prepared with assistance from AGE)

NCOPL and AGE discussed these comments with DPIE – Water on 11 May 2021. Potential measurement errors in head observations used to calibrate the model are discussed in Section D 3.2 in Appendix D of the Groundwater Assessment (AGE, 2020). Given that 240 alternative parameter realisations have been generated with varying degrees of fit to the observed data then the range of model predictions generated are unlikely to be sensitive to measurement errors. Similarly, initial parameters and ranges used during calibration of the model were informed by previous numerical modelling, literature ranges and local measurements. Accordingly, it is considered unlikely that potential error in hydraulic conductivity measurements represents a significant source of error.

All groundwater level data used for conceptualisation and groundwater model purposes in the Groundwater Assessment (AGE, 2020) was subject to review comprising:

- graphical review of a groundwater level hydrograph for each monitoring point, to identify any isolated erroneous readings; and
- review of groundwater level contours for each hydrostratigraphic unit based on average groundwater levels at each observation point, to identify any anomalously high or low average groundwater level readings.

Data for VWPs were, therefore, effectively verified against manual dips from other nearby standpipe piezometers in the same unit. Any erroneous data identified during this review were flagged and excluded from use for conceptualisation and model calibration purposes. In total, some 1,437 daily groundwater level records representing around 1% of the total Narrabri mine data set were flagged as being potentially erroneous. As expected, the vast majority of the data flagged were related to VWP installations rather than manual dips from standpipe monitoring piezometers.

Further Quality Assurance checks carried out by NCOPL environmental staff during field data collection in the future would be described in the Project Water Management Plan.

In the absence of a specific page or section reference, AGE has been unable to find this erroneous text which describes the Pamboola Formation as being part of model layer 10. The numerical model structure is as described in Section D 2.4.3 in Appendix D of the Groundwater Assessment (AGE, 2020). The Arkarula Formation is represented as model layer 10. The Pamboola Formation is one of a number of formations represented using model layer 11.

Anecdotal evidence provided by site geologists suggests that mapped geological faults are not a barrier to groundwater flow, although no data were available to support this. Accordingly, as described in Section D 2.4.4 of Appendix D of the Groundwater Assessment, each mapped fault was parameterised initially such that they do not act to limit groundwater flow (i.e. they neither represent a conduit or a barrier). These initial values were then also allowed to vary widely during the calibration such that the hydraulic conductivity of these features could increase or decrease as necessary to fit the available groundwater level and inflow data. As noted in the Groundwater Assessment, the calibrated model was able to satisfactorily replicate observed groundwater levels.

Data Quality Assurance

Issue

DPIE – Water provided recommendations for data quality assurance and control, including sample collection, data handling and water quality control protocols.

Response

The Water Management Plan would be updated to incorporate the Project. The Water Management Plan would include data quality assurance and control protocols and would consider comments provided.

Water Management Plan Updates

Issue

DPIE – Water provided recommendations that the Water Management Plan be updated for the Project post-approval of the Project. A number of recommendations for the content of the updated plan were included, including for additional monitoring sites, data handing and gathering procedures and analysis.

Response

NCOPL supports the recommended update to the Water Management Plan to reflect additional monitoring, metering and management measures to report on groundwater inflows and potential impacts to water sources.

The current Water Management Plan and related annual review reports which relate to the existing/approved Narrabri Mine are available via the Narrabri Mine website (https://whitehavencoal.com.au/our-business/documentation/?q=Narrabri+Mine). A revised version of this Water Management Plan has recently been submitted to DPIE Water and already addresses many of the matters raised above. It is intended that this draft Water Management Plan would be further reviewed and updated on approval of the Project, incorporating the proposed additional monitoring outlined in the Groundwater Assessment (AGE, 2020) and addressing the DPIE – Water submissions relating to the Water Management Plan.

Cumulative Impacts with the Narrabri Gas Project

Issue

An organisation raised concern that it may be difficult to determine which of NCOPL or Narrabri Gas Project may be responsible for impacting bores

Response

Cumulative groundwater modelling was undertaken for the Project. When cumulatively assessing impacts with the Narrabri Gas Project, the same nine bores (i.e. including consideration of the Impact Assessment Addendum [Attachment 7]) are predicted to be impacted (because the majority of the predicted drawdown is due to the Project), with maximum impacts occurring towards the end of the mine life or post-mining. Therefore, it is likely that bores impacted in the areas identified as being potentially affected by the Project would be impacted as a result of the Project rather than cumulative impacts.

This would be confirmed by updates to the groundwater model, which would occur at regular intervals throughout the Project. Model updates would consider the latest groundwater monitoring data available at the time, therefore, model updates would have regard to any impacts that may be occurring at the time due to the operation of the Project and Narrabri Gas Project.

Validation of Actual Groundwater Take and Licensing and Predictions

Issue

DPIE – Water provided recommendations for a water balance of the underground mine operations to validate groundwater take and licence requirements, including accurate metering of pumped water into and out of the mine.

Response

NCOPL supports the development of a comprehensive water balance to directly measure groundwater take as it occurs at the underground operations to validate groundwater take predictions and to inform model updates and licence requirements.

Section 7 of the Surface Water Assessment (WRM, 2020) describes the water balance modelling undertaken for the Narrabri Mine operations. Water balance modelling has been continually refined and updated since mining operations commenced to incorporate changes in procedures and metered water data. The model is deemed by WRM to be suitably calibrated and sufficient to be used to define the volume of dewatered groundwater, separate from returned underground mine-filtered water. The process used to calculate these volumes (i.e. by analysing flow metre data for pumps into and out of the mine) is described in Section 5.5 of the Surface Water Assessment.

NCOPL would continue collecting and metering all inflows and outflows and to use the water balance model to calculate the groundwater take.

Other Water Licensing Matters

Issue

DPIE – Water raised concern regarding a number of water licensing matters for NCOPL to attend to, including reporting of take, potential expiration of Water Management Act approvals, nomination of works in WALs via dealings, compliance with Water Sharing Plans and applicability of exemptions under the *Water Management Act 2000* for State Significant Development (SSD) projects.

Response

NCOPL would report on water take at the site each year (direct and indirect) in the Annual Review.

NCOPL would ensure that relevant nomination of work dealing applications for Water Access Licences proposed to account for water take by the Project have been completed prior to the water take occurring.

NCOPL would consult with Natural Resources Access Regulator (NRAR) in regard to the necessary regulatory arrangement for water supply and take infrastructure for the Narrabri Mine in consideration of applicable exclusions under the EP&A Act.

Issue

Concern was raised in a representation that the groundwater impacts described in AGE (2020) are difficult to discern on their property and concern was also raised regarding potential for loss of property value.

Response

In response, NCOPL commissioned AGE to provide a property-specific summary report which provided:

- description of the geology on the property;
- a cross-section showing the geology of the property relevant to the Project; and
- drawdown contours on the property.

In summary, there is no bore on this property and drawdown on water-bearing geological units due to the Project is unlikely to prevent the establishment of a bore in the future. As noted previously, the Groundwater Assessment was peer reviewed by Mr Brian Barnett.

It is understood that the landowner received approval for dwelling construction on the property subsequent to lodgement of the Project EIS. Notwithstanding, no exceedances of amenity-based criteria, such as, for air quality and noise impacts, are anticipated on the property for the Project or the existing mine. Accordingly, property values on this property of elsewhere in the vicinity of the Project were not expected to be impacted by the development of the Project. NCOPL has provided all the relevant material from the EIS to the landholder concerned and making and 'open door' policy with all such landowners to address issues of concerns as they are raised.

4.2.2 Subsidence

Subsidence Impacts on the Single Partially Completed Dwelling

Issue

Subsidence Advisory NSW and NSW Resources Regulator noted that subsidence impacts mostly relate to NCOPL-owned land, with the exception of a single partially completed residential dwelling. It was recommended that this dwelling be vacated prior to subsidence occurring.

Response

NCOPL acknowledges the submission from Subsidence Advisory NSW and the Resources Regulator and notes that the property relating to the single partially completed dwelling is currently under negotiation for acquisition.

Predicted Extent of Subsidence and Surface Development Areas

Issue

One organisation queried the potential extent of subsidence and surface development areas affected by the Project.

Response

Attachment 5, Section A5.2.1 of the EIS states:

> ***General Rehabilitation and Mine Closure Objectives***
>
> *The Project would require the progressive rehabilitation of approximately 1,617 ha of surface development areas. In addition, the Project would require the remediation of subsidence impacts in the approximate 6,253 ha underground mine area.*

Figure A5-2 in Attachment 5 of the EIS shows the progressive rehabilitation area and the remediation area (for subsidence). Section 2, Table 2-2 of the EIS specifies that the Project would require approximately 640 ha of additional surface development footprint to support underground mining. Notwithstanding, as described in the Amendment Report (NCOPL, 2021) surface disturbance would be reduced by approximately 31 ha for the amended Project.

Section 6.6.3 of the EIS states:

> ***Indicative Surface Development Footprint***
>
> *Approximately 639 ha would be required for the development of surface infrastructure for the Project. A breakdown of the disturbance per land use is provided in Table 6-13.*

Section 6.7.3 of the EIS states:

> ***Direct impacts***
>
> *After applying the measures to avoid and/or minimise impacts on biodiversity values described above, the Project would result in the disturbance of approximately 643.8 ha of native vegetation within the Biodiversity Assessment Development Footprint (Table 6-17) (Figure 6-13) (Appendix D), comprising 472.6 ha of native woodland/forest and 171.2 ha of derived native grassland.*
>
> *This quantification of disturbance includes approximately 574.6 ha of total clearance, approximately 3.6 ha of potential subsidence ponding impacts and 52.7 ha to account for areas of potential cracking impacts on vegetation (Appendix A, Ditton Geotechnical Services, 2020). These potential subsidence impacts are discussed further below.*
>
> *It also includes approximately 12.9 ha to account for partial land clearance associated with the ETL safety clearance (Table 6-17).*

Potential Subsidence Impacts on Narrabri Gas Project Infrastructure

Issue

The NSC raised concern regarding subsidence impacts on Narrabri Gas Project infrastructure.

Response

NCOPL has consulted with Santos regarding its Narrabri Gas Project, located adjacent to the Narrabri Mine. NCOPL would continue to liaise with Santos regarding the Project including any potential cumulative subsidence impacts with Santos-owned infrastructure.

Clarification of Longwall Cut Height

Issue

In a request for information, the DPIE queried the longwall cutting height assumed in the EIS.

Response

The maximum height of cutting for the longwall is 4.3 m. Based on operational experience, in some parts of the mine (i.e. small, isolated areas) it is possible that the coal roof could prematurely cave, ahead of the longwall shield supports resulting in an effective increase in mining height (and subsidence).

As the subsidence predictions have been calibrated against actual measurements, the subsidence predictions include consideration of the possible extraction of greater than 4.3 m in these small, isolated areas.

4.2.3 Groundwater Dependent Ecosystems

Risk Rankings of Springs and Groundwater Dependent Ecosystems

Issue

The IESC requested that the ranking of risks to springs and GDEs in the Environmental Risk Assessment (Operational Risk Mentoring, 2020) be confirmed.

Response

The consequence level was incorrectly assigned and should have been reported as a 2 (i.e. minor), resulting in a Low risk level. A Low risk level is consistent with the outcomes of the Groundwater Assessment (AGE, 2020) and BDAR (Resource Strategies Pty Ltd [Resource Strategies], 2020).

Potential Impacts of Drawdown on Groundwater Dependent Ecosystems

Issue

The IESC, DPIE – Water and one organisation raised concern regarding the impacts of predicted drawdown on groundwater-dependent vegetation (including low-priority GDEs) and potential indirect impacts on native fauna, in the event of loss or decline in the condition of this vegetation. It was further recommended that additional monitoring of GDEs (including water level monitoring) and other aquatic biota be undertaken to confirm predicted impacts.

Response (prepared with assistance from AGE)

Terrestrial flora in the areas where predicted drawdown is in the order of 10 to 20 m are facultative[1], rather than obligate[2]. Given this, and the fact that the predicted drawdown is expected to occur gradually, the drawdown could potentially result in additional stress to large trees, however, is unlikely to result in widespread loss. Assessment of groundwater drawdown impacts on terrestrial ecosystems is provided in Section 6.19.3 of the EIS:

> *As described in Section 6.4.3, the Project would result in groundwater table drawdown, predominantly due to groundwater inflows to the underground mining area during operations. Groundwater drawdown is expected to occur gradually during operations, with maximum drawdown predicted to occur post mining, and recovery taking many decades (Appendix B).*
>
> *The magnitude of predicted water table drawdown at 'high priority' groundwater dependent vegetation (Figure 6 29b) would be significantly less than the estimated seasonal water table variation (Appendix B), and the drawdown would occur at a very slow rate.*
>
> *Minor changes to the groundwater regime may not have any adverse impacts on facultative groundwater dependent vegetation that uses groundwater as required (opportunistically), but these ecosystems can dieback if reduced access to groundwater is prolonged or if the change is too rapid that the trees are not able to adapt (Appendix D).*
>
> *At some groundwater dependent vegetation, predicted drawdown exceeds 10 m which is expected to result in larger trees potentially not being able to access groundwater in drought conditions (Appendix D).*
>
> *The drawdown could result in additional stress to larger trees associated with the facultative GDEs during prolonged drought conditions, but is not likely to result in the widespread loss of the larger trees, or prevent the long-term viability of the dependent ecosystem, due to (Appendix D):*
>
> - *the GDEs being facultative (not obligate);*
> - *the presence of same ecosystems in areas where groundwater is too deep for trees to access;*

[1] Refers to GDEs that use groundwater optionally or opportunistically.

[2] Refers to GDEs that are extremely dependant on groundwater.

- *the localised areas of material (i.e. greater than 1 m) predicted drawdown;*
- *the availability of other water sources during non-drought conditions; and*
- *the rate of drawdown would occur at a very slow rate.*

There is no evidence that any vegetation surrounding the existing Narrabri Mine has experienced any groundwater drawdown related impacts (i.e. dieback) from the existing operations.

As discussed in Section 6.4.3, no groundwater quality impacts are anticipated due to the Project during operations or post-mining (Appendix B).

Maximum drawdowns of less than 5 cm are predicted at three potential spring sites (AGE, 2020). It is therefore considered unlikely that discharge from these springs would be significantly affected. On the other hand, drawdown in excess of the relevant AIP threshold is predicted at a number of potential GDE areas. These areas are predominantly located within the Gunnedah Oxley Basin MDB Groundwater Source and include areas which are mapped as being dominated by Red Gum, River Red Gum, shallow freshwater wetland sedgeland with smaller areas of Ironbark and Box grassy woodland. The majority of these mapped GDEs are located close to Tulla Mullen Creek to the south east of the Narrabri Mine and in areas close to the Namoi River to the north-east. Predictions suggest that up to 157.9 ha of areas mapped as high priority GDEs could experience drawdowns greater than the estimated AIP threshold due to the Project only and 160.9 ha if the Narrabri Gas Project was to be developed concurrently. Further assessment of potential impacts on GDEs is provided in Section 6.19 of the EIS.

Existing and proposed monitoring locations are shown in Figure 8 and include two new monitoring locations to the south of the Project close to mapped GDE areas.

Figure 10 shows the location of high-priority GDE areas in relation to Approved and Project longwall panels. GDEs where predicted maximum drawdowns exceed 5 m (a threshold mentioned by the IESC as being of interest) are shown shaded based on the GDE type, other GDEs where maximum impacts of less than 5 m are predicted are shown shaded grey. As shown in this map no GDEs are mapped in areas overlying longwall panels. Maximum impacts of more than 5 m are predicted at a small number of GDE polygons to the east and south-east of the Project area. Further assessment of the potential ecological impacts of these predicted drawdowns on GDEs is provided in Section 6.19 of the EIS.

Maximum drawdowns of less than 5 cm are predicted at three potential spring sites. Further monitoring at the Mayfield, Hardys and Eather spring sites is outlined in Section 8.2 of the Groundwater Assessment (AGE, 2020). The purpose is to observe any changes to flow rates and surface conditions and to confirm whether these features are groundwater-dependent. Depending on the results of these visits, further ongoing groundwater and surface water monitoring at these sites, similar to the shallow monitoring proposed at the creek sites would be implemented in addition to ecological monitoring. Site-specific monitoring details (including monitoring frequency and duration) would then be developed as part of the Water Management Plan.

Given the abovementioned impacts, no monitoring of aquatic biota is proposed or considered necessary.

Potential Impacts of the Re-injected Brine on Groundwater Dependent Ecosystems

Issue

The IESC and an organisation raised concern regarding the assessment of, and impacts associated with, brine re-injection, including that brine re-injection modelling conducted by AGE (2020) only considered salinity and not other water quality parameters and potential impacts of this activity on GDEs. It was suggested that there may be a development of preferential flow pathways above the goaves, which may result in salinity increases in these areas and that tracer fluids could be injected to assist to test the occurrence of these flow pathways.

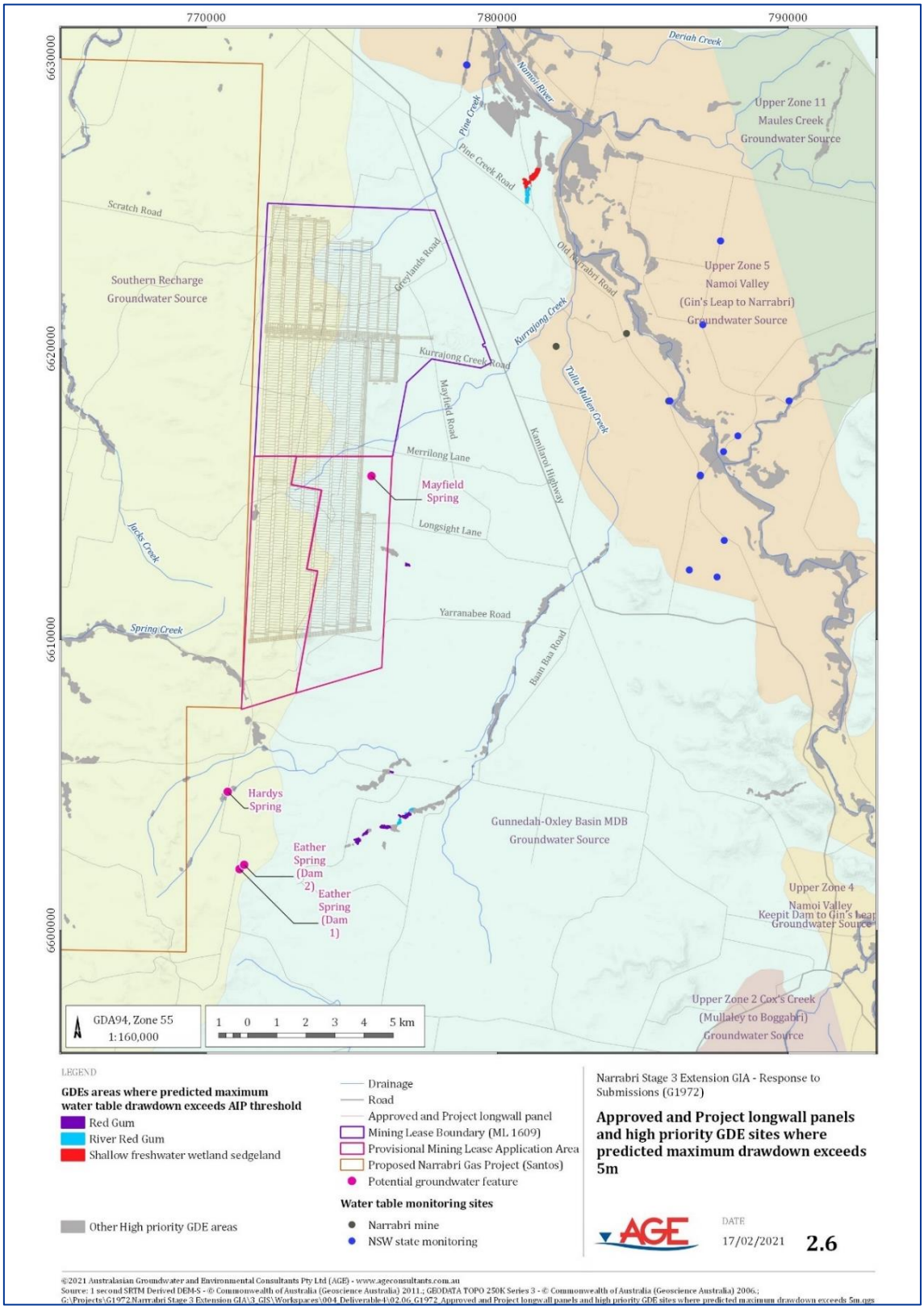


Figure 10
Approved and Project Longwall Panels and High-Priority GDE Sites Where Predicted Maximum Drawdown Exceeds 5 m

Response (prepared with assistance from AGE)

Brine re-injection is an approved component of the Narrabri Mine. Notwithstanding, AGE (2020) includes an assessment of potential impacts of brine re-injection due to the Project. In accordance with the AIP (DPI – Office of Water, 2012), which does not include minimal impact considerations for other indices, the Groundwater Assessment (AGE, 2020) focuses on impacts on groundwater salinity or TDS.

Potential impacts of the re-injection of brine into the mine goaf at the completion of mining are identified in Section 7.8.2 of the Groundwater Assessment (AGE, 2020). Since the majority of the TDS load in the brine came from underground in the first place and the practice of brine re-injection is approved for the existing Narrabri Mine, then the long-term water quality impacts of re-injecting these solids in a more concentrated form into the Hoskissons Coal Seam was assessed as being negligible. Nevertheless, further calculations were undertaken to quantify the impact of brine re-injection in terms of total salinity. The results, which were based on predicted TDS loads in excess of the 99th percentile presented in the Surface Water Assessment (WRM, 2020), suggest a possible slight increase in TDS concentrations in the Hoskissons Coal Seam in the long term from approximately 8,700 to 10,100 mg/L. Post-mining re-injection is therefore considered unlikely to affect potential groundwater usage in the Hoskissons Coal Seam since few, if any, water supply bores in the area target this unit on account of its high background TDS. Furthermore, no impact on groundwater quality in adjacent aquifers is expected. Numerical modelling results suggest that the goaf areas would not become fully saturated until after 2261 (i.e. around 218 years after closure of the mine). Thereafter, groundwater model predictions also suggest downward head gradients within the mining area in the long-term (i.e. from the Hoskissons Coal Seam to the underlying Arkakula Formation). As summarised in Table 7.8 in the Groundwater Assessment, existing monitoring data indicates an average TDS in the Arkarula Formation of 12,884 mg/L (i.e. more than the predicted long term TDS in the goaf), and hence groundwater quality in this unit might be expected to improve due to leakage from the overlying unit.

As discussed in Section 7.8.2 of the Groundwater Assessment (AGE, 2020), numerical model-based predictions suggest:

- That the hydraulic conductivity of the goaf area is likely to be sufficiently high to allow re-injection of the brine at the rates required with only minimal head increases (less than 6 m at the point of injection).
- The total volume of brine to be injected represents less than 2% of the pore space in the goaf, which is estimated to be 137,617 ML at the completion of mining.
- That the available pore space would not be filled until around 200 years after mining ceases.

During the estimated 218-year recovery period, hydraulic gradients would remain towards the mine leading to the gradual dilution of the brine *in situ*, as generally lower TDS groundwater is drawn in from surrounding groundwater units. Longer-term predictions, which include simulation of fracturing of the overlying strata, also suggest downward fluxes within the mining area. Hence, whilst this fracturing may lead to the development of preferential pathways in the overlying strata, it is not clear by what mechanism the IESC believes that brine could migrate vertically upwards through these fractures against the prevailing hydraulic gradients, which are towards the mine during the recovery period and downward in the long term. Vertical movement upwards would also tend to be reduced by density differences between the brine and fresher groundwater in the overlying units.

Hydraulic interactions above the goaf areas would be monitored via an expanded network of monitoring facilities, which includes a further six VWP nests. However, it is not clear how the IESCs suggestion that harmless tracer fluids be injected into partially saturated goaf areas to model flow pathways in the system above the goaf areas would work. Most tracer fluids injected into these areas would report to the mine drainage system, rather than the overlying strata. It may be that the IESC are referring to the use of a tracer such as Helium gas which has been used to measure overburden conductivity above longwall panels ranging from 50 to 220 m below ground level at the Beltana No.1 and Ashton mines in the Hunter Valley (Heritage and Gale, 2009). In addition to the further VWP installations outlined above, NCOPL would assess the feasibility of using Helium gas, or other tracers/indicators to investigate seam to surface connectivity above selected longwall panels.

Post-closure re-injection of relatively small amounts of brine into goaf areas is not expected to impact water quality in adjacent units or at GDEs which are located at surface between 165 m and 400 m above the coal seams (AGE, 2020). Numerical modelling results, which include simulation of the mine and the proposed re-injection, indicate that hydraulic gradients would remain towards the goaf areas for around 200 years post-closure and then revert to generally downward gradients once full recovery has been achieved.

No significant impact on salinity or beneficial use in surrounding strata or on sensitive receptors at the ground surface some 165 to 440 m above the goaf are expected.

4.2.4 Surface Water

Potential Impacts of Loss of Surface Water and Surface Cracking on Biodiversity

Issue

The IESC and DPIE – Water raised concern regarding the potential for loss of surface water which may lead to impacts on local flora and fauna (including terrestrial and aquatic). Further, it was noted that the surface water systems are a component of the Lowland Darling River aquatic ecological community.

It was suggested by the IESC that the impact assessment should be risk-based and would benefit from modelling of erosion above Longwalls 101 to 111, surface water modelling informed by stream flow data and stream gauging to confirm and quantify impacts under a range of climatic scenarios (wet, average and dry) (including a licensing strategy, as required by the AIP).

Potential mechanisms for impacts on surface water quality from stream cracking were also raised by the IESC and an organisation.

Finally, it was suggested by IESC that the impact assessment would benefit from a description of impacts on surface water resources resulting from longwall mining which has occurred to date at the Narrabri Mine.

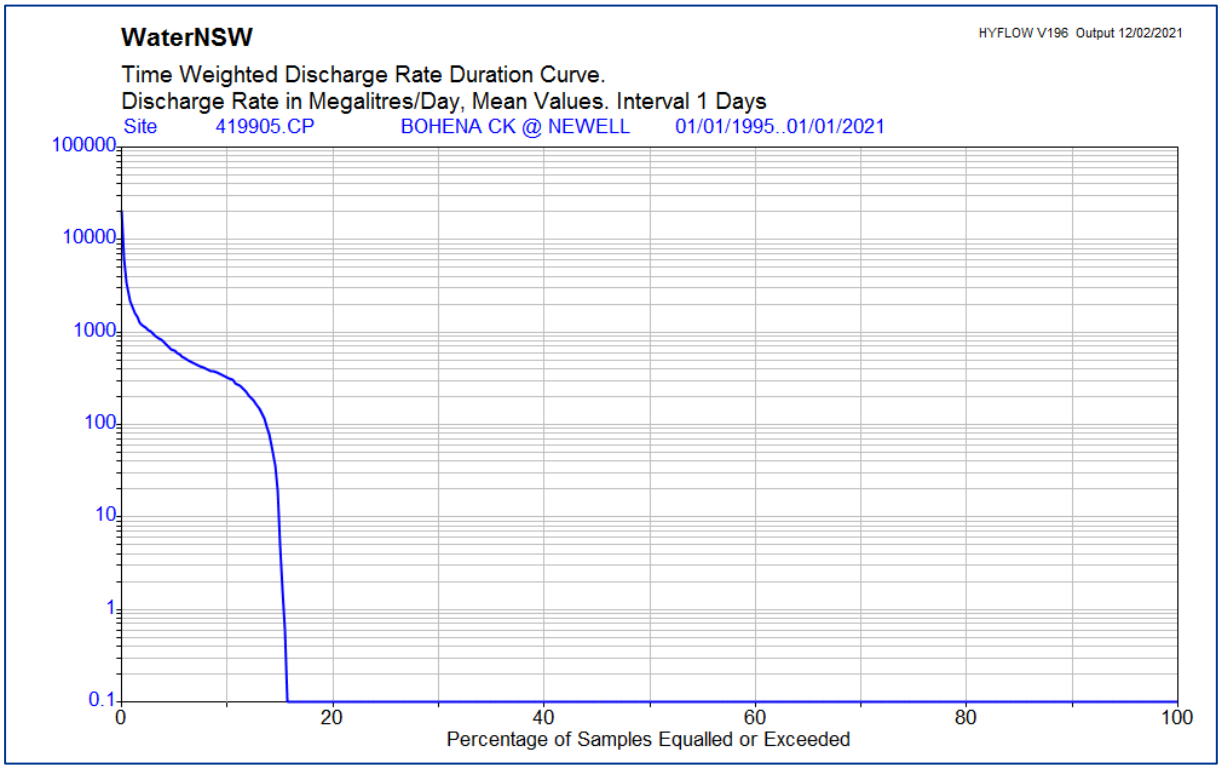
Response (prepared with assistance from WRM)

Potential for Loss of Surface Water Flow

Section 8.1 of the Surface Water Assessment (WRM, 2020) considers and describes the likely impacts of subsidence and cracking on the surface water resources. The assessment concludes that the Project is not expected to impact on the low and medium flows or flow regime of the watercourses. With respect to baseflows, the assessment states that the watercourses are 'all ephemeral with minimal to no baseflow' under existing conditions and, therefore, there would be no baseflow to lose. The downstream vegetation would be adapted to the existing intermittent and infrequent flow conditions already and any change would be significantly less than the natural variation in flow.

Although there is no recorded flow data on-site, the statement on the lack of baseflow is based on the 15 years that NCOPL (and WRM representatives) have been observing the waterways through the planning and operational phases of the mine. It is also based on observations from WRM staff who have inspected the waterways almost every year since 2007.

Further evidence of the lack of baseflow is shown in Figure 11, which is a ranked plot of the recorded daily flows at the WaterNSW stream gauge on Bohena Creek at the Newell Highway (GS410905). Although the Bohena Creek catchment is much larger, its flow characteristics are expected to be similar to the site catchments because it drains the Pilliga State Forest and has similar soil and vegetation characteristics as the upper headwaters of the site catchments. The figure shows that Bohena Creek flowed on about 15% of days and there is little to no baseflows, which for Bohena Creek could be considered as it flows less than 100 megalitres per day (ML/d) (1.1 cubic metres per second). This is also supported by the environmental assessment undertaken for the Narrabri Gas Project (CDM Smith, 2016), which determined that Bohena Creek is a 'losing' stream that loses water to the perched alluvial aquifer.



Source: WRM (2021).

Figure 11
Daily Flow Duration Curve, Bohena Creek at the Newell Highway (GS419905)

On the basis that there are no baseflows along the waterways under existing conditions, any impact on stream flows due to subsidence would be to surface runoff and not baseflows. Therefore, the potential loss of baseflows has been adequately considered in the EIS.

NCOPL has not 'modelled the erosion to tributaries along fractures between Longwalls 101 and 111'. However, the Extraction Plan Water Management Plan (NCOPL, 2016a) commits NCOPL to monitor the area affected by surface cracking on a monthly basis and/or following significant rainfall and remediate the cracks if needed. Pictures of a subsidence-induced surface crack and the remediated crack above the existing mine are shown in Figure 12. This type of remediation would occur to any of the farm dams if a significant drawdown was observed. Note that additional leakage from the dams above the existing subsidence area has not occurred to date.

NCOPL acknowledges the IESC's recommendation to demonstrate the impacts from surface cracking or subsidence due to the Project on local catchment stream flows. However, establishing a stream gauge that is capable of demonstrating the impacts has always been deemed impractical (i.e. in WRM's aforementioned on-site experience). First, all assessments undertaken to date have predicted negligible to no loss of stream flows due to the existing Narrabri Mine and Project for the following reasons:

- The predicted surface ponding volumes are small in comparison to the existing ponding volumes and overall stream volumes.
- The loss of surface flow due to surface cracking is deemed unlikely.
- The Groundwater Assessment (AGE, 2020) predicted existing water table levels some 5 m to 20 m below the bed level of the waterways, suggesting changes to groundwater would not impact on baseflows (as there are no baseflows).

Source: NCOPL (2021).

Figure 12
Before and After Photographs of Crack Remediation at the Narrabri Mine

These predictions have generally been consistent with the observations encountered for the waterways across the existing longwall mining areas.

In addition, the Subsidence Assessment (Ditton Geotechnical Services, 2020) concludes that there is potential, albeit highly unlikely, that creek flows could be temporarily re-routed into open cracks to below-surface pathways and re-surface downstream of the mining extraction limits in the mining area. The resurfacing of the flows would not be a loss of flow to the system. Further to this, remedial measures (such as shown in Figure 12) would be implemented to ensure it would not be repeated, if it did occur.

Given the predicted surface water losses are negligible, a very accurate and reliable stream gauge would be required to predict a change, which is not practical for the local waterways for the following reasons:

- The establishment of a reliable stage discharge relationship (rating curve) for the site would require frequent stream gauging. It is not practical or possible to engage a skilled hydrographer that is local and can attend site and measure the flows given the short duration and infrequent nature of the flow events.
- The monitoring of stream water levels from a waterway with a mobile sandy bed is generally unreliable, as small shifts in sand can change the flow depths. This means that regular stream gauging would be required to ensure the low flow rating curve is up to date and reliable.

- The broad, ill-defined flows mean that a very small increase in water level of 0.1 m to 0.2 m would lead to a significant increase in flow rate, which means that a significant number of gaugings across all flow rates would be required to make the rating reliable. There are an insufficient number of flow events in any year for this to physically occur.
- To overcome these reliability issues, a low flow control weir would be required to provide both reliable water level and stream flow estimates. It is not practical to establish a weir given the volume of sediment and the broad and erosive nature of the existing channels. Further, a Water Supply Works approval under the *Water Management Act 2000* would be required for the weir, which would be hard to demonstrate that it would satisfy the management goal NSW Weirs Policy, which states *The construction of new weirs, or enlargement of existing weirs, shall be discouraged*.

Further to this, if reliable flow measurements could be obtained, the use of surface water modelling to demonstrate the minor surface flow impacts is impractical and not meaningful. Surface water modelling requires an extensive period of baseline flow data and reliable catchment rainfall data to calibrate the soil moisture loss parameters to derive a pre-disturbance flow sequence. Several years of data would be required for a site such as this, given the infrequent nature of the flows, to derive a reliable soil moisture accounting model to simulate stream flows. Even if reliable parameters could be adequately calibrated to determine a pre-disturbance flow sequence, the natural variability in surface runoff would far exceed the differences expected by the Project (which are negligible).

Given the above, baseline stream gauging or automatic water level monitoring has not been undertaken to date, nor is it considered appropriate for the waterways traversing the Project.

The annual volume of surface water take due to subsidence-related surface fracturing is not expected to be quantifiable or measurable as it is expected to be near zero. Notwithstanding, NCOPL has committed to continue monitoring the underground dewatered volumes. A sudden increase in the monitored flow following surface runoff would suggest that surface water may have reached the underground workings. Should a sudden increase occur following surface runoff, it would be quantified, reported and have remedial measures implemented to prevent it from occurring again.

Note that no measurable changes in underground dewatered volumes following surface runoff events have been encountered to date at the existing mine.

Section 8.2 of the Surface Water Assessment (WRM, 2020) describes and quantifies the potential impacts of subsidence on the local waterways of the Project. The expected change to proportion of rainfall that would appear as surface runoff is expected to be negligible. Any change would require a change to the pervious/impervious nature of the surface. The only change in impervious surface is an increase in the potential for ponded areas, which only occurs when the ponded areas are full of water. The increased impervious area was calculated to be between 5 ha and 8 ha, or less than 0.1% of the local watercourse catchments. Such a change would not be measurable.

A risk-based approach has also been adopted when considering the potential changes in no- and low-flow days:

- First, the Subsidence Assessment (Ditton Geotechnical Services, 2020) determined that a direct hydraulic connection to the surface due to mine subsidence is unlikely to possible.
- Second, there is generally only surface flow, and not baseflow from the local catchments. The assessment concluded that the Project would not have a measurable impact on surface flows. Notwithstanding, NCOPL has committed to repairing any surface cracks, if required, to minimise the changes in surface flow.
- Last, the local ecology along these waterways is already adapted to these flow conditions and, therefore, there is a low chance of environmental harm. The waterways also only flow for short distances before they drain into greater Tulla Mullen Creek and the Namoi River channels. Given the low to no risk, a more detailed impact assessment on the flow regime (including modelling and collection of detailed monitoring and hydrographic data) is not warranted.

Section 8.6 of the Surface Water Assessment (WRM, 2020) outlines the water licensing considerations for the Project. The additional water captured in the in-stream surface depressions is not expected to be a take of water, as the ponded water remains in-stream. It is also likely to be temporary as any depression would fill with sediment. There is not expected to be any loss of flow from surface cracking.

Notwithstanding the above, NCOPL may rely on its harvestable right entitlement for the Project water storages (subject to incorporation in the Water Management Plan). Additional water entitlement from the *Water Sharing Plan for the Namoi and Peel Unregulated Water Sources 2012* is not expected to be required.

In summary, the existing monitoring data from the Narrabri Mine suggests that the water quality risks to the local surface waters potentially impacted by the Project is low. This is a reflection on the adequacy of the existing Surface Water Management strategy, detailed in Sections 5 and 6 of the Surface Water Assessment, which outlines a risk-based approach to water management based on water quality.

Water Quality

Section 4.5 of the Surface Water Assessment (WRM, 2020) compares the background (upstream) and downstream water quality data collected at the Narrabri Mine to date. This includes runoff from the existing subsided areas. The comparison found that 'the differences in water quality between undisturbed monitoring locations (KCUS, KC1US and KC2US) and those located downstream of the Narrabri Mine (KCDS, KC1DS, KC2DS, PC and PC1) is small. Further, there has not been an increasing (or decreasing) trend in recorded water quality over the life of the Narrabri Mine'.

Observations of Existing Site Impacts

Section 8.1 of the Surface Water Assessment (WRM, 2020) describes the potential impacts on Kurrajong Creek and Tulla Mullen Creek Tributary No. 1. The evidence of the existing headward erosion on Kurrajong Creek is described in Section 4.3. As described in the assessment, some bed incision is expected on the downstream side of each chain pillar due to the increased channel slope. The loose sand bed material eroded from these reaches are expected to accumulate in the subsidence trough immediately upstream of the next chain pillar, which has a significantly reduced channel slope.

This process is expected to occur across each chain pillar as mining progresses upstream. As the bed across the chain pillars erode and the subsidence depressions accumulate the sediment, the only significant long-term bed form change would be at the upstream end of the most western longwall panel, which would remain with an increased slope, and at the eastern side of the most downstream panel, which would have a reduced bed slope. The streams are all first and second order watercourses with very little catchment at the upstream end of the most western longwall panel, significantly reducing the potential long-term impacts.

As a result, although changes to the channel morphology are expected, they are not expected to lead to significant geomorphic changes, such as an avulsion, or create a downstream sand slug (as the sand would be captured in the depressions).

NCOPL has committed to continue monitoring the channel changes across the existing mine and the waterways impacted by the Project and implement mitigation measures if required. These commitments are provided in the Water Management Plan.

Lower Darling River aquatic ecological community

Further to the above, given WRM's assessment that the Project is unlikely to impact the flow regime of local creeks, it follows that impacts on the Lower Darling River aquatic ecological community would not be material. Impacts on the Lower Darling River aquatic ecological community are addressed in Section 6.4 of the BDAR:

> *The Lowland Darling River aquatic endangered ecological community listed under the FM Act includes the Namoi River (Figure 1) and associated tributaries, such as Kurrajong Creek and Pine Creek. Kurrajong Creek and Pine Creek do not provide any sufficient permanent habitat for aquatic biota as flow likely only occurs during heavy rainfall events. The potential for aquatic GDEs to occur was considered by AGE (2020), who concluded that Kurrajong Creek and Pine Creek are not aquatic GDEs.*
>
> *Kurrajong Creek would be traversed by multiple access tracks and the services corridor associated with the Project within the Development Footprint. There would also be subsidence impacts on watercourses as described in Section 6.2.1. Erosion and sedimentation are discussed in Section 6.2.2.*

The following measures would be implemented to mitigate and manage the adverse impacts on the Lowland Darling River aquatic endangered ecological community (Section 7):

- *vegetation clearance protocol, including delineating areas to be cleared and/or retained (Biodiversity Measure 1);*
- *progressive revegetation of disturbed areas (mine rehabilitation) with species characteristic of the surrounding vegetation (Biodiversity Measure 2);*
- *management of the potential for localised Project-related channel erosion on Kurrajong Creek and other ephemeral creek lines using appropriate sediment and erosion controls (Biodiversity Measure 6);*
- *monitoring programme for creek lines (including Kurrajong Creek) (Biodiversity Measure 7); and*
- *construction of drainage line crossings would be undertaken in accordance with the policy and guideline document of DPI-Fisheries NSW Why do fish need to cross the road? (Fairfull and Witheridge, 2003) (Biodiversity Measure 8).*

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

Based on the above, the Project would not adversely impact any threatened species or communities listed under the FM Act. The MOP and Extraction Plan (incorporating the BMP and RMP) would facilitate the implementation of the management measures.

Further it is noted that DPI Fisheries, in its submission, stated:

DPI Fisheries note that subsidence impacts on waterways will be minor.

Impacts of Climate Change on Surface Water Flow

Issue

The IESC recommended that the impacts of climate change should be considered when assessing impacts of the Project on surface water flow, with the year 2240 being mentioned as it is when the peak baseflow reductions in the Namoi River are expected to occur.

Response (prepared with assistance from WRM)

The Namoi River is a regulated system with low flows controlled by releases from Keepit Dam. They are not strictly baseflows. These releases are made to meet the downstream demands for irrigation, stock and domestic and town water supplies (amongst other demands). It is unlikely that the stock and domestic and town water supply demand would change by the year 2240 without significant population or land use changes further downstream. As such, the Namoi River releases to meet these demands are not expected to be significantly different in the year 2240, irrespective of climate change.

Further, baseflow losses to the Namoi River and its tributaries of up to approximately 200 ML/yr are predicted post-mining (AGE, 2020). Mean flow rates in the Namoi River at Gunnedah (upstream of the Project) are maintained at approximately 1,900 ML/day (i.e. approximately 700,000 ML/yr). In the context of the Namoi River regulated system, a baseflow loss of 200 ML/yr (or approximately 0.03% of the mean Namoi River flow) is minor. Hence, the Project would not measurably affect baseflow in the Namoi River post-mining (WRM, 2020).

Treatment of Mine-affected Water and Monitoring of On-site Storages

Issue

The IESC requested additional information regarding the treatment of mine-affected water, and the monitoring regime for on-site mine water storages (including soluble metals).

Response

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

Brine (generated from the water treatment facilities) and groundwater inflows are used for dust suppression. Brine is approved to be stored in Brine Storage Ponds at the Pit Top Area.

The existing Project Approval 08_0144 (i.e. the existing consent for the Narrabri Mine) outlines the conditions by which any discharge must occur (Schedule 4, Condition 11):

> 11. *Any raffinate from the water conditioning plant discharged to the Namoi River must be discharged in accordance with the conditions of an EPL and meet the following criteria:*
>
> *(a) 50 percentile of all samples (volume based) are below 250 mg/l of Total Dissolved Solids;*
>
> *(b) 100 percentile of all samples (volume based) are below 350 mg/l of Total Dissolved Solids; and*
>
> *(c) pH values of all sampled water to be between 6.5 and 8.5.*

Further, Project Approval 08_0144, Schedule 4, Condition 17 requires the development of a Raffinate Discharge and Transfer Control and Monitoring Plan, which must include:

> *(a) be approved by the Secretary prior to any raffinate discharge to the Namoi River;*
>
> *(b) include measures for the continuous monitoring and recording of volumes of water discharged to the Namoi River;*
>
> *(c) contain an ambient water quality monitoring program upstream and downstream of the discharge point; and*
>
> *(d) contain a water quality monitoring program for discharged waters.*

Prior to discharge to the Namoi River, the water quality parameters described in the current or future Project Approval / Development Consent would need to be met, as well as any other requirements of an Environment Protection Licence, and described in an approved Raffinate Discharge and Transfer Control and Monitoring Plan. In addition, NCOPL would expect similar condition be imposed for the Project. As part of this, NCOPL would consider additional water quality monitoring, including soluble metals.

Additional Surface Water Quality Sampling

Issue

The IESC raised concern that additional surface water quality sampling is required (frequency and event-based sampling over an appropriate period).

Response (prepared with assistance from WRM)

Additional surface water sampling sites for the Project were established in 2017 following review of existing monitoring and recommendations for new sites by WRM. All available surface water quality monitoring data was assessed as part of the EIS. The extreme drought conditions that occurred during the preparation of the EIS meant that limited surface runoff occurred to enable surface water samples to be collected. Surface water sampling is also inherently difficult to obtain in the Narrabri Mine and MLAs 1 and 2 due to the small catchments and the ephemeral nature of the waterways (i.e. typically limited duration/opportunity for sampling). Access to the more remote locations is also difficult during occasional wet weather.

Section 4.5 of the Surface Water Assessment (WRM, 2020) describes the background water quality data that has been collected at the existing mine since 2007.

Section 9.3 of the Surface Water Assessment (WRM, 2020) states that NCOPL has committed to extending the suite of water quality parameters to include those that would be expected from the Project waste materials.

Given the ephemeral infrequent nature of the stream flows, all baseline monitoring is 'event-based'. However, the flow rate associated with the monitoring samples was not collected due to the difficulty in defining stream flows for these catchments. Sufficient data is available to derive appropriate site-specific water quality guideline values and these are presented in Table 4.4 of the Surface Water Assessment.

Notwithstanding, NCOPL supports the expansion of the surface water monitoring program. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan.

Baseflow in Ephemeral Streams Overlying the Project

Issue

The IESC raised concern regarding whether baseflow occurs in the ephemeral streams above the Project, and whether these streams are gaining or losing systems.

Response (prepared with assistance from AGE)

All of the creeks draining the immediate Project area (i.e. Pine, Kurrajong, Jacks and Tulla Mullen Creeks) are highly ephemeral (AGE, 2020). Flow is only observed in these creeks immediately after significant rainfall events. Accordingly, they are considered to be predominantly losing systems, which would provide an additional source of periodic recharge to underlying groundwater systems during and immediately subsequent to heavy rainfall periods.

Additional Monitoring on the Namoi River

Issue

The IESC recommended that additional monitoring be undertaken on the Namoi River.

Response

NCOPL supports the expansion of the surface water and groundwater monitoring program, including background monitoring sites on Kurrajong Creek and the Namoi River. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan.

Section 4.5 of the Surface Water Assessment (WRM, 2020) describes the background surface water monitoring program for Kurrajong Creek and the Namoi River. NCOPL has committed to continuing the monitoring program over both the Narrabri Mine and Project area and include other parameters of relevance to the Project. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan.

Baseline Water Quality

Issue

The IESC requested clarification of whether baseline values for water quality have been undertaken for the existing Narrabri Mine and whether the water management Trigger Action Response Plan (TARP) is available.

DPIE – Water requested to be consulted during the preparation of the updated TARPs for the Project.

Response (prepared with assistance from WRM)

A TARP for the Narrabri Mine is included in the *Narrabri Mine Extraction Plan Water Management Plan LW 107 to LW 110* (NCOPL, 2017). It includes triggers and responses for water quality measured in the receiving waters and water quality (and volumes) measured in the water storage dams. For the receiving waters, the current TARP references water quality triggers referenced in EPL 12789 for oils and grease, pH and total suspended solids.

The TARP contains two levels of triggers that would result in remedial actions being involked in relation to the following aspects:

- water quality;
- ponding;
- changes in water course morphology;
- erosion above longwall panels;
- groundwater levels and quality;
- hydraulic connectivity; and
- mine inflows quantity and quality.

Section 4.5 and Table 4.4 of the Surface Water Assessment (WRM, 2020) presents the background water quality data collected at the site since 2007. The sites denoted as KCUS, KCDS, KC1US, KC2US collect runoff from catchments that have not been disturbed by mining activities and would be suitable to derive baseline water quality.

The Water Management Plan and the associated TARPs would be updated to incorporate the Project and would include the water quality parameters with sufficient baseline data, namely EC and TOC with the 90th percentile background level selected for the baseline trigger.

Note that baseline total suspended solid concentrations for median and 80th percentile values at the background stations significantly exceed the 100th percentile concentration limits in the EPL. NCOPL would liaise with the Environment Protection Authority (EPA) to determine the most appropriate limits in consideration of the baseline data.

