Narrabri Gas Project
Response to Submissions

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Foreword

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Foreword

Santos is an Australian energy pioneer that has delivered natural gas to homes and businesses throughout Australia since 1954.

We are now seeking approval to develop the Narrabri Gas Project, which has the potential to supply enough natural gas to meet up to half of NSW's natural gas demand.

At a time when Australia needs more gas to meet demand and lower energy prices, the Narrabri Gas Project will deliver critical gas supplies to the NSW domestic market and support the more than 1 million homes, 33,000 businesses and 300,000 jobs that rely on natural gas as a source of energy.

The Narrabri Gas Project will also deliver around $1.2 billion in royalties directly to the NSW budget to help fund essential government services like health, transport and education. Locally, the project will provide around 1,300 jobs during construction, 200 ongoing jobs and a regional benefit fund of up to $120 million to invest in local community programs.

Natural gas power generation provides a clean source of continuous energy as ageing coal-fired plants are closed and is highly efficient and quick starting for times when wind and solar are not producing energy.

Coal seam gas is a clever way to extract energy from coal without mining, capturing the natural gas that may otherwise be released straight to the atmosphere if the coal was mined.

Operational facilities, including well sites, will have a low impact on the landscape taking up only 1 per cent of the project area and allowing existing activities to continue around them.

Key findings on the Narrabri Gas Project include:

- The project would not impact existing water users and would not have a significant impact on groundwater resources
- Drilling will be carried out safely using the NSW *Code of Practice for Coal Seam Gas Well Integrity* which has been reviewed by the NSW Chief Scientist and Engineer
- Significant impacts on threatened and endangered flora and fauna will be avoided
- Aboriginal cultural heritage sites will be protected
- The project will coexist with current land uses including agriculture and forestry

This response to submissions on the Environmental Impact Statement is the next step in the comprehensive NSW government assessment process and confirms the Narrabri Gas Project can be developed safely and sustainably.

Santos is confident it has the track record and expertise required to safely and sustainably develop the Narrabri Gas Project and deliver clean energy to NSW for many years to come.

Kevin Gallagher
Managing Director and Chief Executive Officer
Santos Ltd

Executive summary

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Executive Summary

Santos NSW (Eastern) Pty Ltd (the proponent) on behalf of its joint venture participants, propose to develop natural gas in the Gunnedah Basin about 20 kilometres south-west of the town of Narrabri, NSW. This would include the progressive installation of up to 850 new gas wells on up to 425 new well pads over approximately 20 years and the construction and operation of gas processing and water treatment facilities. These activities are described as the Narrabri Gas Project, or simply, the project.

Why is the project needed

The NSW Government has recognised the need to secure its future gas supplies through the development of an onshore gas industry in NSW. The *NSW Gas Plan* provides the framework for the regulation and management of the energy sector. The Narrabri Gas Project is identified as a Strategic Energy Project in the *NSW Gas Plan*.

The project has the potential to supply up to 200 terajoules of natural gas per day; which is sufficient gas to meet up to half of NSW's natural gas demand. This is the natural gas that heats and powers more than one million family homes in NSW and fuels some 33,000 businesses. About 500 heavy industrial users consume approximately 75 per cent of the gas supplied to NSW and it is estimated that about 300,000 jobs rely on a safe and secure supply of natural gas. The gas would be made available for the NSW market to optimise the opportunities for the use of gas as a source of energy including via a high-pressure gas transmission pipeline which would connect to the existing Moomba to Sydney gas pipeline.

Since the release of the Narrabri Gas Project Environmental Impact Statement (EIS), the Australian Energy Market Operator (AEMO) has released an update to its 2017 *Gas Statement of Opportunities* where the predictions for gas shortfalls was significantly increased. AEMO stated:

> *"In real terms and based on no further response to today's information, the projected shortfall risk for 2018 is between 54 petajoules (PJs) to 107 PJs, and in 2019 between 48 PJs to 102 PJs. To put this into context, total projected demand for domestic gas is expected to be approximately 642 PJs in 2018, and 598 PJs in 2019."*

The Australian Competition and Consumer Commission also confirmed this outlook in their *Gas Inquiry 2017-2020 Interim Report* released in September 2017. The updated outlook increases the urgency for additional new gas supplies.

Public exhibition of Environmental Impact Statement

In February 2017, the EIS for the project was submitted to the NSW Department of Planning and Environment for consideration (development application number SSD 14_6456). The EIS was placed on public exhibition for 90 days from 21 February to 22 May 2017. During this period, the community, interest groups, key stakeholders, local Councils and relevant Government departments were invited to provide submissions on the project for consideration by the Department of Planning and Environment as part of the planning process.

Ongoing consultation with community and other stakeholders

Community and stakeholder engagement activities associated with the submission of the EIS have been undertaken from late January 2017. Activities were undertaken in consultation with the Department of Planning and Environment as the Department hosted an extensive community engagement and information program in the local area in relation to the EIS process.

Consultation has also been undertaken with relevant local, State and Commonwealth Government authorities, infrastructure and service providers, community groups and affected landowners. The project's Community Consultative Committee also remains a key forum to ensure comprehensive and representative community engagement. The NSW Land and Water Commissioner chairs the Committee, which generally meets monthly, with membership comprising elected representatives of community groups and agricultural industry representatives that have a large membership base and broad representation of the local community. At the time of writing, ten Committee meetings have been held since January 2017. Representatives from the Department have also been regularly attending the meetings to provide updates through its members to the broader community.

Submissions overview

The Department of Planning and Environment received 23,007 submissions and it categorised them by submission type (Government Agency, special interest groups, organisations and individuals) as well as, for the individual submissions, either being a 'form letter' or 'unique' submission The Department of Planning and Environment assigned each submission a unique submission number and published them on its website.

There were 17 submissions received from Government Departments and institutions at the Federal, State and local levels, 101 from special interest groups and 33 from organisations. There were in the order of 6,000 online website submissions from individuals.

The majority of the submissions were form letter submissions from individuals. Form submissions contain pre-written text and are submitted independently, with or without additional text, by a large number of individuals. About 16,500 form submissions were received.

Submissions were received from across Australia, including approximately:

- 17,000 from New South Wales
- 2,000 from Queensland
- 500 from Western Australia
- 300 from South Australia
- 300 from the Australian Capital Territory
- 150 from Tasmania
- 100 from the Northern Territory.

Around 200 submissions were received from international locations while approximately 3,000 submissions were either submitted anonymously or without postcode details.

The majority of submissions received (98 per cent) expressed objection to the project while the remaining submissions either expressed support (1 per cent) or made neutral comments (1 per cent). The significant number of form letters had a large influence on overall support.

Around one third of all submissions from the Narrabri local government area were in support of the project. When the influence of form submissions was removed, support for the project in the Narrabri local government area was around 58 per cent.

Response to submissions report

To prepare this Response to Submissions (RTS), the submissions were reviewed and issues raised requiring a response were identified and considered.

The most commonly raised issues related to groundwater and geology; followed by issues relating to terrestrial ecology. Other issues frequently raised in submissions concerned the strategic context and need for the project (mainly associated with a general opposition to fossil fuels); social and health impacts; waste management; Aboriginal heritage and landscape and visual matters (primarily in relation to the potential for lighting impacts to affect the operations of the Siding Spring Observatory, which is located to the south of the project near Coonabarabran). The content of the form letters had a significant influence on the number of times a particular issue was recorded as being raised.

The RTS addresses the issues by subject matter, consistent with the chapter headings in the EIS. Submissions from Government Agencies have been addressed separately and individually and are set out in Chapter 5.

To assist in providing responses to the issues raised in submissions three areas of additional assessment activities have been undertaken. These are in relation to terrestrial ecology, air quality and landscape and visual impacts (lighting). The results of the additional assessments remained consistent with the findings of the EIS.

For terrestrial ecology the additional studies described below were undertaken and are included in the RTS as Appendices E, G and H respectively.

Appendix E - Box Gum Woodland analysis: In summary, Box Gum Woodland was found not to be present in the project area and it is considered likely that *Eucalyptus melliodora* (Yellow Box) either does not occur in the study area, or occurs at such a low abundance to be meaningless in terms of plant community composition.

Appendix G - Supplementary Biometric plots: The number of plot-based floristic surveys for some Plant Community Types presented in the EIS was less than required under the *Framework for Biodiversity Assessment* for a number of reasons including land access restrictions at the time of survey, pooling of derived native grassland data due to the same broad condition state and changes to underlying PCT / Biometric Vegetation Types which occurred in 2014. In response to submissions, an additional nine Biometric Vegetation Plots were surveyed and this data will be provided to the Office of Environment and Heritage as part of the ongoing development of the Biodiversity Offset Strategy for the project. The data from the plots has informed updates to the Biodiversity Offset Strategy in Appendix F of this RTS.

Appendix H - Supplementary targeted survey for *Lepidium aschersonii* and *Lepidium monoplocoides:* Modelling for threatened flora populations *Lepidium aschersonii* and *Lepidium monoplocoides* was not undertaken for the EIS assessment due to insufficient records and poor seasonal conditions during the surveys in which they were detected. To improve the knowledge of the distribution and extent of these species within the project area, targeted surveys for both species were undertaken in October 2017. The surveys found both species to be more prevalent than was estimated. The upper disturbance limits have been revised for both species however there is no change to the underlying assessment of impact to these species that was included in the EIS. The revised upper limits are still well below the assessed limit reflecting a conservative approach.

In relation to air quality, the EPA's updated assessment guidelines were gazetted in late January 2017. This was after the finalisation of the Air Quality Impact Assessment for the EIS but a few days prior to the submission of the EIS. Although the Air Quality Impact Assessment met the EIS requirements through its use of the previous guidelines, a supplementary assessment was undertaken against the revised guideline, including revised criteria for some pollutants. The supplementary assessment also presents the air quality modelling results for the additional $PM_{2.5}$ criteria and a further range of pollutants. Consistent with the findings of the EIS assessment, the impact assessment criteria would be met for all pollutants at all locations beyond the boundaries of the major facilities and at the boundary of well sites.

The Air Quality Addendum is contained at Appendix I.

In response to concerns raised in submissions regarding the potential for the project to impact on the operations of the Siding Spring Observatory, an assessment of the potential for light impacts from the use of the pilot and safety flares was commissioned. In summary, the assessment found that the light generated during routine and non-routine flaring scenarios would result in limited vertical light impacts and would not make a contribution to skyglow conditions at the reference location used in the Department of Planning and Environment's *Dark Sky Planning Guidelines.* Thus the use of pilot and safety flares for the project would have a negligible impact on the Observatory's operations.

The Gas Flare Light Assessment is contained at Appendix K.

In addition, the Water Baseline Report has been revised and updated to reflect additional water monitoring data collected up to July 2017 and to provide information on the characteristics of produced water, treated water and the brine following successful commissioning of the Leewood Water and Brine Treatment Plant in mid-2016. The updated Water Baseline Report is contained at Appendix D.

Conclusions from this report

At completion of the RTS, and in consideration to the additional assessment activities undertaken, from the project remains consistent with what was described in Chapter 6 (Project description) of the EIS. Results of the additional assessment activities confirmed the overall low environmental and social impacts of the project as assessed in the EIS, with manageable residual risk.

In reviewing the project commitments after consideration of the submissions, the proponent has added a commitment in respect of the development and implementation of a Social Impact Management Plan. Additionally, clarification has been made to the project commitment relating to the surface development exclusion zone that applies to Yarrie Lake for the project. Yarrie Lake reserve is defined as the following land: Lot 51, DP 43308; Lot 52, DP 43308 and Lot 53, DP 43308. It is a designated surface development exclusion zone (plus a buffer of at least 50 m) for the project. No surface infrastructure will be located within the Yarrie Lake reserve, or the 50 m buffer area. The updated schedule of project commitments is set out in Appendix B.

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Chapter 1 Introduction

1.1 Overview

In February 2017, the Environmental Impact Statement (EIS) for the Narrabri Gas Project (the project) was submitted to the NSW Department of Planning and Environment for consideration as part of development application number SSD 14_6456.

Consistent with requirements under the NSW *Environmental Planning and Assessment Act 1979*, the EIS was placed on public exhibition from 21 February to 22 May 2017, during which period the Department of Planning and Environment received 23,007 submissions.

Submissions were received from a wide range of stakeholders including government institutions, special interest groups, organisations and individuals.

The proponent (Santos) is now required to respond to the submissions. This response to submissions report (RTS) summarises the submissions and responds to the issues raised.

The structure and contents of the RTS reflect the draft guideline *Responding to Submissions* (NSW Department of Planning and Environment 2017).

The RTS will be considered in the determination of the project under the NSW *Environmental Planning and Assessment Act 1979*.

1.2 Report structure

The structure and content of the RTS is as follows:

- Chapter 1 provides an overview of the RTS as it relates to the EIS and legislation.
- Chapter 2 summarises activities during public exhibition of the EIS, including:
  - Consultation undertaken by the proponent
  - An explanation of the submissions process required under the legislation
  - Additional project definition and assessment work undertaken post EIS lodgement.
- Chapter 3 describes how submissions were managed and analysed by the proponent and provides a statistical summary of the submissions received, including:
  - Submissions by stakeholder and type
  - Submissions by geographical location
  - Submissions by support for the project
  - Summary of key issues raised in submissions.
- Chapter 4 provides an overview of the project description and further developments that have occurred following the production and public exhibition of the EIS.
- Chapter 5 responds to submissions from Government Agencies with the issues raised in each submission responded to individually.
- Chapter 6 responds to submissions from special interest groups, organisations and individuals, with issues grouped and responded to collectively.
- Chapter 7 provides a conclusion and evaluation of the project in light of issues raised.
- Chapter 8 provides the references cited in this document.

Chapter 2 EIS public exhibition

2.1 Consultation activities

2.1.1 Background

In July 2013, the proponent announced that the focus of the company's operations in NSW was to be in PEL 238. They announced that they were seeking approval for a more focused exploration and appraisal program targeting areas in and around the Pilliga Forest to ascertain the commercial and technical viability of the project, and had commenced activities to inform the preparation of an Environmental Impact Statement (EIS).

Due to the extensive community consultation activities undertaken in relation to the submission of the project EIS, a Stakeholder and Community Engagement Plan was developed to support the delivery of this program and is revised from time to time to reflect progression in project deliverables. The plan is complementary to the broader PEL 238 Community Consultation Plan and focuses on the commitment to stakeholder and community engagement activities for the Project EIS.

The aim of the consultation activities has been to:

- Engage with landholders, community members and other key stakeholders regarding the project and the development of the EIS.
- Identify potential issues.
- Minimise the risk of conflict.
- Provide additional information in relation to proposed activities such that wider community awareness and understanding is achieved and issues are resolved early in the planning process.

The proponent consults on, and provides regular updates to, stakeholders on activities being undertaken within the project area including:

- Petroleum exploration and appraisal activities.
- Environment studies and activities.
- Community activities.
- Specific projects.
- Future planned work and tenure development.
- EIS progress.
- Other initiatives and industry news.

Chapter 9 and Appendix D of the EIS describe the extensive consultation undertaken prior to lodgement of the EIS. Post EIS lodgement activities are described below.

2.1.2 Consultation tools

A range of consultation tools and activities have been used to provide multiple opportunities for both targeted stakeholder and the wider community to participate and comment on the project as summarised in Table 2-1.

Table 2-1 Consultation tools

Consultation tools	Description of activity
Community Information Sessions	• Information sessions for particular stakeholder groups to provide information on proponent activities and ensure potential issues are identified and resolved. • Specific forums for landholders, Leewood neighbours, the Aboriginal Community, Contractors and Suppliers, and publicly advertised community information events.
Community Consultative Committee	• The NSW Land and Water Commissioner chairs the committee which includes representatives from key industry and community organisations.
Email and telephone	• A generic email address and 1800 telephone number is included on all printed material to ensure the community can seek information on work program activities and provide feedback.
Website	• The proponent maintains a project website regularly updated with current information and promoting forthcoming activities. • It includes a feedback component where visitors to the site can email questions through (after registering).
Brochures and fact sheets	• A brochure and series of fact sheets are available to support consultation activities and provide further information on activities.
Activity Update Reports	• A monthly activity update for the project area is prepared and emailed to key stakeholders and interested parties. • The updates are disseminated by representative bodies and entities to their members and associates.
Media Updates	• The proponent provides information through print media including advertisements, advertorials, and media releases on key announcements. • The proponent maintains a Facebook and Twitter page to provide information through social media channels. • Updates on proponent activities are provided at least monthly through advertisements in the local Narrabri Courier newspaper.
Shopfronts	• Shopfronts are open during business hours and have printed information and displays aimed to build awareness and understanding of project objectives.
Community Site Tours	• Community Site Tours to visit operational sites in PEL 238 are scheduled for the third Thursday of each month. Tours are advertised in the Narrabri Courier newspaper, Activity Update Reports, on the website and at Community Consultative Committee meetings. • Other site tours are provided upon request from interested community groups and other stakeholders.
Face to face meetings	• Regular meetings are scheduled with key stakeholders to provide information and opportunity for potential issues to be raised and addressed.

2.1.3 Post EIS lodgement consultation

Community engagement activities from late January 2017 have focussed on providing information to the community relating to the preparation and submission of the State Significant Development Application and associated EIS for the project. The development application was submitted to the NSW Department of Planning and Environment on 1 February 2017.

Key outcomes of ongoing community consultation and engagement have been:

- Raised awareness of the project; that the EIS was submitted to DPE in February 2017; and the various avenues for the community to view the document and make a submission during the public exhibition period.
- Raised awareness of the information contained within the EIS document and provided access to technical specialists to assist in understanding and interpreting this information.
- Strengthened relationships with stakeholders, decision makers, potential champions and opponents to the project.
- Implemented strategies to assist managing and minimising the risk of conflict, and resolved issues as they arose.
- Provided timely, accurate and credible information to stakeholders and the broader community; and provided opportunities for interaction and feedback.
- Facilitated positive Aboriginal cultural heritage outcomes by consulting with relevant parties and encouraging them to participate in decision making regarding the management of their cultural heritage.

Activities were undertaken in consultation with DPE to minimise duplication as the DPE also hosted an extensive community engagement and information program in the local area in relation to the EIS process. Representatives from DPE have also been regularly attending the Community Consultative Committee to provide updates to members and the broader community.

Consultation has been undertaken with relevant local, State and Commonwealth Government authorities, infrastructure and service providers, community groups and affected landowners.

Activities have been undertaken to provide effective and genuine community consultation on the project and the information contained within the EIS. Community information sessions and other consultation tools and activities have been utilised to proactively provide information to key stakeholders and the community to assist in understanding the project and respond to issues of concern.

There has been an extensive program of community engagement and consultation in relation to the project since July 2013. The effectiveness of the ongoing program is demonstrated by the increased understanding and diminished concern within the local community for the project, and an increased awareness of the potential impacts and benefits of the project. As the program has been in place for a relatively long period, consultation activities specifically for the EIS have been integrated as extensions and enhancements to the ongoing program.

A summary of post EIS lodgement consultation activities is shown in Table 2-2.

The project's Community Consultative Committee remains a key forum to ensure thorough and representative community engagement in PEL 238. The NSW Land and Water Commissioner chairs the Committee, with membership comprising elected representatives of community groups and agricultural industry representatives that have a large membership base and broad representation of the community throughout PEL 238. State and Local Government representatives and senior staff from the proponent are also on the Committee. At the time of writing, ten Committee meetings had been held since January 2017. Copies of the Communiques, Monthly Activity Updates, Committee newsletters and monthly presentations from the meetings are available at https://narrabrigasproject.com.au/community/consultative-committee/.

Table 2-2 Post EIS lodgement consultation activities

Consultation type	Number of events	Approx. number of participants
Shopfront visitors	Approx. 650	—
Website (page views)	27,500	—
Calls to 1800 Number	2	—
Generic Email:	—	—
General enquiries	4	—
Employment enquiries	2	—
Contract / supply enquiries	4	—
Site tour enquiries	3	—
Land access enquiries	0	—
Corporate social responsibility requests/enquiries (e.g. sponsorships)	5	—
Positive feedback	1	—
Negative feedback	1	—
Activity Updates sent directly to stakeholders	10	300/month
Fact Sheets and brochures distributed (general)	>1,000	—
Fact Sheets distributed (EIS specific, including letterbox drop Narrabri area)	>7,000	—
Advertisements, media articles, interviews, LTE's and published activity updates	Approx. 25	—
Field visits, Site Tours and Information Sessions:	—	—
Community Information Sessions (EIS specific)	7	100
Letters and emails to stakeholders (EIS specific)	>700	—
Telephone calls to stakeholders (EIS specific)	>350	—
Community Site Tours	6	30
Aboriginal community meetings and site tours	8	70
Specific group tours (e.g. community groups, clubs, Government, media, industry partners)	14	150
Landholders	15	46

Consultation type	Number of events	Approx. number of participants
Contractor and Vendor Forum	2	85
Community events with staffed display	2	250
Community Consultation Committee Meetings	8	20 members
Meetings with Federal, State and Local Government representatives	>200	—

The CSIRO, through the Gas Industry Social and Environmental Research Alliance (GISERA) NSW, has undertaken research in the Narrabri local government area in relation to community expectations and perceptions of coal seam gas. Part of their research describes how community members source information about the project. The research report states that four main ways of learning were identified in the data including: sourcing information on the internet; word of mouth and talking to people in their social network; attending information sessions hosted by service clubs, the proponent and/or local Chambers; and attending a site visit. For many participants 'seeing was believing', with site visits proving to be a very effective way of becoming more informed about the industry and understanding "what was going on" (Walton *et al.* 2017). The proponent has hosted around 35 operational site visits since January 2017, comprising greater than 150 participants in total.

A recent GISERA survey identified that 42.1 per cent of survey participants gathered information from industry sources and 26.8 per cent from attending a site visit to proponent facilities (Walton and McCrea 2017). The research found that people who reported a higher self-rated knowledge of the industry had lower perceptions of concern towards natural gas development, and that residents of Narrabri and surrounds held significantly more positive views than those from Wee Waa or Boggabri. At one end of the spectrum, 30 per cent of residents indicated they 'reject' gas development in the Narrabri Shire, while at the other end of the spectrum 15 per cent of residents indicated that they 'embrace' it. However, of the remaining respondents (55 per cent) indicated they would either tolerate (27 per cent), be ok with (15 per cent), or approve of (13 per cent) gas development in the Shire.

2.2 Submissions process

The submissions process for the project is prescribed under the *Environmental Planning and Assessment Act 1979* and associated statutory guidelines.

The submissions process depicted in Figure 2-1 (NSW Department of Planning and Environment 2017) and includes public exhibition of the EIS, analysis and response to public submissions and determination of the project.

In accordance with the submissions process, the EIS was submitted to the Department of Planning and Environment for consideration as part of development application number SSD 14_6456 and subsequently placed on public exhibition from 21 February to 22 May 2017 in accordance with Section 89F (now Schedule 1, Section 9) of the *Environmental Planning and Assessment Act 1979*.

It is noted that the 90 day public exhibition period was an additional 60 days to the minimum 30 day period that was required under the *Environmental Planning and Assessment Act 1979*.

During public exhibition, submissions were made by mail, email or via an online form to the Department of Planning and the Environment. 23,007 submissions were made by stakeholders including government institutions, special interest groups, organisations and individuals.

The proponent is now required to respond to the submissions. This report summarises the submissions and responds to the issues raised.

Submissions received on the EIS are summarised in Section 3 and responded to in Section 4 and Section 5 of this report. The Department of Planning and Environment is required to consider the submissions in a determination of the development application.

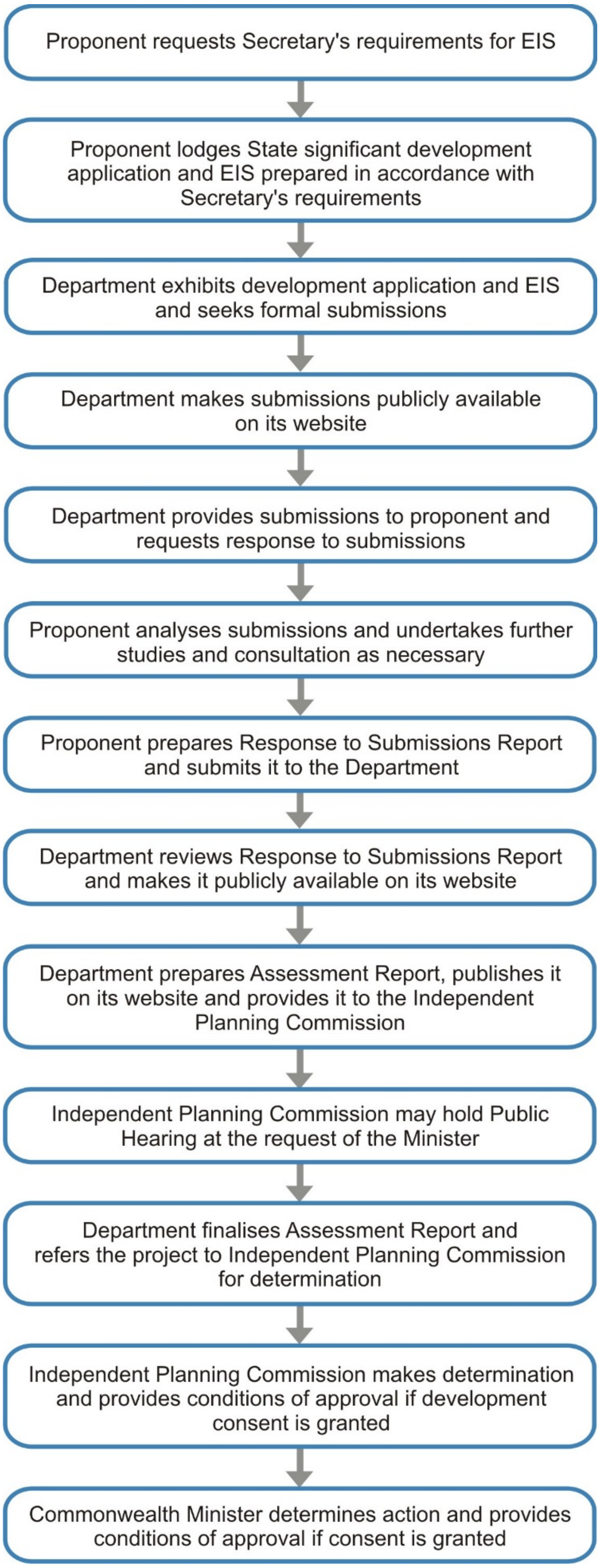


Figure 2-1 Response to submissions and assessment process

2.3 Additional assessment activities

Since the lodgement of the EIS, additional assessment activities have been undertaken to assist with responding to submissions. These include assessments in relation to terrestrial ecology, air quality and landscape and visual impacts. These additional assessment activities are discussed below.

2.3.1 Terrestrial ecology

In response to submissions on terrestrial ecology as part of the EIS, the following additional studies have been undertaken and are included as appendices to the RTS:

- Box Gum Woodland analysis (Appendix E).
- Supplementary Biometric plots (Appendix G).
- Supplementary targeted survey for *Lepidium aschersonii* and *Lepidium monoplocoides* (Appendix H).

A brief overview of each of these is included below.

Box Gum Woodland analysis

Submissions on the EIS for the project claimed that Box Gum Woodland was present in the project area.

The Box Gum Woodland analysis report presents an assessment as to whether White Box Yellow Box Blakely's Red Gum Woodland / White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland occurs within the project area. This ecological community is listed as an Endangered Ecological Community (EEC) under the New South Wales (NSW) *Biodiversity Conservation Act 2016* (BC Act) (formerly NSW *Threatened Species Conservation Act 1995* (TSC Act)) and as a Critically Endangered Ecological Community (CEEC) under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Collectively they are commonly referred to as 'Box Gum Woodland'.

A detailed analysis from vegetation plots located in vegetation dominated or co-dominated by *Eucalyptus blakelyi* (Blakely's Red Gum) was analysed and compared to the NSW Scientific Committee Final Determination under the BC Act and the listing advice and policy statement for the community under the EPBC Act. This analysis included a review of literature cited in the Final Determination and listing advice, and compares field data vegetation plots with the list of characteristic species in the Final Determination. It also included an assessment of soil and geology, landscape and vegetation mapping data with reference to other vegetation mapping projects and the literature cited in the Final Determination and EPBC Act listing advice. This analysis was further supported by an inspection at 25 sites across seven discrete locations along Bohena Creek seeking to determine the presence or absence of *Eucalyptus melliodora* (Yellow Box).

Box Gum Woodland was found not to be present in the project area because the assemblage of species and soil type was not consistent with that found in the Final Determination (BC Act), listing advice (EPBC Act) and relevant literature. Furthermore, following targeted searches along the length of Bohena Creek, it is considered likely that *Eucalyptus melliodora* either does not occur in the study area, or occurs at such a low abundance to be meaningless in terms of plant community composition.

Supplementary Biometric plots

Submissions on the EIS for the project identified that the number of plot based floristic surveys for some Plant Community Types is less than required by the *Framework for Biodiversity Assessment*.

The number of plot based floristic surveys for some Plant Community Types was less than required under the *Framework for Biodiversity Assessment* for a number of reasons including land access restrictions at the time of survey, pooling of derived native grassland data due to the same broad condition state and changes to underlying Plant Community Types / Biometric Vegetation Types which occurred in 2014.

In response to submissions, an additional nine Biometric Vegetation Plots have been surveyed and this data will be provided to OEH as part of the ongoing development of the Biodiversity Offset Strategy for the project. The supplementary biometric plots are mapped in Appendix G of this RTS. The data from the plots has informed updates to the Biodiversity Offset Strategy with the relevant data reproduced in Appendix D to Appendix G of this RTS.

Supplementary targeted survey for Lepidium aschersonii and Lepidium monoplocoides

Submissions on the EIS for the project requested further information on how impacts to *Lepidium aschersonii* and *Lepidium monoplocoides* had been calculated.

As part of the EIS a threatened flora modelling report was prepared to investigate threatened flora populations in the North-east Pilliga Forest, Appendix F4 of Appendix J1 of the EIS. The scope of the study was to provide statistically robust modelled estimates of population size and distribution, and outline habitat requirements for threatened flora populations in order to adequately address the potential impacts of the project. Modelling for *Lepidium aschersonii* and *Lepidium monoplocoides* was not undertaken at this time due to insufficient records and poor seasonal conditions during the surveys in which they were detected.

To improve the knowledge of the distribution and extent of these species within the project area, targeted surveys for both species were undertaken between 23 and 27 October 2017. Population estimates were developed based on the total area of potential habitat for each species within the project area, the proportion of habitat occupied and the average density of plants per square metre.

Upper disturbance limits for each species were revised by assessing the total area of habitat impacted by the project, the proportion of habitat occupied and the average density of plants per square metre. The revised upper disturbance limit for *Lepidium aschersonii* is 77,691 which represents 0.94 per cent of the total population estimated within the project area. The revised upper disturbance limit for *Lepidium monoplocoides* is 1,116 which represents 0.51 per cent of the total population estimated within the project area. Both limits are well below the proportional impact of 1.55 per cent assessed in the EIS. The upper disturbance limits to these species are considered conservative and do not change the underlying assessment of impact to these species contained in the EIS.

2.3.2 Air quality

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005) (Approved Methods), The *Approved Methods* were subsequently revised (NSW EPA 2017) following completion of the air quality impact assessment.

An Air Quality Addendum has been prepared that interprets the results of the Air Quality Impact Assessment against the revised *Approved Methods* (NSW EPA 2017) and contains further discussion of the results of the Air Quality Impact Assessment for the purpose of the RTS. It found that the project would continue to comply with the relevant criteria under the *Approved Methods*. The addendum is provided as Appendix I.

2.3.3 Landscape and visual

Additional assessment was undertaken to assess the potential for light from the project to affect observing conditions at Siding Spring Observatory with reference to the *Dark Sky Planning Guideline: protecting the observing conditions at Siding Spring* (Department of Planning and Environment 2016).

The assessment included light surveys at the Siding Spring Observatory and at the existing flares operating for Narrabri exploration and appraisal activities. The survey results together with skyglow modelling were used to determine the impact of both the routine and non-routine flaring activities proposed for the project.

The assessment found that the proposed flaring operations during both routine and non-routine scenarios would result in limited vertical light impacts, well below the 30^0 reference point in the Guideline. A non-routine event requiring maximum throughput of gas to the safety flare would result in the maximum contribution to skyglow. In this event the light would reach natural skyglow levels at a maximum of 7.4^0 above the horizon during cloudy conditions. Thus, the project would not make a contribution to skyglow conditions at the 30^0 reference location used in the Guideline and would have negligible impact on the Observatory's operations. The assessment is provided as Appendix K to this RTS.

Chapter 3 Submissions summary

3.1 Overview of submissions

23,007 submissions were received during the public exhibition period from 21 February to 22 May 2017. The submissions were sent though a number of channels including:

- Web form on a dedicated website
- Email to a dedicated project address
- Hard copy to the NSW Department of Planning and Environment.

Submissions were received from a wide range of stakeholders including government institutions, special interest groups, organisations and individuals.

The majority of the submissions were received from individuals and adopted the format of a form submission. Form submissions are essentially pre-written submissions that are distributed and then submitted independently from a large number of individuals. In the order of 16,500 form submissions were received. Additionally, in the order of 6,000 online submissions were made by individuals, many of which were unique, though many of which also incorporated content from the form submissions.

The remaining submissions comprised those from 33 organisations, 101 special interest groups and 17 government institutions at the federal, state and local levels, being:

- Australian Rail Track Corporation
- Australian Astronomical Observatory
- NSW Department of Primary Industries
- NSW Division of Resources and Geoscience
- NSW Environment Protection Authority
- Forestry Corporation of NSW
- Heritage Council of NSW
- NSW Local Land Services
- NSW Health
- NSW Office of Environment and Heritage
- NSW Rural Fire Service
- NSW Roads and Maritime Services
- Transport for NSW
- Gilgandra Shire Council
- Gunnedah Shire Council
- Narrabri Shire Council
- Warrumbungle Shire Council

3.2 Submissions management

Submissions received by the NSW Department of Planning and Environment were collated and categorised as being from an agency, special interest group, organisation or individual. Submissions from individuals were further categorised as being either a form submissions or a unique submission. Each submission was assigned a unique submissions number by the NSW Department of Planning and Environment.

The proponent received the submissions from the NSW Department of Planning and Environment and analysed and classified them according to the issues that were raised. The submissions and issues raised were classified by issues and sub-issues. This classification enabled the proponent to gain an overview of the issues that were of most importance to submitters.

The issues in the classification system were based on the chapters of the EIS while sub-issues were identified through the analysis of the submissions. The issues and sub-issues that made up the submissions classification system are shown in Table 3-1.

Table 3-1 Submissions classification system

Primary classification	Secondary classification
Chapter 1 Introduction	All
Chapter 2 Location and setting	All
Chapter 3 Strategic context and need	Further development
	Renewables
	Need for gas
Chapter 4 State legislation and approvals	EP&A Act
	Other State legislation
	Gas export pipeline
Chapter 5 Commonwealth requirements	All
Chapter 6 Project description	Infrastructure design and maintenance
	Rehabilitation
	Decommissioning
	Well construction and integrity
	Roads — construction access and maintenance
	Employment
	Fracture stimulation
Chapter 7 Produced water management	Quality and quantity
	Treatment
	Disposal
Chapter 8 Assessment of alternatives	All
Chapter 9 Community and stakeholder consultation	All
Chapter 10 Approach to the impact assessment	Risk assessment
	Field Development Protocol
Chapter 11 Groundwater and geology	EPBC Act
	Great Artesian Basin
	Baseline data
	Groundwater model
	Groundwater impacts
	Monitoring
Chapter 12 Surface water quality	Baseline data
	Beneficial reuse
	Managed release
	Surface water quality impacts
Chapter 13 Hydrology and geomorphology	Flooding
	Creek crossings
Chapter 14 Soil and land contamination	Baseline data
	Erosion and sedimentation

Primary classification	Secondary classification
	Spills or leaks
	Soil quality
Chapter 15 Terrestrial ecology	Flora and fauna baseline data
	Flora and fauna impacts
	Offsetting
Chapter 16 Aquatic ecology	Baseline data
	Aquatic ecology impacts
	Groundwater dependant ecosystems
	Stygofauna
Chapter 17 Property and land use	Public land
	Private land
	Crown land
Chapter 18 Air quality	Baseline data and assessment method
	Air quality impacts
	Management and monitoring
Chapter 19 Noise and vibration	Baseline data and assessment method
	Noise and vibration impacts
	Management and monitoring
Chapter 20 Aboriginal heritage	Baseline data and assessment method
	Aboriginal heritage impacts
	Management and monitoring
Chapter 21 Historic heritage	All
Chapter 22 Traffic and transport	Baseline data and impact assessment
	Management and monitoring
	Intersection upgrades
Chapter 23 Landscape and visual	Siding Spring Observatory
	Landscape and visual impacts
Chapter 24 Greenhouse gas	Assessment methodology
	Greenhouse gas emissions
Chapter 25 Hazard and risk	Bushfire
	Chemicals
	Assessment methodology
	Potential impacts
Chapter 26 Social and health	Assessment methodology
	Social impacts
	Health impacts
Chapter 27 Economics	Cost benefit analysis
	Regional economic assessment
	Investment risk
Chapter 28 Waste management	Drill cuttings

Primary classification	Secondary classification
	Salt
	General waste
Chapter 29 Cumulative impacts	Assessment methodology
Chapter 30 Environmental management and monitoring	Management plans
	Monitoring and audit
Chapter 31 Project commitments	All
Chapter 32 Justification and conclusion	Ecologically sustainable development

3.3 Submissions statistics

3.3.1 Submissions by type

23,007 submissions were received on the project and subsequently collated, analysed and classified. Of this total, 17 were from agencies, 102 were from special interest groups, 33 were from organisations, and 6,211 were classified as unique submissions from individuals or organisations.

The remaining 16,644 submissions, about 70 per cent of the total, were identified as form submissions. The NSW Department of Planning and Environment identified eight main variations of form submissions and classified them as Form 1 through 8. Minor variations within those form letters were denoted alphanumerically as Form 1A and Form 1B or Form 2A and Form 2B, for example.

Submissions by submission type are quantified in Table 3-2.

Table 3-2 Submissions by type

Submitter	Submission type	Count	Percentage
All submissions	—	23,007	100%
Agency	—	17	0.1%
Special interest groups	—	102	0.4%
Organisation	—	33	0.1%
Individual	Unique	6,211	27.0%
	All Forms	16,644	72.3%
	Form 1A	5,365	23.3%
	Form 1B	1,204	5.2%
	Form 2A	4,349	18.9%
	Form 2B	1,730	7.5%
	Form 2C	59	0.3%
	Form 2D	3	<0.1%
	Form 3A	3,288	14.3%
	Form 3B	152	0.7%
	Form 3D	123	0.5%
	Form 3E	21	0.1%
	Form 4A	50	0.2%
	Form 5A	68	0.3%
	Form 6A	107	0.5%
	Form 6B	22	0.1%
	Form 6C	57	0.2%
	Form 6D	6	<0.1%
	Form 7A	7	<0.1%
	Form 7B	3	<0.1%
	Form 7C	4	<0.1%
	Form 8A	11	<0.1%
	Form 8C	15	0.1%

3.3.2 Submissions by support

Some level of opposition is typical of the planning and assessment phase of a major project and does not necessarily represent general public opinion. In fact, the public exhibition of a project is intended to be an opportunity to raise objections or concerns regarding the assessment of the project.

The majority of submissions received (98 per cent) expressed objection to the project while the remaining submissions either expressed support (1 per cent) or made neutral comments (1 per cent).

As discussed in Section 3.1, the majority of submissions received were pre-written form submissions expressing opposition to the project. As such, these form letters had a large influence on overall support.

Support in the Narrabri local government area, as the local region of the project, was substantially greater with around 33 per cent of submissions supporting the project. When the influence of form submissions was removed, support in the Narrabri local government area was a majority at 58 per cent.

3.3.3 Submissions by origin

Submissions were received from across Australia, including approximately:

- 16,600 from New South Wales
- 2,000 from Queensland
- 1,700 from Victoria
- 500 from Western Australia
- 300 from South Australia
- 300 from the Australian Capital Territory
- 150 from Tasmania
- 100 from the Northern Territory.

Approximately 200 submissions were received from international locations while approximately 2,000 submissions omitted location details that meant they could not be analysed by origin.

The origin of submissions by local government area is depicted in Figure 3-1. The local government areas with the highest number of submissions are summarised in Table 3-3.

Table 3-3 Submissions by origin

Local government area	State	Number of submissions
Sydney Inner West	NSW	1,181
Newcastle	NSW	999
City of Sydney	NSW	879
Coonamble	NSW	558
Randwick	NSW	531
Northern Beaches	NSW	531
Narrabri	NSW	527

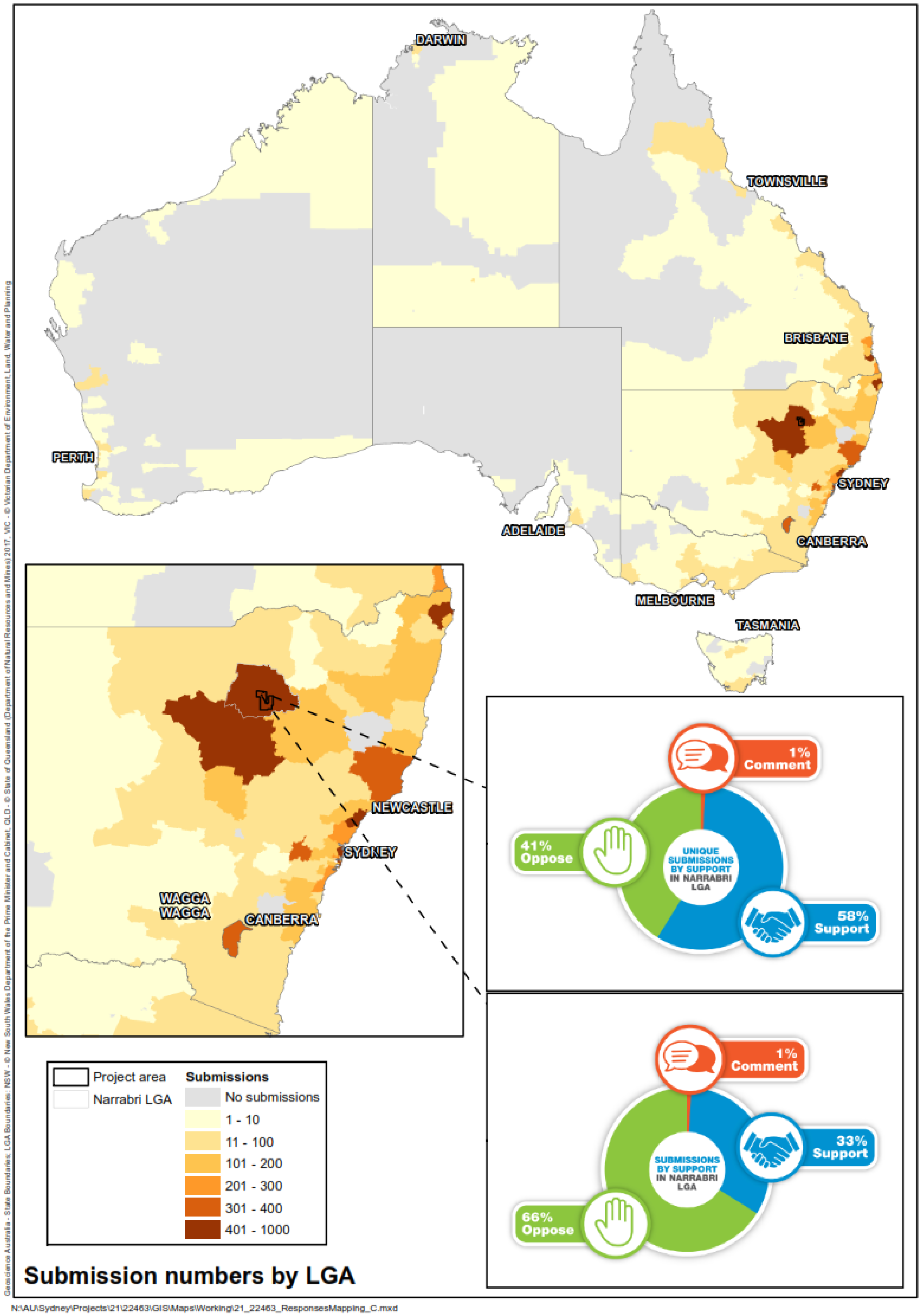


Figure 3-1 Submissions by origin

3.4 Summary of issues raised

Table 3-4 sets out the issues raised in submissions. The table shows how many times each issue was raised across all submissions collectively. It also shows how many times each issue was raised in submissions that were unique to account for the influence of form submissions on the total.

As shown, the most commonly raised issue related to groundwater and geology, followed by terrestrial ecology. This was the case for all submissions collectively as well as unique submissions.

A range of other issues were also raised frequently including social and health, strategic context and need, waste management, Aboriginal heritage, landscape and visual, economics and greenhouse gas. These issues were raised between 60 and 80 per cent of the time in all submissions collectively. When only unique submissions are considered, these same issues were raised less frequently, between about 20 and 30 per cent of the time, demonstrating the influence of form submissions on the statistics.