NCOPL supports the expansion of the surface water and groundwater monitoring program, including development of TARPs. The TARPs would be developed in consultation with DPIE – Water. It is envisaged that the site-specific monitoring details (including monitoring frequency and duration) would be developed as part of a revised Water Management Plan.

Pit Top Area Runoff and Southern Mine Water Storage Management System

Issue

The EPA raised that the Pit Top Area Runoff and Southern Mine Water Storage management system must be designed to maintain sufficient storage to achieve no managed overflows of wastewater, brine or effluent.

Response

The capacity of the mine water and “Pit Top Area Runoff” management system is designed to maintain sufficient storage to achieve no managed overflows of wastewater, brine or effluent from the mine water affected areas of the site including the “Pit Top Area Runoff” water management area and the proposed Southern Mine Water Storage. Sediment dam storage capacity would be restored through transfer of water to other water storages or through controlled release via licensed discharge points, in accordance with the requirements of an EPL following rainfall events that exceed sediment dam design capacity.

Erosion and Sediment Control Plan

Issue

The EPA suggested that NCOPL prepare an Erosion and Sediment Control Plan (ESCP) for the Project in accordance with *Managing Urban Stormwater – Soils and Construction, Volumes 1 and 2* (Landcom, 2004; DECC, 2008).

Response

NCOPL supports the preparation of an ESCP for all aspects of the construction and operation phases of the Project and notes the following commitments from the EIS:

Section 6.5.4 of the EIS:

> *The Erosion and Sediment Control Plan component of the Water Management Plan would be reviewed and updated for the Project to identify measures to minimise soil erosion and transport of sediment off-site.*

Section 3.6 of the Surface Water Assessment:

> *Erosion and Sediment Control Plans for the Narrabri Mine, which utilise these guidelines, is provided in the Water Management Plan (NCOPL, 2013) and the Extraction Plan Water Management Plan LW107 to LW110 (NCOPL, 2017).*

Section 9.1 of the Surface Water Assessment:

> *The Water Management Plan and the Extraction Plan Water Management Plan LW107 to LW110 outlines the water management system and water management strategy for the Narrabri Mine (Section 5). The Water Management Plan includes:*
>
> - *Site Water Balance;*
> - *Erosion and Sediment Control Plan;*
> - *Surface Water Monitoring Plan; and*
> - *a Surface and Groundwater Response Plan in the form of a TARP.*
>
> *The Erosion and Sediment Control Plan would be reviewed and updated for the Project and would identify activities that could cause soil erosion and generate sediment and describe the specific controls (including locations, function and structure capacities) to minimise the potential for soil erosion and transport of sediment off-site.*

Attachment 4, Section A4.2.3 of the EIS:

> *The Erosion and Sediment Control Plan would be reviewed and updated for the Project to identify measures to minimise soil erosion and transport of sediment off-site.*

Southern Mine Water Storage Liner

Issue

The EPA recommended that the Southern Mine Water Storage is constructed to achieve a permeability of less than $1x10^{-14}$ metres per second (m/s) over a compacted clay depth of 900 millimetres (mm) or equivalent synthetic liner.

Response

NCOPL supports the recommendation from the EPA in regard to design of the additional mine water pond, and notes the following commitments in the EIS that the storage will achieve the recommended permeability:

Section 2.5.10 of the EIS:

> *Additional water management infrastructure would be required directly south of Longwall 210 to store water from mine dewatering activities. Development of the additional water management infrastructure area would generally include:*
>
> - *installation of a lined Mine Water Storage (herein referred to as the Southern Mine Water Storage) (Figure 2-6);*
>
> …
>
> *The Brine Storage Ponds would be lined with a low permeability high-density polyethylene (HDPE) with a permeability of less than $1x10^{-14}$ m/s to minimise the potential for seepage*

Section 6.2 of the Surface Water Assessment:

> *The additional mine water storage proposed to be constructed south of Longwall 210 (the Southern Mine Water Storage) (Figure 1.3 of Appendix C) is proposed be a "turkey nest" storage used to store mine water dewatered from the southern longwall panels, prior to transfer to the Pit Top Area, as required.*

Remediation of Impacts on Surface Water Resources

Issue

DPIE – Water recommended that monitoring and remediation of impacts on surface water resources would need to be implemented, with performance reporting provided to the DPIE – Water. Remediation works should be conducted in accordance with *Guidelines for Controlled Activities on Waterfront Land* (NRAR, 2018). It was also requested that triggers for remediation of subsidence impacts to watercourses be specified.

Response

NCOPL currently undertakes monitoring and management of surface cracking in accordance with its:

- Procedure for Subsidence Monitoring and Management of LW107 - LW110 (NCOPL, 2020c); and
- Procedure for Subsidence Crack Repair (in limited access areas) (NCOPL, 2020d).

The *Procedure for Subsidence Monitoring and Management of LW107 - LW110* (NCOPL, 2020c) includes a TARP which outlines triggers for surface cracking, creek stability and ponding impacts. In relation to impacts on watercourses, triggers have been developed including:

- surface cracking;
- creek stability and condition;
- creek bed and bank stability;
- observed subsidence ponding; and
- surface water quality.

Subsidence monitoring of the Narrabri Mine has identified subsidence-related cracking within the modelled estimations described in the Subsidence Assessment (Ditton Geotechnical Services, 2020). These cracks have been successfully managed to date by filling in naturally (for small cracks) or by use of machinery for larger cracks (Figure 12).

NCOPL proposes to continue monitoring and management of subsidence-related surface cracking in accordance with the current procedures. The procedures would be evaluated from time to time to assess their suitability.

Project remediation works would be undertaken in consideration of the *Guidelines for Controlled Activities on Waterfront Land* (NRAR, 2018).

4.2.5 Biodiversity

Potential Impacts on Stygofauna

Issue

The IESC raised concern regarding potential impacts on stygofauna. It was suggested that even the predicted limited drawdown in areas where alluvial sediments are shallow may be enough to isolate stygofaunal assemblages. In addition, concern was raised regarding the potential impacts of brine-reinjection on stygofauna.

Response

Dr Peter Hancock assessed the information presented in the EIS relating to potential impacts to stygofauna (Attachment 4).

Drawdown of the lower Tulla Mullen Creek alluvial aquifer is predicted to be less than one metre for most of the area affected (Figure 6-29a of EIS). In the area modelled for drawdown, the aquifer of Tulla Mullen Creek is between approximately 20 and 60 m deep, with less extensive alluvium up to 10 m thick extending west along Sandy Creek (Figure 4.3 of AGE [2020]). Stygofauna are most likely to occur in the thicker sections of aquifer because this is where the water level is most stable, and the connection to the Namoi Alluvium likely to be strongest. The modelled drawdown of less than 1 m is within the historical range of drawdown in the Namoi Alluvium (AGE, 2020), and within tolerance range for stygofauna. Further, a drawdown of less than 1 m would not isolate the Tulla Mullen Creek alluvium from the Namoi Alluvium, so there is no risk of stranding or isolating upstream communities.

Dr Peter Hancock concluded that the predicted drawdown at Tulla Mullen Creek and Namoi alluvium would have a negligible effect on stygofauna communities.

Potential impacts of the re-injection of brine into the mine goaf at completion of mining are identified in Section 7.8.2 of the Groundwater Assessment (AGE, 2020). Since the majority of the TDS load in the brine came from underground in the first place and the practice of brine re-injection is approved for the existing Narrabri Mine, then the long-term water quality impacts of re-injecting these solids in a more concentrated form into the Hoskissons Coal Seam was assessed as being negligible. Nevertheless, as summarised in Section 7.8.2 of the Project Groundwater Assessment, further calculations were undertaken to quantify the impact of brine re-injection in terms of total salinity. The results, which were based on predicted TDS loads in excess of the 99th percentile presented in the Surface Water Assessment (WRM, 2020), suggest a possible slight increase in TDS concentrations in the Hoskissons coal seam in the long term from around 8,700 to 10,100 mg/L. Post-mining re-injection is, therefore, considered unlikely to affect potential groundwater usage in the Hoskissons Coal Seam since few, if any, water supply bores in the area target this unit on account of its high background TDS.

Furthermore, no impact on groundwater quality in adjacent aquifers is expected. Numerical modelling results suggest that the goaf areas would not become fully saturated until after 2261 (i.e. around 218 years after closure of the mine). Thereafter, groundwater model predictions also suggest downward head gradients within the mining area in the long-term (i.e. from the Hoskissons Coal Seam to the underlying Arkakula Formation). As summarised in Table 7.8 in the Groundwater Assessment, existing monitoring data indicates an average TDS in the Arkarula Formation of 12,884 mg/L (i.e. more than the predicted long-term TDS in the goaf), and hence groundwater quality in this unit might be expected to improve due to leakage from the overlying unit.

Dr Peter Hancock concluded that it is very unlikely that the re-injected brine salutation would impact on stygofauna communities (Attachment 4).

Riparian Vegetation Monitoring

Issue

The IESC suggested that riparian zone vegetation (along watercourses within the project area) should be monitored to detect any changes due to mining and trigger rehabilitation actions such as replanting.

Response

As described in the BDAR, a Creek Line Monitoring Programme is comprised of annual geomorphic survey of creek stability and condition for up to two years after longwall mining in the vicinity of the creek is complete.

The stated key performance criteria is noted as a 'change to overall drainage pattern is not more than predicted detected alteration in channel dimensions or processes within normal range compared to baseline data'.

Remediation of ponding areas would include:

- Ponding areas located in areas with no significant vegetation and where the water quality of the ponded water is non-saline are to be allowed to self-correct.
- Ponding areas located in areas with significant vegetation to be assessed and remedial measures (e.g. drainage) developed and implemented in consultation with the landholder and a suitably qualified specialist (e.g. hydrogeologist, geomorphologist).

BDAR Certification

Issue

BCS requested that the BDAR should be certified as Biodiversity Assessment Method (BAM) compliant within 14 days of the submission date and associated BAM-C credit cases should be submitted to consent authority within 14 days of certifying the BDAR.

Further, the plot field sheets for the Project should be submitted.

Response

The BDAR will be revised and submitted in September 2021, following additional survey work on the Glossy Black-Cockatoo being undertaken in consultation with DPIE and BCS. The revised BDAR will be certified and associated BAM-C credit cases will be submitted to consent authority within 14 days of certifying the BDAR.

As agreed with BCS on 19 March 2021, the field data provided digitally was sufficient as Eco Logical Australia and AMBS collected the survey data digitally in the field, so there are no 'paper scans' or similar available for the hand-written plot field data sheets.

Consideration of All Surface Impacts

Issue

Clarification was requested by BCS that all surface impacts from the proposal be included in the development footprint.

Response

Section 2.5 of the EIS provides a comprehensive definition of all the surface infrastructure components.

NCOPL confirms that all surface impacts from the Project were included in the development footprint assessed in the BDAR. Notwithstanding, since lodgement of the Project EIS, NCOPL has refined the Project design to reduce the environmental impacts of the Project and respond to particular comments raised in submissions on the EIS.

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

- removing some components of the indicative Surface Development Footprint that are no longer required by the revised Project design; and
- relocating some components of the indicative Surface Development Footprint to reduce impacts on Coolabah Bertya.

The indicative Surface Development Footprint for the amended Project would reduce the EIS footprint by approximately 31 ha. Accordingly, a revised BDAR is being prepared for the amended footprint.

Further justification of the amendments to the indicative Surface Development Footprint is provided in the Amendment Report.

In addition, DPIE requested clarification of the reduction in potential impacts of the initial design of the indicative Surface Development Footprint and the Project footprint (Section 5.1.2 of the BDAR). The recalculated reduction in footprint between the initial design and the amended indicative Surface Development Footprint is provided in Table 7. Further clarification regarding the reduction in footprint will be provided in the revised BDAR.

Table 7
Comparison of the Initial and Amended Project indicative Surface Development Footprint

Vegetation	Originally Proposed Indicative Surface Development Footprint (ha)[1]	Approximate Revised Project Indicative Surface Development Footprint (ha)[#]	Approximate Re-calculated Difference
Woodland*	454.7	419.6	35.1 ha less clearance
Derived Native Grassland	143.1	124.7	18.4 ha less clearance
Belah Woodland (PCT 55)	8.3	7.5	0.8 ha less clearance

[1] BDAR Figure 28.

[#] Values will be subject to rounding in the revised BDAR.

* Inclusive of PCT 55.

Impact Reduction Area

Issue

BCS commented that the identified Impact Reduction Area should not be considered as a form of avoidance and that the final credit obligation for the Project should be presented without manual deductions to ecosystem and species credits development footprint is associated with the Narrabri Underground Mine Stage 2 development.

Response

NCOPL consulted with DPIE – Biodiversity Conservation Division (BCD) (now BCS) on 10 December 2019 and 25 June 2020 and DPIE on 11 December 2020 in relation to the assessment of the Impact Reduction Area, and the BDAR reflects the outcome of those meetings.

On 23 March 2021, DPIE and BCS accepted that part of the approved footprint is being relinquished as part of the Project (The existing Narrabri Mine [Stage 2] Project Approval 08_0144 would be surrendered if the Project is approved [i.e. the new Development Consent would consolidate/replace the current Project Approval]). For this reason, the change does not require a separate development application. Notwithstanding, DPIE and BCS requested that the Impact Reduction Area is removed from the BDAR and assessed in a separate stand-alone document. DPIE and BCS accept the approach of determining the biodiversity value (number of credits if it were to be impacted) of the Impact Reduction Area using the BAM.

The Impact Reduction Area Report will be submitted to DPIE in September 2021, at the same time as, but separate to, the revised BDAR.

Mine Site Ecological Rehabilitation Offset

Issue

BCS commented that the proposal to apply the use of mine site ecological rehabilitation as an offset should be removed from the BDAR.

Response

NCOPL consulted with BCD (now BCS) on 10 December 2019 and 25 June 2020 and DPIE on 15 July 2020 in relation to mine site ecological rehabilitation, and the BDAR reflects the outcome of those meetings. The draft ancillary rule for mine rehabilitation were provided to NCOPL from the BCD (now BCS) (on 26 February 2020) for use in the BDAR and DPIE advised NCOPL that it supported the use of rehabilitation to seek offset credits.

On 19 March 2021, BCS expressed a preference that the sections of the BDAR which have been prepared according to the Draft Ancillary Rules for Mine Site Ecological Rehabilitation are removed from the BDAR.

The mine site ecological rehabilitation calculations will be removed from the revised BDAR, but noting that BCS is supportive of the BDAR referencing the intention to undertake mine site rehabilitation when a method for doing so has been published and finalised.

Equivalency Assessment of White Box –Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Issue

BCS raised that an equivalency assessment should be provided for the State listing of White Box –Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (DNG).

Response

The following additional text will be added to the revised BDAR:

> *One of the PCTs mapped at the site, PCT 435, is recognised in BioNet Vegetation Classification (DPIE, 2020b) as a 'partially subset' of BC Act-listed* White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions *critically endangered ecological community (commonly known as Box-Gum Woodland CEEC) in some locations in NSW. Areas of PCT 435 within the study area tend to occur on rocky slopes (not fertile lower parts of the landscape), have a relatively high cover of shrubs (>30%, not sparse or absent) and often dominance of Callitris glaucophylla, as well as a low cover of tussock grasses (groundcover not dominated by tussock grasses). For this reason, these patches were not considered to be equivalent to the listed TEC under the BC Act (AMBS, 2020a) (Attachment B).*

Glossy Black-Cockatoo Credit Calculations

Issue

BCS considered that revisions to credit calculations for the Glossy Black-Cockatoo post-consent would require a modification application.

Response

Section 4.2.5 of the BDAR states:

> *The methodology for defining a species polygon for the Glossy Black-Cockatoo was not defined in the BioNet Threatened Biodiversity Data Collection (DPIE, 2020d) prior to and during the survey work for this Project and therefore it was taken that species polygon was habitat with suitable hollow bearing trees and frequent sightings (breeding habitat) (AMBS, 2020b) (Attachment C). More recently in mid-2020, after the survey work, the methodology for defining a species polygon for the Glossy Black-Cockatoo has been specified in the BioNet Threatened Biodiversity Data Collection (DPIE, 2020d) to specifically require the identification of a nest tree (in use by the species) and a circular species polygon with a buffer radius of 200 m to be established around each nest tree. This new method would have the effect of reducing the number of credits required for this Project, but also reducing the number of credits that can be generated for the species at Biodiversity Stewardship Sites.*
>
> *Given that the methodology for mapping a species credit polygon for the Glossy Black-Cockatoo was revised since the surveys for this Project, it is reasonable for the biodiversity credit requirements for the Glossy Black-Cockatoo to be reduced if NCOPL obtains an Expert Report (in accordance with the BAM [OEH, 2017]) or undertake additional targeted surveys as required by DPIE.*

NCOPL expects that the possible change in credit obligation can be conditioned given DPIE changed the methodology after the survey work for the Project was completed. For example, Condition B49 of Maxwell Project approval (SSD 9526) allows reduction of the credit requirement with submission of additional survey findings or expert report:

> *The biodiversity credit requirements outlined in conditions B47 and B48 for Diuris tricolor; Prasophyllum petilum; Pterostylis chaetophora; Ozothamnus tesselatus and Thesium australe, may be reduced if the Applicant demonstrates to the satisfaction of the Planning Secretary, that the credit requirements in Table 6 and/or Table 7 do not accurately reflect the extent of impacts on these species as a result of the development. Any request from the Applicant to reduce these credit requirements must:*
>
> *(a) be in writing and addressed to the Planning Secretary; and*
>
> *(b) be supported by an expert report or survey report outlining the findings of additional surveys, which has been prepared:*
>
> *(i) by a suitably qualified and experienced person/s;[a,b]*
>
> *(ii) in accordance with the BAM;*
>
> *(iii) in consultation with Council; and*
>
> *(iv) in consultation with BCD,*
>
> *to the satisfaction of the Planning Secretary.*
>
> [a] *In the case of an expert report, a 'suitably qualified and experienced person' means a person who meets the relevant requirements outlined in section 6.5.2 of the BAM*
>
> [b] *In this case of a survey report, a 'suitably qualified and experienced person' means an accredited person as defined in section 1.6 of the BC Act.*

Potential Impacts on Geological Features of Significance

Issue

BCS requested that further information be provided regarding the likely prescribed impacts of the proposal on geological features of significance.

Response

The following text will be added to the revised BDAR:

> *An assessment of the impacts from the Project on the Large-eared Pied Bat is provided in Sections 8.1.3 and 9.2.10. The unnamed rocky outcrop is of lower importance to the Large-eared Pied Bat compared to Bulga Hill and other habitat in the bioregion (within the species wider range) as no breeding was recorded at the unnamed rocky outcrop (Attachment C). The Fauna Survey Report (AMBS, 2020b) (Attachment C) states:*
>
> > *The unnamed rocky outcrop had less complexity in both caves and crevicing* [with regard to Bulga Hill] *… though both were present … No caves with mouth widths greater than 4 m were observed. Of the caves that were present, two had depths of approximately 3 m while another two had depths of up to 2 m. Numerous crevices were present with unknown depths. It is likely that this rocky outcrop could provide temporary night roosts, or even occasional daytime roosts, to some species.*
>
> *Literature on the Large-eared Pied Bat is referenced in Section 9.2.10, including a description of its distribution, roost sites and habitat.*
>
> *As described in Section 5.1.2, NCOPL reviewed the positioning of infrastructure to avoid or minimise impacts on the unnamed rocky outcrop. However, as described in Section 6.2.1, the results of subsidence modelling has shown that subsidence impacts are possible and would include cracking. Ditton Geotechnical Services (2020) undertook a subsidence assessment for the Project, in which potential subsidence impacts were predicted based on several empirical and calibrated analytical models.*
>
> *Remediation of surface cracks is described in Section 6.2.1, however short to long-term changes to the habitat at the unnamed rocky outcrop are possible. Despite the potential impacts (subsidence) on the unnamed rocky outcrop, the Large-eared Pied Bat is likely to persist in the locality given breeding was recorded at Bulga Hill, which would be avoided. A species credit requirement has been calculated for the Large-eared Pied Bat based on a buffer around the unnamed rocky outcrop (Figure 26).*

Targeted Flora Surveys

Issue

BCS requested that further justification be provided for targeted flora surveys conducted during drought conditions.

Response

Further consultation was undertaken with BCS and, on the 19 March 2021, BCS concluded that the justification provided in Attachment B of the BDAR related to the potential occurrence of threatened flora is considered sufficient in this circumstance. Sections of the BDAR will be revised to give reference to, and provide a summary of the findings of Section 3.5 of Attachment B.

Various Points of Clarification in the Biodiversity Development Assessment Report

Issue

BCS requested that a number of points of clarifications be made in relation to the following aspects in the BDAR:

- managing the potential for trampling of threatened flora species is further explained serious and irreversible impact (SAII);
- assessment for threatened Microchiropteran bats would require further consideration of indirect impacts;
- the assessment and justification of avoidance and mitigation measures for Coolabah Bertya require revision. Further assessment and clarification is required regarding the potential for subsidence impacts to affect overlying biodiversity values;
- further clarification of subsidence impacts on biodiversity;
- adequate justification is required to support stratification of non-native vegetation;
- vegetation zone mapping should be revised to correct significant spatial errors;

- the species polygon for Squirrel Glider should be inclusive of PCT 404.
- a total loss of VI should be assumed for ETL management areas; and
- requirement for post-consent management plans to appropriately mitigate operational risks and residual impacts to resident fauna.

Response

Potential for Trampling of Threatened Flora Species

Sections 6.2.1 and 7 of the BDAR states:

> *Prior to any remediation of surface cracks, NCOPL would undertake a review of environmental impacts that may result from the remediation at the specific location and consider whether remediation of surface cracks is environmentally beneficial or if alternative methods of remediating the crack are warranted (e.g. without machinery). The review would consider, among other factors, the known locations of threatened flora species.*

This text will be repeated in an addition section of the revised BDAR to make it clear that this also applies to manage risk of trampling during remediation.

SAII Assessment of Microchiropteran Bats – Assessment of Indirect Impacts

Section 8.1.3(d) provides an assessment of indirect (subsidence) impacts on the threatened Microchiropteran bats. A detailed assessment of indirect impacts is provided in Section 6.2 of the BDAR, including noise, human activity and light spill.

The following additional text will be added to the revised BDAR:

> *Noise would exist temporarily during construction and operation. The scale of noise impacts for the Project would be similar to the approved Narrabri Mine and the main noise sources are located at the existing Pit Top Area, located 11 km north of Bulga Hill.*
>
> *Lighting is used at the existing Narrabri Mine and would be used for the Project. Artificial lighting for the Project has the potential to affect the behavioural patterns of bats. For example, bats can be attracted to insects that swarm around artificial lights. Night-lighting of the Project surface facilities would be kept to a practicable minimum and would generally be in working areas only (i.e. the existing pit top area* [11 km north of Bulga Hill]*, and some working areas of the underground mine area).*
>
> *Although the Project would temporarily increase human activity during construction and revegetation activities, access to ML 1609, MLA 1 and MLA 2 is controlled and generally restricted to authorised personnel. It is unlikely that increase human activity, which is mainly during the day, would have an adverse impact on these bats.*

Avoidance and Mitigation Measures of Coolabah Bertya Require Revision

The BDAR assessed Coolabah Bertya as a potential SAII entity. After the EIS was submitted, DPIE changed Coolabah Bertya to an approved SAII entity, changed the species 'Sensitivity to Loss' (from moderate to very high), 'Level of Biodiversity Concern' (high to very high) and 'Biodiversity Risk Weighting' (2 to 3) on BioNet *Threatened Biodiversity Data Collection*. As a result, the Project species credit requirements for Coolabah Bertya increased from 51,878 credits (as reported in the BDAR) to 73,926 credits. The revised BDAR will be updated to reflect that DPIE's new classification of this species.

Section 8.1.2(d) of the BDAR states:

> *At a broad level, the Project has been designed to avoid or minimise impacts on biodiversity values through:*
>
> - *the use of underground longwall mining methods, which significantly reduces vegetation and soil disturbance (and impacts on hydrological features) in comparison to open cut mining methods;*
> - *the use of the substantial existing infrastructure at the existing approved and operating underground mine (such as the Pit Top Area), limiting the requirement to develop new infrastructure; and*
> - *locating multiple surface infrastructure components within the same alignment.*

NCOPL considers that it is not feasible to avoid all clearance impacts on Coolabah Bertya as the population extends to the central portion of ML 1609 above the existing approved Stage 2 longwalls (LW 206, 207, 208 and 209) (Figure 18).

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

AMBS undertook further surveys of Coolabah Bertya to identify potential infrastructure relocation areas since lodgement of the EIS. Accordingly, NCOPL has refined the Project design to reduce the potential impacts to Coolabah Bertya by approximately 2.3 ha, compared to the Project EIS. Further information regarding the amended indicative Surface Development Footprint is provided in the Amendment Report.

The revised BDAR will consider the amended Project's potential impacts on Coolabah Bertya.

As noted by the BCS, NCOPL proposes a translocation and propagation program for Coolabah Bertya. NCOPL recognises the benefits of this research program to further the understanding around management of this species and accepts BCS's recommendation for preparation of a *'translocation and propagation management plan'* in consultation with BCS and a suitably qualified person for Coolabah Bertya, and the BDAR will be updated to adopt this recommendation. There is no recognised species 'expert' (as defined under the BC Act) for Coolabah Bertya.

A detailed assessment of indirect impacts is provided in Section 6.2 of the BDAR, including surface cracking, groundwater drawdown and edge effects. The following additional text will be added to the revised BDAR:

Land subsidence is unlikely to materially impact the potential habitat for Coolabah Bertya within the predicted subsidence area as dieback or more than occasional tree fall (outside of potential ponding areas and identified areas of potential cracking impacts [Figure 6]) is unlikely based on experience and monitoring results at the existing mine (ELA, 2014; ELA, 2019d).

Surface cracking is more likely in the eastern portion of the Project (outside of the majority of woodland areas), because the depth of cover trends from lower to higher, east to west. Localised changes to soil moisture may occur around surface cracks, but this is unlikely to at a frequency to result in a material impact to the Coolabah Bertya population. Further, minor cracks are not expected to require remediation, as geomorphological processes would result in these cracks filling naturally over time.

Coolabah Bertya is not associated with any areas of groundwater dependant vegetation and therefore groundwater drawdown is not a relevant potential impact pathway for this species.

Coolabah Bertya was observed on the edge of existing State Forest tracks (e.g. Scratch Road)*, suggesting that this tall shrub can withstand edge effects* (Figure 18)*. Unlike the existing State Forest tracks, the tracks for the Project would be temporary and subject to progressive rehabilitation, limiting the duration of edge effects.*

Further Clarification of Subsidence Impacts on Biodiversity

Subsidence is predicted to impact on overlying vegetation in the following ways (other than subsidence induced ponding):

- cracking resulting in root shearing in areas of low depth of cover (less than 180 m); and
- surface cracks resulting in minor impacts on vegetation.

These are discussed in turn below.

Root Shearing

As described in the BDAR, a number of trees were observed to be dead or highly stressed following the completion of mining of Longwalls 101 and 102. The impacts were studied by Eco Logical Australia (2014). The study included:

- tree health assessment and associated data analysis;
- soil landscape character assessment;

- soil moisture assessment;
- groundwater assessment;
- subsidence sheer stress assessment;
- analysis of rainfall preceding subsidence; and
- tree regeneration assessment.

Eco Logical Australia (2014) attributed the observed impacts to factors such as dry conditions, low depth of cover and heavy soil texture. The area with a depth of cover of 180 m and below were found to approximately correlate to the area of potential cracking impacts noted by Eco Logical Australia (2014), however the majority of impacts occurred at a depth of cover of 170 m and below. Figure 31 of Appendix D of the EIS shows the areas of 180 m depth of cover for the Project and for the existing Narrabri Mine. For the existing Narrabri Mine, not all trees in this area were observed to be stressed, however, the BDAR assumes all trees within the noted 180 m depth of cover would be impacted. Furthermore, the assessment by Ditton Geotechnical Services (2020) (Peer Reviewed by Professor Bruce Hebblewhite) indicates that the risk of potential impacts on vegetation due to this mechanism is limited to clayey soils above Longwall 210, particularly if dry conditions prevail at the time of mining.

It is, therefore, considered that the methodology used to assess this potential impact in the BDAR is conservative.

Surface Cracking

As described in the BDAR, land subsidence (which is predicted to occur across the predicted subsidence area) is unlikely to materially impact vegetation or habitat, as dieback or more than occasional tree fall is unlikely. Surface cracking is more likely in the eastern portion of the Project (outside of the majority of woodland areas) because the depth of cover trends from lower to higher, east to west. As noted in the BDAR, it is conceivable that ground animals could fall into subsidence cracks and would likely climb out (i.e. this would not necessarily result in fauna death). Cracks would naturally fill over time or would be remediated.

Progressive Model Review and Updates

In addition, the role of faults in the subsidence predictions is described in Appendix A of the EIS (Ditton Geotechnical Services, 2020). As described in Ditton Geotechnical Services (2020), the magnitudes of the measured differential subsidence also affected by the near surface geology and topographic relief, which can result in anomalies along the subsidence effect profiles. The anomalies are usually due to discontinuous movements along rock mass joints, faults and/or dykes during subsidence development. It is, therefore, important that measured subsidence and differential subsidence profiles are reviewed regularly against the empirical models to test their reliability. If the variation between the predictions and measured values is significant (i.e. more than 5% of predictions are exceeded for a given mining geometry or the magnitudes of the predicted effects are exceeded by 15%), then the model is amended and predictions for the next longwall panels adjusted.

This model review and amendment process has been followed by for the Project (i.e. model subsidence predictions have been adjusted upwards to reflect the measured subsidence that has occurred at the Narrabri Mine to date). Given the nature of the geology mined to date is very similar to the Project, anomalies such as faults have been considered in the subsidence predictions made by Ditton Geotechnical Services (2020) for the Project.

Adequate Justification of Stratification of Non-native Vegetation Required

NCOPL met with BCS in April 2021 and explained that the areas of non-native vegetation were delineated using a combination of visual assessment of remote imagery and on-ground assessment of species composition, BCS accepted the information presented and requested that it be included in the BDAR.

Areas of potential non-vegetation were identified in remote imagery using visual cues, including recent cultivation patterns and evidence of woody exotic species (e.g. European olives) having been planted in rows. The floristic composition and degree of dominance by exotic species was then assessed on-ground. Where the dominant species of the dominant strata were found to be exotic, these areas were delineated as non-native vegetation (Plate 2).

The composition is exotic plants, the structure is poor (no trees, shrubs), and function is poor (no trees or regeneration, minor litter cover, with weed cover. Considering the vegetation integrity scores of the native grasslands, these exotic areas are not likely to generate a vegetation integrity score above the threshold for requiring an offset and are likely to meet the definition of Category 1 land (which can be developed without surveys and assessment).

The Area mapped as 'Exotic' is consistent with the 'cropping' layer on the *Landuse Mapping for NSW 2017* (DPIE, 2020).

Plate 2
Example of Area Mapped as 'Exotic'

Vegetation Mapping to be Revised to Correct Spatial Errors

Further consultation was undertaken with BCS and, on 19 March 2021, BCS agreed that the minor gaps and overlaps identified would have limited effects on specific vegetation zone area calculations in this circumstance. No further action is necessary.

It was found that the gaps equate to less than 0.07 ha across all vegetation zones, which if further divided into vegetation zones would not be of a magnitude to result in any changes to the area calculations for the Project, given the area calculations were already rounded up to be conservative. Any overlaps are likely to be in the same order of magnitude (also minor and insignificant) and would have the effect of increasing the area of each vegetation zone (also insignificantly).

Squirrel Glider

Further consultation was undertaken with BCS and, on 19 March 2021, BCS agreed that the justification to guide species polygon mapping for the Squirrel Glider is accepted in this circumstance. No further action is necessary.

The occurrence or habitat of a 'species credit species', like the Squirrel Glider, cannot be predicted by vegetation surrogates and landscape features. For this reason, targeted field surveys are required for species credit species to identify its presence and habitat (not a desktop assessment).

No Squirrel Gliders were found during AMBS's targeted surveys for the species throughout the study area between 2016 and 2019. A database review revealed a single database record of the species in the study area from ten years ago (2011).

The species polygon presented in the BDAR based on the field surveys (excluding the majority of areas of PCT 404) is conservative and appropriate because:

- The field surveys found that the database record was in contiguous 'vegetation' with PCT 404, but was not located in contiguous 'habitat' for the species. Rather, the Squirrel Glider recorded within the study area was recorded in PCT 399 (*Red Gum - Tea Tree Creek Woodland*). The record is close to PCT 435 (*White Box - White Cypress Woodland*) and PCT 88 (*Pilliga Box – Buloke Woodland*). All three of these PCTs support higher densities of hollow-bearing trees than most of the study area, and all three were included in the species polygon for the species.
- The majority of PCT 404 is expressed as thick Burrows Wattle tall shrubland. Trees within these areas are young or stunted due to the rockier geology, poorer soils and potentially a history of fire and logging. Hollows within these areas were rarely encountered and did not come close to the density thresholds described in the *Threatened Biodiversity Data Collection* species profile and published literature. If hollows were present, they were usually unsuitably small.
- AMBS notes that the Squirrel Glider is reported to utilise disturbed woodlands or paddock trees. However, most studies reporting this behaviour occur in more fertile areas of Victoria or Coastal NSW, where the trees are usually old growth Blackbutt (*Eucalyptus pilularis*), Red Gum (several species) or Scribbly Gum (several species) trees which support large numbers and varieties of hollows. The field surveys found that such patterns of hollow abundance are not matched in the Burrows Wattle tall shrubland areas of PCT 404 within the Project area.

The field surveys found there are small areas of PCT 404, usually associated with broad drainage channels between low rocky hills, that support larger Red Ironbark and White Bloodwood trees with comparatively large numbers of hollows. The understorey in these areas is more diverse and includes several *Acacia* species which could provide sap food resources for the Squirrel Glider. These habitats could support the species in the area and were included in the species polygon, despite the fact that the species was not detected during numerous spotlighting surveys in 2016 and 2019.

ETL Management Area as VI

Section 6.1.1 of the BDAR states:

> *The 66 kV ETL would be progressively extended as ventilation shafts and the mine is developed (Figure 6). Trees would be removed 30 m either side of the ETL for safety reasons. The maintenance activities along the ETL would conclude once the ETL is no longer operational.*

A total loss of VI has been assumed for land clearance associated with the ETL constructed footprint, and that a partial loss of in VI was calculated only for the 30 m buffer to each side of the ETL (i.e. the ETL Management Area). Within the buffer, only trees, shrubs and regeneration that could interfere with the ETL would be removed, leaving the remaining layers intact. The vegetation in the ETL Management Area is mostly existing cleared land (exotics) and DNG.

Mitigation Measures Post-consent

Section 7 of the BDAR includes a range of measures to mitigate and manage impacts on fauna, consistent with the existing approved Narrabri Mine. Section 7 states:

> *Table 20 provides measures to mitigate and manage impacts from the Project. NCOPL would be responsible for implementing the measures. After the measures to mitigate and manage impacts, there would be a negligible risk to biodiversity with a* ***low consequence in the medium to long term after mining operations.***

Section 6.3.6 of the revised BDAR provides an assessment of the potential impacts from vehicles strike considering a range of factors, not only the speed limit. Sections 6.1.1 and 6.1.2 of the revised BDAR provide an assessment of the potential impacts from clearance considering a range of factors not only the vegetation clearance protocol.

NCOPL accepts that relevant post-consent management plans (i.e. the Biodiversity Management Plan) would be prepared in consultation with BCS. NCOPL acknowledges that additional detail on the measures would be described in the Biodiversity Management Plan according to the SMART (Specific, Measurable, Achievable, Realistic, Timebound) principles.

Excessive Clearing in Pilliga State Forest

Issue

An organisation raised concern that there has been excessive clearance of the Pilliga State Forest due to existing Narrabri Mine operations.

Response

The total clearing for the currently approved Stage 2 operations is within the approved limits assessed in the EA (i.e. less than 210.5 ha clearing of woodland/forest native vegetation) and the MOPs have been progressively updated to include expected disturbance.

Habitat Fragmentation, Edge Effects, Remediation of Subsidence Impacts and Cumulative Impacts

Issue

An organisation raised concern that habitat fragmentation and edge effects (such as weed incursion) were not considered in the BDAR. Further, it was raised that biodiversity impacts associated with remediation of subsidence impacts have not been considered in the BDAR.

It was described that cumulative impacts should have been discussed on a vegetation community basis, including consideration on the Corben's Long-eared Bat. A query was raised that the Black-striped Wallaby should have been considered as a species credit species.

Concern was raised that potential impacts on the Pilliga State Forest were not adequately addressed, including potential cumulative impacts with the Narrabri Gas Project.

Response

Impacts

Habitat fragmentation is discussed primarily in Section 6.3.2, edge effects in Section 6.2.5 and weeds in Section 6.2.9 of the BDAR. Measures to mitigate and manage all of these impacts are outlined in Section 7 of the BDAR. Further detailed information regarding subsidence impacts can be found in Appendix A of the EIS and in regards to subsidence remediation, the BDAR states:

> *Prior to any remediation of surface cracks, NCOPL would undertake a review of environmental impacts that may result from the remediation at the specific location and consider whether remediation of surface cracks is environmentally beneficial or if alternative methods of remediating the crack are warranted (e.g. without machinery). The review would consider, among other factors, the known locations of threatened flora species.*

Cumulative Impacts

Potential cumulative impacts are discussed in Section 6.1.4 of the BDAR.

Narrabri Gas Project (approximately 988.8 ha of proposed native vegetation clearance) (Eco Logical Australia, 2016). The surface development for the Project would involve progressive clearance (over a 23-year period) of in the order of approximately 500 ha of native vegetation. This is a relatively small area compared to the extensive and continuous native vegetation within Jacks Creek State Forest (approximately 10,045 ha), Pilliga East State Forest (approximately 131,899 ha) and neighbouring reserves (approximately 192,366 ha total).

Based on the foregoing, the Project's contribution to cumulative impacts on biodiversity in the region is not expected to be material.

Black-striped Wallaby

Threatened species that are 'ecosystem credit species' and/or 'species credit species' are pre-determined by DPIE in the *BioNet Threatened Biodiversity Data Collection*. The Black-striped Wallaby (*Macropus dorsalis*) is listed as an ecosystem credit species.

There are a number of ecosystem credit species from the BAM Calculator for the Project with a high 'sensitivity to potential gain' (as defined in the *BioNet Threatened Biodiversity Data Collection*), including the Black-striped Wallaby. The ecosystem credit calculation uses the highest 'sensitivity to potential gain' class in the credit calculation for a vegetation zone. In this case, the high 'sensitivity to potential gain' was used in the BAM Calculator to generate the ecosystem credits, and therefore any potential impacts on the Black-striped Wallaby are included in this calculation.

IBRA-subregion in the BAM Stage 1 Assessment

Issue

BCS requested clarification regarding the IBRA-subregion in the BAM Stage 1 Assessment.

Response

The following text will be added to the revised BDAR:

> *The BAM-C was run separately for each phase of the Project. For each phase, where a vegetation zone is across one or more IBRA subregions, the IBRA subregion in which most of the phase occurred was used. This allowed a more accurate prediction of the species associated with the habitat in that phase, compared to if only one IBRA subregion was selected and applied to phases outside of that IBRA subregion. Phase 1 and 2 were in the Liverpool Plains IBRA subregion and Phase 3, 4, 5 and 6 were in the Pilliga IBRA subregion.*

As shown in Tables 3 and 4 of the BDAR, this approach has resulted in a larger list of threatened species being considered for the Project and the approach does not change the ecosystem credits produced for each phase as the highest 'sensitivity to gain' is 'high' across all phases.

4.2.6 Hazards and Risk

Fire Management Plan

Issue

It was requested that a Fire Management Plan be prepared for the Project in consultation with the NSW Rural Fire Service (RFS) Namoi Fire Control Centre.

Response

NCOPL supports the recommendations from the RFS and would consult with the NSW RFS Namoi Fire Control Centre during the preparation of a Fire Management Plan.

Bushfire Management Plan

Issue

FCNSW requested that vegetation clearance and the route of ETLs in the State forest be designed to minimise the possible impact from windthrow (trees uprooted by wind).

FCNSW also requested that the Bushfire Management Plan would include a description of the equipment and other resources to be made available for bushfire detection and suppression.

Response

NCOPL would consult with FCNSW when preparing the Bushfire Management Plan in regard to requirements for bushfire management adjacent to proposed ETLs.

In addition, NCOPL would consult with FCNSW when preparing the Bushfire Management Plan. The Bushfire Management Plan will include a description of equipment and other resources to be made available for bushfire detection and suppression.

Restrictions to Fire for Mine Site Ecological Rehabilitation

Issue

FCNSW requested detail regarding the restrictions in the application of fire to land subject to mine site ecological rehabilitation.

Response

Following Mining Lease relinquishment, there is no ongoing land use restrictions in the proposed mine site ecological rehabilitation areas according to the current draft *Ancillary Rules for Mine Site Ecological Rehabilitation* (DPIE 2019). However, note that there may be further requirements of any approval issued by DPIE.

4.2.7 Rehabilitation and Final Landform

Design Principles for the Reject Emplacement Area Final Landform

Issue

NSW Resources Regulator raised concern regarding the geomorphic design principles for the final landform of the reject emplacement area and that the capping thickness should be confirmed prior to final rehabilitation.

Response

Long-term Stability Associated with Erosion

NCOPL commissioned ATC Williams to undertake a review of the capping assessment and closure design of the reject emplacement area at the Narrabri Mine (ATC Williams, 2019).

Further, Landloch Pty Ltd was engaged to assess the erosional stability of the reject emplacement area's proposed capping layer configuration to determine if the proposed capping layer and overall landform rehabilitation design would remain erosionally stable in the long term. Landloch assessed the following items (ATC Williams, 2019):

- assessment of erodibility characteristics of the soil (capping layer) material to be applied over the entire landform, by application of simulated rain and overland flows to the materials;
- assessment of sediment characteristics of the soil (capping layer) material using settling columns;
- WEPP (Water Erosion Prediction Project) runoff/erosion model simulations to assess the erosion performance of batters with the soil (capping layer) applied to the surface of the landform, considering the effect of vegetation cover on the surface; and
- SIBERIA landform evolution modelling to assess the long-term erosional performance of the landform as a whole.

The SIBERIA landform evolution modelling was based on the conceptual landform comprising a maximum height of 15 m, batter slopes of 5 horizontal (H):1 vertical (V) and plateau gradient of 1% sloping to the north for the following vegetation cover scenarios:

- 50% vegetation cover - to model the effect of poor or insufficient vegetation establishment;
- 80% vegetation cover - to model the effect of vegetation cover levels observed to be achievable on similar topsoil materials on-site; and
- 95% vegetation cover - to consider what vegetation levels may be needed given the potential higher risk of erosion from plateau runoff discharging to the batters.

It is highlighted that the landform was modelled without any stormwater management, with outcomes representing the predicted landform evolution resulting from uncontrolled discharge of runoff from the plateau and down the batter slopes.

Simulations were run for a 500-year period, with 100-year outputs including average erosion rates, depth of rill formation and visual representation of erosion and deposition.

ATC Williams (2019) concluded that the modelling outcomes confirmed that management of stormwater runoff both from the plateau and down the batters would be required in order to reduce erosion rates to acceptable levels and prevent potential for rilling and subsequent gully formation. Two specific management aspects are required in this regard (ATC Williams, 2019):

- minimisation of uncontrolled runoff over the plateau edge reporting to the batter slopes – it is proposed that this would be achieved by formation of swale drains on the plateau that would collect and discharge surface runoff to contour drains constructed down the batter slopes at 5% grade (refer Section 8.1.5 for further information); and
- reduction of effective slope lengths down the batter – it is proposed that this would be achieved through construction of the batter contour drains mentioned above. In addition to conveying flows reporting from the proposed plateau swale drains, the contour drains would be designed to ensure that the maximum slope lengths reported in Section 7.3.2 are achieved.

It is proposed that the recommended management measures would be incorporated into the final landform design. For example, Section 2.14.1 describes the following:

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

Geomorphic Design

The use of geomorphic final landform design is not appropriate for a reject emplacement area, given it would require secondary earthworks, which would expose coal reject material. In addition, the relatively small size of the reject emplacement area final landform (i.e. 15 ha) does not facilitate the development of geomorphic landform design. It is considered that a geotechnically stable landform which encapsulates the coal rejects is appropriate as the final landform design for the reject emplacement area.

Further detail of final landform design in regard to final land use and erosion control would be provided in a Rehabilitation Strategy or Rehabilitation Management Plan (or similar) as is typically required by the development consent.

In addition, NCOPL acknowledges the submission made by the Resources Regulator in regard to the requirement for a Rehabilitation Management Plan and assessments in relation to the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* as well as other Work, Health and Safety regulatory obligations.

Soil Resources for Final Rehabilitation Activities

Issue

Calculations of the amount of soil resources required for final rehabilitation activities was requested by DPI – Agriculture. In addition, DPI - Agriculture requested that a map be provided which depicts the progressive restoration of agricultural land, as proposed. Further, it was noted that any agricultural land lost for biodiversity offset purposes should be described.

Response

Given that the clearance required for the Project would occur progressively, soil resources would be managed by stockpiling at the discrete clearing location for later rehabilitation of the clearing at the location.

Attachment 5, Section A5.3.2 of the EIS states:

> ***Soil Stripping and Handling***
>
> *Recovered soil resources would be used in the rehabilitation of the Project or stockpiled for later use in rehabilitation.*

Given the implementation of these measures, NCOPL expects sufficient soil resources to be available for Project rehabilitation activities.

In addition, Attachment 5 Section A5.3.6 of the EIS states:

> ***Establishment of Agricultural Land***
>
> *The rehabilitated Project would include pasture areas similar to surrounding areas that would be suitable for light intensity grazing.*
>
> *Appropriate management and amelioration measures would be implemented so that rehabilitated pasture areas would be comparable in productivity to pre-mining pasture conditions (Section 6.6). This may include the application of gypsum and fertiliser to topsoil in order to address potential acidity, organic carbon and/or nutrient deficiency constraints, and enhance rapid establishment of a sustainable vegetation growth.*
>
> *Approximately 2,063 ha of surface development areas and remediated underground mine areas would be re-established as agricultural land (pasture) following the closure of the Project.*

Further to the above, NCOPL undertook an investigation of current soil stockpile quantities on-site and identified approximately:

- 64,039 cubic metres (m^3) of topsoil; and
- 149,756 m^3 sub-soil.

This would result in approximately 75 mm of topsoil thickness and 170.5 mm of sub-soil thickness across the Pit Top Area.

In order to minimise vegetation clearance at any one time, the clearance of vegetation and subsequent revegetation would be undertaken progressively, with the area of vegetation cleared at any particular time generally being no greater than that required to accommodate planned development activities for the subsequent 12 months (Attachment 5 of the EIS).

As described in the Agricultural Impact Statement (2rog, 2020), the potential for biodiversity offsets to remove agricultural land has been considered:

> *NCOPL is considering potential biodiversity offset areas, which would be conserved to offset biodiversity impacts associated with the Project. At this stage, the precise areas are yet to be determined, with the areas to be conserved on a staged basis finalised prior to disturbance impact occurring. Biodiversity offset areas for the Project would be managed in accordance with a Biodiversity Stewardship Site Agreement. The key objective for the long-term security of offsets would be provided by entering into an in-perpetuity agreement with the NSW Biodiversity Conservation Trust that would safeguard the long-term restoration and protection of the areas. The creation and function of biodiversity offset areas would likely result in a reduction in current agricultural production within the offset areas.*

Bushfire Risks from Rehabilitation and Offset Areas

Issue

The NSC raised concern that the rehabilitation and offset areas may result in new and exacerbated bushfire risks. To limit bushfire risks, NSC requested that all revegetation works be limited to provide a minimum separation distance of 100 m from all dwellings at the time the revegetation works are carried out.

Response

Bushfire risk, including potential bushfire from rehabilitation and offset areas would be managed in accordance with existing practices. The Narrabri Mine maintains a *Bushfire Prevention Standard* (NCOPL, 2016b) and *Fire Danger TARPs* (NCOPL, 2019a) to provide bushfire prevention and control measures for the Narrabri Mine.

Existing specific mitigation and management measures to reduce bushfire risk that would continue to be implemented for the Project include:

- Fixed plant and building required to meet the Building Code of Australia and comply with Australian Standard (AS) 2419.
- Self-bunded fuel and storage areas located and constructed in accordance with AS 1940-2017, fitted with fire extinguishers.
- Maintenance of a non-smoking site.
- Clear access is maintained around all mining-related activities.
- Implementation of fire breaks as a component of planned infrastructure corridors (i.e. including services and gas drainage).
- Availability of appropriate firefighting equipment.