Table 3-4 Summary of issues raised

	Submissions (all)		Submissions (unique)	
Primary classification	Quantity	Percentage	Quantity	Percentage
Groundwater and geology	20,140	87.5%	3,590	56.4%
Terrestrial ecology	19,130	83.1%	2,589	40.7%
Social and health	18,249	79.3%	1,707	26.8%
Strategic context and need	18,219	79.2%	1,848	29.0%
Waste management	18,011	78.3%	1,474	23.2%
Aboriginal heritage	17,946	78.0%	1,607	25.3%
Landscape and visual	17,478	76.0%	1,157	18.2%
Economics	16,870	73.3%	527	8.3%
Greenhouse gas	14,671	63.8%	1,942	30.5%
Hazard and risk	1,215	5.3%	1,002	15.7%
Soil and land contamination	1,079	4.7%	1,061	16.7%
Surface water quality	1,034	4.5%	1,019	16.0%
Project description	925	4.0%	766	12.0%
Property and land use	661	2.9%	631	9.9%
Air quality	340	1.5%	287	4.5%
State legislation and approvals	238	1.0%	196	3.1%
Produced water management	211	0.9%	210	3.3%
Justification and conclusion	132	0.6%	131	2.1%
Approach to the impact assessment	124	0.5%	109	1.7%
Assessment of alternatives	112	0.5%	44	0.7%
Aquatic ecology	78	0.3%	78	1.2%
Cumulative impacts	70	0.3%	20	0.3%
Environmental management and monitoring	70	0.3%	70	1.1%

	Submissions (all)		Submissions (unique)	
Primary classification	Quantity	Percentage	Quantity	Percentage
Community and stakeholder consultation	61	0.3%	60	0.9%
Noise and vibration	47	0.2%	46	0.7%
Project commitments	44	0.2%	44	0.7%
Hydrology and geomorphology	34	0.1%	34	0.5%
Traffic and transport	31	0.1%	29	0.5%
Location and setting	22	0.1%	22	0.3%
Historic heritage	18	0.1%	18	0.3%
Commonwealth requirements	10	<0.1%	9	0.1%

Chapter 4 The project

4.1 Timing

In relation to project timing, as set out in Chapter 6 (Project description) of the EIS (refer to EIS Section 6.1.4), the project schedule proposed an indicative construction start date of around early/mid 2018, with first gas scheduled for around 2019/20. Acknowledging the current project schedule, it is likely that an indicative construction start date would be around mid/late 2019. This initial phase of construction would include new core holes, appraisal wells, supporting infrastructure and ancillary activities within the project area in addition to the ongoing operation of existing exploration and appraisal activities. Subject to the timing of approvals, findings of the further exploration and appraisal activities and a final investment decision, first gas would be around 2021/22.

Also as discussed in Chapter 6 of the EIS (refer to Section 6.1.4), additional exploration and appraisal activities would assist to further appraise the gas reserves and inform a final investment decision on the production project.

These exploration and appraisal activities prior to a final investment decision may be undertaken under the State significant development consent, if granted, prior to the issue of the petroleum production leases. If this was the case, these activities would be undertaken in accordance with the conditions of the existing tenure in which they were located, being either Petroleum Exploration Lease (PEL) 238 or Petroleum Assessment Lease (PAL 2) and in accordance with activity approval requirements for exploration and appraisal under the *Petroleum (Onshore) Act 1991*. Gas produced by the exploration and appraisal activities would be flared or used to generate electricity in the Wilga Park Power Station in accordance with legislative requirements. Water produced during exploration and appraisal activities would be managed through existing infrastructure including water management infrastructure and the irrigation of treated water at Leewood. The mitigation and management measures outlined in the project commitments will be implemented commensurate with the nature and scale of the activities.

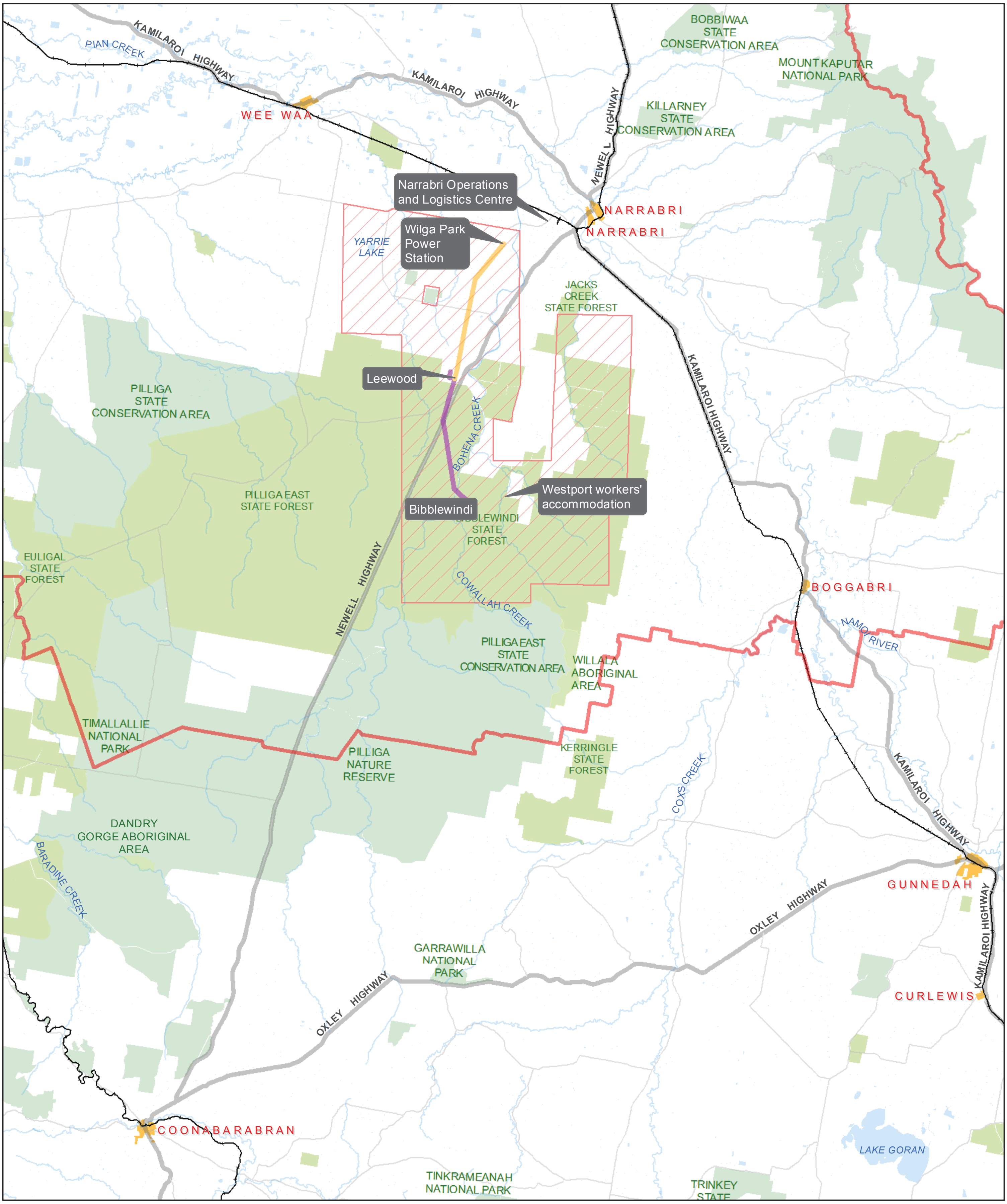
4.2 Project area

The project has been proposed in its current location for the following reasons:

- There are favourable geological and hydrogeological conditions, including the presence of thick aquitards that separate the target coal seams from the overlying freshwater aquifers accessed by groundwater users.
- The area has been strategically set aside for land uses including extractive industry under the NSW Government's own planning processes, being the *Brigalow and Nandewar Community Conservation Area Act* 2005.
- The project is compatible with existing land use, being predominantly forestry and agriculture.
- A large proportion of the Narrabri host community is supportive of the project.
- There is no Government mapped Biophysical Strategic Agricultural Land (BSAL) in the project area, nor was BSAL found during a soil survey undertaken over the project area under the Government's methodology as outlined in the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (NSW Government 2013). This has been confirmed by the issue of a BSAL Certificate for the project area by the NSW Department of Planning and Environment (refer to Chapter 14 and Appendix I2 in the EIS).
- The project area excludes the Brigalow Nature reserve.
- Yarrie Lake reserve (plus a buffer of at least 50 metres) will not host surface infrastructure.

- The two Brigalow State Conservation areas located within the project area will not host surface infrastructure.
- There is ease of access to Bibblewindi and Leewood as the Newell Highway passes through the project area. There is also an extensive network of existing tracks throughout the forest, thereby minimising the need for clearing.

Figure 4-1 shows the regional context of the project area and the key project infrastructure.



LEGEND

- Project area
- Urban Areas
- State forest
- Parks and reserves
- Aboriginal areas
- Lakes and dams
- Watercourses
- Highways
- Major Roads
- Train line
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor
- Narrabri LGA

0 5 10 20
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
Response to Submissions

Job Number 21-22463
Revision A
Date FEB 2015

Regional context and location of key infrastructure

Figure 4-1

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

4.3 Project description

The project remains consistent with the project as described in Chapter 6 (Project description), in the EIS.

The proponent, on behalf of its joint venture participants, propose to develop natural gas in the Gunnedah Basin about 20 kilometres south-west of the town of Narrabri, NSW. This would include the progressive installation of up to 850 new gas wells on up to 425 new well pads over approximately 20 years and the construction and operation of gas processing and water treatment facilities. As defined in Chapter 1 of this report, these activities comprise the project.

The proponent is a wholly owned subsidiary of the Santos Limited group of companies (Santos). Santos is an Australian energy company established in 1954, which has been supplying natural gas to NSW since 1976 and producing natural gas from coal seams for almost two decades. Santos began exploring for natural gas in north-western NSW in 2008. Since its foundation, Santos has grown to be one of the leading independent oil and gas producers in the Asia-Pacific region, supplying the energy needs of homes, businesses and major industries across Australia and Asia.

The NSW Government has recognised the need to secure its future gas supplies through the development of an onshore gas industry in NSW. The NSW Gas Plan (NSW Government 2014) provides the framework for the regulation and management of the energy sector. The project is identified as a Strategic Energy Project in the NSW Gas Plan.

The project has the potential to supply up to 200 terajoules of natural gas per day; which is sufficient gas to meet up to half of NSW’s natural gas demand. This is the natural gas that heats and powers more than one million family homes in NSW and fuels some 33,000 businesses. It supports the industries that supply essential goods and employ hundreds of thousands of workers. The gas would be made available for the NSW market via a high-pressure gas transmission pipeline which would connect to the existing Moomba to Sydney gas pipeline.

The project would comprise the construction and operation of the following key components (refer to Table 4-1 and Figure 4-2):

- Up to 850 new exploration, appraisal and production wells located on up to 425 new well pads within the project area. Each well pad would initially be one hectare in size to allow for the safe drilling of up to three wells on each well pad. After well establishment is complete, around three quarters of the well pad would be rehabilitated to leave a small operating well pad of around one quarter of a hectare.
- The construction of new access tracks where required and the installation of water and gas gathering lines and supporting infrastructure.
- A central gas processing facility for the compression, dehydration and treatment of the gas to be located at a property known as Leewood, south of Narrabri. Leewood that is owned by the proponent and its joint venture participants.
- A water management facility, also located at Leewood, for the storage and treatment of produced water which is a by-product of gas production. Produced water would be treated and used for irrigation, stock watering, dust suppression, construction and drilling activities. Managed release of treated water to Bohena Creek may be undertaken during periods when the creek was flowing at a volume of at least 100 megalitres per day.
- An in-field gas compression and water management facility located within, and adjacent to, the existing facility known as Bibblewindi, within the State Forest.
- Installation of gas and water pipelines, and power and communication lines, within the existing Bibblewindi to Leewood infrastructure corridor which will require widening.
- Power for the project would be supplied by an optional power generation facility to be installed at the Leewood property, from the grid and/or the Wilga Park Power Station. To facilitate power being sourced from the grid and/or the Wilga Park Power Station, a power line would be installed within the existing Leewood to Wilga Park Power Station infrastructure corridor. Gas for the power generation

facility at Leewood and the Wilga Park Power Station would be sourced from the project gas field and gas transfer to Wilga Park Power station would utilise the existing gas flow line, riser and gathering system as described in Section 2.4 and Table 2-1 of the EIS.

- Ancillary activities including an expansion of the workers' accommodation on a privately owned property called Westport, two intersection upgrades on the Newell Highway at the appropriate time during the project, and water pipelines to facilitate the transfer of treated water.
- The project area covers about 950 square kilometres (95,000 hectares), and the project footprint would directly impact about one per cent of that area.

The project area contains a portion of the region known as 'the Pilliga'; which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation, managed under the NSW *National Parks and Wildlife Act 1974*. The Pilliga has spiritual meaning and cultural significance for the Aboriginal people of the region.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purpose of 'forestry, recreation and mineral extraction, with a strategic aim to 'provide for exploration, mining, petroleum production and extractive industry' under the *Brigalow and Nandewar Community Conservation Area Act 2005*. The parts of the project area on state land are located within this section of the Pilliga. There are no areas of National Park within the project area.

The remainder of the project area is situated on private land which is used predominantly for agriculture. This area does not include biophysical strategic agricultural land (BSAL) as mapped by the NSW Government. Extensive soil testing has been undertaken in accordance with the NSW Government's assessment requirements that have confirmed the absence of BSAL. A site verification certificate acknowledging this was issued by the NSW Department of Planning and the Environment on 1 December 2015.

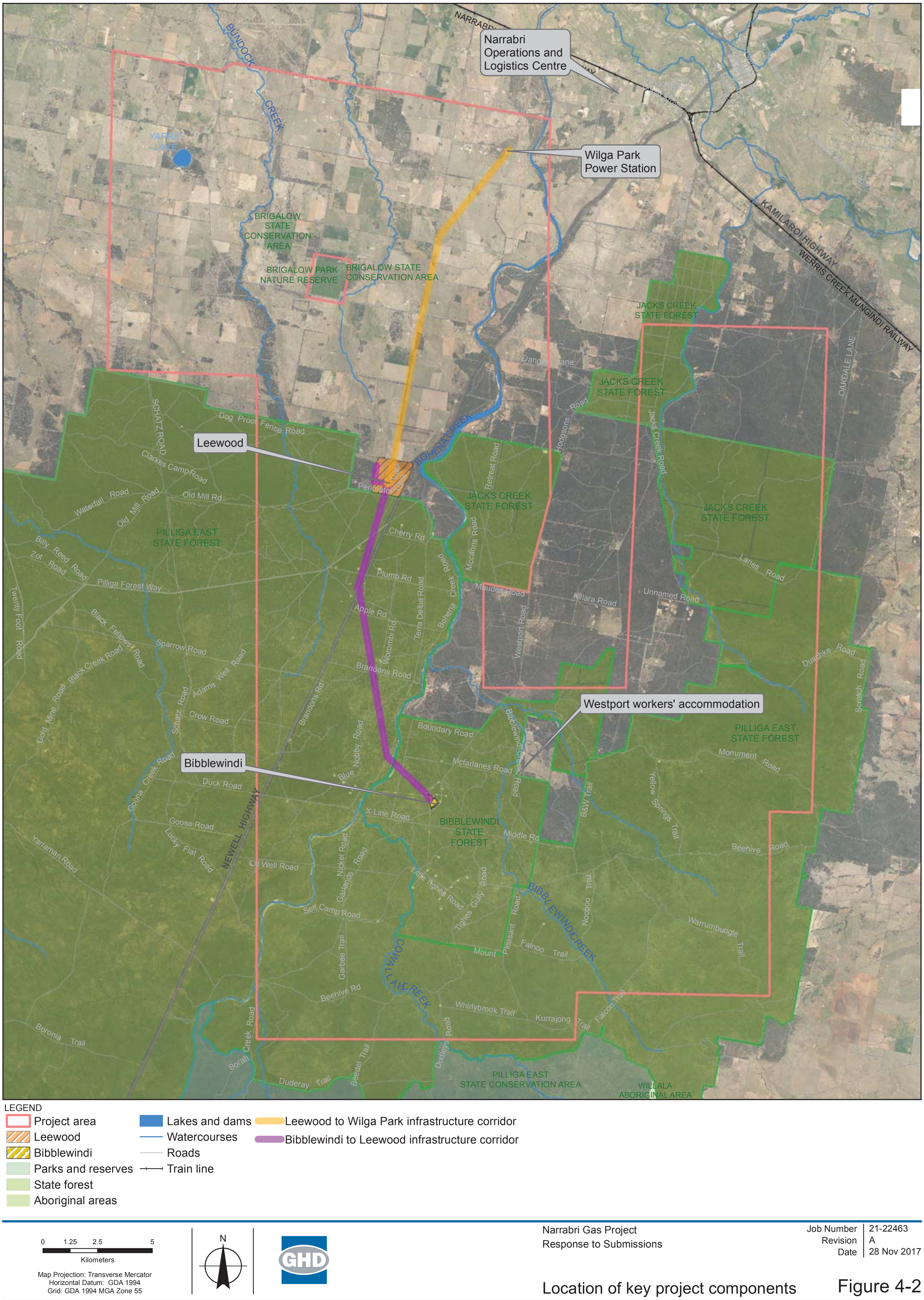
Table 4-1 Key project components

Component	Infrastructure or activity
Major facilities	
Leewood	• a central gas processing facility for the compression, dehydration and treatment of gas • a central water management facility including storage and treatment of produced water and brine • optional power generation for the project • a safety flare • treated water management infrastructure to facilitate the transfer of treated water for irrigation, dust suppression, construction and drilling activities • other supporting infrastructure including storage and utility buildings, staff amenities, equipment shelters, car parking, and diesel and chemical storage • continued use of existing facilities such as the brine and produced water ponds • operation of the facility

Component	Infrastructure or activity
Bibblewindi	• in-field compression facility • safety flare • supporting infrastructure including storage and utility areas, treated water holding tank, and a communications tower • upgrades and expansion to the staff amenities and car parking • produced water, brine and construction water storage, including refurbishment and recommissioning of two existing ponds • continued use of existing facilities such as the 5 ML water balance tank • operation of the expanded facility
Bibblewindi to Leewood infrastructure corridor	• widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground power (up to 132 kV), and buried communications transmission lines
Leewood to Wilga Park underground power line	• installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor
Gas field	

Gas exploration, appraisal and production infrastructure	• seismic geophysical survey
	• installation of up to 850 new wells on a maximum of 425 well pads
	  – new well types would include exploration, appraisal and production wells
	  – includes well pad surface infrastructure
	• installation of water and gas gathering lines and supporting infrastructure
	• construction of new access tracks where required
	• water balance tanks
	• communications towers
	• conversion or upgrade of existing exploration and appraisal wells to production in addition to the 850 new wells

Ancillary	• upgrades to intersections on the Newell Highway
	• expansion of workers' accommodation at Westport
	• a treated water pipeline and diffuser from Leewood to Bohena Creek
	• treated water irrigation infrastructure including:
	  – pipeline(s) from Leewood to the irrigation area(s)
	  – treated water storage dam(s) off site from Leewood
	• operation of the irrigation scheme



Narrabri Gas Project
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Job Number 21-22463
Revision A
Date 28 Nov 2017

Location of key project components

Figure 4-2

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

4.4 Project description further development

Since the EIS was submitted, further consideration has been given to methods to minimise traffic associated with well construction activities. In addition to the previously approved facility at the Narrabri Operations Centre as described in the EIS (refer to Table 2-1 in Chapter 2 – Location and setting), it is proposed that the Leewood and Bibblewindi facilities each include equipment for drilling fluid treatment and recycling and cement storage and blending to support well drilling and construction activities. The inclusion of drilling support facilities at these locations will minimise the distance that vehicles will need to travel between wells being drilled, and the location from which drilling fluids and cement are sourced. This will reduce overall traffic movements and impacts on the surrounding road network including the Newell Highway.

The drilling support facilities would be accommodated within the proposed footprint of the Leewood and Bibblewindi facilities. No additional clearing would be required. The indicative locations of the drilling support facilities at Leewood and Bibblewindi are included in Figure 4-3 and Figure 4-4.

Each drilling support facility would be located on a hardstand area and include a cement storage and blending plant for the production of cement used for well construction. The plant's footprint would be around 30 metres by 15 metres and consist of up to four storage silos with a total maximum capacity of 150 tonnes, together with blend and scale tanks, admix hopper, dust collector and air compressor and associated plant and equipment. The plant would blend dry cement with chemical additives as required and the blended powdered cement would then be transported to the well drilling site where it would be mixed with water and used to cement the well's steel casing in place.

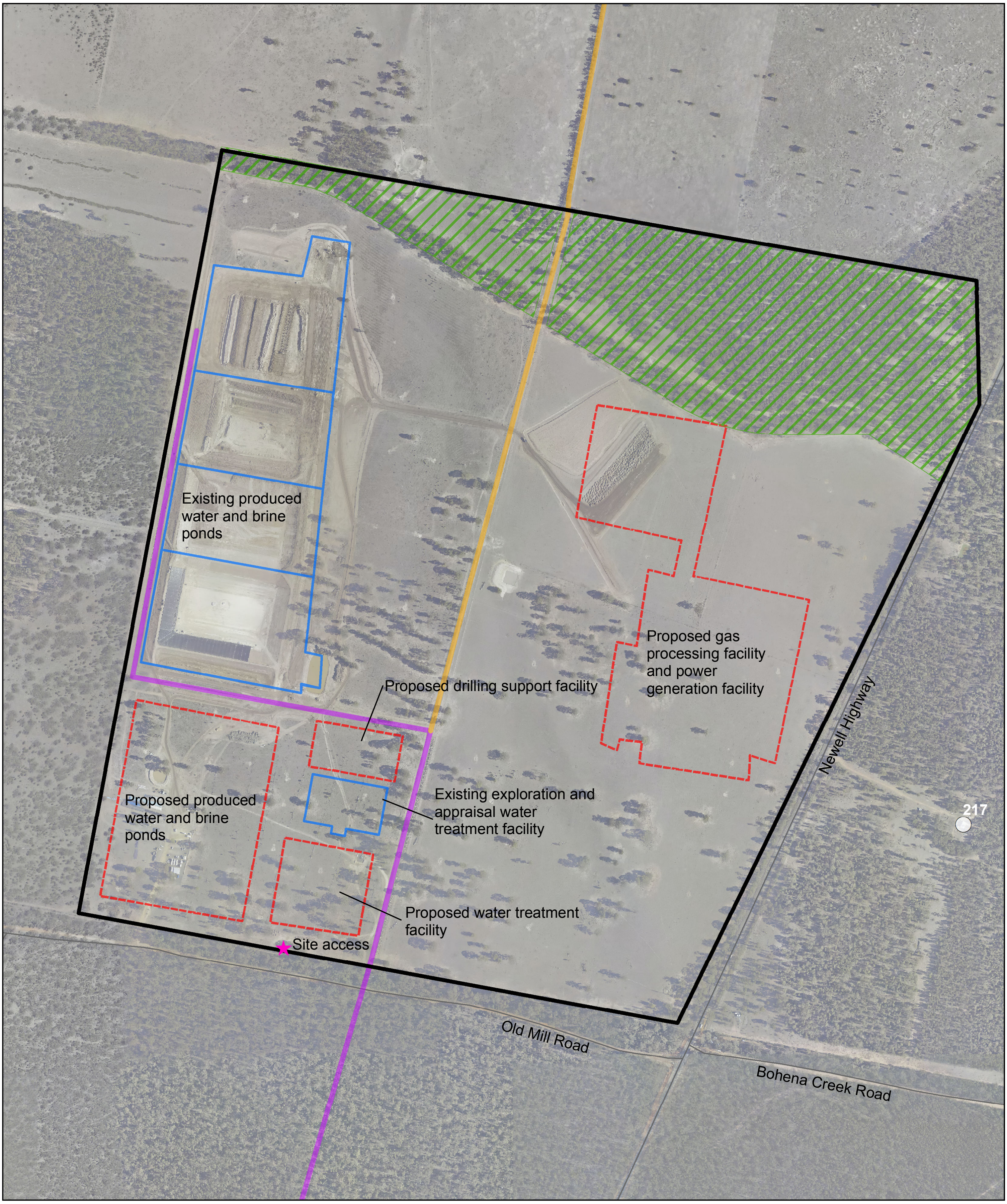
The drilling fluids mixing and recycling plant to prepare drilling fluids for use in drilling would be around 40 metres by 20 metres and would mix new fluids and treat used fluids to allow them to be reused, minimising the amount of waste fluids generated. It would process up to 5,000 m^3 of drilling fluid per year and have a maximum storage capacity of around 475 m^3. The fluids would be mixed with water and additives as required to adjust chemical and physical properties, and flocculated and centrifuged to remove solids. The drilling fluids would then be transported by tanker to the well site for use in drilling. The equipment would include up to six storage tanks, water and processed fluid tanks, flocculation and centrifuge, hopper and mixing units, pumps and cuttings skips.

There would also be a warehouse, storage building and office area, and vehicle loading and unloading areas.

The drilling support facilities would be designed and operated in accordance with the project commitments. This includes the storage and handling of chemicals in accordance with the relevant Australian Standards. Drilling fluids and cuttings that are not appropriate for beneficial reuse will be classified in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) and disposed of at an appropriately licensed facility. As a small part of the overall Leewood and Bibblewind facilities, noise and air emissions are expected to be consistent with those assessed.

Additional chemical storage requirements at the sites will not result in the introduction of new hazards to the facilities and remain consistent with the *State Environmental Planning Policy No 33—Hazardous and Offensive Development* and dangerous goods assessments undertaken for the EIS (refer Appendix S).

The mitigation and management measures outlined in the project commitments (refer to Appendix B of this RTS) will be applied.



LEGEND
- Leewood
- Existing facilities
- Proposed infrastructure
- Vegetation to remain
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor
- Roads

Aeirial Imagery: Dec 2013

0 0.075 0.15 0.3
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
Response to submissions

Job Number 21-22463
Revision A
Date 10 Apr 2018

Existing and proposed infrastructure
at Leewood

Figure 4-3

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:afoddy

LEGEND

Indicative Bibblewindi site boundary

Bibblewindi to Leewood infrastructure corridor

Indicative infrastructure location

Existing wells

Aeirial Imagery: Dec 2013

0 0.05 0.1 0.2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Narrabri Gas Project
Response to submissions

Job Number	21-22463
Revision	A
Date	10 Apr 2018

Existing and proposed infrastructure at Bibblewindi

Figure 4-4

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NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013.

Chapter 5 Response to agency submissions

5.1 Commonwealth Government: Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC)

Baseline groundwater dependent ecosystem information

The IESC has recommended considerable additional baseline data collection at groundwater dependent ecosystem locations, including but not limited to:

- additional stygofauna sampling
- identification of the source(s) of water to high priority groundwater dependent ecosystems (e.g. Hardys and Eather Springs) using isotope and geochemical tracer studies
- collection of field data on water level and flow to spring groundwater dependent ecosystems under baseline conditions and estimated sensitivity to variable climatic conditions
- baseline field-based ecological monitoring (especially of the Fuzzy Box Woodland and Carbeen Open Forest community) in conjunction with remote sensing (e.g. methods outlined in Emelyanova *et al.*, in press)
- monitoring of the structure and composition of the ecological communities.

The submission also suggested that there was only limited or inadequate sampling of groundwater dependent ecosystems for the EIS.

The proponent notes that more sampling in Bohena Creek alluvium may find stygofauna. Taxa in Bohena Creek alluvium, however, are also highly likely to be present in the Namoi Alluvium, and not new species, nor endemic.

The proponent also notes that the two groundwater dependent ecosystems, Hardy and Eather springs, were not sampled, as access was either denied by, or not able to be obtained from, the landholder. The proponent does, however, retain considerable baseline data on groundwater dependent ecosystems in the project area which was presented in Appendix B to EIS Appendix F. Chapter 11 (Groundwater and geology) of the EIS concluded the potential impacts of the project on groundwater dependant ecosystems are expected to be minor and a low risk.

The main groundwater dependent ecosystems in the project area are likely to be the Type 2 waterholes on Bohena Creek, which were sampled and reported in Bohena Creek reports (EIS Appendix G1 and Appendix B to EIS Appendix F).

The proponent notes that groundwater modelling has demonstrated that there will be negligible impact to shallow groundwater systems, specifically to the Namoi alluvial groundwater from the project, and hence, very unlikely to have impacts on stygofauna or other groundwater dependent ecosystems. The maximum probable drawdown on groundwater over the life of the project is less than 0.5 m which is within the error of the modelling, and as such, impacts on groundwater and their respective communities is considered to be negligible.

The Water Monitoring Plan is focussed on early detection of a specific and measurable change that can be reasonably attributed to project activities. The key principle of the Water Monitoring Plan is that monitoring activities are designed to inform an understanding of whether or not the project is contributing to changes in water quantity or quality within water assets, particularly the high valued groundwater sources in the GAB and alluvial aquifers.

This includes four monitoring bores in the Bohena Creek Alluvium, 18 wells in the Namoi Alluvium with one more proposed, and 26 wells in the GAB.

The approach utilises leading resource condition indicators for early warning of potential changes to water resource condition arising from the project. Sentinel monitoring locations are nominated at intermediate depths within the Gunnedah-Oxley Basin (seven existing wells with another six proposed in the Triassic and four existing in the Permian) to detect unexpected change in subsurface condition prior to potential impacts on receptors within shallow high-valued groundwater sources. Thus, the risk of impact to groundwater dependent ecosystems will be monitored throughout the life of the project. Groundwater dependent ecosystems are not proposed to be monitored because they are not predicted to be impacted due to a large degree of physical separation, both vertically in the sub-surface and horizontally at the surface, and therefore the lack of connectivity between the target coal seams and the groundwater dependent ecosystems. The sentinel monitoring approach ensures that any unexpected impacts are identified and management actions initiated well prior to any potential for impact to groundwater dependent ecosystems occurring.

In the long term, monitoring results may trigger the need to monitor closer to groundwater dependent ecosystems. Such a management response, however, would occur many years, and potentially decades, in advance of measurable change to aquifers supporting groundwater dependent ecosystems that could be objectively linked to project activities.

Water extraction amount and uncertainty

The IESC considered the approach used in the model is adequate to provide reasonable estimates of groundwater take from water resource units, however, further confidence in the estimates would be obtained if modelled heads in target seams could be verified as suitable for gas desorption and subsequent production.

The submission recommended that the proponent should consider providing detail on the reservoir modelling, including confirmation that gas extraction will be limited to five per cent from the Hoskissons seam and 95 per cent from the Maules Creek Formation. The submission further stated the assumptions and values used in the reservoir model are not provided.

The submission also questioned whether uncertainty in the estimates of water production volumes in the EIS has implications for the modelling predictions of potential impacts.

Data from the historical cumulative water production in thirty-seven appraisal wells from seven coal seam gas pilots in Early-Permian targets provide some guidance and constraint on production profiles for the extraction of produced water. This information has been used in the groundwater modelling, such that the model mimics optimised water extraction. The Base Case is designed to emulate the optimal production profile based on the data from the appraisal wells. The High Case represents a production curve that is significantly larger than the appraisal wells (i.e. no appraisal well to date has produced more than half the production simulated by the High Case scenario).

The historical water-production data show that the cumulative water-production curve for the EIS Base Case envelopes 36 out of 37 appraisal well cumulative production volumes and is significantly larger in volume that the average of the appraisal wells. On this basis, the modelling for the EIS may be considered conservative in that it assumes more production than anticipated based on experience from existing appraisal wells.

The water extraction scenario for which approval is sought under the EIS consists of five per cent of total water extraction from the Hoskissons Coal (Late Permian coal seams) and 95 per cent from the Maules Creek Formation (Early Permian coal seams). As such, the potential impacts of proposed water extraction from the Hoskissons Coal (Late Permian coal seam targets) have been assessed. The Base, High and Low Case modelling simulations all have five per cent of total water extraction from the Hoskisson Coal.

Note that the percentage values above apply to water extraction, not to gas extraction, as mistakenly referred to in the comment. In responding to the submission comment, the proponent has assumed that the comment relates to water extraction as reported and modelled in the EIS.

There is no uncertainty in the estimate of water production. The EIS assessment has been undertaken on the extraction of a fixed maximum water volume from the target coal seams over the life of project. The maximum extraction volume under the Base Case for which approval is sought is 37.5 gigalitres over 25 years without contingency on the performance of the field. This total extraction volume is equivalent to average water production of 1.5 gigalitres per year for 25 years.

Predictive simulations in the EIS include a High Case scenario for water production in which the total water volume extracted from the target coal seams is 87.1 gigalitres over 25 years in the ratio of five per cent from Late Permian coal seams and 95 per cent from Early Permian coal seams. This scenario is equivalent to average water production of approximately 3.5 gigalitres per year for 25 years, and 2.3 times the extraction volume of the Base Case scenario. The High Case scenario predicts a maximum drawdown of 0.6 m in the Pilliga Sandstone and less than 0.5 m drawdown in the Namoi Alluvium. The High Case scenario has assessed uncertainty in the water production volume of the Base Case up to a 230 per cent increase of the total extraction volume predicted by the reservoir modelling and sought under EIS approval.

All water extracted for the project will be done under a Water Access Licence issued by the Department of Primary Industries (Water) (DPI Water) for the water source, as is the case for other water users in NSW including irrigators and industrial users. For the Gunnedah Oxley Basin MDB Groundwater Source that the project will extract from, the long term annual extraction limit is around 206 gigalitres per year. This is the amount of water that the NSW Government makes available for extraction by users under the water sharing plan licensing system. This is about half of the average volume that is recharged into this groundwater source each year through rainfall. The other half of the volume is not available for extraction and is maintained in the system for environmental purposes.

The average volume of water extracted by the project is 1.5 gigalitres per year. This equates to around 0.7 per cent of long term annual extraction limit from the Gunnedah Oxley Basin MDB Groundwater Source.

Groundwater monitoring plan

The submission recommends, as soon as possible, the proponent should consider providing a Groundwater Monitoring Plan detailing a groundwater impact early warning monitoring system that includes management, mitigation and contingency measures. The submission considered the proposed groundwater monitoring network not suitable due to limited spatial coverage, which would not provide an early warning of groundwater depressurisation and potential impacts to landowner bores and groundwater dependent ecosystems.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring plan for the project.

The water monitoring approach proposed is based on the concept of monitoring at locations that are most likely to see changes as a result of the project. These locations are effectively sentinel locations, i.e. they will provide early warning of unexpected impacts prior to impacts occurring in more valuable water sources or sensitive receptors.

The approach is focussed on early detection of a specific and measurable change that can be reasonably attributed to project activities. The key principle is that monitoring activities are designed to inform an understanding of whether or not the project is contributing to changes in water quantity or quality within water assets, particularly the high valued groundwater sources in the GAB and alluvial aquifers. The approach utilises leading resource condition indicators for early warning of potential changes to water resource condition arising from the project. Sentinel monitoring locations are nominated at intermediate depths within the Gunnedah-Oxley Basin to detect unexpected change in subsurface condition prior to potential impacts on receptors within shallow high-valued groundwater sources.

As the project will operate within the NSW Government's water sharing plan rules through the acquisition of a water access licence for water extracted, the water extraction has also been assessed through the government's water sharing plan assessment and allocation process.

Acquisition of water entitlements by the proponent under the water sharing rules is designed to ensure that unacceptable drawdowns do not occur in the groundwater sources covered under the associated water sharing plans. Predictive simulations in the EIS groundwater modelling are designed primarily to inform the entitlement quantities, which relate to the Base Case water extraction volume from the Gunnedah-Oxley Basin Groundwater Source being sought under the EIS approvals application.

Potential groundwater impacts

The submission stated that further confidence in groundwater modelling would be obtained if modelled heads in target seams resulting from the imposed range of extraction rates could be verified as suitable to enable gas desorption and subsequent production, and noted it is important to confirm that modelling abstraction in production bores as a flux does not under-estimate drawdown impacts at a distance from the points of abstraction.

The primary purpose of the EIS groundwater modelling is to predict changes in the subsurface water balance that may be induced by project water extraction from target coal seams; especially the predicted induced water fluxes between groundwater sources, which would be classified as aquifer interference under the NSW *Aquifer Interference Policy*. Within this context, it is important that the groundwater modelling accurately simulates the volume of water extraction being sought under the approvals application and predicts the peak rates of induced take from the potentially affected groundwater sources, starting from commencement of production until full pressure recovery occurs in the basin.

Predictions from the groundwater modelling thus inform the quantity of water entitlements that the proponent must hold or acquire within the potentially affected groundwater sources. If these entitlements are acquired for the project in accordance with the water sharing rules, then the predicted drawdowns simulated by the model are less relevant because they do not account for transfer of entitlements (trades) that will be required in heavily or fully allocated sources (e.g. the Great Artesian Basin and Lower Namoi Alluvium).

Acquisition of entitlements under the water sharing rules is designed to ensure that unacceptable drawdowns do not occur in the groundwater sources covered under the associated water sharing plans. Thus, it is more important to represent extraction volumes and fluxes as accurately as possible in the groundwater modelling rather than focussing on simulated drawdowns that would be either acceptable or mitigated under the water sharing rules.

Notwithstanding, a more recent groundwater modelling exercise of the project by GISERA (Sreekanth *et al*. 2017) considered probabilistic results based on 500 realisations of various model parameters, generating a range of water production volumes between 4.4 gigalitres and 107 gigalitres (compared to the EIS Base Case of 37.5 gigalitres). The GISERA report concluded "…changes to the water balance components induced by the gas development are relatively small compared to the probabilistic estimates of their baseline values." Overall, the findings and conclusions of the GISERA report regarding potential impacts of the project on high-valued water sources are consistent with the conclusions in the EIS and also included estimates of water flux increases between the coal measures and the Pilliga Sandstone aquifer and the Pilliga Sandstone aquifer and the alluvium. The GISERA report variously concluded "…very small increases in river flux.." and "…only very small amount of flow from the deeper formations…". These statements were made in light of the fact that the GISERA modelling extracted more water than is proposed from coal seams located closer to the Great Artesian Basin, and thereby over-estimated potential impacts on the Great Artesian Basin.

Previously, SWS (2012) carried out numerical groundwater modelling to assess potential impacts from a range of coal seam gas and coal mine scenarios in the Namoi region. Critically, despite invoking "extensive and widespread mining and coal seam gas" (Scenario 3), including an expanded Narrabri Gas Field and gas production from the Bando Trough near Gunnedah, the long-term predicted maximum impacts on groundwater levels associated with gas production in the Narrabri area remained below the minimal impact trigger as defined by the *NSW Aquifer Interference Policy*. The modelled coal seam gas groundwater extractions in SWS (2012) were comparable to the Base Case profiles modelled for the EIS, but multiplied across multiple gas fields.

The lack of significant modelled potential impacts in drawdown from recent numerical groundwater models, under different modelling frameworks, optimisation and analyses provides good confidence that modelling flux, as was undertaken for the EIS, does not underestimate drawdown impacts away from the point of abstraction.

Further, the existing sensitivity and uncertainty assessment in the Groundwater Impact Assessment of the EIS has tested model parameters that result in groundwater pressure drawdowns in the Great Artesian Basin and at the water table. The results are discussed in Section 6.10 of the Groundwater Impact Assessment and a summary of results for all simulations is presented in Section 6.11 of the Groundwater Impact Assessment (EIS Appendix F). All determined drawdowns would be considered minimal impact under the NSW *Aquifer Interference Policy* and would occur over 150 years in the future.

Review of groundwater modelling predicted impacts

The submission recommended the proponent should conduct annual data reviews, data trend analyses and reporting on project changes (e.g. footprint, layout and timeframes) relative to the EIS and use this information to:

- Review the groundwater model two-to-three years after commencement of water production.
- Undertake validation and recalibration of the groundwater modelling.
- Review and revise relevant management plans to ensure early prediction of impacts and the implementation of adequate monitoring, management and contingency measures.

The submission also recommends the collection of extraction rates and subsequent head data at production wells.

The Water Monitoring Plan (EIS Appendix G3) incorporates the provisions recommended in the submission, including data review, model re-calibration, re-prediction, and review and revision of groundwater monitoring and management. The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the Project.

The proponent is committed to monitoring and reporting groundwater extraction and coal seam pressures for the project. Monitoring and reporting of water production volumes is included as a minimum impact consideration in Section 3.7.2 of the Water Monitoring Plan.

Acquirement of water entitlements by the proponent under the water sharing rules is designed to ensure that unacceptable drawdowns do not occur in the groundwater sources covered under the associated water sharing plans. Predictive simulations in the EIS groundwater modelling are designed primarily to inform the entitlement quantities, which relate to the Base Case water extraction volume from the Gunnedah-Oxley Basin Groundwater Source being sought under the EIS approvals application. It follows that the realised drawdowns within each water source should be either acceptable or mitigated under the water sharing rules if sufficient entitlements are acquired. Furthermore, drawdowns simulated in the EIS groundwater modelling should not be interpreted as predictions of potential drawdown in high-valued groundwater sources under the water sharing rules.

Effect of faulting on groundwater flow

The submission recommended further consideration of the scale and extent of faulting in the region and the likely impact on groundwater during and post gas extraction to justify excluding faulting from the groundwater model.

Regional structure and associated faulting within the project area and surrounds has been primarily imaged via interpretation of local seismic lines. Thousands of kilometres of 2D seismic of various age has been acquired through the Narrabri region since the early 1960s to the present. Seismic data is of variable quality and many of the older lines have been reprocessed to enhance overall image quality. These lines currently form a broad two to four kilometre seismic grid across the project area. Key seismic horizons (including the Base Jurassic, and Triassic unconformities, the Hoskisson's and Bohena Seam and Basement) have been interpreted across the Bohena Trough with structure maps generated for each horizon. Faults have been mapped on each seismic line and incorporated into structural mapping.

In general, faulting within the project area is small scale and sparse with most structures only identifiable on single seismic lines, with associated fault throws of five to 40 metres, compared to 50 to 100 metres of total formation thickness.

There is no evidence that the faults extend into the overlying formations.

Some larger structures are evident on the flanks of the basin (e.g. to the west of Dewhurst 9) and / or are associated with Triassic intrusive activity (e.g. on the Coonarah and Brigalow Park anticlines). These structures, however, generally do not extend into the overlying Jurassic strata, which remains largely unstructured.

Most faulting within the project area is considered to be compressional and is believed to be associated with closure of the Bowen-Gunnedah-Sydney basinal system during the Middle Triassic.

Multiple lines of evidence indicate most known faulting within the project area is of small scale and does not extend into the overlying formations. Potential impacts to groundwater flow due to faulting is therefore considered to be highly unlikely. There is no evidence to contradict this view.

Data obtained through drilling further exploration and appraisal wells would be used to further refine the structural information for the project area. Pressure monitoring of key reservoir and aquifer zones will also be undertaken throughout project life, to monitor the impact of production activities. Where necessary, the acquisition of further seismic data may be considered for the project.

Uncertainty analysis

The submission recommended a range of different hydrogeological conceptualisations should be used to address uncertainties associated with recharge to various hydrogeological units within the region, including work completed by Iverach *et al*. (in press) suggesting that groundwater from the Great Artesian Basin to certain areas of the Namoi alluvium could be up to 70 per cent of the total contribution.

A probabilistic uncertainty analysis was suggested to provide the bounds and likelihood of groundwater impacts.

The submission recommended the model be subjected to further ‘pressure testing’, including assessment of which hydraulic conductivity parameters could lead to an impact exceeding the two metre minimum impact thresholds under the *NSW Aquifer Interference Policy*.

Modelled predictions of potential project impacts on high-valued groundwater sources are not sensitive to the groundwater recharge estimate applied at the upper surface of the groundwater model. Simulated water extraction in the EIS groundwater modelling is from deep coal seams within the Gunnedah Basin, such that the induced effects in the overlying aquifers occur by vertical propagation of depressurisation into those strata from below. These effects are entirely due to changes in storage within the groundwater sources and take place in advance of depressurisation reaching the water table and associated interaction with surface hydrological processes such as groundwater recharge and evapotranspiration. It follows that potential impacts of coal-seam depressurisation on high-valued groundwater sources are controlled by the hydrogeological properties of the intervening strata rather than recharge and evapotranspiration rates at the water table.

Regarding the concept of ‘artesian recharge’ from the Great Artesian Basin to the Lower Namoi Alluvium, a full review of existing estimates of vertical flux is presented in Section 6.11.3 of this RTS under the sub-heading “Simulated vertical flux between the Great Artesian Basin and Namoi Alluvium”. The review includes a discussion of the results and findings from the studies by Calf (1978), Williams (1985), Merrick *et al*. (1986), Merrick (2001) and Iverach *et al*. (in press). Based on the review, the EIS groundwater modelling is judged to be conceptually and numerically consistent with the existing investigations, which are broadly consistent with each other.

The method used for assessing predictive uncertainty in the EIS groundwater modelling is presented in Section 6.10 “Model Uncertainty and Sensitivity” of the Groundwater Impact Assessment (EIS Appendix F).

The independent review of the project’s EIS groundwater modelling by CSIRO states “The sensitivity analysis can be considered a qualitative uncertainty analysis, showing the extremes of the plausible ranges of parameter values. In this case, it is a valid alternative to a formal uncertainty analysis in which estimates of the probability of each prediction (corresponding to a particular plausible combination of parameter set and water production curve) are provided."

A more recent groundwater modelling exercise of the project by GISERA (Sreekanth *et al*. 2017) considered probabilistic results based on 500 realisations of the model parameters. For a range of water production volumes between 4.4 gigalitres and 107 gigalitres (compared to the EIS Base Case of 37.5 gigalitres) the GISERA report concluded "…changes to the water balance components induced by the gas development are relatively small compared to the probabilistic estimates of their baseline values." Overall, the findings and conclusions of the GISERA report regarding potential impacts of the project on high-valued water sources are consistent with the conclusions in the EIS.

The GISERA modelling did, however, assume water extraction from coal seams in the ratio of 50 per cent from Late Permian (shallowest) coal seams and 50 per cent from Early Permian (deepest) coal seams. This modelling differs from the field development plan for which approval is sought under the EIS, which is based on water extraction from coal seams in the ratio of five per cent from Late Permian (shallowest) coal seams and 95 per cent from Early Permian (deepest) coal seams. Thus, the GISERA modelling extracted more water than is proposed from coal seams located closer to the Great Artesian Basin, and thereby over-estimated potential impacts on the Great Artesian Basin.

The existing sensitivity and uncertainty assessment in the Groundwater Impact Assessment of the EIS has tested model parameters that result in groundwater pressure drawdowns in the Great Artesian Basin and at the water table. The results are discussed in Section 6.10 of the Groundwater Impact Assessment and summary of results for all simulations are presented in Section 6.11 of the Groundwater Impact Assessment (EIS Appendix F).

Representation of Bohena Creek alluvium in the groundwater modelling

The submission stated consideration should be given to inclusion of the Bohena Creek alluvium as a model layer so that potential impacts to this area can be represented and accounted for in the groundwater model or, preferably, in a separate smaller scale (daughter) model that enables time-variable localised impacts to be considered.

Based on a limited number of shallow piezometers installed within the alluvium upstream of the Newell Highway crossing, groundwater in Bohena Creek alluvium is understood to be recharged by surface flows, is ephemeral and disconnected from underlying aquifers.

Under this conceptualisation, small predicted depressurisation effects at the regional water table are considered to have negligible potential to effect temporary perched groundwater within the creek alluvium that is recharged by surface flows.

Representation of evapotranspiration in the groundwater modelling

The submission stated prior studies in the region have identified extensive areas of the Pilliga that are likely to have evapotranspiration rates in excess of local rainfall and hence are likely to utilise groundwater. To ensure this process is adequately accounted for in the model, the submission a suggested analysis of remotely sensed data.

As discussed in relation to groundwater recharge, the modelled predictions of potential project impacts on high-valued groundwater sources are not influenced by surface processes at the water table. Depressurisation effects propagating upwards from deep coal seams are entirely due to changes in storage within the groundwater sources and take place in advance of depressurisation reaching the water table and associated interaction with surface hydrological processes such as groundwater recharge and evapotranspiration.

Studies undertaken subsequent to the EIS have confirmed that Type 3 groundwater dependent ecosystems in the project area are restricted to Bohena Creek and other major watercourses and are not located across the Pilliga (DPI Water 2016).

Development of daughter groundwater models

The submission recommends that consideration be given to the development of local scale daughter models to improve the local-scale detail of predicted effects in high-valued groundwater sources.

Modelling predicts that no significant impacts will occur in high value groundwater sources, therefore local scale models will not provide additional information.

Further, local nested models would not work well within the basin setting of the project because predicted depressurisation in the deep coal seams first spreads laterally at depth within the target seams before much slower vertical propagation into over lying strata. In this situation, it is not practical to ‘cookie cut’ a local scale model since the local boundary conditions over time are not defined.

More generally, there is no advantage in developing a local-scale model unless additional local-scale data are available to inform better representation of geometry or better representation of the proposed stresses on the local water source. Neither of these circumstances applies to the EIS groundwater modelling.

Calibration of the EIS groundwater model to existing impacts from coal mines

The submission recommends that the performance of the EIS groundwater model could be further tested using existing drawdown associated with existing coal mines, particularly the Narrabri North underground mine.

The EIS groundwater model is a large regional-scale model which has specifically been designed for predicting drawdown over a large area. The independent peer review by CSIRO also stated that the model is ‘fit for purpose’.

Further, the Narrabri North coal mine targets Late Permian coal seams from which only 5 per cent of project water extraction will occur. The majority of project water extraction (95 per cent) will occur from deeper Early Permian coal seams in the Maules Creek Formation. Calibration of the EIS groundwater model to local mine-scale effects within the Hoskissons Coal (if this were practicable) would not inform improved prediction within the Early Permian strata of the Gunnedah Basin where most water extraction will occur.

5.2 Australian Rail Track Corporation

Interaction with Inland Rail

The submission from the Australian Rail Track Corporation regarded the interaction of the project and Inland Rail—including the Narrabri to North Star and Narromine to Narrabri sections. It noted the limited public information on the Narromine to Narrabri component.

The submission agreed with the EIS that potential for cumulative impacts with Narrabri to North Star section is negligible. It indicated that cumulative impacts with Narromine to Narrabri section would depend on the preferred route progressed through the formal planning assessment process.

The potential cumulative impacts of the project and Inland Rail were considered in the cumulative impact assessment in Chapter 29 of the EIS. As noted in the submission, limited public information was available on the Narromine to Narrabri component.

The statement in the submission that potential for cumulative impacts between the project and the Narromine to Narrabri component of Inland Rail would depend on the preferred route is noted. It is expected that the potential cumulative impacts would be considered further through the formal planning assessment process for the Narromine to Narrabri component of Inland Rail.

5.3 Siding Spring Observatory

Light at Siding Spring Observatory Dark Sky Committee

The submission noted the potential for impacts from project light sources on observing conditions at Siding Spring Observatory. It noted other light sources in the region and potential for light to approach the threshold in the *Dark Sky Planning Guideline* (Department of Planning and Environment 2016).

The submission noted potential sources of light included the 50 metre safety flares at Leewood and Bibblewindi and pilot flares. It submission requested an estimation of the brightness of the flares and requested the proponent explore the possibility of enclosing the flares to reduce their brightness.

The submission also raised construction lighting from drill rigs, and construction and operational lighting at Leewood, Bibblewindi and Westport workers' accommodation. It noted that the proponent was aware of construction mitigation including cut-off light fittings and low colour temperature lights.

In response to the submission the proponent commissioned a Gas Flare Light Assessment to assess the light impacts of the project flares and their potential to contribute to skyglow that would affect observing conditions at the Observatory. The Gas Flare Light Assessment is at Appendix K.

The Gas Flare Light Assessment included light monitoring at the Observatory in addition to monitoring in the vicinity of the pilot flares operating for the existing Narrabri exploration and appraisal operations. Modelling was then undertaken to determine the light emissions from flares that would operate as part of the project including up to six pilot flares within the project area and a safety flare at Leewood (approximately 100 km north-north east of the Observatory) and Bibblewindi (approximately 90 km north north-east of the Observatory). The assessment included modelling for the safety flares operating in both routine (pilot flame) and non-routine (maximum flow rate) scenarios during maintenance or other non-routine activities.

The *Dark Sky Planning Guidelines* (Department of Planning and Environment 2016) are a matter for consideration for State significant development that is within 200 kilometres of the Observatory and likely to impact the night sky. The guidelines state that “at the Observatory a threshold figure of 10 per cent of the natural skyglow at 30^0 above the horizon has been adopted as the maximum tolerable level of artificial light”, as this is critical to the assessment of impacts on the observing conditions at the Observatory. The guideline also refers to the cumulative effect of artificial skyglow within the region caused by rural industries and intensive livestock agriculture operations, urban development including sports fields, industrial and commercial buildings, housing development and street lights and other development including mining and extractive industries and gas flares.

The assessment found that for routine flaring operations for the project, the extent of the horizontal skyglow with up to six pilot flares will be limited to bearings N22^0E - N55^0E from the Observatory. The vertical extent of skyglow will remain at the same altitude currently perceived from the Observatory, which is less than 1^0 above the horizon. Low lying cloud cover and aerosols (<500 m altitude) will influence the extent of skyglow emitted throughout the atmosphere, however this affect would be negligible compared to natural skyglow produced by starlight.

The safety flare would be directly visible from the Observatory, during a non-routine safety flaring event in which it was required to operate at the maximum gas flow rate. From the flare, the extent of skyglow would progressively decrease in intensity reaching natural skyglow conditions approximately 12 kms horizontally and 4 kms vertically from the flare on a clear night, equating to 2.5^0 above the horizon. In cloudy conditions this event would contribute to artificial skyglow to a maximum extent of 7.4^0 above the horizon. Thus, the project would not make a contribution to skyglow conditions at the 30^0 reference location adopted in the guidelines and would have negligible impact on the Observatory’s operations.

For context, the frequency and extent of a non-routine flaring event occurring is significantly less than the frequency of a quarter moon rising over the northeast horizon on a clear night, which would produce significantly greater skyglow having the potential to affect observing conditions.

Further detail, including the results of the in situ light surveys conducted at Bibblewindi, Dewhurst and Tintsfield appraisal pilot flares and expected light emissions from project flares is available in the Gas Flare Light Assessment in Appendix K.

All lighting will be designed to meet the Australian standard AS/NZS 4282 – 1997 *Control of the obtrusive effects of outdoor lighting*. The limits set out in the Standard is used as a basis for assessment of the nuisance likely to be caused by proposed site lighting. The objective of this Standard is to provide a common basis for assessment of the likely effects of developments that involve the provision of outdoor lighting. AS/NZS 4282 provides guidance in the form of generally acceptable maximum values of luminance, luminous intensity and threshold increment at the site boundary of residential areas that may view the light source as a nuisance.

Construction and site lighting will be designed to meet AS/NZS 4282 generally and AS/NZS 1158 for roadways and plant. This may include the use of narrow beam floodlights with spill light limited either through appropriate luminaire selection or through the use of “barn door” or similar shading devices fitted to the light fittings. To minimise skyglow, the standards require no light output above the horizontal plane.

The design and operation of night lighting would also consider the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring*.

With regard to lighting at drilling sites, at this stage of the project drilling contracts have not been finalised and therefore exact details of lighting infrastructure to be utilised during drilling is not known. A general description of drill site lighting is provided below, however, further consultation on lighting will be undertaken with the Dark Sky Committee once a drilling contractor is finalised.

Drill sites of this nature require up to four light towers situated on the drill pad to provide general site lighting at night. Light towers are around ten metres in height with light fittings directed downwards to illuminate the work area and ensure workplace lighting requirements are met.

The drilling mast support provides localised light using tubular fluorescent bulbs with lighting pointing towards the mast itself. In addition, an aviation safety light (red light) is installed at the top of the mast.

Other site lighting is required to provide lighting of equipment and work areas to ensure safe operations. Many of the lights are mounted on swivels and can be easily moved and positioned for the work situation.

A number of the proponent's drilling contractors have worked in other environments where lighting impacts were an important consideration (e.g. residential proximity or fauna sensitivity) and have adapted practices in these situations to minimise lighting impacts.

Air quality at Siding Spring Observatory

The submission raised the concern that construction activities outside of daylight hours may result in dust emissions that enhance the scattering of light and contribute to unwanted skyglow. The submission sought assurance that dust mitigation procedures would be employed for construction at night.

With the exception of drilling and completion and well workovers which are required to operate continuously, construction activities will generally be limited to day time hours.

The Air Quality Impact Assessment undertaken for the EIS (EIS Appendix L) reported that ground-level concentrations of dust associated with the construction at Leewood and Bibblewindi sites are predicted to be below the impact assessment criteria at all sensitive receptors. Concentrations of dust were found to be relatively limited to the vicinity of the construction area for well pads, pipeline and access track construction.

Notwithstanding this, an Air Quality Management Plan would be implemented during construction and operation of the project. The Plan would include an air quality monitoring program and a suite of measures that could be implemented to prevent or minimise air emissions, where necessary.

Standard construction dust control measures that would be reflected in the Air Quality Management Plan include watering or application of commercial dust suppressants on disturbed soil surfaces, covering erodible material prior to transport and vehicle speed controls.

5.4 NSW Department of Primary Industries

Consent for disturbance to Crown land

The submission noted that disturbance to Crown land would require consent from the Minister administering the *Crown Lands Act 1989*.

The potential requirement for approvals for project infrastructure or activities on Crown land is acknowledged and was discussed in Section 4.5.4 of Chapter 4 of the EIS.

Justification for well pads in forested areas

The submissions requested justification for siting well pads in forested land despite the large areas of cleared land in the project area.

The project would be developed within the defined project area which comprises about 950 square kilometres, which is about 12 per cent of the existing Petroleum Exploration Lease (PEL) 238 area. The location and configuration of the project area within PEL 238 was based on the following opportunities and constraints:

- Residential zones – the project area would be more than two kilometres from residential zones and identified future residential growth areas, and would not impact on critical industry clusters as defined in the State *Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007* (the Mining SEPP).
- Conservation areas – the project area would avoid conservation areas such as the Pilliga National Park, the Pilliga State Conservation Area, the Pilliga Nature Reserve and the Brigalow Park Nature Reserve.
- Government policy – the project area would be consistent with government policy and would target an area that has been identified within the Strategic Regional Land Use Plans and the *Brigalow and Nandewar Community Conservation Area Act 2005* as suitable for development of natural gas from coal seams.
- Coal seam thickness and quality – there are positive subsurface geological indicators over the target gas areas, specifically within the Bohena Trough. For example, should the project be relocated slightly to the east, west or south of its current location, the Bohena Trough becomes shallower, resulting in coal seams thinning and ultimately pinching out. This would not result in an economic project.
- Known resource – the project area contains a significant gas resource. Exploration and appraisal in PEL 238 has enabled the proponent to confirm that the recoverable gas available in the project area can potentially underpin a commercial gas development. The same level of exploration and appraisal has not been undertaken by the proponent in other areas of PEL 238. As a result, the time required to produce gas from other areas in PEL 238 (assuming they hold sufficient gas) would be substantially longer.
- Biophysical strategic agricultural land (BSAL) – the project area would avoid areas of BSAL (refer to EIS Chapter 14 and Appendix I2). No agricultural land in the project area is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL) and detailed soil analysis has established the absence of BSAL. This has been confirmed by the issue of a BSAL Certificate for the project area by the NSW Government (refer to EIS Appendix I2).
- Existing leases – the project area would avoid the constraints of coal mining leases to the east. It also aligns on the western boundary with the existing PAL 2 lease.

The specific location of well pads will be determined in accordance with the Field Development Protocol (the Protocol) (see Appendix C to this RTS). The Protocol sets out the locational criteria for the infrastructure and the procedures to be implemented to ensure that the infrastructure is sited in accordance with the criteria. It provides a framework for the siting of gas wells and associated infrastructure to be installed within the project area and seeks to systematically avoid, minimise and manage the environmental impacts of the project in accordance with legislation, environmental, social and cultural constraints, management plans and proposed conditions if approved.

Approximately 75 per cent of the project area is native vegetation. Project infrastructure would be situated on approximately one per cent of the project area, therefore, around 99 per cent of the native vegetation will not be directly impacted.

Proposed direct impacts to native vegetation have been assessed, and following avoidance and mitigation, residual impacts will be offset in accordance with relevant policies. Please refer to Appendix J1 and Appendix J2 of the EIS.

Adequacy of agricultural impact statement

The submission stated the Agricultural Impact Statement was not produced in accordance with the *Guidelines for Agricultural Impact Statements* (NSW Department of Planning and Infrastructure 2012) and was required to be read in conjunction with the chapters of the EIS to be understood.

The Agricultural Impact Statement (Appendix K of the EIS) and various other supporting elements of the EIS were produced in accordance with, and with due consideration to, the *Guidelines for Agricultural Impact Statements* (NSW Department of Planning and Infrastructure 2012) and *Agricultural Impact Statement technical notes* (Department of Primary Industries 2013).

The Agricultural Impact Statement referenced other parts of the EIS where related technical assessments were provided. This was considered a practical approach to minimise the requirement to duplicate large volumes of technical assessments throughout the EIS. A detailed cross-reference of the matters in the guidelines and their location of their technical assessments is provided below in Table 5-1.

Table 5-1 Agricultural impact statement guidelines cross reference

Matters	Cross-reference
1.0 Information relating to the site and region: Detailed assessment of the agricultural resources and agricultural production of the project area	
1.1 Soil information	Appendix K Section 4.2 Land capability, including soils. This section also refers to separate technical soils reports that are appendices to the EIS, namely: • Appendix I1 Interpretive soils report • Appendix I2 BSAL certificate.
1.2 Slope and land characteristics	Appendix K Section 4.2 Land capability, including soils. Describes the land and soil capability (LSC) classes within the project area. More detailed description is included in Appendix I1 Interpretive soils report, which includes Section 3.1 topography and landform, topography and slope in the project area and geology and soil classifications in the project area.
1.3 Water characteristics (availability, quality)	Appendix F (Groundwater Impact Assessment), Appendix G1 (Managed Release Bohena Creek), Appendix G2 (Concept Irrigation Design), Appendix G4 (Water Baseline Report), EIS Chapters 7, 11 and 13.
1.4 History of agricultural enterprises within project area and surrounding land	Appendix K Section 4.4 Land use. Includes a description of current land use, with a number of tables and maps describing land use and agricultural enterprises within the project area as well for the region. Appendix K Section 4.5 Value of agricultural production. Describes value of production by enterprises within the Narrabri LGA and within the project area.
1.5 Location and areas of land to be temporarily removed from agriculture and the period of time	Appendix K Section 1.2 Description of the project. Provides details on key project components, including extent of wells, roads, tracks and supporting infrastructure. Appendix K Section 5 Impact assessment. Includes description and Table 5-1 of the area of land (hectares) to be temporarily removed from agriculture. EIS Chapter 6 – Project Description.
1.6 Location and area of land to be returned to agricultural use post project and its productive potential relative to pre-project	As per 1.5 above.

Matters	Cross-reference
1.7 Location and area of land that will not be returned to agriculture, including areas to be used for environmental plantings or biodiversity offsets	Appendix K Section 5 Impact assessment. Includes description and Table 5.2 of the area of land (hectares) to be removed from agriculture for approximately 25 years (i.e. the life of the project). Appendix L (Biodiversity Offset Strategy) to Appendix E (Ecological Impact Assessment).
1.8 Agricultural enterprises to be undertaken on buffer and/or offset zone lands for the life of the project	Appendix K Section 5 Impact assessment. Describes that it is proposed that water produced during gas extraction will be treated at the Leewood central water treatment facility and then be made available for irrigated agriculture. Appendix L (Biodiversity Offset Strategy) to Appendix E (Ecological Impact Assessment).
2.0 Identification of the agricultural resources and current enterprises within the surrounding locality of the project area	
2.1 Agricultural resources within locality, including: • Soil characteristics, including soil types and depths • Topography / slope • Key agricultural support infrastructure • Water resources and other water users' extraction locations • Location and type of agricultural industries • Climate conditions.	Appendix K Section 4.2 Land capability, including soils and Appendix K Section 4.4 Land use. Include a description of current land use, with a number of tables and maps describing land use and agricultural enterprises within the locality, predominantly Narrabri LGA. Other appendices describe soil resources: Appendix I1 Interpretive soils report and Appendix I2 BSAL certificate; and water resources: Appendix F Groundwater impact assessment and Appendix G4 Water baseline report. In addition: Appendix I2 was issued by DP&E under advice from OEH and is the result of BSAL clearance through extensive soil characterisation and assessment work in the Project's BSAL report. Topography / slope as described above in 1.2. Agricultural support and infrastructure in Appendix K and figures in Chapter 2 and 6. Climate conditions in Section 4.1 of Appendix K and also in Appendix L – Air Quality.
2.2 Current agricultural enterprises within the surrounding locality	As per 2.1 above, plus Appendix K Section 4.5 Value of agricultural production, which describes value of production by enterprises within the Narrabri LGA.
3.0 Assessment of impacts	
3.1 Identification and assessment of the impacts (including cumulative impacts) of the project on agricultural resources or industries	Appendix K Section 5 Impact assessment. Considers direct and indirect impacts. EIS Chapter 29: Section 29.3.7 for cumulative impact assessment.

Matters	Cross-reference
3.2 Account for physical movement of water away from agriculture	Appendix K Section 5 Impact assessment. Describes that it is proposed that water produced during gas extraction will be treated at the Leewood central water treatment facility and then be made available for irrigated agriculture. Various other technical reports are included as appendices to the EIS (Appendices F, G1, G2 and G4).
3.3 Assessment of socio-economic impacts	Appendix K Section 5.3 Economic impact. Includes Table 5.5 and Table 5.6 on the dollar value impacts at farm level. Other appendices consider broader socio-economic impacts, including Appendix T1 Social impact assessment, Appendix T2 Health impact assessment, Appendix U1 Economic assessment (cost benefit analysis), Appendix U2 Economic assessment (macroeconomic analysis). The above are summarised in EIS Chapters 26, 26, 27 and 27 respectively.
4.0 Mitigation measures	
4.1 Project alternatives	EIS Chapter 8
4.2 Monitoring programs to assess predicted versus actual impacts as the project progresses	Appendix K Section 6 Mitigation measures. Table 6.1 describes that Land Access Agreements, service agreements and Farm Management Plans would be developed in consultation with affected landholders, with on-going monitoring as required. EIS Chapter 30.
4.3 Trigger response plans and trigger points at which operations will cease or be modified or remedial actions will occur to address impacts including a process to respond to unforeseen impacts	Appendix K Section 6 Mitigation measures. Table 6.1 describes that Land Access Agreements, service agreements and Farm Management Plans would be developed in consultation with affected landholders, with on-going monitoring as required. EIS Chapter 30.
4.4 The proposed remedial actions to be taken in response to a trigger event	Appendix K Section 6 Mitigation measures. Table 6.1 describes a range of activities as on-going as required. These include: landholder engagement protocols, Land Access Agreements, notification processes, compensation provisions, infrastructure locations, rehabilitation, other property-specific mitigation as agreed with the landholder, including an Irrigation Management Plan where applicable. EIS Chapter 30.

Matters	Cross-reference
4.5 The basis for assumptions made about the extent to which remedial actions will address and respond to impacts	Appendix K Section 6 Mitigation measures. EIS Chapter 30.
4.6 Demonstrated capacity for the rehabilitation of disturbed lands to achieve the final land use and restore natural resources	Appendix K Section 6 Mitigation measures. Table 6.1 describes mitigation and management measures, including that a rehabilitation plan is proposed that includes measures to restore disturbed sites to a state that is as close as reasonably practical to the pre-construction condition or better, or to the satisfaction of landowners. Also included as attachments to the EIS are Appendix V Rehabilitation strategy and Appendix W Decommissioning report.
4.7 Demonstrated planning for progressive rehabilitation that minimises the extent of disturbance	See Appendix V Rehabilitation strategy and Appendix W Decommissioning report.
5.0 Consultation	Appendix K Section 2.2 Data sources. Describes consultation activities. Appendix D Stakeholder and community consultation report. Summarised in EIS chapters 17 and 9 respectively.

Monitoring of irrigation areas

The submission stated that ongoing monitoring and reporting of soil chemistry in irrigation areas against defined trigger levels should be a condition of consent.

The risks of impacting soil from irrigation activities were assessed in the EIS, including with reference to the ANZECC/ARMCANZ (2000) long-term irrigation trigger values and the *Environmental Guidelines: Use of Effluent by Irrigation (DEC 2004a)*. The assessment concluded the risk to soil structure from irrigation activities was low due to the quality of the treated water and its suitability for irrigation and other beneficial uses.

Produced water would undergo a desalination process whereby salinity would be reduced followed by amendment (addition of calcium and sulphate salts (e.g. calcium chloride; gypsum) to adjust the sodium adsorption ratio (SAR)). These treatment processes will produce irrigation water at a quality that does not present a risk of adverse impact to soil chemistry. Further, the desalinated and amended water would be of a quality that is consistent with that utilised for other irrigation activities.

Table 7-2 in Chapter 7 (Produced water management) of the EIS assessed the target treated and amended water qualities against applicable water quality guidelines aligned with proposed beneficial reuse options. This table has now been revised to include actual water quality data from the commissioned Leewood Water and Brine Treatment Plant (WBTP) and is presented in Table 6-4 of this RTS and in the updated Water Baseline Report at Appendix D to this RTS.

The results show that the treated water quality data meet the ANZECC/ARMCANZ (2000) long term (greater than 20 years) irrigation trigger values. Thus the water is suitable for the proposed irrigation activities.

There will be two forms of treated water monitoring to ensure appropriate water quality is maintained. Continuous monitoring for pH and electrical conductivity would be undertaken using real time on-line equipment. If the treated water quality does not meet the required specifications, the dedicated control system will ensure the water is re-treated.

In addition to the automated monitoring system, samples of the treated water would be analysed on a monthly basis by a National Association of Testing Authorities (NATA) accredited laboratory. A broad range of parameters would be analysed including compounds indicative of the chemicals used for treatment, cleaning and disinfection such as total residual chlorine.

This approach to ensuring the treated water quality meets the ANZECC/ARMCANZ (2000) long term (greater than 20 years) irrigation trigger values, including continuous on-line monitoring systems, ensures that the water to be used for irrigation is appropriate and ongoing soil monitoring is not warranted.

As committed in Chapter 31 of the EIS, irrigation of treated water during production will be undertaken in accordance with an irrigation framework under the Produced Water Management Plan.

Refinement of groundwater model

The submission noted that the groundwater model has a Class 1 confidence level and stated it would require revision and calibration based on a groundwater monitoring plan over the first five years of the project to improve this level of confidence.

The Water Monitoring Plan (EIS Appendix G3) includes triggers to update the groundwater modelling predictions. Model updates occur if either the Level 1 or Level 2 response trigger is exceeded. The Level 1 response trigger would be exceeded if there are three or more years in which realised cumulative water extraction exceeds cumulative water production defined in the EIS and this would require updating of modelling predictions. The Level 2 response trigger would be exceeded if pressure decline in Triassic Age strata (i.e. early detection monitoring) exceeds or is likely to exceed the predicted maximum drawdown published in the EIS and this would require revision and re-calibration of the model. If the response triggers are not exceeded, then the Water Monitoring Plan will be subject to the reporting regime as set out in Section 4.3 of the Water Monitoring Plan. The annual report to be prepared will include a review against the trigger levels for the reported year.

There is also provision in the Water Monitoring Plan for a periodical review to be undertaken after the first three years of operation and then every five years thereafter. The periodical reviews will assess the sufficiency of monitoring and identifying whether additional monitoring infrastructure is required. The Water Monitoring Plan will be updated to reflect resulting changes from the reviews.

Alternative conceptual groundwater models

The submission states alternative conceptual groundwater models were not considered.

Section 5 “Conceptual Hydrogeological Model” of the Groundwater Impact Assessment (EIS Appendix F) explains the conceptual model for the EIS is based on the conceptualisations of existing studies, including modelling of shallow alluvial sources within the Lower Namoi alluvium (Merrick 1999, 2000, 2001), the Lower Gwydir alluvium (Bilge 2002), the Upper Namoi alluvium (McNeilage 2006) and the Lower Macquarie alluvium (Bilge 2007).

Conceptualisation of the deeper groundwater sources in the EIS is based on investigation and modelling of the Great Artesian Basin (Radke *et al*. 2000; Welsh 2000, 2006) and modelling of the Gunnedah-Oxley Basin for the Namoi Catchment Water Study (SWS 2011, 2012). To the proponent’s knowledge, alternative hydrogeological conceptualisations of the Gunnedah Basin have not been proposed and the conceptualisation used in the EIS is directly comparable to that used in groundwater modelling of the area by the CSIRO’s Gas Industry Social and Environmental Research Alliance (GISERA) and for the bioregional assessments undertaken by the Commonwealth Government.

To the proponent’s knowledge, therefore, the conceptual hydrogeology of the project area is not disputed by the hydrogeological community and the use of alternative groundwater conceptual models for the project area is therefore not justified.

Classification and description of hydrostratigraphy

The submission questioned some classification and description of hydrostratigraphy in the Groundwater Impact Assessment, but stated these may be addressed in future iterations of the groundwater model.

The proponent concurs with the submission which states: “Given the confidence classification of Class 1, and regional nature of the model, there is unlikely to be value in addressing these issues at this stage. However, this may need to be addressed in future iterations of the model.”

There is also provision in the Water Monitoring Plan for a periodical review to be undertaken after the first three years of operation and then every five years thereafter. Review would include assessment of the need to re-evaluate the model through assessment against predicted trigger levels. Specifically, if the Level 2 response trigger is exceeded (i.e. if pressure decline in Triassic Age strata exceeds or is likely to exceed the predicted maximum drawdown published in the EIS), this would require revision and re-calibration of the model, which would include review of classification and description of the hydrostratigraphy.

Initial hydraulic head quantification

The submission states that initial hydraulic heads were derived through steady state runs of the groundwater model as opposed to observed and interpolated data.

This method was chosen to support the predictive simulations in the EIS as recommended in the Australian Groundwater Modelling Guidelines (Guiding Principle 4.5; Barnett *et al*., 2012).This is a commonly applied method in groundwater modelling studies.

Initial conditions derived using interpolation of observed data, as suggested in the submission (e.g. contouring based on kriging), would result in a distribution of hydraulic head that would not be founded in hydraulics (i.e. would not conform to Darcy's Law for groundwater flow) and would be in disequilibrium with the model boundary conditions and parameterisation.

Using interpolated groundwater head for the initial condition would thus be inappropriate as it would result in transient effects during predictive simulations unrelated to the project activities, rather simulations would reflect the imbalance of the initial condition.

Justification of modelled groundwater extraction

The submission recommended that further detail should be provided about the two modelling approaches considered for simulating water extraction from the target coal seams. It was recommended that further justification should be provided for using dewatered volumes to stimulate produced water extraction rather than prescribed drawdown in the target coal seams, including the uncertainty this might introduce regarding the predicted drawdown impacts in other groundwater sources, particularly in the Great Artesian Basin and alluvium.

The submissions requested justification of the approach to model the planned extraction of 37.5 gigalitres over 25 years rather than extraction to induce a required pressure for gas desorption.

The submission noted the assumed groundwater extraction volume and profile was based on a reservoir model. It requested that the assumptions, method and uncertainty of calculation of the groundwater extraction volume and profile be provided.

It requested details on assumptions and uncertainties associated with the planned extraction of groundwater and their sensitivity to temporal and spatial variability of field development.

Section 6.8.3 "Representation of Coal Seam Water Production" in the Groundwater Impact Assessment (EIS Appendix F) provides an explanation of the considered advantages and disadvantages of the two options for representing project water extraction:

- Option 1: Using the predicted volumes of water production from reservoir modelling; and

- Option 2: Lowering the pressure in the target coal seams to the level required for gas production and allowing the groundwater model to compute water production.

Option 1 supports assessment of potential impacts from induced groundwater flows consistent with the volume of water extraction being predicted for the project and the water extraction licenses being sought under the approval application.

Option 2, if implemented, would yield predictions of water extraction volumes that are variable dependent on the choice of hydrogeological properties, and would be inconsistent with the volume of water extraction being sought under the approval application.

Further rationale for choosing Option 1 is presented in the EIS Appendix F and summarised below.

Both options involve uncertainty in the prediction of drawdown in the GAB and Namoi alluvium. Predictions yielded from Option 1 are considered less uncertain than would be obtained using Option 2 because the predictions for Option 1 relate to a defined and fixed extraction volume of 37.5 GL for the Base Case. Option 2 would involve the same uncertainties inherent in Option 1 (i.e., those related to model design and parameterisation) and would have additional uncertainty due to the mismatch between the simulated water extraction and the expected water production from the reservoir modelling. For example, the sensitivity simulations conducted as part of the uncertainty analysis for the Base Case would all have different water extraction volumes, which would each differ from the Base Case water extraction.

The Base Case water production is informed by historical water production volumes in thirty-seven appraisal wells from seven coal seam gas pilots in Early-Permian targets. This information has been used in the reservoir modelling, such that the model mimics optimised water extraction.

The Base Case is designed to emulate the optimal production profile based on the data from the appraisal wells. The historical water-production data show that the cumulative water-production curve for the Base Case envelopes 36 out of 37 appraisal well cumulative production volumes and is significantly larger in volume that the average of the appraisal wells. On this basis, the modelling for the EIS may be considered conservative in that it assumes more production than anticipated based on experience from existing appraisal wells. The High Case represents a production curve that is significantly larger than the appraisal wells, with no appraisal well having produced more than half the production simulated by the High Case scenario.

The regional-scale groundwater model developed for the project is designed to assess the potential impacts from extraction of the water quantity needed to produce gas. The model is not the best tool for predicting appropriate depressurisation in the target coal seams to release gas that results from this water extraction. This is because, unlike the reservoir modelling, the regional-scale model does not model multi-phase flow processes and does not have a sufficient spatial resolution of the coal seams and sealing strata. Further, the scale at which the groundwater model is developed is too coarse to accurately evaluate spatial variability of the field development. As noted above, however, the modelled production curves are considered extremely conservative (over predict production volumes) compared to historical appraisal well data and hence present a worse-case scenario.

The existing sensitivity and uncertainty assessment in the Groundwater Impact Assessment of the EIS has tested model parameters that result in groundwater pressure drawdowns in the Great Artesian Basin and at the water table. The results are discussed in Section 6.10 of the Groundwater Impact Assessment and summary of results for all simulations are presented in Section 6.11 of the Groundwater Impact Assessment (EIS Appendix F).

Under the proposed Water Monitoring Plan, extensive groundwater monitoring data, including for groundwater levels, will be regularly collected. In addition, the volume of groundwater extracted will also be recorded. Monitoring results will be analysed and evaluated for significant trends. An annual report will collate and review observed changes in the condition of water sources, if discernible, against those predicted in the groundwater impact assessment and check data against the trigger levels. The monitoring data could be utilised in updating the groundwater modelling in accordance with management actions required in the event of level 1 or 2 response triggers being exceeded.

Provision of pilot well development groundwater information

The submission sought groundwater data collected during pilot well development appraisal including information on pressure declines in adjacent groundwater units.

Appraisal wells are not designed, operated or monitored in ways analogous to aquifer pumping tests and hence existing data acquired from operation of appraisal wells in general does not support analysis of hydrogeological properties of sealing strata above and below target coal seams. Thus, constraints mitigating against the use of pilot well data to assess pressure decline in adjacent groundwater units include: pressure monitoring occurs only in-seam; water extraction rates are variable by design and can have multiple draw points; flow is two-phase when gas is produced, and appraisal wells can have relatively complex in-seam alignments and inter-connections compared to water bores. Further, there is generally no monitoring of adjacent groundwater units.

Hence, data from the appraisal wells can inform the profile of water extraction over the life of the project and provide confidence in the extraction volumes modelled. Data from appraisal wells does not provide additional information that can inform model parameterisation or constraint, nor meaningful information on characteristics or impacts on adjacent groundwater units. With the exception of ongoing monitoring of groundwater pressure in the Porcupine Formation at the location of the former Bibblewindi 9-Spot pilot (described below), all groundwater pressure data acquired from the proponent's appraisal wells consist solely of in-seam pressure records.

The former Bibblewindi 9-Spot pilot, targeting Early Permian coal seams, ceased operation in 2012. Groundwater pressure monitoring in the Porcupine Formation (Bore BWD6) above the coal seams commenced in 2015. There is no period of overlap between the in-seam pressure monitoring during pilot operation and subsequent pressure monitoring in the Porcupine Formation. Water production at nearby pilots Bibblewindi West and Bibblewindi East, however, is currently ongoing. Pressure monitoring in well BWD6 has not been undertaken for long enough to date to assess whether groundwater pressure in the Porcupine Formation has been affected by historical water production from the former Bibblewindi 9-Spot pilot or ongoing water production from Bibblewindi West and Bibblewindi East pilots.

Validation of planned groundwater extraction

The submission stated that groundwater extraction must be monitored during production to validate planned groundwater extraction. It stated that adequate water entitlements must be held and that increased groundwater extraction would require further assessment.

Water production will be monitored and reported throughout the life of project; noting monitoring and reporting of water production volumes is required for the Level 1 response trigger identified in the Water Monitoring Plan (EIS Appendix G3). The proponent will acquire the relevant water licenses at the appropriate time.

Peak annual groundwater extraction

The submission sought clarification on the discrepancy of peak annual groundwater extraction values in years 2 to 4, stated as 3,650 megalitres in Chapter 11 (Groundwater and geology) of the EIS and 5,922 megalitres in the Groundwater Impact Assessment (EIS Appendix F).

The submission recommends that the proponent should state the maximum predicted take from all water sources and explain the difference throughout the EIS.

There are no discrepancies in the reported peak annual extraction rates. The two volumes cited refer to two different water-production scenarios, being the Base Case and the High Case, respectively.

The Groundwater Impact Assessment undertook predictive simulations for three volumes of water production for the project over the 25-year assessment period: the Base Case simulated cumulative water production of 37.5 gigalitres (GL); the Low Case of 35.5 GL; and the High Case of 87.1 GL. The three different water production scenarios generate three different peak annual groundwater extraction values for years 2 to 4.

Information regarding the maximum predicted take for all water sources is presented in the Groundwater Impact Assessment (EIS, Appendix F). Thus, for the Base Case example, Table 6-19 and Figure 6-33, in Appendix F, Section 6.9.1: “Base Case Simulated Water Production”, tabulate and show graphically the predicted rates of induced storage release (i.e. the net induced take) from all groundwater sources defined in applicable Water Sharing Plans. The maximum values of induced storage release (i.e. the maximum values of net induced takes) are included in these presentations of the modelling results. The maximum rates are also stated and discussed in the accompanying section text (e.g. seventh bullet point in Section 6.9.1.1). Table 6-51 in Appendix F, Section 6.11: “Summary of the Modelling Results”, contains a summary of the maximum rates of induced storage release in the Upper Namoi Alluvium, Lower Namoi Alluvium, Great Artesian Basin and Gunnedah-Oxley Basin groundwater sources for all predictive and sensitivity simulations considered in the EIS.

An equivalent assessment of predicted take for all water sources under the High Case scenario is presented in EIS Appendix F, Section 6.9.3: “High Case Simulated Water Production”, with similar modelling outputs (tables and figures) as produced for the Base Case (see Figure 6-49 and Table 6-23 onwards in Section 6.9.3 of EIS Appendix F).

Table 5-2 (below) presents an additional summary of the predicted maximum takes (i.e. the peak flux change at each water source base) from potentially impacted water sources for the EIS Base Case. For all other water sources not listed in Table 5-2, predicted takes are zero, or below the mass-balance accuracy of the groundwater model. The NSW Great Artesian Basin Surat Shallow Groundwater Source, as reported in Table 5-2, is not explicitly represented by the groundwater model, but this source entirely overlies the NSW Great Artesian Basin Surat Groundwater Source and incorporates the regionally extensive Rolling Downs Group aquitard. Predicted maximum take from the NSW Great Artesian Basin Surat Shallow Groundwater Source is therefore assessed to be less than the modelled prediction of 0.16 megalitres per year for the underlying Great Artesian Basin Surat Groundwater Source.

The EIS (Appendix F) thus presents the net flux (take) to each source; Table 5-2, below, reports the maximum take from the base of each source, directly comparable to the definition of water take in the water sharing plans.

Table 5-2: Peak induced flows (maximum take) for the EIS Base Case

Groundwater source	EIS Base Case (37.5 GL) Peak flux change at source base	
	ML/y	Time (years after start of FDP, to nearest model time step)
Gunnedah-Oxley Basin	3,553	3
GAB Southern Recharge	57.3	190 - 200
GAB Surat	0.16	950 – 1,000
NSW GAB Surat Shallow	<0.16	>1,000
Lower Namoi Alluvium	4.19	250 – 300
Upper Namoi Alluvium (UNA) UNA Zone 2 UNA Zone 5	1.00 0.16 0.90	250 – 300 550 – 600 250 - 300

Groundwater extraction licence

The submission stated the proponent will be required to seek groundwater extraction licence prior to the start of groundwater extraction for the project.

It noted that groundwater extraction licences would need to include induced flow from Lower Namoi, Upper Namoi and Great Artesian Basin water sources.

The submission is noted. The proponent will acquire the relevant water licences at the appropriate time.

Assumed climatic variables of groundwater model

The submission stated that the assumed climatic variables were not appropriate as only a percentage of rainfall was applied as a recharge estimate outside the Namoi alluvium.

The percentage of rainfall that was applied as a recharge estimate in the regional-scale groundwater model outside the Namoi alluvium is consistent with the review of recharge estimates conducted for the groundwater impact assessment and with estimates determined by others (e.g. Calf, 1978; Merrick, 1999, 2001; Smerdon and Ransley, 2012).

The review of regional studies concluded that the existing estimates of groundwater recharge into outcrop units of the Gunnedah-Oxley Basin are around one per cent of rainfall or less (EIS Appendix F, Section 5.5.2). In the groundwater modelling, the applied rainfall recharge percentages outside the alluvium area are one per cent in areas where transmissive units outcrop (e.g. Pilliga Sandstone); 0.1 % in areas where aquitard units outcrop (e.g. Permo-Triassic units) and 0.15 % over the areas of the Liverpool Ranges and Warrumbungle volcanics (EIS Appendix F, Section 6.4.5).

Calibration of groundwater model

The submission stated that calibration of the groundwater model is satisfactory as a Class 1 model but notes it was not calibrated based on data collected during pilot well development.

Pilot well developments provided two sources of data that were incorporated into the regional-scale groundwater model: 1) estimates of water production rates, and 2) estimates of coal seam depressurisation (pumping) response.

1) Water production rates were incorporated into the model as model inputs. A base case and high case water production were inputs to the transient model runs. Since they are model inputs, by definition they cannot also be calibration targets.

2) Estimates of coal seam depressurisation (pumping) response data from pilot well development were incorporated into the calibration of the model. Analysis of pilot-well data provided a range of possible permeability values for the coal seams which constrained the calibration of coal seam formation permeability.

It is important to note that the regional-scale model cannot be calibrated directly to local scale pilot-well pumping responses. The large scale of the model is not appropriate for replicating small scale pumping responses. For example, the observed local-scale depressurisation response from a pilot well might not influence more than the equivalent of a single model cell of the regional-scale groundwater model.

For regional-scale groundwater models, data from aquifer pumping tests are usually analysed using an appropriate technique (e.g. an analytical pumping test solution) to derive an indirect estimate of the aquifer hydrogeological properties. These derived values can then be used to inform the parameterisation of regional-scale groundwater models. Aquifer pumping tests are designed and conducted specifically to collect the types of data required to undertake pumping-test analyses. This is analogous to permeability data indirectly acquired from pilot well development.

Detail of groundwater model predictions for comparison

The submission stated that groundwater model predictions were not sufficiently detailed to allow comparison with observed data during operation of the project.

The proponent’s proposed water monitoring network includes sentinel monitoring bores that are strategically located both within deeper formations close to target coal seams and centralised around the first phase of production to maximise likelihood of registering a response if one occurs. The monitoring plan specifically includes trigger values for early warning and threshold actions for impacts to local receptors. These trigger values are derived from detailed groundwater model predictions, and have been defined so that they can be compared against observed monitoring data during the operation of the project.

All monitoring data is compiled into a reporting framework, such that sufficiency of monitoring will be regularly assessed to allow identification of additional monitoring requirements. The Water Monitoring Plan (EIS Appendix G3) would be updated to reflect changes that are considered to be required.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

Correlation of model outputs to objectives

The submission stated that for comprehensibility the model results listed in Table 6-15 of the Groundwater Impact Assessment (EIS Appendix F) should be linked to project or model objectives.

Table 6-15 in Section 6.8.9 "Modelling Outputs and Visualisation of Results" of the Groundwater Impact Assessment (EIS Appendix F) contains a description of the ways in which the groundwater modelling results have been summarised in tabular and graphical forms (i.e. an explanation of the types of tables and figures used to present the modelling results). The modelling objectives are stated earlier in Section 6.1 of the Groundwater Impact Assessment.

The relationships between the results, tables and figures and the groundwater modelling objectives are as follows:

- The objective: *Estimate changes in hydraulic head in the target coal seams, and head and water table elevations in connected hydrostratigraphic units due to the proposed coal seam gas field development activities*, is informed by:
  - Table – Summary of maximum predicted drawdown
  - Map – Maximum predi*cted* drawdown
- The objective: *in areas where drawdown is predicted, estimate the recovery time for hydraulic head to return to pre- coal seam gas development levels*, is informed by:
  - Table – Induced storage releases (net takes) from Water Sharing Plan groundwater sources due to coal seam water production
  - Time series graph – Induced storage releases (net take) from Water Sharing Plan groundwater sources due to coal seam water production
- The objective: *Identify and quantify the potential groundwater loss or gain in each Water Sharing Plan zone due to intra- and inter-formational flows*, is informed by:
  - Table – Summary of WSPRA groundwater fluxes
  - Bar charts – Maximum change in flow rates between WSPRAs and total volumetric exchange between WSPRAs
  - Time series graphs – Time variation of flow rates between WSPRAs
  - Sankey diagram – Total volumetric contributions to coal seam water production
- The objective: *Identify those landholders who may potentially be impacted by coal seam gas activities and quantify the predicted impacts*, is informed by:
  - Table – Summary of maximum predicted drawdown
  - Map – Maximum predicted drawdown.

Assessment against *Aquifer Interference Policy*

The submission notes that the model is limited in its ability to produce results at the scale and accuracy to assess it against the *Aquifer Interference Policy*. It stated this would be possible with further data collection and model refinement in the first five years of the project.

The submission stated that the assessment should consider items 14 to 16 of the *Aquifer Interference Policy* given the confidence level of the groundwater model.

The Water Monitoring Plan (EIS Appendix G3) includes management actions to update the groundwater modelling predictions if either Level 1 or Level 2 response triggers are exceeded. The

Level 1 response trigger would be exceeded if there are three or more years in which realised cumulative water extraction exceeds cumulative water production in the EIS and would require updating of modelling predictions. The Level 2 response trigger would be exceeded if pressure decline in Triassic Age strata (early detection monitoring) exceeds or is likely to exceed the predicted maximum drawdown published in the EIS and would require revision and re-calibration of the model. Either could occur in the years following commencement of water production (i.e. more or less frequently than every five years).

If the response triggers are not exceeded, then the Water Monitoring Plan will be subject to the reporting regime as set out in Section 4.3 of the Water Monitoring Plan. The annual report to be prepared will include a review against the trigger levels for the reported year.