In addition, consistent with NSCs recommendation, NCOPL would provide a minimum separation distance of 100 m from all dwellings at the time revegetation works are being carried out.

Rehabilitation Management Plan, Extraction Plans and Mine Closure Plan Consultation

Issue

FCNSW requested to be consulted during the preparation of the Rehabilitation Management Plan, Extraction Plans and Mine Closure Plan for the Project.

Response

NCOPL would consult with FCNSW when preparing the Rehabilitation Management Plan, Extraction Plans and Mine Closure Plan for the Project.

4.2.8 Amenity

Noise Limits for the Project

Issue

EPA provided recommended conditions of approval for noise limits for the Project. Further, EPA noted that the *Voluntary Land Acquisition and Mitigation Policy* (VLAMP) (NSW Government, 2018) would apply for those receivers where noise criteria are predicted to be exceeded by greater than 5 'A' weighted decibels.

Response

NCOPL confirms that the EPA's recommended conditions in relation to noise accurately reflect the findings within the EIS.

Further, NCOPL acknowledges the EPA's submission in regard to application of the VLAMP and conditions can confirm that all receivers within the Noise Management Zone and Noise Affectation Zone have been consulted and agreements in place where required (with the exception of receiver 601a). The property in relation to dwelling 601a is in the process of acquisition.

Air Quality Criteria

Issue

EPA noted that no change in the existing air quality criteria in the existing EPL is required.

Response

NCOPL supports the EPA's submission in regard to maintaining existing air quality conditions in the Environment Protection Licence.

4.2.9 Road and Rail Transport

Drilling Waste Disposal and Transport Route

Issue

EPA recommended that drilling wastes disposed at the Project complies with the specifications defined in the document *The Treated Drilling Mud Order 2014* (EPA, 2014), and that this waste should be characterised periodically.

EPA requested that the transport route for this waste be clarified.

Response

NCOPL supports the EPA's recommendations in relation to management of drilling waste. The transport route would depend on the origin of drilling wastes (which would be sourced from other Whitehaven exploration activities), however transport volumes would be relatively low (approximately four heavy vehicle trips per week).

Kamilaroi Highway and Kurrajong Creek Road Intersection

Issue

TfNSW noted that the intersection of Kamilaroi Highway and Kurrajong Creek Road was considered in detail in the Narrabri Stage 2 Environmental Assessment, and some further detail from this documentation was requested.

Response

Section 4 of R.W. Corkery & Co. Pty Ltd (2009) Environmental Assessment for the Narrabri Coal Mine Stage 2 Longwall Project, Section 4B.10.2.2 states:

> *In accordance with the RTA Road Design Guide, these storage and taper zones have been developed to cater for the maximum anticipated traffic volume arriving at the intersection over a 6-minute period (equivalent to the maximum closure time of the railway crossing). Notably, the 98m storage zone of the right turn lane would cater for up to 13 light vehicles and 1 heavy vehicle and includes a 38m distance between the Kamilaroi Highway and the hold line of the railway crossing (to cater for heavy vehicle storage on this side of the intersection). It is also notable that the remaining 160m distance of the right-hand turn lane is the maximum distance available before the Kamilaroi Highway narrows for a culvert ridge over Kurrajong Creek Tributary 2.*

Section 4B10.5.1 states:

> *Based on the traffic projection figures for the Kamilaroi Highway ..., average traffic levels generated by the Longwall Project would increase traffic on the Kamilaroi Highway by 14%. Maximum traffic levels generated by the Longwall Project would increase Kamilaroi Highway traffic by 21%. As road traffic levels would not increase throughout the Longwall Project, this percentage increase would reduce to 9% and 14% for average and maximum traffic generating days respectively.*
>
> *This level of increase in traffic numbers is still well within the capacity of the Kamilaroi Highway and given the Kamilaroi Highway – Kurrajong Creek Road intersection has been designed to store up to 13 light and 1 heavy vehicle during rail crossing closure, there would be no noticeable impact on traffic flows and congestion on the Kamilaroi Highway.*

Assessment of B-Doubles

Issue

TfNSW raised concern that the Road Transport Assessment assumes the use of B-doubles, which are not approved for Kurrajong Creek Road.

Response

NCOPL proposes to seek reclassification of the section of Kurrajong Creek Road and the highway intersection to be a gazetted B-double route. NCOPL has initiated this process with NSC, who has indicated that NCOPL must lodge a permit request with the National Heavy Vehicle Regulator (NHVR). Once this request is made, the NHVR will be individually assessed by NSC prior to issue. NSC does not have any in-principle issues with the use of B-doubles on Kurrajong Creek Road.

Existing/approved Workforce and Peak Operational Workforce Assessment Scenario

Issue

TfNSW raised concern that the existing/approved workforce is up to approximately 520 personnel. In addition, information was requested to confirm that the size of the workforce during the June 2019 survey period was representative of the peak operational workforce. Further, TfNSW requested information to confirm that transport impacts under atypical scenarios are captured by the assessment.

Response

Workforce was previously described in Narrabri Mine approval documentation, most recently, Narrabri Mine Modification 5 Environmental Assessment (MOD 5) Table ES-1, Section 2.9 and Section 3.9 state that the existing operational workforce (employees and contractors) is approximately 370 personnel, and that there is no change to this number as part of MOD 5.

Notwithstanding, the workforce at the Narrabri Mine is currently up to approximately 520 full-time equivalent personnel (Section 2.1.11 of the EIS). These workforce numbers are reported to the CCC approximately annually.

Section 6.15.3 of the EIS states that the Project would allow for the continued employment of up to approximately 520 full-time equivalent personnel at the Narrabri Mine. The average Project operational workforce between 2022 and 2044 would be in the order of approximately 370 full-time equivalent on-site personnel. This is the same number as approved as part of MOD 5.

In addition, TTPP (2021) reviewed NCOPL employee and contractor data over one year during the same period as the traffic surveys, which indicated 270 NCOPL employees and 253 FTE contractors were based at Narrabri Mine. This total of 523 FTE workers is consistent with the peak 520 FTE workforce at the existing Narrabri Mine, and therefore the traffic surveys in the Road Transport Assessment (TTPP, 2020) represent peak operational conditions.

Peak and Average Train Movements

Issue

TfNSW requested clarification regarding the forecast of peak and average daily train movements. Further, TfNSW requested clarification regarding data (e.g. frequency and delay) on trains accessing the Narrabri Mine rail loop, and whether this data may change in the future. Lastly, it was requested that intersection performance be re-modelled based on this additional data.

Response

The currently approved maximum production rate of 11 Mtpa is not proposed to increase as part of the Project. Therefore, rail transport movements would not change from the currently approved mine as described in Section 4.2 of the Road Transport Assessment (TTPP, 2020).

The Project would not change the average or peak number of trains at the Narrabri Mine. The Narrabri Mine-generated train movements would continue to occur 24 hours per day and seven days per week.

Notwithstanding, TTPP has undertaken additional modelling of the level crossing and the intersection of Kurrajong Creek Road and Kamilaroi Highway to review vehicle queue behaviour onto the Kamilaroi Highway. The queueing space in the storage bays as marked on the Kamilaroi Highway is approximately 125 m to the north and 150 m to the south (TTPP, 2021; Attachment 3).

TTPP concludes that the available storage space is sufficient for the modelled events up to the 97th percentile, and for the majority of 99th percentile events. Notwithstanding, TTPP recommends the installation of “queued vehicles” (W5-231n) warning signs on Kamilaroi Highway to alert drivers of the possible presence of a queue (Attachment 3).

Operational Performance of Existing Mine Access Road

Issue

TfNSW requested the operational performance (including incidents and crashes) of the existing mine access road to be clarified/further explained.

Response

Three incidents at the rail crossing have been recorded to date. The incidents related to vehicles crossing the rail line while boom gates have been activated and occurred in October 2015, January 2016 and May 2019. The three incidents were classified by NCOPL as 'near misses'. Near misses are defined by Whitehaven as incidents that have the potential to cause damage to people, property or the environment. The three near miss incidents had no resulting damage to people, property or the environment.

Traffic Management Plan and Driver's Code of Conduct

Issue

Transport for NSW recommended that a Traffic Management Plan be prepared for the Project, including a driver's Code of Conduct.

Response

The current operational workforce is not proposed to increase as part of the Project. Therefore, no additional management measures are considered necessary by NCOPL as the traffic volumes would remain the same as the currently approved mine.

NCOPL supports the recommendation from TfNSW to develop a drivers Code of Conduct.

Third-party Submissions on Road and Rail

Issue

Transport for NSW requested that any third-party submissions on road or rail issues be provided.

Response

No other third-party submissions regarding road or rail transport have been received.

All submissions are provided on the Major Projects website: https://www.planningportal.nsw.gov.au/major-projects/project/10731

Cumulative Impacts on Rail Line

Issue

GSC requested that cumulative impacts to the rail line be considered including consideration of rail capacity.

Response

The Hunter Valley coal rail network is managed by the Australian Rail Track Corporation (ARTC). The Werris Creek Mungindi Railway, which forms part of the Hunter Valley coal rail network, would continue to be used to transport ROM coal to the Port of Newcastle for export.

A Project summary letter was sent to the ARTC on 11 December 2019. This included an overview of the Project and Project requirements for rail track capacity and train path availability (i.e. no change to approved daily train movements and continuation of operations to 2044). Confirmation that access to the NSW rail network would continue to be available for the Project was requested.

The ARTC responded via letter on 21 July 2020, indicating that sufficient capacity can be established to accommodate the Project to 2044.

NCOPL would continue to work with the ARTC on access arrangements to the Hunter Valley coal rail network as the Project progresses.

4.2.10 Greenhouse Gas

Mine Safety Gas Management Techniques

Issue

Two organisations raised concern regarding the proposed mine safety gas management techniques, including pre-mining and goaf gas drainage, which would result in direct greenhouse gas emissions. Further, concern was raised that gas drainage would be surface drainage, rather than underground in-seam drainage for capture and re-use on the surface. Further, it was noted that surface gas drainage would result in additional clearance compared with underground in-seam gas drainage. Lastly, it was noted that NCOPL has raised the possibility of flaring of gas for the Project, which raises other potential risks associated with the flaring operation. As described further herein, flaring of some of the pre-drainage gas is proposed as part of the amended Project (NCOPL, 2021). The resulting greenhouse gas emissions abatement is described in Jacobs (2021).

Response

Section 6.17 of the EIS assesses greenhouse gas emissions from the Project. As described in Section 6.17.2 of the EIS, methane emissions from coal mines and venting are included as fugitive emissions within Scope 1 emissions. A description of the methodology in relation to Scope 1 emissions is provided in Section 6.17.2 of the EIS and Section 9 of the Air Quality and Greenhouse Gas Assessment (Jacobs, 2020). As described further herein, flaring of some of the pre drainage gas is proposed as part of the amended Project (NCOPL, 2021). The resulting greenhouse gas emissions abatement is described in Jacobs (2021).

Gas management is required for the safety of the mine workforce. Gas management methods used for underground coal mining is dependent upon the geology and gas characteristics of the coal seam being mined. For example, coal mines in the southern coalfields of NSW have lower gas volumes, but higher methane content than the Project. Further, the coal mines in the Bowen Basin of Queensland have similar gas volume to the Project, however, they have a higher methane content. The Project has relatively high levels of gas content in comparison with other coal mines in Australia, however, it is made up primarily of carbon dioxide, with smaller amounts of methane.

Due to the geology and gas content at the current Narrabri Mine, several gas extraction methods are used to maintain safety, which include Surface to Inseam (SIS), Underground to Inseam (UIS) and goaf drainage. UIS is used where access is available from underground roadways and the gas drainage does not require long lead times prior to mining. SIS is used where a greater lead time for gas drainage where underground roadways are not available and therefore surface access is required. Goaf drainage is used to extract gas from behind the longwall where there is no underground access so it must be done from the surface. From recent analysis conducted by Palaris (2021), the variability of gas volumes across the Project area is likely to mean that gas volumes are too low in some parts of the Project area to warrant use of SIS techniques, meaning that a number of service boreholes are no longer required (NCOPL, 2021). Notwithstanding, as discussed in Section 2.5.7 of the EIS, exploration boreholes would still be required ahead of longwall development in these areas to inform coal, strata characteristics and gas quantity. Some of the exploration boreholes described in the EIS have been removed in the Amendment Report (NCOPL, 2021a) as the results of previous exploration activities have been finalised, meaning that additional exploration boreholes in these areas are no longer required.

Surface disturbance is required for SIS, UIS and goaf drainage. The Project has been benchmarked against other similar mines across Australia, with the proposed surface development area being smaller than the industry average for similar underground mining operations (Palaris, 2020a).

The current methane content of the gas at the Narrabri Mine is in the order of 5% of the total gas content, making flaring unviable. As described in Section 2.6.7 of the EIS, gas extracted from the Hoskissons Coal Seam associated with the Project is expected to have a higher methane content than the approved mine area, but a lower volume than for the existing Narrabri Mine (Palaris, 2020b). Gas from the Narrabri Mine is currently vented to the atmosphere (Section 2.1.6 of the EIS).

NCOPL has commissioned Palaris (2021) to undertake further benchmarking of gas volume/content for flaring. From this review, it has been established that a methane content of approximately 30%, oxygen content of less than 6% and gas content of 3.5 m^3/tonnes coal is required to sustain flaring. There are parts of the Stage 3 area where gas with this methane content and gas flowrate is expected (i.e. sections of Longwalls 204 to 209) and flaring of pre-drainage gas would be conducted in these areas (NCOPL, 2021).

Flares used for the Project would be enclosed (i.e. the burner head is enclosed with a refractory shell), which would assist to limit potential impacts. Each flare is expected to be connected to a number of pre-drainage boreholes. Consequently, it is expected that approximately three flaring units would be in operation at any one time. Therefore, potential visual impacts are expected to be minimal.

Overall Scope 1, 2 and 3 Emissions of the Project

Issue

An organisation raised concern regarding the overall extent of potential Scopes 1, 2 and 3 emissions and how these emissions benchmark in Australia. It was described that these emissions are inconsistent with climate change objectives and that, were the emissions costed, they would render the Project uneconomic.

Response

The estimation of greenhouse gas emissions has been carried out in accordance with the principles of the Greenhouse Gas Protocol and using emission factors from the most up-to-date information relating to activities in Australia. The estimate of 489.6 million tonnes of carbon dioxide equivalent (Mt CO_2-e) (Scopes 1, 2 and 3) (Jacobs, 2021) is a total over the proposed 23-year life of the operation. Annual averages are reported in the assessment order to make a direct comparison to the annual emissions reported in National and State inventories. Greenhouse emissions from the Project would be different to those estimated for other proposed mining operations due to the nature and scale of operations.

The greenhouse gas calculations show that fugitive emissions from mine ventilation and gas drainage would be the most significant direct (Scope 1) emissions. These impacts would be abated via the use of flaring, which is further discussed in the response above and is expected to result in approximately 1% of Scope 1 abatement. Scope 1 emissions are estimated to be approximately 0.16 tonnes of carbon dioxide equivalent per tonne ROM coal (t CO_2-e/t ROM coal) (Jacobs, 2021).

In comparison, selected scope 1 emissions from other NSW underground coal mines are estimated at (Jacobs, 2021):

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

The Project would comply with all applicable national measures in place to help Australia meet the target in its Nationally Determined Contribution under the *Paris Agreement*, such as the National Greenhouse and Energy Reporting Scheme. Additionally, the Project would be consistent with the first priority area of action in the *Net Zero Plan Stage 1: 2020-2030* (DPIE, 2020c) in that it would flare pre-drainage gas to reduce Scope 1 greenhouse gas emissions. NCOPL would continue to investigate developments in greenhouse gas abatement technology (NCOPL, 2021) while continuing to support jobs and communities.

4.2.11 Aboriginal Cultural Heritage

Potential Impacts on Aboriginal Heritage Sites

Issue

An organisation raised concern regarding the potential for impacts on Aboriginal heritage sites.

Response

The ACHA (Whincop, 2020) identified a total of 60 Aboriginal cultural heritage sites within the area surveyed as part of the EIS. The surface disturbance of the Project was modified to avoid all known Aboriginal cultural heritage sites. Therefore, it is anticipated that none of the known Aboriginal cultural heritage sites would be directly impacted by the Project.

In regard to potential impacts on Aboriginal cultural heritage, Section 11.2.1 of the ACHA (Whincop, 2020) states the following:

> *The subsidence assessment undertaken for the Project included an assessment of the likely impacts of subsidence on the two (2) axe-grinding groove sites identified in the Investigation Area (Appendix A, Ditton Geotechnical Services, 2020). One axe-grinding groove site (Longsight GG1) was identified on sandstone boulders that would only be subject to impacts from vertical displacement of the floaters (i.e. individual or loose rocks or boulders), which would be unlikely to have an impact on the axe-grinding grooves.*
>
> *The second grinding groove site (Mayfield GG1) is located on multiple partially outcropping sandstone slabs. It could not be determined during the survey as to whether the sandstone slabs are floaters or connected to bedrock. If they are floaters, they would be subject to impacts from vertical displacement, which would be unlikely to have an impact on the axe-grinding grooves. However, if the sandstone slabs are connected to bedrock, they may be subject to potential cracking and/or possible erosion damage (due to concentrated water flows) due to subsidence (Appendix A, Ditton Geotechnical Services 2020).*

Further investigation is proposed to be undertaken of Mayfield GG1 to determine potential connection to bedrock with a qualified archaeologist and RAPs.

In addition, the existing Narrabri Mine Aboriginal Cultural Heritage Management Plan (NCOPL, 2019b) would be updated to incorporate the recommended management strategies described in the ACHA (Whincop, 2020).

Investigations into Mayfield GG1 Aboriginal Cultural Heritage Site

Issue

Further investigations into the Aboriginal heritage site Mayfield GG1 are proposed, and Heritage NSW noted that these investigations are supported, and that consideration be given to test and salvage programs as part of the Aboriginal Cultural Heritage Management Plan.

Response

NCOPL acknowledges Heritage NSW comments and would undertake further investigation of Mayfield GG1 in consultation with the RAPs during the Aboriginal Cultural Heritage Management Plan phase of the Project.

NCOPL would also undertake any future test excavation and salvage programs in consultation with RAPs when preparing a revised Aboriginal Cultural Heritage Management Plan (post-Project approval).

Registered Aboriginal Parties' Participation in Biodiversity Management and Rehabilitation Activities

Issue

Heritage NSW suggested that NCOPL considers ways to incorporate RAPs in on-site activities such as biodiversity management and rehabilitation activities.

Response

NCOPL would consider ways for the RAPs to play a role in on-site biodiversity management activities or activities associated with rehabilitation of ground disturbance areas, post-Project approval.

4.2.12 Land Resources and Agriculture

Impacts on Biophysical Strategic Agricultural Land

Issue

An organisation raised concern regarding the potential impacts on 500 ha of Biophysical Strategic Agricultural Land (BSAL).

Response

The figure of 500 ha impact on BSAL provided by the organisation appears to be incorrect.

Section 6.6.3 of the EIS describes that:

> *Approximately 22 ha of the Indicative Surface Development Footprint would be located on areas mapped as BSAL, including 18 ha of verified BSAL (Appendix G, Soil Management Designs, 2019 and GT Environmental, 2020) within MLA 1 and 4 ha of regionally mapped BSAL within ML 1609 (DPIE, 2020c). These areas would be rehabilitated to the pre-existing land use prior to mine closure. Additional ponding as a result of subsidence may affect up to 1.45 ha of BSAL.*

In addition, 2rog (2020) makes the following conclusion regarding potential impacts on BSAL:

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

Groundwater in Gunnedah-Oxley Basin Water Source Use in Agriculture

Issue

An organisation suggested that hard rock aquifers of the Gunnedah Oxley Basin water source are used for agriculture.

Response

The groundwater bores found to be potentially impacted by the Project are not production or irrigation bores, rather are used for stock and domestic purposes. The bore census was completed on all of the nine privately-owned bores where drawdown in excess of the 2 m AIP Threshold is predicted. Three of the bores were found to be unlikely to be impaired by this drawdown. Notwithstanding, make good commitments would mitigate potential impacts on all impacted bores (Attachment 7). Attachment 7 includes identification of indicative 'make good' measures at potentially impaired bores, such as, installation of a new and/or deeper bore.

Therefore, Attachment 7 indicates that sterilisation (i.e. widespread loss of water supply) of the properties served by these bores due to lack of ongoing access to groundwater is considered unlikely to occur.

4.2.13 Social

Significance Rating in the Social Impact Assessment

Issue

An organisation raised concern regarding the significance ratings of potential impacts in the Social Impact Assessment (SIA) (CDM Smith, 2020) and that uptake of the SIA survey was limited.

Response

The risk-based method utilised to identify and assess the significance of social impacts for the Project closely follows the process outlined in the *Social Impact Assessment Guideline for State Significant Mining, Petroleum Production and Extractive Industry Development* (SIA Guideline) (NSW Department of Planning and Environment, 2017). The process undertaken included:

1. Identifying and clearly articulating the impact, including the parties affected and timing.
2. Assessing consequence, based on consideration of the extent, duration and severity of the impact and the sensitivity of the affected party.
3. Assessing likelihood of the impact occurring.
4. Utilising a risk assessment model to determine overall significance of each impact.

Hence, the significance ratings noted in the SIA (CDM Smith, 2020) are a product of the SIA Guideline (NSW Department of Planning and Environment, 2017) and the author's opinion of the relative significance of the issues considered.

The SIA (CDM Smith, 2020) was undertaken in accordance with the SIA Guideline (NSW Department of Planning and Environment, 2017).

The SIA drew upon various sources of information to provide background and baseline social information for the Project area, which included the following direct engagement activities:

- individual meetings with 17 neighbouring landholders and landholders who requested discussions with the SIA team;
- meetings with the Narrabri Mine CCC, including presentations and discussions;
- an online and hard-copy community survey advertised through the *Narrabri Courier* and the *Namoi Valley Independent*;
- meetings with officers of NSC;
- meeting with officers of GSC;
- meetings with representatives of the Gomeroi people from the Narrabri Local Aboriginal Land Council and Gomeroi Narrabri Aboriginal Corporation;
- meetings with service providers – RFS and NSW Health; and
- meeting with representatives from the Narrabri and District Chamber of Commerce.

The online and hardcopy community survey undertaken for the SIA (CDM Smith, 2020) was considered to have a low uptake, where there were 81 responses with 41 from the local area (Narrabri and Gunnedah LGAs). The survey did not utilise a random sampling technique or seek to gather a minimum number of responses. Therefore, the survey cannot be considered a representative sample and is not used to make any statements about the views of the population of the Narrabri LGA or Gunnedah LGA (or any other community).

While it is considered that a greater uptake of the community survey would have provided a more accurate reflection of the community view on the Project, other engagement methods and literature were considered to provide adequate and accurate information to assess potential social impacts.

4.2.14 Other Matters

Conveyancing Search of the Project Area

Issue

Crown Lands recommended that NCOPL ensures that a comprehensive conveyancing search of the project area is undertaken and any impacts on Crown lands be authorised by Crown Lands NSW.

Response

NCOPL acknowledges the submission from DPIE Crown Lands and plans to undertake the recommended searches. Where required, NCOPL would undertake relevant approvals and obtain authorisation via the Department, or alternate authorising instruments identified prior to the works being commenced.

Surface Construction Hours Clarification

Issue

TfNSW requested that the surface construction hours be clarified.

Response

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

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

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

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

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

Whitehaven's Environmental Record

Issue

An organisation raised concern regarding Whitehaven Coal's (NCOPL's majority owners) previous dealings with the community and environmental record. Further, it was noted that NCOPL is currently being prosecuted for operations within EL 6243.

Response

For the Vickery Extension Project, the Independent Planning Commission (IPC) (IPC, 2020) noted that there is:

> *….no fit and proper person test in respect of development consents and that matters such as the identity of an applicant or past planning law breaches have been found to be irrelevant considerations for consent authorities such as the Commission.*

Notwithstanding, Section A7.4.9 of Attachment 7 of the EIS presents NCOPL's environmental record.

Additional Community Representations

Additional community representations from members of the public were received, subsequent to end of the exhibition period. The community representations raised concerns in regard to groundwater, noise, air quality, surface water and property values. A summary of where the matters raised by the community representatives have been addressed is presented in Table 8.

Table 8
Summary of Matters Raised by Community Representations and Where Issues have been Addressed

Representative	Representative Email Correspondence	Issue	Matter Raised	Section Where Issue Addressed
A (approximately 15 km south of the pit top area)	▪ 22 March 2021 ▪ 25 March 2021 ▪ 19 April 2021 ▪ 5 May 2021	Social	▪ Lack of consultation ▪ Lack of advertisement of drop-in session	Section 4.1.1
			▪ Depreciation of property value	Section 4.2.1
		Groundwater	▪ 'Make good' provision timing ▪ Modelling confidence and modelled 'worst-case' scenario ▪ Inadequate Bore Census – yield testing not undertaken	Section 4.1.1
		Amenity	▪ Not considered to be a sensitive receptor in amenity studies	Section 4.1.1
		Land Resources and Agriculture	▪ Stock impacts from drought and bores running dry	Section 4.1.1
		Other	▪ Proposal is inconsistent with Ecological Sustainable Development	Section 7 of the Project EIS
B (approximately 5 km south of the pit top area)	▪ 1 March 2021 ▪ 24 March 2021 ▪ 30 March 2021 ▪ 11 April 2021 ▪ 19 April 2021 ▪ 5 May 2021	Social	▪ Depreciation of property value	Section 4.2.1
			▪ Inadequate consultation and advertisement of the Project EIS	Section 4.1.1
		Groundwater	▪ General groundwater impacts ▪ Groundwater Assessment difficult to navigate ▪ Requested map showing drawdown area ▪ Groundwater Assessment size too large ▪ Requested groundwater modelling files ▪ Impacts to stock and domestic bores ▪ Groundwater modelling not 'independent'	Section 4.2.1
		Subsidence	▪ Subsidence and cracking impacts	Section 4.2.1
		Land Resources and Agriculture	▪ Impacts to core stock breeding land	Section 4.1.2
		Amenity	▪ Impacts to amenity on property (air and noise) ▪ Not considered to be a sensitive receptor in amenity studies	Section 4.2.1
		Other	▪ Existing Narrabri Mine impacts ▪ Exploration Licence 6243 extends over property boundary	Section 4.2.1
			▪ Proposal is inconsistent with Ecological Sustainable Development	Section 7 of the Project EIS

Table 8 (Continued)
Summary of Matters Raised by Community Representations and Where Issues have been Addressed

Representative	Representative Email Correspondence	Issue	Matter Raised	Section Where Issue Addressed
C (approximately 23 km south of the pit top area)	▪ 27 April 2021	Groundwater	▪ Bore census extent inadequate ▪ Inadequate groundwater sampling technique used in Bore Census ▪ 'Make good' provision timing	Section 4.1.1
D (approximately 10 km east-southeast of the pit top area)	▪ 17 May 2021	Groundwater	▪ Potential impacts on Namoi alluvium ▪ Bore census inadequate ▪ DPIE – Water submission	Section 4.1.1 and Attachment 5

5 PROJECT EVALUATION

Submissions on the Project were received from government agencies, local councils, organisations and members of the public during the exhibition period for the EIS. Approximately 76% of submissions received from public authorities, organisations and members of the public supported the Project.

This Submissions Report provides responses to issues raised by submissions from government agencies, local councils, organisations and members of the public during the exhibition period for the EIS and has been prepared in consideration of the Exhibition Draft *Preparing a Submissions Report State Significant Development Guide* (DPIE, 2020a).

Since lodgement of the Project EIS, NCOPL has continued to consult with community members, Councils, NSW and Commonwealth government agencies, DPIE and its independent experts regarding the Project.

Potential environmental, social and economic impacts of the Project have been assessed against established thresholds of acceptability contained in relevant guidelines and policies, including for groundwater, surface water, biodiversity, noise and air quality. Potential impacts have been avoided or minimised as far as is reasonable or feasible. Mitigation measures and offset strategies are proposed where residual impacts are predicted.

An Amendment Report (NCOPL, 2021) has also been prepared to incorporate a reduction in the Surface Development Footprint and flaring of pre-drainage gas. Consequently, the amended Project would result in reduced surface development impacts (approximately 31 ha less) and less Scope 1 greenhouse gas emissions (approximately 1% less) than unabated emissions.

In weighing up the main environmental impacts (costs and benefits) associated with the proposal as assessed and described in the EIS and the Submissions Report (incorporating the amended Project), the Project is, on balance, considered to be in the public interest.

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ATTACHMENT 1

SUBMISSIONS SUMMARY

Table A1
Register of Submitters

Submitter Category	Submitter	Reference Number	Where Comments are Addressed (Section)
Public	Name withheld	766401	-
	Name withheld	766406	-
	Name withheld	766411	-
	Name withheld	766416	-
	Mel Brown	766421	-
	Name withheld	766426	-
	Name withheld	766431	-
	Martin Mackinnon	766436	-
	Ashley Howland	766441	-
	Name withheld	766446	-
	Name withheld	766451	-
	Chris Bentham	766456	-
	Name withheld	766461	-
	Name withheld	766466	-
	Damien Ribaldone	766471	-
	Ian Crawford	766476	-
	Kathrine Coulter	766481	-
	Brock Heideman	766486	-
	Name withheld	766491	-
	Daniel Whiley	766496	-
	Name withheld	766501	-
	Name withheld	766506	-
	Name withheld	766511	-
	Name withheld	766516	-

Table A1 (Continued)
Register of Submitters

Submitter Category	Submitter	Reference Number	Where Comments are Addressed (Section)
Public	Name withheld	766521	-
	Jacques du Toit	766526	-
	Name withheld	766531	-
	Name withheld	766536	-
	Matt Ryan	766541	-
	Stuart Middleton	766546	-
	Scott Mitchell	766551	-
	Kyle Eakin	766556	-
	Owen Salisbury	766561	-
	Mereka Gleeson	766566	-
	Richard Hokin	766571	-
	Gareth Lamond	766576	-
	Keryn Zambrowski	766591	-
	Andrew Garratt	766596	-
	Name withheld	766601	-
	Name withheld	766601	-
	Joshua Killerby	766626	-
	Clark Coleman	766631	-
	Name withheld	766636	-
	Name withheld	766641	-
	Name withheld	766651	-
	Courtney Noble	766656	-
	Name withheld	766661	-
	Name withheld	766681	-

Table A1 (Continued)
Register of Submitters

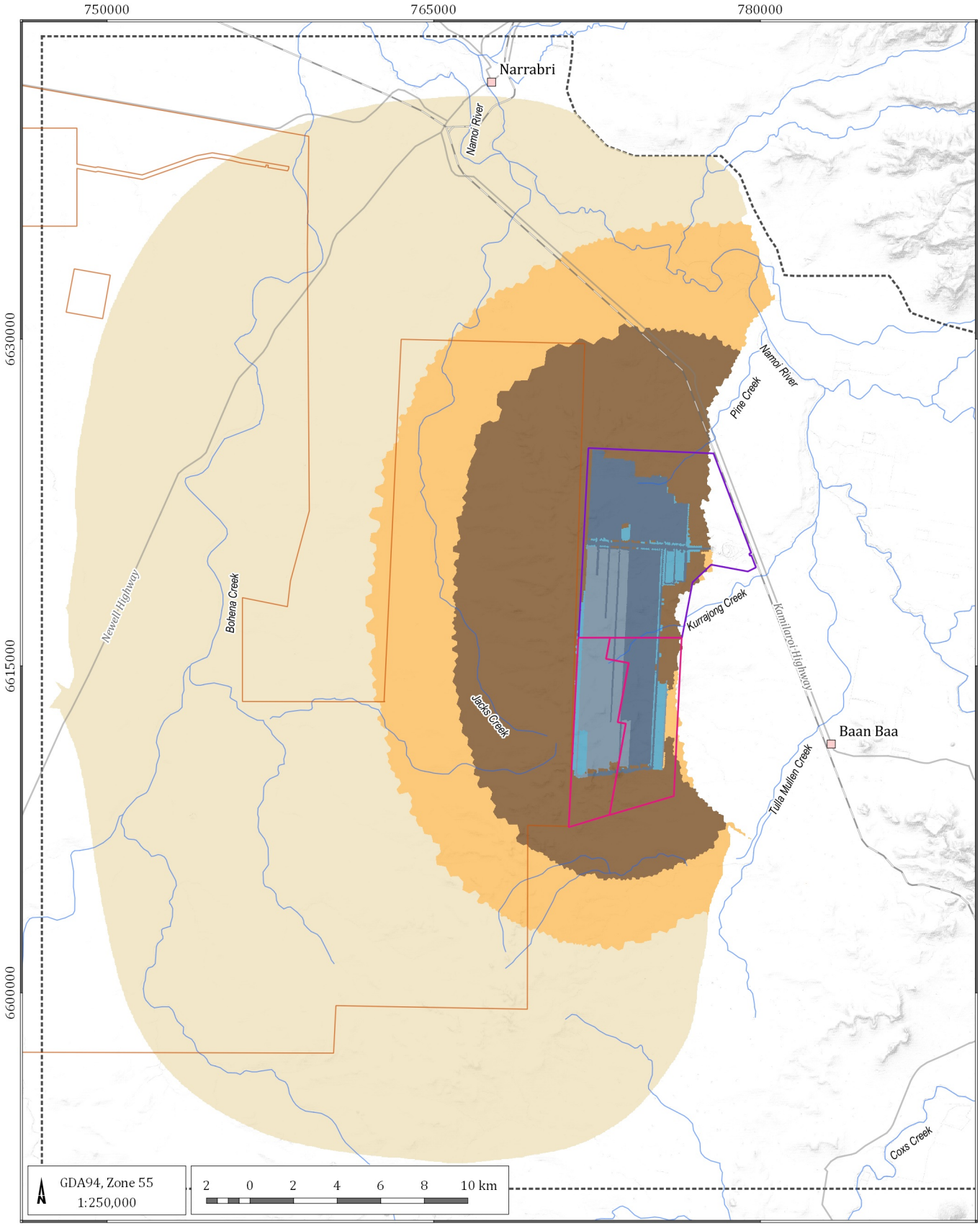
Submitter Category	Submitter	Reference Number	Where Comments are Addressed (Section)
Public	Justin Steele	766686	-
	Name withheld	766691	-
	Name withheld	766696	-
	John Granzow	766701	-
	Name withheld	766706	-
	Name withheld	766711	-
	Name withheld	766716	-
	Daniel Skyrm	766721	-
	Tim Suter	766726	-
	Brendan Davey	766731	-
	Darren Swain	766736	-
	Thomas Mackey	766741	-
	Name withheld	766761	-
Organisation	WesTrac	766396	-
	Projence Pty Ltd	766666	-
	Boggabri/Baan Baa Farmers	766746	Sections 4.1.1, 4.2.1, 4.2.10, 4.2.12 and 4.2.14
	Lock the Gate Alliance	766756	Sections 4.1.2, 4.2.1, 4.2.2, 4.2.5, 4.2.10, 4.2.11, 4.2.12 and 4.2.13
	Leard Forest Research Node	766766	Sections 4.2.5, 4.2.10 and 4.2.14
	Siding Spring Observatory	767071	-
Public Authority	DPI Fisheries	766391	Section 4.2.4
	NSW Resources Regulator	766581	Sections 4.2.2 and 4.2.7
	DPI Agriculture	766586	Section 4.2.7
	Regional NSW - Mining, Exploration and Geoscience	766606	Section 4.2.5
	Transport for NSW	766611	Sections 4.2.9 and 4.2.14

Table A1 (Continued)
Register of Submitters

Submitter Category	Submitter	Reference Number	Where Comments are Addressed (Section)
Public Authority	Environment Protection Authority	766646	Sections 4.2.4, 4.2.8 and 4.2.9
	Subsidence Advisory NSW	766671	Section 4.2.2
	Crown Lands	766676	Section 4.2.14
	Narrabri Shire Council	766751	Sections 4.2.2, 4.2.7 and 4.2.9
	Biodiversity, Conservation and Science Directorate	766771	Section 4.2.5
	Gunnedah Shire Council	766776	Section 4.2.9
	Rural Fire Service	766781	Section 4.2.6
	DPIE - Water	767066	Sections 4.1.1, 4.2.1, 4.2.3 and 4.2.4
	Heritage NSW	767101	Section 4.2.11
	Independent Expert Scientific Committee	N/A	Sections 4.2.1, 4.2.3, 4.2.4 and 4.2.5
	Forestry Corporation of NSW	773581	Sections 4.2.6 and 4.2.7

ATTACHMENT 2

AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS – MAXIMUM PREDICTED DRAWDOWN IN EACH AQUIFER



LEGEND

- Populated place
- Road
- Rail
- Drainage
- Mining Lease Boundary (ML1609)
- Provisional Mining Lease Application Area
- Proposed Narrabri Gas Project (Santos)
- Model boundary

Year

- 2009 - 2019
- 2019 - 2029
- 2029 - 2039
- 2039 - 2049
- 2049 - 2149
- 2149 - 2249
- 2249+

Narrabri Stage 3 Extension GIA - Response to Submissions (G1972)

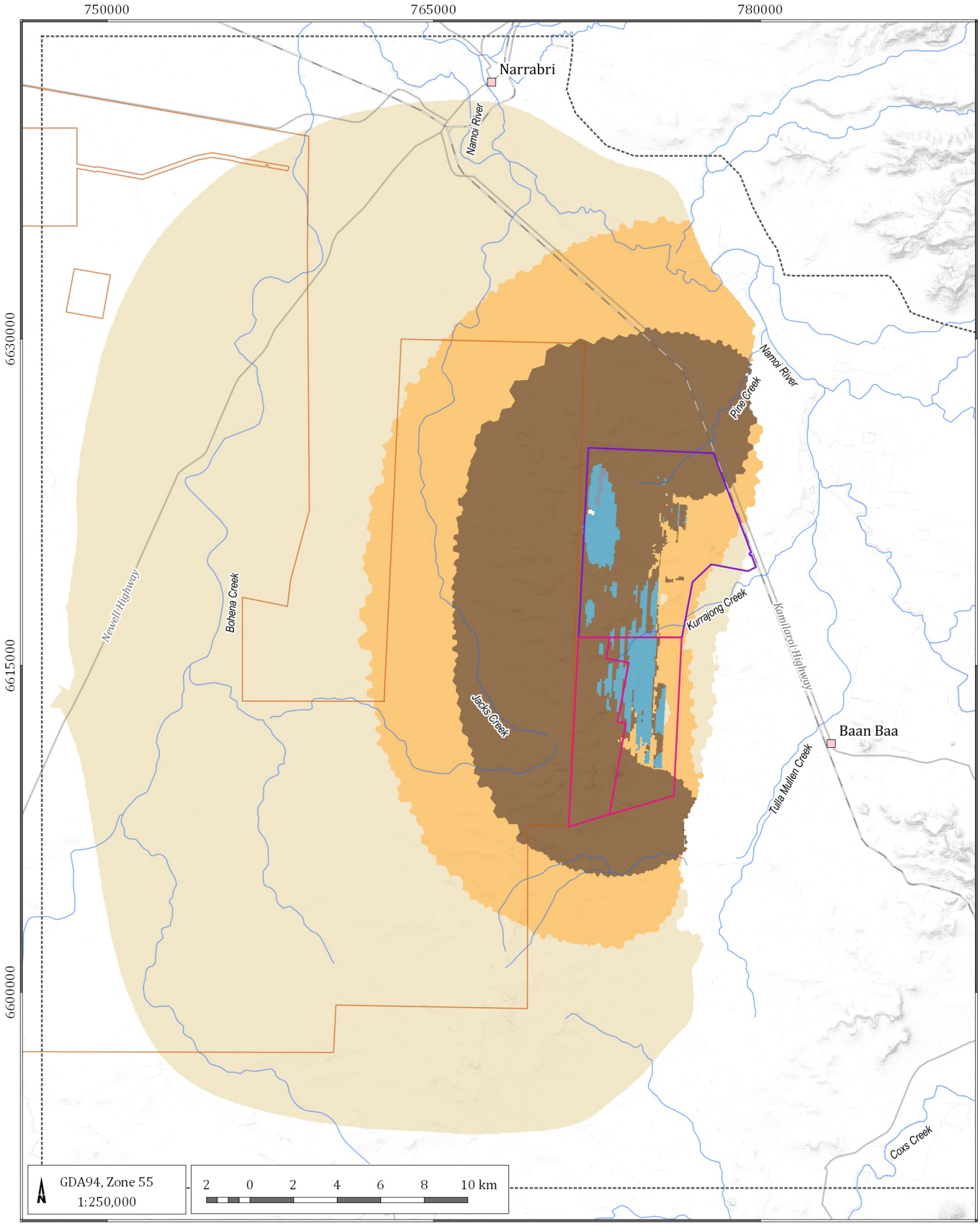
Predicted maximum drawdown timing, due to the Project - Hoskissons Coal Seam

AGE

DATE 19/05/2021

FIGURE No: 1

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972.Narrabri Stage 3 Extension GIA\3_GIS\Workspaces\004_Deliverable4\A - 01_G1972_Predicted maximum drawdown timing, due to the Project - Hoskissons Coal Seam.qgs



LEGEND

- Populated place
- Road
- Rail
- Drainage
- Mining Lease Boundary (ML1609)
- Provisional Mining Lease Application Area
- Proposed Narrabri Gas Project (Santos)
- Model boundary

Year

- 2009 - 2019
- 2019 - 2029
- 2029 - 2039
- 2039 - 2049
- 2049 - 2149
- 2149 - 2249
- 2249+

Narrabri Stage 3 Extension GIA - Response to Submissions (G1972)

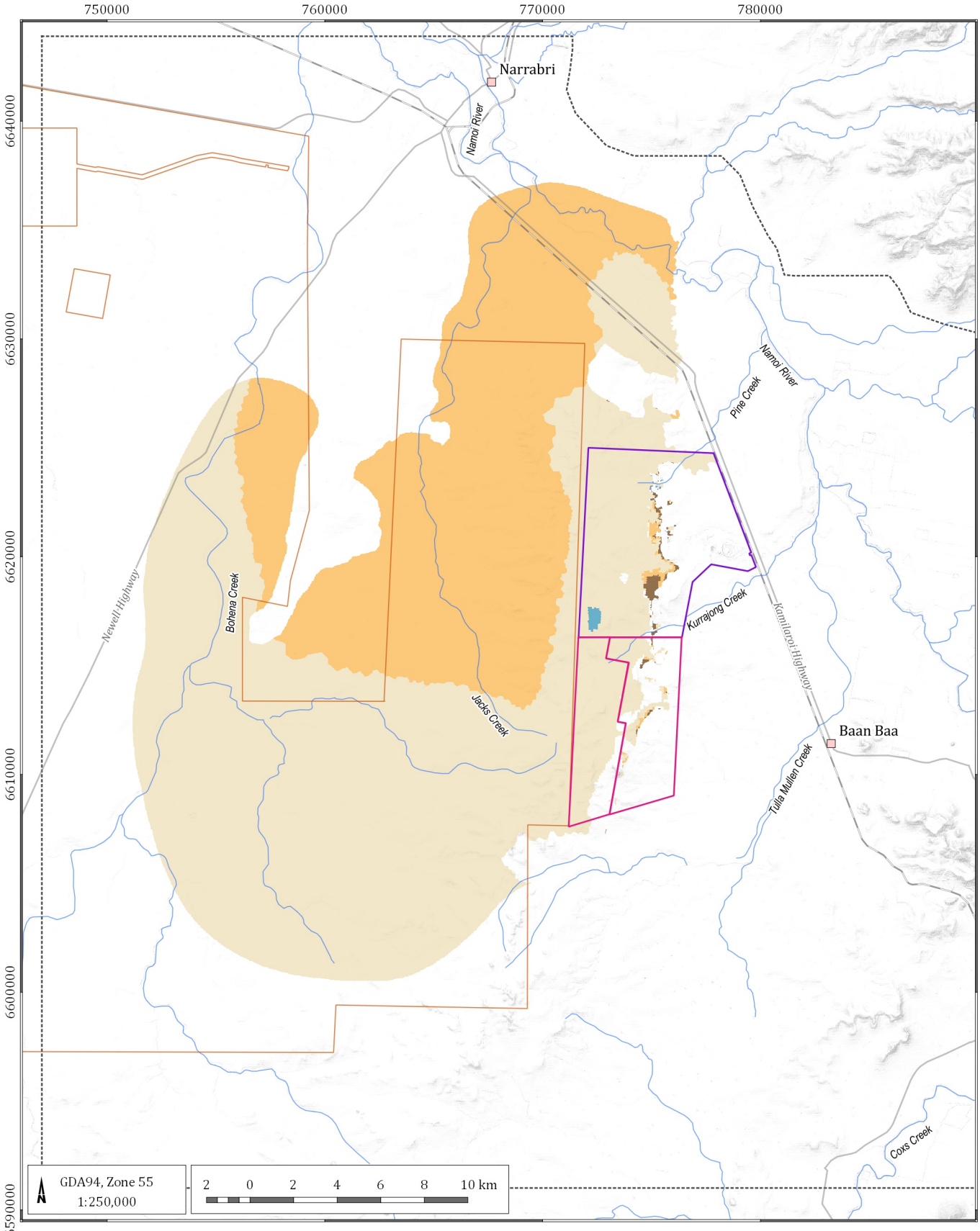
Predicted maximum drawdown timing, due to the Project - Napperby Formation

AGE

DATE 19/05/2021

FIGURE No: **2**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972.Narrabri Stage 3 Extension GIA\3_GIS\Workspaces\004_Deliverable4\A - 02_G1972_Predicted maximum drawdown timing, due to the Project - Napperby Formation.qgs



LEGEND

- Populated place
- Road
- Rail
- Drainage
- Mining Lease Boundary (ML1609)
- Provisional Mining Lease Application Area
- Proposed Narrabri Gas Project (Santos)
- Model mesh

Year

- 2009 - 2019
- 2019 - 2029
- 2029 - 2039
- 2039 - 2049
- 2049 - 2149
- 2149 - 2249
- 2249+

Narrabri Stage 3 Extension GIA - Response to Submissions (G1972)

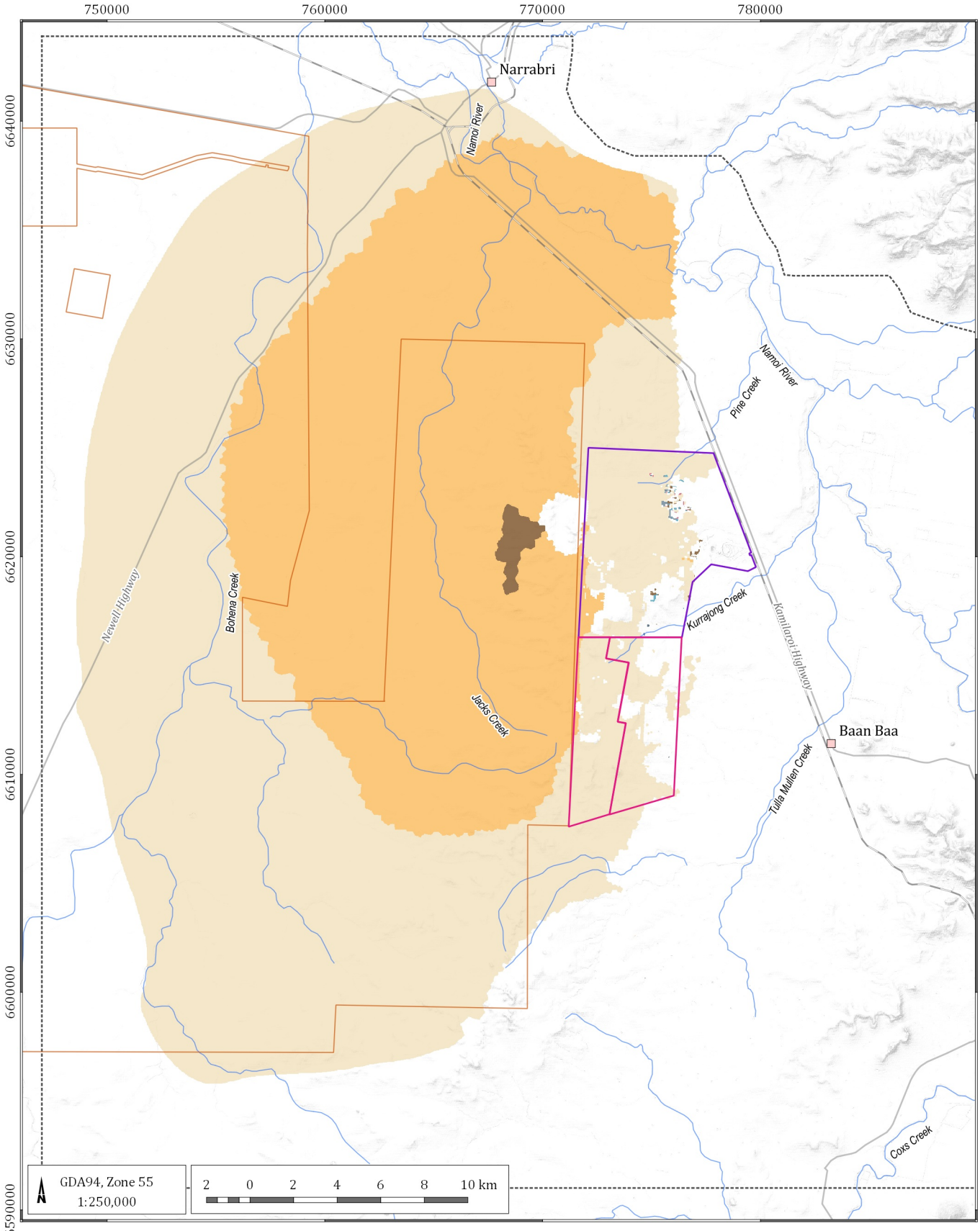
Predicted maximum drawdown timing, due to the Project - Purlawaugh Formation