There is also provision in the Water Monitoring Plan for a periodical review to be prepared after the first three years of operation and then every five years thereafter. The periodical reviews will assess the sufficiency of monitoring and identifying whether additional monitoring infrastructure is required. The Water Monitoring Plan will be updated to reflect resulting changes from the reviews.

The proponent acknowledges that items 14 to 16 in Table 2 of the *Aquifer Interference Policy* were omitted from *Appendix D - Aquifer Interference Framework* within the Groundwater Impact Assessment (EIS Appendix F). The subject matter of these items, however, was addressed within the EIS and items 14 to 16 are specifically addressed below.

Table 2 of the aquifer interference assessment is a sixteen-point checklist that asks the question: Has the proponent:

- *Item 14: Considered the potential for causing or enhancing hydraulic connections, and quantify the risk?*

  The Risk Assessment in Section 7 of the Groundwater Impact Assessment (EIS Appendix F) considers potential risks of aquifer connectivity via wells (Section 7.4.2), including coal seam gas wells (7.4.2.1), conventional gas wells (7.4.2.2), coal mine core holes (7.4.2.3) and groundwater bores (7.4.2.4). Potential for enhanced aquifer connectivity via geological faulting is also addressed in Section 7.4.3 of the Risk Assessment.

- *Item 15: Quantified other uncertainties in the groundwater or surface water impact modelling conducted for the activity?*

  Groundwater modelling uncertainty and sensitivity analysis are considered in Section 6.10 of the published Groundwater Impact Assessment (EIS Appendix F).

- *Item 16: Considered strategies for monitoring actual and reassessing predicted take of water throughout the life of the project, and how these requirements will be accounted for?*

  The proponent is committed to monitoring and reporting groundwater extraction for the project. Monitoring and reporting of water production volumes is included as a minimum impact consideration in Section 3.7.2 of the Water Monitoring Plan (EIS Appendix G3).

Provision of baseline groundwater level and pressure data

The submission requested that the proponent provide all available baseline groundwater data by geological unit including target coal seams including:

- groundwater level data
- groundwater pressure data

- hydraulic property data.

The submission acknowledged that some information was summarised in the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS).

The submission also requested justification that the baseline groundwater data adequately characterised spatial and temporal variations and an assessment of whether the collected data could be interpolated to a groundwater level and pressure surface.

The proponent notes:

- All available hydrogeological data is presented in the revised Water Baseline Report. This includes all water level / water pressure data and hydraulic properties reported by hydro-geological formation and described spatially in relation to the project.
- The data on hydrogeological properties summarised in Section 5.3 and Appendix C of the Groundwater Impact Assessment (EIS Appendix F) (for target seams and overlying geological units) are referenced to their sources and are publicly available. Relevant data compilations will be explicitly described and presented in the updated Water Baseline Report.

The proponent has updated the Water Baseline Report as part of this RTS (refer to Appendix D).

The Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS) was written as a statement of the current status of baseline groundwater and surface water data for the project. The baseline data are presented in the Water Baseline Report without interpretation. The Water Baseline Report provides spatial and temporal data for all available monitoring sites. The interpolation and interpretation of this data is provided in the Groundwater Impact Assessment (Appendix F of the EIS).

Clarifications of baseline groundwater data

The submission sought clarification of groundwater quality data in the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS).

The submission stated the pH, potassium and sulfate values reported in Table 4-3 of the Water Baseline Report were unusually high and may be indicative of sample contamination. The submission stated that dissolved oxygen or Eh data may clarify the reported sulfate values.

The submission stated that pH values reported in Table 4-4 were unusually low and may be indicative of degassing during storage of samples. More generally, the submission noted unusual pH values for some individual bore samples.

The submission stated that quality assurance evidence, trend analysis and field measurements that would collectively demonstrate sample integrity were not provided.

The Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS) does not offer interpretation of observed values. Quality control and assurance of baseline data is addressed through the proponent's quality assurance process, which includes Standard Operating Procedures for sample collection and analysis, and all data is subjected to stringent data verification and validation prior to being published (see Appendix B of the Water Baseline Report).

The updated Water Baseline Report presents time-series data for water levels and pressures. Water quality data are presented as ranges, with variability in the short time-series currently not conducive to trend analysis.

The proponent notes that the high values reported as maximum levels represent isolated samples that may be outliers in the dataset, but which cannot be eliminated following standard QA/QC procedures. These data, however, would skew trend analysis. Some values represent older data while some may represent samples taken before final development of the bore (i.e. they may still contain components of drillings fluids). Consistency in field salinity and pH are used to verify a sample population's integrity and these have been re-presented in the updated Water Baseline Report (Appendix D to this Response to Submissions).

Provision of information on landholder bores

The submission requested further information on existing landowner bores identified in the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS) including location, data collected and frequency of collection.

Landholder bore data was provided in confidence and therefore will only be presented in aggregate and without reference to individual bores. Note that the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS) states that "these data do not form part of the formal groundwater baseline".

Government groundwater monitoring bores

The submission stated that the assignment of the following groundwater bores to groundwater units differed from the interpretation of the DPI Water, being:

- GW021266-4
- GW025338-3
- GW025340-3
- GW025343-2
- GW030121-1
- GW030121-3
- GW030310-2
- GW030400-1
- GW036497-1
- GW036546-1
- GW036546-2
- GW036546-3.

It sought clarification of the assignment of the groundwater bores to groundwater units and an assessment of subsequent changes to the assessment of baseline groundwater conditions.

The proponent acknowledges the assigned geological units may be incorrectly assigned and review of NSW Office of Water Work Summaries results in re-assignment of some of these bores as defined below (note that none of these bores had chemistry data and were only recorded for water levels – changes to these bores does not impact on the modelling nor the impact assessment):

GW021266-4, Orallo Fm, 107.3-113.4; Geologist and driller logs indicate this pipe is located the Lower Naomi Alluvium	Reassign from Orallo Fm to Lower Namoi Alluvium (logged as gravel).
GW025338-3 Mooga Ss - Geologist log indicates this pipe is located the Lower Naomi Alluvium	Keep as Mooga Sandstone (logged as sandstone).
GW025340-3 Mooga Ss - Geologist and driller logs indicate this pipe is located the Lower Naomi Alluvium	Reassign from Mooga Sandstone to Lower Namoi Alluvium (logged as sandy clay).
GW025343-2 Mooga Ss - Geologist and driller logs and depth indicate this pipe is located the Lower Naomi Alluvium	Keep as top of Mooga Sandstone or reassign to bottom of Lower Namoi Alluvium (logged as transition from fine gravel to sandstone).
GW030121-1 Pilliga Ss - Geologist, driller logs and depth indicate this pipe is located the Lower Naomi Alluvium	Reassign from Pilliga Sandstone to Lower Namoi Alluvium (logged as gravel and coarse sand).
GW030121-3 Pilliga Ss - Sandstone based on drillers log only. No geologist log available could be in Lower Naomi Alluvium	Keep as top of Pilliga Sandstone (logged as sandstone).
GW030310-2 Pilliga Ss - Geologist and driller logs indicate this pipe is located the Lower Naomi Alluvium	Reassign from Pilliga Sandstone to Lower Namoi Alluvium (logged as large gravel and stones).
GW030400-1 Pilliga Ss - Geologist and driller logs indicate this pipe is located the Lower Naomi Alluvium	Reassign from Pilliga Sandstone to Lower Namoi Alluvium (logged as gravely clay).
GW036497-1 Napperby Fm - Geologist and driller logs and depth indicate this pipe is located the Upper Naomi Zone 2 alluvium	Reassign from Napperby Formation to Lower Namoi Alluvium (logged as sand and gravel).
GW036546-1 Digby Fm - Geologist and driller logs indicate this pipe is located the Upper Naomi Zone 2 alluvium	Reassign from Digby Formation to Lower Namoi Alluvium (logged as sand bands and sandy clay).
GW036546-2 Napperby Fm - Geologist and driller logs and depth indicate this pipe is located the Upper Naomi Zone 2 alluvium	Reassign from Napperby Formation to Lower Namoi Alluvium (logged as clay bands and sandy gravel).
GW036546-3 Black Jack Gp - Geologist and driller logs indicate this pipe is located the Upper Naomi Zone 2 alluvium	Reassign from Black Jack Group to Lower Namoi Alluvium (logged as clay bands and sandy gravel).

Development of Groundwater Monitoring Plan

The submission recommended a Groundwater Monitoring Plan be developed in consultation with DPI Water and define:

- Monitoring sites appropriate for early detection of impacts.
- Appropriate impact thresholds and mitigation strategies.
- Appropriate monitoring bore construction standards.

The submission stated the purpose of the Plan would be to collect sufficient data to review and calibrate the groundwater model in consultation with DPI Water in the first five years of the project and five year intervals thereafter.

The proponent is committed to implementing a groundwater monitoring program capable of early detection of impacts of the project on groundwater resources and dependent users. The Water Monitoring Plan (EIS Appendix G3) is founded on the principle of early detection monitoring (Section 3.1) and identifies monitoring thresholds and trigger levels and associated management actions for mitigation of potential impacts (Section 3.7).

The proponent's proposed water monitoring network thus includes sentinel monitoring bores that are strategically located both within deeper formations close to target coal seams as well as centralised around the first phase of production. The bores would be installed in accordance with the *Minimum Construction Requirements for Water Bores in* Australia (NUDLC 2012), including the mandatory requirements and the recommendations for good industry practice. The Water Monitoring Plan includes trigger values for early warning and threshold actions for impacts to local receptors. It therefore achieves the aims recommended by the submission.

All monitoring data is compiled into a reporting framework, such that sufficiency of monitoring will be continuously assessed to allow identification of additional monitoring requirements. The Water Monitoring Plan is to be updated to reflect changes that are considered to be required.

The Water Monitoring Plan includes management actions trigger to update the groundwater modelling predictions. Model updates occur if either the Level 1 or Level 2 response trigger is exceeded. The Level 1 response trigger would be exceeded if there are three or more years in which realised cumulative water extraction exceeds cumulative water production in the EIS and would require updating of modelling predictions. The Level 2 response trigger would be exceeded if pressure decline in Triassic Age strata (early detection monitoring) exceeds or is likely to exceed the predicted maximum drawdown published in the EIS and would require revision and re-calibration of the model. Either could occur in the years following commencement of water production (i.e. more or less frequently than every five years).

There is provision in the Water Monitoring Plan for a periodic review to be prepared after the first three years of operation and then every five years thereafter. The periodic reviews will assess the sufficiency of monitoring and identify whether additional monitoring infrastructure is required. The Water Monitoring Plan will be updated to reflect resulting changes identified in the reviews.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

Currency of background groundwater use

The submission notes that background groundwater use data is provided to 2011. It states that more recent data for subsequent years should be provided.

These data were used to illustrate historical groundwater extraction in the Groundwater Management Areas (GMAs) and provide general context for comparing existing groundwater usage and the proposed annual volume of groundwater extraction by the project. The data are not used in the Groundwater Impact Assessment for the groundwater modelling or for assessing potential impacts on groundwater resources from the project. The data are used to constrain the steady-state calibration of the model and provide representative average conditions for the region.

Estimates of annual groundwater extraction from the Namoi Alluvium, Gunnedah-Oxley Basin and Peel Valley GMAs in Section 5.5.3 “Groundwater Extraction” of the Groundwater Impact Assessment (EIS Appendix F) span the 27-year period 1985 to 2011. The years 1996-2000 were chosen as representative of a period of relatively consistent extraction rates and are comparable to the Long-term Average Annual Extraction Limits and issued extraction licences reported in the EIS (see Chapter 11, Tables 11-2 and 11-3).

Groundwater hydrographs and analysis

The submission indicated there is inadequate presentation of modelled and observed hydrographs. It stated that limited hydrographs were provided the groundwater impact assessment but noted further information was provided in the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS).

The submission noted Section 5.4.3 of the Groundwater Impact Assessment (EIS Appendix F) that assessed the effect of pilot well development on a nearby monitoring bore. It stated that it was inappropriate to draw conclusions based on this scenario due to the limited duration of monitoring and the smaller volume of water pumped during pilot well development than during the project.

The groundwater model is calibrated in steady state, which precludes presentation of modelled and observed hydrographs (i.e. transient data). As noted in the submission comment, hydrographs showing historical groundwater pressure in selected groundwater monitoring bores are presented in the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS).

The predicted impacts of the project on groundwater pressure in high-valued groundwater sources of the Great Artesian Basin and Namoi Alluvium are too small to be discernible if presented as hydrographs spanning many hundreds of years. Instead, maps of maximum drawdown have been prepared for the high-valued groundwater sources, showing both the maximum value of drawdown in each model cell and the times these maxima occur. These maps are a more effective way of summarising the drawdown predictions from the groundwater modelling.

Regarding the assessment of pressure data collected from the Bibblewindi 6 well (BWD6) at the Bibblewindi 9-Spot pilot, the proponent acknowledges the existing pressure measurements in BWD6 are not sufficient to assess effects of water extraction on groundwater pressure or the trend in groundwater pressure in the Porcupine Formation.

Adequacy of baseline groundwater data to inform monitoring

The submission stated the baseline groundwater data presented in the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS) were not sufficiently detailed to determine thresholds.

The Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS) presents all data in summarised form, either as charts or tables that assimilate all collected data. This report has been updated and revised to encompass all data available to July 2017.

The level 2 groundwater monitoring thresholds in the Water Monitoring Plan were not determined using existing baseline water monitoring data. Instead they are based on the predicted maximum drawdowns for the project determined through the groundwater modelling. This approach is conservative as it provides early detection of the potential for unexpected impacts to occur. The level 2 trigger monitoring points are located in the Triassic Age strata of the Gunnedah Oxley Basin such that if a level is triggered, management actions including further investigation can commence to ascertain if the impact is likely to propagate to the shallower high valued groundwater sources. The trigger levels for each monitoring location are set out in Table 3-13 of the Water Monitoring Plan (EIS Appendix G3).

All monitoring data is compiled into a reporting framework, such that sufficiency of monitoring will be regularly assessed to allow identification of additional monitoring requirements to determine thresholds. The Water Monitoring Plan (EIS Appendix G3) is to be updated to reflect changes that are considered to be required.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

Adequacy of groundwater monitoring network to detect change

The submission stated the groundwater monitoring network presented in the Water Monitoring Plan (EIS Appendix G3) was not adequate for early detection of changed groundwater conditions.

It stated monitoring locations were too distant to the target coal seams and recommended the network be expanded to include locations stratigraphically closer to target seams.

It also noted the groundwater monitoring network was not sufficiently extensive to improve the conceptualisation groundwater flows in the groundwater system.

It recommended that these issues be addressed through the further development of the Groundwater Monitoring Plan for the project.

The proposed water monitoring network comprises sentinel monitoring bores that are strategically located both within deeper formations close to target coal seams. This approach is conservative as it provides early detection of the potential for unexpected impacts to occur. The monitoring points are located in the Triassic Age strata of the Gunnedah Oxley Basin such that if a level is triggered, management actions including further investigation can commence to ascertain if the impact is likely to propagate to the shallower high valued groundwater sources. The trigger levels for each monitoring location are set out in Table 3-13 of the Water Monitoring Plan (EIS Appendix G3).

All monitoring data is compiled into a reporting framework, such that sufficiency of monitoring will be continuously assessed to allow identification of additional monitoring requirements. The Water Monitoring Plan is to be updated to reflect changes that are considered to be required.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

General comments on Water Baseline Report

The submission raised a number of general comments and editorial issues regarding presentation of information in the Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS).

1. *Appendix G3, Table 4-1, be corrected to note that GW036546-1 is a DPI Water monitoring bore not a Santos owned monitoring bore.*

   Response: Submission comment noted and EIS corrected. It is a typographical error.

2. *Revise the geological units the proponent has assigned to 12 Government monitoring bores sites (EIS Appendices G3 and G4) in consultation with DPI Water (refer to table in the response above re "Government Groundwater Monitoring Bores").*

   Response: Submission comment noted and EIS corrected. See item "Government groundwater monitoring bores", above.

3. *To address whether a change in strata identified in the baseline monitoring report and the monitoring plan will revise their conclusions regards the adequacy of early detection monitoring network, EIS Appendix G3, or their assessment of the adequacy of baseline information in Gunnedah Oxley Basin, EIS Appendix G3.*

   Response: The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

4. *For groundwater quality data reporting a description of the quality assurance / quality control measures for all aspects of the data presented (field, office, lab and database) should be presented in the Water Baseline Report and Water Monitoring Plan.*

   Response: Quality control and assurance of baseline data is addressed through update, revision and re-issue of the Water Baseline Report.

5. *Correct the inconsistency in the reported number of groundwater quality monitoring bores: 40 in Table 3-2, 42 in Section 4-2.*

   Response: Submission noted and updated in the amended Water Baseline Report (see Appendix D to this Response to Submissions).

6. *Describe how the following data anomalies in Table 4-3 will be addressed in determining baseline conditions:*

   a. *CO_3 levels when at the reported pH, CO_3 would be non-detectable (Minimum pH = 5.8 yet min. CO_3 = 1 mg/L)*
   b. *reported values for pH range and maximum (pH 6.6 – 13)*
   c. *high pH in some bores may indicate influence from bore cement grouting*
   d. *K^+ concentrations are excessively high for natural conditions*
   e. *Inclusion of D.O. and Eh data associated with the SO_4^{2+} concentrations.*

   Response: Submission noted and addressed in the revised Water Baseline Report amended (see Appendix D to this RTS):

   a. Within the table, all values recorded as "1" should be labelled as "<1". This error has been addressed.
   b. There is a wide range of pH across each formation; within individual bores, however, the range is restricted. There are very few samples with pH>10.
   c. The influence of drilling fluids is apparent in some early samples for some deeper bores, particularly where the samples are from fine-grained or low permeability strata. This can affect the pH and a few constituents (e.g. K), but the samples are retained for the information on minor and trace constituents. Where determined this effect is highlighted in the Water Baseline Report.
   d. The few very high values may represent remnant drilling fluids that have incompletely flushed from the well. This can be determined as the concentration will change (lower) over time).
   e. Very few D.O. or Eh analyses have been undertaken, and are not included in the standard sampling protocols. In part, this is because these measurements must be undertaken in the field with carefully calibrated equipment to be meaningful, but mainly as early

determinations were generally low D.O. (< 2 ppm) for the majority of deep bores and highly variable for shallow (alluvium) bores.

7. *Discuss in relation to data Table 4-4*

   a. *whether the pH range 4.1 - 9.5 is realistic, and*

   b. *the reasons for the extreme pH values tabulated for many individual groundwater samples*

   Response: Submission noted and the Revised Water Baseline Report checked and confirmed (see Appendix D to this RTS):

   a. The pH range represents the full range recorded across all samples collected from the Pilliga Sandstone and does not discriminate between Lower and Upper Pilliga, nor by location. The extended range compared to the field determinations indicates on-going reactions in the sample bottles, which is common for samples with relatively high bicarbonate levels and indicates dis-equilibrium chemistry in the aquifer, confirming that groundwaters continue to evolve as they move through the substrate.

   b. The pH range can vary based on the conditions at the point of monitoring. The influence of drilling fluids is apparent in some early samples for some deeper bores, particularly where the samples are from fine-grained or low permeability strata. This can affect the pH and a few constituents (e.g. K), but the samples are retained for the useful information on minor and trace constituents.

Limited information on baseflow in rivers

The submission stated the Groundwater Impact Assessment (EIS Appendix F) and Groundwater Dependent Ecosystem Report (EIS Appendix B to Appendix F) contained limited information on base flow in rivers.

Section 4.4.4 Surface Water–Groundwater Interaction of the Groundwater Impact Assessment (EIS Appendix F) presents information regarding baseflow to rivers and streams in the study area. Several assessments have mapped gaining (baseflow) and losing reaches of rivers and streams.

The location and extent on baseflow in rivers has been presented in Appendix F of the EIS. The potential for impact to baseflow in rivers is predicted, by proxy, from the degree of impact to shallow alluvial aquifers to which they are connected. The numerical groundwater model demonstrates that the predicted impact to shallow alluvial groundwater that is connected to rivers and streams (that forms the baseflow component of the water balance) is determined to be negligible.

Data presentation including measurement error reporting

The submission stated that the measurement error was not reported for directly measured quantities such as groundwater piezometry, chemical concentrations or hydraulic flows.

Quality control and assurance of baseline data is addressed in the updated Water Baseline Report (Appendix D of this RTS).

Specifically, time series of pressure and level data illustrate temporal variability that includes measurement error, whilst the limit of reporting is provided for chemical concentrations which is also a measure of the measurement error.

Consideration of Groundwater Dependent Ecosystems

The submission notes that Appendix B of the Groundwater Dependent Ecosystem Report (EIS Appendix B to Appendix F) contains Groundwater Dependent Ecosystem summary sheets that suggest high or moderate ecological value, whilst the conclusion of the report is that all Type 2 (spring / baseflow) Groundwater Dependent Ecosystems have low ecological value.

The submission suggests an adequate monitoring program should be developed to monitor impacts to Groundwater Dependent Ecosystems.

The data sheets and report follow the *NSW DPI Risk assessment guidelines for groundwater dependent ecosystems*. Evaluations made by remote sensing and high resolution imagery on the potential for sensitive species finds that whilst features may be Groundwater Dependent Ecosystems (GDEs), their potential for sustaining Matters of National Environmental Significance is low.

The proponent acknowledges that there is an omission of listing of Type 1 GDE. The Namoi aquifer is, however, acknowledged as a GDE in the Bohena Creek study, though it was not mentioned in the GDE Report as the focus for that assessment was on 'spring' ecosystems; rather than on all GDEs.

The proponent notes that more sampling in Bohena Creek alluvium may find stygofauna (Type 1 GDEs). Taxa in Bohena Creek alluvium, however, are also highly likely to be present in the Namoi Alluvium, and unlikely to be new species.

Two GDEs, Hardy and Eather Springs, were not sampled as access was not able to be obtained from the landholder.

The main GDEs in the project area are the Type 2 waterholes on Bohena Creek, which were sampled and reported in the Bohena Creek reports. The risk of impact to GDEs will be monitored and managed throughout the life of the project, with the Water Monitoring Plan focussed on early detection of a specific and measurable change that can be easily and objectively related to the proposed project activities. The Water Monitoring Plan for the project does not propose to monitor GDEs because they are not predicted to be impacted. There is an insignificant risk of impact to GDEs due to the large degree of physical separation, both vertically in the sub-surface and horizontally at the surface, and therefore lack of connectivity between the target coal seams and GDEs. Hence, additional baseline data would not be of benefit to aid GDE protection.

In the long term, monitoring results may trigger monitoring closer to GDEs. The monitoring program is designed, however, that such a management response would occur many years, and potentially decades, in advance of measurable change to aquifers that support GDEs and could be objectively linked to project activities.

Bohena Creek hydrological gauging station

The submission stated that the Bohena Creek hydrological gauging station would not be an appropriate reference for triggering managed release at the managed release point.

It stated it Bohena Creek hydrological gauging station would not be representative of conditions at the managed release point due to its downstream location.

The submission also noted that Bohena Creek hydrological gauging station would not have the capacity to detect flows in the order of 100 megalitres / day.

To resolve this issue, the submission recommended the installation of a hydrological gauging station in close proximity to the Bohena Creek managed release point. It also recommended the existing Bohena Creek gauging station at Newell Highway be upgraded.

Modelling of the catchment and use of upstream-downstream monitoring of the discharge site during discharge events will calibrate the site to the Newell Highway gauge. No gauging will be required at, or upstream of, the discharge site. The variable nature of the stream bed at the proposed discharge site does not lend itself to the establishment of a permanent gauge. The site at the Newell Highway bridge, however, presents as a competent, defined channel and thereby provides an ideal location to calibrate flow down the Bohena Creek. The distance of eight kilometres from the proposed discharge site is not excessive and can be accurately calibrated to the Newell Highway gauge.

The proponent acknowledges that the current gauge at the Newell Highway gauging station has poor sensitivity below 1,000 megalitres per day and that a refined gauge may need to be installed at that site.

Bohena Creek discharge may generate additional sedimentation and damage

The submission suggested that the discharge will create additional sedimentation, which upon entering the Namoi will affect Eel-tailed Catfish and flood-entrained material may potentially cause damage to pipeline footings.

The operation of the managed release will not raise the velocity of the creek waters 30+ kilometres downstream at the confluence with the Namoi sufficiently to cause additional sedimentation. Thus, there is no potential for effects on the Eel-tailed Catfish in the Namoi as a result of sedimentation caused by the project. The minimum receiving water flow rate (100 megalitres per day) is 10 times the proposed maximum rate of discharge. The nature of flow in the creek is such that when it flows it typically flows at considerably greater rates than 100 megalitres per day, and hence the discharge will be unidentifiable in the receiving water flow past the mixing zone.

Pipeline footings will be designed appropriately to meet the need to sustain flooding impacts and protect the integrity of crossing pipes.

Bohena Creek monitoring for ecological health

The submission noted the potential impact of releases on Bohena Creek ecological health maybe difficult to determine in the short term and recommends that a “cautionary approach” be adopted and that “continued monitoring of water quality in conjunction with ecological monitoring (as outlined in Appendix G1, page XIV (in the EIS) should provide a reliable benchmark (or control) for potential changes that may be detected in relation to treated water release.”

The proponent notes that an ecotoxicological assessment of the potential impacts of the managed release has been undertaken and findings included in the EIS (Appendix G1). The study found no potentially detrimental impacts would occur from the managed release to the creek during the managed release scenario flow event of greater than 100 megalitres per day.

The proposed surface water quality monitoring program is set out in the Water Monitoring Plan. The approach includes monitoring both surface water flows and Bohena Creek water quality in locations both upstream and (a number) downstream of the managed release location. Monitoring would be conducted at the end of a managed release event and again within five to seven days after the end of a managed release event.

Bohena Creek managed release water quality

The submission noted the discussion of ANZECC/ARMCANZ (2000) trigger values in the assessment and recommended overall mean (or where possible maximum) salinity concentrations of treated water discharge to Bohena Creek remain at 357 microSiemens / cm so Namoi River salinity targets are met.

The submission also noted that the predicted maximum treated mercury concentrations exceed the ANZECC/ARMCANZ (2000) trigger value for freshwater ecosystems and suggest “that periodic monitoring (and a prevention strategy) is undertaken to ensure concentrations remain below the default trigger level”.

The mixing modelling set out in the EIS indicated that salinity (EC) will remain below the adopted lowland trigger value of 350 microSiemens / cm.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project’s EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

The proponent notes that median (modelled) daily discharge at Mollee on the Namoi just downstream of the Bohena Creek confluence, is 350 tonnes per day (127,750 tonnes per annum). This compares with an expected release of around one tonne per day from Leewood in a managed release event when existing creek flow is greater than 100 megalitres per day. Thus, the managed release would contribute less than 0.01 per cent of the salinity at the Namoi confluence.

Water quality results of the treated water from the Leewood Water and Brine Treatment Plant (presented in the updated Water Baseline Report (Appendix D to this RTS) and in Table 6-4 of this RTS), have reported mercury concentrations below the laboratory limits of reporting (LOR). While this LOR is slightly higher than the recommended 99 per cent protection level of 0.00006 mg/L for slightly – moderately disturbed systems (ANZECC/ARMCANZ, 2000), it is an order of magnitude below ANZECC/ARMCANZ (2000) guideline thresholds for potable, recreational, irrigation and stock water (refer to Table 7-1 in the revised Water Baseline Report at Appendix D to this RTS).

Ecotoxicological assessment of the potential impacts of the managed release have been undertaken and findings included in the EIS (Appendix G1). The study found no potentially detrimental impacts would occur from the managed release to the creek during the managed release scenario flow event of greater than 100 megalitres per day.

General comments on Groundwater Impact Assessment and Water Monitoring Plan

The submission raised a number of general comments and editorial issues regarding presentation of information in the Groundwater Impact Assessment (EIS Appendix F) and Water Monitoring Plan (EIS Appendix G3). These, and the proponent's responses, are presented below.

Submission	Response
The submission identified that Figure 4-9 (Section 4.4.4.4) and Figure 5-19 (Section 5.6.1) of the Groundwater Impact Assessment both show surface water groundwater interactions but with conflicting areas of losing and gaining streams.	The proponent acknowledges that there are differences in the maps prepared by Ivkovic (2006) and CSIRO (2007) and this reflects the complexity of the systems and incomplete knowledge on the nature of interactions between surface and groundwaters in the region. (We note that this does not have direct bearing on the interpretation of the groundwater modelling, nor influence the conceptualisation of the model for the purposes of the Groundwater Impact Assessment.)
The submission identified that Table 5-1 (Section 5.2 of the Groundwater Impact Assessment) lists the Cubbaroo formation as a 'significantly transmissive unit' which is contradictory to 5.2.1 where the Cubbaroo Formation is described as a 'less significantly transmissive unit'. DPI Water considers the entire Upper and Lower Naomi Alluvium to be a significantly transmissive based on the proponent's definition.	The proponent acknowledges this inconsistency and clarifies that the statement in Section 5.2.1 is a typographical error. The sentence should be "The Cubbaroo formation is considered to be a significantly transmissive unit".
The submission states that in Section 2.1.3 the numbers quoted in Table 2-2, which lists sustainable diversion limits (SDLs) and proposed reductions in SDLs, are not current.	The SDLs listed in Table 2-2 are consistent with the long-term average SDLs listed in *Schedule 4– Matters relating to groundwater SDL resource units* of the *Basin Plan* 2012. The proponent acknowledges that the stated reductions in SDLs for the Lower Namoi Alluvium (LNA) and Upper Namoi Alluvium (UNA) in Table 2-2 are outdated, and instead represent the proposed reductions to Guide SDLs that were under consideration at the time of the Guide to the proposed Basin Plan. There are currently no SDL changes proposed for the LNA and UNA.

The submission states that in Section 2.2.4, under the heading 'NSW Upper and Lower Namoi Groundwater Sources 2003', the reference to the Available Water Determinations for the supplementary water access licences and extraction limit is misleading and the statement following 'This is in response to the observed decline in groundwater levels in the Upper and Lower Alluvium' is incorrect.	The proponent acknowledges this correction, explaining that an assumption was made in the Groundwater Impact Assessment that the purpose of reducing groundwater extraction from this groundwater source was to mitigate decline in storage.
The submission states that the labels on Figure 4-11 (Section 4.5.11) are illegible	The proponent acknowledges that the figure scale is too small, noting that the figure was prepared at a larger format and detail was lost during insertion into the Groundwater Impact Assessment and subsequent document production. The figure can be re-issued at an appropriate scale and format.

Provision of gas well layouts

The submission requested that details of planned gas wells and their planned groundwater extraction volumes be provided to the Department of Primary Industries in advance of each stage of field development.

As discussed in Appendix C of the EIS, through the implementation of the Field Development Protocol, the proponent will develop a Plan of Operations that would detail the proposed layout of field infrastructure.

The Plan of Operations will be prepared for each stage of development and provided to the NSW Department of Planning and Environment and the Commonwealth Department of Environment and Energy prior to implementation. Digital spatial data sets of existing and proposed infrastructure will also be provided. The Government will be provided a Plan of Operations no less frequently than at two-yearly intervals.

Groundwater extraction will occur in compliance with the NSW *Water Management Act 2000*, including volumetric limits and monitoring and reporting requirements under relevant Water Access Licence(s).

Monitoring of pipeline footings

The submission stated that pipeline footings should be designed with withstand flood events of varying magnitudes and should be monitored periodically and after flood events.

Gas and water gathering lines would be designed in the first instance to avoid impacts to watercourses by following existing roads, tracks or other previously disturbed areas. All gas and water gathering lines would be designed to the relevant Australian Standard including the *Australian Pipeline Industry Association Ltd (APGA) Code of Practice for Upstream Polyethylene Gathering Networks-CSG Industry*.

Where it is necessary for gas and water gathering lines to cross watercourses, the selection of crossing points will, where practical:

- use existing vehicular crossings
- be located on straight sections of channel
- maximise avoidance of steep, unstable banks, permanent pools and waterholes.

Where gas and water gathering lines occur within the one per cent annual exceedance probability (AEP), they will be designed and installed to ensure that there will be negligible modification of flows. Sediment and erosion controls will be implemented and there will be no ongoing impacts to geomorphology.

Waste management and monitoring program

The submission requested a waste management and monitoring program designed to prevent spills and contamination and ensure waste is managed in line with appropriate guidelines.

As committed in Chapter 31 of the EIS, a Waste Management Plan would be implemented for the project. The plan would be developed in line with relevant laws and guidelines to ensure waste is managed appropriately and spills and contamination are prevented. It would incorporate statutory requirements including waste classification, recording, transport and tracking under the *Protection of the Environment Operations Act 1997* and *Protection of the Environment Operations (Waste) Regulation 2014,* including waste classification, recording, transport and tracking.

The Plan would estimate waste quantities, sources of waste generation and specify waste and recycling collection systems and infrastructure. It would detail how waste would be transported and stored as well as identify locations for off-site disposal and recycling.

The EIS found that the potential for leaks and spills to lead to land contamination and the potential was found to be low. A number of mitigation measures are proposed regarding leaks and spills including that chemicals will be stored and handled in accordance with relevant Australian Standards and that refuelling will occur with suitable containment for volumes greater than 50 litres and not within 40 metres of a watercourse.

5.5 NSW Division of Resources and Geoscience

Offset sites and potential impacts to resources

The submission requested the proponent consult with the Division of Resources and Geoscience of the Department of Planning and Environment during development and implementation of the biodiversity offsets strategy to avoid impacts to other resources.

A number of properties on the BioBank site expressions of interest register, properties currently for sale, and over 280,000 hectares of native vegetation on freehold land have been identified as part of the Biodiversity Offset Strategy. The locations of these prospective offset sites are currently confidential, as most of the candidate properties are privately owned.

The proponent will, in the course of finalising the offsets program, discuss these matters further with the NSW Office of Environment and Heritage.

Decommissioning and rehabilitation outcomes

The submission seeks information on the following matters relating to rehabilitation:

- protocol to determine when wells are to be decommissioned
- protocol to record pre-disturbance vegetation condition or agricultural productivity
- protocol to record location and manage condition of stockpiled topsoil until rehabilitation
- conceptual final land use plans for Leewood and Bibblewindi including landform of ponds
- protocol for removal of gas and water gathering lines if requested by a landholder.

The Rehabilitation Strategy for the project was presented in Appendix V of the EIS. As stated in the assessment, a Rehabilitation Plan containing detailed rehabilitation measures would be prepared post-approval consistent with the Rehabilitation Strategy and relevant approval conditions.

The primary objective of rehabilitation is to manage topsoil to conserve the soil seed bank, nutrients and to encourage the establishment of vegetation. This will be achieved through slashing and mulching of vegetation (rather than clear-felling), minimising impacts on topsoil and the soil seedbank during construction and facilitating natural regeneration through rapid rehabilitation following construction. Topsoil management is detailed in Section 6.6 of Appendix V of the EIS. The risk assessment contained in the Rehabilitation Strategy (Table 6 of Appendix V of the EIS) includes measures to minimise the risk of inappropriate topsoil management.

One of the key objectives of the Rehabilitation Strategy is to rehabilitate disturbed areas to their pre-production condition. Management of rehabilitation will require the collection, storage and management of accurate records from initial clearing or ground disturbance to rehabilitation to ensure effective management of rehabilitation. Forested land will be rehabilitated to its former vegetation community and agricultural land will be rehabilitated to meet the former agricultural capability class. Data collected from rehabilitation sites will be compared to data collected in reference sites in the same plant community type which will enable comparison with pre-production vegetation.

Planning for closure and rehabilitation will commence at least two years ahead of decommissioning of wells and other infrastructure. A rehabilitation plan and a decommissioning management plan containing detailed rehabilitation schedules and conceptual final land use plans, including for Leewood and Bibblewindi, will be prepared post-approval and will be consistent with relevant approval conditions.

Rehabilitation in the project area has been monitored since 2013 and has shown that rehabilitation sites approximate 72% of the condition of reference sites, and are clearly on a trajectory to becoming self-sustaining Plant Community Types, representative of pre-occurring types. The proponent has committed to undertaking infrastructure decommissioning and rehabilitation in line with leading practice policy and guidelines including but not limited to:

- *The NSW Code of Practice for Coal Seam Gas – Well Integrity* (NSW Trade and Investment 2012).
- The Australian Pipelines and Gas Association (APGA*) Code of Practice for Upstream Polyethylene Gathering Networks - CSG Industry*.
- Australian Pipeline Industry Association (APIA) (2013). *Code of Environmental Practice for Onshore Pipelines.*

- NSW Department of Industry, Skills and Regional Development (2015*). Exploration Code of Practice: Produced Water Management, Storage and Transfe*r.
- NSW Department of Industry, Skills and Regional Development (2015a). *Exploration Code of Practice: Rehabilitation.*

The NSW Government's *NSW Code of Practice for Coal Seam Gas – Well Integrity* (NSW Trade and Investment 2012) outlines methods to decommission wells such that 'risks to the environment (surface water and groundwater, air, vegetation, fauna) are identified, eliminated where possible, or minimised through appropriate management practices'. It states 'CSG well abandonment must ensure the environmentally sound and safe isolation of the well, protection of groundwater resources, isolation of the productive formations from other formations, and the proper removal of surface equipment. Titleholders are responsible for the well until the Department is satisfied that the titleholder can demonstrate that the well is safe and non-polluting.'

The proponent has committed to meeting the Government's requirements in this regard. The fact that the Department will not sign off on decommissioned wells until it is satisfied that wells are safe and non-polluting provides further assurance.

A Decommissioning Management Plan would be established for the decommissioning of gas wells that would be decommissioned in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (NSW Trade and Investment 2012). The Plan would be developed in consultation with key stakeholders such that key infrastructure valued by those stakeholders may be ultimately gifted to the landholders, with other infrastructure being decommissioned in line with regulatory requirements, including approval conditions.

Strategic context and need

The submission notes the strategic need for the project as a potential supplier to the east coast gas market, citing the *2017 Gas Statement of Opportunities* (AEMO 2017a).

It states that the project is the "most suitable NSW-based option, within the current market and related framework, to deliver on the [NSW] Government's priorities for secure, reliable and affordable gas supply to the residents of NSW".

The proponent notes the Division of Resources and Geoscience's (DRG's) comments whereby they stated that in its latest *Gas Statement of Opportunities* (GSOO), the Australian Energy Market Operator (AEMO) highlights that gas for LNG exports is projected to continue dominating gas demand and supply in eastern and south-eastern Australia to 2036 (AEMO 2017a). Due to the interconnected gas pipeline network in the east coast gas market it is now possible for gas produced in this market to be exported as LNG via the three major Gladstone facilities (Queensland Curtis LNG, Asia Pacific LNG and Gladstone LNG).

According to AEMO (2017a), it is likely that 2017 will see some levelling off of Gladstone LNG exports at close to their maximum capacities expected to be reached in the early 2020s. As a result of the increasing demand for LNG exports out of Gladstone, the majority of gas previously contracted from the Cooper Basin has now been contracted to meet export requirements.

Of particular relevance to the project, AEMO (2017a) states "Development of the proposed Narrabri Gas Project could provide extra supply into the domestic market. Assuming first production in 2020, AEMO's (2017a) modelling shows that the project has the potential to remove all domestic gas shortfalls from 2020 to 2024." The project is not a complete solution to meeting the long-term east coast gas supply requirements but is a credible solution at least in the medium term, as longer term solutions are realised. The gas may also be made available to optimise opportunities for its use as a source of energy including, for example, at the Wilga Park Power Station.

DRG went onto state that forming long term solutions necessitates an understanding of the time required to continue exploration, undertake appraisal, develop a project application and gain the required approvals to commence production and then build the required pipeline and processing infrastructure. A review of the work programs, for the remaining petroleum titles in NSW indicate that it would be highly unlikely that gas could be delivered into the East Coast Gas Market prior to 2026-2028. Furthermore it is anticipated that for new petroleum titles granted under the Strategic Release Framework for Coal and Petroleum Exploration it would also be at least 8 to 10 years, subject to a significant discovery, to deliver gas into the market.

Concluding on the need for the project, DRG stated that the east coast gas market has short, medium and long term supply issues. Therefore, DRG views the project as contributing to a solution to the forecast domestic gas supply shortfall, particularly in the medium term.

Resource assessment and recovery

The submission provided details of the assessment of the geological aspects of the resource undertaken by suitably qualified practitioners from the NSW Division of Resources and Geoscience.

It found that the project “has a reservoir system that meets or exceeds all the requirements with respect to the geological factors, for a successful project”. It also noted that the natural structural features that define permeability of the target coal formations include a dominant cleat system characterised by long continuous fractures that could provide commercial gas flow without the need for hydraulic fracturing. Further, it stated that the existing appraisal wells indicated very good gas flow rates.

The review by the NSW Division of Resources and Geoscience is noted and aligns with the proponents understanding of the resource as discussed in Section 2.3 of the EIS.

Economic benefits

The submission recognised the economic benefits and royalties predicted to flow from the project and noted the resource estimate and predicted gas price were likely to be conservative.

The comments on the economics benefits and royalties of the project and conservatism of estimated resource and gas price are noted. The proponent notes that the Division of Resources and Geoscience (DRG) estimate the net present value of the gas reserves over the life of the project as assessed in the EIS to be approximately $6.3 billion.

Further, DRG noted that another important aspect of future royalty calculation for the project is estimation of future annual production. The proponent has estimated that if the project is approved, over 1,500 petajoules (PJ) of gas would be able to be economically extracted from the project area from 2019 to 2041. The maximum rate of extraction would be up to 200 TJ/day of gas. Division of Resources and Geoscience concluded that both the total amount of gas to be produced from the project and maximum rate per annum is achievable given current information of the area.

Using the above parameters, Division of Resources and Geoscience calculated that in a typical full production year, excluding a Gas Community Benefit Fund royalties rebate, NSW will receive around

$32 million per annum in royalty, and the net present value of this royalty stream over the life of the Project would be $313 million using a seven per cent real discount rate.

5.6 NSW Environment Protection Authority

Management plan enforcement

The submission requested that management plans are clearly referenced in approval conditions to ensure their preparation is legally enforceable. It also recommended that plans be developed in consultation with relevant government agencies to ensure language is enforceable.

The project has committed to developing and implementing a project wide Environmental Management Strategy, comprising of a number of management plans. These plans will include:

- Produced Water Management Plan
- Erosion and Sediment Control Plan
- Noise and Vibration Management Plan
- Soil Management Plan
- Air Quality Management Plan
- Cultural Heritage Management Plan
- Biodiversity Management Plan
- Pest, Plant and Animal Control Plan
- Historic Heritage Management Plan
- Traffic Management Plan
- Waste Management Plan
- Bushfire Management Plan
- Community and Stakeholder Management Plan
- Decommissioning Management Plant
- Rehabilitation Plan.

The plans would reflect EIS management and mitigation measures, conditions of approval, statutory obligations and landholder agreements. Indicatively the management plans would also include details of existing environmental values and potential impacts, management objectives, performance criteria, management and mitigation measures and monitoring requirements and corrective actions.

Baseline groundwater quality

The submission requested additional baseline groundwater quality data within the project area and the west of the Gunnedah Oxley Basin to validate assumptions of the groundwater model. It recommended that additional baseline groundwater quality monitoring wells be installed.

The Water Baseline Report has been updated and augmented (Appendix D to this RTS). Specifically, the proponent notes:

- All available hydrogeological data is presented in the revised Water Baseline Report with assessment of its capability to provide interpreted surfaces. This includes all water level / water pressure data and hydraulic properties reported by hydro-geological formation and described spatially in relation to the project.
- The data on hydrogeological properties summarised in Section 5.3 and Appendix C of the Groundwater Impact Assessment (EIS Appendix F) (for target seams and overlying geological units) are referenced to their sources and are publicly available. Relevant data compilations are explicitly described and presented in the updated Water Baseline Report.
- The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

Ongoing groundwater monitoring and modelling

The submission recommended that the proponent monitor and model groundwater over the life of the project. It also specified that geological stratigraphy should be recorded during installation of gas wells or monitoring wells for input into the groundwater model.

The proposed Water Monitoring Plan (EIS Appendix G3) provisions for regular data review and, if required, model re-calibration, re-prediction, and review and revision of groundwater monitoring and management.

The Water Monitoring Plan (EIS Appendix G3) includes triggers to update the groundwater modelling predictions. Model updates occur if either the Level 1 or Level 2 response trigger is exceeded. The Level 1 response trigger would be exceeded if there are three or more years in which realised cumulative water extraction exceeds cumulative water production in the EIS and would require updating of modelling predictions. The Level 2 response trigger would be exceeded if pressure decline in Triassic Age strata (early detection monitoring) exceeds or is likely to exceed the predicted maximum drawdown published in the EIS and would require revision and re-calibration of the model. Either could occur in the years following commencement of water production (i.e. more or less frequently than every five years).

If the response triggers are not exceeded, then the Water Monitoring Plan will be subject to the reporting regime as set out in Section 4.3 of the Water Monitoring Plan. The annual report to be prepared will include a review against the trigger levels for the reporting year.

There is also provision in the Water Monitoring Plan for a periodical review to be prepared after the first three years of operation and then every five years thereafter. The periodical reviews will assess the sufficiency of monitoring and identifying whether additional monitoring infrastructure is required. The Water Monitoring Plan will be updated to reflect resulting changes from the reviews.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

Collection of hydrostratigraphic data during drilling and installation of coal seam gas wells for the project will also support local-scale review of the thicknesses of the intersected strata and hence provide updated values for the model. Notwithstanding this new information from future drilling works, the groundwater modelling for the project is regional in scale and combines strata of the Gunnedah Basin into vertical sequences distinguished as being either coal seams or interburden; where the interburden sequences consist of all strata located below, between and above the target coal seams.

Groundwater monitoring network

The submission states that the location of groundwater monitoring wells in the groundwater monitoring network should coincide with the baseline monitoring network, potentially affected areas identified by the groundwater model, and be commensurate with the field development.

It also stated that the groundwater monitoring network should be expanded commensurate with the scale of the project and with installation occurring prior to field development.

It also stated that groundwater monitoring at produced water storage facilities should be agreed with the EPA.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

The proponent's proposed water monitoring network includes sentinel monitoring bores that are strategically located both within deeper formations close to target coal seams. The monitoring plan includes trigger values for early warning and management actions for further investigation into potential risks to shallower high value groundwater sources.

All monitoring data is compiled into a reporting framework, such that sufficiency of monitoring will be continuously assessed to allow identification of additional monitoring requirements. The Water Monitoring Plan is to be updated to reflect changes that are considered to be required.

Extensive seepage detection monitoring is in place around the existing produced water storage facilities. The need for seepage detection monitoring of the new produced water storage facilities will be considered in line with the Produced Water Management Plan and the requirements of the NSW Department of Industry, Skills and Regional Development (2015) *Exploration Code of Practice: Produced Water Management, Storage and Transfer*.

Groundwater monitoring at coal seams

The submission recommends that groundwater monitoring include monitoring of dewatering of target coal seams "rather than monitoring of secondary impacts [in overlying aquifers]".

Project operations will necessarily include monitoring of water extraction volumes and in-seam pressures in target coal seams as a matter of course. This does not, however, correspond directly to potential impacts in overlying aquifers, dependent on the geology and connectivity between the formations.

Thus, the proposed water monitoring network comprises sentinel monitoring bores that are strategically located within deeper formations close to target coal seams to facilitate early warning and management actions for further investigation into potential for risks to shallower high-value groundwater sources.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project as required.

Groundwater monitoring and management plans

The submission recommended that groundwater monitoring, modelling and management be in accordance with plans developed in consultation with the appropriate agencies including DPI Water and the Environment Protection Authority. It recommended the plans include "trigger actions and thresholds [from] statistical analysis of baseline data trends".

The Water Monitoring Plan (EIS Appendix G3) includes these concepts, including identification of thresholds, trigger levels and management actions designed to reflect the concepts of Level 1 and Level 2 impacts defined in the NSW *Aquifer Interference Policy*.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

Well integrity

The submission requested confirmation that gas wells would be constructed in compliance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (NSW Trade & Investment 2012).

As stated in Chapter 31 of the EIS (Project commitments), the proponent has made the following project commitment: 'Drilling, completion and rehabilitation of wells in compliance with the *NSW Code of Practice for Coal Seam Gas - Well Integrity'*.

Soil survey data

The submission stated that further clarity in the methodology of the soil assessment could be provided for greater application to an irrigation operational scale. In that regard, the submission requested clarification on the desktop soil survey methodology, including:

- Application of LiDAR data
- A digital elevation model (DEM)
- Application of gamma ray spectrometry data
- Incorporation of existing eSpade data.

Appendix I1 of the EIS – Interpretive soils assessment, included a desktop assessment of the project area. The desktop assessment used existing publicly available and proponent resources to provide initial characterisation of soil and land within the project area. The desktop assessment assisted in identifying locations where field investigations were to focus.

Preliminary data collected and reviewed for the desktop assessment included the following:

- Geology and soil maps and reports
  - *Australian Soil Resource Information System* (ASRIS) (2013). Australian Collaborative Land Evaluation Program (ACLEP), accessed 17/02/2014, available at www.asris.csiro.au/
  - Brown, R.E., Brownlow, J.W. and Krynen, J.P. (1992). *Manilla-Narrabri 1:250,000 Metallogenic Series Sheet* SH/56-9, SH/55-12 (Brown, RE, Krynen, J. P. & Brownlow, J.W. 1990) and associated explanatory report, Metallogenic Study and Mineral Deposit Data Sheets

  - Pengelly, E. (2010) *Soil Landscapes of the Baan Baa 1:100,000 Sheet*. Liverpool Plains portion. NSW Department of Environment, Climate Change and Water, Sydney.
  - Raymond, O.L. Liu, S., Gallagher, R, Highet, L.M., Zhang, W. (2012), *Surface geology of Australia, 1:1,000,000 scale*, 2012 edition [Digital Dataset], Geoscience Australia, Commonwealth of Australia, Canberra, available at http://www.ga.gov.au
  - Wallis (1968). *Narrabri 1:250,000 Geological Series, Sheet SH55-12*.
- NSW soil and land reports and guidelines:
  - NSW Department of Planning and Infrastructure (2012). *New England North West Strategic Regional Land Use Plan*, State of New South Wales.
  - NSW Department of Environment, Climate Change and Water (2010). *Soil and Land Constraints Assessment for Urban and Regional Planning*.
  - NSW Department of Primary Industries (2012). *Agricultural Impact Statement Guideline*.
  - NSW Department of Primary Industries (2013). *Agricultural Impact Statement Technical Notes – A Companion to the Agricultural Impact Statement Guideline.*
  - New South Government Office of Environment and Heritage (2013). *Land and Soil Capability Mapping of NSW*, version 2.5 (v130205). Sourced: http://www.environment.nsw.gov.au/resources/soils/LSC_NSW_v2.5.pdf, Accessed: 2 September 2014.
  - *NSW Soil and land information system (SALIS) and soil profile report*, emailed from NSW Government (used to visually validate the desktop mapping)
  - NSW Office of Environment and Heritage (2012). *Inherent Soil Fertility Mapping: Upper Hunter and New England – North-west Strategic Regional Land use Areas*.
  - NSW Office of Environment and Heritage (2012). *Australian Soil Classification Soil Type map of NSW*, 1:250,000 scale.
  - NSW Office of Environment and Heritage (2012). *Land and Soil Capability mapping – New England/North West Strategic Regional Landuse Priority Area*.
  - NSW Office of Environment and Heritage (2012). *The land and soil capability assessment scheme; Second approximation*. Sydney.
- Namoi Catchment Management Authority (CMA) reports:
  - Baker (2009). *Land Management Units in the Namoi Catchment,* Catchment Management Authority.
- Site-specific information collected to date for the project:
  - BeneTerra (2014). *Leewood soil survey* (data from Santos Ltd).
  - Ecological Australia (2011). *Soil constraints assessment, Narrabri gas fields*. Prepared for AECOM.
  - Geoff Cunningham Natural Resource Consultants (2008). *Soils assessment, Narrabri coal seam gas utilisation project, part 4*. Prepared for Eastern Star Gas Limited, New South Wales.
  - RPS (2013*). Agricultural Resource (Soil) Risk Assessment, Narrabri Gas Development Project*. Prepared for Santos NSW (Eastern) Pty Ltd.
  - RPS (2014). *BSAL Desktop Assessment Report – Southern project area*. Narrabri Gas Development Project. Prepared for Santos NSW (Eastern) Pty Ltd.

To increase confidence in the historic data sourced from the publication above, a terrain analysis was undertaken to assist in the improved delineation and classification of soil types and map units within the project area. The terrain analysis considered slope gradient, topography, and landform using a digital elevation model (DEM) and remote sensing data. Remote sensing data included aerial photography supplied by the proponent, Google Earth Pro imagery, Landsat imagery, 'radiometrics' (or airborne gamma-ray spectrometry data (AGS)) and geomagnetics. LiDAR data supplied by the proponent was also used for the DEM analysis.

The use of AGS and geophysical data analysis assisted in the accuracy of soil landscape modelling and to produce preliminary soil mapping units (PSMUs) in the investigation area. PSMUs were created to identify tracts of land that are expected to share similar soil attributes (related to geology, vegetation, and landform patterns, and geomorphological processes. The method above was then used as an input into site verification sampling in the field.

Soil survey density

The submission stated that the soil survey did not meet the minimum number of observations or detailed soil profile descriptions specified in McKenzie *et al.* (2008).

It also stated that soil surveys would be required at irrigation areas to inform irrigation management and made recommendations regarding survey density, profile descriptions and classification systems. It requested the results of those soil surveys be provided once they are completed.

The assessment of the potential impacts of the project on soils was undertaken in accordance with the Secretary's environmental assessment requirements.

Three soil surveys were completed to support the project. These were:

- *Narrabri Gas Project Site Verification of Biophysical Strategic Agricultural Land* (GHD 2015). Submitted to NSW DP&E in 2015 that supported the issue of EIS Appendix I2 – Site verification of BSAL certificate.
- *Narrabri Gas Project Interpretative Soils Report* (GHD 2016). EIS Appendix I1.
- *Narrabri Gas Project Irrigation General Concept Design* (BeneTerra 2015). EIS Appendix G2.

Each of the three reports undertook soil sampling, analysis and reporting consistent with their stated purposes, being respectively:

- Clearance of the project area for BSAL (refer EIS Appendix I2).
- Classifying soils for soil impact hazards to inform construction of the project under the proposed Soil Management Plan for the project (EIS Appendix I1).
- Undertaking an irrigable land survey and concept irrigation design (EIS Appendix G2).

Each soil survey was fit for purpose. Importantly, when selecting a property for irrigation, a range of factors would be considered including irrigation water quality, soil properties, plant salinity tolerance, climate, landscape (including geological and hydrological features), and water and soil management through typical irrigation management practices. As committed in Chapter 31 of the EIS, irrigation of treated water during production will be undertaken in accordance with an irrigation framework under the Produced Water Management Plan.

Soil profile data

The submission noted the soil profile descriptions provided in Appendix I1 and Appendix G2 of the EIS and requested additional detailed soil profile descriptions for the project area, nominal irrigation area and planned irrigation areas and coordinates for the 40 soil profiles in Appendix G2.

The submission requested further information on baseline data for irrigation areas, including soil surveys and assessments.

Soil profile descriptions for the 45 soil profiles are provided in Appendix A of EIS Appendix I1. The surface observations, in addition to the soil profiles, were included in the BSAL report submitted to, and accepted by, the NSW Department of Planning and Environment in 2015. Further, all soil profile and soil observation sites were lodged with NSW OEH on soil profile cards for upload by OEH onto to e-Dirt (http://www.environment.nsw.gov.au/edirtwebapp/Login.aspx?ReturnUrl=%2fedirtwebapp).

Appendix G2 of the EIS reports soil descriptions and analytical data for 40 soil profiles in the vicinity of Leewood. This irrigation assessment demonstrated that there is approximately 9,000 hectares of land within a 20 kilometre radius of Leewood with suitable soils for sustainable irrigation.

Appendix G2 of the EIS includes assessment and critical parameters for the local soils. Final distribution of treated and amended water for irrigation use has yet to be determined. The proponent notes, however, that all interested landholders will have data to support the use of the amended waters for irrigation on their soils. This information will be used by the landholders subsequent to approval and will allow customised amendment of treated waters to suit the specific soils and intended use.

Consistent with standard practice, irrigators would undertake their own assessment of the suitability of their land in line with typical irrigation management practices that would consider leaching fraction, drainage, water quality and a range of other parameters, including soil assessment through soil survey and analysis, to inform the suitability of the land for irrigation.

Soil profile representativeness

The submission stated soil profiles at road reserves may not be representative of map units.

Field soil survey methods were originally developed for the BSAL assessment (*Narrabri Gas Project Site Verification of Biophysical Strategic Agricultural Land* (GHD 2015) provided to the NSW Department of Planning and Environment in 2015, from which the Department issued a BSAL certificate that confirmed the project area does not contain BSAL (refer to EIS Appendix I2). The soil profile and observation data collected and reported in GHD (2015) was used as necessary to inform the soil assessment in Appendix I1 of the EIS.

Soil sample locations to validate the accuracy of soil landscape modelling and to produce preliminary soil mapping units were identified in accordance with methods within the *Interim protocol for site verification and mapping of biophysical strategic agricultural land* (OEH 2013). Moreover, soil sampling methodology, including the location of soil samples, was undertaken in consultation with, and the acceptance of, OEH soil technical contact officers throughout the BSAL investigation. Therefore, the methods used and the locations of soil data reported in Appendix I1 were agreeable to the OEH soil technical officers; noting that generally, locations along undisturbed road verges arguably better represent *in situ* natural conditions than cropped and / or ploughed paddocks.

Bicarbonate in treated and amended water

The submission stated that bicarbonate levels are not provided for treated and amended water. It noted that bicarbonate levels in previous site data and the target value of 139 mg/L provided in Chapter 12 of the EIS exceeded the trigger value for irrigation at 100 mg/L determined by the Queensland Department of Environment and Heritage Protection. It stated that soil structure would be a risk requiring management at planned irrigation areas.

As discussed in Chapter 7 of the EIS (Produced water management), treated and amended water will be fit-for-purpose for beneficial reuse by irrigation.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

The data includes data for bicarbonate (reported as alkalinity as $CaCO_3$ – at the pH levels of the treated and treated and amended water, no carbonate is expected to be present). The results show that the water quality complies with the relevant ANZECC/ARMCANZ (2000) guidelines for long-term irrigation, with levels in treated and treated and amended water around 30 mg/L.

To clarify, water exiting the treatment plant following reverse osmosis is analysed and reported as treated water. If this water is to be used for irrigation, permeate is amended with calcium salts to lower the sodium adsorption ratio (SAR) to a level suitable for application to the local soils.

Sodium adsorption ratio of treated water

The submission questioned the sodium adsorption ratio (SAR) of permeate stated as <5 mg/L in Appendix T3 of the EIS. It stated this would be instead typical of amended water.

Further, the submission stated the assumed treatment rate of 90 per cent was not an appropriate assumption given the "rejection rates for different salts by the [reverse osmosis] membranes".

It stated that clarification should be provided on the risk of elevated sodium adsorption ratio in treated water where reused for dust suppression or stock watering.

The results of water quality from the operation of the Leewood Water and Brine Treatment Plant provide that the maximum sodium adsorption ratios for treated and treated and amended water are 29 and 3.7, respectively (refer to the updated Water Baseline Report in Appendix D to this RTS).

Based on the updated water quality results, dust suppression activities would use treated and amended water. This approach would maintain the permeability and structural longevity of the soil by encouraging aggregate stability of soil particles by balancing sodium levels through addition of appropriate salts such as gypsum.

Treated or treated and amended water of appropriate quality would be utilised for stock watering.

Irrigation in forested areas

The submission queries whether treated water would be irrigated in forested areas other than for dust suppression on forest roads or construction and operation areas. It noted the potential impact of such irrigation was not considered in the assessment in Appendix G2 of the EIS.

There is no plan to irrigate in forested areas other than for dust suppression on roads, access tracks and project construction and operational areas.

Irrigation trigger values

The submission states that the ANZECC/ARMCANZ (2000) long term trigger values for irrigation should be considered instead of ANZECC/ARMCANZ (2000) short term trigger values for irrigation of some treated and amended water given the duration of the project.

Table 7-2 in Chapter 7 of the EIS (Produced water management), assessed the target treated and amended water quality against applicable water quality guidelines aligned with proposed beneficial reuse options. This target data has been updated, and additional comparison made with the ANZECC/ARMCANZ (2000) long-term (greater than 20 year) irrigation trigger values, which is shown in Table 6-4 of this RTS. The data shows that all target analytes conform to long-term irrigation trigger values.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

Dust suppression in forested areas

The submission stated that the use of treated water for dust suppression in forested areas could potentially increase dust emissions as soil dissolves into finer particles. It requested assessment of this risk and identification of mitigation and management measures. It also sought clarification of whether this practice would apply to operational areas in forested areas.

The results of treated water quality from the operation of the Leewood Water and Brine Treatment Plant provide that the maximum Sodium Adsorption Ratios reported for treated and treated and amended water are 29 and 3.7, respectively (refer to the updated Water Baseline Report in Appendix D of this RTS).

Based on the updated treated water quality results, dust suppression activities would use treated and amended water.

Appropriate risk management and mitigation would be implemented including restricting the quantity of water applied to that required to control dust and would only be applied in dry conditions, minimising the potential for waterlogging or ponding. Water would be applied to project construction and operational areas as required for dust suppression such as access tracks and well pads under construction.

Dust suppression activities would be actively monitored to ensure water application rates are appropriate to observed conditions and prevent ponding or runoff.

Bohena Creek downstream uses

The submission states that managed release to Bohena Creek has the potential to affect downstream users that extract water for stock watering or domestic use. It recommended a survey of Bohena Creek downstream uses to confirm these potential impacts. It stated that water quality objectives should consider identified downstream uses.

The EIS used water quality and hydrological science to assess the risk of managed release of treated water to Bohena Creek (refer EIS Appendix G1- Managed release (Bohena Creek)). The assessment showed that once the water is treated to the target water quality, it is largely compatible with background water quality in Bohena Creek. Refer to Table 12-4 in Chapter 12 (Surface water quality), for further information.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

Produced water pipe rupture

The submission stated the risk of produced water pipe rupture has not been assessed. It recommends that an emergency response procedure is developed to detect pipe rupture.

The potential for loss of produced water from water gathering lines was discussed in Chapter 26 of the EIS – Hazard and risk. As stated, produced water infrastructure would be tested prior to operations and leak detection / pressure monitoring systems would be in place to detect losses of produced water and trigger corrective and remedial actions.

Waste classification of salt product

The submission stated that further information should be provided to demonstrate that waste salt would not contain other contaminants, and therefore classify as general solid waste.

As stated in Chapter 31 of the EIS (Project commitments), waste salt would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

The composition of the mixed solid salt product was forecast based on water quality analysis of both the produced water generated through exploration and appraisal activities and the brine produced at the Leewood water treatment facility.

Testing was undertaken in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) based on the chemical contaminants known or likely to be present in the produced water. The results are summarised in Table 5-3, Table 5-4 and Table 5-5 and show it would classify as general solid waste, with contaminants significantly below relevant thresholds.

As stated in Chapter 31 of the EIS, a Waste Management Plan would be implemented for the project. The plan would include the testing program for the salt product generated by the treatment process, including the frequency of testing in accordance with the *Waste Classification Guidelines*.

Table 5-3 Salt classification

Contaminant	Maximum values of specific contaminant concentration (SCC) for classification without TCLP		CAS Registry Number	Forecast Salt Conc. (mg/kg)	CT1 Exceeded
	General solid waste	Restricted solid waste			
	CT1 (mg/kg)	CT2 (mg/kg)			
Arsenic	100	400	-	0.19	NO
Benzene	10	40	71-43-2	BLOR	NO
Benzo(a)pyrene	0.8	3.2	50-32-8	BLOR	NO
Beryllium	20	80	-	BLOR	NO
Cadmium	20	80	-	0.01	NO
Chromium (VI)	100	400	-	BLOR	NO
Cresol (total)	4,000	16,000	1319-77-3	BLOR	NO
2,4-D	200	800	94-75-7	BLOR	NO
Ethylbenzene	600	2,400	100-41-4	BLOR	NO
Fluoride	3,000	12,000	-	520	NO
Lead	100	400	-	BLOR	NO
Mercury	4	16	-	BLOR	NO
Moderately harmful pesticides (total)	250	1,000	See Table 5-4	0.0011	NO
Molybdenum	100	400	-	0.20	NO
Nickel	40	160	-	BLOR	NO
C6–C9 petroleum hydrocarbons	650	2,600	-	BLOR	NO
C10–C36 petroleum hydrocarbons	10,000	40,000	-	BLOR	NO
Polycyclic aromatic hydrocarbons (total)	200	800	See Table 5-5	BLOR	NO

Selenium	20	80	-	BLOR	NO
Silver	100	400	-	BLOR	NO
Toluene	288	1,152	108-88-3	BLOR	NO
Xylenes (total)	1,000	4,000	1330-20-7	BLOR	NO
BLOR = Below limit of reporting					

Table 5-4 Moderately harmful pesticides

Moderately Harmful Pesticides		
Name	CAS Registry Number	Forecast Salt Conc. (mg/kg)
Atrazine	1912-24-9	0.0006
Azoxystrobin	131860-33-8	BLOR
Bifenthrin	82657-04-3	BLOR
Brodifacoum	56073-10-0	BLOR
Carboxin	5234-68-4	BLOR
Cyfluthrin	68359-37-5	BLOR
Cyhalothrin	68085-85-8	BLOR
Cypermethrin	52315-07-08	BLOR
Deltamethrin	52918-63-5	BLOR
Dichlorvos	62-73-7	BLOR
Difenoconazole	119446-68-3	BLOR
Dimethoate	60-51-5	BLOR
Diquat dibromide	85-00-7	BLOR
Ethion	563-12-2	BLOR
Fenthion	55-38-9	BLOR
Fenitrothion	122-14-5	BLOR
Fipronil	120068-37-3	BLOR
Indoxacarb	173584-44-6	BLOR
Malathion (Maldison)	121-75-5	BLOR
Metalaxyl	57837-19-1	BLOR
Metalaxyl-M	70630-17-0	BLOR
Methidathion	950-37-8	BLOR
Methyl chlorpyrifos	5598-13-0	BLOR
Oxyfluorfen	42874-03-3	BLOR
Paraquat dichloride	1910-42-5	BLOR
Parathion methyl	298-00-0	BLOR
Permethrin	52645-53-1	BLOR
Profenofos	41198-08-7	BLOR
Prometryn	7287-19-6	BLOR
Propargite	2312-35-8	BLOR

Pentachloronitrobenzene (Quintozene)	82-68-8	BLOR
Simazine	122-34-9	0.0005

BLOR = Below limit of reporting

Table 5-5 Polycyclic aromatic hydrocarbons (total)

Polycyclic aromatic hydrocarbons (total)		
Name	CAS Registry Number	Forecast Salt Conc. (mg/kg)
Acenaphthene	83-32-9	BLOR
Acenaphthylene	208-96-8	BLOR
Anthracene	120-12-7	BLOR
Benzo(a)anthracene	56-55-3	BLOR
Benzo(a)pyrene	50-32-8	BLOR
Benzo(b)fluoranthene	205-99-2	BLOR
Benzo(ghi)perylene	191-24-2	BLOR
Benzo(k)fluoranthene	207-08-9	BLOR
Chrysene	218-01-9	BLOR
Dibenzo(a,h)anthracene	53-70-3	BLOR
Fluoranthene	206-44-0	BLOR
Fluorene	86-73-7	BLOR
Indeno(1,2,3-cd)pyrene	193-39-5	BLOR
Naphthalene	91-20-3	BLOR
Phenanthrene	85-01-8	BLOR
Pyrene	129-00-0	BLOR

BLOR = Below limit of reporting

Waste salt disposal

The submission stated that further information should be provided on the facilities to be utilised for waste salt disposal and their long-term capacity to accept it.

It also recommended that information be provided on contingency planning in the event that licensed facilities within 150 kilometres of the project be unable to accept waste salt.

As discussed in Chapter 28 (Waste management) of the EIS, estimated average daily salt volumes would be about 115 tonnes per day during the peak period in around years' two to four and about 47 tonnes per day for the remaining years of the assessment period. The salt would be temporarily stored on site in a weather proof structure prior to being collected and transported to an appropriately licensed facility in accordance with all regulatory requirements.

As outlined in the response above, the composition of the mixed solid salt product was forecast based on water quality analysis of both the produced water generated through exploration and appraisal activities and the brine produced at the Leewood water treatment facility.

Testing was undertaken in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) based on the chemical contaminants known or likely to be present in the produced water. The results are summarised in Table 5-3, Table 5-4 and Table 5-5 which show it would classify as general solid waste, with contaminants significantly below relevant thresholds.

There are a substantial number of waste facilities available, including government and privately owned facilities that are licensed to receive general solid waste in the order of hundreds of thousands of tonnes per annum. The average volume of salt produced annually by the project would be a very small proportion of the overall capacity of any one such facility.

As part of the ongoing development of salt management, options for alternative beneficial reuse applications are being investigated.

Drill cutting disposal

The submission requested information on the characteristics and testing of drill cuttings and the receiving soil, including its nutrient requirements, to ensure the suitability of the disposal strategy. It also requested clarification of procedures to identify and separate inappropriate material including coal.

As explained in Chapter 6 (Project description) and Chapter 28 of the EIS (Waste management), two types of drill cuttings will be generated. These will be managed separately due their different composition.

The rock-based drill cuttings will predominantly be derived from the vertical wells and the coal-based drill cutting will predominantly be derived from the lateral wells which are drilled through the target coal seams. The rock-based drill cuttings will be beneficially re-used on the well pads, via a mix, turn, bury strategy, where appropriate.

The coal-based drill cuttings (and other drill cuttings not suitable for use in the well pads) will be transported off-site to a facility that can lawfully accept the material, which would be classified as general solid waste. As discussed in Chapter 28 (Waste management) of the EIS, estimated average monthly coal-based drill cutting volumes would be about 3,000 m^3 (around 5,000 tonnes) over the assessment period. This equates to around 165 tonnes per day, which is about four B-double truckloads. There are a substantial number of waste facilities available, including government and privately owned facilities that are licensed to receive general solid waste in the order of hundreds of thousands of tonnes per annum. The average volume of drill cuttings produced annually by the project would be a very small proportion of the overall capacity of any one such facility.

The proponent is also investigating opportunities for the beneficial reuse of the coal-based drill cuttings.

As stated in Chapter 31 of the EIS (Project commitments), a Waste Management Plan would be implemented for the project, which would detail the management of the cuttings, including their separation, storage and reuse or disposal. The management of drill cuttings will occur in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) and other relevant statutory requirements, including requirements with respect to sampling and frequency of testing.

It is noted that the NSW Environment Protection Authority has advised the proponent that appropriate excavated material generated as part of well establishment or drilling and beneficially reused at the site would not trigger waste licensing requirements or require a resource recovery exemption. A letter from the NSW Environment Protection Agency to this effect was included as Appendix E of the EIS.

The mix, turn and bury strategy has been utilised for rock based drill cuttings on a number of the existing appraisal well pads. Inspections have found that the rehabilitation is progressing well at these well pads and consistent with conditions for the successful reestablishment of vegetation.

Produced water treatment and reuse

The submission requested information on the management and beneficial reuse of treated, amended and produced water.

As discussed in Chapter 7 of the EIS (Produced water management), produced water would be processed through a water treatment facility. Once treated, the water would be beneficially reused for stock watering, dust suppression, irrigation of crops, drilling and construction and firefighting. The treated would also be available for managed release to Bohena Creek under appropriate flow conditions. If necessary, the treated water would be amended to match beneficial use requirements, such as for irrigation.

Amendment involves the addition of calcium and sulphate salts (e.g. calcium chloride; gypsum) to adjust the sodium adsorption ratio (SAR). These processes will produce irrigation water at a quality that does not present a risk of adverse impact to soil chemistry. Further, the desalinated and amended water would be of a quality that is consistent with that utilised for other irrigation activities.

Table 7-2 in Chapter 7 (Produced water management) of the EIS assessed the target treated and amended water qualities against applicable water quality guidelines aligned with proposed beneficial reuse options. This table has now been revised to include actual water quality data from the commissioned Leewood Water and Brine Treatment Plant (WBTP) and is presented in Table 6-4 of this RTS and in the updated Water Baseline Report at Appendix D to this RTS.

The results show that the treated water quality data meet the ANZECC/ARMCANZ (2000) long-term (greater than 20 year) irrigation trigger values. Thus, the water is suitable for the proposed irrigation activities.

In addition to the suitability of the treated and amended water, the availability of local soils to utilise the treated and amended water for irrigation has also been assessed (refer to EIS Appendices G2 (Concept irrigation design), Appendix G4 (Water baseline report) and I1 (Interpretive soils report)). The assessments found that there is around 9,000 hectares of irrigable land within 20 kilometres of Leewood that could accommodate the 12 megalitres of treated and amended water per day. Site selection and assessment would be in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (DEC 2004), with irrigation proceeding in accordance with an Irrigation Management Plan, which would seek to ensure:

- the structure, stability and productive capacity of the soils are maintained
- erosion is minimised
- there are effective surface water and stormwater runoff controls.

Irrigation would also include a program of regular monitoring, with the irrigation schedule being adjusted as needed to address trends identified through the monitoring system.

There will be two forms of treated water monitoring to ensure appropriate water quality is maintained. Continuous monitoring for pH and electrical conductivity would be undertaken using real time on-line equipment. If the treated water quality does not meet the required specifications, the dedicated control system will ensure the water is re-treated.

In addition to the automated monitoring system, samples of the treated water would be analysed on a monthly basis by a National Association of Testing Authorities (NATA) accredited laboratory. A broad range of parameters would be analysed including compounds indicative of the chemicals used for treatment, cleaning and disinfection such as total residual chlorine.

This approach to ensuring the treated water quality meets the ANZECC/ARMCANZ (2000) long-term (greater than 20 year) irrigation trigger values, including continuous on-line monitoring systems, ensures that the water to be used for irrigation is appropriate and ongoing soil monitoring is not warranted.

As committed in Chapter 31 of the EIS, irrigation of treated water during production will be undertaken in accordance with an irrigation framework under the Produced Water Management Plan.

As the submission notes, produced water was included in the Waste Inventory in Chapter 28 (Waste management) of the EIS. The waste inventory also clearly states that the produced water is considered an interim waste and would be stored in the produced water ponds at Leewood and Bibblewindi prior to treatment. It states that there will be beneficial reuse of the treated water for a number of purposes and that there would be a managed release of treated water under licence to Bohena Creek. The waste inventory does not state that the produced water would be used on site.

Produced, treated and amended water would be managed in accordance with the relevant provisions of the *Protection of the Environment Operations Act 1997*. The beneficial reuse and managed release of the treated and amended waters would be undertaken in accordance with the relevant conditions of an environmental protection licence (EPL) and / or resource recovery arrangements under the *Protection of the Environment Operations Act 1997*.

Storage of waste

The submission requested further information on the quantity and classification of waste to be temporarily stored on site prior to disposal.

The approximate quantities and classifications of waste to be generated by the project are discussed in section 28.4 of Chapter 28 of the EIS (Waste management).

The volume of produced water, brine, and treated and amended water to be stored would be a function of the production rates of produced water. It should be noted that the volume to be produced would not exceed the design volume that could be safely stored in the purpose-built produced-water storages as discussed in Chapter 6 (Project description) of the EIS. The solid salt product would be stored in a covered interim storage facility at Leewood prior to its transfer and disposal off-site.

Other waste streams, including general solid waste and small volumes of medical, special or hazardous waste (such as tyres or batteries), would be stored in appropriate containers or storage areas and, where necessary, suitably bunded areas. Waste would be routinely collected over the life of the project. All waste would be classified in accordance with the EPA's *Waste Classification Guidelines.* Waste requiring disposal would be sent off-site to an appropriately licensed waste facility. All waste transport would be undertaken by licensed transporters and tracked in accordance with legislative requirements.

Waste risk assessment

The submission requested clarification of the risk assessment applied to the waste assessment including reference to a risk matrix.

The environmental risk assessment framework was discussed in Chapter 10 of the EIS (Approach to impact assessment). The waste assessment was completed in accordance with relevant guidelines.

The findings of the risk assessment reported in Section 28.6 of the EIS were expressed in terms of the environmental risk assessment, including the risk matrix, as outlined in Section 10.2.1 of Chapter 10 (Approach to impact assessment) of the EIS. Residual risk was found to be low to very low.

Waste Management Plan

The submission notes the EIS commitment to develop a Waste Management Plan and requests further information on the mitigation measures to be included in the Plan.

As stated in Chapter 31 of the EIS, a Waste Management Plan would be implemented for the project, which would incorporate statutory requirements under the *Protection of the Environment Operations Act 1997* and *Protection of the Environment Operations (Waste) Regulation 2014* including waste classification, recording, transport and tracking.

The Waste Management Plan would be structured around the waste management hierarchy defined under the *Protection of the Environment Operations Act 1997*. That is, opportunities to avoid, reduce, reuse, recycle and treat waste would be investigated in order to reduce the volumes waste and minimise potential environmental impacts.

The Plan would also detail the project waste inventory and for each waste stream identify appropriate containment, collection regimes management and waste management facilities to be utilised. The Plan would also outline testing and monitoring regimes and corrective actions.

Air quality modelling software

The submission requested clarification of the rationale for the application of air quality modelling software CALPUFF and AUSPLUME to project activities. It also requested clarification of the worst case conditions incorporated into the AUSPLUME model to determine separation distances.

CALPUFF was used for facilities with pre-determined locations and accounted for the large spatial extent of the project area and the variability of the terrain (between approximately 170 and 470 metres above sea level) and land use (for example, forest and agricultural land).

AUSPLUME was selected for the assessment of field infrastructure as it allowed for a conservative model configuration to determine separation distances to achieve compliance with air quality criteria without pre-empting the location of infrastructure, which would be in accordance with Field Development Protocol.

The AUSPLUME model was run for four meteorological scenarios. The scenario that produced the worst case conditions for air quality impacts was used to determine separation distances.

Air quality equipment selection

The submission noted the use of generic emissions factors that were not equipment specific. It stated that the actual air emissions may differ from the Air Quality Impact Assessment depending on the selected equipment. As such, it requested further information on the selected equipment and their air emissions based on supplier guarantee or monitoring.

The submission noted the nitrogen oxide limit adopted from the *Protection of the Environment Operations (Clean Air) Regulation 2010* assumed gas-fired reciprocating combustion engines and stated that a different limit would apply if gas turbines were instead selected.

The Air Quality Impact Assessment was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). The assessment was based on a dispersion modelling study that used site-specific details of the project, assumptions and estimation techniques to simulate and assess the dispersion and impact of air pollutants. The approach defined air emission rates, source characteristics, local meteorology, land use, terrain and the sensitive receptors to assess the potential for air quality impacts in relation to air quality criteria. Nominal specifications or emissions factors were used to assess the emissions of the project and this approach is considered appropriate to, and typical of, the current stage of project design, planning and assessment.

The application of emissions factors in the Air Quality Impact Assessment is an industry standard approach and is considered appropriate for the assessment of the project. The emissions factors that were applied were from recognised sources such as National Pollutant Inventory (NPI) emissions estimation technique handbooks, the USEPA AP42 emission handbooks and regulatory emissions limits. Use of regulatory emissions limits in particular is highly conservative as these limits represent the maximum allowable emissions for equipment that would be licensed to operate within NSW.

Emission characteristics were adopted for gas fired reciprocating engines based on the project description at the time of assessment. Emissions of nitrogen oxides were assessed for engines based on engine specific data, published emission factors and the limits defined in the *Protection of the Environment Operations (Clean Air) Regulation 2010*. If gas turbines were included in the detailed design of the project they would be required to comply with the same standard as assessed under the *Protection of the Environment Operations (Clean Air) Regulation 2010*.

Air quality assessment method

The submission notes that ground level concentrations were estimated and displayed for buffer limiting pollutants. It requested justification of the assessment of buffer limiting pollutants and recommended further information of other emissions be provided, including polycyclic aromatic hydrocarbons and $PM_{2.5}$.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The Air Quality Impact Assessment accounted for all pollutants considered to have the potential to be emitted by the project. The assessment ranked all pollutants according to the ratio of its emission rate to its relevant air quality criteria. The rankings were presented in the Air Quality Impact Assessment in Appendix L of the EIS.

The approach demonstrates that if top ranked pollutants comply with the relevant air quality criteria, lower ranking pollutants would also comply. As such, the top pollutants were assessed through dispersion modelling. The adopted approach thus streamlines the assessment process for all pollutants.

The full set of ground level concentrations that were considered in the Air Quality Impact Assessment in Appendix L of the EIS are presented in the Air Quality Addendum in Appendix I of this RTS. The addendum also contains further discussion on how polycyclic aromatic hydrocarbons and $PM_{2.5}$ were assessed.

Air quality emissions inventory

The submission stated that the emissions data for gas fired power generators incorrectly estimated oxygen correction at five per cent instead of three per cent as determined under the *Protection of the Environment Operations (Clean Air) Regulation 2010*. The submission also stated that the emissions data for diesel fired generators at well pads omitted sulfur dioxide emissions.

The value of five per cent presented in Table 5-8 is a typographical error and should be three per cent oxygen based on the *Protection of the Environment Operations (Clean Air) Regulation 2010*. The Air Quality Impact Assessment assessed emissions from gas fired power generators based on the correct values under the *Protection of the Environment Operations (Clean Air) Regulation 2010*. The error in Table 5-8 does therefore not affect the outcomes of the Air Quality Impact Assessment.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

Sulfur dioxide emissions were considered in the Air Quality Impact Assessment through the ranking method described in responses above. Sulfur dioxide was not found to be a critical pollutant and detailed results were not presented as the mass emission rates were found to be extremely low.

To demonstrate the adequacy of the approach, ground level concentrations of all considered pollutants including sulfur dioxide are presented in the Air Quality Addendum in Appendix I of this RTS. As shown, ground level concentrations of sulfur dioxide were predicted to be about 0.1 per cent of the relevant air quality criterion at a distance of five metres from the emission source.

Air quality cumulative impacts

The submission stated that the Air Quality Impact Assessment should have considered the potential air quality cumulative impacts of well pads, Leewood and Bibblewindi accounting for the maximum number of well pads likely to be in operation concurrently.

The findings of the Air Quality Impact Assessment have indicated that cumulative impacts would be very unlikely to occur. As discussed above, the assessment used AUSPLUME for the assessment of field infrastructure as it allows for a conservative model configuration to determine separation distances to achieve compliance with air quality criteria regardless of the location of the well sites.

As discussed in the Air Quality Impact Assessment in Appendix L of the EIS, the assessment found that the predicted maximum 1-hour average ground-level concentrations of nitrogen dioxide from gas fired well pad generator emissions (including background concentrations) were predicted to be below the 50 $\mu g/m^3$ criterion well within the boundary of the well pad. As production wells would have a minimum spacing of 750 m cumulative impacts are not predicted to occur.

Similarly, based on conservative estimates using the worst case emissions estimates from the *Protection of the Environment Operations (Clean Air) Regulation 2010*, the predicted maximum 1-hour average ground-level concentration of nitrogen dioxide at the Leewood plant boundary was less than half of the ambient nitrogen dioxide criterion. Thus, even if a well pad was sited on the boundary of the Leewood facility there would not be an exceedance of the nitrogen dioxide criteria.

Further information on the cumulative impacts of well pad emissions near Leewood and Bibblewindi was included as part of the Air Quality Addendum in Appendix I to this RTS. It shows project emissions would remain well below the air quality criteria defined for all pollutants.

Air quality fugitive emissions

The submission notes that the Air Quality Impact Assessment omits fugitive methane and carbon dioxide emissions on grounds they do not pose a direct risk to human health. The submissions stated fugitives may contain “volatile organic compounds, air toxics and odour substances”. It recommends that all potential components of fugitive emissions should be assessed, and measures to mitigate and manage the emissions should be proposed.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary’s environmental assessment requirements and the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

As stated in the Chapter 18 of the EIS (Air quality) a leak detection and repair program is currently undertaken for the exploration and appraisal infrastructure in accordance with Environment Protection Licence requirements. The program includes monitoring of all well site infrastructure and sets out repair response timeframes and reporting requirements if a leak is detected. A summary of monitoring results is provided as part of the annual report prepared under the Environment Protection Licence. No reportable leaks have been detected. The program will continue to be carried out in accordance with Environment Protection Licence requirements and this is included in the project commitments in Appendix B of this RTS.

As also stated in Chapter 18 of the EIS (Greenhouse gas) (including fugitive methane emissions) for the project were calculated by application of the Commonwealth Government’s *National Greenhouse and Energy Reporting (Measurement) Determination 2008* and *National Greenhouse Accounts Factors* (Commonwealth Department of Environment and Energy 2016a). The assessment was provided in Chapter 24 (Greenhouse gas).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) conducted a study that aimed to develop methods for characterising methane and other gaseous emissions from different area sources in NSW, particularly the coal seam gas industry (Day *et al.* 2016). The study showed that:

- Methane levels attributed to coal seam gas operations were low relative to other sources.
- Measurements of volatile organic compounds considered as major precursors to the formation of ozone in the atmosphere were shown to be lower at coal seam gas sites than in the vicinity of the other source types such as animal feedlots or waste facilities.

- Measurements of volatile organic compounds prioritised under United States Environmental Protection Agency ambient air quality guidelines for human and environmental health were shown to be lower at coal seam gas sites than in the vicinity of the other source types.

Further details of the study conducted by Commonwealth Scientific and Industrial Research Organisation are presented in the Air Quality Addendum provided in Appendix I to this RTS.

Air quality background concentrations

The submission requested clarification for the air quality background concentrations used in the Air Quality Impact Assessment including nitrogen dioxide, ozone and particulate matter.

It noted that background concentration of nitrogen was based on monitoring about 14 kilometres southeast of Leewood and 13 kilometres northeast of Bibblewindi.

It noted the statement in the EIS that background concentration of nitrogen dioxide and ozone would have low seasonal variability but stated that monitoring in NSW indicated nitrogen dioxide concentration peaks in winter while ozone concentration peaks in summer.

It also stated that the adopted 70th percentile PM_{10} as recorded at Tamworth was not considered in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA 2017).

The adopted background air quality concentrations were considered appropriate for the project area to assess the potential impacts of the project on air quality.

It is acknowledged that nitrogen dioxide levels in highly urbanised and industrialised locations in NSW may be seasonally variable and that ozone levels will be highly dependent on the availability of precursor pollutants and solar incidence. This is due to the variety of pollutant sources. Furthermore, higher solar incidence in the summer would likely lead to increased ozone generation. Notwithstanding this, the project area and region are likely to have a different mix of background air pollutants and sources compared with other regions of NSW where ambient air monitoring is conducted. This is particularly the case for urban and industrial airsheds like Sydney, lower Hunter Valley and Newcastle.

At the time of the completion of the Air Quality Impact Assessment, there were no ambient air quality monitoring stations with publicly available data within the Narrabri region. An analysis was conducted of ambient air quality in the wider region including data from monitor sites in Tamworth, Muswellbrook, Singleton and Beresfield. The results of that analysis were summarised in Table 4-1 of the Air Quality Impact Assessment in Appendix L of the EIS. The air quality data from most of these sites was not considered to represent the project area and region. As such, a site-specific monitoring program was conducted for the key criteria pollutants being nitrogen dioxide and ozone. Four months of monitoring data was found to be representative as analysis of results showing that nitrogen dioxide and ozone concentrations were low with limited potential variability across the year. The results of the monitoring were presented in Appendix A of Appendix L of the EIS and were adopted in the EIS's Air Quality Impact Assessment.

Particulate matter was not included in the site-specific monitoring program as it was not considered to be a critical pollutant based on assessments undertaken for coal seam gas activities in Queensland. In this case, existing ambient air quality data from Tamworth were applied. The method in the Victorian *State Environment Protection Policy (Air Quality Management)* was applied to the data to make it representative of the project area and region, given Tamworth is a relatively urbanised environment with a mix or rural and commercial industry in comparison with the project area. The method involves using the 70th percentile 24-hour average background concentration of PM_{10}. This approach is commonly used to assess air quality in Victoria and Queensland and was considered appropriate for the project, especially considering the nature of the activities and limited potential for particulate matter to be generated during operation.

Following completion of the Air Quality Impact Assessment, background particulate matter collected as part of the Namoi Region Air Quality Monitoring Project have become available and are presented in the Air Quality Addendum in Appendix I to this RTS, with the monitoring locations also mapped. Two of the monitoring locations, Maules Creek and Wil-gai, are within about 70 kilometres of Leewood. The monitoring data confirm that background concentrations of $PM_{2.5}$ are very low.

Air quality assessment maximum predicted concentration

The submission questioned whether assessing the maximum predicted concentrations of nitrogen dioxide at the boundary of Leewood represented an overall assessment of maximum impact, stating that greater concentrations were predicted about 10 kilometres to the north.

The submission recommended that the maximum predicted concentration at existing or likely offsite sensitive receptors be presented to clarify the overall maximum impact.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). The assessment found that the concentration of pollutants would comply with the relevant air quality criteria during the operation of the project. For example, the maximum ground level concentrations for nitrogen dioxide were well under half of the criteria for both the 1-hour and annual averaging periods.

The maximum cumulative 1-hour average ground-level concentration of nitrogen dioxide was predicted to the north of the Leewood project area. This is due to emissions from Wilga Park Power Station that have been included in the model. Wilga Park is an existing facility and was included in the model to provide for the cumulative assessment of nitrogen dioxide. Wilga Park was modelled as operating at its approved maximum capacity, which is well above the level at which it currently operates. Table 8-2 and Table 8-7 in the Air Quality Impact Assessment presented the maximum predicted concentrations of nitrogen dioxide including emissions from Wilga Park Power Station operating at its approved maximum capacity.

The mapped area has been extended in the Air Quality Addendum in Appendix I of this RTS to show the locations of the maximum ground level concentrations predicted. The results of all pollutants assessed (in additional to priority pollutants) are also presented in Appendix I of this RTS.

The cumulative Air Quality Impact Assessment considered the maximum ground-level concentrations of priority pollutants beyond site boundaries.

Air quality assessment of largest emissions source

The submission noted the similarity of predicted nitrogen dioxide emissions for Leewood between power supply option 1 and power supply option 2 and request confirmation that the power generation facility would be the largest emission source at Leewood.

The power supply at Leewood would be the largest emissions source. Discussion of the emissions sources at Leewood and their contribution to predicted concentrations is provided in the Air Quality Impact Assessment, being Appendix L of the EIS.

Air quality assessment approved methods

The submission stated that the assessment of $PM_{2.5}$ and PM_{10} in the Air Quality Impact Assessment should be updated in accordance with the revised *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA 2017). The revised guidelines include an annual PM_{10} criterion reduced from 30 µg/m^3 to 25 µg/m^3 and 24-hour and annual $PM_{2.5}$ criteria at 25 µg/m^3 and 8 µg/m^3 respectively.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The revised approved methods were gazetted in late January 2017, well after the finalisation of the Air Quality Impact Assessment. They include a reduced annual average PM_{10} criterion in addition to the adoption of criteria for $PM_{2.5}$ (24 hour and annual average).