AGE

DATE 19/05/2021

FIGURE No: **3**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972.Narrabri Stage 3 Extension GIA\3_GIS\Workspaces\004_Deliverable4\A - 03_G1972_Predicted maximum drawdown timing, due to the Project - Purlawaugh Formation.qgs



LEGEND

- Populated place
- Road
- Rail
- Drainage
- Mining Lease Boundary (ML1609)
- Provisional Mining Lease Application Area
- Proposed Narrabri Gas Project (Santos)
- Model boundary

Year

- 2009 - 2019
- 2019 - 2029
- 2029 - 2039
- 2039 - 2049
- 2049 - 2149
- 2149 - 2249
- 2249+

Narrabri Stage 3 Extension GIA - Response to Submissions (G1972)

Predicted maximum drawdown timing, due to the Project - Garrawilla Volcanics

AGE

DATE 19/05/2021

FIGURE No: **4**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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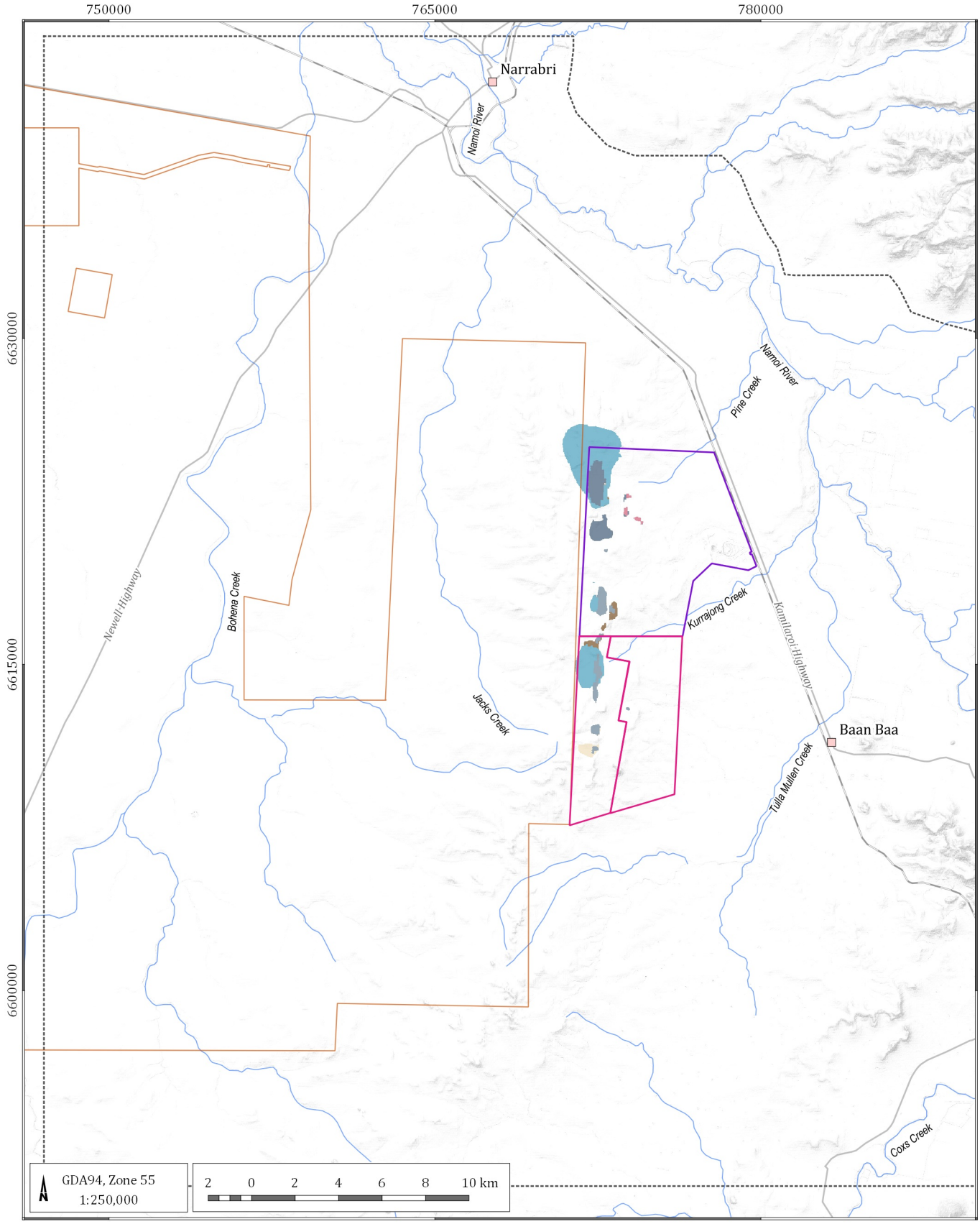


LEGEND

- Populated place
- Road
- Rail
- Drainage
- Mining Lease Boundary (ML1609)
- Provisional Mining Lease Application Area
- Proposed Narrabri Gas Project (Santos)
- Model boundary

Year

- 2009 - 2019
- 2019 - 2029
- 2029 - 2039
- 2039 - 2049
- 2049 - 2149
- 2149 - 2249
- 2249+

Narrabri Stage 3 Extension GIA - Response to Submissions (G1972)

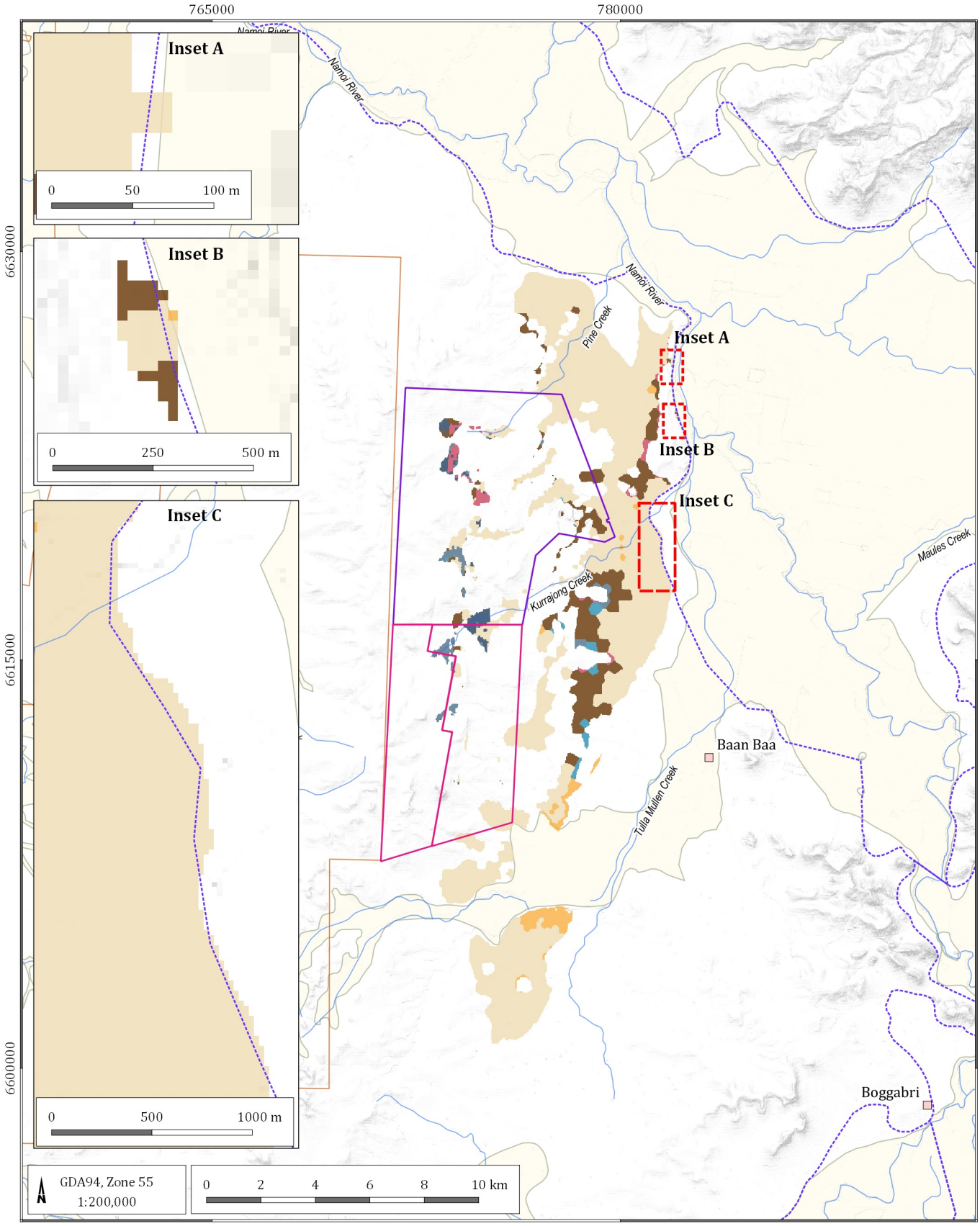
Predicted maximum drawdown timing, due to the Project - Pilliga Sandstone

AGE

DATE 19/05/2021

FIGURE No: **5**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972.Narrabri Stage 3 Extension GIA\3_GIS\Workspaces\004_Deliverable4\A - 05_G1972_Predicted maximum drawdown timing, due to the Project - Pilliga Sandstone.qgs



LEGEND

- Populated place
- Drainage
- Mining Lease Boundary (ML1609)
- Provisional Mining Lease Application Area
- Proposed Narrabri Gas Project (Santos)
- Highly productive alluvial aquifer
- Quaternary alluvium

Year

- 2009 - 2019
- 2019 - 2029
- 2029 - 2039
- 2039 - 2049
- 2049 - 2149
- 2149 - 2249
- 2249+

Narrabri Stage 3 Extension GIA - Response to Submissions (G1972)

Predicted maximum drawdown timing, due to the Project - Quaternary alluvium / regolith

AGE

DATE 19/05/2021

FIGURE No: 6

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972.Narrabri Stage 3 Extension GIA\3_GIS\Workspaces\004_Deliverable4\A - 06_G1972_Predicted maximum drawdown timing, due to the Project - Quaternary alluvium_regolith.qgs

ATTACHMENT 3

THE TRANSPORT PLANNING PARTNERSHIP – SUPPORTING INFORMATION TO TFNSW SUBMISSION

Our Ref: 17380

17 February 2021

Whitehaven Coal Limited
10 Kurrajong Creek Road
BAAN BAA NSW 2390

Attention: Mr Mark Vile – Environmental Coordinator – NCO Stage 3 Project

Dear Mark,

RE: NARRABRI UNDERGROUND STAGE 3 EXTENSION PROJECT
RESPONSE TO SUBMISSIONS

As requested, please find herein The Transport Planning Partnership's (TTPP) input in response to requests for additional information by Transport for New South Wales (TfNSW) regarding the Narrabri Underground Mine Stage 3 Extension Project Environmental Impact Statement. Each of the requests are outlined below, together with TTPP's additional information.

Workforce

Primary evidence confirming the actual peak workforce size required to achieve the maximum 11 Mtpa production, and peak numbers of workers assigned to each shift (including day, afternoon, and night, operational, administrative and construction shifts), is requested. The daily and hourly trip generation volumes surveyed onsite in June 2019, and peak hourly volumes assessed in the road transport report, do not clearly correlate with a peak site operational workforce of 520 FTE personnel.

For example, a weekday peak hourly operational shift traffic (two-way) volume of some 120-150 vehicles per hour was surveyed, along with a weekday daily total (two-way) volume of 858 movements. This is less than the minimum ~1,000 daily vehicle trips to be expected if the average occupancy rate per light vehicle is close to 1 person, plus lunch trips, deliveries, visitors and so on.

Without provision or reference to a mine attendance log, for example, it is difficult for TfNSW to confirm the size of the workforce present during the June 2019 traffic survey period. If it was less than the peak workforce sought under this proposal, supplementary traffic analysis identifying the impacts of the peak operational workforce to be approved under this consent is required in order for a thorough assessment to be undertaken. The focus should be on potential queuing and safety impacts – further discussion of Levels of Service at either the

highway intersection or mid-block is not required by TfNSW, as these are currently shown to remain at LOS A or B and are not likely to significantly deteriorate.

The peak workforce of 520 people referred to in the Road Transport Assessment is the total Mine workforce expressed on a full-time-equivalent basis. Due to part-time workers, rostering arrangements, shift arrangements, annual leave and sick leave, it is neither the number of individual people who work at the site, nor the number of workers attending the mine an any particular day. No direct comparison should therefore be drawn between the surveyed number of vehicle movements and a calculation of movements by 520 workers.

TTPP has obtained and reviewed the personnel login and logout records for the week during which the traffic surveys were conducted from 17 to 23 June 2019. These include all people working at the mine each day, excludes short stay visitors and deliveries (who are not required to log in or out). On the average weekday, 413 people logged into and out of the mine per day, equivalent to approximately 80 percent of the total peak FTE workforce. During the same week, Narrabri Mine generated an average of 858 vehicle trips per weekday. On the weekend days, an average of 183 people logged into and out of the mine per day, equivalent to approximately 35 percent of the total peak FTE workforce.

TTPP has also obtained and reviewed Whitehaven employee and contractor data over one year during the same period, which indicates that there were 270 Whitehaven employees and 253 FTE contractors based at Narrabri Mine. This total 523 FTE workers is consistent with the peak 520 FTE workforce expected at the Mine, and the traffic surveys represent peak operational conditions.

Atypical Periods During Mine Operations

The traffic survey was taken during a one-week period. Additional information identifying other critical (peak) traffic scenarios that may be expected for atypical periods during mine operation, such as during railway and mine operational shutdowns would be of benefit.

With regard to mine operational shutdowns, NCOPL has advised that there is, on average, one change-out per year which has a duration of approximately six weeks. The net increase in workforce during these periods is similar to that described in Section 2.16 of the EIS, requiring approximately 20 full-time equivalent personnel (in addition to the current operational workforce) for multiple, short periods throughout the Project life. These activities generally occur 7.00 am to 6.00 pm Monday to Sunday.

During a change-out, an additional 20 FTE workforce could therefore be expected to attend the site, with workers likely to arrive just prior to 7:00 am. The arrival peak for the change-out workforce is later than the AM peak period for the movement of the operational workforce. Review of the login data demonstrates that on the average weekday, the number of people logging in to the site during the morning is as follows:

- 38 people between 5:45 am and 6:00 am;
- 55 people between 6:00 am and 6:15 am;

- 31 people between 6:15 am and 6:30 am; and
- 23 people between 6:30 am and 6:45 am.

If all of the additional change-out workforce all arrived during the 15 minutes immediately prior to their start time, the total number of people entering the site would remain well below the peak which occurs earlier.

Similarly, on the average weekday, the number of people logging out of the site during the evening is as follows:

- 11 people between 6:15 pm and 6:30 pm;
- 37 people between 6:30 pm and 6:45 pm;
- 7 people between 6:45 pm and 7:00 pm;
- 6 people between 7:00 pm and 7:15 pm; and
- 3 people between 7:15 pm and 7:30 pm.

If all of the additional change-out workforce all departed during the 15 minutes immediately following their work end time, the total number of people entering the site would remain well below the peak which occurs earlier.

The impact of the change-out periods on the movement of people (and therefore vehicles) to and from the Mine and the potential interaction with background peak conditions would therefore be negligible.

NCOPL has advised that during rail shutdowns, there is no change to its operations, with additional stockpiling of product coal occurring until rail operations resume. In the event of a major rail shutdown for an extended period of time which exceeded the capacity of the Mine to stockpile, approval would be sought for alternative transport arrangements, which is beyond the scope of this review.

Rail Movement Forecasts

Table 3.5 in the transport assessment provides indicative daily train movements based on GTA Consultants (2018). The GTA Consultants report refers to the 2016 ARTC Master Train Plan and it is unclear how it arrived at the daily average and peak train movements cited. An updated forecast of daily average and peak train movements is required to better understand the road-rail interactions at the mine access road level crossing. This should include both the anticipated year of Stage 3 opening and the scenario 10 years post-development (10 years being the appropriate planning horizon set out in Austroads Guide to Traffic Management Part 12). The forecast should consider likely changes in train demand due to major projects within that planning horizon such as Inland Rail, Narrabri Inland Port intermodal and the Moree Special Activation Precinct.

The daily train movements forecast for 2030 presented in GTA Consultants (2018) are derived from forecasts presented in assessments of various major developments in the region. They

are not based on the Master Train Plan, as actual train times and frequencies do not necessarily align with the contracted train paths contained in the Master Train Plan.

The daily forecasts in GTA Consultants (2018) were sourced from rail movement data collated for the Noise and Blasting Assessment undertaken for the Vickery Extension Project (Wilkinson Murray, 2018), which were in turn sourced from a number of assessments undertaken for other projects in the region. The forecasts are presented in Section 7 of that report and are generally based on maximums assessed as part of each development's planning approvals. Those theoretical assessment values are not necessarily observed by the operational developments, and are extremely unlikely to occur simultaneously or on an ongoing basis. For example, the Mine is permitted an average of four trains per day, however the train loading data for the Mine demonstrates there was an average of 1.1 trains loaded per day between 1 December 2018 and 30 June 2019, and an average of 1.5 trains loaded per day between 1 October 2020 and 8 February 2021.

TTPP has been unable to obtain forecasts of how train movements may be expected to change with the Inland Rail and other projects. It is however noted that review of level crossing data (refer to following section) indicates that the delay resulting when a coal train passes through the level crossing is distinctly higher than for all other trains, which include both passenger and freight trains. The 95th percentile delay resulting from all trains excluding coal trains is 2 minutes and 24 seconds. The Project does not propose any change to the average or peak number of trains to be loaded at Narrabri Mine per day, noting that Narrabri Mine is the only source of coal trains through the level crossing on Kurrajong Creek Road. The probability of delays occurring due to coal train movements will therefore not change with the Project, nor with any changes to other passenger or freight train movements through the level crossing.

Queue Modelling

Table 3.17 in the transport assessment summarises queue lengths based on the average number of vehicles. Estimations of the 95th percentile queue lengths and show working is sought by TfNSW. It is preferable that this estimate outline reasonable worst-case duration (e.g. monthly) of delays caused by a coal train at the level crossing based on available data. Queue analysis is to reflect the likely frequency of heavy vehicle arrivals. Further information on preferred modelling type can be supplied via TfNSW directly.

TTPP has obtained level crossing closure duration data from ATRC for the Kurrajong Creek level crossing. That data includes the duration of the operation of the level crossing's active controls for all train movements through the level crossing over the whole of January 2021, and approximately one week in February 2021. NCOPL provided train loading data at the Mine over the same period, and TTPP cross-matched these two data sets to identify which closures were related to coal trains entering or leaving the Narrabri Mine Loop. A total of 148 coal train movements were identified, with the following characteristics:

- minimum duration 5 minutes 24 seconds;
- average duration 7 minutes 41 seconds;

- 85th percentile duration 8 minutes 54 seconds;
- 95th percentile duration 9 minutes 26 seconds.

After consulting with TfNSW, TTPP has prepared a SIDRA network model of the level crossing and the intersection of Kurrajong Creek Road and Kamilaroi Highway to review vehicle queue behaviour. The model represents the peak 15-minute road traffic demands (for inbound traffic to the Mine), combined with the average, 85th percentile and 95th percentile delays due to a coal train. It is important to note there are some conceptual limitations when considering the application of the various percentile queue lengths output by SIDRA for this situation, which are discussed below.

The SIDRA queue length output is measured to the back of the queue, and represents the maximum extent of the queue that occurs during each cycle of traffic signals (in this case, the signals control the level crossing opening and closing to vehicular traffic). SIDRA models make allowance for the stochastic nature of traffic behaviour, as evident from randomness effects in delay and queue length equations, percentile queue values, effect of random arrival headways and so on.

A percentile queue length is defined to be the queue length that has only a specified percentage of the average queue lengths observed for individual cycles fall. As discussed in the SIDRA User Guide, in the case of traffic signals operating at a cycle time of 120 seconds, a 30-minute peak analysis period would have 15 cycles. The queue length would exceed the 95th percentile value in 15 x 0.05 = 0.75 cycles during the analysis period, i.e., exceeded approximately once in the peak analysis period. In the case of a level crossing which is closed irregularly and for varying lengths of time, the application of percentile queues to expected day-to-day performance requires some further consideration and understanding of the model.

In the case of the modelled level crossing and the movement of coal trains, the "cycle" is made up of two phases:

- Phase A (vehicles), when no coal train is present and vehicles are free to cross as soon as they arrive at the level crossing. The duration of this phase will vary considerably, ranging between minutes and days.
- Phase B (train), when a coal train is present at the crossing with the duration characteristics determined from the ARTC timing data and described above.

Due to the irregularity of coal train movements, the "cycle" does not repeat with any regularity. For the purpose of this assessment, and in consultation with the SIDRA Support team, the "cycle" modelled is over a 15 minute period. The range of Phase B (train) timings has been modelled according to the ARTC data, and the Phase A (vehicles) timing modelled as the balance of the 15 minute analysis period.

With the signals operating at a cycle time of 15 minutes, the 15-minute peak analysis period would have one cycle. By definition, the queue length would exceed the 95th percentile

value in 1 x 0.05 = 0.05 cycles during the analysis period. This clearly cannot be realistically directly related to a number of events in a single cycle. It may therefore be considered to reflect the likelihood of the event occurring over many repetitions of the cycle. For a traditional intersection design, the 95th percentile queue length adopted for design purposes may practically occur once during the peak period every weekday throughout the year. By comparison, the 95th percentile queue length determined by the SIDRA model may be expected to occur once during 5% of weekday AM peak periods over a year, and only if a coal train is present at the level crossing on each and every weekday AM peak period throughout that year.

Furthermore, SIDRA multiplies 15-minute analysis period inputs to a one-hour demand scenario, with the result that in some of the models, the output number of vehicles in the 95th percentile queue exceeds the number of vehicles input to the model during the peak 15-minute period. For the higher percentile output queues to occur at the level crossing, the number of inbound vehicles over the 15-minute analysis period (and in some cases, additional vehicles as well) would need to arrive wholly during Phase B (train), such that all those vehicles would queue.

The output queue lengths generated during train delays of varying lengths should be considered in the context of the likelihood that they will occur, noting the model relates to a level crossing closure which occurs during the peak 15 minutes for inbound traffic demand (between 5:45 am and 6:00 am) on a weekday. Throughout the remainder of the weekdays, the inbound traffic volumes would be less than those modelled, and the resulting queues would also be reduced. Unlike a standard road intersection assessment of a peak period, at which demand on the road approaches is generally consistent from day to day, coal trains are not present at the level crossing during each and every occurrence of inbound traffic.

To gauge the likelihood of a coal train being present on the level crossing during the inbound peak, TTPP has reviewed NCOPL's train loading data over the period from 1 October 2020 to 8 February 2021 (in addition to that assessed in the Road Transport Assessment between 1 December 2018 and 30 June 2019). That data confirms that there is no distinct pattern in the timing of coal train loading, which is spread throughout the day. The probability of a coal train being present at the level crossing at any time can therefore be considered to be equal across the day, i.e., it is no more or less likely that a coal train would use the level crossing during the AM inbound peak than any other time of day. The probability of a coal train of various delay profiles being present at the level crossing at any time has been estimated as follows:

- On average, a coal train movement results in a delay of 7 minutes and 41 seconds. The probability of an "average delay" coal train being present at any moment over a day is 4.2% on an average day with four trains loaded, and 8.2% on a peak day with eight trains loaded.
- The 85th percentile delay occurs or is exceeded for 15% of coal trains, i.e., 15% of the four (average) or eight (peak) trains per day would delay vehicles by 8 minutes 54 seconds or more. The probability of an "85th percentile delay" coal train being present on the level

crossing at any moment over a day is calculated at 0.7% for the average four trains per day, and 1.5% for the peak eight trains per day.

- The 95th percentile delay occurs or is exceeded for 5% of coal trains, i.e., 5% of the four (average) or eight (peak) trains per day would delay vehicles by 9 minutes and 26 seconds or more. The probability of a "95th percentile delay" coal train being present on the level crossing at any moment over a day is calculated at 0.3% for the average four trains per day, and 0.5% for the peak eight trains per day.

As the Project does not propose any change to the average and peak number of trains, it would not change the above probabilities of a coal train using the level crossing.

The resulting probabilities that various combinations of train delays and various percentile vehicle queues would occur on any day are summarised in Table 1.

Table 1: Probability that Queues of Reported Length will Occur During Inbound AM Peak

Train Delay Length	Minimum Back of Queue Length			
	Average	70th Percentile	85th Percentile	95th Percentile
Average Train Demand 4 trains per day				
Average	2.09%	1.25%	0.63%	0.21%
85th Percentile	0.37%	0.22%	0.11%	0.04%
95th Percentile	0.13%	0.08%	0.04%	0.01%
Peak Train Demand 8 trains per day				
Average	4.09%	2.45%	1.23%	0.41%
85th Percentile	0.74%	0.44%	0.22%	0.07%
95th Percentile	0.26%	0.16%	0.08%	0.03%

All of the above combinations of train delay lengths and back of queue distances have a probability of occurring during the inbound AM peak of less than 5% and so can be considered to occur less frequently than a 95th percentile event. Many of the combinations have a probability of less than 2% and so can be considered to occur less frequently than a 98th percentile event.

Assuming one inbound peak of 15 minutes occurs per weekday, the frequency at which each of the combinations of train delay and back of queue may occur over one year (52 weeks) of continual operation at the average (four trains per day) or peak (eight trains per day) train demands is summarised in Table 3. Weekend days are excluded as their traffic demands are lower than weekends thus the queue outcomes on weekend days will be lower than on weekdays.

Table 2: Nominal Frequency that Queues of Reported Length will Occur per Year

Train Delay Length	Minimum Back of Queue Length			
	Average	70th Percentile	85th Percentile	95th Percentile
Average Train Demand – 4 trains per day ongoing for 260 Weekdays				
Average	5.4	3.3	1.6	0.5
85th Percentile	1.0	1.6	0.3	0.1
95th Percentile	0.3	0.2	0.1	0.0
Peak Train Demand – 8 trains per day ongoing for 260 Weekdays				
Average	10.6	6.4	3.2	1.1
85th Percentile	1.9	1.1	0.6	0.2
95th Percentile	0.7	0.4	0.2	0.1

Consistent with the Road Transport Assessment, the future assessment with the Project assumes that the additional Project traffic would enter the Mine during the same peak hour as the existing operational traffic. One quarter of those are assumed to arrive during the peak 15 minutes. As the existing inbound operational peak 15 minutes occurs between 5:45 am and 6:00 am, and the additional Project workers would not be expected to commence work until 7:00 am, this represents an unlikely scenario.

Table 3 presents the output back of queue lengths from the SIDRA model, which assumes the default queued vehicle lengths of 7 m per light vehicle and 13 m per heavy vehicle (i.e., a combination of various lengths of rigid vehicles and articulated vehicles). It is likely that on-site at times of high demand, drivers may queue with less space per vehicle given that the majority of drivers are Mine workers who are familiar with the conditions. This is noted in the SIDRA User Guide, which presents observed queue space lengths for different conditions, and notes that the average queue space for light vehicles in isolated right turn bays is less than the default 7.0 m per vehicle. Nevertheless, the default has been adopted, as data on observed conditions at Narrabri is not available. As described above, there is a conceptual imbalance between modelled results and actual conditions, due to the manner in which SIDRA performs these calculations, and the frequency with which they may actually occur.

Table 3: Back of Queues on Kamilaroi Highway to 15 Minutes Peak Inbound Traffic (metres)

Train Delay Length	Average		70th Percentile		85th Percentile		95th Percentile	
	North	South	North	South	North	South	North	South
Existing								
Average	78.0	86.8	96.8	107.6	114.0	126.8	127.4	141.6
85th Percentile	93.0	103.5	115.4	128.3	**136.0**	**151.2**	**151.9**	**168.8**
95th Percentile	99.7	110.8	123.6	137.4	**145.6**	**161.9**	**162.7**	**180.8**
2032 with Project[A]								
Average	91.2	96.7	113.1	120.0	**133.3**	141.3	**148.9**	**157.9**
85th Percentile	108.4	114.9	**134.4**	142.5	**158.4**	**167.9**	**176.9**	**187.6**
95th Percentile	116.0	123.0	**143.8**	**152.5**	**169.4**	**179.7**	**189.2**	**200.7**

Back of queues in metres in the storage bays in Kamilaroi Highway, queues lengths assume SIDRA queue space defaults of 7m per light vehicle and 13m per heavy vehicle.
[A] assumes Project construction traffic arrives during the operational traffic inbound peak.

	Event probability 95th to ≤ 97th percentile
	Event probability 97th to ≤ 99th percentile
	Event probability >99th percentile

The queuing space within the storage bays as marked in Kamilaroi Highway is approximately 125 m to the north and 150 m to the south, which excludes drivers stopping in the narrower part of the taper, on the painted island or on the shoulder. Comparing this with the results in Table 3, the available storage space is therefore sufficient for the modelled events up to 97th percentile, and for the majority of events up to 99th percentile, the exception being approximately one extra vehicle in the right turn bay queue in the 85th percentile queue future scenario. That event may be expected to occur 1.6 to 3.2 times per year (Table 2) for ongoing operations at the average and peak number of trains per day respectively.

While the above assessment has found that the likelihood of overflow of the available storage lanes is very low, Whitehaven may consider implementing a protocol for its employees and contractors to ensure drivers do not join the back of the queue if their vehicle will impede the flow of through traffic. The protocol would require drivers to not queue on the painted island prior to the storage lane, rather to continue along the highway, turn at a safe place and return. As the maximum queues would occur at the end of the closure times of the level crossing, it is expected that the queues would have started to dissipate before such a vehicle returned. As queues would be infrequent, installation of "queued vehicles" (W5-231n) warning signs on Kamilaroi Highway would also alert drivers of the possible presence of a queue.

We trust the above is to your satisfaction. Should you have any queries regarding the above or require further information, please do not hesitate to contact the undersigned on 8437 7800.

Yours sincerely,

Penny Dalton
Associate Director

ATTACHMENT 4

ECO LOGICAL AUSTRALIA PTY LTD –
REVIEW OF POTENTIAL IMPACTS TO STYGOFAUNA OF THE PROJECT

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17 February 2021

Our ref: 18220

David Ellwood
Director NCO Stage 3 Project
Narrabri Coal Operations Pty Ltd
10 Kurrajong Creek Road
Baan Baa NSW 2390

Dear David,

Review of Narrabri Stage 3 Project stygofauna assessment and response to IESC comments

Attached is a brief report to assist Narrabri Coal Operations Pty Ltd (NCOPL) in responding to comments from the Independent Expert Scientific Committee (IESC) on Coal and Coal Seam Gas regarding stygofauna assessment in the Narrabri Stage 3 Project Environmental Impact Statement (EIS). The IESC recommends sampling for stygofauna in areas of predicted drawdown, specifically in the alluvium of lower Tulla Mullen Creek and around three springs identified near the Project Area.

The report reviews matters relevant to stygofauna ecology as covered in the EIS, makes an assessment on whether the work adequately addresses the Secretary's Environmental Assessment Requirements (SEARS), and provides comments on the IESC submission.

I consider the work done in the EIS to have sufficiently addressed the SEARS. I also do not consider it necessary that additional stygofauna samples be collected from Tulla Mullen Creek, nor from bores near Hardy, Eather and Mayfield Springs.

Regards,

Dr Peter Hancock
Senior Groundwater Ecologist

Review of stygofauna assessment for Narrabri Underground Mine Stage 3 Extension Project

IESC Comments

In their advice to the decision maker, the IESC comment that they are not confident that impacts to stygofauna have been adequately assessed (Paragraph 5), as stygofauna in the proposed impact area have not been sampled. To address this, the IESC recommends samples be collected from the alluvium of lower Tulla Mullen Creek, as well as from bores near Mayfield, Hardy and Eather Springs (Paragraph 16). IESC also require the impacts of brine injection on stygofauna be assessed.

Summary of stygofauna assessment for Stage 3 Project

Impacts to stygofauna are primarily considered in Appendix B (Groundwater Assessment) of the EIS (AGE 2020). While no sampling was conducted for stygofauna, the results from previous studies were used to conclude that the Namoi alluvium and some of its tributaries contain stygofauna communities. From this it was assumed that the Tulla Mullen Creek alluvium also has stygofauna (Section 7.6.2.3 of AGE 2020). It was also concluded that the Pilliga Sandstone and other non-alluvial aquifers in the project area are unlikely to contain stygofauna. I agree with these conclusions, and with the determination that the small amount of drawdown modelled for the Namoi and Tulla Mullen Creek alluvium will have negligible impact on stygofauna communities.

Likelihood of stygofauna in Tulla Mullen Creek alluvium

Stygofauna have been collected from the Peel River alluvium in the upper Namoi catchment (Hancock and Boulton 2008, Tomlinson 2008), the Namoi River alluvium west of Vickery State Forest (Eco Logical Australia 2016) and the Namoi alluvium downstream of Narrabri (Korbel et al., 2013). Stygofauna are known from some of the tributary aquifers of the Namoi (e.g. Peel River, Tomlinson 2008; Driggle Draggle Creek, ELA 2016; Maules Creek, Anderson et al 2010). The results of these studies, and the high level of hydrological connectivity along the Namoi alluvium and its tributary aquifers, make it likely that the stygofauna community extends along the Namoi alluvial aquifer (Hose et al. 2015). It is therefore reasonable to assume that the alluvium of Tulla Mullen Creek, particularly in the well-developed lower reaches, will have stygofauna. It is also reasonable to assume that, based on the connectivity of the alluvium and the generally widespread distribution of taxa encountered to date, it would have the same stygofauna taxa as other parts of the Namoi alluvium and that taxa endemic to Tulla Mullen Creek are unlikely.

The IESC suggests that stygofauna should be collected from the lower reaches of Tulla Mullen Creek, and from reference sites. However, given the high level of connectivity between Tulla Mullen and the Namoi River alluvial aquifers, it is unlikely that the lower Tulla Mullen Creek aquifer would have any endemic taxa. Although sampling of the Tulla Mullen alluvium may confirm that stygofauna occur in the aquifer, the information would not change the assessment because stygofauna have already been assumed.

Potential for impact on the Tulla Mullen Creek alluvium

Drawdown of the lower Tulla Mullen Creek alluvial aquifer is predicted to be less than one metre for most of the area affected (Figure 6-29a of EIS). In the area modelled for drawdown, the aquifer of Tulla Mullen Creek is between approximately 20 and 60 m deep, with less extensive alluvium up to 10 m thick extending west along Sandy Creek (Figure 4.3 of AGE 2020). Stygofauna are most likely to occur in the thicker sections of aquifer because this is where water level is most stable, and the connection to the Namoi alluvium likely to be strongest. The modelled drawdown of less than 1 m is within the historical range of drawdown in the Namoi alluvium (AGE 2020), and within tolerance range for stygofauna. Further, a drawdown of less than 1 m would not isolate the Tulla Mullen Creek alluvium from the Namoi Alluvium, so there is no risk of stranding or isolating upstream communities.

Likelihood of stygofauna around Mayfield, Eather, and Hardy Springs

Eather and Hardy Springs have not had significant flow for at least ten years and are thought to be sourced from the Pilliga Sandstone, while Mayfield Spring is sourced from Purlawaugh Formation. Impacts to these sites are expected to be minor, with less that 0.05 m drawdown predicted. All three of these springs are more than 5 km from the alluvium boundary, in geological strata that are unlikely to have a porosity extensive and interconnected enough to support stygofauna.

Stygofauna are not well adapted to living in surface water as they are blind and fall easy prey to predators such as dragonfly larvae and small fish. To survive, stygofauna live in the substrate of the spring bottom. In locations where springs are known to support stygofauna, the spring substrate is generally alluvium or calcrete (Halse et al 2002, Department of Biodiversity, Conservation and Attractions 2020). These substrate types were absent from the three springs in the project area, making it unlikely that they support stygofauna.

Many species of endemic epigean (ie. surface-dwelling) invertebrates have been reported from springs in Queensland (Wilson and Keable 2004, Ponder and Clarke 1990). Although not stygofauna, these species are thought to have evolved in spring complexes where groundwater provides a relatively stable and permanent body of water and are vulnerable to changes in groundwater pressure. Hardy Spring is a moist, grass-lined drainage channel with no surface ponding or visible seepage and has not had significant discharge for at least 10 years (ENRS 2020). There are two agricultural dams at Eather Spring which are thought to have been filled with rainwater rather than groundwater. No visible seepage from the spring site was present during the site visit, and the landholder reported that there has not been flow for approximately 10 years (ENRS 2020). Neither of these springs appear active enough to provide a stable source of water for endemic fauna.

Mayfield Spring is currently active and has been modified for livestock access. Chemical analysis of water indicates the source is Purlawaugh Formation. The level of disturbance of the spring make it unlikely that any endemic epigean species will occur there.

Potential impact to Mayfield, Eather, and Hardy Springs

Drawdown at Eather and Hardy Springs is modelled to be 1 and 5 cm respectively. This level of drawdown is likely to have a negligible impact on the ecology of these two springs. Likewise, the modelled drawdown of 2 cm at Mayfield Spring will have negligible impact on the ecology of this spring.

In the unlikely event that stygofauna were living beneath the springs, a fall of 1-5 cm in the underlying aquifer would have no significant impact on the community.

Impacts of brine injection to stygofauna communities.

The approved method of disposing of brine solution is to inject it into the mine goaf at the completion of mining (AGE 2020). Re-injection of 2,367 to 2,830 ML of brine solution (76,554 to 91,630 mg/L TDS) is planned to occur over three years following the completion of mining. Brine would be injected through 20 bores that target the southern end of the 100 series and northern end of the 200 series panels. These are approximately 5 km from the Namoi alluvium, and 180 to 420 m below ground (DGS 2020). The volume of brine to be injected is less than 2% of the goaf pore space, and modelling predicts that the total pore space will not be filled until 200 years after mining ceases (AGE 2020). During this time, hydraulic gradients will cause water to drain towards the mine, causing dilution of brine solution (AGE 2020). It is very unlikely that the injected brine solution would impact on stygofauna communities.

Does the assessment adequately address the SEARS?

The project SEARS require impacts to stygofauna (as a key component of groundwater dependent ecosystems) to be considered under the Specific Issue of Water. Although no stygofauna samples were collected during the EIS, sufficient recognition was given to previous surveys of the Namoi alluvium, and a conservative assumption was made that Tulla Mullen Creek alluvium contains stygofauna. The modelled drawdown in both alluvial aquifers is minor, so the assessment concluded that there would be negligible impact to stygofauna communities. I consider the level of assessment to be adequate in meeting the SEARS requirements.

Conclusion and recommendations

I have reviewed relevant sections of the Narrabri Stage 3 Environmental Impact Statement and consider the assessment of impacts to stygofauna to be adequate. It is my opinion that drawdown to the alluvium of Tulla Mullen Creek and Namoi River, as modelled for the EIS, will have a negligible impact to stygofauna communities. Brine injection will also have a negligible impact on stygofauna communities.

Eather, Hardy and Mayfield Springs are unlikely to support stygofauna communities because their geology is unsuitable. Further, it is unlikely that these springs would support endemic surface-dwelling taxa, as they are heavily impacted from agricultural use, and two of them have had little or no discharge for at least 10 years.

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ATTACHMENT 5

AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS REPONSES TO NRAR/DPIE – WATER COMMENTS

Australasian Groundwater & Environmental Consultants

Memorandum

Project number	G1972
To	Mark Vile
Company	NCOPL
From	AGE Consultants Pty Ltd
Date	31 May 2021

RE: Narrabri Stage 3 Extension Groundwater Assessment response to DPIE - Water submission

1 Introduction

Responses to comments included in the Department of Planning, Industry and Environment: Water (DPIE - Water) submission letter and attachment dated 19 April 2021 which relate to the Narrabri Underground Mine Stage 3 Extension Project Groundwater Assessment Report (Australasian Groundwater and Environmental Consultants Pty Ltd [AGE], 2020a, referred to hereafter as the GA Report)[1] are provided below. DPIE - Water comments which relate to the Narrabri Coal Operations Groundwater Model Five Year Calibration Report Update (AGE, 2020b, referred to hereafter as the Calibration Report) will be addressed separately in a revised version of this Calibration Report (AGE, 2020b)[2].

Attachment A to the DPIE - Water letter provides a number of recommendations on pages 2 and 3 of the attachment which appear to be a summary of conclusions included elsewhere. Accordingly, we have provided responses to each of the recommendations, rather than responding to the conclusions.

Importantly, it is noted that DPIE – Water was consulted regularly during the Project GA, including:

- 10 December 2018, 12 December 2019 and 9 July 2020.
- DPIE – Water provided comments on the Gateway Certificate Preliminary Groundwater Assessment on 26 April 2019. These comments were addressed in the Environmental Impact Statement (EIS) GA Report.
- DPIE – Water provided comments on 15 January 2021 and 19 April 2021.
- A workshop was held with DPIE – Water on 11 May 2021 to discuss the approach being taken to address the comments.

[1] AGE, 2020a, Groundwater Assessment – Narrabri Underground Mine Stage 3 Extension Project, Final Report, October 2020 (https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-10269%2120201023T021150.054%20GMT).

[2] AGE, 2020b, Narrabri Coal Operations Groundwater Model Five Year Calibration Report Update, August 2020.

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Furthermore, predicted maximum drawdowns do not exceed 2 metres (m) in any part of the highly productive Namoi Alluvium, despite DPIE – Water's claim of a risk of up to 10 m of drawdown on this water source. As outlined herein, the modelling which supports the Project GA Report is comprehensive and has been peer reviewed by Mr Brian Barnett. Whilst we have carefully considered all comments provided by DPIE – Water, no amendments to the model are considered necessary and we are confident that the Project GA Report's findings remain accurate.

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2 Submission responses

2.1 Recommendation 1

2.1.1 Submission

The Model Calibration Report is required to be revised to make it fit for purpose of meeting Schedule 4, Condition 9 in Stage 2 Modification (MOD5) Mine Approval (PA 08_144). This must be done after revising the 2020 Model as described in recommendation 2 below.

2.1.2 Response

This submission relates to the separate Calibration Report (AGE, 2020b) and these comments will be addressed separately in a revised version of this report.

2.2 Recommendation 2

2.2.1 Submission

The 2020 Model, the Model Report, the Groundwater Assessment, and the Environmental Impact Statement are required to be revised to resolve issues identified above and provide confidence in the modelling work and efficiently inform decisions on the sought Mine extension. Those should include, but not be limited to:

a) *Provision of data supporting the development of the conceptualisation and model parameters. This should include justification of the very high level of vertical hydraulic anisotropy for some layers and choice of modelling to represent surface water-groundwater interactions. Hydrogeological cross sections showing vertical groundwater head gradients and flow directions are required for conceptualisation.*
b) *Confirmation whether or not the mine area includes alluvium and regolith as there are discrepancies between maps in the report. Corrections on impacts may be necessary.*
c) *Confirm the impact and probability of the impact on the alluvium aquifer, Great Artesian Basin aquifer and on surface water flows using the extension only scenario and cumulative worst case scenario (Narrabri Gas + existing Narrabri Coal + proposed extension).*
d) *Confirm water take volumes from each water source over the project life.*
e) *Reviewing the completeness of the rationale for model layers. With respect to the Namoi Alluvium represented as a single layer, consider whether this may constrain the sensitivity of the model to its vertical hydraulic conductivity. Consider adding information on the choice of the variable layering of the Napperby Formation.*
f) *Consideration on consistency between modelling approaches in the area, especially on boundary locations and types.*
g) *DPIE Water notes that the model does not include the brine injection activities. The reason of the omission needs to be transparent.*
h) *Model calibration requires clarifications. Information needs to be more transparent and complete especially with respect to calibration metrics for steady state calibration. The model may require adjustments.*

i) *A review of the initial assumption for the transient model is required. The report indicates a positive value for the change in groundwater system's storage (7.9 ML/day, the equivalent to ~2.9 GL/year or a total increase in groundwater storage of 30.3 GL over the transient modelling period 1 January 2009–30 June 2019). This appears inconsistent with the rainfall conditions during that period.*

j) *A review of the assumption resulting in an apparent gain in surface water systems from groundwater. The Department considers the outcome counter- intuitive and suggests field data may indicate the opposite relationship. Evidence needs to be shown to support the current assumptions.*

k) *Finally, the modelling report would benefit from some formatting and generally a better presentation. It is a difficult document to navigate. The report should also be stand alone. It is advised inconsistent definition of parameters like hydraulic conductivity vertical anisotropy makes it hard to undertake comparisons. It is defined as 'Kh:Kv' in the model calibration section whereas it is defined as 'Kv:Kx' in the uncertainty analysis section.*

2.2.2 Response 2a

Data supporting the conceptualisation and parameterisation of the numerical groundwater flow model is presented in Section 5 of the GA Report (AGE, 2020a). These are described in turn below.

It is important to note that the GA Report has built off the Gateway Application Preliminary Groundwater Assessment (Hydrosimulations, 2019)[3] (Dr Noel Merrick). Following on from this review, NCOPL obtained additional core permeability data and installed an additional nested VWP and extensometer monitoring facility installed prior to the underlying longwall panel being developed. Data collected at this facility provided valuable additional data on the extent of cracking emanating from the advancing longwall face. The GA Report benefitted from these empirical data and was also peer reviewed by Mr Brian Barnett, co-author of the *Australian Groundwater Modelling Guidelines* (Barnett et al, 2012)[4].

2.2.2.1 Modelled anisotropy

Data used to support the vertical hydraulic conductivity and anisotropy values adopted in the modelling work is presented and discussed in Section 5.3.2 of the GA Report (AGE, 2020a). As described in Section D3.3 of Appendix D of the GA Report initial anisotropy values and ranges for calibration were then defined for modelling purposes through reference to the thickness, degree of consolidation and average lithological composition of each model layer (see Figure 2.1) as well as previous model calibration. Hence, relatively thin and/or homogenous consolidated layers including the Pilliga Sandstone, Garrawilla Volcanics, Napperby Sill, Digby Conglomerate, Hoskissons Coal Seam and Arkarula Formation were assigned initial anisotropy ratios of 100 and a range of 10 to 1,000 used for calibration. The same initial value and range was also adopted for the Quaternary alluvium, colluvium and regolith in model layer 1. Accordingly initial values adopted for these seven layers were therefore the same as the 'accepted' value identified in the DPIE - Water letter (i.e 100).

Higher initial anisotropies of 1,000 were therefore only assigned to layers representing the remaining four consolidated layers (the Purlawaugh, Napperby upper, Napperby lower and Pamboola layers) on the basis that these layers are relatively thick and/or more lithologically heterogenous. As shown in Figure 2.1 the available lithological data, which comprises around 400,000 m of drilling in 1,900 exploration holes suggests that these strata comprise 30-60% fine material (mudstone, claystone and siltstone), substantially more than the other strata present. The relatively high initial anisotropy values adopted for selected layers are therefore considered to be supported by:

- lithological data for some 1,900 exploration holes (see Figure 2.1);
- the available hydraulic test data, comparison of median and harmonic means of core test results to arithmetic average of slug test results suggests anisotropies of over 100,000 in some cases (see Section 5.3.2 of the GA Report, AGE 2020a); and
- previous model calibration results (HydroSimulations, 2019) which returned anisotropy values ranging from 100 to 8,750.

[3] HydroSimulations, 2019. Narrabri Underground Mine Stage 3 Extension Project: Gateway Application Preliminary Groundwater Assessment.

[4] Barnett B., Townley L.R., Post V., Evans R.E., Hunt R.J., Peeters L., Richardson S., Werner A.D., Knapton A. and Boronkay A., 2012. "Australian Groundwater Modelling Guidelines", Waterlines report, National Water Commission, Canberra, June 2012.

Furthermore, as described in Appendix D of the GA Report (AGE, 2020a) a range of anisotropy values were explored during the model calibration and then further explored during the predictive uncertainty analysis. For the four layers discussed above (i.e. the Purlawaugh, Napperby upper, Napperby lower and Pamboola layers) where relatively high initial values were adopted then lower bound anisotropy values of 100 were adopted for the calibration and uncertainty analysis. Hence where necessary to fit the data then modelled anisotropies were adjusted from their initial values during the calibration process. Calibrated anisotropies are summarised in Appendix D Table D 3.7 of the GA Report (AGE, 2020a) and confirm that anisotropies only significantly exceed 100 in three of the 11 model layers, the Purlawaugh Formation (Layer 3), the Napperby upper (Layer 5) and the Garrawilla Volcanics (Layer 4). Modelled anisotropies for the Napperby lower (Layer 7) and the Pamboola Formation (Layer 11) were therefore substantially reduced during the calibration. Conversely the anisotropy of the Garrawilla Volcanics was increased to fit the observed data. As shown in Appendix D Table D 3.7 of the GA Report (AGE, 2020a) model calibrated anisotropy values range from 10 to 10,421, however it is not clear where the DPIE - Water comment that anisotropies of 100,000 have been assumed in some layers originated.

The sensitivity of model predictions to the same wide range of anisotropies used for calibration were then further assessed through completion of a predictive uncertainty analysis.

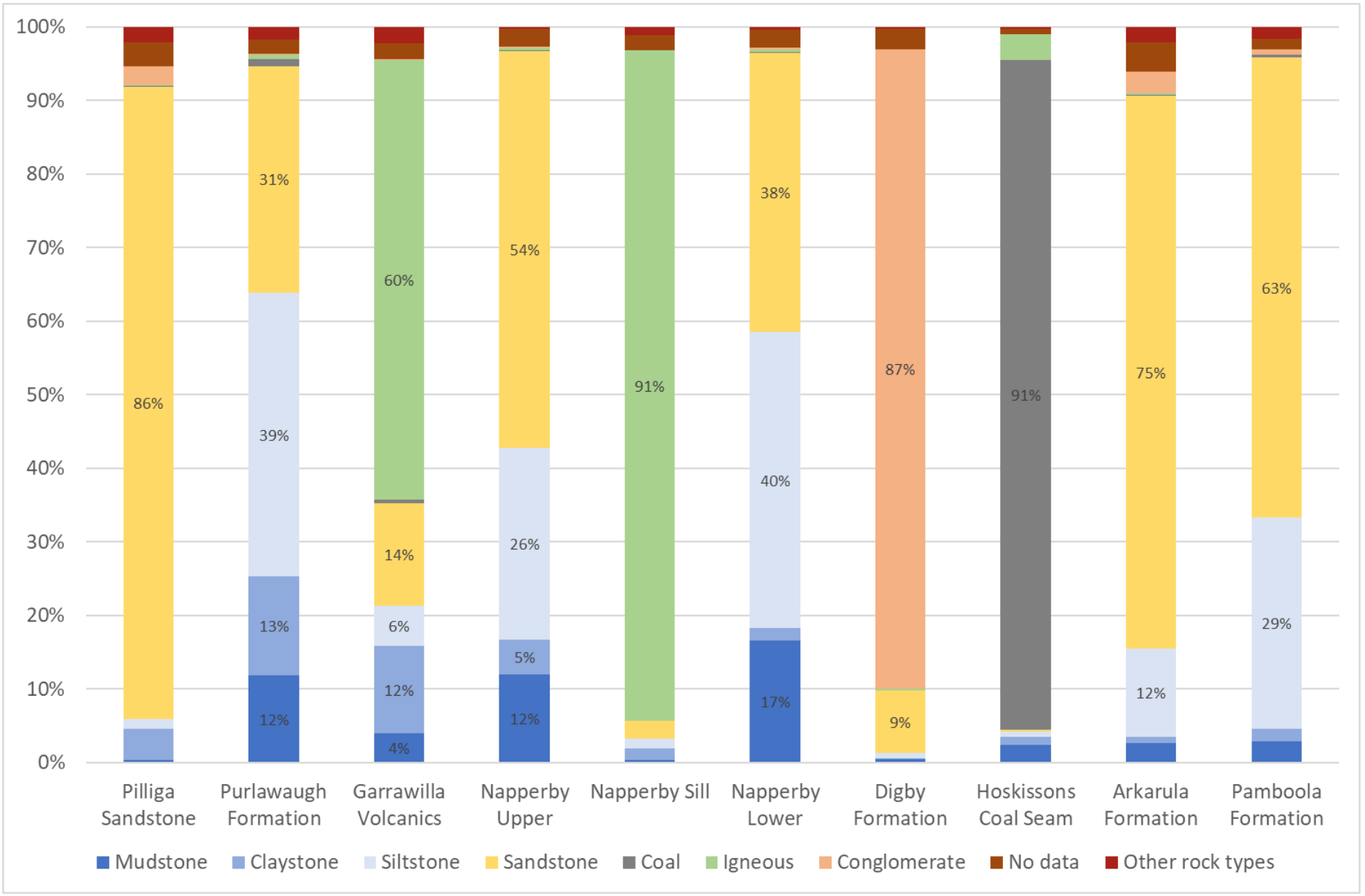


Figure 2.1 Average lithological composition of the main hydrostratigraphic units from NCOPL exploration drilling results (Figure 4.2 AGE, 2020a)

2.2.2.2 Representation of surface water – groundwater interactions

As described in Appendix D Section 2.5.2. of the GA Report (AGE, 2020a), major water courses in the modelled domain (i.e. the Namoi River, Maules Creek, Cox's Creek and Bohena Creek) have been modelled using the MODFLOW Stream package. Observed flow data, which is available for each of these water courses, suggests flows are relatively persistent which, in turn, suggests that groundwater discharge is occurring for at least part of the time. Conversely potentially significant leakage may be occurring from these water courses during periods when groundwater levels fall below the river/creek bed. Accordingly these water courses were simulated using the MODFLOW stream (STR) package which simulates surface water flow gains or losses (depending on the relative levels in the water course and underlying aquifer). This package also routes flow along the modelled water courses hence ensuring that total modelled flow losses cannot exceed flow gains in the upstream catchment.

The remaining mapped water courses in the area have been simulated using the MODFLOW river (RIV) package but parameterised in a way that prevents any loss (i.e. they act like MODFLOW drains). This is achieved by setting the modelled river level to the same value as the bed level (i.e. assigning a water depth of zero). This representation is consistent with the highly ephemeral nature of these minor water courses. Flow is understood to occur in these channels only following heavy rainfall and for a limited time period, suggesting limited interaction between groundwater and surface water in either direction.

Since surface water runoff to watercourses is not simulated in the model, potential additional recharge from this source is not simulated directly. Recharge to shallow alluvium systems may therefore be under-estimated. However, from an impact assessment point of view this is likely to result in a conservative over-estimation of impacts on these shallow systems, since additional recharge of this type would act to buffer drawdown impact caused by development of the mine.

2.2.2.3 Conceptualisation

A conceptual schematic illustrating the hydrogeological setting of the area and a description of the conceptual model is provided in Section 5.9 of the GA Report (AGE, 2020a). Groundwater level flow directions and observed head differences at nested monitoring points are also discussed at length in Section 5.2 of the GA Report (AGE, 2020a) although are not shown on the schematic itself.

A number of additional cross sections through the numerical groundwater flow model, developed for landholder consultation purposes are also included in Attachment A. Cross section locations are shown in Figure A1 in Attachment A.

2.2.3 Response 2b

Mapped surface geology used for model construction purposes is shown in Figure 4.5 of the GA Report. As shown, no areas of Quaternary Alluvium (Q_m_c) are mapped within the current mining lease (ML) or the mining lease application (MLA) areas. However, colluvium valley flank deposits (Q_Cr) are mapped across part of these areas. Furthermore, based on CSIRO Quaternary cover mapping (Wilford et al., 2015[5]) un-mapped weathered regolith or residual soils are also thought likely to be present in areas where consolidated bedrock strata are mapped at outcrop. Accordingly, as shown in Appendix D Figure D3.1 of the GA Report (AGE, 2020a) model layer 1 which represents the Quaternary Alluvium, colluvium and regolith is present across the entire model domain. Outside of the areas of mapped Quaternary Alluvium the thickness of this surficial layer is based on the CSIRO data set (Wilford et al., 2015).

[5] Wilford J, Searle R, Thomas M and Grundy M, 2015. Soil and Landscape Grid National Soil Attribute Maps – Depth of Regolith (3" resolution) – Release 2. V6. CSIRO Data Collection https://doi.org/10.4225/08/55C9472F05295.

2.2.4 Response 2c

An additional scenario and associated reporting to assess the Project on its own is not considered worthwhile in this case. The proposed Stage 3 mine plan includes the extension southwards of each of the approved Stage 2 panels, such that the proposed mine plan will deviate from the approved plan once development of the first longwall panel (LW209) extends beyond the boundary of the current lease area. The proposed Stage 3 mine plan therefore involves significant year-on-year alterations to the approved Stage 2 plan and is not therefore a simple extension (i.e. the physical extensions into the new MLA area would occur progressively over a long period as each longwall individually progresses). Accordingly, any Stage 3 extension scenario, whereby only the southern half of each panel is developed, would be an entirely theoretical construct which would not be impossible to implement in practice. It would also not be possible to measure the separate groundwater inflows from Stage 2 against Stage 3 for the same reasons. The groundwater assessment (AGE, 2020a) reports on the predicted impacts of:

- the Narrabri Mine Stage 3 Extension Project mine plan (i.e. the Project only); and
- concurrent development of the Narrabri Gas[6] and Narrabri Mine Stage 3 Extension projects (i.e. cumulative impacts).

A comparison of Project only impacts with Stage 2 impact predictions developed by Hydrosimulations (2015)[7]) is then also presented in Section 7.10 of the GA report (AGE, 2020a). As described in this section of the GA report, with regard to flow impacts on over and underlying units the predicted impacts of the Project are actually less than the predicted Stage 2 MOD 5 impacts which have already been approved. Conversely, additional licences for direct extraction from the Gunnedah Oxley Basin Murray Darling Basin water source will be required since inflow to the extended mine workings will be increased.

2.2.5 Response 2d

As required for licensing purposes maximum takes from each water source are presented in Table 7.7 in the GA report. Hydrographs showing the timing of impacts on the majority of water sources are also presented in the GA report as follows:

- Upper and Lower Namoi regulated river sources, Figure 7.19 and Figure 7.20;
- Namoi Alluvium sources, Figure 7.16 and Figure 7.17; and
- NSW Murray Darling Basin Porous Rock Groundwater Sources (Figure 7.2).

2.2.6 Response 2e

The rationale for adopting a single layer for the Namoi Alluvium is presented in Appendix D Section D 2.4.3 of the GA Report (AGE, 2020a). A single layer was adopted for this unit on the basis that:

- the boundary between Narrabri Formation and the underlying Gunnedah Formation is not always obvious;
- previous detailed modelling of the Namoi Alluvium (McNeilage, 2006[8]) suggested very similar properties for both of these formations; and
- reference to a series of east-west lithological sections through the Namoi Alluvium, see Appendix E of the GA report (AGE, 2020a) show no clear stratification of the alluvium.

[6] CDM Smith, 2016. Narrabri Gas Project Groundwater Impact Assessment.
[7] HydroSimulations, 2015. Narrabri Mine Modification, Groundwater Assessment.
[8] McNeilage C, 2006. *"Upper Namoi groundwater flow model"*. Published by NSW Department of Natural Resources.

With regard to whether or not the adoption of a single layer constrains the sensitivity of the model to its vertical hydraulic conductivity, parameter identifiability, or the sensitivity of the calibration to each model parameter, is summarised in Appendix D Table D3.10 of the GA Report (AGE, 2020a). As shown in this table the calibration is actually more sensitive to the horizontal hydraulic conductivity (Kh) of the Quaternary Alluvium than most other parameters, including the vertical hydraulic conductivity (Kv) of this layer. This is related to concentration of observation bores in this unit. As summarised in Appendix D Table D 3.1, almost half of the 229 observation bores used for model calibration are completed into the Quaternary Alluvium. Furthermore, a relatively good match to this observed data has been achieved which suggests that the single layer conceptualisation is not inconsistent with the available data.

2.2.7 Response 2f

The DPIE - Water letter alludes to some apparent inconsistencies between groundwater models developed to assess the impacts of the Narrabri Coal Mine, the Narrabri Gas Project and BTM complex, in particular with regard to peripheral (lateral) boundary conditions and types.

2.2.7.1 BTM complex model

With respect to the BTM complex model (AGE, 2020c)[9] there appear to be few, if any, significant inconsistencies with regard to the lateral boundary conditions and types. The BTM complex model simulates the impact of extraction from a number of relatively shallow coal seams targeted by open cut operations at the Boggabri, Tarrawonga and Maules Creek mines to the east of the Namoi River. The targeted seams, which form part of the Maules Creek sub-basin, dip towards the east and do not extend beneath the Namoi Alluvium. Hence predicted impacts extend largely eastward from the mine and no significant drawdown is predicted in the Namoi Alluvium. As outlined in the GA Report (AGE, 2020a) the Narrabri Mine is located to the west of the Namoi River and targets the Hoskissons Coal Seam. On this side of the river the strata dip towards the west and the targeted coal seam, which forms part of the Mullaley Sub-Basin, also does not extend beneath the Namoi Alluvium. Hence predicted impacts to the east of the mine are limited in extent and no significant drawdown is predicted in the Namoi Alluvium. Both the BTM and Narrabri models, however, extend beyond the Namoi River such that each model is able to predict drawdown at the river without the location of the boundary affecting predictions. As expected, given that the BTM and Narrabri mines are located in different sub-basins, there is no overlap of predicted impacts.

With regard to lateral boundaries both the BTM complex and Narrabri models then also employ a mixture of general head or no-flow boundary conditions around the periphery of the model domain. No flow boundary conditions are adopted in areas where no cross boundary flow is anticipated (e.g. across the Mooki Thrust Fault in the BTM complex model). General head boundaries are used in areas where flow into, or out of, the model domain is anticipated (e.g. within the Namoi Alluvium).

Similar internal boundary conditions have also been adopted in the two models. Both models simulate the Namoi River using the MODFLOW Stream package and simulate other minor water courses using the MODFLOW River package, but parameterised in a way that prevents any loss (i.e. they act like MODFLOW drains). However, unlike the BTM complex model the Narrabri Mine model simulates Maules Creek using the MODFLOW Stream package, rather than the MODFLOW River package. Since the Narrabri Mine is not predicted to have any significant impact on groundwater levels in the vicinity of Maules Creek this difference between the two models is considered unlikely to make any material difference to impacts predicted in the GA Report (AGE, 2020a).

[9] AGE, 2020c, Boggabri, Tarrawonga, Maules Creek Complex Groundwater Model Update (https://www.idemitsu.com.au/mining/wp-content/uploads/2016/02/G1850P.BTM_model_update_v03.02.pdf).

Furthermore, it is noted in the IESC advice that (IESC, 2020)[10]:

> *10. Considering the significant distances (ca. 30-50 km) to the nearest open cut coal mines in the area, and the justification provided for selecting groundwater model boundaries, it is reasonable for the proponent to exclude the potential cumulative impacts of mines located to the south-west of the project area. Additionally, the geological characteristics of the Boggabri Ridge separating the Mulley sub-basin from the Maules Creek sub-basin justify not including these other open cut mines in the cumulative impact assessment.*

2.2.7.2 Narrabri Gas Project

Consistent with the larger footprint and depth of extraction at the Narrabri Gas Project a substantially larger model domain was developed as part of the impact assessment for this project (CDM Smith, 2016). In this case the active model domain extends to the boundaries of the Gunnedah Basin and beyond in some cases. Lateral boundaries comprise no-flow or prescribed head boundary conditions depending on whether or not groundwater flow into or out of the model domain is anticipated. The rationale used to select appropriate lateral boundary conditions is therefore considered to be consistent with that adopted for the BTM and Narrabri models (Section 2.2.7.1). Nevertheless, some differences may arise in the different models due to the different model domains. For instance, unlike the Narrabri Gas Project model (CDM Smith, 2016) the Narrabri Mine model (AGE, 2020a) does not extend to the limit of the Gunnedah Basin to the west and therefore employs a general head boundary at the western boundary of the model, since groundwater flow is expected across this boundary. No such boundary is employed in the Narrabri Gas Project model since this model extends to the boundary of the Gunnedah Basin and beyond.

Internally, the Narrabri Gas Project model (CDM Smith, 2016) used MODFLOW River cells to simulate groundwater-surface water interaction with the Namoi River and Cox's Creek. Other water courses do not appear to have been simulated in the model. In general, the MODFLOW Stream package used to represent the Namoi River and Cox's Creek in the Narrabri Mine and BTM models (AGE, 2020a; AGE, 2020c) is considered to be a better option than the River package. As discussed in Section 2.2.2.2 use of the Stream package ensures that total modelled flow losses cannot exceed flow gains in the upstream catchment. The apparent absence of other water courses from the Narrabri Gas Project model (CDM Smith, 2016) is also considered to be a deficiency. However, given that predicted impacts on the water table due to the Narrabri Gas Project are negligible (CDM Smith, 2016) it is considered unlikely that the use of the stream package and/or simulation of more water courses would have materially affected the reported impacts.

Given that the Narrabri Gas Project targets the same coal seam as the Narrabri Coal Mine and is located immediately to the west, overlapping impacts are expected and a cumulative impact scenario including the concurrent operation of both projects has been included in the Narrabri Mine Stage 3 Extension GA Report (AGE, 2020a).

Furthermore, it is noted in the IESC advice that (IESC, 2020):

> *9. The IESC notes that the proponent has incorporated impacts associated with the Narrabri Gas Project, using Santos' 'base case' scenario, into the cumulative impact predictions of the groundwater modelling. The IESC considers that this is an acceptable approach to assessing potential cumulative groundwater impacts at the site, noting the comments in Paragraph 3b.*

2.2.8 Response 2g

The potential water quality impacts of brine disposal into the mine goaf at completion of mining are described in Section 7.8.2 of the GA (AGE, 2020a). This assessment makes reference to output from a re-injection scenario undertaken using the numerical model which was undertaken to quantify:

- what level of head increase would occur at the point of injection;
- post closure inflow rates to the goaf; and
- how long groundwater levels would take to recover to fill the void spaces within the goaf.

[10] IESC, 2020, Advice to decision maker on coal mining project – IESC 2020-119: Narrabri Underground Mine Stage 3 Extension Project (Narrabri Mine Extension) (State Ref No 9882) – Expansion.

Thereafter, a series of analytical calculations were undertaken drawing on heads and flows calculated using the numerical model to quantify potential impacts on water quality.

All reported head and flow predictions are based on model runs which include re-injection.

2.2.9 Response 2h

Calibration of the numerical model was undertaken using a single simulation with an initial steady state stress period used to derived initial conditions for subsequent transient stress periods. Accordingly, the calibration scatter plots, shown in Figures 3.8, 3.9 and 3.10 of the GA Report (AGE, 2020a), include measurements used for calibration of the steady state and transient stress periods. Consequently, the reported scaled root mean square error statistics (SRMS) represent combined steady state and transient statistics, although will tend to be dominated by the transient results. Scatter plots showing measurements used to calibrate the steady state model stress period only are shown in Figure 2.2, Figure 2.3 and Figure 2.4. As summarised in Table 2.1 SRMS statistics for the initial steady state stress are comparable to, or slightly better, than those reported for the combined steady state and transient data sets reported in the GA Report (AGE, 2020a) and are also within ranges typically considered acceptable for models of this type.

In addition, the peer reviewer, Mr Brian Barnett concluded:

> *I have concluded that the calibration approach and outcomes meet all reasonable expectations (including guiding principles outlined in the Australian Groundwater Modelling Guidelines) and in most regards exceed current industry standards.*

Table 2.1 SRMS calibration statistics

Bore group	Steady State SRMS	Combined Steady State and Transient SRMS
Namoi Alluvium	3.9%	3.3%
NCOPL monitoring bores	8.8%	7.7%
Other monitoring bores	4.8%	9.4%

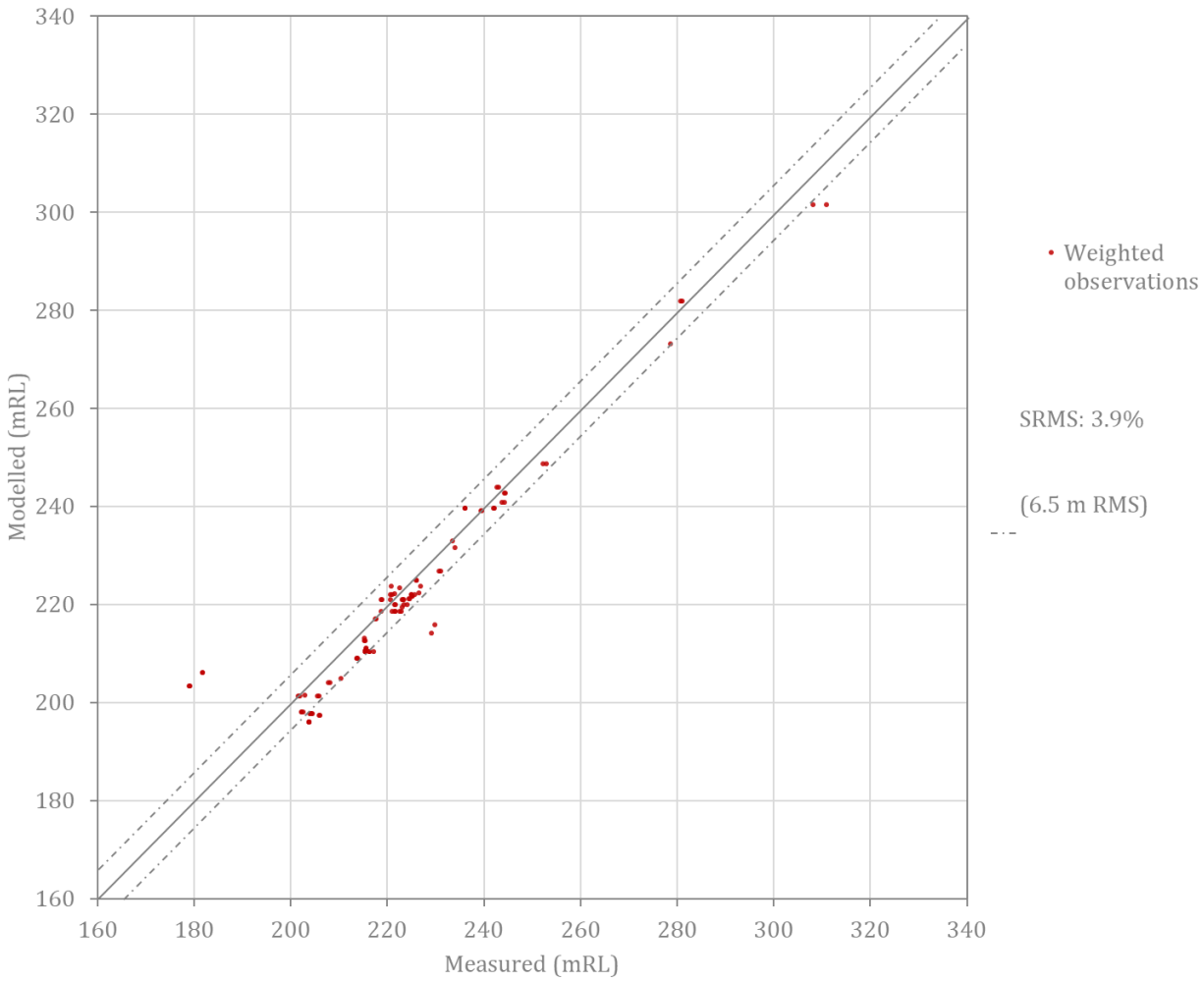


Figure 2.2 Steady State calibration – modelled vs observed groundwater levels, Namoi Alluvium

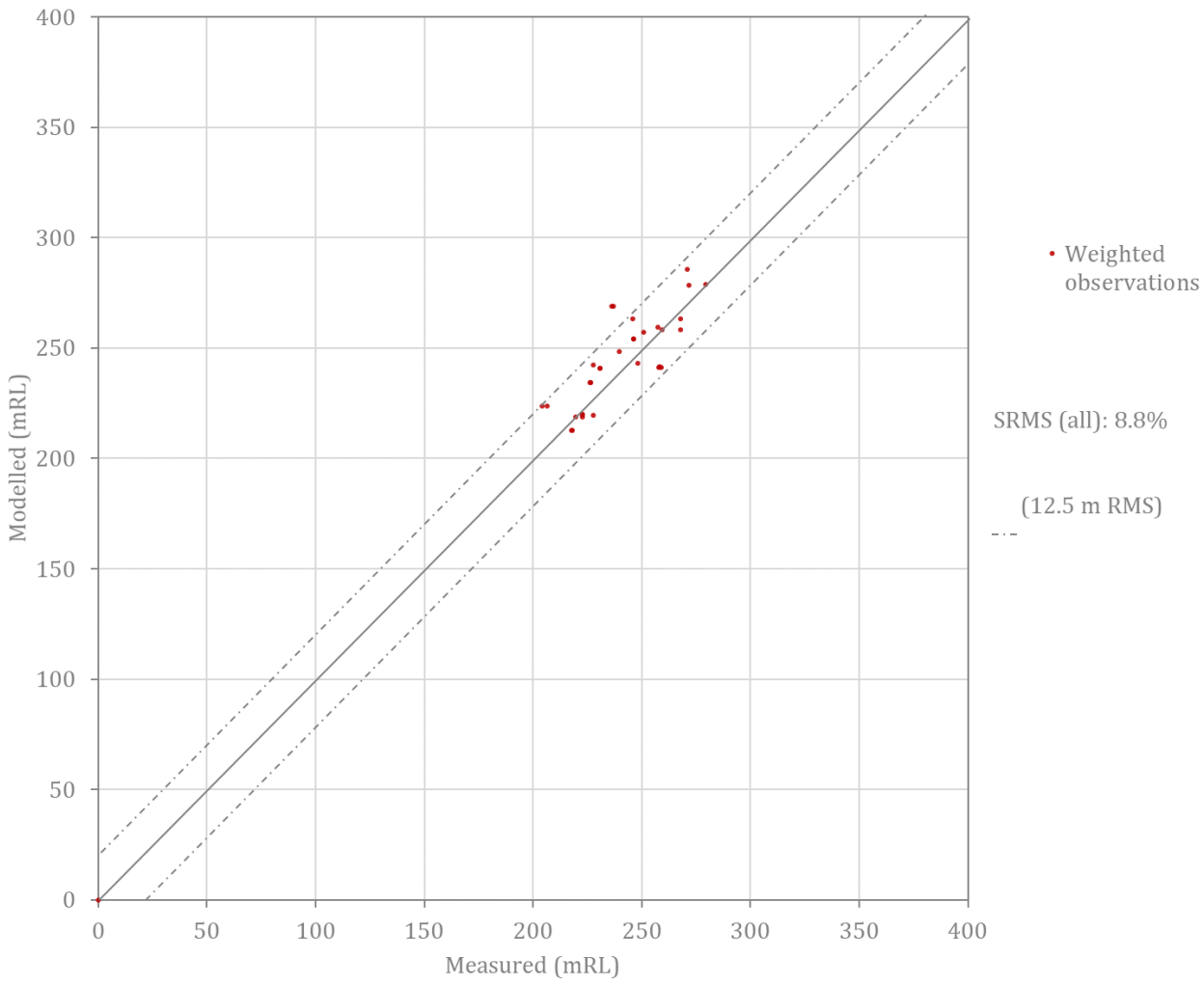


Figure 2.3 Steady State calibration – modelled vs observed groundwater levels, NCOPL monitoring bores

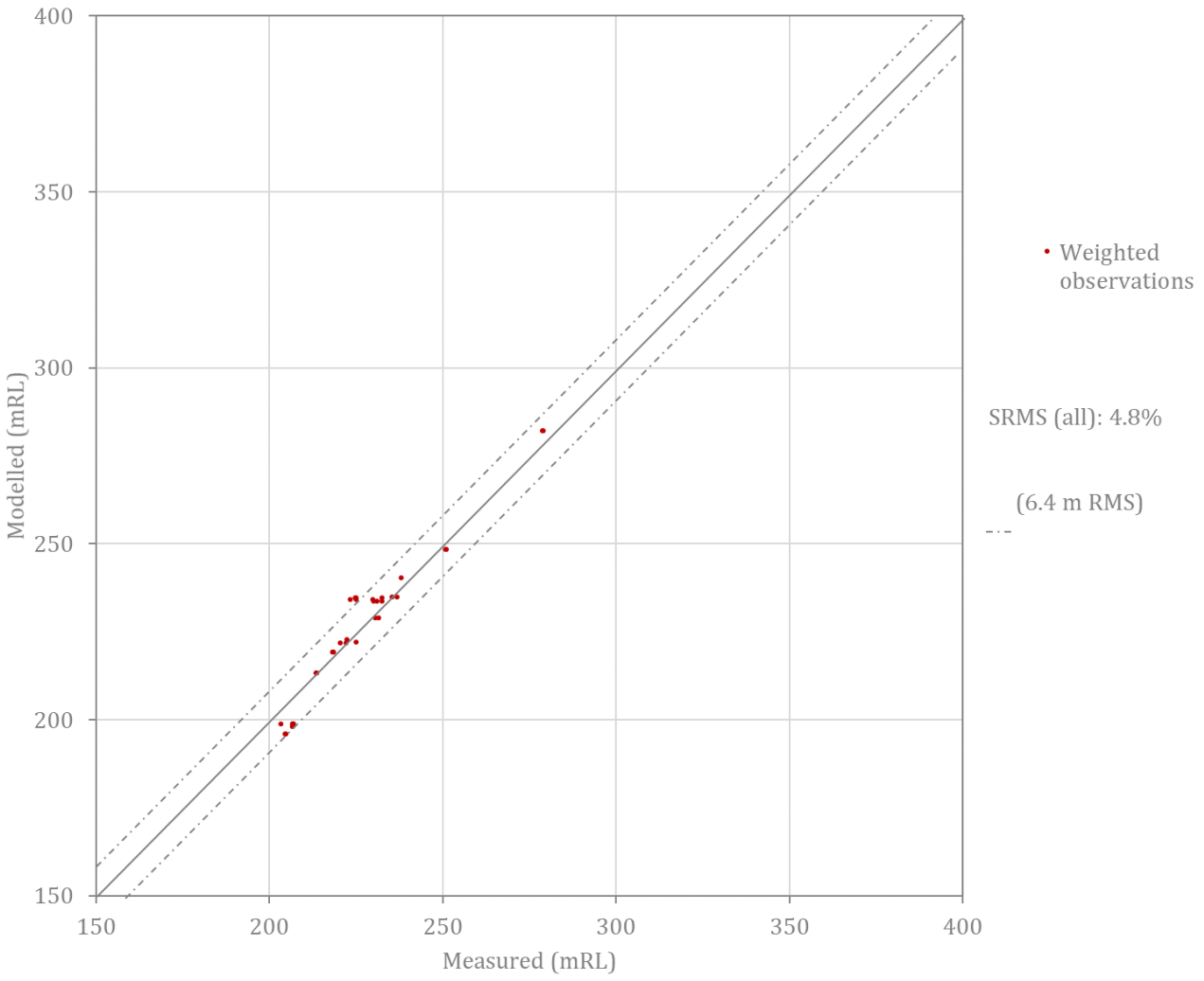


Figure 2.4 Steady State calibration – modelled vs observed groundwater levels, other bores

2.2.10 Response 2i

Modelled water balance results for the calibration period January 2009 to June 2019 are presented in the Table D 3.11 of the GA Report (AGE, 2020a). On average over the calibration period these results suggest storage inflows of 57.8 million litres per day (ML/d) compared to storage outflows of 49.9 ML/d. Accordingly, on average over the period modelled, 7.9 ML/d is being released from storage into the model leading to generally declining modelled groundwater levels, especially during the recent period. Contrary to the assertion in the DPIE - Water letter, this is considered to be consistent with the relatively dry rainfall conditions which have persisted during the majority of this period (see Figure 3.1 in the GA Report, AGE, 2020a).

2.2.11 Response 2j

Item 2j in the DPIE - Water letter appears to relate to surface water – groundwater interaction components of the modelled water balance shown in Appendix D Table D 3.11 of the GA Report (AGE, 2020a). As reported in this table, model results suggest net discharges of groundwater to both minor and major water courses. It should be stressed that gaining conditions are not assumed in any way in the model but are a result of the model calibration. In addition to time series data for over 100 observation bores within the Namoi Alluvium, the calibration data set includes observed baseflow gains/losses in the Namoi River between Boggabri and Narrabri. As reported in Appendix D Table D 3.12 of the GA Report (AGE, 2020a), on average over the calibration period, observed baseflow gains were 19.3 ML/d, compared to modelled baseflow gains of 14.3 ML/d. Hence, if anything the model is slightly underestimating actual gains. Furthermore, as shown in Figure D 3.8 of the GA Report (AGE, 2020a) and in Figure 2.2, the observed groundwater levels in the Namoi Alluvium are generally well matched in the model. In particular there is little to no evidence that the model is systematically over-estimating groundwater levels and hence flow towards the Namoi Alluvium. If anything, as shown in Figure 2.2, modelled groundwater levels tend to be generally slightly lower than observed. Given that observed heads in the vicinity of the Namoi River and observed gains in the river itself are both relatively well matched it is not clear why the department considers the modelled gain to be counter-intuitive.

2.2.12 Response 2k

We understand that the DPIE - Water comments relating to the document being difficult to navigate relate to Appendix D of the AGE report, which provides further detail on the numerical modelling work undertaken. This appendix is intended to be read in conjunction with the main report and as such is not stand-alone. To avoid repetition there are numerous cross references to the main body of the report and impact predictions are not presented in the modelling appendix. We recognise that this is not a perfect solution but on balance think this represents a better option for all readers (i.e. including members of the public reviewing the report) than adding all the modelling detail into the main body of the report. Nevertheless, DPIE – Water's comments will be taken on board and we will seek to address the navigation difficulties, as far as possible, in future reporting.

Unfortunately, the interchangeable use of Kv and Kx flagged by DPIE - Water in the modelling appendix were not previously picked up, in either internal AGE or external review comments.

2.3 Recommendation 3

2.3.1 Submission

Simulate and assess appropriate scenarios to inform decisions on the sought mine extension approval.

2.3.2 Response

As outlined in the responses provided above, we do not see a need to undertake any further scenarios at this stage. In particular, an additional scenario and associated reporting to assess the impacts of Stage 3 extension on its own is not considered worthwhile in this case. The proposed Stage 3 mine plan also includes significant alterations to the approved Stage 2 plan and is not therefore a simple extension (Section 2.2.4). Similarly, as discussed in Section 2.2.8, all reported head and flow predictions are based on model runs which already include the proposed post closure re-injection to the goaf. Hence no further simulations are required to address this comment.

2.4 Recommendation 4

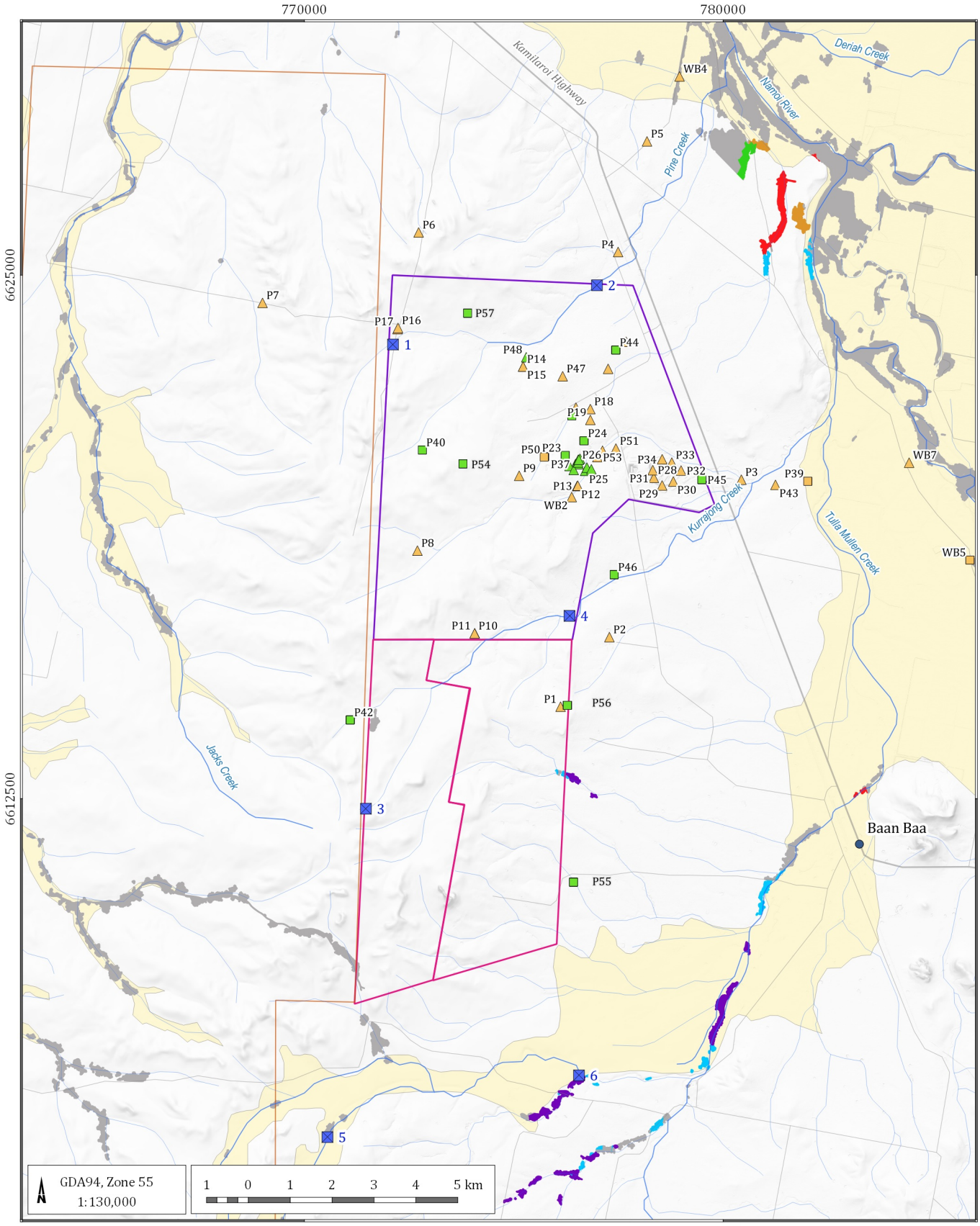
2.4.1 Submission

Prepare and implement field investigations program/s to fill the data gaps identified in the Model Report.

2.4.2 Response

Additional monitoring recommendations are provided in Section 8.2 of the Project GA Report (AGE, 2020a) and include the installation of additional groundwater level and quality monitoring facilities at six locations upstream and downstream of the mine lease areas on Kurrajong, Pine and Tulla Mullen Creeks. Approximate locations for these additional facilities are shown in Figure 2.5. In addition to installing standpipe piezometers in the Quaternary alluvium and immediately underlying bedrock strata, as recommended in the Project GA Report (AGE, 2020a) NCOPL also now proposes to install a further six VWP monitoring nests at each of these locations to address other submissions on the EIS. Each VWP nest would include monitoring in each stratigraphic present above the Hoskissons Coal Seam. Since a number of the proposed sites are above proposed longwall panels this will also provide additional data on actual height of fracturing. These additional facilities would be installed as soon as possible after approval is received, such that they could provide significant additional groundwater level data into a refinement of the groundwater model, to be completed within two years of approval.

Maximum drawdowns of less than 5 centimetres (cm) are predicted at each of the three potential spring sites (Mayfield, Hardys and Eather) discussed in the GA Report (AGE, 2020a). Nevertheless, further monitoring at each site is outlined in Section 8.2 of the GA Report (AGE, 2020a) ,the purpose of which is to observe any changes to flow rates and surface conditions and to confirm whether these features are groundwater dependent. Depending on the results of these visits, the Water Management Plan (WMP) would be revised to include ecological monitoring and further ongoing groundwater and surface water monitoring, similar to the shallow monitoring proposed at the creek sites.



LEGEND

- Populated place
- Drainage
- Road
- Mining Lease Boundary (ML 1609)
- Provisional Mining Lease Application Area
- Proposed Narrabri Gas Project (Santos)
- Alluvium extent

GDEs areas where predicted maximum water table drawdown exceeds AIP threshold

- Narrow-leaved Ironbark
- Box grassy woodland
- Red Gum
- River Red Gum
- Shallow freshwater wetland sedgeland
- Other High priority GDE areas

- Proposed new monitoring site

Existing groundwater monitoring sites

- Standpipe - Nested
- Standpipe - Single
- VWP - Nested
- VWP - Single

Narrabri Stage 3 Extension GIA - Response to Submissions (G1972)

Existing and proposed groundwater level monitoring locations

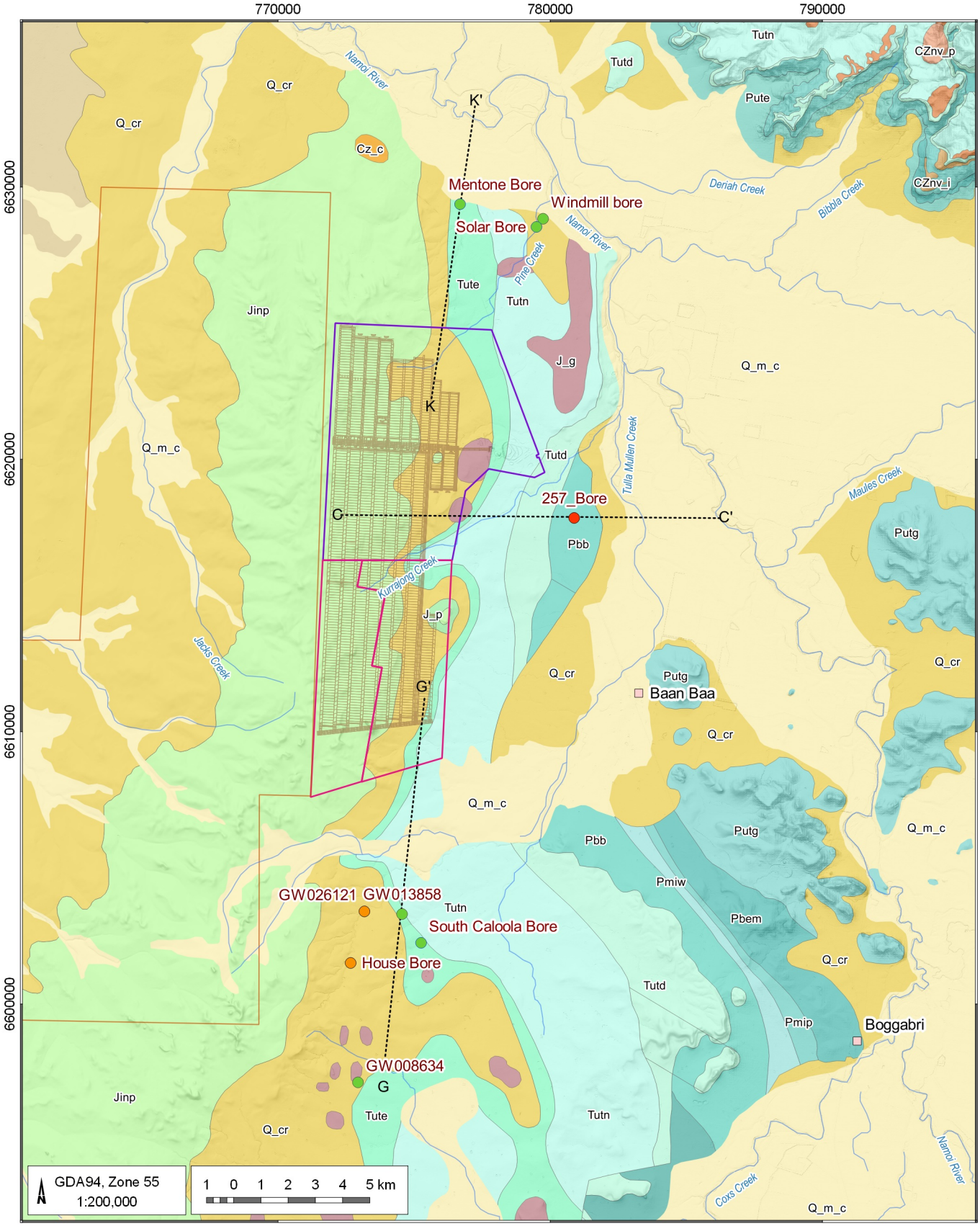
DATE 17/02/2021

FIGURE No: **2.5**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972.Narrabri Stage 3 Extension GIA\3_GIS\Workspaces\004_Deliverable4\02.05_G1972_Existing and proposed groundwater level monitoring locations.qgs

Attachment A

Additional cross sections



LEGEND

- Populated place
- Drainage
- Cross section line
- Longwall panels
- Mining Lease Boundary (ML1609)
- Proposed Narrabri Gas Project (Santos)

Impacted unit

- Arkarula Formation
- Garrawilla Volcanics
- Napperby Formation

Surface geology (NSW seamless geology)

- (CZnv__p) - Trachyte intrusives
- (CZnv__v) - Volcanics
- (Jinp) - Pilliga Sandstone
- (J__g) - Garrawilla Volcanics
- (Tute) - Deriah Formation
- (Tutn) - Napperby Formation
- (Tutd) - Digby Formation
- (Pbj) - Black Jack Group
- (Pbb) - Brothers Subgroup
- (Pmiw) - Watermark Formation
- (Pmip) - Porcupine Formation
- (Pbem) - Maules Creek Formation
- (Pute) - Werrie Basalt
- (Putg) - Boggabri Volcanics

Narrabri Stage 3 Extension Groundwater Assessment response to DPIE - Water submissions (G1972)

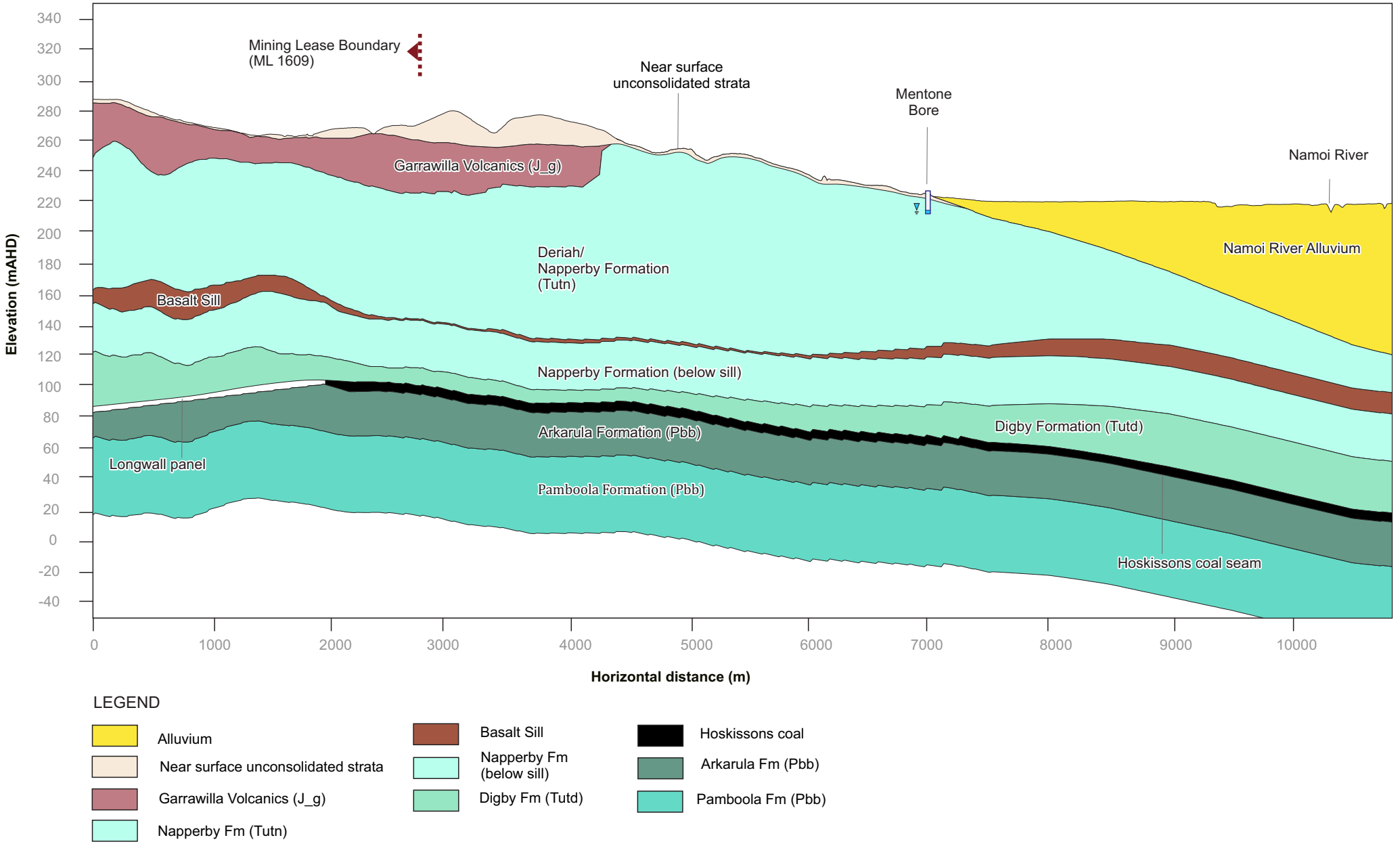
Cross section locations

AGE

DATE 28/05/2021

FIGURE No: **A 1**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972.Narrrabri Stage 3 Extension GIA\3_GIS\Workspaces\001_GIA\A 01_G1972_Cross section locations.qgs