Despite the Air Quality Impact Assessment having been completed in accordance with the Secretary's environmental assessment requirements, a supplementary assessment has been undertaken to provide further assessment of the impact of particulate matter against the revised *Approved Methods* (NSW EPA 2017). The changes in the impact assessment criteria for PM_{10} and $PM_{2.5}$ have not affected the conclusions of the Air Quality Impact Assessment. The results are provided in the Air Quality Addendum in Appendix I to this RTS and show that:

- Predicted maximum 24-hour and annual average ground-level concentrations of PM_{10} comply with their respective impact assessment criterion of 50 µg/m^3 and 25 µg/m^3.
- Predicted maximum 24-hour ground-level and annual average ground-level concentrations of $PM_{2.5}$ comply with their respective impact assessment criterion of 25 µg/m^3 and 8 µg/m^3.

Noise management level

The submission requested that the proponent commit to meeting noise management levels for construction noise at all hours, including outside standard construction hours.

As stated in the commitments in Chapter 31 (Environmental management and monitoring) of the EIS, noise from the project will meet the relevant noise criteria at occupied residences unless a written agreement is in place with the landholder. This commitment includes construction noise outside standard construction hours.

Cumulative noise assessment

The submission stated that components of the project and existing pilot wells and Wilga Park power station should be in combination considered against noise management levels.

The Noise and Vibration Assessment in Appendix M of the EIS included a cumulative assessment of the project, existing pilot wells and Wilga Park power station.

It found that the operation of multiple wells (including pilot wells) situated at the separation distance set out in the Field Development Protocol would comply with the relevant noise criteria. It also found the cumulative noise of wells (including pilot wells) and Wilga Park would comply with the relevant noise criteria at sensitive receivers.

As stated in the commitments in Chapter 31 of the EIS, noise from the project will meet the relevant noise criteria at occupied residences unless a written agreement is in place with the landholder.

Noise assessment tonality

The submission stated that noise monitoring of an ADR 200 drill rig undertaken by the NSW EPA was tonal whereas the noise assessment that states drill rig noise would be atonal.

Drill rig noise levels were based on operational noise monitoring of drilling rigs utilised by the proponent for the construction of the existing Dewhurst exploration and appraisal wells. These noise levels are considered an appropriate basis for assessing the potential noise impacts of the project.

The operational noise monitoring data indicated the drilling rigs did not have low frequency, tonal or other problematic sound characteristics. As such, drilling rigs utilised for the project are not expected to have these problematic sound characteristics.

Additional mitigation would be implemented in the unexpected event that operational noise monitoring for the project identifies problematic sound characteristics. These measures would be detailed in the project's Noise and Vibration Management Plan.

Noise assessment generator configuration

The submission noted that the number of engines at Leewood power generation facility varied in the noise assessment between "ten gas engines plus two standby" and "two halls, each with four gas engines and one standby". The submission requests clarification on the configuration.

The Leewood power generation facility was modelled consistent with that described in Chapter 6 of the EIS (Project description) being a configuration of ten operating gas engines plus two standby gas engines. This is the intended configuration for the purposes of project planning and assessment. Statements indicating a different configuration were a typographical error and did not represent the assessment undertaken.

Vibration assessment buffers

The submission requested confirmation of buffer distances with regard to vibration impacts. It noted the statement in the Noise and Vibration Assessment that vibration impacts would not be likely within 200 metres but also noted the larger buffer distances stated for seismic surveys.

The Noise and Vibration Assessment found that vibration impacts would not be likely at residences given their distribution through the project area, the nature of field development and mitigation and management measures set out in the noise assessment.

Vibration buffer distances to achieve the daytime 'human comfort' criteria were predominantly less than the 200 metre buffer distance set out under the Feld Development Protocol.

The exception was the potential use of specialised vehicles for seismic surveys which have the potential to exceed the 'human comfort' criteria up to 285 m from the vehicle source. It should be noted that criteria for structural impacts are achieved at 60 m, well within the 200 m.

The nature of seismic activities are such that the vehicles do not remain in a location but rather continually travel along the seismic line, momentarily stopping at set distances along the line to generate a seismic signal using a vibrating plate. Thus the likelihood of exceeding the 'human comfort' criteria at a residence for a significant period of time is considered to be negligible. Seismic surveys are undertaken during daytime hours.

If vibration-generating activities are to be undertaken in the vicinity of occupied residences or buildings, a Vibration Management Plan will be developed and implemented.

Highly noise affected levels

The submission seeks clarification of mitigation at receptors that may classify as highly noise affected including the predicted exceedance near the Wilga Park to Leewood transmission line. It recommended consideration of respite periods for highly noise affected receptors.

As stated in the Noise and Vibration Assessment of the EIS (refer to Appendix M), the highly noise affected level has the potential to occur at one residence during construction of the Wilga Park to Leewood underground power line. This noise level is predicted to occur for less than one day based on the standard rate of construction.

Mitigation and management measures would be determined in consultation with the affected resident, including respite periods if appropriate.

Drilling noise assessment

The submission sought clarification of the buffer distance under adverse weather presented for drilling in terms of the method of calculation and assumed mitigation.

Drilling noise and buffer distances were assessed using SoundPlan noise modelling software under various weather conditions as required by the *NSW Industrial Noise Policy* (NSW EPA 2000).

The assessment also assessed noise with standard mitigation measures applied to pump engines, generators and power units. This was based on operational noise monitoring of drilling rigs utilised by the proponent for the construction of the existing Dewhurst exploration and appraisal wells.

Source of maximum noise levels

The submission sought clarification on how maximum noise levels (L_{max}) were determined.

Maximum noise levels were determined with reference to equipment specification sheets and other guidance as appropriate including *Prescribing noise conditions for environmental authorities for petroleum activities* (Department of Environment and Heritage Protection, no date).

A maximum noise adjustment of +3 dBA was applied to continuously operating equipment such as generators and +8 dBA for heavy machinery in line with industry standard practice.

Mitigation measures for blasting

The submission requested reconsideration of the feasibility of the mitigation measures for blasting presented in the Noise and Vibration Assessment. It stated that some measures, such as limiting bench heights, would be more appropriate to larger blasting activities than proposed. It sought advice on other more feasible and appropriate measures that would be considered.

It is acknowledged that some mitigation and management measures for blasting presented in the Noise and Vibration Assessment would be more appropriate to larger blasting activities such as mining than the activities proposed. If blasting is required, appropriate measures would be selected and implemented for specific site conditions in accordance with *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC 1990). This is stated in the project commitments in Chapter 31 of the EIS.

Construction start dates

The submission noted that the Noise and Vibration Assessment indicated a 2016 construction start date for Bibblewindi and the field and requested a revision of these dates.

The statement in the Noise and Vibration was erroneous but does not affect the findings of the assessment. As stated in the project description in Chapter 6 (Project description) of the EIS, the indicative construction schedule for the purpose of the impact assessment commenced around early-mid 2018.

As set out in Chapter 4.1 of this RTS, acknowledging the current project schedule timing, it is likely that an indicative construction start date would be around mid/late 2019 with first gas scheduled for around 2020/21.

5.7 Forestry Corporation of NSW

Requirement for forest permit

A number of matters raised in the submission from Forestry Corporation of NSW concerned the interaction of the project and Forestry Corporation of NSW. The matters raised included:

- general project activities and access
- specific project activities, including
  - seismic surveys
  - sewage treatment
  - surveillance of facilities
  - irrigation of forested areas
  - surveillance of project infrastructure
- notification periods for project activities
- project traffic and interaction with forestry
- road construction and maintenance standards
- buried infrastructure specifications and depths
- particular project elements including surveillance
- pest, plant and animal control measures and activities
- bushfire management activities and restrictions
- other forest management activities in relation the project
- decommissioning and rehabilitation requirements.

The submission stated a forest permit would be required to address these issues. It also stated that the forest permit should include compensation for loss of productivity and/or commercial timber.

The proponent acknowledges the important role that Forestry Corporation of NSW plays in managing State forests. The proponent recognises the requirement for a forest permit under the NSW *Forestry Act 2012.*

Forestry Corporation of NSW have been routinely consulted throughout project planning, including consultation regarding the requirement for a forest permit. The proponent will continue to engage with Forestry Corporation of NSW pursuant to a forest permit that is appropriate for the project.

The proponent will be required to pay an annual fee for the lease of land for project infrastructure as a condition of the forest permit. Forestry Corporation would also retain the right to timber cleared for the establishment of project infrastructure.

As is currently the case for the existing exploration and appraisal activities, it is expected that the forest permit will include provisions for road maintenance and funding commensurate with road use for project activities.

Potential impacts on forestry roads

The submission stated that the EIS did not adequately identify the forestry roads that would be utilised for the project and for what purpose they would be utilised. It stated project traffic on forestry roads could affect their functional capacity, safety or condition. It also stated that there was potential for forestry roads to be closed under some circumstances including operational requirements, surface condition or weather; which were not considered.

The submission stated that project roads and access tracks should accommodate use by fire services and be through roads (without dead ends) for fire safety.

The Traffic and Transport Assessment in the EIS (Appendix P - summarised in Chapter 22) discussed the existing road network and identified the key access routes for the project.

The Traffic and Transport Assessment found that predicted increases in daily and peak-hour traffic on forestry roads including X-Line and Old Mill Road would be consistent with their functional class and associated flow volumes. As such, impacts are not considered to constitute a significant material impact on the functional capacity of forestry roads in the project area.

As stated Chapter 31 of the EIS (Project commitments), a Traffic Management Plan would be implemented that would avoid, mitigate and manage potential impacts on forestry roads. The Plan would include a range of measures to mitigate and manage project traffic with regard to road safety. These measures would include the likes of safety inductions, speed limits, vehicle monitoring and warning signage.

As is currently the case for the existing exploration and appraisal activities, it is expected that the forest permit will include provisions for road maintenance and funding commensurate with road use for project activities.

The proponent will monitor and report on evident deterioration of road conditions over the peak construction period and would consult with the relevant road authorities regarding potential maintenance liability where the deterioration is attributable to project activities. It is acknowledged that some forestry roads could be closed in some circumstances such as wet weather on the grounds of providing a safe environment for drivers, reducing environmental damage and maintaining the road condition. In those circumstances, it would be necessary for the proponent to review alternative traffic routes including those along forestry roads.

The proponent is presently working with the NSW Rural Fire Service in relation to bushfire management for its exploration and appraisal project in the Pilliga. The proponent is committed to making bushfire risk as low as reasonably practicable through the implementation of a Bushfire Management Plan prepared in conjunction with landholders, the Forestry Corporation of NSW and the NSW Rural Fire Service. The Plan would formalise and build on measures informed by the proponent’s participation in the Resource Industry Fire Management Group, including its commitment to maintaining forest access for fire management.

Impact of project activities on forest activities

The submission requested further information on the potential impacts of the project on forestry, recreation, beekeeping and other forest activities.

Potential impacts of the project on forest activities were discussed in the property and land use assessment in Chapter 17 of the EIS. Potential impacts on beekeeping were also assessed in the Agricultural Impact Statement in Appendix K of the EIS, while potential impacts on recreation were also assessed in the Social Impact Assessment in Appendix T1 of the EIS.

Potential impacts on forest activities were found to be limited as field development would be characterised by relatively limited and discrete areas that could co-exist with other land uses including forestry, recreation, beekeeping and other activities that would occur over the wider area. The State forest would remain accessible to other users via existing roads and access tracks in the project area.

As discussed above, Forestry Corporation of NSW have been routinely consulted throughout project planning for the proponent’s exploration and appraisal activities. During this consultation it was recognised that the project was unlikely to directly correspond with timber harvesting priorities. The proponent will continue to engage with Forestry Corporation of NSW with regard to project activities in State forest pursuant to a forest permit under the *Forestry Act 2012*.

Brigalow regional assessment

The submission requested supporting evidence for the statement in the EIS that the declaration of reserves under Brigalow and Nandewar western regional assessment anticipated the project.

The submission stated that decisions under the Brigalow and Nandewar western regional assessment should not be taken to endorse or offset the project.

The purpose of the discussion in Chapter 4 of the EIS was to demonstrate that the project is consistent with the zoning objectives of the *Brigalow and Nandewar Community Conservation Area Act 2005*.

As stated in Chapter 4 of the EIS, the *Brigalow and Nandewar Community Conservation Area Act 2005* reserved forested land in the Brigalow and Nandewar area as a Community Conservation Area. Figure 4-1 of Chapter 4 of the EIS shows that part of this Community Conservation Area is within the project area. This part of the Community Conservation Area is designated as Zone 4.

The EIS recognises that under the *Brigalow and Nandewar Community Conservation Area Act 2005* and associated Community Conservation Area Agreement, Zone 4 is designated for forestry, recreation and mineral extraction and that one of the strategic aims of the zone is to provide for exploration, mining, petroleum production and extractive industry in accordance with the *Mining Act 1992* and the *Petroleum (Onshore) Act 1991* and associated Regulations and guidelines.

In the second reading of the *Brigalow and Nandewar Community Conservation Area Bill,* the (then) NSW Minister for the Environment stated that the Community Conservation Area would provide for "sustainable industries that will provide jobs in the timber, gas, minerals and apiary sectors". The Minister also noted that the Bill would "preserve the full economic potential of the regions by ensuring the local coal and gas reserves can be accessed by the mining industry" noting the potential that "more than $2 billion will be invested" with some development already in place (NSW Legislative Assembly 2005). The Minister also referred to areas with high gas potential where significant exploration activity had already occurred. These high potential areas of the Pilliga were identified at that time by the previous operator and are now substantially within the project area.

Condition of the Pilliga

The submission requested supporting evidence for the statement in the EIS that the ecology of the Pilliga has been impacted by logging and grazing.

Areas of the Pilliga have been disturbed by various activities including logging and grazing as well as fire and weed invasion. Despite the disturbance, the large areas of remnant vegetation in the project area are not considered to be significantly fragmented.

The presence of disturbance in the Pilliga is recognised in various other environmental management documents concerning the Pilliga including *Brigalow and Nandewar State Conservation Areas: Actively managing for better ecological outcomes* (NSW Government 2014a) and the *Ecologically Sustainable Forest Management Plan* (FCNSW 2008).

Removal of culturally significant trees

The submission requested supporting evidence for the statement in the EIS that timber harvesting and grazing resulted in removal of culturally significant box trees and kurrajongs.

The Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS states that although parts of the Pilliga forest were not subject to historical broad scale clearing for agriculture, they were disturbed by historical timber getting. The assessment stated that timber getting would have had an impact on the survival of scarred trees and provides the example of box species and kurrajongs that were valued for their bark and fibre.

This statement was considered to accurately represent historical disturbance and its relationship with Aboriginal cultural heritage values in the professional opinion of the suitably qualified expert that undertook the Aboriginal heritage impact assessment.

Access agreements

The submission stated that the EIS did not adequately describe the how Land Access Agreements with landholders would remain relevant considering the likely staged nature of the project.

As stated in Chapter 17 of the EIS (Property and land use), the drilling of wells would only occur on private land if there is a Land Access Agreement with the landholder. A Farm Management Plan would be developed with the landholder to ensure appropriate siting of project infrastructure.

The development of such agreements and plans would progress in parallel with field development and would remain in force for the duration of project activities on a given private property.

Pre-existing disturbance

The submission states that the EIS did not adequately quantify and map pre-existing disturbance in the project area, such as pre-existing roads.

Existing infrastructure and disturbance in the project area was discussed and mapped in various parts of the EIS including the discussion of location and setting in Chapter 2 and the discussion of terrestrial ecology in Appendix J1 (as summarised in Chapter 17). As discussed in Chapter 2 of the EIS, the project area hosts a range of existing infrastructure, while the broader Pilliga has been subject to disturbance from other activities including the establishment of more than 5,000 kilometres of roads, tracks and trails.

The existing infrastructure including roads, tracks and trails in the project area were shown in Figure 2-4 in Chapter 2. As discussed in Appendix J2 of the EIS, high resolution aerial photography and light detection and ranging (LiDaR) data were used to map the disturbance. Section 5 of Appendix J2 includes a series of maps that document the ecological values (and disturbed areas) in the project area.

Quality of commercial timber

The submission stated that the EIS did not provide evidence to support its assessment of the current and future potential for forestry activities in the State forest within the project area.

> The assessment of the present and future value of sawlog in the project area was based on professional knowledge of the fire history of the project area, existing activities in the project area and the nature of the sawlog with regard to its regeneration rates. Recent fire history was discussed in the bushfire risk assessment within the Hazard and Risk Assessment in Appendix S of the EIS.
>
> The discussion in the EIS aligns with biomaterial reports produced by Forestry Corporation of NSW, the most recent of which indicates that no sawlog was harvested in Pilliga East State Forest in the reporting period of 2014-15, with harvest limited to other products such as firewood or fencing timber. Figures for Bibblewindi State Forest or Jacks Creek State Forest were not provided in that report (FCNSW 2015).
>
> Prior to this period, between 2005 and 2014, substantial volumes of high quality sawlog were produced in Pilliga East State Forest (81,629 m^3) and to a lesser extent Jacks Creek State Forest (12,511 m^3) (FCNSW 2014). The reasons for this shift in production would vary, but may include the availability of sawlog of appropriate species and maturity, the incidence of fire and commercial matters.

Bibblewindi water management

The submission requested clarification of the reasoning for restoration of ponds at Bibblewindi. It stated the restoration represents an opportunity cost to Forestry Corporation of NSW given the land could be used for production forest.

> As discussed in Chapter 2 of the EIS (Location and setting), the pond to be upgraded is part of an existing and approved facility covered by the current Occupation Permit, and for this reason is not considered to present an opportunity cost to Forestry Corporation of NSW.
>
> As discussed in Chapter 6 of the EIS (Project description), it is necessary to upgrade Bibblewindi Pond 3 to meet standards as set out in the *Exploration Code of Practice: Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015).

Seismic investigations clearing

The submission noted that seismic investigations might require vegetation clearing and requests information on the rehabilitation requirements.

> As discussed in the ecology assessment summarised in Chapter 15 of the EIS, seismic surveys would largely be undertaken in previously cleared areas such as road verges. Where clearing is required, it would generally be limited to the one-off slashing of shrub and mid-storey vegetation at a maximum width of three metres. Clearing of canopy species would be minimised or avoided as far as possible. Vegetation clearing for seismic activities would occur within the assessed upper disturbance limits.

Cleared areas would be rehabilitated in accordance with the Rehabilitation Strategy and Plans committed to in Chapter 31 (Project commitments) of the EIS, which would build on the Rehabilitation Strategy presented as Appendix V of the EIS.

Soil and debris stockpiles

The submission requested that soil and debris be stockpiled within the disturbance footprint to prevent additional disturbance. It requests confirmation of the size and duration of stockpiles. It also requests stockpiles be fenced to prevent theft or ignition during hazard reduction burns.

It is expected that topsoil would be stockpiled in the disturbance footprint of the project. Topsoil would be stripped, stockpiled and managed in accordance with the Rehabilitation Strategy, Erosion and Sediment Control Plan and Soil Management Plan as appropriate. As such, measures would be applied at soil stockpiles to preserve or improve soil structure and prevent loss of soil resource through erosion and sedimentation. This is discussed in further detail in Appendix I1 of the EIS (Interpretive soil report).

The Soil Management Plan would include guidance on soil stripping, handling, stockpiling, spreading and rehabilitation for the key soil types within which construction works would be undertaken. It would also include soil amendment details if required to ameliorate soils to mitigate erosivity and dispersivity potential in sodic soils within the project area.

Drill cutting classification

The submission requested evidence that drill cuttings would classify as naturally excavated material and would therefore be appropriate for burial at well pads. It stated that drill cuttings used for construction purposes should be removed from State forest at the end of the project.

As explained in Chapter 6 (Project description) and Chapter 28 (Waste management), two types of drill cuttings will be generated. These will be managed separately due their different composition.

The rock-based drill cuttings will predominantly be derived from the vertical wells and the coal-based drill cutting will predominantly be derived from the lateral wells which are drilled through the target coal seams. The rock-based drill cuttings will be beneficially re-used on the well pads, where appropriate.

The coal-based drill cuttings (and other drill cuttings not suitable for use in the well pads) will be transported off-site to a facility that can lawfully accept the material. The proponent is also investigating opportunities for the beneficial reuse of the coal-based drill cuttings.

As stated in Chapter 31 of the EIS (Project commitments), a Waste Management Plan would be implemented for the project. The Plan will detail the management of the cuttings, including their separation, storage and reuse or disposal. The management of drill cuttings will occur in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) and other relevant statutory requirements, including requirements with respect to sampling and frequency of testing.

It is noted that the NSW Environment Protection Authority have advised the proponent that excavated material generated as part of well establishment or drilling and beneficially reused at the site would not trigger waste licensing requirements or require a resource recovery exemption. A letter from the NSW Environment Protection Agency to this effect was included as Appendix E of the EIS.

The mix, turn and bury strategy has been utilised for rock based drill cuttings on a number of the existing appraisal well pads. Inspections have found that the rehabilitation is progressing well at these well pads and consistent with conditions for the successful reestablishment of vegetation.

Sewage treatment plant

The submission requested information on the size and location of sewage treatment plant at Bibblewindi as well as the volume and quality of treated effluent. It also requested information on the method of disposal of the treated effluent and potential impacts at the disposal location.

As discussed in Chapter 6 (Project description) of the EIS, sewage generated by the project workforce would be managed using packaged wastewater treatment plants designed to Australian standards.

A 400-person plant would be installed at Leewood while a 200-person plant would be installed at Bibblewindi. The existing 64-person plant at Westport workers' accommodation would also be upgraded to a 200-person plant.

Treated effluent would be disposed at a dedicated on-site disposal area by subsurface infiltration or absorption trenches, irrigation or similar, in line with all regulatory requirements.

Groundwater dependent ecosystems

The submission states that the EIS does not provide adequate data to support the conclusion that the project would not have substantial impacts on groundwater dependent ecosystems.

Potential impacts on groundwater dependent ecosystems (GDEs) were assessed in the Groundwater Impact Assessment in Appendix F of the EIS and summarised in Chapter 11 (Groundwater and geology). The assessment was conducted by a suitably qualified aquatic ecologist in accordance with the relevant NSW assessment guidelines and utilised a regional groundwater model that was peer reviewed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and found to be fit-for-purpose.

The groundwater modelling has demonstrated that there will be negligible impact to the Namoi alluvial groundwater from the project. Specifically, the maximum predicted drawdown in shallower aquifers was less than 0.5 metres occurring gradually over 200 years. The GDE assessment found that these changes would be indiscernible from variations in groundwater that already occur because of seasonal environmental fluctuations and groundwater extractions. Therefore, the project presents a low risk to groundwater dependent ecosystems.

Stream buffers

The submission states that the 40-metre stream buffer for linear infrastructure discussed Chapter 16 of the EIS is inconsistent with the 50-metre stream buffer required in State forest.

Riparian corridors were determined in accordance with the *Guidelines for riparian corridors on waterfront land* (Department of Primary Industries 2012). Non-linear infrastructure and large ponds and dams will be excluded from these buffers.

Baseline and predicted traffic volumes

The submissions requested clarification around baseline and predicted traffic volumes on forestry roads.

It is acknowledged that traffic count data provided in the Forestry Corporation of NSW submission indicates that daily traffic along forestry roads is lower than estimated in the Traffic Impact Assessment in Appendix P of the EIS, which is summarised in Chapter 22 of the EIS (Traffic and transport).

Although lower baseline volumes result in a higher expected percentage increase in daily traffic flow it does not change the absolute forecast daily traffic volumes from the project. The forecast daily traffic volumes would remain within the volumes defined for the functional classification of the roads.

The forecast traffic volumes in the assessment are conservative as they represent an “absolute peak” construction traffic generation scenario with the potential to occur over three days, while traffic volumes would be lower for the remainder of the construction and operation of the project.

The forecast traffic volumes do not include third party traffic such as government agencies.

Forestry road extent

The submission argues that the EIS overstates the extent of forestry roads under management of Forestry Corporation of NSW. It notes Forestry Corporation of NSW manages in the order of 600 kilometres of roads whereas the EIS states in the order of 5,000 kilometres of roads, track and trails, including forestry roads have been established in the project area.

As stated in Chapter 2 of the EIS (Location and setting), the ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and other human activities through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of wildfire.

The 5,000 kilometres of roads, tracks and trails refers to the Pilliga as a whole including all State Forests, National Parks, Nature Reserves and conservation areas. The project area has around 1,000 kilometres of roads, tracks and trails.

Liability for chemical spills

The submission stated that the proponent should be liable for environmental damage in the event of a chemical spill in State forest.

The potential for the project to cause spills or leaks was assessed in Chapter 14 (Soils and land contamination) and Chapter 25 (Hazard and risk) of the EIS. The assessments found that the likelihood of the project causing a spill was low.

The project would be designed in accordance with the relevant codes of practice to minimise the risk of spills or leaks occurring. These would include:

- *Code of Practice for Coal Seam Gas – Well Integrity*
- *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*
- *Exploration Code of Practice: Produced Water Management, Storage and Transfer.*

As discussed in Chapter 6 of the EIS (Project description), and in accordance with the codes of practice, produced water ponds would be designed to incorporate double lining, leak detection and seepage collection. In addition to this, the NSW Dam Safety Committee would review and confirm the dam design.

The project would also incorporate a range of monitoring systems that would enable quick detection and rectification in the unlikely event of a leak or spill, including continuous pressure monitoring of produced water gathering lines, and leak detection and monitoring bores for produced water ponds. Further, exploration, appraisal and production gas wells would be remotely monitored and controlled and would automatically shut down in the event of non-routine operational conditions.

Chemicals will be stored and handled in accordance with the relevant Australian Standards, including *AS 1940-2004 The storage and handling of flammable and combustible liquids*. Refuelling would occur with suitable containment for volumes greater than 50 litres and not within 40 metres of a watercourse. Bunding, drip trays and other preventative measures would be implemented as necessary and spill kits would be situated as appropriate in areas where there is potential for spills to occur. Regular inspection of plant, equipment and infrastructure would be carried out in accordance with operational procedures.

The proponent will be responsible to develop a Pollution Incident Response Management Plan in accordance with *Protection of the Environment Operations Act 1997*. A response plan is currently in place for exploration and appraisal activities in accordance with these requirements.

In summary, a significant number of design, construction and operational measures are proposed or already in place that mean there is a low risk of spills or leaks. As demonstration of this, the proponent has conducted exploration and appraisal activities in the project area, including operation of the water treatment plant at Leewood, without a reportable incident in over 4.5 years.

Bushfire assessment

The submission stated that the EIS did not adequately assess bushfire and requested further evidence for the finding that the project would have a remote likelihood of causing a bushfire. It requested further information including a risk assessment of all activities presenting a risk of ignition, details of how the proponent will reduce the risk of ignition and details of emergency response resources and actions. It also stated the presence of the project workforce would increase the risk of bushfire.

The submission stated that bushfire suppression resources and operational constraints triggered by fire danger should be detailed in the proposed Bushfire Management Plan. The submissions also stated that the proponent should consider operational contingencies during dangerous fire weather.

The project bushfire assessment was presented in Appendix S of the EIS and summarised in Chapter 25 (Hazard and risk). The assessment concluded that the likelihood of project activities causing a bushfire was remote given the range of measures proposed in addition to measures already in place as informed by the proponent's participation in the Resource Industry Fire Management Group.

The assessment committed the proponent to prepare a Bushfire Management Plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire Management Plan currently in place for the exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project's activities.

The EIS identifies many strategies to manage bushfire risks, as discussed in Chapter 25 (Hazard and Risk) and Section 6.25 of this RTS report.

Asset protection zones and hazard reduction burning

The submission stated that the EIS did not adequately detail the process to designate asset protection zones and strategic fire advantage zones required by the Rural Fire Service. The submission also stated that project infrastructure may impose restrictions on hazard reduction burning undertaken by Forestry Corporation of NSW. It also stated that slashing or other fuel reduction methods may be required.

The project is State Significant Development and is exempted under section 4.41 and 4.14(1B) of the *Environmental Planning and Assessment Act 1979* and does not require a Bush Fire Safety Authority from the NSW Rural Fires Act 1997. It is, however, recognised that the project would be situated on bush fire prone land and appropriate bushfire protection measures commensurate with the nature and scale of risk needs to be provided. Asset Protection Zones and automated shut-in values are key components of these protection measures. As stated in Chapter 31 of the EIS (Project commitments), a Bushfire Management Plan would be produced in consultation with key stakeholders including NSW Rural Fire Service and Forestry Corporation of NSW.

It is not expected that Forestry Corporation of NSW would carry out bushfire management activities for the protection of project infrastructure. As a result, it is not expected that the project would restrict bushfire management activities carried out by Forestry Corporation of NSW.

As discussed in the Field Development Protocol in Appendix C the EIS, the proponent will develop a Plan of Operations that would set out field infrastructure at each phase of field development. The plans would serve to inform Forestry Corporation of NSW of locations of project infrastructure.

Environmental management plans

The submission requested that Forestry Corporation of NSW be consulted in the development of environmental management plans including environmental monitoring for the project.

The proponent has committed to consultation with the Forestry Corporation of NSW with regard to the relevant aspects of the project through the forest permit process under the *Forestry Act 2012*.

Definition of State forest

The submission states that State forest is incorrectly defined in the EIS as “land reserved by the Department of Natural Parks, Recreation, Sport and Racing for state forest purposes”.

The text was in error and appeared in the terms and abbreviations summary in Chapter 34 of the EIS and does not affect the findings of the EIS. It is acknowledged that declaration of state forest may be made under Section 14 of the *Forestry Act 2012*.

Fauna buffers

The submission states that the proposed 50-metre buffer for barking owl nests is inadequate and should be increased to 200 metres to align with current practices.

The Ecological Impact Assessment in Appendix J1 of the EIS and Biodiversity Assessment Report in Appendix J2 of the EIS were undertaken in accordance with the Secretary’s environmental assessment requirements for the project and the NSW *Framework for Biodiversity Assessment*.

The proposed measures including fauna buffers were determined through those assessments and are appropriate for the avoidance, mitigation and management of potential impacts on biodiversity values.

Proposed Koala research

The submission requests the proponent collaborate with Forestry Corporation of NSW and its environmental research partners in undertaking proposed Koala research.

The proponent has committed to consultation with Forestry Corporation of NSW regard to the relevant aspects of the project through the forest permit process under the *Forestry Act 2012*.

Rehabilitation

The submissions raised a number of issues regarding the project rehabilitation strategy, including:

- source of rehabilitation material
- source of seeds and seedling
- soil compaction in rehabilitation areas
- fencing of rehabilitation areas
- nature of partial rehabilitation
- preparation for rehabilitation
- selection of reference sites
- development of completion criteria
- monitoring and intervention of rehabilitation
- likelihood of rehabilitation success
- rehabilitation toward production forest.

The Rehabilitation Strategy for the project was presented in Appendix V of the EIS. As stated in the assessment, a Rehabilitation Plan containing detailed rehabilitation measures would be prepared following approval of the project. The Rehabilitation Plan would be consistent with the Rehabilitation Strategy and relevant approval conditions.

Rehabilitation material would comprise topsoil and cleared / mulched vegetation generated during construction. The cleared and mulched material may be used to improve soil organic matter.

Seeds and seedlings would be preferentially collected from the project area in consultation with an appropriate seed collection authority or experienced botanist to identify appropriate species.

As topsoil to be used in rehabilitation would be stripped and stockpiled during construction it is not expected to be subject to compaction. As stated in the Rehabilitation Strategy, ripping would be undertaken as necessary to encourage revegetation and successful rehabilitation.

Perimeter fencing would be considered on a case by case basis depending on the risk of grazing animals entering rehabilitation areas, including linear rehabilitation areas.

Partial rehabilitation areas would be vegetated with shrubs and grasses. Following decommissioning of well pads, areas would be fully rehabilitated.

Planning for closure and rehabilitation will commence at least two years ahead of decommissioning of wells and other infrastructure. Both the project and preparation for rehabilitation would occur progressively and not only during the two-year period in advance of first rehabilitation.

As stated in the Rehabilitation Strategy, rehabilitated areas would be monitored and assessed against completion criteria with regard to reference sites. Reference sites would be selected to be representative of the same plant community type in the vicinity of the rehabilitation area.

A series of quantifiable data would be collected and would serve as completion criteria. The data would include vegetation structure and condition and presence of habitat features such as hollow bearing trees.

As shown in Table 11 of the Rehabilitation Strategy, monitoring of rehabilitation sites would occur over multiple years to ensure rehabilitation success. A two year natural regeneration period would occur following initial rehabilitation. Rehabilitation intervention would occur during that period in the event of a bushfire or if after the two year natural regeneration period there is little evidence of germination. If seasonal conditions during the two year natural regeneration period are poor, such as drought, an additional twelve months may be allowed for natural regeneration before rehabilitation intervention.

Rehabilitation undertaken to date shows similar numbers of native species to reference sites, a dense shrub layer, relatively low weed cover and regeneration of overstory species through coppice regrowth. It is expected that as midstory and canopy species continue to grow, with continued weed monitoring and management, rehabilitated areas will attain similar composition and structure to adjacent remnant woodland, and are on a trajectory to attaining (preliminary) completion criteria.

As stated in Appendix V of the Rehabilitation Strategy, Forestry Corporation NSW will be consulted to provide advice on rehabilitation techniques and management in State forest to encourage restoration of vegetation communities compatible with Forestry Corporation NSW land use objectives.

Other minor Rehabilitation Strategy clarifications

The submission seeks clarification of the following concepts in the Rehabilitation Strategy in Appendix V of the EIS:

- nature of performance objectives
- land to which performance objectives apply
- anomalies that would trigger inspection
- meaning of whole of landscape monitoring
- duration of rehabilitation for mid story and canopy species
- application of species richness value to entire community or per strata
- timing of groundcover assisted restoration
- use of presence of absence of canopy species to measure rehabilitation success.

The following clarifications are offered to the points raised in the submission:

- The performance objectives are presented in the preliminary completion criteria column of Table 11 of the Rehabilitation Strategy (EIS Appendix V).
- The performance objectives would apply to land subject to the Rehabilitation Strategy and plans.
- Anomalies refer to indications from remote sensing data that rehabilitation sites are not performing as expected.
- Whole of landscape monitoring refers to the monitoring of all rehabilitation sites and their performance with reference to the surround landscape and reference sites.
- The durations for mid-story and canopy species in Table 11 (10 years and 15 years respectively) refer to re-establishment of those strata, whereas the references to five years relate to the timing of updates to the Rehabilitation Strategy based on monitoring of the trajectory of rehabilitation sites.
- The completion criteria of 75 per cent species richness would apply per strata.
- Assisted restoration of groundcover would occur where less than 25 per cent has regenerated in comparison to reference sites after 12 months.
- Canopy species were presented as one of a series of measures of rehabilitation success and are considered, in combination with other measures, to be appropriate.

Transfer of rehabilitation liability

The submission seeks confirmation that securities and liability for rehabilitation outcomes would persist with a change in the operational management of infrastructure such as groundwater monitoring bores.

As a condition of tenure the proponent is required to lodge a security deposit for the full cost of rehabilitation of its activities. The value of the security is independently verified by an appropriately qualified third party and approved by the NSW Government (Department of Planning and Environment 2017b). The security remains in place until the NSW Government is satisfied that rehabilitation has been successfully completed.

Decommissioning of Bibblewindi safety flare

The submission sought clarification of the reasoning for retention of the Bibblewindi safety flare following decommissioning and noted that Forestry Corporation of NSW would be responsible or the environment and safety in State forest following the project.

> As stated in Chapter 6 of the EIS (Project description), ancillary equipment installed at Bibblewindi including the safety flare would be disassembled and removed during decommissioning.
>
> The discussion of the recommissioning of ponds and installation of safety flare at Bibblewindi in Appendix W (Decommissioning report) relates to the construction phase.

Construction material

The submission queried whether imported bund material and material used to improve road surfaces would be removed from State forests during project decommissioning.

It raised the concern that incorporation of construction material into the soil profile would reduce forest productivity and requested evidence that this would not occur or an associated offset.

> Project decommissioning requirements for forested areas would be discussed with Forestry Corporation of NSW during preparation of the Decommissioning Management Plan.
>
> The proponent does not propose to incorporate road surface material into the soil profile.

5.8 Heritage Council of NSW

Mitigation and management of potential impacts

The submission notes that the project would not have physical impacts on heritage places listed on the State heritage Register or *Narrabri Local Environmental Plan 2012*. It stated the proposed avoidance of multiple other identified sites of potential heritage significance was appropriate.

> As identified in the submission, no heritage items on the State heritage register of *Narrabri Local Environmental Plan 2012* are within or adjacent to the project area.

Johnston’s Albion Sawmill

The submission requested that Johnston’s Albion Sawmill be mapped and undergo photographic archival recording as a condition of consent.

As discussed in the Historic Heritage Assessment in Appendix O of the EIS, Johnston's Albion Sawmill was assessed to be not of heritage significance. The sawmill location was identified on historic maps however an intensive survey of the area did not identify cultural heritage material of the period.

A partial concrete foundation was found that appeared to have been previously moved by construction machinery such as a grader or bulldozer. The site has been heavily impacted by later uses and modification and a substantial amount of material has been removed, possibly for road building activities. The resultant embankments have been used by trail bike riders and campers. As such, further mapping and archival recording is not considered to be necessary.

Unexpected finds protocol

The submission requested that an unexpected finds protocol for archaeological sites be incorporated into the Historic Heritage Management Plan for the project.

As discussed in Section 8.2 of Appendix O of the EIS, an unexpected finds procedure would be developed for the event that historic heritage items are encountered. The unexpected finds procedure would be incorporated in the Historic Heritage Management Plan.

5.9 NSW Local Land Services

Potential impacts on ecology and natural resources

NSW Local Land Services raised a range of issues in relation to terrestrial and aquatic ecology and natural resource management, with reference to the Local Land Services *Transitional Regional Natural Resource Management Plan* and its various targets. The submission referenced and commented on a range of direct and indirect impacts, avoidance and mitigation measures, the draft Biodiversity Offsets Strategy and rehabilitation. The submission considered issues associated with the siting of new infrastructure, construction, operation, decommissioning and rehabilitation.

The project has been declared a 'controlled action' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, with approval therefore required from the Commonwealth Minister for the Environment and Energy. The controlled action decision determined that the project must be assessed under the bilateral agreement between the Commonwealth and NSW Government. Assessment requirements for the project were detailed in the Secretary's environmental assessment requirements.

The project area has been surveyed extensively for various development proposals (over 13,000 hours of survey effort has been undertaken since 2002), including extensive field surveys undertaken specifically for the project. The objectives of the field surveys were to determine the abundance, distribution, ecology and habitat preferences of threatened and migratory species, populations and ecological communities within the project area. To determine the conservation value of each habitat present in the project area from a local and regional perspective, and determine the importance of populations present from a local and regional perspective.

Vegetation mapping undertaken for the project included aerial photographic interpretation of high resolution 10 cm aerial imagery supported by high resolution LiDaR datasets including canopy height modelling. Validation and attribution of the vegetation mapping included the detailed survey of 327 full floristic plots and approximately 1,300 rapid data points. Approximately 250 of the rapid data points (20 per cent) were withheld for an accuracy assessment. All of the survey data (over 1,600 data points) collected were utilised in the development of vegetation mapping.

The ecological assessment has been undertaken in accordance with the Secretary's environmental assessment requirements. The assessment concluded that with the various avoidance and mitigation measures, there would be no significant impacts on species or ecological communities, including threatened species and threatened ecological communities. In accordance with the Secretary's environmental assessment requirements, *NSW Framework for Biodiversity Assessment* and the associated *NSW Biodiversity Offsets Policy for Major Projects*, a Biodiversity Assessment Report was prepared and submitted as part of the EIS (Appendix J2).

The submission from the NSW Office of Environment and Heritage raised a number of questions in relation to the Biodiversity Assessment Report and the draft Biodiversity Offsets Strategy. The proponent has responded to these in Section 5.11.

Data collected as part of the survey effort indicate that there is a widespread and abundant pest animal population currently in the project area, particularly foxes, cats and pigs. An important mitigation measure for the project is a commitment that feral animals and weeds will be managed in accordance with a Pest, Plant and Animal Control Plan. The Plan will be finalised following determination in consultation with landholders and relevant agencies including NSW Local Land Services.

Potential impacts on travelling stock reserves

The submission requested information on the potential impacts of the project on travelling stock reserves. It noted that Local Land Services manages about 583 hectares of these reserves in the project area including high conservation value reserves at Newell Highway and Yarrie Lake.

It requested that impacts on travelling stock reserves be described, including those outside the project area, and measures to avoid, mitigate and manage these impacts are identified. It highlighted potential impacts of the project on aquifers and associated water points.

The submission requested the project be assessed against the *NSW Travelling Stock Reserves State Planning Framework 2016–21* (Local Land Services 2016) and its guiding principles.

It is recognised that travelling stock reserves managed by NSW Local Land Services are situated in the vicinity of, and within, the project area (refer to Figure 5-1).

The *NSW Travelling Stock Reserves State Planning Framework 2016-21* identifies values of travelling stock reserves including Aboriginal cultural heritage, European cultural heritage, agricultural productivity, environmental conservation and social and recreational values.

The EIS considered the potential impacts of the project on these and other values in the project area and is therefore considered to have taken these matters into account including through the development of avoidance, mitigation and management measures.

With consideration to the location of the travelling stock reserves in the project area, and constraints defined in the Field Development Protocol in Appendix C of the EIS, it is expected that minimal project infrastructure would be located in travelling stock reserves. The proponent will consult with NSW Local Land Services regarding the location of project infrastructure in this respect.

As shown in Figure 5-1, Yarrie Lake reserve is located in the project area and is partly a stock reserve. Yarrie Lake reserve is defined as the following land: Lot 51, DP 43308; Lot 52, DP 43308 and Lot 53, DP 43308. It is a designated surface development exclusion zone (plus a buffer of at least 50 m) for the project. No surface infrastructure will be located within the Yarrie Lake reserve, or the 50 m buffer area.

Pest management and biosecurity

The submission stated that the project should implement legislated biosecurity and weed management requirements where project activities may affect travelling stock reserves. It also stated that weed management should include weed hygiene measures to prevent weed propagation.

The submission stated that management of pest species should be with consideration to:

- NSW *Biosecurity Act 2015* and *Biosecurity Regulation 2017*
- *Local Land Service Transitional Regional Natural Resource Management Plan*
- *Draft North West Regional Strategic Weed Management Plan 2017-2022*

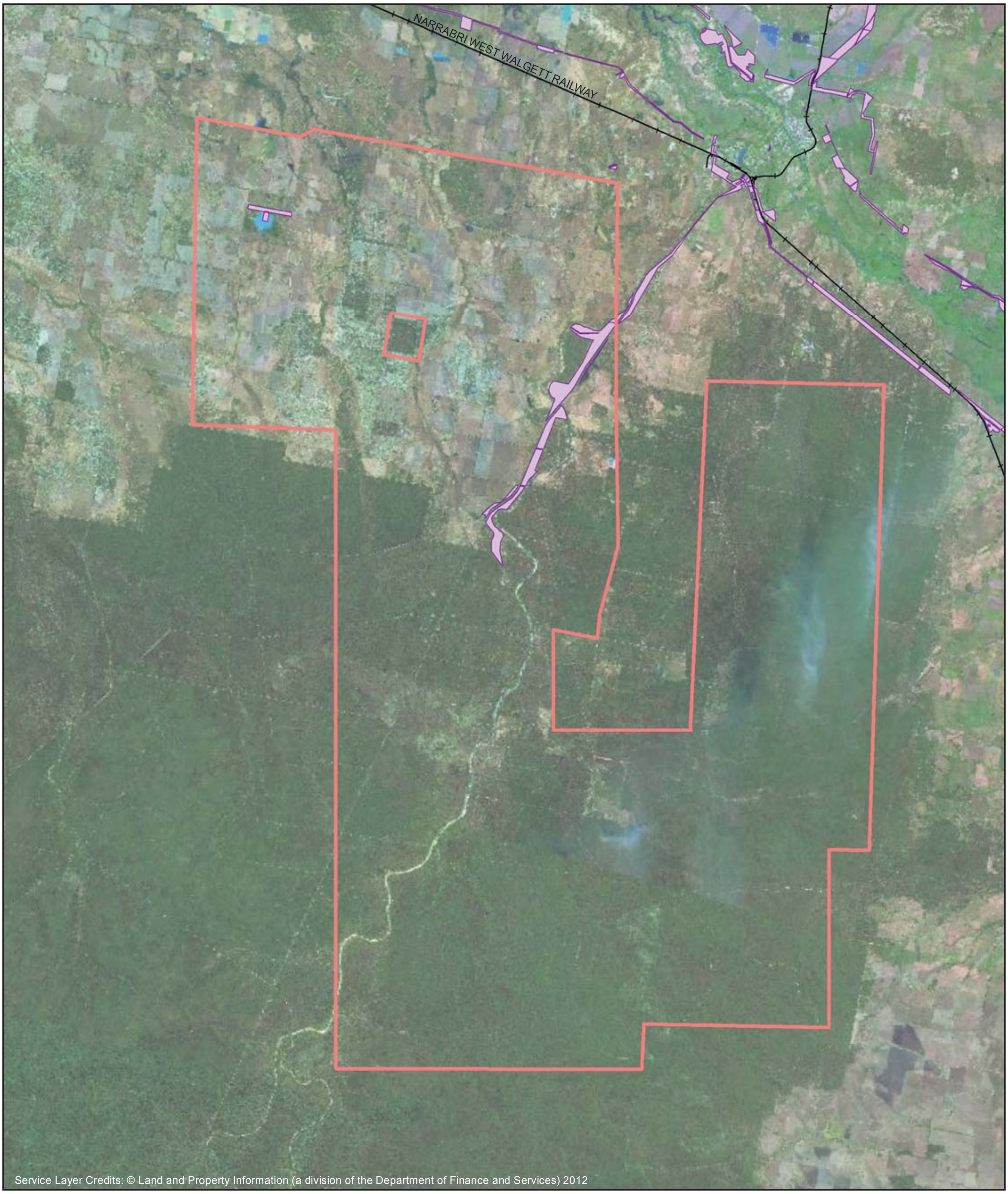
As stated in the commitments in Chapter 31 of the EIS, pests, plants and animals would be managed in accordance with a Pest, Plant and Animal Control Plan. The Plan would provide measures to minimise weed transportation, monitor invasive species and ensure that weeds are managed effectively. The Pest, Plant and Animal Control Plan would include weed hygiene measures.