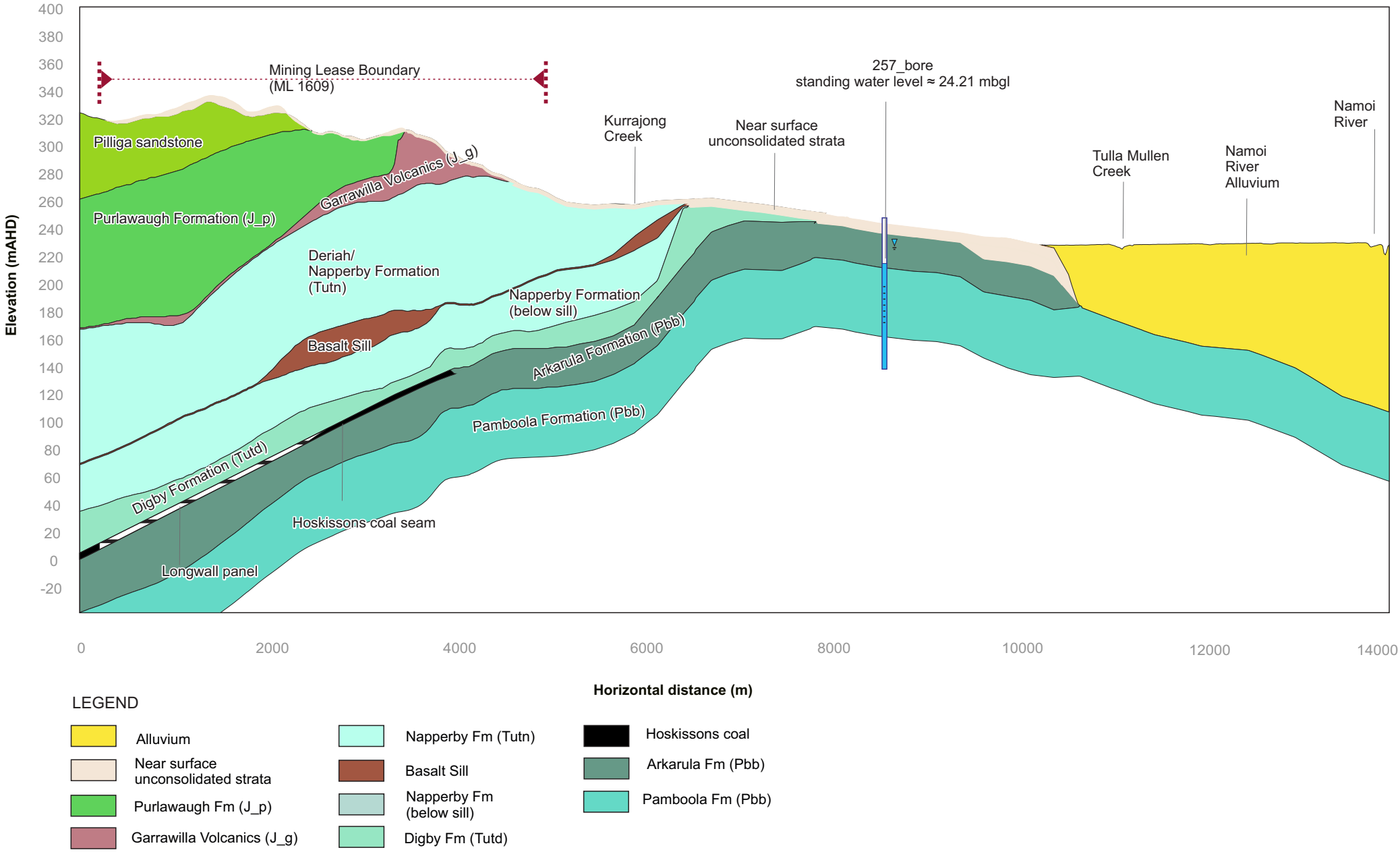


Cross section (K - K')

Figure - A 2

Narrabri Stage 3 Extension Groundwater Assessment response to DPIE - Water submissions (G1972)

AGE

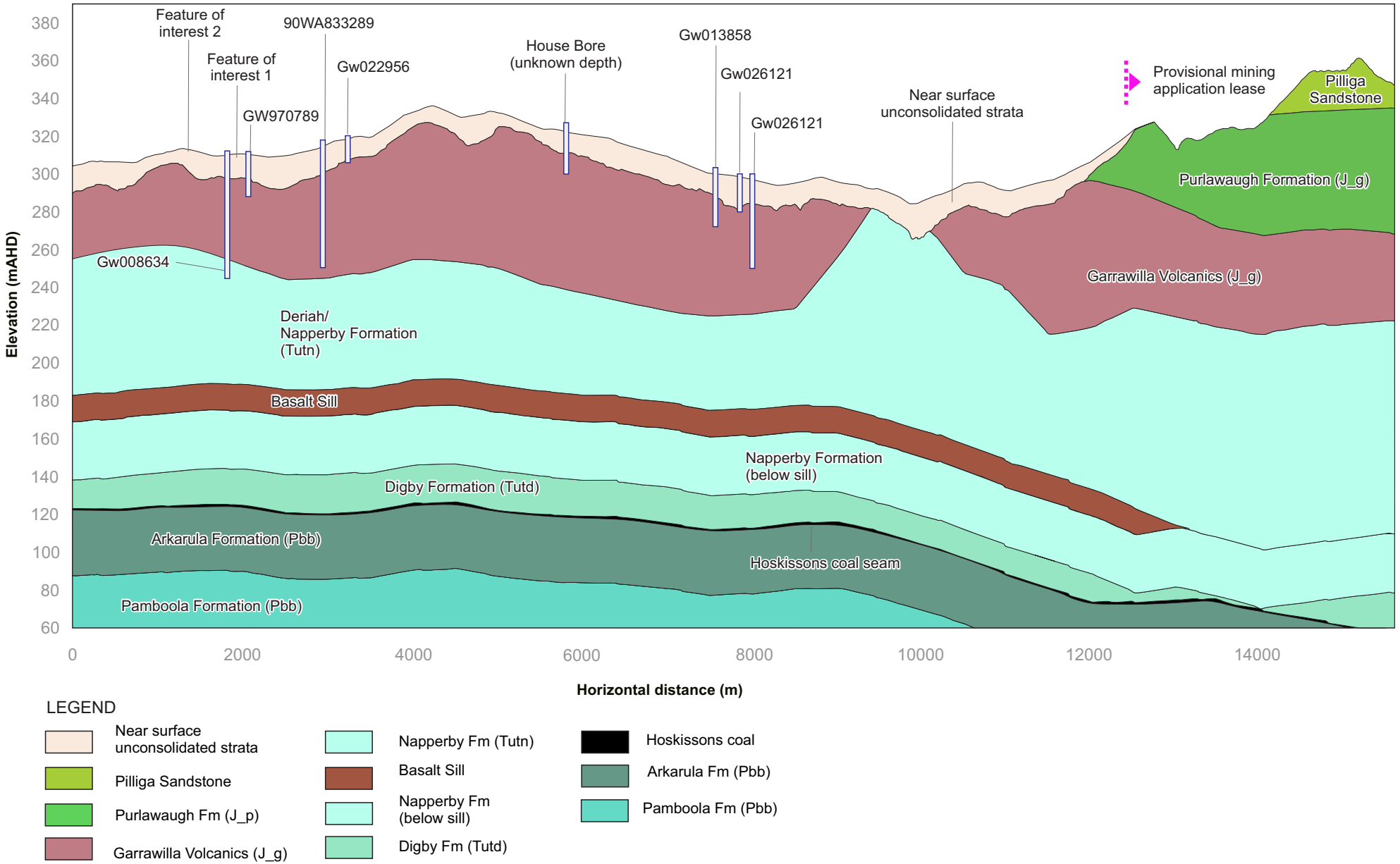


Cross section (C - C')

Figure - A 3

Narrabri Stage 3 Extension Groundwater Assessment response to DPIE - Water submissions (G1972)

AGE



Cross section (G - G')

Figure - A 4

Narrabri Stage 3 Extension Groundwater Assessment response to DPIE - Water submissions (G1972)

ATTACHMENT 6

BORE CENSUS ROUND 3 REPORT

Australasian Groundwater & Environmental Consultants

Report on

Narrabri Underground Mine Stage 3 Extension Project Round 3 Bore Census

Prepared for
Narrabri Coal Operations Pty Limited

Project No. G1972F
May 2021

ageconsultants.com.au

ABN 64 080 238 642

Document details and history

Document details

Project number	G1972F
Document title	Narrabri Underground Mine Stage 3 Extension Project – Round 3 Bore Census
Site address	Narrabri Coal Operations Pty Ltd, 10 Kurrajong Creek Road, BAAN BAA NSW 2390
File name	G1972F.Narrabri Stage3 round3 Bore Census.v04.01.docx

Document status and review

Edition	Comments	Author	Authorised by	Date
v01.01	DRAFT report for internal review	PL	KP	07/05/2021
v02.01	Second draft incorporating results for additional bores	PL	KP	17/05/2021
v03.01	Third draft addressing client comments	PL	KP	25/05/2021
v04.01	Fourth draft addressing client comments	PL	KP	31/05/2021

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Narrabri Underground Mine Stage 3 Extension – Round 3 Bore Census

1 Introduction

The Narrabri Mine is located approximately 25 kilometres (km) south-east of Narrabri and approximately 60 km north-west of Gunnedah within the Narrabri Shire Council Local Government Area of New South Wales (NSW). The Narrabri Mine is operated by Narrabri Coal Operations Pty Limited (NCOPL).

As part of the Groundwater Assessment (GA) for the Narrabri Underground Mine Stage 3 Extension Project (the Project) two previous rounds of bore census activities were completed by Environment & Natural Resource Solutions (ENRS) (ENRS, 2020)[1] and impacts were assessed at all known registered bores and at a number of unregistered bores identified during bore census activities (Australasian Groundwater and Environmental Consultants Pty Ltd) (AGE, 2020)[2]. Nevertheless, one of the submissions received on the Project asserts that a number of registered bores have not been included in the impact assessment. Accordingly, NCOPL requested that AGE undertake a third round of bore census activities, this time focusing on areas shown in Figure 1.1. This report provides a summary of these third round bore census activities, which were completed on 22 March, between 12 and 16 April and on 13 May 2021.

1.1 Objectives

This report captures the data gathered during the third round bore census, the main objectives of which were to:

- identify water supply bores and other potential groundwater features in the identified areas depicted on the map in Figure 1.1;
- where possible, conduct site inspections and meet with landholders to verify borehole conditions and groundwater usage; and
- compile the bore census results to support the groundwater assessment process.

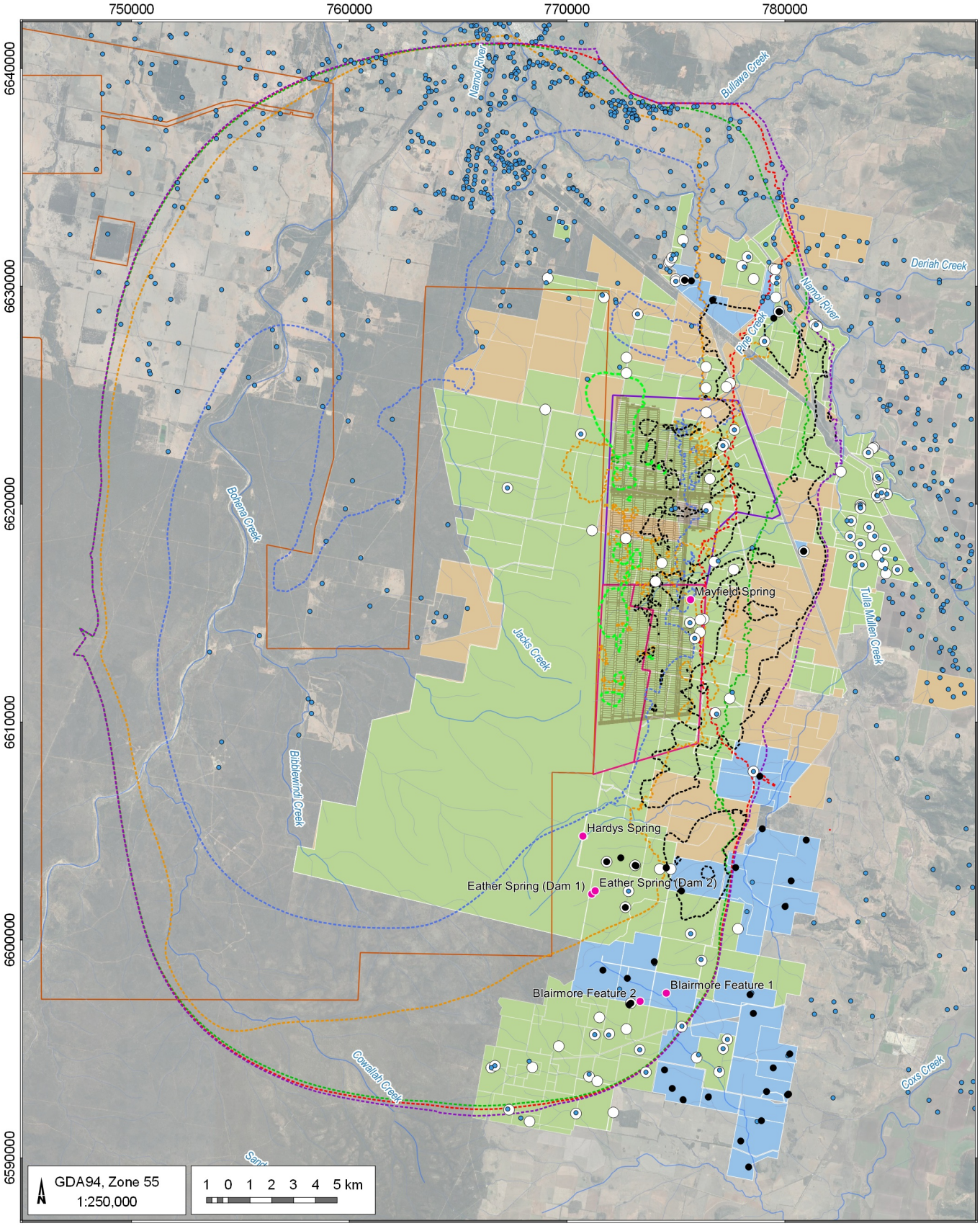
In addition, further bore appraisals were completed at eight landholder bores identified in the Project GA report (AGE, 2020) as being likely to experience drawdown of more than the 2 metre (m) minimum impact threshold identified in the NSW *Aquifer Interference Policy* (AIP)[3] (hereafter referred to as potentially impacted bores). The main objective of these appraisals was to confirm whether or not the predicted drawdown would likely lead to actual impairment of the supply and hence inform subsequent make good negotiations.

[1] (ENRS), 2020, Groundwater Bore Census – Narrabri Underground Mine Stage 3 Extension Project.
[2] AGE, 2020, Groundwater Assessment Narrabri Mine Stage 3 Extension Project, August 2020.
[3] Department of Primary Industries (DPI) - Office of Water, 2012a. Aquifer Interference Policy.

1.2 Scope of works

The scope of work for this third round bore census comprised the following tasks:

- conduct a desktop review of registered groundwater bore records and potential groundwater features of interest within the targeted areas shown in blue on Figure 1.1;
- prepare landholder property maps to support site inspections;
- conduct site inspections to meet with landholders and inspect relevant features where possible:
- meet with the landholder, review property maps and identify any existing or historical bores;
  - record location of any existing bores (easting and northing);
  - photograph each bore site;
  - record any/all available construction information (year drilled, drilled and current depths, casing type, screen type, top and bottom of screen, bore diameter);
  - measure the depth to groundwater (where access allows);
  - obtain pumping equipment details, including whether or not the bore is currently in use;
  - conduct field measurement of water quality (potential Hydrogen [pH], temperature and electrical conductivity [EC]); and
  - document bore construction, equipment, purpose and pumping regime.
- where possible, collect a water sample from each bore and submit the quality samples for laboratory analysis for major ions and metals;
- identify any additional potentially impacted bores for further bore appraisal; and
- document the bore census results, and prepare this Groundwater Bore Census Report.



LEGEND

- Registered water supply bore locations
- Potential groundwater feature
- Bores inspected after EIS submission
- Bores inspected prior to EIS submission
- Drainage
- Project longwall panels
- Mining Lease Boundary (ML 1609)
- Proposed Narrabri Gas Project (Santos)
- Provisional Mining Lease Application Area
- Properties visited prior to EIS submission
- Properties visited or contacted after EIS submission
- Other properties contacted by mail prior to EIS submission

Predicted 2m drawdown contour/limit of formation

- Near surface unconsolidated strata
- Pilliga Sandstone
- Purlawaugh Formation
- Garrawilla Volcanics
- Napperby Formation
- Hoskissons Seam
- Arkarula Formation

Narrabri Stage 3 Extension GIA (G1972F)

Summary of Project bore census and bore appraisal activities and predicted drawdown

AGE

DATE 31/05/2021

FIGURE No: 1.1

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972F.NarrabriStage3_Bore AppraisalNo3\3_GIS\Workspaces\001_Deliverable1\01.01_G1972F_Summary of Project bore census and bore appraisal activities and predicted drawdown.qgs

2 Methodology

The following supplies a brief overview of the methodology applied to undertake the third round bore census.

2.1 Landholder consultation

Where possible landholders were contacted by a NCOPL representative between March and April 2021 to invite them to participate in the bore census. Based on bore records included in the PINNEENA and/or Bureau of Meteorology NGIS databases, 18 registered water supply bores within the proposed investigation area were identified. Via consultation with the relevant landholders, a number of other unregistered bores within the area were identified and included in the bore census. Not all identified landholders were reached despite numerous attempts at contact. A summary of the bore census data collated is provided in Appendix A. The data captured for each bore is listed in Appendix B.

2.2 Land access

Prior to the bore census inspections, participating landholders were notified by an NCOPL representative of the date and time of the inspection. The identified sites were visited on 22 March, between 12 and 16 April and 13 May 2021.

2.3 Landholder meeting

Upon arrival at each property the bore census team, comprising representatives from AGE and NCOPL, met with the landholders (where possible) to provide an overview of the process and document any information provided by the landholders. In most cases the landholders were able to confirm which groundwater bores were present or did not exist. Additional unregistered bores were added to the census where relevant. Groundwater bores were then visited to ground-truth their location and to survey the bore construction details and water quality. Landholders were also asked to identify the presence of any other groundwater features. Feedback obtained from the landholders was incorporated into the overall bore census database where relevant.

2.4 Bore location survey

The location of each groundwater bore inspected was surveyed using a Global Positioning System (GPS) to record the coordinates (GDA 94, MGA 55). In general, a GPS is expected to be accurate to within 5 metres (m) where supported by sufficient satellite coverage. Records were saved digitally within the GPS unit and recorded manually on designated field sheets.

2.5 Bore head photograph

Digital photos were taken at each groundwater bore site with the GPS location embedded within the file. Multiple photos were taken to record the bore head and surrounding infrastructure, if any. Where the groundwater bore was equipped, the photo frame was set to include the complete infrastructure.

2.6 Bore construction log

A key aim of the third round bore census was to document the bore construction details at each groundwater bore. Where available, a copy of the driller's log was provided by the landholders. Where a driller's log was not available, the existing bore details, namely: location, depth, age and construction, were applied to correlate this site data with a registered groundwater bore (Groundwater Works Number). Where the available information confirmed the correlation with a registered bore, the Groundwater Works Summary report was utilised to provide additional details of groundwater bore construction.

2.7 Depth measurements

Where the groundwater bore condition and equipment provided down-hole access, the depth of the groundwater level was measured using a groundwater dipper. However, in the majority of situations where a bore was equipped with a pump it was not possible to insert the dipper into the bore as either the bore head is sealed or there was insufficient access.

Field notes were made where access was restricted, or the depth of the bore and groundwater level could not be gauged. The depth to standing water was gauged and recorded in designated field sheets. The stick-up height of the bore casing above ground level was measured and recorded to facilitate an accurate calculation of the groundwater depth relative to ground level.

2.8 Water quality

Groundwater quality was tested in the field where a water sample could be obtained. Samples were collected via installed pumping equipment or from nearby water holding infrastructure or using a bailer in unequipped bores. A multi-probe water quality meter was used to measure the temperature, EC (a measure of salinity) and pH (a measure of acidity/alkalinity). In addition to field testing, several water samples were sent to a NATA laboratory for analysis for analysis of major ions and metals.

3 Summary of bore census results

A total of 35 groundwater bore locations and two groundwater features were inspected during the third round bore census. A summary table of locations and details of the bores inspected are provided in Appendix A. Of the 37 sites inspected, 26 sites are in use, ten sites are not in use, one site was confirmed not present, and one site was not located. Individual bore cards are attached in Appendix B.

Further bore appraisal reports were also developed for the following bores:

- Each of the eight potentially impacted private bores identified in the Project GA report (AGE, 2020);
- Other bores on the same property as the eight impacted bores identified in the Project GA report (AGE, 2020);
- Two unregistered bores (the South Caloola property bore, and Mentone property bore) and one registered bore (Hillview property bore (Solar Bore, GW903687)) identified for the first time during the round 3 bore census and which fall within the predicted zone of influence of the Project (Figure 1.1). Two of these bores were constructed following completion of the round 1 census and the third bore is on property which was not previously visited during rounds 1 or 2 since the PINEENA records indicates that there were no bores on the property;
- All bores and other features identified on the Blairmore property, on the basis that bores to both the north and south of the property were predicted to be impacted in the Project GA reports (AGE, 2020) but those on the property itself were not.

Those bores for which bore appraisal reports are also available are identified in the final column of the summary table in Appendix A. Bore appraisal reports were therefore not completed for the remaining bores listed in the summary table in Appendix A since they fall outside the predicted zone of influence of the Project (i.e. the area expected to experience more than 2 m of drawdown, (Figure 1.1) and were therefore assessed as being unlikely to be impacted.

3.1 Water quality results

Laboratory water quality analysis results relating to water samples obtained during the third bore census are captured in Appendix C.

Appendix A

Bore census summary table

No	Local Bore Name	Groundwater Works Number	Easting (GDA Zone 55)	Northing (GDA Zone 55)	Date of visit	Status	Purpose	Bore Depth (mbTOC*)	Approximate Measured Depth to Water (mbTOC)	Laboratory Sample Taken (Yes/No)	Field Electrical Conductivity (µS/cm)	Field pH (pH units)	Bore appraisal report available^
1	Windmill Bore		779733	6628836	22-Mar-21	In use	Stock	20	10.83	yes	1,345	7.3	Windmill bore appraisal report
2	House BH		779468	6594124	22-Mar-21	In use	Stock	156		yes	5,287	8.05	NA
3	Solar Bore	GW903687	779494	6628534	22-Mar-21	In use	Stock			no			Solar bore appraisal report
4	257_Bore		780873	6617836	22-Mar-21 / 12-Apr-21	In use	Stock	100	24.21	yes	9,617	6.71	257 bore appraisal report
5	GW013858	GW013858	774556	6603315	22-Mar-21	In use	Stock	33.5	12.79	yes	5,174	7.39	Nidenthana property bore appraisal report
6	WB10		775711	6630250	12-Apr-21	Not in use		48.08	11.78	yes	22,680	6.65	GW054227 bore appraisal report
7	GW054227	GW054227	775401	6630279	12-Apr-21	Confirmed not present							GW054227 bore appraisal report
8	South Caloola		775254	6602244	12-Apr-21	In use	Stock	41	36.59	yes	2,620	7.24	South Caloola bore appraisal report
9	GW026121	GW026121	773126	6603421	12-Apr-21	Not in use	Stock	20.1	11.98	no			Nidenthana property bore appraisal report
10	Blairmore Feature 1		774557	6597554	13-Apr-21	In use	Stock			yes	6,309	8.39	Blairmore property bore appraisal report
11	Blairmore BH1	GW970789.1.1	772767	6598235	13-Apr-21	In use	Stock	22.8	8.92	yes	4,103	8.08	Blairmore property bore appraisal report
12	Blairmore BH2	Licence: 90WA833289	771645	6598607	13-Apr-21	In use	Stock	72	21.18	yes	2,643	7.64	Blairmore property bore appraisal report
13	Blairmore Feature 2		773353	6597177	13-Apr-21	In use	Stock			yes	3,396	7.89	Blairmore property bore appraisal report
14	Blairmore BH3	GW022956	774004	6598999	13-Apr-21	Not in use		16.25	16.18	no			Blairmore property bore appraisal report
15	Sweet Water Bore	GW008634	772930	6597095	13-Apr-21	In use	Stock	78.3	7.42	yes	521	8.23	GW008634 bore appraisal report
16	Old House Bore	GW034757	780226	6594767	13-Apr-21	Not in use	Stock	67	63.51	no	7,259	6.81	NA
17	Cattle Grid Bore (CGB)	GW971342	780127	6592888	13-Apr-21	In use	Stock	95	27.2	Yes	3,442	7.87	NA
18	GW13704	GW13704	780172	6592920	13-Apr-21	Not in use							NA
19	Kinora Bore		779161	6593035	13-Apr-21	Not in use	Stock	137	32.91	no	4,755	7.13	NA
20	Dreadnought House BH	GW017073	776486	6592784	13-Apr-21	In use	Stock	153.31	31.21	yes	1,515	8.84	NA
21	Dreadnought Windmill Bore	GW017072	775327	6592663	13-Apr-21	In use	Stock	118	38.53	yes	6,419	6.86	NA

No	Local Bore Name	Groundwater Works Number	Easting (GDA Zone 55)	Northing (GDA Zone 55)	Date of visit	Status	Purpose	Bore Depth (mbTOC*)	Approximate Measured Depth to Water (mbTOC)	Laboratory Sample Taken (Yes/No)	Field Electrical Conductivity (µS/cm)	Field pH (pH units)	Bore appraisal report available^
22	Sunnyside Bore	GW008635	778554	6596625	13-Apr-21	In use	Stock	162.5	38.62	yes	6,185	6.98	NA
23	GW013851	GW013851	772467	6603766	13-Apr-21	Not in use		15.25					Nindethana property bore appraisal report
24	Kia-Ora House Bore		778925	6591700	14-Apr-21	In use	Stock, domestic	33	15	yes	2,273	5.39	NA
25	Kia-Ora Clump Bore		778339	6589574	14-Apr-21	In use	Stock	83	27	no			NA
26	Kia-Ora Middle Bore		777976	6590765	14-Apr-21	In use	Stock	38	18	yes	6,258	7.16	NA
27	GW001302	GW001302	774477	6594030	14-Apr-21	Confirmed not present							NA
28	GW001270		774829	6593180	14-Apr-21	Not in use							NA
29	GW017170	GW017170	780011	6601530	14-Apr-21	In use	Stock	32.6	20.23	yes	7,006	6.86	NA
30	GW007860	GW007860	778401	6597487	14-Apr-21	In use	Stock	168.8	46.25	yes	5,887	6.85	NA
31	Sedona Old Windmill		778543	6607517	15-Apr-21	In use	Stock						NA
32	Boeyaba House Bore		777741	6603319	15-Apr-21	In use	Stock, domestic		4.75	yes	4,272	7.91	NA
33	Bore 1 Hill	GW970624	780291	6602707	15-Apr-21	In use	Stock	61.5	26.37	yes	15,130	6.94	NA
34	School Bore		778964	6605099	15-Apr-21	In use	Stock	66	4.32	yes	3,799	7.17	NA
35	Old House Bore	GW170129	780983	6604580	15-Apr-21	Not in use							NA
36	Solar Bore	GW903687	779491	6628525	13-May-21	In use	Stock	23.88	12.58	yes	6,006	6.83	Turra property bore appraisal report
37	Mentone Bore		776686	6629368	13-May-21	Not in use	Stock	16.69	9.9	yes	3,919	7.16	Mentone property bore appraisal report

* metres below top of casing
^ Bore appraisal report provided to landowner.

Appendix B

Bore census identification cards and Water NSW work summary reports

Latest survey date:	22/03/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	683 WYNELLA ROAD, WILLALA		
Local bore name:	House BH	**Ref No/GW Number:**	Not Registered
Easting (GDA94 Zone 55):	779468	**Northing:**	6594124

Geology and hydrogeology

Water bearing zone 150m, blow yield during drilling development was 0.53L/sec

Bore construction details (summary)

Depth (mBTOC) (metres below top of casing):	156	**Casing stick-up (metres above ground level):**	0.20
Casing material:		**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	Unknown

Water usage and pumping details

Status:	In Use	**Purpose:**	Stock
Pump type:	Submersible	**Power source:**	Electric
Pump intake depth (mBTOC):	~130	**Pump rate (L/sec):**	0.3

Water level information

Depth to water (mBTOC):	unknown	**Time of measurement:**	
Approximate time since pumping:	Not known		

Water quality

Sample method:	From tank	**Temp. (°C):**	21.54
Electrical Conductivity (µS/cm):	5282 (22/3/2021)	**pH:**	8.05 (22/3/2021)

Laboratory sample obtained:

COMMENTS: Land manager reports water has high salinity.

Photographic record

Latest survey date:	22/03/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Riverview, 2215 Old Narrabri Road, Turrawan		
Local bore name:	Windmill bore	**Ref No/GW Number:**	Not Registered
Easting (GDA94 Zone 55):	779733	**Northing:**	6628836
Geology and hydrogeology			
The bore is likely situated in the Napperby formation but may also intersect shallow groundwater bearing alluvial / colluvium and residual deposits.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	20	**Casing stick up (metres above ground level):**	0.53
Casing material:	Steel	**Nominal casing diameter (mm):**	140
Screen interval (m top and bottom)	Unknown	**Screen type**	Unknown
Water usage and pumping details			
Status:	In Use	**Purpose:**	Stock
Pump type:	Suction pump single stage	**Power source:**	Petrol (Onga, B65H, Honda Engine (6.5 HP).
Pump intake depth (mBTOC):	19	**Pump rate (L/sec):**	Unknown
Water level information			
Depth to water (mBTOC):	10.83 (22/3/2021) 10.52 (9/10/2019)	**Time of measurement:**	22/03/2021, 08:15 09/10/2019, 08:30
Approximate time since pumping:	Not known		
Water quality			
Sample method:	Pump	**Temp. (°C):**	21.54 (9/10/2019)
Electrical Conductivity (µS/cm):	1345 (22/3/2021) 1456 (9/10/2019)	**pH:**	7.3 (22/3/2021) 6.73 (9/10/2019)

COMMENTS: Land manager reports the water precipitates a black slime. Total depth from land manager.

Photographic record

Latest survey date:	22/03/2021	Survey Personnel:	PL+MV

Location, owner details and GW works number

Property details:	Wilga, 16346 Kamilaroi Highway, Baan Baa		
Local Bore Name:	'257_Bore'	**Ref No/GW Number:**	Not Registered
Easting (GDA94 Zone 55):	780874	**Northing:**	6617836

Geology and hydrogeology

Bore intersects Digby and Pamboola Formation. Water bearing zone ~55m

Bore construction details (summary)

Depth (mBTOC) (metres below top of casing):	~100	**Casing stick up (metres above ground level):**	0.71
Casing material:	Steel	**Nominal casing diameter (mm):**	165
Screen interval (m top and bottom)	~55 to 75	**Screen type**	Steel slotted

Water usage and pumping details

Status:	In use	**Purpose:**	Stock
Pump Type:	Pneumatic	**Power source:**	Electrical compressor
Pump intake depth (mBTOC):	~60	**Pump rate (L/sec):**	Unknown

Water level information

Depth to water (mBTOC):	**24.21 (22/3/2021)** 58 (10/10/2019)	**Time of measurement:**	10:15 (22/03/2021)
Approximate time since pumping:	Pump was not connected, no pumping for at least a week		

Water quality

Sample method:	No sample	**Temp. (°C):**	
Electrical Conductivity (µS/cm):	9 617 (12/4/2021) 14 217 (10/10/2019)	**pH:**	6.71 (12/4/2021) 6.73 (10/10/2019)

Laboratory sample obtained: Yes

Comments: Bore depth and details obtained from landholder

Photographic record

Latest survey date:	12/04/2021	Survey Personnel:	PL/MV
Location, owner details and GW works number			
Property details:	17714 Kamilaroi Highway		
Local Bore Name:	WB10	**Ref No/GW Number:**	Not Registered
Easting (GDA94 Zone 55):	776018	**Northing:**	6630078
Geology and Hydrogeology			
The bore terminates in and likely extracts from the Napperby Formation.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	48.08	**Casing stick-up (metres Above Ground Level):**	0.85
Casing material:	Steel	**Nominal casing diameter (mm):**	165
Screen interval (metres top and bottom)	unknown	**Screen type**	unknown
Water usage and pumping details			
Status:	Not in use	**Purpose:**	NA
Pump type:	No pump equipment installed	**Power Source:**	NA
Pump intake depth (mBTOC):	NA	**Pump Rate (L/sec):**	NA
Water level information			
Depth to water (mBTOC):	11.88 (26/3/2021) 11.78 (12/4/2021)	**Time of measurement:**	16:05 14:30
Approximate time since pumping:	NA		
Water quality			
Sample method:	Bailed	**Temp. (°C):**	23.3 (12/4/2021)
Electrical Conductivity (µS/cm):	21,784 (26/3/2021) 22,680 (12/4/2021)	**pH:**	6.74 (26/3/2021) 6.65 (12/4/2021)

Comments: Landholder indicated that the bore is unsuitable for use due to the high salinity of the water drawn.

Photographic record

Latest survey date:	22/03/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Nindethana, 338 Towri Road, Baan Baa		
Local Bore Name:	GW013858	**Ref No/GW Number:**	GW013858
Easting (GDA94 Zone 55):	774254	**Northing:**	6603250
Geology and Hydrogeology			
The bore terminates in and likely extracts from the Napperby Formation. The Napperby Formation is identified as a “less productive” unit under the AIP. Water bearing zone is 30.40 to 33.40 (3 m thick) (Refer to the WaterNSW work summary)			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	33.5	**Casing stick-up (metres above ground level):**	0.2
Casing material:	Steel	**Nominal casing diameter (mm):**	152
Screen interval (metres top and bottom)	24.30 to 30.30	**Screen type**	Mech slotted
Water usage and pumping details			
Status:	In Use	**Purpose:**	Stock
Pump Type:	Submersible	**Power source:**	Electric
Pump intake depth (mBTOC):	unknown	**Pump Rate (L/sec):**	unknown
Water level information			
Depth to water (mBTOC):	12.79 (22/3/2021)	**Time of measurement:**	14:20
Approximate time since pumping:	Not known		
Water quality			
Sample method:	pump	**Temp. (°C):**	21.9
Electrical Conductivity (µS/cm):	5,174 (22/03/2021) 4,788 (20/05/2020)	**pH:**	7.06 (22/03/2021) 7.39 (20/05/2020)

Comments: Information on bore depth, water bearing zone and screen interval obtained from government record.

Photographic record

WaterNSW
Work Summary

GW013858

Licence: 90WA820488 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,DOMESTIC
Intended Purpose(s): STOCK

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date: 01/01/1958

Final Depth: 33.50 m
Drilled Depth: 33.50 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: NINDETHANA NSW
GWMA: 604 - GUNNEDAH BASIN
GW Zone: -

Standing Water Level (m):
Salinity Description: Poor
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	WHITE	PARKES	2
Licensed:	WHITE	PARKES	Whole Lot //

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 8836-N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)

Northing: 6603301.000
Easting: 774555.000

Latitude: 30°40'17.3"S
Longitude: 149°51'56.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD..ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.30	30.40	152			
1	1	Opening	Perforations	24.30	30.30	152		1	Mechanically Slotted, A: 12.70mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
30.40	33.40	3.00	Unconsolidated	18.20		0.30			

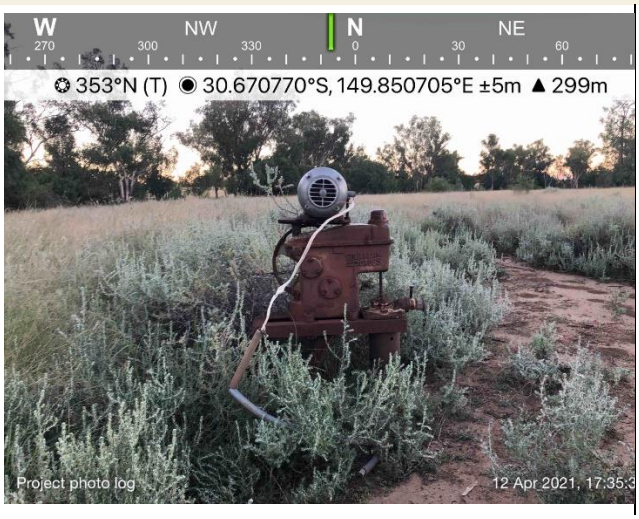
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	30.48	30.48	Subsoil Clay	Subsoil	
30.48	33.52	3.04	Water Supply	(Unknown)	
0.00	30.48	30.48	Boulders Floating	Boulders	

Latest survey date:	20/05/2020	Survey Personnel:	ML+MV
Location, owner details and GW works number			
Property details:	Nindethana, 338 Towri Road, Baan Baa		
Local Bore Name:	GW026121	**GW Number:**	GW026121
Easting (GDA94 Zone 55):	773126	**Northing:**	6603421
Geology and Hydrogeology			
Garrawilla Volcanics, Water Bearing zone: unknown			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	20.1	**Casing Stick-up (metres above ground level):**	0.28
Casing material:	Steel	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)	unknown	**Screen type**	unknown
Water usage and pumping details			
Status:	NOT in Use	**Purpose:**	Stock
Pump Type:	Mono pump	**Power Source:**	
Pump Intake Depth (mBTOC):	unknown	**Pump Rate (L/sec):**	unknown
Water level information			
Depth to Water (mBTOC):	11.98 (20/05/2020)	**Time of Measurement:**	12:36
Approximate time since pumping:	Not known		
Water quality			
Sample method:	No sample obtained	**Temp. (°C):**	Not measured
Electrical Conductivity (µS/cm):	Not measured	**pH:**	Not measured

Comments: information on bore depth, from government record.

Photographic record



WaterNSW
Work Summary

GW026121

Licence: 90WA820857 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore
Work Status: Supply Obtained
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date:
Final Depth: 20.10 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property: NINDETHAND NSW
GWMA: 601 - GREAT ARTESIAN BASIN
GW Zone: 001 - OXLEY BASIN
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	WHITE	PARKES	1
Licensed:	WHITE	PARKES	Whole Lot //

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 8836-N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6603397.000
Easting: 773172.000
Latitude: 30°40'15.3"S
Longitude: 149°51'04.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

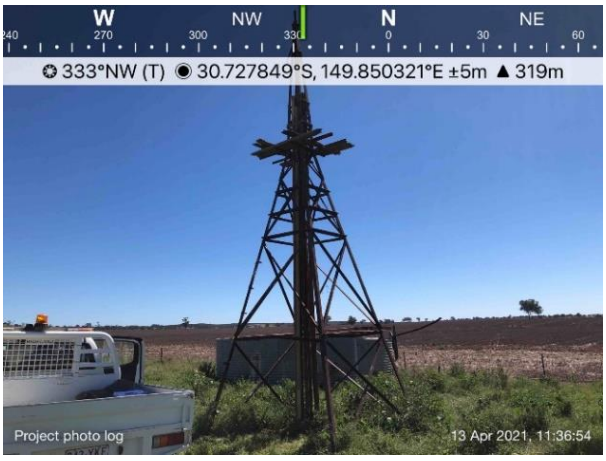
Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.40	-0.40	127			

*** End of GW026121 ***

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	South End, 1230 Delwood Road,		
Local Bore Name:	Sweet Water Bore	**Ref No/GW Number:**	GW008634
Easting (GDA94 Zone 55):	772927	**Northing:**	659093
Geology and Hydrogeology			
Garrawilla Volcanics and Napperby Formation, Water bearing zones: 28.6 to 30.1, yield of 0.25L/sec (Fractured, Garrawilla Volcanics) – 70.70 to 74.3, yields of 0.63 L/sec (Consolidated, likely Napperby Formation)			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	78.3	**Casing stick-up (metres above ground level):**	0.22
Casing material:	Steel	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)	25.9 to 30.4 and 70.70 to 78.2	**Screen type**	unknown
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock and Domestic
Pump Type:	piston	**Power source:**	wind
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	7.9 (19/05/2020) 7.42 (13/04/2021)	**Time of Measurement:**	9:38 11:45
Approximate time since pumping:	Not known		
Water quality			
Sample method:	bailer	**Temp. (°C):**	20.7
Electrical Conductivity (µS/cm):	435 (19/05/2020) 521 (13/04/2021)	**pH:**	8.41 8.23

Comments: Windmill not in use/pump rods out of bore.

Photographic record



WaterNSW
Work Summary

GW008634

Licence: 90WA820179 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date: 01/04/1950
Final Depth: 78.30 m
Drilled Depth: 78.30 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: BLAIRMORE NSW
Standing Water Level (m):
GWMA: 601 - GREAT ARTESIAN BASIN
Salinity Description: Good
GW Zone: 001 - OXLEY BASIN
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WALLA WALL	18
Licensed:	POTTINGER	WALLA WALLA WEST	Whole Lot //

Region: 90 - Barwon
CMA Map: 8836-N
River Basin: 419 - NAMOI RIVER
Grid Zone:
Scale:
Area/District:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6597026.000
Easting: 772850.000
Latitude: 30°43'42.3"S
Longitude: 149°50'58.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD_ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.40	78.30	152			Seated on Bottom
1	1	Opening	Perforations	25.90	30.40	152		1	
1	1	Opening	Perforations	72.50	78.20	152		2	

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
28.60	30.10	1.50	Fractured	15.20		0.25			
70.70	74.30	3.60	Consolidated	15.20		0.63			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	8.22	8.22	Soil	Soil	
8.22	32.61	24.39	Rock Black Water Supply	Rock	
32.61	33.52	0.91	Rock Black Hard	Rock	
33.52	78.33	44.81	Sandstone Water Supply	Sandstone	

Latest survey date:	12/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	South Caloola, Delwood Road, Boggabri		
Local bore name:	South Caloola Bore	**Ref No/GW Number:**	Not registered
Easting (GDA94 Zone 55):	775254	**Northing:**	6602244
Geology and hydrogeology			

Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	41	**Casing stick up (metres above ground level):**	0.3
Casing material:	Steel	**Nominal casing diameter (mm):**	165
Screen interval (m top and bottom)	Unknown	**Screen type**	Unknown

Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Not equiped	**Power source:**	
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	

Water level information			
Depth to water (mBTOC):	36.59	**Time measured:**	16:30
Approximate time since pumping:	Not known		

Water quality			
Sample method:	Bailed	**Temp. (°C):**	20.3
Electrical Conductivity (µS/cm):	2620	**pH:**	7.24

Laboratory sample obtained: Yes

Comments: Water had oily and hydrogen sulphide, like odor

Photographic record

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Blairmore, 880 Delwood Road, Boggabri		
Local bore name:	Blairmore Feature 1	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	774557	**Northing:**	6597554
Water usage			
Status:	In use	**Purpose:**	Stock
Water quality			
Sample method:	Grab sample	**Temp. (°C):**	10.16
Electrical Conductivity (µS/cm):	6,309 (13/04/2021, 8:10AM)	**pH:**	8.39

Laboratory sample obtained: Yes (13/04/2021, 8:10AM)

Comments: Probable groundwater discharge observed into natural drainage line or stream which then feeds into a constructed catchment dam. Presence of reed species around discharge point as well as the downstream dam suggests semi-permanent feature. Downstream dam (photo 1 below), recent rainfall presumably has contributed to flow and stored volume.

Photographic record:

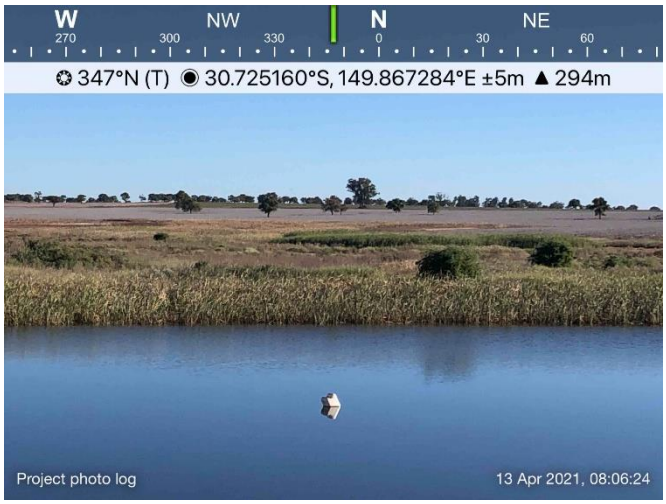


Photo 1

Photo 2

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Blairmore, 880 Delwood Road, Boggabri		
Local bore name:	Blairmore BH1	**Ref No/GW Number:**	GW970789
Easting (GDA94 Zone 55):	772767	**Northing:**	6598235
Geology and hydrogeology			
The bore terminates in and likely extracts from the Garrawilla Volcanics. Water bearing zone, 10 to 12 mbgl, airlift yield, 0.88 L/sec. Bore drilled 24/02/2014 (refer to Appendix B for the Water NSW data).			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	22.8	**Casing stick up (metres above ground level):**	0.36
Casing material:	PVC	**Nominal casing diameter (mm):**	135
Screen interval (metres top and bottom)	8 to 20	**Screen type**	slotted
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump type:	Submersible	**Power source:**	Solar
Pump intake depth (mBTOC):	~20	**Pump rate (L/sec):**	1.4
Water level information			
Depth to water (mBTOC):	8.92	**Time and date measured:**	8:30, 13/04/2021
Approximate time since pumping:	Directly before measurement		
Water quality			
Sample method:	Grab sample from poly tank	**Temp. (°C):**	17.79
Electrical Conductivity (µS/cm):	4,103 (13/04/2021)	**pH:**	8.08
Laboratory sample obtained: Yes - 13/04/2021			
Comments:			
Photographic record			

WaterNSW
Work Summary

GW970789

Licence: | **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): STOCK, DOMESTIC

Work Type: Bore
Work Status: Supply Obtained
Construct.Method: Down Hole Hammer
Owner Type: Private

Commenced Date:
Completion Date: 24/02/2014

Final Depth: 22.80 m
Drilled Depth: 22.80 m

Contractor Name: TAMWORTH DRILLING CO
Driller: Garry Stanley Strudwick
Assistant Driller: Nigel Hawkins

Property:
GWMA:
GW Zone:

Standing Water Level (m): 7.000
Salinity Description: Potable
Yield (L/s): 0.880

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A: / **Licensed:**	POTTINGER	WILLALA	2//1188650

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 8836-N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6597740.000
Easting: 772410.000

Latitude: 30°43'19.5"S
Longitude: 149°50'40.9"E

GS Map: -

MGA Zone: 55

Coordinate Source: GIS - Geogra

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	5.00	215			Down Hole Hammer
1		Hole	Hole	5.00	22.80	165			Rotary - Percussion - Foam Injection
1		Annulus	Cement	0.00	5.00	215	168		
1	1	Casing	Pvc Class 9	-0.50	22.80	135	125		Seated on Bottom, Glued, S: 12.00-22.80m
1	1	Casing	Steel - Erw	-0.50	5.00	168	158		Welded - Butt
1	1	Opening	Slots - Horizontal	8.00	20.00	135		0	Mechanically Slotted, PVC Class 9, Glued, SL: 100.0mm, A: 0.25mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
10.00	12.00	2.00	Unknown	7.00		0.88		02:00:00	

Drillers Log

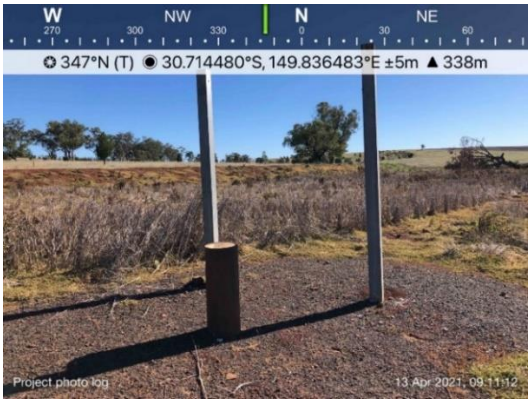
From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.00	2.00	Soil; black	Soil	
2.00	4.00	2.00	Clay; brown	Clay	
4.00	12.00	8.00	Basalt; broken & silt	Basalt	
12.00	22.80	10.80	Basalt; grey	Basalt	

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Blairmore, 880 Delwood Road Boggabri		
Local bore name:	Blairmore BH2	**Ref No/GW Number:**	Licence: 90WA833289 (works number unavailable)
Easting (GDA94 Zone 55):	771645	**Northing:**	6598607
Geology and hydrogeology			
The bore terminates in and likely extracts from the Garrawilla Volcanics. Water bearing zone, 67 to 69 mbgl, airlift yield, 2 L/sec. Bore drilled in 14 Sept 2015 (refer to Appendix B for the WaterNSW data).			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	72	**Casing stick up (metres above ground level):**	0.45
Casing material:	PVC	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)	54 to 72 m	**Screen type**	slotted
Water usage and pumping details			
Status:	Not equipped	**Purpose:**	Stock
Pump type:	NA	**Power source:**	NA
Pump intake depth (mBTOC):	NA	**Pump rate (L/sec):**	NA
Water level information			
Depth to water (mBTOC):	21.18	**Time and date measured:**	9:10, 13/04/2021
Approximate time since pumping:	Unknown – not equipped		
Water quality			
Sample method:	Bailed at 25m	**Temp. (°C):**	21.34
Electrical Conductivity (µS/cm):	2,643	**pH:**	7.64

Laboratory sample obtained: Yes (9:10AM, 13/04/2021)

Comments: Landholder indicated that water was highly saline when pumped previously.