Consultation with NSW Forestry Corporation, the NSW National Parks and Wildlife Service and private landholders will be held during the preparation of the Pest, Plant and Animal Control Plan and nil-tenure feral animal strategy to identify ways to integrate the feral animal control strategy with other strategies across the Pilliga region and provide additional benefits.

Justification for project scale

The submission requested demonstration of the need for 425 well pads in light of alternatives such as fewer well pads to reduce ecological impacts.

Chapter 8 (Assessment of alternatives) describes the alternatives considered when developing and siting a commercial project in the area. Chapter 6 (Project description) details the well design and well pad layouts, including the use of double and triple stacked wells to reduce the number of well pads required, and therefore, the project’s environmental footprint.



LEGEND

- Project area
- Travelling Stock Reserves
- Train line

0 1 2 4 6 8

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
Response to Submissions

Job Number	21-22463
Revision	A
Date	27 Feb 2018

Travelling stock reserves within the project area

Figure 5-1

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_Z162_TravellingStockReserves.mxd

Data source: Aerial Imager: Sixmaps (2017 - NSW LPI); General Topo: NSW LPMA DTDB 2012, 2013; Travelling Stock Reserves: NSW OEH 2017. Created by:jrprice

Well pad clearing

The submission queries the need to clear one hectare followed by partial rehabilitation at the end of construction. It recommended initial clearing be reduced through micro-siting.

The initial well pad area of one hectare is necessary for operational and safety purposes during well construction including drilling. The approach to siting well pads was described in the Field Development Protocol in Appendix C of the EIS and the updated Field Development Protocol is provided as Appendix C of this RTS.

Well pads locations would be planned with regard to ecological constraints identified through field surveys including those for the Ecological Impact Assessment in Appendix J1 of the EIS. As detailed in the constraint matrix in Table 7-1 of the Field Development Protocol, the process will result in the majority of well pads being located outside of high and moderate ecological sensitivity class.

Micro-siting involves, amongst other things, ensuring compliance with all of the relevant avoidance measures and constraints at the site-scale. Micro-siting in the field seeks to further direct the development away from sensitive ecological and cultural features. The micro-siting process involves field scouting of ecological features (such as threatened flora and hollow-bearing trees) and pre clearance surveys for Aboriginal cultural heritage within the proposed area of the development.

Decommissioning clearing

The submission requested identification of additional clearing for decommissioning and that this clearing be included in the draft Biodiversity Offset Strategy for the project.

As stated in the Ecological Impact Assessment in Appendix J1 of the EIS, the upper disturbance limit of clearing required for the project is 988.8 hectares. This upper disturbance limit is for all disturbances including additional clearing for decommissioning. Residual impacts on threatened species and ecological communities will be offset as part of a Biodiversity Offset Strategy in general accordance with the *NSW Biodiversity Offset Policy for Major Projects*.

Bushfire management

The submission stated that information provided on bushfire management was limited to a commitment to development a Bushfire Management Plan.

The project bushfire assessment was presented in Appendix S of the EIS and summarised in Chapter 25 (Hazard and risk). The assessment concluded that the likelihood of project activities causing a bushfire was remote given the range of measures proposed in addition to measures already in place as informed by the proponent’s participation in the Resource Industry Fire Management Group.

The assessment committed the proponent to prepare a Bushfire Management Plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire Management Plan currently in place for the exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project’s activities.

The EIS identifies many strategies to manage bushfire risks, as discussed in Chapter 25 (Hazard and Risk) and Section 6.25 of this RTS report.

Partial rehabilitation and asset protection zones

The submission sought clarification on the compatibility of partial rehabilitation at well pads and asset protection zone requirements. It sought confirmation of the nature of the asset protection zone and confirmation of additional clearing to that discussed in the assessment.

As stated in the Ecological Impact Assessment in Appendix J1 of the EIS, the upper disturbance limit of clearing required for the project is 988.8 hectares. Residual impacts on threatened species and ecological communities will be offset as part of a Biodiversity Offset Strategy in general accordance with the *NSW Biodiversity Offset Policy for Major Projects*.

The project is State Significant Development and is exempted under section 4.41 and 4.14(1B) of the *Environmental Planning and Assessment Act 1979* and does not require a Bush Fire Safety Authority from the *NSW Rural Fires Act 1997*. It is, however, recognised that the project would be situated on bush fire prone land and appropriate bushfire protection measures commensurate with the nature and scale of risk needs to be provided. Asset Protection Zones and automated shut-in values are key components of these protection measures.

As stated in Chapter 31 of the EIS (Project commitments), a Bushfire Management Plan would be produced in consultation with key stakeholders including NSW Rural Fire Service and Forestry Corporation of NSW.

Managed release to Bohena Creek

The submission stated that the assessment did not justify the managed release to Bohena Creek as a critical part of its water management strategy.

The proposed managed release to Bohena Creek is one component of the treated water management strategy, which includes beneficial reuse options for the treated and / or amended water and includes irrigation, construction, firefighting, stock watering and dust suppression. The managed release to Bohena Creek under specified natural flow conditions complements these beneficial reuse options, such as during wet weather events when demand for the other beneficial reuse options may be limited.

As stated in Chapter 7 of the EIS (Produced water management), treated water would only be released to Bohena Creek during flow conditions equal to, or greater than, 100 megalitres per day as measured at the Newell Highway gauging station, and to an amount not exceeding 12 megalitres per day (i.e. less than 12 per cent of the flow in the creek).

The risk assessment for this managed release found that potential impacts on hydrology and geomorphology were negligible. The assessment also found that impacts from managed release on water quality and aquatic ecology would be low to negligible when considering baseline water quality under the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000).

Potential groundwater impacts

The submission requested demonstration of how the project would avoid impacts to the Great Artesian Basin, Pilliga Sandstone, wetlands and Ted's Hole with regard to managed release.

It stated the assessment did not demonstrate that the project would achieve water target 2 of Local Land Services *Transitional Regional Natural Resource Management Plan* to achieve an improvement in groundwater systems to support dependent ecosystems and services by 2020.

Potential impacts on the Great Artesian Basin were assessed in detail in the Groundwater Impact Assessment (EIS Appendix F). The assessment found there will be no direct extraction of water from the Great Artesian Basin, and therefore, a very limited potential to indirectly depressurise the Great Artesian Basin. The assessment includes consideration of potential indirect (induced) effects on water pressure in the Great Artesian Basin due to depressurisation in the underlying Gunnedah-Oxley Basin. The Groundwater Impact Assessment found that the project would generate a maximum drawdown of less than 0.5 metres occurring gradually over 200 years in the Namoi Alluvium and Pilliga Sandstone. Impacts were expected to be indiscernible from existing variations in groundwater that occur from existing extraction, replenishment from the environment and seasonal fluctuations.

Managed release protocols are outlined in Appendix G1. As stated in Chapter 7 of the EIS (Produced water management), treated water would only be released to Bohena Creek during flow conditions equal to, or greater than, 100 megalitres per day as measured at the Newell Highway gauging station.

Ecotoxicology, hydrology and hydrogeological assessments of the potential impacts of the managed release have been undertaken and findings are included in the EIS (Appendix G1 and its appendices). The studies found no potentially detrimental impacts would occur from the managed release to the creek during the managed release scenario flow event of greater than 100 megalitres per day. Accordingly, potential impacts on downstream values such as Ted's Hole would also be avoided through the implementation of managed release protocols and associated dilution.

Water monitoring

The submission requested a surface water and groundwater baseline and monitoring program be implemented across the project area to account for potential impacts to water sources in the travelling stock route network in addition to Bohena Creek, Narrabri Creek and Namoi River.

The EIS included a Water Monitoring Plan (Appendix G3).

The proponent is committed to implementing a groundwater monitoring program capable of early detection of impacts of the project on groundwater resources and dependent users. The Water Monitoring Plan (EIS Appendix G3) is founded on the principle of early detection monitoring and identifies monitoring thresholds and trigger levels and associated management actions for mitigation of potential impacts. The thresholds and trigger levels in the Water Monitoring Plan are designed to reflect the concept of Level 1 and Level 2 impacts as defined in the *NSW Aquifer Interference Policy*. Table 3-11 of the Water Monitoring Plan (Appendix G3 of the EIS) outlines the proposed management actions for Level 1 and Level 2 impacts, and lists the proposed make-good provisions for existing bore owners.

The proponent's proposed water monitoring network includes sentinel monitoring bores that are strategically located both within deeper formations close to target coal seams and centralised around the first phase of production. The monitoring plan includes trigger values for early warning and management actions to mitigate impacts to local receptors.

All monitoring data is compiled into a reporting framework, such that sufficiency of monitoring will be periodically reviewed to allow identification of whether additional monitoring is required. The Water Monitoring Plan is to be updated to reflect changes that are considered to be required through this review process.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the ground and surface water monitoring program for the project.

Social impact assessment

The submission noted the social impact assessment and requested assessment of how the project would address negative community perceptions and meet people targets 1 and 2 of Local Land *Services Transitional Regional Natural Resource Management Plan*.

The Social Impact Assessment presented in Appendix T1 of the EIS was prepared in accordance with the Secretary's environmental assessment requirements and the relevant social impact assessment guidelines and social baseline information at the time of preparation.

It is noted that people targets 1 and 2 of the *Transitional Regional Natural Resource Management Plan* (North West Local Land Services 2015) are as follows:

- Natural resource management decisions contribute to social wellbeing.
- There is an increase in the adaptive capacity of the catchment community.

The *Transitional Regional Natural Resource Management Plan* identifies actions to meet the above targets including understanding and defining social wellbeing; engaging with stakeholders regarding development; and understanding natural resources, their management and implications of crossing environmental thresholds.

The project is considered to be consistent with these targets and actions through its ongoing commitment to stakeholder engagement, regular communication updates and site tours and participation in the Community Consultative Committee for the project.

The Environmental Management Strategy for the project would adopt an adaptive management approach that would involve ongoing monitoring for potential impacts on environmental values through a series of environmental management plans. A Social Impact Management Plan will also be developed and implemented for the project.

5.10 NSW Health

Air quality contours

The submission stated that the Air Quality Impact Assessment should include air quality data for all key pollutants relation to sensitive receptors. Specifically it requested annual $PM_{2.5}$ contours and air toxics concentrations at sensitive receptors.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The Air Quality Impact Assessment accounted for all pollutants considered to have the potential to be emitted by the project. The assessment ranked all pollutants according to the ratio of its emission rate to its relevant air quality criteria. The rankings were presented in Appendix B of the Air Quality Impact Assessment.

It was assessed that if the top ranked pollutants complied with the relevant air quality criteria, lower ranking pollutants would also meet the criteria. As such, the top pollutants were assessed through dispersion modelling. The adopted approach thus streamlines the assessment process for all pollutants.

To demonstrate the adequacy of the approach, ground level concentrations of all pollutants that were considered are presented in the Air Quality Addendum in Appendix I of this RTS. The addendum also contains further discussion on how air toxics and $PM_{2.5}$ were assessed.

Air quality monitoring

The submission stated that air quality monitoring should be undertaken prior to, and during, the project, and be independently verified to validate the findings of the Air Quality Impact Assessment.

As stated in Chapter 18 of the EIS (Air quality), an Air Quality Management Plan would be implemented during construction and operation of the project. The Air Quality Management Plan would include an air quality monitoring program.

The air quality monitoring program would be carried out by suitably qualified air quality practitioners and would serve to validate the findings of the Air Quality Impact Assessment and demonstrate compliance with the relevant air quality criteria.

Criteria for PM_{10}

The submission note that the criteria for PM_{10} adopted in the assessment of 30 µg/m was revised to 25 µg/m in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA 2017).

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The revised approved methods were gazetted in late January 2017, well after the finalisation of the Air Quality Impact Assessment. They include a reduced annual average PM_{10} criterion in addition to the adoption of a 24-hour average and annual average criterion for $PM_{2.5}$.

A supplementary Air Quality Assessment has been undertaken to assess the project activities against the revised *Approved Methods* (NSW EPA 2017).

The results are provided in the Air Quality Addendum in Appendix I and show:

- Predicted maximum 24-hour and annual average ground-level concentrations of PM_{10} comply with their respective impact assessment criterion of 50 µg/m³ and 25 µg/m³.
- Predicted maximum 24-hour ground-level and annual average ground-level concentrations of $PM_{2.5}$ comply with their respective impact assessment criterion of 25 µg/m³ and 8 µg/m³.

Water quality

The submission stated the potential for adverse human health impacts from surface water contamination from would be very low given the proposed management plans.

The submission is noted and is consistent with the findings of the Health Impact Assessment in Appendix T2 of the EIS, which found that potential health impacts were not expected with implementation of proposed avoidance, mitigation and management measures.

5.11 NSW Office of Environment and Heritage

Validation of vegetation data and disturbance estimates

The submission stated the vegetation map should be validated against all vegetation plot data. It requested clarification on the underling vegetation data and its validation.

The submission presented data from the NSW Office of Environment and Heritage vegetation information system and recommended a series of revisions based on recorded plot data.

Vegetation mapping undertaken for the project included photographic interpretation of high spatial resolution (10 cm) aerial imagery supported by high resolution LiDaR datasets including canopy height modelling. Validation and attribution of the vegetation mapping included the detailed survey of 327 full floristic plots and approximately 1,300 rapid data points. Approximately 250 of the rapid data points (20 per cent) were withheld for an accuracy assessment. All of the survey data (over 1,600 data points) collected as part of the project were utilised in the development of the vegetation mapping.

Plant community types were attributed based on expert allocation following the NSW Vegetation Classification (Benson *et al*. 2010) and based on a quantitative analysis of floristic data, landscape position and known occurrence of the plant communities in the Pilliga (Appendices D and F1 of EIS Appendix J1). The final mapped product is accurate at a 1:10,000 scale and is the most detailed vegetation map available of the region.

NSW Office of Environment and Heritage undertook a review of plant community types for 220 plots and identified that at least 16 of these plots (7 per cent) may have a better plant community type. Of these 16 plots, four plots are located in ‘derived native grassland’ and two are located in regrowth (i.e. extensively modified). In accordance with the *Framework for Biodiversity Assessment*, these plots were assigned the best fit plant community type based on likely pre-1750 vegetation community as they could not be quantitatively assigned to a plant community type due to their disturbed condition.

The remaining ten plots are considered a good match for the plant community type as assigned. They have at least one (and usually multiple) characteristic species present in each structural layer and are a good fit collectively with the landscape position of vegetation mapped for the project. It is important to consider not just the floristics at an individual plot location, but also how that plot and vegetation fit in the broader landscape, particularly due to the variable nature of plant communities in the Pilliga.

While it is acknowledged that some NSW Office of Environment and Heritage suggested plant community types could be equally suitable for some plots, the plant community types assigned in the EIS are considered a good fit for the vegetation mapped across the project area no changes to the vegetation mapping presented in the EIS are proposed.

To provide further confidence to NSW Office of Environment and Heritage the proponent has committed to ensuring no adverse outcomes on endangered ecological communities outside of mapped areas. As discussed in the Field Development Protocol in Appendix C of the EIS, if an endangered ecological community is identified that was not mapped at that particular location, the proponent will seek to avoid the community. If avoidance is not possible, then the impact would count toward the upper disturbance limit for that endangered ecological community. For all other impacts, the upper clearing limits would be assessed as per the mapped plant community type.

Ecological sensitivity analysis ranks and weightings

The submission suggested changes to the ecological sensitivity analysis ranks and weightings used to guide disturbance calculation and avoidance measures. It stated that the ecological sensitivity analysis should be redone based on those suggested changes.

The ecological sensitivity analysis is a spatial tool developed specifically for the project, to avoid and minimise impacts on areas of higher ecological sensitivity. The ecological sensitivity analysis was based on a number of ecological features or characteristics such as patch size, density of threatened flora and high quality fauna habitat, which were then ranked and weighted.

The ecological sensitivity analysis provided a meaningful way of identifying the most sensitive areas, enabling the project to maximise avoidance of these areas. High sensitivity areas cover approximately four per cent of the project area, and moderate-high cover approximately 13 per cent of the project area. While project infrastructure will occupy approximately one per cent of the project area, disturbance of the high ecological sensitivity class is limited to 0.5 per cent of the class. Disturbance limits for vegetation communities were calculated as discussed in Appendix F3 of Appendix J1 of the EIS. The limits accounted for the spatial distribution of the high ecological sensitivity class, and the 0.5 per cent disturbance limit.

A detailed review of NSW Office of Environment and Heritage suggested rankings and weightings for the ecological sensitivity analysis has been undertaken. This process identified that NSW Office of Environment and Heritage suggested changes would have a negligible effect on the outcome of the ecological sensitivity analysis (a one per cent increase to high and a five per cent increase to moderate-high categories mainly associated with endangered ecological communities).

Given that the sensitivity analysis underpins the modelling of upper disturbance limits and that the suggested changes would have a negligible effect on the outcome, no changes to the analysis are proposed.

Ecosystem credit liability total

The submission sought confirmation of the total ecosystem credit liability for the project. It raised a series of queries regarding ecosystem credit liability for direct, indirect and cumulative impacts.

A revised working draft Biodiversity Offset Strategy is provided as Appendix F to this RTS.

Ecosystem credit liability calculation

The submission sought clarification regarding the applicability of rehabilitation areas in the calculation of biodiversity offsets.

Following construction, approximately 50 per cent of vegetation clearing associated with well pads and gas and water gathering lines (totalling about 587 hectares) will be rehabilitated as described in the Ecological Impact Assessment in Appendix J1 and Rehabilitation Strategy in Appendix V of the EIS. The Rehabilitation Strategy is designed to further reduce the impact of the project on biodiversity values (including threatened and migratory species, populations and ecological communities).

The proponent does not propose to claim rehabilitated areas as an offset. Rather, best practice rehabilitation of disturbed land is being used to reduce the overall impact, and therefore, offset liability for the project. Rehabilitation monitoring in the project area since 2013 has shown that rehabilitation sites approximate 72 per cent of the condition of reference sites, and are clearly on a trajectory to becoming self-sustaining plant community types, representative of pre-occurring types.

NSW Office of Environment and Heritage has requested that the benefit of rehabilitation be calculated as part of a Biodiversity Offset Strategy after calculation of credits required for impact (rather than as part of impact calculations). Areas subject to rehabilitation assessed in the EIS currently require 32 ecosystem credits per hectare where directly impacted areas require 47 credits per hectare (on average). This means that the proposed approach to rehabilitation in the EIS is equivalent to generating 15 credits per hectare for rehabilitation areas.

To validate the number of credits that should be generated for rehabilitation as part of the project, a number of scenarios were reviewed in the BioBanking Credit Calculator to ascertain the maximum number of credits per hectare able to be generated for rehabilitation; being:

- Scenario 1 – All site values set at ‘0’ (bare earth).
- Scenario 2 – Site values set at 25 per cent of benchmark for each value (very low site value).
- Scenario 3 – Site values set based on the average value recorded at existing rehabilitation sites in the Pilliga (i.e. results achievable within five years of rehabilitation).

Under each scenario, the ‘gain’ for each site value was increased to its maximum (where available). The maximum number of credits were generated for the second scenario (10 credits / hectare) while both the first and third scenarios generated a similar number of credits (nine credits / hectare).

However, when you consider the results of the rehabilitation undertaken to date in the Pilliga, site value scores have exceeded the maximum allowable gain for native plant species richness, native ground cover (grasses), native ground cover (other), over-storey regeneration and length of fallen logs. When the weightings for each value are applied in accordance with the BioBanking Assessment Methodology, the rehabilitation undertaken to date in the Pilliga results in a 17 per cent overall increase above the best possible gain score.

Due to the demonstrated ability to achieve successful rehabilitation outcomes in short timeframes resulting in self-sustaining plant community types representative of pre-occurring types, the proponent is requesting a 17 per cent increase on the maximum number of credits able to be generated using the BioBanking Credit Calculator (i.e. 12 credits / hectare). Due to the proposed rehabilitation techniques (including minimal soil disturbance and management of the topsoil seedbank), the proposed rehabilitation far exceeds planting, seeding, or other management activities undertaken on BioBank sites, and is not comparable to mine rehabilitation.

A revised working draft Biodiversity Offset Strategy is provided as Appendix F to this RTS, which includes revisions to rehabilitation credits.

Avoidance of threatened ecological communities

The submission notes the potential for the project to avoid endangered ecological communities under the *Threatened Species Conservation Act* 1995 and *Environment Protection and Biodiversity Conservation Act 1999* given the flexibility provided by the Field Development Protocol. It specifically recommended the project avoid Weeping Myall Woodland, Fuzzy Box Woodland and Brigalow. Given the relatively large area of Brigalow in the project area the submission recommended that the community be avoided when in good condition under the *Environment Protection and Biodiversity Conservation Act 1999* or otherwise listed under the *Threatened Species Conservation Act 1995*.

The avoidance strategy included in the modelling of upper disturbance limits as part of the EIS maximises avoidance and minimisation of impacts to endangered ecological communities. The upper disturbance limits assume that wherever native vegetation can be avoided by relocating infrastructure, that it will be avoided. The forward development of the project is contingent on strictly adhering to the assumptions of the modelling (i.e. avoidance) and will be implemented through the Field Development Protocol (Appendix C of the EIS).

Furthermore, the ecological scouting framework discussed in Appendix G of Appendix J1 of the EIS prioritises the avoidance and minimisation of impact to State and Commonwealth listed threatened species, populations and ecological communities. Due to their spatial distribution and configuration, it is not possible to completely avoid all endangered ecological communities and some disturbance will be necessary and included in the upper disturbance limits.

Consideration of indirect impacts

The submission stated that the full credit value of indirect impacts from the buffers should be included in the project's total credit liability. It stated that indirect impacts were calculated as a proportion of defined buffer areas and stated they should instead be included in their entirety.

The *Framework for Biodiversity Assessment* requires proponents to demonstrate minimisation of indirect impacts on biodiversity values using reasonable onsite measures. Both the Ecological Impact Assessment (Appendix J1 of the EIS) and Biodiversity Assessment Report (Appendix J2 of the EIS) described the likely indirect impacts of the project as well as proposed mitigation measures.

Due to the nature of the project, where indirect impacts are likely to be a more significant issue (when compared to a development with a consolidated footprint), the proponent has committed to offset a proportion of the indirect impacts as if they were direct impacts. A detailed methodology was proposed for calculating indirect impacts which contribute to the total quantum of offsets for the project (see Section 4.11.2 of Appendix J1 of the EIS).

The methodology for calculating indirect impacts assessed the likely maximum extent of indirect impacts pre-mitigation and post mitigation. The post mitigation indirect impact extent is then assessed as equivalent to a particular level of direct impact. The total area assessed as indirectly impacted was 181.1 hectares, or 18 per cent of the directly impacted area (988.8 hectares).

For the purposes of offsetting, calculations were constrained to a 30-year period for indirectly impacted areas (20 years during development i.e. the expected maximum lifespan of a production well, followed by a 10-year rehabilitation period), after which, indirect impacts will cease to function and the indirectly impacted area will be equivalent to areas not affected by the project (i.e. remnant native vegetation and habitat). As such, 30 per cent multiplier was applied to indirectly impacted areas when determining final credit liability. This approach exceeds the statutory requirements for the project and is part of an overall commitment to avoid, minimise, rehabilitate and offset impacts.

Replication of plots for vegetation condition assessment

The submission noted that some plots were replicated within or across vegetation communities in classifying their condition in the project area. It requested that only the nearest plot with the highest summed condition score for the specific vegetation community type be replicated rather than all plots for the specific community or related communities.

Both the *Framework for Biodiversity Assessment* and *NSW Biodiversity Offset Policy for Major Projects* are in transition and, while compulsory, a flexible approach is permitted to appropriately deal with technical issues, practical implementation issues, or potential adverse outcomes that may arise.

The *Framework for Biodiversity Assessment* requires plant community types to be separated into vegetation zones (areas in the same broad condition state). A minimum number of plots are then required to be completed to determine the site value score for each vegetation zone. The vegetation survey, including stratification process into vegetation zones, was detailed in Section 4.5 of Appendix J2 of Appendix J1 of the EIS.

In the published EIS there is a shortage of nine vegetation plots (five in derived native grassland and four in native vegetation) required to meet the minimum requirements of the *Framework for Biodiversity Assessment*. It should be noted however, that for many vegetation zones (more than 70 per cent), the minimum number of plots far exceeded the requirements (245 additional plots in total). The additional nine plots have now been completed and the results are included in Appendix G of this RTS.

Despite many attempts since 2014, including splitting the assessment and having NSW Office of Environment and Heritage software engineers attempt to resolve ongoing issues, the Major Project Credit Calculator is not capable of processing the full project in a single analysis.

As required by the Framework for Biodiversity Assessment, the direct impacts of the project were assessed by an accredited Biobank Assessor using the Major Project Credit Calculator Version 4.0 and submitted to the Office of Environment and Heritage for approval. The assessment was split into three equal parts to manage known capacity issues with the processing capability of the Major Project Credit Calculator. The outputs of the direct impact credit calculation (in terms of credits required per hectare of impact) were then used to determine the total quantum of biodiversity offsets required for the project (including direct, indirect and cumulative impacts).

No replication of data was required for this assessment as the minimum number of plots per vegetation zone have been surveyed.

Replication of plots for derived native grassland

The submission stated that individual derived native grassland plant community types should be replicated to make up shortfalls identified in the credit calculator. They stated that pooled data should only be used where no plot data for a derived native grassland plant community type was collected.

The derived native grassland across the north-west of the project area was in very low condition due to historical and ongoing agricultural activities, consisting largely of only a few hardy native perennial grasses with the remainder being a combination of exotic pasture and bare ground. As such all derived native grassland data was pooled in the credit calculator (with an average site value score of 20.4) to cover the identified shortfall of plots required by the *Framework for Biodiversity Assessment*.

A detailed review of vegetation plot data for derived native vegetation within each plant community type identified a range of site values scores between 7.3 and 29.7. Four plant community types (out of a total of eight having derived native grassland) had average site value scores below the average site value score of 20.4. Furthermore, three of the four had average site value scores less than 17 (totalling over 20 hectares, or 29 per cent of all derived native grassland) and as such did not formally require offsets under the *Framework for Biodiversity Assessment*. The approach to pooling data in the EIS has therefore been conservative and with offsets determined above the minimum required by the *Framework for Biodiversity Assessment*.

Nevertheless, the additional plots required have now been completed and the results are included in Appendix G of this RTS. No replication of data was required for this assessment as the minimum number of plots per vegetation zone have been surveyed and included in the Major Project Credit Calculator assessments submitted to the Office of Environment and Heritage.

Stratification of offset credit liability

The submissions stated that offset credit liability should be calculated and stratified based on each vegetation zone and condition combination.

The *Framework for Biodiversity Assessment* requires plant community types to be separated into vegetation zones (areas in similar condition state). Specifically, the *Framework for Biodiversity Assessment* requires plant community types to be separated into 'broad condition' states which are defined as 'areas of the same plant community type that are in relatively homogenous condition’. Broad condition is used for stratifying areas of the same plant community type into a vegetation zone for the purpose of determining the site value score. The *Framework for Biodiversity Assessment* states “in identifying areas that are in a similar broad condition state, the assessor may consider areas of the [plant community type] that have a similar over-storey cover, mid-storey cover, ground cover, weediness or combinations of these”.

The *Framework for Biodiversity Assessment* then requires the site value score to be determined by plant community type and broad condition state (i.e. vegetation zone). For the purposes the assessment of the project, vegetation was stratified into two broad condition states being ‘native vegetation’ (Moderate/Good) and 'derived native grassland' (Moderate/Good derived grassland), despite a further level of stratification being developed for the vegetation mapping (i.e. low, moderate and good). A review of remnant native vegetation across the entire study area identified that 88 per cent has been mapped in 'good' condition, 11 per cent in 'moderate' condition and less than one per cent in 'low' condition. This highlights the fact that the vast majority of vegetation in the project area is in the same 'broad condition state'.

For the purposes of the EIS, impacts to all native vegetation were assessed. By pooling data into higher level 'broad condition states', the average site value score (or condition) of remnant vegetation may have changed if areas in lower condition were pooled with areas in higher condition. However, as the benchmarks for vegetation condition in the project area include large variance between upper and lower values for each attribute, it is not considered likely that the change would be significant (i.e. even remnant vegetation mapped in 'low' condition may still be considered to have high value due to the broad benchmarks).

To confirm these assumptions, a detailed review of site value scores between the further levels of stratification included in the vegetation mapping (i.e. low, moderate and good) was undertaken. This review determined only a seven per cent variance between the site value scores of ‘good’ and ‘moderate’ condition states. Therefore, all vegetation is considered to be in the same ‘broad condition state’ for the purposes of the *Framework for Biodiversity Assessment*. Due to the relatively low proportion of vegetation in ‘moderate’ or ‘low’ condition states, the effect of further stratification on offset requirements would be negligible, and effects would likely reduce offset liability rather than increase it. As such, no additional stratification of vegetation has been undertaken.

Potential Koala habitat in project area

The submission noted the potential habitat for Koala in the project area and history of sightings in the broader region. It requested preparation of further assessment and offset credit liability for the Koala or an expert report to further assess the potential for Koala to be present in the project area.

The number of credits required to offset impacts to potential habitat for Koala were calculated as requested by NSW Office of Environment and Heritage. To determine required offsets, the following process was followed as requested by the Office of Environment and Heritage:

- Plant community types associated with Koala in BioNet were identified and cross-referenced with plant community types impacted by the project.
- The credits required for direct impacts to Koala were assessed in the Major Project Credit Calculator in accordance with the *Framework for Biodiversity Assessment*
- The credits required for indirect and cumulative impacts to Koala were determined using the credits per hectare metric developed from the direct impact calculations undertaken in the Major Project Credit Calculator in accordance with the *Framework for Biodiversity Assessment*.

Based on this process, a total of 30,454 credits are required to be offset for this species. The proponent is committed to finding suitable potential habitat (as defined through plant community type association described above) as an offset for Koala, as part of the project Biodiversity Offset Strategy. A revised working draft Biodiversity Offset Strategy is provided as Appendix F to this RTS.

Value of proposed Koala research

The submission noted the proposed Koala research and limit of 10 per cent of the total offset package in line with the *NSW Biodiversity Offsets Policy for Major Developments*. It requested that the proposed Koala research as a proportion of the total offset package be clarified.

As stated in the working draft Biodiversity Offset Strategy in Appendix L of the Appendix J1 of the EIS, compensatory measures (including though not limited to the Koala research proposal) will be capped at

10 per cent of the total offset package in accordance with the *NSW Biodiversity Offsets Policy for Major Developments*.

The Koala research proposal is a component of the compensatory measures proposed and is currently value at approximately $70,000, which is significantly less than 10 per cent of the likely total offset liability of the project.

Spotted-tailed quoll and Rufous Bettong

The submission stated that survey effort for spotted-tailed quoll and Rufous Bettong was less than that required by the NSW Office of Environment and Heritage guidelines, and therefore, did not justify the conclusion that these species were unlikely to be present. It recommended that an expert report be prepared to determine the likelihood of occurrence or otherwise that these species be assumed present and included in the Biodiversity Offset Strategy.

Spotted-Tail Quoll is nominated as an 'ecosystem credit' under the *Framework for Biodiversity Assessment*, and therefore, specific offset requirements are not required.

Rufous Bettong was not recorded as part of the surveys undertaken for the EIS despite approximately eight times the minimum survey effort required for the directly impacted area being undertaken. There are very few records from the broader Pilliga Region, and none from within the project area. As such no expert report or calculation of credits for this species is proposed

The *Framework for Biodiversity Assessment* through the Major Project Credit Calculator and background databases, identifies a number of species which are known or predicted to occur in the Interim Biogeographic Regionalisation for Australia subregions and plant community types in the project area. Offsets are required to be determined where these species (or suitable habitat) occur.

Spotted-Tail Quoll is nominated as an 'ecosystem credit' under the *Framework for Biodiversity Assessment,* and therefore, specific offset requirements are not required (and are unable) to be determined for this species. Accordingly, an ‘expert report’ is not required for this species.

NSW Office of Environment and Heritage survey guidelines state a certain amount of required effort up to 100 hectares of stratification unit, with an additional effort for larger areas. This additional effort is not defined and the guidelines have clearly not been developed to cover a large study area such as the 95,000-hectare project area.

Rufous Bettong is nominated as a ‘species credit’ under the *Framework for Biodiversity Assessment* and therefore specific offset requirements are required to be determined for this species if:

- The species is identified on site during surveys
- The species is assumed to be present
- An expert report determines that the species is present.

No Rufous Bettong have been recorded as part of the surveys and assessment undertaken as part of the EIS, despite approximately eight times the minimum survey effort required for the directly impacted area being undertaken. In addition, over 1,500 trap nights were surveyed using remote cameras which are a new method (post publication of survey guidelines in 2004) suitable for the detection of this species.

There are no Rufous Bettong records in the project area, and the nearest record is 25 kilometres distant. For the Pilliga Region there are only three records of Rufous Bettong, the latest being in 2014, with others in 1993 and 2008.

Given the species was not recorded as part of the surveys undertaken for the EIS, and there are very few records from the broader Pilliga Region, and none from within the project area, it has been assumed that this species does not occur for the purposes of the *Framework for Biodiversity Assessment*. As such no expert report or calculation of credits for this species is proposed.

Myriophyllum implicatum

The submission requested justification for the statement in the assessment that *Myriophyllum implicatum* would not be impacted and stated that impacts to the species should be assessed in line with the *Framework for Biodiversity Assessment*.

There is no proposed impact on *Myriophyllum implicatum* as outlined in the Ecological Impact Assessment in Appendix J1 of the EIS, and therefore, no upper disturbance limit has been modelled.

The single known location for this species will be avoided as part of the forward development of the project. Due to the habitat preferences for this species (i.e. shallow wetlands), its extent in the project area is likely to be limited, and known records at the time of locating infrastructure will be avoided.

Furthermore, the ecological scouting framework discussed in Appendix G of Appendix J1 of the EIS prioritises the avoidance and minimisation of impact to State and Commonwealth listed threatened species, populations and ecological communities based on listing status.

Lepidium aschersonii and *Lepidium monoplocoides*

The submission requested clarification on the calculation of impacts to *Lepidium aschersonii* and *Lepidium monoplocoides.* It recognised that impacts on these species were anticipated in the Biodiversity Assessment Report but were excluded from the threatened flora modelling report.

A threatened flora modelling report was prepared to investigate threatened flora populations in the North-east Pilliga Forest and was presented in Appendix F4 of Appendix J1 of the EIS. The scope of the study was to provide statistically robust modelled estimates of population size and distribution, and outline habitat requirements for threatened flora populations in order to adequately address the potential impacts of the project.

However, only a portion of the species known to occur in the project area were detected during targeted flora surveys in sufficient numbers for modelling, namely *Diuris tricolor*, *Polygala linariifolia*, *Pterostylis cobarensis*, *Commersonia procumbens* and *Tylophora linearis*. These species are the subject of the modelling report. Furthermore, within the project area, detailed mapping and population estimates have been previously developed for *Bertya opponens* and *Pomaderris queenslandica* as presented in Appendix J1 of the EIS. However, modelling for *Lepidium aschersonii* and *L. monoplocoides* was not undertaken due to insufficient records and poor seasonal conditions during the 2014 surveys in which they were detected. The impacts on these species were calculated as a proportion of their total population (based on the average of impacts to other threatened flora species populations).

The proponent has now completed targeted surveys and population estimation for *Lepidium aschersonii* and *L. monoplocoides* within the project area. The results of the surveys and population estimation are presented in Appendix H of this RTS. This has resulted in the development of revised upper disturbance limits for each of these species as detailed below.

An estimated 8,264,623 *L. aschersonii* occur within the project area based on an average density of 0.45 plants per square metre and an occupancy of 74 per cent of suitable habitat. An estimated 218,265 *L. monoplocoides* occur within the project area based on an average density of 0.07 plants per square metre an occupancy of 82 per cent of suitable habitat.

The revised upper disturbance limit for *L. aschersonii* is 77,691 which represents 0.94 per cent of the total population estimated within the project area. The revised upper disturbance limit for *L. monoplocoides* is 1,116 which represents 0.37 per cent of the total population estimated within the project area.

Both limits are well below the proportional impact of 1.55 per cent assessed in Appendix J1 of the EIS. The revised upper disturbance limits to these species are considered conservative and do not change the underlying assessment of impact to these species contained in Appendix J1 and Appendix J2 of the EIS. A revised working draft Biodiversity Offset Strategy is provided as Appendix F to this RTS.

Vegetation disturbance monitoring

The submission requested information on how the proponent will monitor vegetation disturbance to ensure proposed limits are not exceeded. It specifically requested information on frequency of monitoring, reporting of results and means of accessing reports.

A reporting framework to manage and document upper disturbance limits is included in the Field Development Protocol (Appendix C of the EIS). The framework includes the following safeguards:

- A Plan of Operations, including direct impacts on vegetation communities, to be prepared and submitted to the NSW Department of Planning and Environment and the Commonwealth Department of Environment and Energy prior to implementation.
- An annual review to ensure compliance with the Field Development Protocol, management plans and procedures, the Plan of Operations, and State and Commonwealth approvals.
- An independent third-party environmental audit every three years from commencement to ensure compliance with the Field Development Protocol, Plan of Operations, State and Commonwealth approvals, management plans, relevant licences and the annual compliance review.

Offset reporting framework

The submission stated the proponent should develop a monitoring report framework that documents the clearing of all plant community types and threatened flora and fauna habitat areas within the proposed upper disturbance limits.

A monitoring report framework documenting the individual site assessment and results of the ecological scouting framework is an integral component of the Field Development Protocol outlined in Appendix C of the EIS. This information will be reported as part of the Plan of Operations to be submitted to the NSW Department of Planning and Environment and Commonwealth Department of Environment and Energy as outlined in the response above.

Prior disturbance offsets

The submission requested confirmation of the development for which prior disturbance would be incorporated in the biodiversity offsets for the project. It requested a table be provided that clearly shows the developments and their offset requirements to be carried forward.

Infrastructure being carried forward as part of the project includes a series of wells, gas and water gathering lines and facilities as shown in the revised working draft Biodiversity Offset Strategy provided as Appendix F to this RTS.

This includes infrastructure being carried forward for which impacts have already been offset, and infrastructure being carried forward for which impacts are to be offset as part of the project. The total amount of impact against each plant community type (in hectares) and total number of credits required for infrastructure being carried forward for which impacts are to be offset is included in the revised working draft Biodiversity Offset Strategy provided as Appendix F to this RTS.

Biodiversity offset strategy

The submission stated the draft Biodiversity Offset Strategy did not fulfil the requirements of the *Framework for Biodiversity Assessment*. It stated that the strategy had not demonstrated that all reasonable steps had been followed before considering supplementary measures. It requested that the proponent provide a detailed Biodiversity Offset Strategy including full costing of all components.

The working draft Biodiversity Offset Strategy is fully compliant with the *Framework for Biodiversity Assessment* and all ‘reasonable steps’ have been undertaken as required by the *Framework for Biodiversity Assessment*. A revised working draft Biodiversity Offset Strategy provided as Appendix F to this RTS.

Vegetation clearing timing

The submission requested that vegetation clearing timing be clarified and that it avoid key breeding or hibernation seasons for threatened fauna species known to occur.

As stated in the EIS, vegetation clearing would be managed to minimise clearing during sensitive breeding periods for fauna. A hierarchical timing for clearing from most to least preferred is: March to June; February and July / August; and September to January.

The upper disturbance limit for direct impact on native vegetation is 988.8 ha and to minimise clearing during sensitive periods, less than 50 per cent (494 ha.) of the disturbance will be outside the most preferred period from March to June, and less than 20 per cent (197 ha.) of this disturbance will be during the least preferred period from September to January.

Treated water in forested areas

The submission sought clarification of the statement in Chapter 7 of EIS that treated water would be reused to irrigate local soils in forested areas. It stated that impacts of reusing treated water in forested areas including rehabilitation areas should be considered.

To remove doubt, it is not proposed to irrigate local soils in forested areas with treated water for the purpose of rehabilitating native vegetation.

Regent Honeyeater offset

The submission requested that the offset requirement for Regent Honeyeater be calculated based on its associated plant community types listed in the threatened species profile database.

The number of credits required for impacts to potential Regent Honeyeater habitat have been calculated as requested by NSW Office of Environment and Heritage. To determine required offsets, the following process was followed as requested by NSW Office of Environment and Heritage:

- Plant communities types associated with Regent Honeyeater in BioNet were identified and cross-referenced with plant community types impacted by the project.
- The credits required for direct impacts to Regent Honeyeater were assessed in the Major Project Credit Calculator in accordance with the *Framework for Biodiversity Assessment*
- The credits required for indirect and cumulative impacts to Regent Honeyeater were determined using the credits per hectare metric developed from the direct impact calculations undertaken in the Major Project Credit Calculator in accordance with the *Framework for Biodiversity Assessment*.

Based on this process, a total of 4,255 credits are required to be offset for this species. The proponent is committed to finding suitable potential habitat (as defined through Plant Community Types association described above) as an offset for Regent Honeyeater as part of the Biodiversity Offset Strategy for the Project. A revised working draft Biodiversity Offset Strategy provided as Appendix F to this RTS.

References to vegetation community and plant species

The submission provided some corrections to references to vegetation including:

- plant community type 40X used instead of plant community type 405
- inconsistent references to biometric vegetation types
- incorrect reference to *Commersonia procumbens* as *R. procumbens*.

The above were raised as minor issues and it was noted that plant community type 40X was correctly considered as plant community type 405 in biodiversity offset calculations.

Plant community type 40X was described separately as it represents a unique assemblage of species on a particular landform in the Pilliga. This was detailed in the vegetation mapping report in Appendix F2 of the Ecological Impact Assessment in Appendix J2 of the EIS. The NSW Office of Environment and Heritage was requested to review this plant community type. For the purposes of the Ecological

Impact Assessment, Biodiversity Assessment Report and corresponding offset calculations, plant community type 40X was assigned to the nearest plant community type (405) as required by the *Framework for Biodiversity Assessment*. Disturbance limits against this community were assessed as plant community type 405 in the Major Project Credit Calculator.

Biometric vegetation types in the Namoi Catchment underwent review in 2014. The surveys and assessment undertaken as part of the EIS for the project have been undertaken since 2010 and continually evolved during this period. Table 33 of the Ecological Impact Assessment in Appendix J1 of the EIS includes the most up to date information on plant community types including corresponding biometric vegetation types from 2014 and 2008.

The genus *Rulingia* was transferred to *Commersonia* in 2011 based on phylogenetic analysis and morphological observations (Whitlock *et al.* 2011). This occurred during the production of appendices which support the Ecological Impact Assessment in Appendix J1 of the EIS. As such, *Rulingia procumbens* is synonymous with *Commersonia procumbens*.

Management measures

The submission raised the following matters to be addressed in management plans:

- Daily checking of open trenches
- Requirements for habitat bridges and glider crossings
- Replacement of hollows smaller and larger than 300 millimetres.

The proponent has committed to checking open trenches daily. Table 46 of the Biodiversity Assessment Report in Appendix J2 of the EIS identifies how impacts during operational phases of the project will be minimised.

The matters to be considered have been taken directly from the *Framework for Biodiversity Assessment* (Section 8.3.2.12). As stated in Table 46, the proponent is proposing to minimise impacts through the compensation of removal of large hollows (>300 mm) at least at a 1:1 ratio. No glider crossings or habitat bridges are proposed or considered necessary for the project.

Habitat descriptions

The submission stated the habitats of Australasian Bittern and Rufous Bettong were not correctly described in Table 16 of the Biodiversity Assessment Report.

The description of habitat for Australasian Bittern and Rufous Bettong contain typographical errors.

The habitat for Australasian Bittern should be described as permanent freshwater wetlands with tall, dense vegetation, particularly Bullrushes (*Typha* spp.) and Spikerushes (*Eleocharis* spp.). Availability of this habitat in the project area is low and likelihood of occurrence remains as assessed in the EIS.

The habitat for Rufous Bettong should be described as a variety of forests from tall, moist eucalypt forest to open woodland, with a tussock grass understorey. A dense cover of tall native grasses is the preferred shelter. The availability of this habitat in the project area is moderate and likelihood of occurrence of this species remains as assessed in the EIS.

Consultation with Registered Aboriginal Parties

The submission stated that NSW Office of Environment and Heritage was satisfied with consultation undertaken by the proponent and the 'comprehensiveness of responses' to issues raised in submissions from Registered Aboriginal Parties regarding the Aboriginal Cultural Heritage Assessment Report and Cultural Heritage Management Plan. It stated that 'the proponent has complied with the ACH consultation requirements'.

The submission noted the proponent commitment to regularly updating Register Aboriginal Parties through the preparation of the Cultural Heritage Management Plan. It recommended the proponent provide information to Registered Aboriginal Parties on the implementation of the Cultural Heritage Management Plan and that additional less formal and more frequent means such as flyers and social media be considered.

The Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS and related consultation were undertaken in accordance with the Secretary's environmental assessment requirements. The Aboriginal Cultural Heritage Assessment Report documented the stages of consultation undertaken in accordance with the *Aboriginal cultural heritage consultation requirements for proponents* (NSW Government 2010).