Photographic record



sent back 19/10/15

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Page 1

1

Driller's Licence No: 2299
Class of Licence: 4
Driller's Name: Jonathan Young
Assistant Driller:
Contractor: Marion Water Drilling Services

New bore [X] Replacement bore [ ]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify) [ ]

Final Depth 72 m 72

2

Work Licence No: 90WA833289
Name of Licensee: Janet Watt
Intended Use: stock/Domestic
Completion Date: 14.9.15

3 DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	72	165	9

4 WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
67	69	2	15	2	2		1					

5 CASING / LINER DETAILS

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
5	152	5	0	72	1,5

Casing support method See Code 5: 2
Type of casing bottom See Code 5: 1
Centralisers installed (Yes/No): No (indicate on sketch)
Sump installed (Yes/No): No From m To m
Pressure cemented (Yes/No): No From m To m
Casing Protector cemented in place: Yes

6 WATER ENTRY DESIGN

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment See Code 6
5	152	5	54	72	5	1,5	2	10	5	H

7 GRAVEL PACK

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded							
Crushed		Ungraded							
						0	5	200	0.2

Bentonite/Grout seal (Yes/No): Yes
Method of placement of Gravel Pack: See Code 7

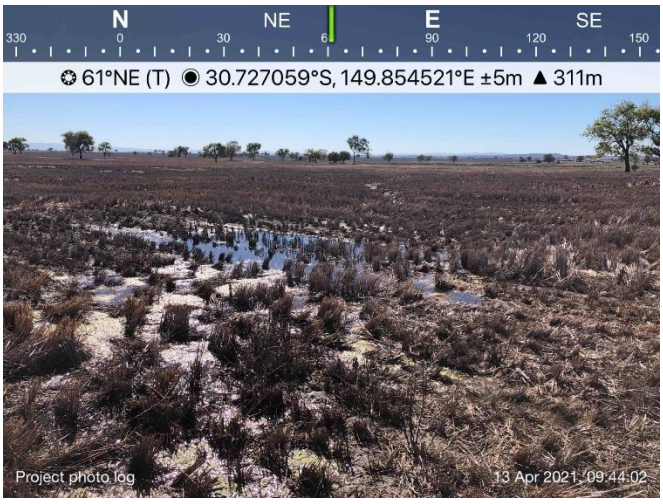
For Departmental use only: G W

Scientific and Technical Operating Procedures

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Blairmore, 880 Delwood Road, Boggabri		
Local bore name:	Blairmore Feature 2	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	773353	**Northing:**	6597177
Water usage			
Status:	In use	**Purpose:**	Stock
Water quality			
Sample method:	Grab sample	**Temp. (°C):**	11.5
Electrical Conductivity (µS/cm):	3,396 (13/04/2021, 9:45AM)	**pH:**	7.89
Laboratory sample obtained: No			

Comments: Shallow surface depression within cultivated area. Vegetation (planted crop) not indicative of a permanent feature and observed seepages and shallow ponded water may be related to recent heavy rainfall events.

Photographic record



Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Blairmore, 880 Delwood Road, Boggabri		
Local bore name:	Blairmore BH 3	**Ref No/GW Number:**	GW022956
Easting (GDA94 Zone 55):	774004	**Northing:**	6598999
Geology and hydrogeology			
On completion the bore likely terminated in the Napperby Formation but based on the works summary report (Appendix B) likely extracted from both the Garrawilla Volcanics and the Napperby Formation. However, the bore is currently backfilled to 16.25 metres below ground level and not in use.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	BH backfilled to 16.25	**Casing stick up (metres above ground level):**	0.15
Casing material:	steel	**Nominal casing diameter (mm):**	152
Screen interval (meters top and bottom)	54 to 72 m	**Screen type**	slotted
Water usage and pumping details			
Status:	not in use - backfilled	**Purpose:**	NA
Water level information			
Depth to water (mBTOC):	Dry (no water level)	**Time and date measured:**	10:25, 13/04/2021
Approximate time since pumping:	Unknown – not in use		
Water quality			
Sample method:	Not sampled	**Temp. (°C):**	Not sampled

Comments: Bore not in useable condition, backfilled to a depth of 16.25 metres below ground level and dry.

Photographic record

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Nungadoo, 348 Wynella Rd, Boggabri		
Local Bore Name:	Cattle Grid Bore (CGB)	**Ref No/GW Number:**	GW971342
Easting (GDA94 Zone 55):	780127	**Northing:**	6592888
Geology and Hydrogeology			
Water bearing zone: 83 to 90 mbgl, yield of 0.40L/sec. Likely Pamboola Formation or older			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	95	**Casing stick-up (metres above ground level):**	0.3
Casing material:	Steel	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)	80 to 93	**Screen type**	unknown
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Submersible	**Power source:**	Solar
Pump intake depth (mBTOC):	~75	**Pump rate (L/sec):**	0.3
Water level information			
Depth to water (mBTOC):	27.2 (02/2015)	**Time of Measurement:**	
Approximate time since pumping:	Not known		
Water quality			
Sample method:	from poly tank	**Temp. (°C):**	21.3
Electrical Conductivity (µS/cm):	3442 (13/04/2021)	**pH:**	7.87
Sample obtained for laboratory analyses: Yes			

Comments: Bore info obtained from landholder. Groundwater level not measured due to equipment.

Photographic record

WaterNSW
Work Summary

GW971342

Licence: | **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): STOCK, DOMESTIC

Work Type: Bore
Work Status: Supply Obtained
Construct.Method: Rotary Mud
Owner Type: Private

Commenced Date:
Completion Date: 10/03/2015

Final Depth: 95.00 m
Drilled Depth: 95.00 m

Contractor Name: Impax Group
Driller: Brent Irvin
Assistant Driller: Sam Roberts

Property:
GWMA:
GW Zone:

Standing Water Level (m): 27.200
Salinity Description:
Yield (L/s): 0.300

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A: / **Licensed:**	POTTINGER	WALLA WALLA	34//755527

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 8836-S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6592861.000
Easting: 780118.000

Latitude: 30°45'51.4"S
Longitude: 149°55'35.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	95.00	200			Rotary Mud
1		Annulus	Cement Grout	0.00	7.00	200	140		PL:Poured/Shovelled
1		Annulus	Bentonite	7.00	70.00	200	140		PL:Poured/Shovelled
1		Annulus	Waterworn/Rounded	70.00	95.00	200	140		Graded, Q:1.000m3, PL:Poured/Shovelled
1	1	Casing	Pvc Class 9	0.00	95.00	140	116		Seated on Bottom, Glued, S: 93.00-95.00m
1	1	Opening	Slots - Horizontal	80.00	93.00	140		0	Mechanically Slotted, PVC Class 9, Glued, SL: 70.0mm, A: 10.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
83.00	90.00	7.00	Unknown	27.20		0.30			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	5.00	5.00	Clay; red brown	Clay	
5.00	10.00	5.00	Clay, sandy; red brown	Clay	
10.00	14.00	4.00	Clay; brown	Clay	
14.00	17.00	3.00	Shale; grey	Shale	

17.00	19.00	2.00	Siltstone; grey	Siltstone	
19.00	21.00	2.00	Shale; grey	Shale	
21.00	22.00	1.00	Coal	Coal	
22.00	23.00	1.00	Siltstone; grey	Siltstone	
23.00	26.00	3.00	Shale; grey	Shale	
26.00	27.00	1.00	Coal	Coal	
27.00	32.00	5.00	Shale; grey	Shale	
32.00	36.00	4.00	Shale; with sandstone inclustions	Shale	
36.00	42.00	6.00	Shale; grey	Shale	
42.00	45.00	3.00	Sandstone; weathered, grey	Sandstone	
45.00	47.00	2.00	Shale; grey/Sandstone	Shale	
47.00	52.00	5.00	Siltstone	Siltstone	
52.00	62.00	10.00	Shale; grey	Shale	
62.00	82.00	20.00	Shale; with sandstone bands	Shale	
82.00	90.00	8.00	Siltstone; grey	Siltstone	
90.00	95.00	5.00	Siltstone; fractured, grey	Siltstone	

Remarks

10/03/2015: Form A Remarks:
Nat Carling, 9-Sept-2015; GPS provided on the Form-A. Incorrect approval number was provided on the Form-A, sourced from location map. Depths of drillers log were adjusted.

***** End of GW971342 *****

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Nungadoo, 348 Wynella Rd, Boggabri		
Local Bore Name:	GW013704	**Ref No/GW Number:**	GW013704
Easting (GDA94 Zone 55):	780171	**Northing:**	6592922
Geology and Hydrogeology			
WaterNSW Work Summary: Water bearing zone 14 and 81 m			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	85.3	**Casing stick-up (metres above ground level):**	
Casing material:	Steel	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)		**Screen type**	unknown
Water usage and pumping details			
Status:	Not in use	**Purpose:**	
Pump Type:		**Power source:**	
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):		**Time of Measurement:**	
Approximate time since pumping:			
Water quality			
Sample method:		**Temp. (°C):**	
Electrical Conductivity (µS/cm):		**pH:**	
Sample obtained for laboratory analyses			

Comments: Landholder did not locate bore, bore not in use. Depth info from government record

Photographic record

WaterNSW
Work Summary

GW013704

Licence: 90WA820380 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK,IRRIGATION,DOMESTIC
Intended Purpose(s): IRRIGATION

Work Type: Bore open thru rock
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date: 01/05/1959

Final Depth: 85.30 m
Drilled Depth: 85.30 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: LONO PINE NSW
GWMA: 604 - GUNNEDAH BASIN
GW Zone: -

Standing Water Level (m):
Salinity Description: 3001-7000 ppm
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WALLA WALL	34
Licensed:	POTTINGER	WALLA WALLA	Whole Lot 34//755527

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:

CMA Map: 8836-S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)

Northing: 6592922.000
Easting: 780172.000

Latitude: 30°45'49.3"S
Longitude: 149°55'37.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD..ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.60	85.30	152			Seated on Bottom

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
14.00	15.20	1.20	Consolidated	12.10		0.04			
81.00	85.20	4.20	Fractured	12.10		0.45			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.91	0.91	Loam Sandy	Loam	
0.91	4.26	3.35	Clay	Clay	
4.26	14.02	9.76	Sandstone Yellow	Sandstone	
14.02	15.24	1.22	Sandstone White Water Supply	Sandstone	
15.24	60.96	45.72	Sandstone Grey	Sandstone	
60.96	73.15	12.19	Shale Sandy	Shale	
73.15	81.07	7.92	Sandstone White Coarse	Sandstone	
81.07	85.34	4.27	Shale Some Traces Coal Water Supply	Shale	

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Nungadoo, 348 Wynella Rd, Boggabri		
Local Bore Name:	Old House Bore	**Ref No/GW Number:**	GW034757
Easting (GDA94 Zone 55):	780226	**Northing:**	6594767
Geology and Hydrogeology			
Water bearing zone: 86.3 to 89 mbgl, yield of 0.29L/sec. Likely Pamboola Formation or older			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	122.2 (blocked at 67m)	**Casing stick-up (metres above ground level):**	0.3
Casing material:	Steel to 61m	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)	Open bore	**Screen type**	
Water usage and pumping details			
Status:	Not in use	**Purpose:**	Stock
Pump Type:		**Power source:**	
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	63.51	**Time of Measurement:**	13:00
Approximate time since pumping:	Not known		
Water quality			
Sample method:	Bailed	**Temp. (°C):**	22.85
Electrical Conductivity (µS/cm):	7259 (13/04/2021)	**pH:**	6.81
Sample obtained for laboratory analyses: No			

Comments: Bore blocked at 67m.

Photographic record

Work Summary

GW034757

Licence: 90WA820998 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore open thru rock
Work Status:
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date: 01/05/1972
Final Depth: 122.20 m
Drilled Depth: 122.20 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: HAMEL NSW
GWMA: 604 - GUNNEDAH BASIN
GW Zone: -
Standing Water Level (m):
Salinity Description: 3001-7000 ppm
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WALLA WALL	44
Licensed:	POTTINGER	WALLA WALLA	Whole Lot //

Region: 90 - Barwon
CMA Map: 8836-N
River Basin: 419 - NAMOI RIVER
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6594680.000
Easting: 780138.000
Latitude: 30°44'52.3"S
Longitude: 149°55'34.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.50	61.10	152			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
86.30	89.00	2.70	Consolidated	70.70		0.29			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.91	0.91	Topsoil	Topsoil	
0.91	5.18	4.27	Sandstone Yellow	Sandstone	
5.18	5.79	0.61	Rubble Basaltic	Gravel	
5.79	7.92	2.13	Sandstone Muddy	Sandstone	
7.92	8.53	0.61	Rubble Basaltic	Gravel	
8.53	24.38	15.85	Sandstone Grey Muddy	Sandstone	
24.38	59.13	34.75	Shale Gritty Sandstone Bands	Shale	
59.13	86.26	27.13	Sandstone Grey Hard	Sandstone	
86.26	89.00	2.74	Sandstone Light Grey Pebbles/pebbly Water Supply	Sandstone	
89.00	109.12	20.12	Shale Dark Grey Hard Gritty	Shale	
109.12	111.86	2.74	Coal Coal	Coal	

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Nungadoo, 348 Wynella Rd, Boggabri		
Local Bore Name:	Kinora Bore	**Ref No/GW Number:**	Not registered
Easting (GDA94 Zone 55):	779161	**Northing:**	6593035
Geology and Hydrogeology			
Water bearing zone: 120 to 130 mbgl, yield of 0.3L/sec. Likely Pamboola Formation or older			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	137	**Casing stick-up (metres above ground level):**	0.5
Casing material:	Steel	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)	118 to 135	**Screen type**	slotted
Water usage and pumping details			
Status:	Not in use	**Purpose:**	Stock
Pump Type:	Not equiped	**Power source:**	
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	32.91	**Time of Measurement:**	14:10
Approximate time since pumping:	Not known		
Water quality			
Sample method:	Bailed	**Temp. (°C):**	22.06
Electrical Conductivity (µS/cm):	4755 (13/04/2021)	**pH:**	7.13
Sample obtained for laboratory analyses: No			

Comments: Bore not in use currently, landholder will use it in dry season again

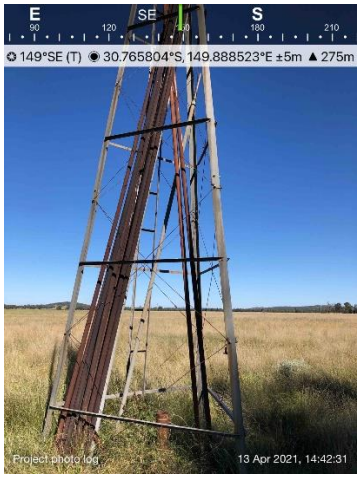
Photographic record

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Dreadnought, 348 Wynella Rd, Boggabri		
Local Bore Name:	Dreadnought House Bore	**Ref No/GW Number:**	GW017073
Easting (GDA94 Zone 55):	776486	**Northing:**	6592784
Geology and Hydrogeology			
Water bearing zone: 73.1 to 79.1, yield of 0.08L/sec; 150.2 to 153.2, yield 0.45L/sec. Likely Pamboola Formation or older			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	153.3	**Casing stick-up (metres above ground level):**	0.48
Casing material:	Steel (to 90m)	**Nominal casing diameter (mm):**	152
	Steel (to 144.8m)		127
Screen interval (m top and bottom)		**Screen type**	
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Not equiped	**Power source:**	Windmill
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	31.21	**Time of Measurement:**	14:35
Approximate time since pumping:	Not known		
Water quality			
Sample method:	Bailed at 38m	**Temp. (°C):**	21.85
Electrical Conductivity (µS/cm):	1515 (13/04/2021)	**pH:**	8.84

Sample obtained for laboratory analyses: yes

Comments: Bore not in use currently

Photographic record



WaterNSW
Work Summary

GW017073

Licence: 90WA820515 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): GENERAL USE

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date: 01/11/1959
Final Depth: 153.30 m
Drilled Depth: 153.30 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: DREADNOUGHT NSW
GWMA: 604 - GUNNEDAH BASIN
GW Zone: -
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WALLA WALL	38
Licensed:	POTTINGER	WALLA WALLA	Whole Lot //

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 8836-S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6592832.000
Easting: 776523.000
Latitude: 30°45'55.3"S
Longitude: 149°53'20.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD..ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.40	144.80	127			Suspended in Clamps
1	1	Casing	Threaded Steel	-0.10	90.10	152			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
73.10	79.10	6.00	Consolidated	30.40		0.07			
150.20	153.20	3.00	Consolidated	30.40		0.45			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.91	0.91	Soil	Soil	
0.91	22.86	21.95	Clay	Clay	
22.86	46.32	23.46	Sandstone Grey	Sandstone	
46.32	73.15	26.83	Shale Sandy	Shale	
73.15	79.24	6.09	Sandstone Grey Water Supply	Sandstone	
79.24	89.61	10.37	Shale Black Coal	Shale	
89.61	140.51	50.90	Shale Sandy	Shale	
140.51	150.26	9.75	Shale Black	Shale	
150.26	153.31	3.05	Sandstone Grey Water Supply	Sandstone	

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Dreadnought, 348 Wynella Rd, Boggabri		
Local Bore Name:	Dreadnought Windmill Bore	**Ref No/GW Number:**	GW017072
Easting (GDA94 Zone 55):	775327	**Northing:**	6592663
Geology and Hydrogeology			
Likely Digby Conglomerate.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	118	**Casing stick-up (metres above ground level):**	0.45
Casing material:	Steel (to 54.3m)	**Nominal casing diameter (mm):**	127
Screen interval (m top and bottom)		**Screen type**	
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Windpump	**Power source:**	Windmill
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	38.53	**Time of Measurement:**	15:25
Approximate time since pumping:	Not known		
Water quality			
Sample method:	Sample from Poly tank	**Temp. (°C):**	23.02
Electrical Conductivity (µS/cm):	6419 (13/04/2021)	**pH:**	6.86

Sample obtained for laboratory analyses: yes

Comments:

Photographic record

WaterNSW
Work Summary

GW017072

Licence: 90WA820516 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date:
Final Depth: 118.80 m
Drilled Depth:

Contractor Name: (None)
Driller:
Assistant Driller:

Property: DREADNOUGHT NSW
GWMA: 604 - GUNNEDAH BASIN
GW Zone: -
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WALLA WALL	50
Licensed:	POTTINGER	WALLA WALLA	Whole Lot //

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 8836-S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6592615.000
Easting: 775373.000
Latitude: 30°46'03.3"S
Longitude: 149°52'37.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.50	54.30	127			Suspended in Clamps

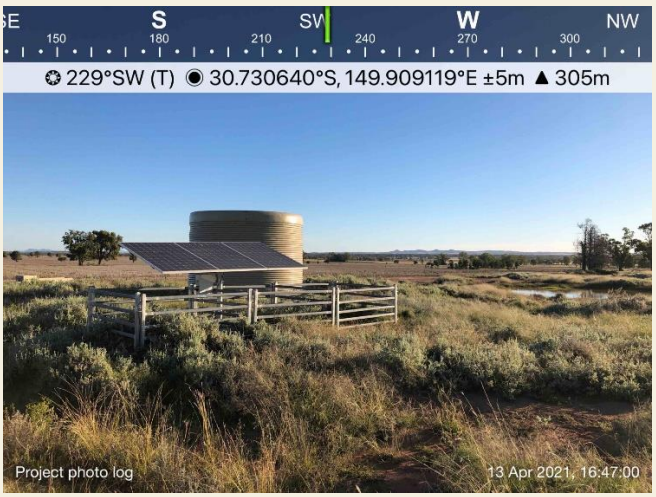
***** End of GW017072 *****

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Sunnyside		
Local Bore Name:	Sunnyside Bore	**Ref No/GW Number:**	GW008635
Easting (GDA94 Zone 55):	778554	**Northing:**	6596625
Geology and Hydrogeology			
Water bearing zone: 125m and 150 to 153m, yield 0.44L/sec. Likely Pamboola Formation or older.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	162.4	**Casing stick-up (metres above ground level):**	0.2
Casing material:	Steel	**Nominal casing diameter (mm):**	127
Screen interval (m top and bottom)	143.8 to 155.9	**Screen type**	Slotted
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Submersible (not installed)	**Power source:**	Solar
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	38.53	**Time of Measurement:**	15:25
Approximate time since pumping:	Not known		
Water quality			
Sample method:	Bailed at 45m	**Temp. (°C):**	21.69
Electrical Conductivity (µS/cm):	6185 (13/04/2021)	**pH:**	6.98

Sample obtained for laboratory analyses: yes

Comments: Landholder indicated the pump equipment will be re-installed soon.

Photographic record



WaterNSW
Work Summary

GW008635

Licence: 90WA820176 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date: 01/03/1950
Final Depth: 162.40 m
Drilled Depth: 162.50 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: BLAIRMORE NSW
GWMA: 604 - GUNNEDAH BASIN
GW Zone: -
Standing Water Level (m):
Salinity Description: Fair
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WALLA WALL	33
Licensed:	POTTINGER	WALLA WALLA	Whole Lot //

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 8836-N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6596601.000
Easting: 778590.000
Latitude: 30°43'51.3"S
Longitude: 149°54'34.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD..ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.40	156.10	127			Suspended in Clamps
1	1	Opening	Perforations	143.80	155.90	127		1	

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
125.80	125.80	0.00	Fractured						
150.50	153.50	3.00	Fractured	45.70		0.44			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	4.57	4.57	Soil	Soil	
4.57	101.19	96.62	Sandstone	Sandstone	
101.19	105.46	4.27	Shale Grey	Shale	
105.46	115.82	10.36	Sandstone Pebbles/pebbly	Sandstone	
115.82	150.57	34.75	Shale Black	Shale	
150.57	162.45	11.88	Rock Black Water Supply	Rock	

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Nindethana, 338 Towri Road, Baan Baa		
Local Bore Name:	GW0013851	**Ref No/GW Number:**	GW0013851
Easting (GDA94 Zone 55):	772467	**Northing:**	6603766
Geology and Hydrogeology			

Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	Blocked at 15.25	**Casing stick-up (metres above ground level):**	0.25
Casing material:	Steel	**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	

Water usage and pumping details			
Status:	Not in use	**Purpose:**	
Pump Type:		**Power source:**	
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):		**Time of Measurement:**	
Approximate time since pumping:			
Water quality			
Sample method:		**Temp. (°C):**	
Electrical Conductivity (µS/cm):		**pH:**	

Sample obtained for laboratory analyses: No

Comments: Bore located at different location as per WaterNSW work summary, bore blocked and not in use.

Photographic record

Latest survey date:	14/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Kia-Ora, Wynella Road, Boggabri		
Local Bore Name:	Kia-Ora House Bore	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	778925	**Northing:**	6591700
Geology and Hydrogeology			

Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	~33	**Casing stick-up (metres above ground level):**	0.1
Casing material:	Steel	**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	

Water usage and pumping details			
Status:	In use	**Purpose:**	Stock and domestic
Pump Type:	Submersible	**Power source:**	Solar
Pump intake depth (mBTOC):	25	**Pump rate (L/sec):**	

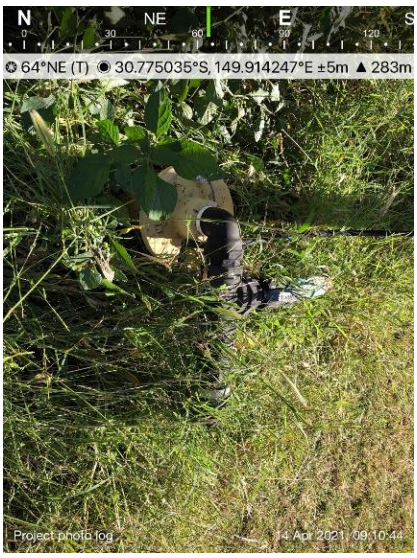
Water level information			
Depth to water (mBTOC):	15 (landholder notes)	**Time of Measurement:**	
Approximate time since pumping:	unknown		

Water quality			
Sample method:	From pipe	**Temp. (°C):**	11.55
Electrical Conductivity (µS/cm):	2273	**pH:**	5.39

Sample obtained for laboratory analyses: Yes

Comments: Bore data obtained from landholder.

Photographic record

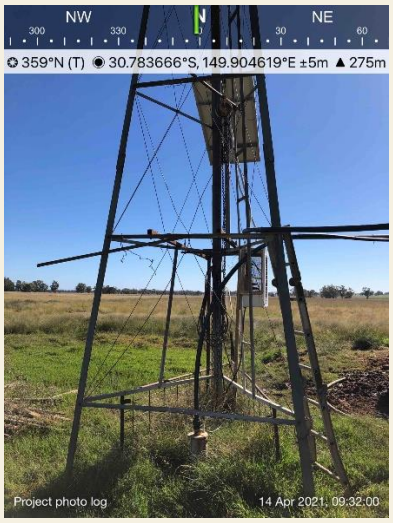


Latest survey date:	14/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Kia-Ora, Wynella Road, Boggabri		
Local Bore Name:	Kia-Ora Middle Bore	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	778339	**Northing:**	6589574
Geology and Hydrogeology			
Landholder notes: Water bearing zone 36 to 38m			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	~38	**Casing stick-up (metres above ground level):**	0.3
Casing material:	Steel	**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Submersible	**Power source:**	Solar
Pump intake depth (mBTOC):	37	**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	18 (landholder notes)	**Time of Measurement:**	
Approximate time since pumping:	unknown		
Water quality			
Sample method:	From poly tank	**Temp. (°C):**	19.16
Electrical Conductivity (µS/cm):	6258	**pH:**	7.16

Sample obtained for laboratory analyses: Yes

Comments: Bore data obtained from landholder. Bore feeds into 3 poly tanks

Photographic record



Latest survey date:	14/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Kia-Ora, Wynella Road, Boggabri		
Local Bore Name:	Kia-Ora Clump Bore	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	778339	**Northing:**	6589574
Geology and Hydrogeology			

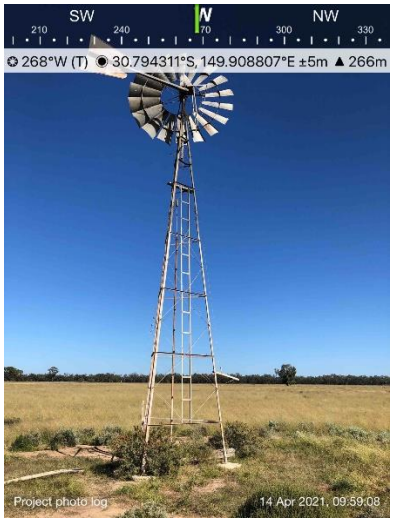
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	~80	**Casing stick-up (metres above ground level):**	0.3
Casing material:	Steel	**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	

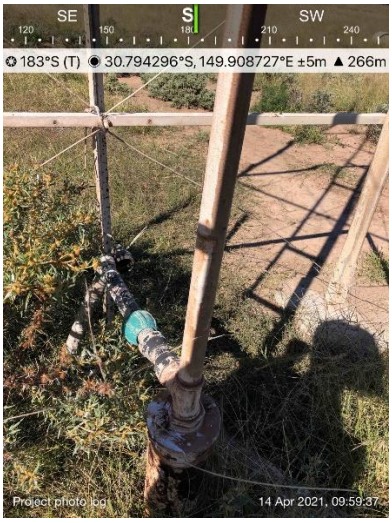
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	piston	**Power source:**	wind
Pump intake depth (mBTOC):	33	**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	27 (landholder notes)	**Time of Measurement:**	
Approximate time since pumping:	unknown		
Water quality			
Sample method:	Not sampled	**Temp. (°C):**	
Electrical Conductivity (µS/cm):		**pH:**	

Sample obtained for laboratory analyses: No

Comments:

Photographic record





Latest survey date:	14/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Glenora 244 Lynford Lane, Boggabri		
Local Bore Name:	GW017170	**Ref No/GW Number:**	GW017170
Easting (GDA94 Zone 55):	780011	**Northing:**	6601530
Geology and Hydrogeology			
Likely Arkarula Formation. Water bearing zone, 28.9 to 32.5, 0.63L/sec.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	32.6	**Casing stick-up (metres above ground level):**	0.25
Casing material:	Steel	**Nominal casing diameter (mm):**	152
Screen interval (m top and bottom)	27.1 to 32.5	**Screen type**	slotted
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Submersible	**Power source:**	solar
Pump intake depth (mBTOC):	30	**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	20.23	**Time of Measurement:**	15:45
Approximate time since pumping:	Not pumped in last 7 days		
Water quality			
Sample method:	bailed	**Temp. (°C):**	22.86
Electrical Conductivity (µS/cm):	7006	**pH:**	6.86

Sample obtained for laboratory analyses: yes

Comments: Water had hydrogen sulphide, like odor

WaterNSW
Work Summary

GW017170

Licence: 90WA820591 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date: 01/04/1961
Final Depth: 32.60 m
Drilled Depth: 32.60 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: K-DALE NSW
GWMA: 604 - GUNNEDAH BASIN
GW Zone: -
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WILLALA	68
Licensed:	POTTINGER	WILLALA	Whole Lot //

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 8836-N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6601587.000
Easting: 780052.000
Latitude: 30°41'08.3"S
Longitude: 149°55'24.1"E

GS Map: -
MGA Zone: 55
Coordinate Source: GD..ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.60	32.60	152			Seated on Bottom
1	1	Opening	Perforations	27.10	32.50	152		1	

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
28.90	32.50	3.60	Consolidated	18.20		0.63			

Drillers Log

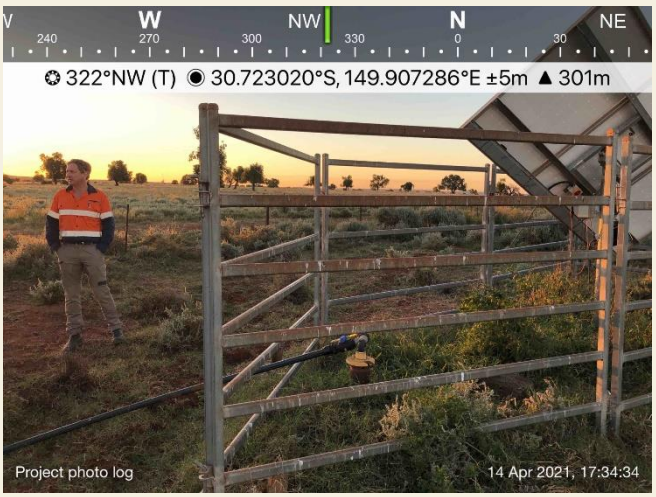
From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.60	0.60	Soil	Soil	
0.60	12.19	11.59	Clay Sandy	Clay	
12.19	15.84	3.65	Sandstone Grey	Sandstone	
15.84	28.95	13.11	Sandstone Yellow	Sandstone	
28.95	32.61	3.66	Sandstone Coarse Water Supply	Sandstone	

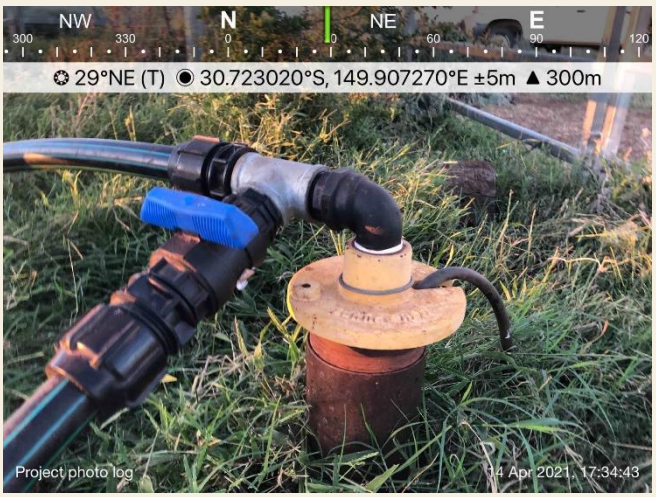
Latest survey date:	14/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Chepy, 818 Blairmore Rd, Boggabri		
Local Bore Name:	GW007860	**Ref No/GW Number:**	GW007860
Easting (GDA94 Zone 55):	778401	**Northing:**	6597487
Geology and Hydrogeology			
Likely Pamboola Formation or older. Water bearing zone 141.4 to 147.8 (0.06L/sec), 159.7 to 162.7 (0.3L/sec)			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	168.8	**Casing stick-up (metres above ground level):**	0.35
Casing material:	Steel to 141.6mbgl	**Nominal casing diameter (mm):**	127
Screen interval (m top and bottom)		**Screen type**	
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Submersible	**Power source:**	solar
Pump intake depth (mBTOC):	~150	**Pump rate (L/sec):**	0.27
Water level information			
Depth to water (mBTOC):	46.25	**Time of Measurement:**	17:35
Approximate time since pumping:	unknown		
Water quality			
Sample method:	pumped	**Temp. (°C):**	22.84
Electrical Conductivity (µS/cm):	5887	**pH:**	6.85

Sample obtained for laboratory analyses: yes

Comments: Pump feed water into nearby poly tank

Photographic record





WaterNSW
Work Summary

GW007860

Licence: 90WA820173 **Licence Status:** CURRENT

Authorised Purpose(s): STOCK
Intended Purpose(s): STOCK

Work Type: Bore open thru rock
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date: **Final Depth:** 168.80 m
Completion Date: 01/11/1949 **Drilled Depth:** 168.90 m

Contractor Name: (None)
Driller:
Assistant Driller:

Property: BLAIRMORE NSW **Standing Water Level (m):**
GWMA: 604 - GUNNEDAH BASIN **Salinity Description:** Fair
GW Zone: - **Yield (L/s):**

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	POTTINGER	WILLALA	61
Licensed:	POTTINGER	WILLALA	Whole Lot //

Region: 90 - Barwon **CMA Map:** 8836-N
River Basin: 419 - NAMOI RIVER **Grid Zone:** **Scale:**
Area/District:

Elevation: 0.00 m (A.H.D.) **Northing:** 6597559.000 **Latitude:** 30°43'20.3"S
Elevation Source: (Unknown) **Easting:** 778482.000 **Longitude:** 149°54'29.1"E

GS Map: - **MGA Zone:** 55 **Coordinate Source:** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.40	141.60	127			Suspended in Clamps

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
141.40	147.80	6.40	Consolidated	60.90		0.06			
159.70	162.70	3.00	Consolidated	42.60		0.30			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	9.14	9.14	Clay Soil	Clay	
9.14	45.41	36.27	Sandstone	Sandstone	
45.41	61.87	16.46	Diorite Black	Diorite	
61.87	141.42	79.55	Shale	Shale	
141.42	147.82	6.40	Sandstone Water Supply	Sandstone	
147.82	159.71	11.89	Shale	Shale	
159.71	162.76	3.05	Sandstone Water Supply	Sandstone	
162.76	168.85	6.09	Shale Grey	Shale	

Latest survey date:	15/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Sedona, Baan Baa Road, Baan Baa		
Local Bore Name:	Sedona Old Windmill	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	778543	**Northing:**	6607517
Geology and Hydrogeology			

Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	Unknown	**Casing stick-up (metres above ground level):**	0.2
Casing material:		**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	mono	**Power source:**	motor-powered
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):		**Time of Measurement:**	
Approximate time since pumping:			
Water quality			
Sample method:	Not sampled	**Temp. (°C):**	
Electrical Conductivity (µS/cm):		**pH:**	

Sample obtained for laboratory analyses: no

Comments: Could not start pump for sample, no access into bore for water level measurement.

Photographic record

Latest survey date:	15/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Boeyaba, Delwood Road, Boggabri		
Local Bore Name:	Boeyaba House Bore	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	777741	**Northing:**	6603319
Geology and Hydrogeology			

Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	Unknown	**Casing stick-up (metres above ground level):**	0.35
Casing material:		**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock and domestic
Pump Type:	piston	**Power source:**	wind
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	4,75	**Time of Measurement:**	9:35
Approximate time since pumping:	unknown		
Water quality			
Sample method:	From garden tap	**Temp. (°C):**	24.2
Electrical Conductivity (µS/cm):	4272	**pH:**	7.91

Sample obtained for laboratory analyses: yes

Comments:

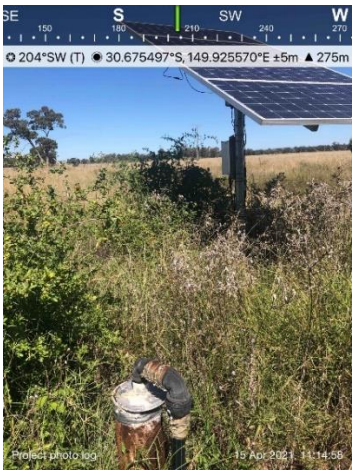
Photographic record

Latest survey date:	15/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Glenora, Caloola Road, Baan Baa		
Local Bore Name:	Bore 1 Hill	**Ref No/GW Number:**	GW970624
Easting (GDA94 Zone 55):	780291	**Northing:**	6602707
Geology and Hydrogeology			
Pamboola Formation or older. Water bearing zone 58 to 61.5mbgl (4.5L/sec)			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	61.5	**Casing stick-up (metres above ground level):**	0.62
Casing material:	PVC class 9	**Nominal casing diameter (mm):**	140
Screen interval (m top and bottom)	55.5 to 61.5	**Screen type**	slotted
Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Submersible	**Power source:**	solar
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):	26.37	**Time of Measurement:**	10:45
Approximate time since pumping:	Not pumped in last 30 days		
Water quality			
Sample method:	bailed	**Temp. (°C):**	21.7
Electrical Conductivity (µS/cm):	15 130	**pH:**	6.94

Sample obtained for laboratory analyses: yes

Comments: Bore feed into poly tank situated about 350m away, bore water salinity is high, landholder indicate only limited use for stock watering

Photographic record



WaterNSW
Work Summary

GW970624

Licence:
Licence Status:

Authorised Purpose(s):
Intended Purpose(s): STOCK

Work Type: Bore
Work Status: Supply Obtained
Construct.Method: Rotary Mud
Owner Type: Private

Commenced Date:
Completion Date: 24/10/2013
Final Depth: 61.50 m
Drilled Depth: 65.00 m

Contractor Name: JOHN CARRIGAN PTY LTD
Driller: John Carrigan
Assistant Driller: Victoria McGill

Property:
GWMA:
GW Zone:
Standing Water Level (m): 33.800
Salinity Description:
Yield (L/s): 4.500

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:			
Licensed:	POTTINGER	WILLALA	63//755530

Region: 90 - Barwon
River Basin: 419 - NAMOI RIVER
Area/District:
CMA Map: 8836-N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6602707.000
Easting: 780288.000
Latitude: 30°40'31.8"S
Longitude: 149°55'31.9"E

GS Map: -
MGA Zone: 55
Coordinate Source: GPS - Global

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	65.00	200			Rotary Mud
1		Annulus	Cement	0.00	6.00	200	140		PL:Poured/Shovelled
1		Annulus	Waterworn/Rounded	6.00	45.00	200	140		Graded, PL:Poured/Shovelled
1		Annulus	Bentonite	45.00	48.00	200	140		PL:Poured/Shovelled
1		Annulus	Waterworn/Rounded	48.00	61.50	200	140		Graded, Q:1.200m3, PL:Poured/Shovelled
1		Backfill	Gravel	61.50	62.00	200			
1		Backfill	Drilled Cuttings	62.00	65.00	200			
1	1	Casing	Pvc Class 9	-1.00	55.50	140	128		Seated, Glued
1	1	Opening	Slots - Horizontal	55.50	61.50	140		0	Mechanically Slotted, PVC Class 9, Glued, A: 1.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
58.00	61.50	3.50	Unknown	33.80		4.50			245.00

Latest survey date:	15/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Glenora, Caloola Road, Baan Baa		
Local Bore Name:	School Bore	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	778964	**Northing:**	6605099
Geology and Hydrogeology			

Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**	66	**Casing stick-up (metres above ground level):**	1.2
Casing material:		**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	

Water usage and pumping details			
Status:	In use	**Purpose:**	Stock
Pump Type:	Submersible	**Power source:**	
Pump intake depth (mBTOC):	47	**Pump rate (L/sec):**	0.4

Water level information			
Depth to water (mBTOC):	4.32	**Time of Measurement:**	11:15
Approximate time since pumping:	Not pumped in last 30 days		

Water quality			
Sample method:	bailed	**Temp. (°C):**	22.3
Electrical Conductivity (µS/cm):	3799	**pH:**	7.17

Sample obtained for laboratory analyses: yes

Comments: bore situated along gully (surface water feature)

Photographic record

Latest survey date:	15/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Glenora, Caloola Road, Baan Baa		
Local Bore Name:	Old house bore	**Ref No/GW Number:**	GW017229
Easting (GDA94 Zone 55):	780983	**Northing:**	6604580
Geology and Hydrogeology			

Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing)**:**		**Casing stick-up (metres above ground level):**	
Casing material:		**Nominal casing diameter (mm):**	
Screen interval (m top and bottom)		**Screen type**	
Water usage and pumping details			
Status:	Not in use	**Purpose:**	
Pump Type:		**Power source:**	
Pump intake depth (mBTOC):		**Pump rate (L/sec):**	
Water level information			
Depth to water (mBTOC):		**Time of Measurement:**	
Approximate time since pumping:			
Water quality			
Sample method:		**Temp. (°C):**	
Electrical Conductivity (µS/cm):		**pH:**	

Sample obtained for laboratory analyses: no

Comments: Landholder indicated that bore is not in use and partly collapsed. Bore not visited

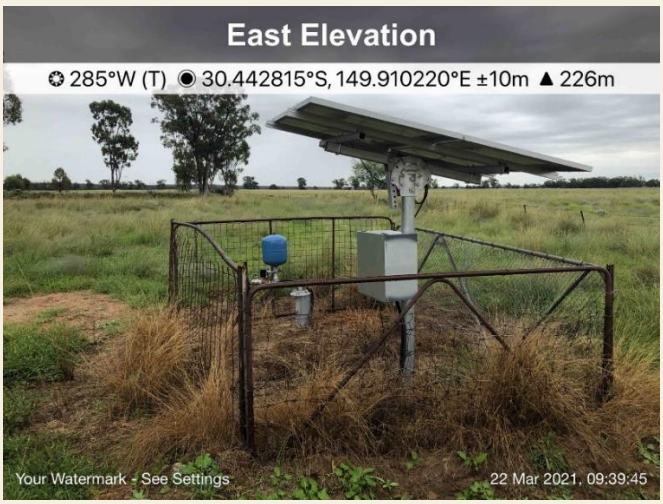
Photographic record

Latest survey date:	13/05/2021	Survey Personnel:	RD+MV
Location, owner details and GW works number			
Property details:	Turra , Turrawan Road, Turrawan		
Local bore name:	'Solar Bore'	**Ref No/GW Number:**	GW903687 (Work License no 90WA836532)
Easting (GDA94 Zone 55):	779491	**Northing:**	6628525
Geology and hydrogeology			
Based on depth information received from the landholder and, depth measured as below, the bore terminates in and likely extracts from the Napperby Formation. The Napperby Formation is identified as a "less productive" unit under the AIP.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	23.88	**Casing stick up (metres above ground level):**	0.41
Casing material:	PVC and steel collar	**Nominal casing diameter (mm):**	~165
Screen interval (meter top and bottom)	unknown	**Screen type**	unknown
Water usage and pumping details			
Status:	In Use	**Purpose:**	Stock and domestic
Pump Type:	Submersible	**Power Source:**	Solar
Pump intake depth (mBTOC):	unknown	**Pump rate (L/sec):**	unknown
Water level information			
Depth to water (mBTOC):	12.58 (13/05/2021)	**Time measured:**	10:00
Approximate time since pumping:	6 hours		
Water quality			
Sample method:	Tap on bore	**Temp. (°C):**	21.6
Electrical Conductivity (µS/cm):	6006	**pH:**	6.83

Laboratory sample obtained: Yes

Comments:

Photographic record



Latest survey date:	13/05/2021	Survey Personnel:	RD+MV
Location, owner details and GW works number			
Property details:	Mentone property, Turrawan Road, Turrawan		
Local bore name:	'Mentone Bore'	**Ref No/GW Number:**	Not registered
Easting (GDA94 Zone 55):	776686	**Northing:**	6629368
Geology and hydrogeology			
Based on depth information received from the landholder and depth measured as below, the bore terminates in and likely extracts from the Napperby Formation. The Napperby Formation is identified as a "less productive" unit under the AIP.			
Bore construction details (summary)			
Depth (mBTOC) (metres below top of casing):	16,69	**Casing stick up (metres above ground level):**	0.53
Casing material:	PVC and steel collar	**Nominal casing diameter (mm):**	~125
Screen interval (metres top and bottom)	unknown	**Screen type**	unknown
Water usage and pumping details			
Status:	Not In Use	**Purpose:**	Stock and domestic
Pump Type:	Not equiped	**Power Source:**	none
Pump intake depth (mBTOC):	na	**Pump rate (L/sec):**	na
Water level information			
Depth to water (mBTOC):	9.9 (13/05/2021)	**Time measured:**	09:00
Approximate time since pumping:	>12 months		
Water quality			
Sample method:	bail	**Temp. (°C):**	19.4
Electrical Conductivity (µS/cm):	3919	**pH:**	7.16

Laboratory sample obtained: Yes

Comments: Dry well beside bore, approximately 7m deep. Assumed to be GW70592

Photographic record

Appendix C

Water Quality Data

G1974F

Parameter	Units	LOR#	ANZECC GUIDELINES				NHMRC											
Sample Location			**Fresh Water Aquatic (95th)**	**Short term irrigation**	**Long Term irrigation**	**Stock Water**	**Drinking Water**	**Windmill Bore**	**House BH**	**GW013858**	**South Caloola**	**257_Bore**	**WB10**	**Blairmore Feature 1**	**Blairmore BH1**	**Blairmore BH2**	**GW008634**	**Dreadnought Windmill Bore**
Lab Number								EB2108019001	EB2108019002	EB2108019003	EB2110387001	EB2110387002	EB2110387003	EB2110387004	EB2110387010	EB2110387009	EB2110387011	EB2110387005
Date Sampled								22/03/2021	22/03/2021	22/03/2021	12/04/2021 15:50	12/04/2021	12/04/2021	13/04/2021	13/04/2021	13/04/2021	13/04/2021	13/04/2021
Physical Parameters																		
pH	pH Units	0.1	**6.5 - 8.5**	**6.0 - 8.5**	**6.0 - 8.5**	-	**6.5 - 8.5[b]**	7.3	8.05	7.39	7.82	7.6	7.58	8.4	8.27	8.1	8.01	7.7
Electrical conductivity	µS/cm	1	**120 - 300**	-		-	-	1280	4940	4840	2310	8950	19400	5970	4080	2600	496	5950
Sodium Absorption Ration (SAR)	-	0.01		-		-	-	4.39	46.9	3.95	17.2	18	33.7	7.77	3.65	11.8	5.4	22.2
Total Dissolved Solids @180°C	mg/L	1.00		-		**3000 - 13000***	**600[b]**	832	3210	3150	1500	5820	12600	3880	2650	1690	322.00	3870
Total Hardness as $CaCO_3$	mg/L	1.00		-		-	**200[b]**	264	150	1770	150	1520	3080	1780	1490	314	40.00	786
Hydroxide Alkalinity as $CaCO_3$	mg/L	1.00		-		-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	1.00		-		-	-	<1	<1	<1	<1	<1	<1	34	<1	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1.00		-		-	-	267	2350	692	721	666	950	718	535	624	164	2770
Total Alkalinity as $CaCO_3$	mg/L	1.00		-		-	-	267	2350	692	721	666	950	752	535	624	164	2770
Major Ions																		
Sulfate as SO_4 - Turbidimetric	mg/L	1		-		**1000 - 2000**	**500[a] / 250[b]**	57	<1	62	1	517	1880	137	183	77	<1	27
Chloride	mg/L	1			**40**	-	**250[b]**	267	492	1360	432	2880	7070	**1710**	**1050**	511	60	792
Fluoride	mg/L	0.1		**2.0**	**1.0**	**2**	**1.5[a]**	0.2	2.6	0.1	0.1	0.5	0.3	0.3	0.2	0.2	0.1	0.8
Calcium	mg/L	1		-		**1000**	-	43	27	204	4	121	293	82	66	73	8	94
Magnesium	mg/L	1		-		-	-	38	20	306	34	297	570	382	322	32	5	134
Sodium	mg/L	1		-		-	**180[b]**	164	1320	382	484	1620	4300	**753**	**324**	**481**	79	1430
Potassium	mg/L	1		-		-	-	5	26	5	16	28	77	17	6	9	21	31
Total Anions	meq/L	0.01		-		-	-	14	60.8	53.5	26.6	105	258	66.1	44.1	28.5	4.97	78.2
Total Cations	meq/L	0.01		-		-	-	12.5	61.1	52.1	24.4	102	250	68.7	44	27.4	4.78	78.7
Ionic Balance	%	0.01		-		-	-	5.71	0.2	1.3	4.22	1.76	1.38	1.93	0.09	1.89	1.9	0.3
EG020F: Dissolved Metals by ICP-MS																		
Aluminium	mg/L	0.01		-		-	-	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001		-		-	-	<0.001	<0.001	<0.001	0.01	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001
Beryllium	mg/L	0.001		-		-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001		-		-	-	0.067	2.06	0.074	0.066	0.081	0.071	0.178	0.016	0.047	0.029	2.02
Cadmium	mg/L	0.0001		-		-	-	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001		-		-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001		-		-	-	<0.001	<0.001	<0.001	0.001	0.009	0.008	<0.001	<0.001	<0.001	<0.001	0.002
Copper	mg/L	0.001		-		-	-	0.004	<0.001	0.004	0.002	0.003	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001		-		-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001		-		-	-	0.014	0.003	0.003	0.098	0.89	1.82	0.01	<0.001	0.075	0.315	0.457
Molybdenum	mg/L	0.001		-		-	-	<0.001	<0.001	<0.001	0.011	0.003	0.002	<0.001	<0.001	0.001	0.001	<0.001
Nickel	mg/L	0.001		-		-	-	0.002	<0.001	0.006	0.004	0.061	0.007	0.003	<0.001	<0.001	0.001	0.002
Selenium	mg/L	0.01		-		-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	0.001		-		-	-	0.543	1.82	2.54	0.187	2.74	13.1	2.56	1.38	1.18	0.089	3.48
Vanadium	mg/L	0.01		-		-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	0.005		-		-	-	0.06	0.012	0.09	0.027	0.046	0.016	0.007	<0.005	<0.005	0.007	0.025
Boron	mg/L	0.05		-		-	-	<0.05	0.1	0.06	0.07	0.06	0.11	0.1	<0.05	<0.05	<0.05	0.1
Iron	mg/L	0.05		-		-	-	<0.05	<0.05	<0.05	17.1	0.12	1.38	<0.05	<0.05	0.05	0.09	0.14
EG035F: Dissolved Mercury by FIMS																		
Mercury	mg/L	0.0001						<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG020T: Total Metals by ICP-MS																		
Aluminium	mg/L	0.01	**0.055**	**5**		**5**	**0.2[b +]**	1.32	0.02	0.47	0.01	0.14	0.02	0.42	0.01	0.14	0.62	0.01
Arsenic	mg/L	0.001	**As (III) 0.024 As (V) 0.013**	**2.0**	**0.1**	**0.5**	**0.01[a]**	<0.001	<0.001	<0.001	0.01	<0.001	0.002	<0.001	<0.001	<0.001	0.001	0.003
Beryllium	mg/L	0.001		**0.5**	**0.1**	-	**0.06[a]**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001
Barium	mg/L	0.001		-		-	**2[a]**	0.062	2.44	0.105	0.078	0.09	0.08	0.187	0.018	0.052	0.039	2.21
Cadmium	mg/L	0.0001	**0.0002**	**0.05**	**0.01**	**0.01**	**0.002[a]**	<0.0001	<0.0001	<0.0001	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0005	<0.0001
Chromium	mg/L	0.001	**CrIII – ID Cr(VI) 0.001**	**1.0**	**0.1**	**1.0**	**0.05[a]**	<0.001	0.005	0.055	<0.001	0.002	<0.001	0.001	0.002	<0.001	0.003	<0.001
Cobalt	mg/L	0.001		**0.10**	**0.05**	**1.0**	-	<0.001	<0.001	0.001	0.001	0.009	0.009	<0.001	<0.001	<0.001	0.002	0.002
Copper	mg/L	0.001	**0.0014**	**5.0**	**0.2**	**0.5 - 5^**	**2[a] / 1[b]**	0.049	0.003	0.016	0.016	0.005	0.004	0.003	0.002	0.002	0.004	0.002
Lead	mg/L	0.001	**0.0034**	**5.0**	**2.0**	**0.1**	**0.01[a]**	0.002	<0.001	0.006	0.01	0.001	0.002	<0.001	<0.001	<0.001	0.002	<0.001
Manganese	mg/L	0.001	**1.9**	**10.0**	**0.2**	-	**0.5[a] / 0.1[b]**	0.014	0.005	0.102	0.101	0.859	1.88	0.036	0.002	0.078	0.365	0.452
Molybdenum	mg/L	0.001	-	**0.05**	**0.01**	**0.15**	**0.05[a]**	<0.001	<0.001	0.001	0.014	0.003	0.002	<0.001	<0.001	0.001	0.001	<0.001
Nickel	mg/L	0.001	**0.011**	**2.0**	**0.2**	**1**	**0.02[a]**	0.002	<0.001	0.012	0.005	0.061	0.007	0.004	<0.001	<0.001	0.005	0.002
Selenium	mg/L	0.01	**Total – 0.011 SeIV - ID**	**0.05**	**0.02**	**0.02**	**0.01[a]**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	0.001			-	-	-	0.606	2.04	3.07	0.19	2.82	13.9	2.68	1.45	1.24	0.086	3.48
Vanadium	mg/L	0.01	-	**0.5**	**0.1**	-	-	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.01	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	**0.008**	**2.0**	**2.0**	**20**	**3[b]**	0.076	0.047	0.137	0.038	0.051	0.027	0.012	0.007	0.007	0.132	0.038
Boron	mg/L	0.05	**0.370**	**refer to guideline**	**0.5**	**5**	**4a**	<0.05	0.16	<0.05	0.07	0.07	0.12	0.1	<0.05	<0.05	<0.05	0.1
Iron	mg/L	0.05	-	**10.000**	**0.200**	-	**0.3b**	0.31	0.43	6.03	20.4	0.55	1.55	0.49	<0.05	0.26	**4.08**	1.83
EG035T: Total Recoverable Mercury by FIMS																		
Mercury	mg/L	0.0001	**0.0006**	**0.002**	**0.002**	**0.002**		0.0002	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

G1974F

Parameter	Units	LOR#	ANZECC GUIDELINES				NHMRC												
Sample Location			**Fresh Water Aquatic (95th)**	**Short term irrigation**	**Long Term irrigation**	**Stock Water**	**Drinking Water**	**Cattle Grid Bore (CGB)**	**Sunnyside Bore**	**Dreadnought House Bore**	**Kia-Ora House Bore**	**Kia-Ora Middle Bore**	**GW017170**	**GW007860**	**Boeyaba House Bore**	**Bore 1 Hill**	**School Bore**	**Mentone Bore**	**Solar Bore**
Lab Number								EB2110387006	EB2110387007	EB2110387008	EB2110387011	EB2110387015	EB2110387013	EB2110387014	EB2110387017	EB2110387016	EB2110387018	ES2118132	ES2118132
Date Sampled								13/04/2021	13/04/2021	13/04/2021	14/04/2021	14/04/2021	14/04/2021	14/04/2021	15/04/2021	15/04/2021	15/04/2021	13/05/2021	13/05/2021
Physical Parameters																			
pH	pH Units	0.1	**6.5 - 8.5**	**6.0 - 8.5**	**6.0 - 8.5**	**-**	**6.5 - 8.5[b]**	8.47	7.8	8.72	5.49	8.01	7.4	7.5	8.48	7.76	7.81	7.62	7.05
Electrical conductivity	µS/cm	1	**120 - 300**	**-**		**-**	**-**	3120	5680	1430	2260	6120	6800	5750	4190	14800	3620	4730	5270
Sodium Absorption Ration (SAR)	-	0.01		**-**		**-**	**-**	53.5	32.5	87.6	2.27	9.55	30.7	91.4	49.8	27.6	29.7	11.4	12
Total Dissolved Solids @180°C	mg/L	1.00		**-**		**3000 - 13000***	**600[b]**	2030	3690	930	1470	3980	4420	3740	2720	9620	2350	2380	3910
Total Hardness as $CaCO_3$	mg/L	1.00		**-**		**-**	**200[b]**	43	386	<1	902	1440	500	65	110	2170	210		
Hydroxide Alkalinity as $CaCO_3$	mg/L	1.00		**-**		**-**	**-**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	mg/L	1.00		**-**		**-**	**-**	42	<1	49	<1	<1	<1	<1	92	<1	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1.00		**-**		**-**	**-**	1250	2410	476	450	843	2700	3660	2310	1390	2040	871	501
Total Alkalinity as $CaCO_3$	mg/L	1.00		**-**		**-**	**-**	1290	2410	525	450	843	2700	3660	2400	1390	2040	871	501
Major Ions																			
Sulfate as SO_4 - Turbidimetric	mg/L	1		**-**		**1000 - 2000**	**500[a] / 250[b]**	<1	<1	<1	<1	115	<1	<1	<1	2110	<1	225	507
Chloride	mg/L	1			**40**	**-**	**250[b]**	396	781	203	460	1600	919	91	86	3720	108	733	1440
Fluoride	mg/L	0.1		**2.0**	**1.0**	**2**	**1.5[a]**	5.6	0.7	0.8	0.6	0.4	0.8	1	1.5	0.6	0.9	0.7	0.2
Calcium	mg/L	1		**-**		**1000**	**-**	9	54	<1	122	154	42	13	16	169	28	85	107
Magnesium	mg/L	1		**-**		**-**	**-**	5	61	<1	145	256	96	8	17	424	34	88	190
Sodium	mg/L	1		**-**		**-**	**180[b]**	807	1470	366	157	833	1580	1700	1200	2950	990	629	891
Potassium	mg/L	1		**-**		**-**	**-**	10	14	6	3	4	32	20	30	34	18		
Total Anions	meq/L	0.01		**-**		**-**	**-**	36.9	70.2	16.2	22	64.4	79.9	75.7	50.4	177	43.8		
Total Cations	meq/L	0.01		**-**		**-**	**-**	36.2	72	16.1	24.9	65.1	79.5	75.8	55.2	172	47.7		
Ionic Balance	%	0.01		**-**		**-**	**-**	0.99	1.29	0.44	6.31	0.56	0.21	0.05	4.53	1.18	4.27		
EG020F: Dissolved Metals by ICP-MS																			
Aluminium	mg/L	0.01		**-**		**-**	**-**	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.05	<0.01			<0.01	<0.01
Arsenic	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.005	<0.001			0.001	<0.001
Beryllium	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001			<0.001	<0.001
Barium	mg/L	0.001		**-**		**-**	**-**	0.469	1.19	0.03	0.089	0.146	2.93	1.79	1.06			0.041	0.107
Cadmium	mg/L	0.0001		**-**		**-**	**-**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001			<0.0001	<0.0001
Chromium	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	<0.001	<0.001	0.003	0.001	<0.005	<0.001			<0.001	<0.001
Cobalt	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001			<0.001	<0.001
Copper	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	0.002	0.013	0.003	<0.001	<0.005	0.01			<0.001	<0.001
Lead	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001			<0.001	<0.001
Manganese	mg/L	0.001		**-**		**-**	**-**	0.002	0.027	0.011	0.006	0.004	0.114	<0.005	<0.001			0.004	0.003
Molybdenum	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	0.008	0.001	<0.001	<0.001	<0.005	<0.001			0.006	<0.001
Nickel	mg/L	0.001		**-**		**-**	**-**	<0.001	<0.001	0.002	<0.001	<0.001	0.001	<0.005	<0.001			<0.001	0.001
Selenium	mg/L	0.01		**-**		**-**	**-**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01			<0.01	<0.01
Strontium	mg/L	0.001		**-**		**-**	**-**	0.44	3.89	0.05	1.92	3.35	5.77	2.16	1.46			1.35	2.48
Vanadium	mg/L	0.01		**-**		**-**	**-**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01			<0.01	<0.01
Zinc	mg/L	0.005		**-**		**-**	**-**	<0.005	0.015	0.011	0.085	<0.005	0.006	0.032	0.006			<0.005	<0.005
Boron	mg/L	0.05		**-**		**-**	**-**	0.16	0.2	<0.05	0.05	<0.05	0.25	0.46	0.37			0.08	<0.05
Iron	mg/L	0.05		**-**		**-**	**-**	<0.05	1.84	0.17	<0.05	<0.05	18.4	0.35	<0.05			<0.05	<0.05
EG035F: Dissolved Mercury by FIMS																			
Mercury	mg/L	0.0001						<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			<0.0001	<0.0001
EG020T: Total Metals by ICP-MS																			
Aluminium	mg/L	0.01	**0.055**	**5**		**5**	**0.2[b] +**	0.02	0.02	0.07	0.04	0.01	0.08	<0.05	0.01			0.22	<0.01
Arsenic	mg/L	0.001	**As (III) 0.024 As (V) 0.013**	**2.0**	**0.1**	**0.5**	**0.01[a]**	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.005	<0.001			0.001	<0.001
Beryllium	mg/L	0.001		**0.5**	**0.1**	**-**	**0.06[a]**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001			<0.001	<0.001
Barium	mg/L	0.001		**-**		**-**	**2[a]**	0.541	1.37	0.042	0.073	0.178	3.39	1.74	1.22			0.05	0.117
Cadmium	mg/L	0.0001	**0.0002**	**0.05**	**0.01**	**0.01**	**0.002[a]**	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001			<0.0001	<0.0001
Chromium	mg/L	0.001	**CrIII – ID Cr(VI) 0.001**	**1.0**	**0.1**	**1.0**	**0.05[a]**	<0.001	<0.001	<0.001	<0.001	0.003	0.003	<0.005	<0.001			0.001	<0.001
Cobalt	mg/L	0.001		**0.10**	**0.05**	**1.0**	**-**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.001			<0.001	<0.001
Copper	mg/L	0.001	**0.0014**	**5.0**	**0.2**	**0.5 - 5^**	**2[a] / 1[b]**	0.002	0.002	0.009	0.037	0.005	0.007	0.039	0.055			<0.001	0.001
Lead	mg/L	0.001	**0.0034**	**5.0**	**2.0**	**0.1**	**0.01[a]**	<0.001	0.001	0.006	<0.001	<0.001	<0.001	<0.005	0.002			<0.001	<0.001
Manganese	mg/L	0.001	**1.9**	**10.0**	**0.2**	**-**	**0.5[a] / 0.1[b]**	0.004	0.032	0.074	0.006	0.004	0.12	<0.005	0.001			0.052	0.004
Molybdenum	mg/L	0.001	**-**	**0.05**	**0.01**	**0.15**	**0.05[a]**	<0.001	<0.001	0.008	0.002	<0.001	<0.001	<0.005	<0.001			0.003	<0.001
Nickel	mg/L	0.001	**0.011**	**2.0**	**0.2**	**1**	**0.02[a]**	<0.001	<0.001	0.004	0.001	<0.001	0.004	<0.005	<0.001			0.001	0.002
Selenium	mg/L	0.01	**Total – 0.011 SeIV - ID**	**0.05**	**0.02**	**0.02**	**0.01[a]**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01			<0.01	<0.01
Strontium	mg/L	0.001			**-**	**-**	**-**	0.45	4.1	0.044	1.88	3.58	5.82	2.26	1.48			1.34	2.73
Vanadium	mg/L	0.01	**-**	**0.5**	**0.1**	**-**	**-**	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.05	<0.01			<0.01	<0.01
Zinc	mg/L	0.005	**0.008**	**2.0**	**2.0**	**20**	**3[b]**	0.01	0.032	0.137	0.095	0.007	0.053	0.04	0.029			0.007	<0.005
Boron	mg/L	0.05	**0.370**	**refer to guideline**	**0.5**	**5**	**4a**	0.16	0.22	0.06	0.06	<0.05	0.27	0.33	0.38			0.06	<0.05
Iron	mg/L	0.05	**-**	**10.000**	**0.200**	**-**	**0.3b**	0.32	2.32	2.85	0.09	0.08	**20.9**	0.41	0.26			0.27	0.06
EG035T: Total Recoverable Mercury by FIMS																			
Mercury	mg/L	0.0001	**0.0006**	**0.002**	**0.002**	**0.002**		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			<0.0001	0.0007

#	Limit of Reporting
a	NHMRC Health Guidelines for Drinking Water (2015)
b	NHMRC Aesthetic Guidelines for Drinking Water (2015)
m TOC	metres below top of casing
1	Exceeds the ANZECC (2000) Long Term Irrigation Water Guidelines
2	Exceeds the ANZECC (2000) Stock Water Guidelines
3	Exceeds the NHMRC (2011) Drinking Water Guidelines
*	Maximum concentration at which good condition might be expected, with 13,000 mg/L for sheep, 5,000 mg/L for beef cattle, 4,000 mg/L for dairy cattle, 6,000 mg/L for horses and 3,000 mg/L for pigs and poultry.
^	Maximum concentrations of copper for sheep is 0.5 mg/L, 1 mg/L for cattle and 5 mg/L for pigs & poultry.
+	NHMRC acid-soluble aluminium concentrations (2015)
-	No value.

ATTACHMENT 7

GROUNDWATER IMPACT ASSESSMENT ADDENDUM

Australasian Groundwater & Environmental Consultants

Memorandum

Project number	G1972F
To	Mark Vile
Company	NCOPL
From	Keith Phillipson
Date	31 May 2021

RE: Narrabri Underground Mine Stage 3 Extension Project – Impact Assessment Addendum

1 Overview

This report provides an addendum to the Narrabri Underground Mine Stage 3 Extension Project (the Project) Groundwater Assessment (Australasian Groundwater and Environmental Consultants Pty Ltd [AGE], 2020)[1], to incorporate the findings of recent bore census and bore appraisal activities conducted for the Project.

In summary, the work undertaken subsequent to the EIS has resulted in the following key conclusions:

- Two of the eight bores identified in AGE (2020) as being likely to experience drawdown of more than the 2 metre (m) minimum impact threshold identified in the NSW *Aquifer Interference Policy* (AIP)[2] (hereafter referred to as potentially impacted bores) have been backfilled or abandoned/ destroyed.
- Three new bores have also been identified as potentially impacted, two newly constructed since round 1 of the bore census was completed (one of which is located on a property where the landowner previously advised that there were no bores) and another unregistered bore, which was not previously assessed.
- Overall, drawdowns of more than 2 m are now predicted at nine bores, including six from AGE (2020) and the three new bores mentioned above.
- However, impairment of supply is only expected at six of these nine bores since the predicted drawdown represents a relatively minor proportion of the standing water column observed in the other three bores.
- Where actual impairment of supply does occur then it is likely that impacts on existing bores could be 'made good' by drilling additional and/or replacement bores elsewhere on the same property.

Two further potential groundwater features of interest were also noted on the Blairmore property during the field work, however no material impacts on these features are predicted. At Blairmore groundwater feature 1 it is considered unlikely that the minor predicted drawdown of less than 2.6 centimetres (cm) could materially affect groundwater flow. The second feature identified (Blairmore groundwater feature 2) appears to be transient in nature and may well not be groundwater dependent. If it is groundwater dependent in any way it is likely to be supported by groundwater discharging from shallow systems which are highly unlikely to be affected by operation of the Narrabri Mine more than 10 kilometres (km) to the north.

[1] AGE, 2020, *Groundwater Assessment Narrabri Mine Stage 3 Extension Project*, August 2020

[2] Department of Primary Industries (DPI) - Office of Water, 2012a. *Aquifer Interference Policy*.

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2 Introduction

In response to comments received from landholders in the area surrounding the Narrabri Underground Mine Stage 3 Extension Project (the Project) Groundwater Impact Assessment (AGE, 2020)[3] NCOPL engaged AGE to undertake further bore census and bore appraisal activities comprising:

- Inspection of existing registered and un-registered bores on a number of properties not previously visited during the previous two rounds of bore census activities conducted by Environment & Natural Resource Solutions (ENRS) (ENRS, 2020)[4]; and
- Further data collation visits to each of the eight potentially impacted bores identified in the Narrabri Underground Mine Stage 3 Extension Project Groundwater Assessment (AGE, 2020).

Properties visited during each of the three rounds of bore census activities, the eight bores previously identified as potentially impacted and other bores inspected during the recent field program are shown in Figure 2.1. Other properties which were contacted by mail, to confirm whether or not there were any groundwater bores on the property, prior to undertaking the first round of bore census activities are also shown.

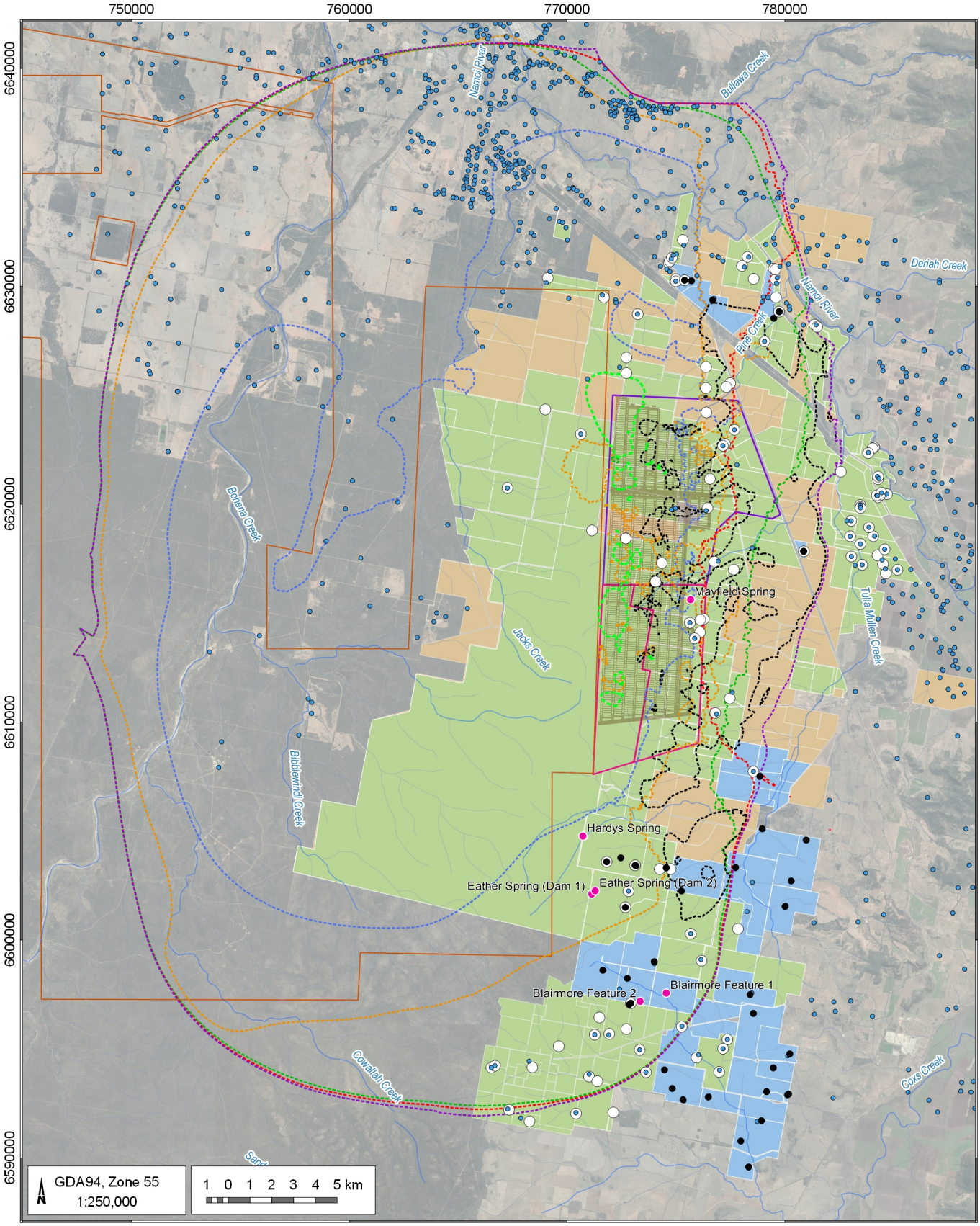
The results of the further investigations outlined above are summarised in a bore census summary report (AGE, 2021a)[5] which provides further details of 37 bores and two potential groundwater features inspected on the properties visited. A series of bore appraisal reports have also been developed to provide further information about each of the eight bores previously identified as potentially impacted (AGE, 2020). The primary aim of these reports was to assess the likely degree of impairment of each of the bores, to inform make good negotiations with the landholders. Draft individual reports have been provided to each affected landholder for their comments.

The key outcomes of this work of relevance to the Project Groundwater Assessment (AGE, 2020) are summarised in Section 3.

[3] AGE, 2020, *Groundwater Assessment Narrabri Mine Stage 3 Extension Project*, August 2020.

[4] ENRS, 2020, *Groundwater Bore Census – Narrabri Underground Mine Stage 3 Extension Project*.

[5] AGE, 2021a, *Narrabri Underground Mine Stage 3 Extension Project – Round 3 Bore Census*.



LEGEND

- Registered water supply bore locations
- Potential groundwater feature
- Bores inspected after EIS submission
- Bores inspected prior to EIS submission
- Drainage
- Project longwall panels
- Mining Lease Boundary (ML 1609)
- Proposed Narrabri Gas Project (Santos)
- Provisional Mining Lease Application Area
- Properties visited prior to EIS submission
- Properties visited or contacted after EIS submission
- Other properties contacted by mail prior to EIS submission

Predicted 2m drawdown contour/limit of formation

- Near surface unconsolidated strata
- Pilliga Sandstone
- Purlawaugh Formation
- Garrawilla Volcanics
- Napperby Formation
- Hoskissons Seam
- Arkarula Formation

Narrabri Stage 3 Extension GIA (G1972F)

Summary of Project bore census and bore appraisal activities and predicted drawdown

AGE

DATE 31/05/2021

FIGURE No: **2.1**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972F.NarrabriStage3_Bore AppraisalNo3\3_GIS\Workspaces\001_Deliverable1\01.01_G1972F_Summary of Project bore census and bore appraisal activities and predicted drawdown.qgs

3 Impact assessment revisions

3.1 Private water supply bores

As described in Section 7.6.1 of the Project Groundwater Assessment (AGE, 2020) impacts were previously assessed at some 1,533 existing registered water supply bores, plus a number of un-registered bores identified during the round 1 and 2 bore census activities (ENRS, 2020). Whilst the round 1 bore census was undertaken prior to any predictions of Project impacts being available, the round 2 census, which was completed in May 2020, was informed by preliminary predictive modelling results. Hence the round 2 census targeted those bores and properties where potentially significant impacts (i.e. drawdowns of greater than 2 m) were anticipated. As shown in Figure 2.1 many of the properties visited during round 3 are located to the south east of the Project area outside of the predicted zone of influence of the mine. Hence, in most cases the additional information collected during the round 3 bore census and bore appraisal activities has not resulted in any changes to the previously assessed impacts, however, four exceptions are outlined in Sections 3.1.1 to 3.1.4 below.

3.1.1 South Caloola, Solar Bore and Mentone Bore

Three bores (the South Caloola, Solar and Mentone bores) which had not been previously assessed were identified within the predicted zone of influence of the Project (Figure 2.1) during the round 3 bore census activities. The South Caloola bore is unregistered and located on a property which was not previously visited as part of bore census activities. It is understood that the Solar and Mentone bores were constructed since completion of round 1 of the bore census (i.e. after August 2019), at that time, no registered bore existed on the properties.

Maximum predicted drawdown at these bores exceeds the 2 m drawdown threshold identified in the AIP and hence they have been assessed as being potentially impacted. We understand, from the bore owner, that the South Caloola bore is 41 m deep and as such is thought to terminate in, and draw water from, the Napperby Formation. Up to 5.46 m of drawdown is predicted at this location and depth. Similarly, we understand from the bore owners that the Solar and Mentone bores are around 23 m and 16 m deep respectively and are both thought to terminate in and draw water from the Napperby Formation. Up to 5.62 m of drawdown is predicted in the Solar bore and 13.11 m in the Mentone bore.

3.1.2 Bore GW013851

Bore GW013851 was one of the eight potentially impacted bores previously identified in the Project Groundwater Assessment (AGE, 2020). It was unable to be located as part of the round 2 bore census (ENRS, 2020) and so was conservatively identified in AGE (2020) as being potentially impacted despite not being found during the census. However, on further investigation in March 2021 the bore was located but found to have been backfilled to around 15 m below ground and no longer be useable as a water supply bore (AGE, 2021b)[6]. Accordingly, as the bore has already been impaired by backfilling there is considered to be no requirement for impacts to be further monitored, assessed or made good.

[6] AGE, 2021b, *Narrabri Underground Mine Stage 3 Extension Project, K & KL Lancaster (Kevin) Bore Appraisal Report – Bores GW013858, GW026121, GW013851.*

3.1.3 Bore GW054227

Bore GW054227 was also previously identified in the Project Groundwater Assessment (AGE, 2020) as potentially impacted. Unlike the other bores listed, this bore was assessed solely using information extracted from the NSW Department of Primary Industries (DPI) -Office of Water PINNEENA groundwater archive (Version 11.1, DPI-Office of Water, 2016)[7], since access could not be arranged at the time. However, despite assistance from the landholder the bore could not be located during the recent field visit and no longer appears to exist on the property (AGE, 2021b)[8]. Accordingly, as the bore appears to have been abandoned and destroyed there is considered to be no requirement for impacts to be further monitored, assessed or made good.

3.1.4 Headroom assessment

As described in Section 7.6.1 of the Project Groundwater Assessment (AGE, 2020), whilst maximum predicted drawdowns at the eight bores listed exceed the 2 m AIP threshold in only three cases does the predicted drawdown exceed 5 m. The potential significance of these drawdowns was assessed at the time using the information available via the round 1 and 2 bore census and the PINNEENA database. In four of the eight bores (House bore, 257_Bore, GW026121 and Windmill Bore) key information on the bore depth and/or the depth to the main water bearing zone was not available.

Updated headroom (or impairment) calculations[9], based on additional information derived from the bore appraisal visits, are presented in the bore appraisal reports. In six cases (GW013858, GW026121, Windmill bore, South Caloola, Solar and Mentone bores) the predicted drawdown has been assessed as being likely to cause impairment, requiring 'make good' measures. Conversely predicted drawdown is considered unlikely to result in impairment of supply in House_Bore, 257_Bore and GW008634.

A summary of the revised impairment assessment results and other information relating to the eight potentially impacted bores identified in the Project Groundwater Assessment (AGE, 2020) and the three newly identified potentially impacted bores (South Caloola, Solar and Mentone bores) are presented in Table 3.1. In all instances where potential impairment has been identified it is likely that impacts on existing bores could likely be 'made good' by drilling additional and/or replacement bores elsewhere on the same property.

A revised map showing the location of the each of the nine potentially impacted bores resulting from the changes outlined above in Sections 3.1.1 to 3.1.4 is shown in Figure 3.1.

3.2 Other groundwater features

During the bore census visit to the Blairmore property two potential groundwater features were mentioned by the landholder and visited by the survey team. Based on the information gathered during the visual inspections to the two sites (refer to Table 3.2 and Table 3.3) and information presented in the Project Groundwater Assessment (AGE, 2020), the following conclusions can be drawn about these potential groundwater features.

[7] DPI - Office of Water, 2016. PINNEENA groundwater archive (Version 11.1).

[8] AGE, 2021c, *GO & TW Hall (Terrence William Hall) Bore Appraisal Report – GW054227*.

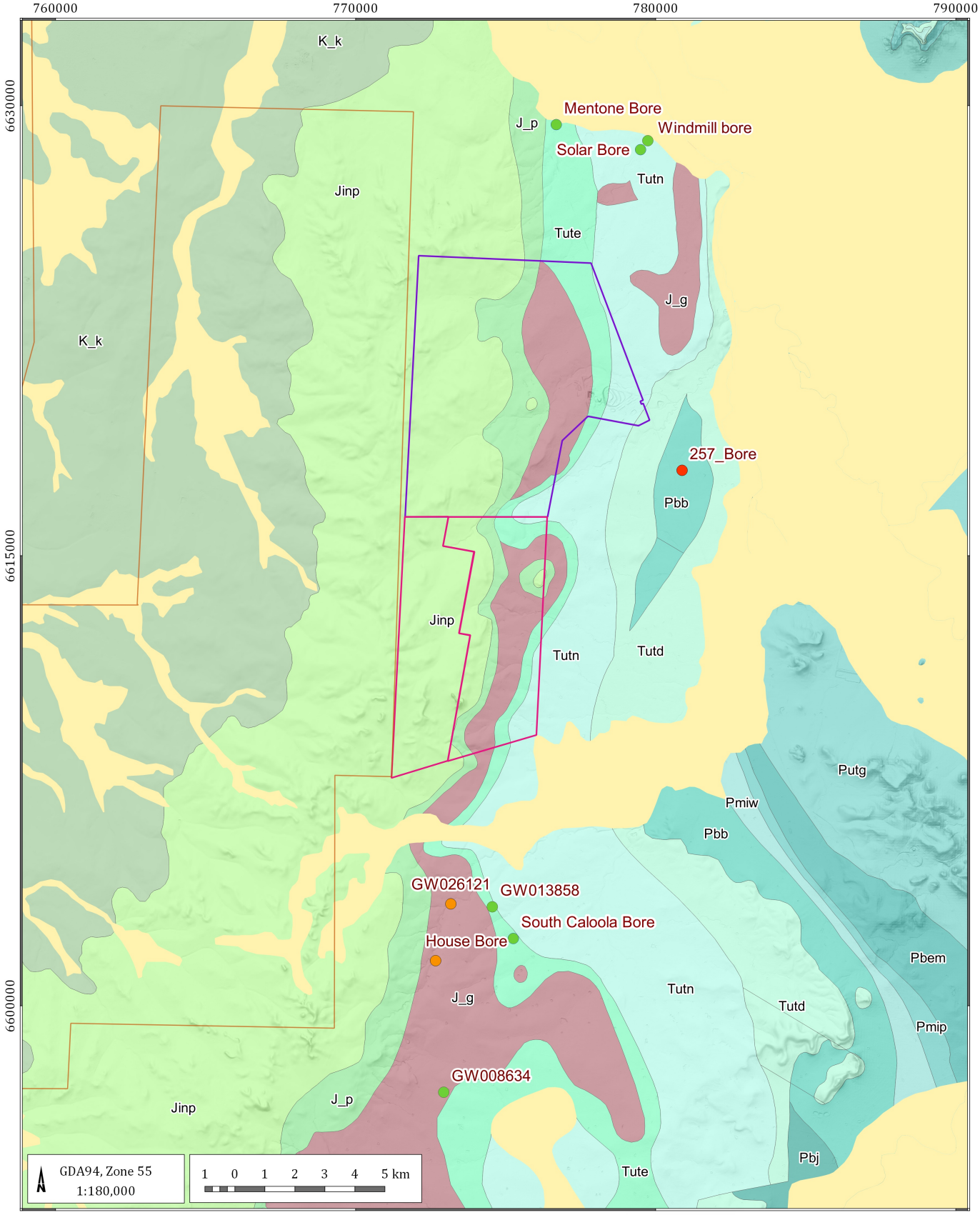
[9] In this case a bore has been assessed as being likely to be impaired if the predicted maximum drawdown exceeds 50% of the standing water column. Where this occurs then the ability of the bore to supply water for its intended purpose is considered likely to be reduced since the available headroom above the bore pump is reduced.

3.2.1 Blairmore groundwater feature 1

- As shown in Figure 2.1 Blairmore groundwater feature 1 is located on an existing drainage line close to the margin of the Garrawilla Volcanics.
- The presence of reed species (see Table 3.2) around the discharge point as well as the downstream dam suggests that these are semi-permanent features suggesting a spring discharging groundwater flow at the margin of the Garrawilla Volcanics.
- Maximum water table drawdowns of less than 2.6 cm are predicted at this location (AGE, 2020).
- Given these very minor predicted drawdowns it is considered unlikely that discharge from this feature would be significantly affected by the Project and/or the Narrabri Gas Project.
- Nevertheless, further regular visits are recommended to observe any changes to flow rates and surface conditions and to confirm whether this feature is groundwater dependent.
- Depending on the results of these visits, further ongoing groundwater and surface water monitoring may also be required to confirm predicted impacts.

3.2.2 Blairmore groundwater feature 2

- Blairmore groundwater feature 2 is located in an area where the older Napperby Formation is thought to be present at subcrop beneath the shallow regolith or colluvium mapped as being present at the surface.
- As shown in Figure 2.1 unlike Blairmore groundwater feature 1 this feature is not located on an existing drainage line but as shown Table 3.3 comprises a shallow water-filled depression within an area under cultivation.
- Furthermore, the vegetation (remnants of a planted crop) at the site are not considered to be indicative of a permanent feature.
- Whilst seepage was observed around the margins of the feature during the site visit on the 13 April 2021 it should be noted that substantial rainfall had occurred prior to the visit. Total rainfall at the nearby Baan Baa rain gauge during March 2021 was 142 millimetres (mm), compared to the monthly long term average for March of 40 mm.
- If this feature is groundwater dependent in any way it is considered likely that it is supported by groundwater discharging from perched near surface strata which are unlikely to be affected by extraction from the Narrabri Mine, the southern limit of which is more than 10 km to the north.
- Nevertheless, further regular visits are also recommended to this site to observe any changes to flow rates and surface conditions and to confirm whether this feature is groundwater dependent.
- Depending on the results of these visits, further ongoing groundwater and surface water monitoring may also be required.



LEGEND

- Mining Lease Boundary (ML1609)
- Proposed Narrabri Gas Project (Santos)
- Provisional Mining Lease Application Area

Solid geology (NSW seamless geology)

- (Qa) - Quaternary alluvium
- (K_k) - Keelindi beds
- (Jinp) - Pilliga Sandstone
- (J_p) -Purlawaugh Formation
- (J_g) - Garrawilla Volcanics
- (Tute) - Deriah Formation
- (Tutn) - Napperby Formation
- (Tutd) - Digby Formation
- (Pbj) - Black Jack Group
- (Pbb) - Brothers Subgroup
- (Pmiw) - Watermark Formation
- (Pmip) - Porcupine Formation
- (Pbem) - Maules Creek Formation
- (Pute) - Werrie Basalt
- (Putg) - Boggabri Volcanics

Impacted unit

- Arkarula Formation
- Garrawilla Volcanics
- Napperby Formation

Narrabri Stage 3 Extension GIA (G1972F)

Existing water supply bores where maximum predicted drawdown exceeds 2m

DATE 28/05/2021

FIGURE No: **3.1**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\G1972F.NarrabriStage3_Bore AppraisalNo3\3_GIS\Workspaces\001_Deliverable1\01.02_G1972F_Existing water supply bores where maximum predicted drawdown exceeds 2m.qgs

Table 3.1 Private bores predicted to experience more than 2 m of drawdown

Bore	Property name	Formation	Predicted maximum cumulative drawdown (m)	Water column length (m)	Percentage reduction in water column (%)	Timing of maximum drawdown (year)	Impairment assessment
House Bore	Towri	Garrawilla Volcanics	2.72	17.6	15%	2360	Relatively minor predicted drawdown which represents 15% of the available water column. Impairment of supply unlikely. Nevertheless, NCOPL is currently discussing further testwork, monitoring and make good provisions with the bore owner.
257_Bore	Wilga	Arkarula Formation and Pamboola Formation	12.61	36.5	35%	2043	Whilst up to 12.6 m drawdown is predicted the impacted standing water level is predicted to remain >20 m above the pump. Impairment of supply unlikely. Nevertheless, NCOPL is currently discussing further testwork, monitoring and appropriate make good agreements with the bore owner.
GW008634	South End	Garrawilla Volcanics/Napperby Formation	0.86 - 3.35	62.8	4-17%	2113	Relatively minor predicted drawdown which represents less than 17% of the available water column. Impairment considered unlikely. Nevertheless, NCOPL is currently discussing further testwork, monitoring and appropriate make good agreements with the bore owner.
GW013851	Nindethana	Garrawilla Volcanics	5.70	NA	NA	2191	Bore confirmed to be partially backfilled and un-useable.
GW013858	Nindethana (east)	Napperby Formation	10.93	17.71	62%	2055	Predicted drawdown represents up to 62% of the available water column. Impairment of supply considered likely. Make good provisions are currently being discussed with the bore owner.
GW026121	Nindethana (west)	Garrawilla Volcanics	4.57	4-8	57 - 100%	2191	Bore not in use and could not be accessed for assessment. However, the predicted drawdown represents over 50% of the available water column, even assuming the pump intake is at the bottom of the bore. Impairment of supply is therefore considered likely. Make good provisions are currently being discussed with the bore owner.
GW054227	(Terrence Hall, Cody's Bore)	Purlawaugh Formation	3.97	NA	NA	2113	Landholder has no knowledge of this bore and it could not be located on site. Assumed abandoned and destroyed.

Bore	Property name	Formation	Predicted maximum cumulative drawdown (m)	Water column length (m)	Percentage reduction in water column (%)	Timing of maximum drawdown (year)	Impairment assessment
Windmill Bore	Riverview	Napperby Formation	4.61	8.70	54%	2050	Predicted drawdown represents around 54% of the available water column. Impairment of supply is therefore considered likely. Make good provisions are currently being discussed with the bore owner.
South Caloola (Zoe)	South Caloola	Napperby Formation	5.46	4.71	100%	2067	Additional unregistered bore identified in recent bore census. Drawdown exceeding the standing water column is predicted and hence impairment of supply is considered likely. Make good provisions are currently being discussed with the bore owner.
GW903687 (Solar Bore)	Turra	Napperby Formation	5.62	11.3	50%	2050	Additional bore identified in recent bore census. Drawdown representing around 50% of the standing water column is predicted even assuming a pump could be installed at the base of the bore. Impairment of supply is therefore considered likely. Make good provisions are currently being discussed with the bore owner.
Mentone Bore	Mentone	Napperby Formation	13.11	6.5	100%	2050	Additional bore identified in recent bore census. Drawdown in excess of the standing water column is predicted even assuming a pump can be installed at the base of the bore. Impairment of supply is therefore considered likely. Make good provisions are currently being discussed with the bore owner.

Table 3.2 Blairmore potential groundwater feature 1 particulars

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Blairmore, David, Janet Watt		
Local bore name:	Blairmore Feature 1	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	774557	**Northing:**	6597554
Water usage			
Status:	In use	**Purpose:**	Stock
Water quality			
Sample method:	Grab sample	**Temp. (°C):**	10.16
Electrical Conductivity (µS/cm):	6,309 (13/04/2021, 8:10AM)	**pH:**	8.39

Laboratory sample obtained: Yes (13/04/2021, 8:10AM)

Comments: Probable groundwater discharge observed into natural drainage line or stream which then feeds into a constructed catchment dam. Presence of reed species around discharge point as well as the downstream dam suggests semi-permanent feature. Downstream dam (photo 1 below), recent rainfall presumably has contributed to flow and stored volume.

Photographic record:

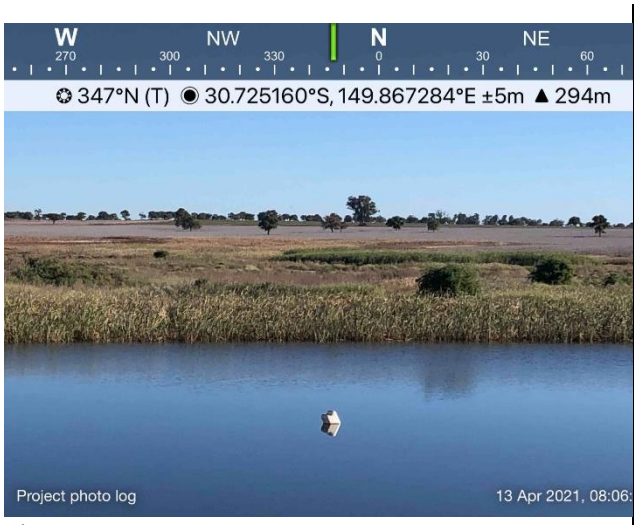


Photo 1

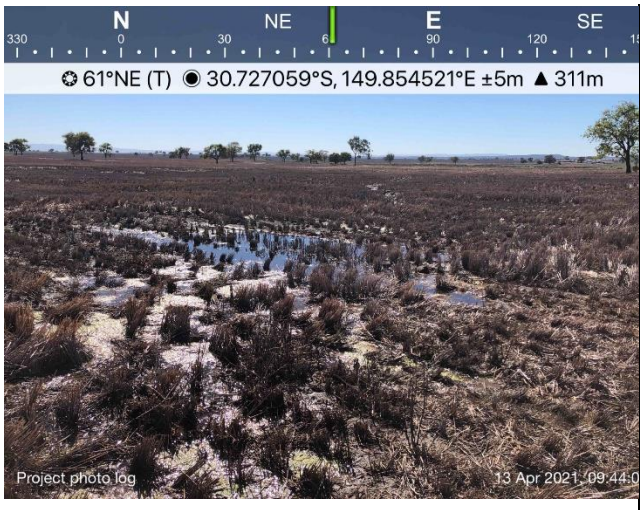
Photo 2

Table 3.3 Blairmore potential groundwater feature 2 particulars

Latest survey date:	13/04/2021	Survey Personnel:	PL+MV
Location, owner details and GW works number			
Property details:	Blairmore, David, Janet Watt		
Local bore name:	Blairmore Feature 2	**Ref No/GW Number:**	
Easting (GDA94 Zone 55):	773353	**Northing:**	6597177
Water usage			
Status:	In use	**Purpose:**	Stock
Water quality			
Sample method:	Grab sample	**Temp. (°C):**	11.5
Electrical Conductivity (µS/cm):	3,396 (13/04/2021, 9:45AM)	**pH:**	7.89
Laboratory sample obtained: No			

Comments: Shallow surface depression within cultivated area. Vegetation (planted crop) not indicative of a permanent feature and observed seepages and shallow ponded water may be related to recent heavy rainfall events.

Photographic record



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