Once the project has been determined and then, following determination, the Cultural Heritage Management Plan is finalised, the proponent does not propose to maintain a register of Registered Aboriginal Parties or correspond with Registered Aboriginal Parties as a group. This approach is consistent with the Secretary's environmental assessment requirements and the *Aboriginal cultural heritage consultation requirements for proponents* (NSW Government 2010). The Community Consultative Committee for the project will continue to meet after the planning assessment has been completed and throughout the operation of the project.

The Community Consultative Committee agenda and minutes are made available to all of the community. The Narrabri Local Aboriginal Land Council is a member of the Community Consultative Committee. In addition, it is proposed that membership of the Aboriginal Cultural Heritage Working Group includes nominees from the Wee Waa Local Aboriginal Land Council, Narrabri Local Aboriginal Land Council and Gomeroi Applicant. The function of the Aboriginal Cultural Heritage Working Group is central to the Cultural Heritage Management Plan. The working group, including representatives of two land councils and the Gomeroi Applicant, will be regularly provided with information regarding execution of the Cultural Heritage Management Plan and they will be provided with all correspondence received by the proponent regarding the Plan.

The updated Cultural Heritage Management Plan is attached as Appendix J to this RTS.

Cultural Heritage Management Plan

The submission expressed that the Cultural Heritage Management Plan was a suitable and appropriate working document that clearly outlined tasks and measures to avoid and mitigate harm to Aboriginal objects. It also expressed support for the establishment of an Aboriginal Cultural Heritage Working Group and other measures such as the registration of identified Aboriginal heritage sites.

The support for the Cultural Heritage Management Plan, Aboriginal Cultural Heritage Working Group and other measures proposed in the assessment is acknowledged.

The updated Cultural Heritage Management Plan is attached as Appendix J to this RTS.

Aboriginal cultural heritage site validation

The submission noted the potential for vegetation to obscure or otherwise inhibit validation of Aboriginal cultural heritage. While the submission accepted the proposed survey methods for site validation, it noted the absence of strategies to overcome these potential difficulties moving forward.

Data on ground cover was collected during fieldwork, and it is clear that the surveys were not hampered by dense vegetation. In a number of cases, the data indicates that more material was identified than originally reported. This is inconsistent with a suggestion that ground cover hindered conduct of the validation program.

The Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS made clear what was originally recorded and what was subsequently recorded. If vegetation and groundcover is found to inhibit further pre-clearance surveys undertaken in accordance with the Cultural Heritage Management Plan, provisions can be made for monitoring of such areas.

The updated Cultural Heritage Management Plan is attached as Appendix J to this RTS.

Landforms and sensitivity

The submission stated that that the basic mapping unit of landform (and particularly the Office of Environment and Heritage landform mapping that were used as the proponent was required to do by the Secretary's environmental assessment requirements) offered an appropriate basis for identifying the distribution pattern of known sites from which to predict areas of high and low site density. It sought clarification regarding the various models for assigning significance, including that for precautionary reasons high significance had been assigned. It stated that Soil Mantled Slopes would have a very low 'ratio' of Aboriginal objects compared to landforms dominated by pronounced water features and questioned that it should be considered a landform of high cultural significance. It also queried the diversity of place types noted in this landform 'due to the range of errors revealed in the site validation program'.

It stated that the assessment had adequately raised the importance of the non-site values, and supported the assessment using all information in developing sensitivity maps. It noted that data limitations meant sensitivity mapping should not be relied on as a primary management tool.

The Aboriginal Cultural Heritage Assessment Report examined various ways in which sensitivity can be modelled. It also expressly looks at each category of site in terms specified in the Burra Charter. On this basis, and in accordance with the precautionary principle, significance values were assigned and presented in the Aboriginal Cultural Heritage Assessment Report.

It is agreed that with the limited data available, and the limitations of that data, sensitivity mapping is not appropriate as a primary management tool. This was recognised in the Aboriginal Cultural Heritage Assessment Report.

The Aboriginal Cultural Heritage Assessment Report made clear that in relation to site importance, landform and water features, there was not a simple correlation, and that the data were too limited to make definitive assertions at that time. The proponent considers that, in light of inherent limitations in the available data, the sensitivity of soil mantled slope is debatable. The landform was classified as high sensitivity based on a range of criteria and not only the density of identified Aboriginal heritage sites. Moreover, the management process of precaution and avoidance makes consideration and resolution of this issue moot at this time.

In light of the commitments to the precautionary principle, pre-clearance surveys, avoidance of Aboriginal heritage sites and buffering of watercourses (riparian corridors) in the Field Development Protocol, it is considered that these issues have been addressed.

The updated Cultural Heritage Management Plan is attached as Appendix J to this RTS.

Aboriginal heritage site avoidance and buffers

The submission accepted the proponent's commitment to avoid all currently known Aboriginal sites including buffers. It accepted that some may be modified as more data is collected. The submissions requested a series of clarifications relating to buffer zones including:

- the reasoning behind the determination of buffer zone 1b
- delineation of buffers of artefact scatters particularly in forested areas
- the hierarchic system of buffers based on stream order.

The sizes of the proposed buffers, including in zone 1b, are considered conservative and adequate particularly given the accuracy of current field GPS equipment.

It also important to note the results of the site verification program for 45 of the 90 known sites in the project area. Around half of the validated sites closely matched the location and description currently recorded in the NSW Aboriginal Heritage Information Management System (AHIMS). Despite searching an area extending out to 100 m from the location recorded in AHIMS, at 38 per cent of locations nothing matching the AHIMS site description was found nor was anything else located. Verifying the description and location of sites with modern GPS equipment is essential for long-term protection. The proponent has committed to completing the site verification for the remaining 45 sites.

It should be clarified that the proposed buffers are not based on a hierarchic system of stream order. The proposed buffers would be based on the field verified Aboriginal heritage sites, including the 90 known sites identified in the assessment, and those identified through pre-clearance surveys.

The boundaries of stone artefact scatters will be addressed on a case by case basis as circumstances require, and informed by results of a program of sub-surface testing implemented at these locations.

Aboriginal cultural heritage pre-clearance survey

The submission stated the Aboriginal cultural heritage survey methods followed the standard of survey methods employed in NSW and accepted the proposed pre-clearance surveys.

The submission made a number of recommended additions to the proposed Aboriginal cultural heritage pre-clearance survey. In summary, the recommendations were:

- presence of a qualified archaeologist
- test excavation program in areas associated with water features
- construction monitoring program for Aboriginal objects.

The submission stated the test excavation program could be undertaken in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (NSW Government 2010a) or an alternative approach developed in consultation with Registered Aboriginal Parties, Office of Environment and Heritage and Department of Planning and Environment with an Aboriginal cultural heritage expert.

The majority view of the Aboriginal community expressed during consultation is that they are experts in their heritage and that they, through the Aboriginal Cultural Heritage Working Group, should select the appropriate cultural heritage officers to walk country and the appropriate technical expert as required for implementation of the Cultural Heritage Management Plan. Under the terms of the Cultural Heritage Management Plan, a technical expert is a suitable qualified archaeologist or a person appointed by the Aboriginal Cultural Heritage Working Group.

Consistent with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (NSW Government 2010a) implementation of the Cultural Heritage Management Plan would include test excavation in areas associated with water features. The program rationale would follow the opinion of a suitable qualified technical expert appointed in accordance with the Cultural Heritage Management Plan. Details of the program are provided in Appendix J to this RTS.

Pre-clearance surveys would be undertaken in accordance with the Cultural Heritage Management Plan. Construction monitoring would be undertaken if it is deemed necessary in the view of the technical expert appointed in accordance with the Cultural Heritage Management Plan. Construction monitoring would be iterative, i.e. results of earlier assessment would inform later decisions on the relative merits of such programs.

Aboriginal cultural heritage additional research

The submissions stated that proponent had proposed an anthropological study to augment the Aboriginal Cultural Heritage Assessment Report undertaken for the EIS.

The proponent has proposed an Additional Research Program, the details of which are described in the Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS. The proponent has not proposed, nor would it commission, an anthropological study as described in the submission.

Aboriginal cultural heritage values of offset sites

The submission expressed support for the commitment in the EIS to investigate the Aboriginal cultural heritage value of lands that may be secured as offset sites. It stated that the NSW Office of Environment and Heritage would be available to discuss the values of the potential offset sites.

Aboriginal cultural heritage values, such as important sites and places of traditional or recent significance, will be considered in the selection of offset sites. The proponent has also committed to prioritising Aboriginal-owned land in this program, as well as providing for direct Aboriginal involvement in management of particular offset areas and, in certain circumstances, it could provide for ownership of those areas.

A number of properties have been nominated by the Aboriginal community and these are being actively considered by the proponent. The locations and cultural values of these prospective offset sites are currently confidential, as most of the candidate properties are privately owned. The proponent will, in the course of finalising the offsets program, discuss these matters further with the NSW Office of Environment and Heritage.

Flood planning level and flood planning area

The submission noted that the flooding assessment include a flood planning area based on a flood planning level of the one per cent annual exceedance probability flood. It stated that the adopted flood planning level should be reviewed against the *Floodplain Development Manual* and *Narrabri Local Environmental Plan 2012* as they include an additional 0.5 metre freeboard.

The submission also stated that a flood planning level and flood planning area defined in the Narrabri Local Environmental Plan 2012 may be excessive for overland flow paths particularly at Leewood and may require variation. It stated that a planning proposal would be required to vary the flood planning level and flood planning area in the local environmental plan.

The flood planning level and flood planning area were determined with reference to the *Floodplain Development Manual*. The manual states that a one per cent annual exceedance probability plus 0.5 metre freeboard is often adopted for residential development.

The manual further notes that other flood planning levels and flood planning areas (including more common events) may be appropriate for commercial and industrial developments. As the project is a commercial and industrial development, the adoption of a one per cent annual exceedance probability is consistent with the manual and appropriate for the assessment.

It is noted that the flood planning level and flood planning area in the *Narrabri Local Environmental Plan 2012* reflect a one per cent annual exceedance probability plus 0.5 metre freeboard. As stated above, the adopted flood planning level and area were considered to be consistent with the *Floodplain Development Manual* and appropriate for the assessment.

Hazard and floodway definitions

The submission notes that the hydrology assessment defined floodways as equivalent to the high hazard zone of the one per cent annual exceedance probability flood in order to remain consistent with the *Narrabri Flood Study* (Narrabri Shire Council 2016). It states this approach omits the low hazard floodway at Leewood and that this floodway should be defined.

As stated in the submission, the definition of floodways was equivalent to a high hazard zone to be consistent with the *Narrabri Flood Study* (Narrabri Shire Council 2016). It is considered the floodway at Leewood is adequately mapped for the purpose of flood assessment in line with the Secretary's environmental assessment requirements for the project (refer to Appendix H of the EIS and its appendices). It is considered that additional classification as a low hazard floodway would be of limited value to the assessment.

Flood study minor technical clarifications

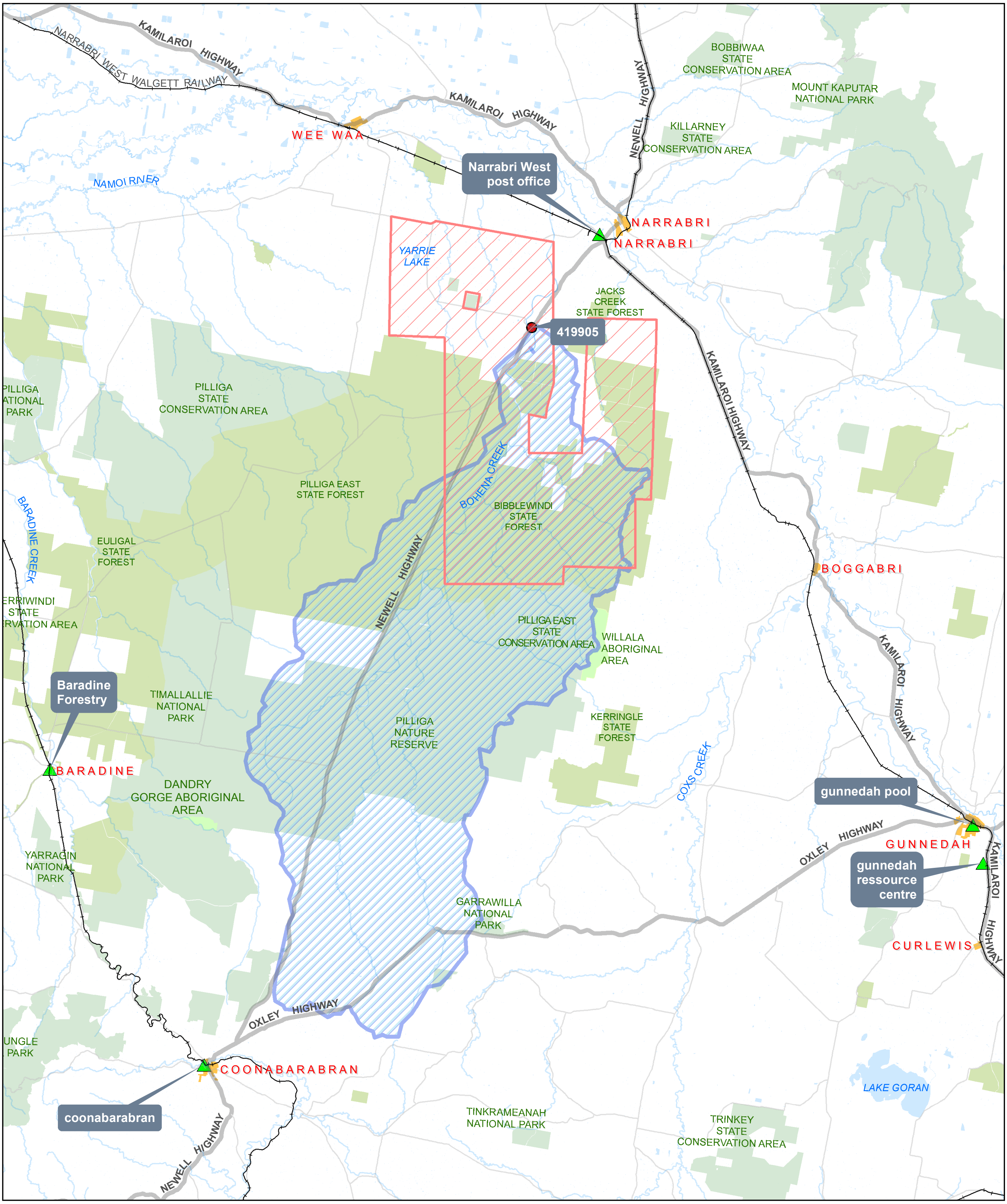
The submission raised some minor technical clarifications of the flood study in Appendix A of Appendix H of the EIS. These minor technical clarifications were as follows:

- Omission of mapped rainfall and gauging station markers.
- Clarification of pluviography, including
  - Derivation of pluviography
  - Sensitivity of pluviography
  - Calculation of time lag velocities.
- Representativeness of 1998 flood event.
- Clarification of areal reduction factors and rainfall loss.
- Determination of critical storm durations and peak flows.
- Model grid size and contingent flow path definition.
- Inconsistency of depth and velocity legends and trimmed data.
- Inconsistency references to model grid size.

The submission acknowledged these were not likely to affect the findings of the flood study.

As identified in the submission the minor technical clarifications do not affect the findings of the flood study (Appendix A to EIS Appendix H). Further clarification to the matters raised is as follows:

- Figure 2-1 omitted missing gauges, now included in Figure 5-2 in this RTS.
- Section 3.6: The rate of the rising limb of the adopted rainfall pattern for the 1998 event, at around 24 hours, is very similar to that of Narrabri West and Gunnedah reflecting the relatively rapid response at these gauges.
- Section 3.8: Rainfall losses were applied per the hydrology model and in accordance with the calibration also discussed in Section 4.3.5 of the flood study.
- Section 4.1: Models were simulated for a range of storm durations from 10 minutes to 24 hours including RAFTS upstream inputs (refer to Section 4.3.5 of the flood study). The graphs shown in Section 4.1.1 were provided as a sample for the 24 hour event.
- Section 4.3.2: The model grid size was judged to be the most appropriate choice available to balance definition of major and minor flow paths at catchment scale.
- Section 4.3.6: Models were simulated for all storm durations identified and results presented were the maximum of these durations.
- Section 5.1: Depth and velocity trimming criteria shown in the results were as stated in the text of the flood study.
- Section 5.1: The TUFLOW model grid size was 20 metres.



LEGEND

- Project area
- Urban Areas
- State forest
- Parks and reserves
- Aboriginal areas
- Lakes and dams
- Watercourses
- Highways
- Major Roads
- Train line
- Flow gauging station
- Rainfall station
- Hydrological catchment

0 5 10 20
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
Response to Submissions

Job Number 21-22463
Revision A
Date 27 Feb 2018

Rainfall and Stream Gauge Location

Figure 5-2

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: jrprice

5.12 NSW Rural Fire Service

The NSW Rural Fire Service have made specific comments on the related infrastructure in its letter to the Department of Planning dated 10.4.17, each of these nine dot points are responded to below.

"All above ground gas extraction, transport, processing and ancillary facilities shall be located outside modelled flame length from potential forest fires."

The longest flame length predicted under a catastrophic bushfire danger level (FFDI 120) for the full range of vegetation types found around the facility is 18 metres. It is not realistic nor necessary to have all above ground facilities separated from forests by distances up to 18 metres. This far exceeds typical infrastructure protection measures applied in NSW as most would have components that do not require bushfire protection or are simply repaired in the event of bushfire damage. The NSW Rural Fire Service Fast Fact for Telecommunication Towers (a far more vulnerable facility) allows major flame impingement onto structures located on steep forested slopes. Telecommunication towers have protection redundancy measures, as do the proposed wells e.g. shut-in values.

There is no obligation or expectation that firefighters will protect infrastructure, with the potential exception of back burning operations, where if feasible fire retardant may be used to protect facilities prior to the impact of a back burn. If this measure is adopted it will be by agreement and design with fire response agencies.

"All gas extraction transport, processing and ancillary facilities shall be engineered to with stand the modelled radiant heat exposure. Proposed infrastructure shall be 'certified' by a registered and practicing engineer for that related field of work"

It is not realistic or necessary to have all facilities located beyond their potential radiant heat exposure. Other bushfire protection measures provide a more pragmatic and appropriate response, these include acceptance that periodically facilities may be damaged by bushfire, operational protocols effective in the total absence of firefighter response, shielding of critical components of higher value facilities, asset protection zones (likely to be effective in the majority of fires), etc.

As part of the Bushfire Management Plan and facility design the radiant heat exposure will be determined using the current proposed asset protection zone (APZ), and a prioritised risk management response applied that will include construction design measures, operational protocols, etc.

The gas at the well head and in the gas gathering network is at a low operating pressure. In the event of a major bush fire threatening project infrastructure the wells would be 'shut in', that is, the valve on the discharge of the well head would close and the well would be isolated from downstream well head equipment.

The infrastructure downstream of the well head, including the gas gathering lines and vents or drains, would be depressurised to the gas compression units or flare system and, as such, the operating pressure in the gas gathering network would rapidly approach atmospheric pressure.

Wells can be 'shut in' remotely using the telemetry control system, however they would also have automated shutdown systems in the event of non-routine operating conditions. All vessels and pipework are protected by pressure safety valves (PSVs) and the pressure increase as a result of radiant heat exposure is considered in selection of the appropriate PSV capacity.

"Flame length and radiant heat values be modelled for the proposed gas flaring infrastructure. Radiant heat levels on surrounding vegetation shall not exceed 10k/Wm^2 on days of FFDI 120."

Safety flares at Leewood and Bibblewindi would be surrounded by a vegetation free zone of up to 130 metres radius, and pilot flares would be surrounded by a vegetation free zone of up to 40 metres radius. The maximum radiant heat flux at the nearest vegetation would be 6.31 kW/m^2 at both ground level and at the tree canopy under a catastrophic bushfire danger level (FFDI 120). As such, the radiant heat flux would be less than 10k/Wm^2.

"All gas transfer pipelines shall be buried to a minimum depth of 300 mm."

As stated in Chapter 6 (Project Description) of the EIS, gas gathering lines would be buried to at least 750 millimetres and the medium pressure gas pipeline within the Bibblewindi to Leewood infrastructure corridor would be buried at a depth of at least one metre.

"Prior to development commencing the developer shall prepare, in consultation with the Narrabri District Fire Control Centre, a Bush Fire Management Plan. This needs to address both prevention and operational issues regarding bush fire protection."

This will occur. The assessment committed the proponent to prepare a Bushfire Management Plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire Management Plan currently in place for the exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project's activities.

"All telecommunication facilities to be installed to NSW Rural Fire Service policy as per the Practice Note on telecommunication facilities."

This Practice Note does not consider the redundancy within the communication network i.e. coverage by another tower in the event of one tower failing and the fact that this network is not an emergency responders network but an operational one for the project.

Notwithstanding this, as required under the Practice Note a minimum 10 metres APZ will be provided, and where rubber or plastic components of the tower essential for its functioning are within the Bushfire Attack Level of 40 or Bushfire Attack Level Flame Zone, they would be shielded e.g. with metal covering.

"Expansion of Westport Workers accommodation shall be to the requirements of SFPP developments i.e. 10 kW/m^2, Emergency Evacuation plan, and water supplies."

The Westport workers accommodation and its expansion is not an SFPP development.

All occupants/users are fully briefed on bushfire risks and the appropriate bushfire response required in the event of a bushfire attack. Most occupants are regular users of the accommodation (unlike tourists) and therefore can be fully trained, managed more effectively and have a higher level of landscape risk consciousness. They are also able bodied, appropriately fitted with PPE and mature persons capable of following instruction and responding effectively to the on-site or off-site refuge. This is unlike SFPP development involving more vulnerable occupants e.g. aged, invalid, unfamiliar with area, poorly equipped etc.

The accommodation buildings proposed are donga-style i.e. small self-contained single bedroom spaces within a larger building. In the event that refuge is required on site, it will be provided in the general use buildings of the site and these buildings are/will be constructed to their Bushfire Attack Level appropriate for a refuge building.

An emergency response and evacuation plan will be prepared to meet the proposed use.

"Some understanding of shutdown procedures in relation to well heads and associated infrastructure needs to be incorporated into the [Bush Fire Management Plan]."

This will occur. This is currently incorporated into the Bushfire Management Plan for the exploration and appraisal activities, and all staff are trained in shutdown procedures.

"A detailed risk management plan needs to be developed that forms the basis for the bush fire management plan. This needs to address both the risk of fire spread to and from the [project]."

This will occur. This is currently incorporated into the Bushfire Management Plan for the exploration and appraisal activities, and all staff and contractors are trained in bushfire awareness.

5.13 NSW Roads and Maritime Services

Newell Highway intersection upgrades

The submission recommended that the intersection of X-Line Road and Newell Highway be upgraded to include sealed auxiliary left short and basic right turn treatments in accordance with Figures 8.3 and 7.5 in part 4A of *Austroads Guide to Road Design* and associated materials.

The submission also recommended that the intersection of Old Mill Road and Newell Highway be upgraded to include a channelised right turn treated in accordance with Figure 7.7 in part 4A of *Austroads Guide to Road Design* and associated materials.

It stated the upgrades be designed to accommodate the largest vehicles accessing them and appropriate to the current speed zone of 110 kilometres per hour.

It also stated that the upgrades would require a works authorisation deed with Roads and Maritime Services and should be completed prior to the start of project construction.

For the intersection of X-Line Road and Newell Highway:

- The proposed intersection upgrade would provide BAR / BAL intersection, including a sealed auxiliary short left turn treatment, as shown in Figure 8.3 of *Austroads Guide to Road Design – Part 4A: Unsignalised and Signalised Intersections*. This meets Roads and Maritime's requirement.
- It should be noted that the Traffic Impact Assessment assumed that all vehicles would access X-Line Road from the north (southbound along the Newell Highway). As such, the number of vehicles turning right into X-Line Road is expected to be minimal and mostly associated within existing operations.
- The current intersection arrangement does not provide a formed shoulder wide enough to be considered as a BAR treatment as indicated in Figures 8.3 and 7.5 in Part 4A of *Austroads Guide to Road Design*. It could be argued that widening would be required to provide a BAR treatment.

For the intersection of Old Mill Road and Newell Highway, the proposed channelised right turn treatment is in accordance with Roads and Maritime's requirements.

It is acknowledged that a works authorisation deed would be required in accordance with Roads and Maritime Services requirements.

X-Line Road and Old Mill Road

The submission requested the X-Line Road and Old Mill Road be sealed for a minimum of 30 metres from the edge of the Newell Highway travel lanes. It requested that the seal be maintained for the life of the project.

Both X-Line Road and Old Mill Road currently have a sealed surface for approximately 30 metres from the edge of the Newell Highway. The proponent will fund the maintenance of the 30 metre sealed sections of X-Line and Old Mill Road for the life of the project.

Newell Highway crossing

The submission stated that the proponent will require a works authorisation deed (WAD) and concurrence with Roads and Maritime Services under Section 138 (2) of the *Roads Act 1993*.

The submission included *Roads and Maritime Services Requirements for Classified Road Crossings*, which prescribe requirements for crossings including:

- Minimum cover depths
- Construction methods
- Crossing geometry
- Dial-before-you-dig
- Location markers
- Road occupancy licensing.

The proponent acknowledges these requirements.

Road reserve restoration

The submission stated that damage or disturbance to road reserves attributable to the project would be required to be restored in accordance with the requirements of the road authority.

The proponent will monitor and report on evident deterioration of road conditions over the peak construction period and would consult with the relevant road authorities regarding potential maintenance liability where the deterioration is attributable to project activities.

Works as executed plans

The submission requested that plans of works as executed would be required to be provided to Roads and Maritime Services at their completion.

Concept designs for the intersection upgrades at the Newell Highway / X-Line and the Newell Highway / Old Mill Roads would be submitted to Roads and Maritime Services.

5.14 Transport for NSW

Access for large trucks

The submission noted that the region of the project would have access for modular B-triples but not 36.5 metre B-triples or AB triples.

Only approved vehicle types would be used for the project, in accordance with Roads and Maritime requirements.

It is acknowledged that the Newell Highway is a Roads and Maritime Services approved higher mass limit (HML) A-double road train (36.6 metre vehicle) route. However, B-triples and AB triples are not permitted along the Newell Highway according to the Roads and Maritime website http://www.rms.nsw.gov.au/business-industry/heavy-vehicles/maps/road-train-map/index.html.

The delivery of oversize materials would be subject to permit requirements.

Clarification of truck types

The submission requested that the assessment provided a clarification of the standard truck sizes that would be utilised for the project.

Various types of machinery will be used during construction and operation of the project. Standard truck types modelled in the Traffic Impact Assessment (EIS Appendix P) are articulated and rigid vehicles (heavy vehicles) unless stated otherwise. Examples include buses, coaches and oversized vehicles.

Haulage routes

The submission requested identification of the haulage route to the Port of Newcastle, given direct access could not be gained via the Newell Highway.

Material and plant deliveries would most likely come from the Port of Brisbane. For the purposes of the Traffic Impact Assessment (EIS Appendix P), the Port of Brisbane was used to assess traffic impact on the national road system. The Port of Newcastle will be used where logically reasonable and would be determined during the project planning stage.

Oversize movements

The submission sought clarification as to whether the haulage movements listed in Table 5-3 and Table 5-4 of the Traffic Impact Assessment (EIS Appendix P) would necessarily be oversize movements. It specifically sought clarification regarding diesel fuel and miscellaneous minor deliveries.

It is acknowledged that diesel fuel and miscellaneous minor deliveries would not be provided using oversized vehicle movements, rather, would be standard rigid or articulated heavy vehicles.

Movements by vehicle type

The submission requested that operational traffic movements detailed in Section 6 of the Traffic Impact Assessment (EIS Appendix P) be classified by vehicle type.

The Traffic Impact Assessment was undertaken by classifying vehicles as either light or heavy vehicles. This is considered sufficient, is a typical approach for undertaking traffic impact assessments, and meets the requirements from the Secretary’s Environmental Assessment Requirements.

5.15 Gilgandra Shire Council

Groundwater extraction and potential contamination

The submission stated that the project would extract groundwater from the Great Artesian Basin. It also noted the reliance of the community on this resource, particularly for agriculture.

The submission requested that consideration be given to landholders that may be affected by groundwater extraction or potential contamination.

The submission’s assertion that the project will extract groundwater for use from the Great Artesian Basin is incorrect. There will be no extraction of groundwater from the Great Artesian Basin for the project.

Water extracted for gas development will come from the coal seams which are part of the Gunnedah-Oxley Basin (see Figure 5-3). This deeper water resource is referred to in NSW legislation as the Gunnedah Oxley Basin MDB Groundwater Source, which is a water source that is not used widely in the vicinity of the project area due to its depth and higher salinity.

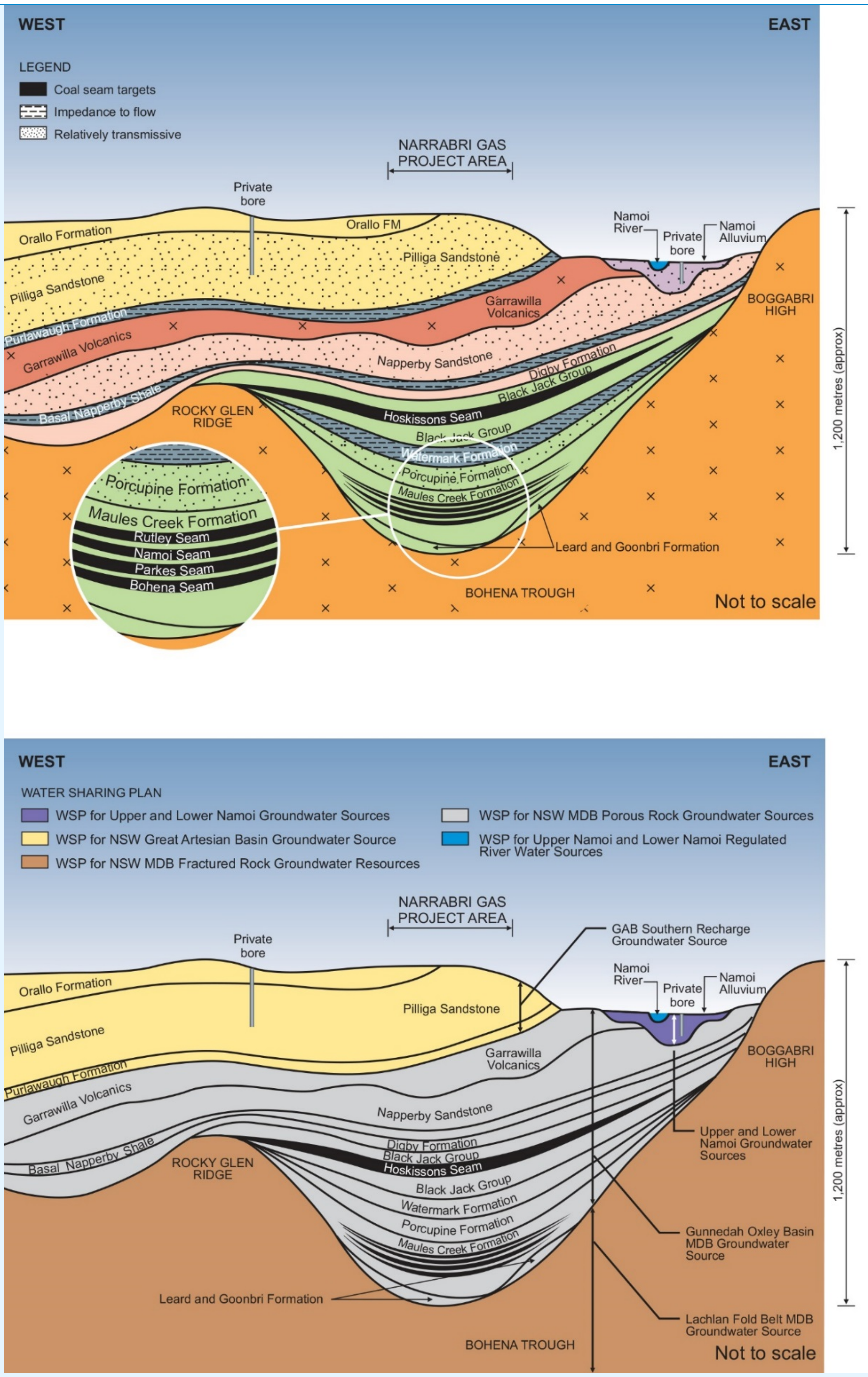


Figure 5-3 Schematic of the hydrostratigraphy of the project area

Figure 5-3 represents a schematic of the hydrogeology of the region and illustrates the stacked nature of the aquifers and aquitards and the relationship between the target coal measures in the Gunnedah Basin sediments below the sediments of the Great Artesian Basin. Note the presence of impeding aquitards between the coal measures and the productive aquifers of the GAB and the Namoi Alluvium.

As the extraction of groundwater from the coal seams reduces the pressure in those formations, this results in a reduced vertical pressure gradient that indirectly results in groundwater exchange between the aquifers that are stacked upon each other.

Potential impacts on all groundwater sources were assessed in the Groundwater Impact Assessment in Appendix F of the EIS and summarised in Chapter 11 (Groundwater and geology). The assessment was conducted by a suitably qualified hydrogeologist in accordance with the relevant assessment guidelines and utilised a regional groundwater model that was peer reviewed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and found to be fit for purpose.

Modelling of existing groundwater transfer across the region (EIS Appendix F) indicates that about 100 megalitres per year is lost from the Pilliga Sandstone after all inputs and outputs are considered (Figure 5-4). Recent independent modelling of an alternative version of the project modelled an average 85 megalitre per annum loss from Great Artesian Basin aquifers (Sreekanth *et al*. 2017).

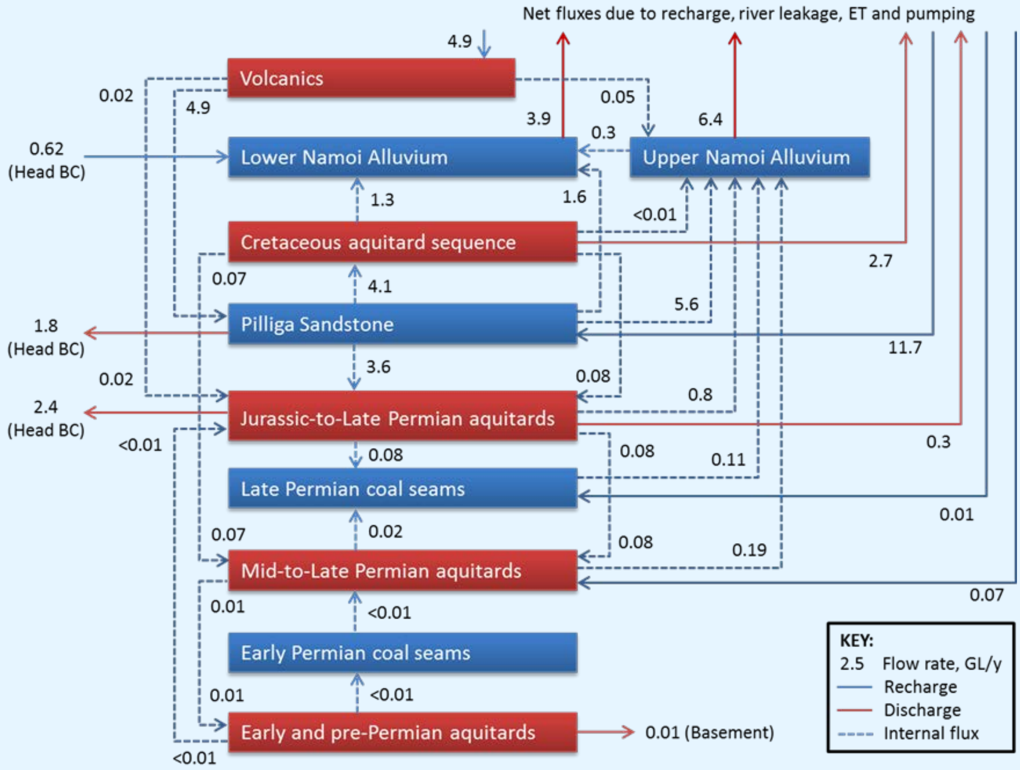


Figure 5-4 Steady-state water mass balance for the project area

As the flux is predominantly out of the Great Artesian Basin and other units and towards the coal measures, induced transfer of potential contaminants is towards the coal seam aquifers and not toward the Great Artesian Basin or alluvial aquifers.

The EIS (Appendix F) presents the net flux (take) to each groundwater source; Table 5-6, below, reports the maximum take from the base of each source, directly comparable to the definition of water take in the water sharing plans.

Table 5-6: Peak induced flows (maximum take) for the EIS Base Case

Groundwater source	EIS Base Case (37.5 GL) Peak flux change at source base	
	ML/y	Time (years after start of FDP, to nearest model time step)
Gunnedah-Oxley Basin	3,553	3
GAB Southern Recharge	57.3	190 - 200
GAB Surat	0.16	950 – 1,000
NSW GAB Surat Shallow	<0.16	>1,000
Lower Namoi Alluvium	4.19	250 – 300
Upper Namoi Alluvium (UNA) UNA Zone 2 UNA Zone 5	1.00 0.16 0.90	250 – 300 550 – 600 250 - 300

Further, analysis of the chemistry of the groundwaters, presented in the revised and updated Water Baseline Report (EIS Appendix G4 and Appendix D to this Response to Submissions), demonstrates that there are no contaminants of concern in coal measures waters, though salinity levels are high and this results in elevated fluoride, lithium and barium levels. Radioactive elements were not detected above detection limits.

All water extracted for the project will be taken under an access licence issued by the NSW Department of Primary Industries, just as is the case for other water users including irrigators, industrial users, other resource developments and those drawing under licence for stock and domestic use.

Current predictive modelling indicates that the project will have no impact on existing entitlement holders. If it becomes apparent through modelling and monitoring reviews that any project water management actions are having an impact, the proponent will enter into a 'make good' arrangement with that licence holder.

Siding Spring Observatory

The submission states that consideration should be given to the impacts of lighting associated with the project on the observing conditions at Siding Spring Observatory. It makes reference to the *Dark Sky Planning Guideline* (Department of Planning and Environment 2016).

In response to the submission the proponent commissioned a Gas Flare Light Assessment to assess the light impacts of the project flares and their potential to contribute to skyglow that would affect observing conditions at the Observatory. The Gas Flare Light Assessment is Appendix K to this RTS.

The Gas Flare Light Assessment included light monitoring at the Observatory in addition to monitoring in the vicinity of the pilot flares operating for the existing Narrabri exploration and appraisal operations. Modelling was then undertaken to determine the light emissions from flares that would operate as part of the project including up to six pilot flares within the project area and a safety flare at Leewood (approximately 100 km north-north east of the Observatory) and Bibblewindi (approximately 90 km north north-east of the Observatory). The assessment included modelling for the safety flares operating in both routine (pilot flame) and non-routine (maximum flow rate) scenarios during maintenance or other non-routine activities.

The *Dark Sky Planning Guidelines* (Department of Planning and Environment 2016) are a matter for consideration for State significant development that is within 200 kilometres of the Observatory and likely to impact the night sky. The guidelines state that “at the Observatory a threshold figure of 10 per cent of the natural skyglow at 30^0 above the horizon has been adopted as the maximum tolerable level of artificial light”, as this is critical to the assessment of impacts on the observing conditions at the Observatory. The guideline also refers to the cumulative effect of artificial skyglow within the region caused by rural industries and intensive livestock agriculture operations, urban development including sports fields, industrial and commercial buildings, housing development and street lights and other development including mining and extractive industries and gas flares.

The assessment found that for routine flaring operations for the project, the extent of the horizontal skyglow with up to six pilot flares will be limited to bearings N22^0E - N55^0E from the Observatory. The vertical extent of skyglow will remain at the same altitude currently perceived from the Observatory, which is less than 1^0 above the horizon. Low lying cloud cover and aerosols (<500 m altitude) will influence the extent of skyglow emitted throughout the atmosphere, however this affect would be negligible compared to natural skyglow produced by starlight.

The safety flare would be directly visible from the Observatory, during a non-routine safety flaring event in which it was required to operate at the maximum gas flow rate. From the flare, the extent of skyglow would progressively decrease in intensity reaching natural skyglow conditions approximately 12 kms horizontally and 4 kms vertically from the flare on a clear night, equating to 2.5^0 above the horizon. In cloudy conditions this event would contribute to artificial skyglow to a maximum extent of 7.4^0 above the horizon. Thus, the project would not make a contribution to skyglow conditions at the 30^0 reference location adopted in the guidelines and would have negligible impact on the Observatory’s operations.

Lighting at Leewood, Bibblewindi, Westport workers’ accommodation and well pads will comply with *Australian standard AS/NZS 4282 – 1997 Control of the obtrusive effects of outdoor lighting*. This may include the use of narrow beam floodlights with spill light limited either through appropriate luminaire selection or through the use of “barn door” or similar shading devices fitted to the light fittings. To minimise skyglow, the standards require no light output above the horizontal plane.

The design and operation of night lighting would also consider the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring*.

5.16 Gunnedah Shire Council

Potential impacts in Gunnedah Shire

The submission requested details of the number of beds existing and required for the project at the accommodation facilities at Narrabri and Boggabri and Westport workers’ accommodation.

A breakdown of the project workforce by place of accommodation was provided in Section 7.7 of the Social Impact Assessment in Appendix T1 of the EIS.

As stated in Section 7.7 of Appendix T1, about 90 per cent of the workforce during peak construction would be accommodated at private workers’ camp accommodation in Narrabri and surrounds. Accounting for expected rostering, this would amount to about 740 workers (or beds).

Existing accommodation facilities in Narrabri and surrounds, including private workers’ camp accommodation, were discussed Section 4.4.6 of the Social Impact Assessment.

The assessment identified private workers' camp accommodation with capacity for the workforce in Narrabri and Boggabri. The decision on where to accommodate the project workforce would be subject to project needs and availability at that time.

Potential impacts on social infrastructure in Gunnedah Shire

The submission stated that the assessment did not adequately consider potential impacts in Gunnedah Shire, specifically the potential impacts of the project workforce on health and education services.

As detailed in the Social Impact Assessment in Appendix T1 of the EIS, the project workforce was considered likely to access social infrastructure and services such as health services within Narrabri Shire. Sections 4.4.7 and 6.3.5 of Appendix T1 provide details on the existing facilities.

Given the location of the project, and the accommodation options for its employees, potential impacts on health and education services in Gunnedah Shire were considered to be unlikely.

Annual review of impacts

The submission from Gunnedah Shire Council requested an annual review of project impacts with regard to social infrastructure and services.

As detailed in Section 7.1 of the Social Impact Assessment in Appendix T1 of the EIS, the proponent plans to monitor and review social impacts and management strategies at regular intervals and report on them through an annual reporting process.

The proponent has committed to developing a Social Impact Management Plan for such purposes. The framework of the Social Impact Management Plan will likely include:

- A list of identified impacts and issues
- Targets and outcomes sought
- A monitoring strategy, including:
  - Responsibility—documenting the party responsible for the implementation of each monitoring strategy
  - Timing and frequency—document how often monitoring of the impact should take place
  - Key performance indicators—informative, relevant, measurable, useful, widely recognised, simple to report and easily understood
  - Reporting – identify methods for reporting on each of the impacts and mitigation measures.

The Social Impact Management Plan will also include details on a grievance management mechanism that will be put in place for the project. It will include information on how feedback will be received, recorded, actioned, responded and closed out.

5.17 Narrabri Shire Council

Sizing of produced water and brine ponds

The submission questioned whether the produced water and brine ponds were sized to prevent overtopping during wet weather events. It questioned what measures would be taken to prevent uncontrolled release during wet weather conditions.

Produced water and brine ponds are and will be constructed as stand-alone structures. They are designed to avoid the addition of surface run-off from surrounding landscape during wet weather events. Their catchment area is therefore limited to the area of the pond itself. As such, the only additional storage that would be required during wet weather would be for the rain that falls directly into the pond structure itself.

In respect of capacity to store in the event of sustained rainfall, the Leewood ponds have, consistent with the NSW Government's Code of Practice: *Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015):

- a spillway capacity designed to pass 0.01 per cent Annual Exceedance Probability (AEP) flows
- wet season design storage allowance (the volume between the maximum operating level (MOL) and full supply level (FSL/spillway level) sized to provide storage for a volume equivalent to the 1:100 AEP and a storm event containment of 1:100 AEP 72-hour duration
- pond level and collection sump monitoring
- an implemented regular inspection and monitoring program.

The Leewood ponds also operate under Trigger Action Response Plans (TARPs), approved by the (now) Division of Resources and Geoscience under the *Petroleum (Onshore) Act 1991*.

TARPs are developed to identify, assess and respond to abnormal conditions and are implemented to manage risk to operations, personnel and the environment. Two TARP documents have been developed to address the requirements of the Produced Water Code of Practice:

- Produced water storage pond level TARP provides the actions to be taken if defined pond management levels are reached.
- Leewood pond leakage management TARP provides actions to be taken if defined leakage rates are reached.

In addition to the trigger points and associated actions to be undertaken, these documents also detail the delegation of responsibility at each trigger points and contact details for both internal and external notification requirements.

Thus, in summary, the Leewood ponds are designed and operated to ensure that there is sufficient storage capacity to contain produced water in extreme rainfall events, in accordance with the relevant Codes of Practice and guidelines. In addition, pond levels are monitored and field operations can be managed to control the volume of produced water if this is necessary.

The facilities meet the requirements of the NSW Government's Code of Practice: *Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015). The current ponds include primary and secondary lining, leak detection and collection and an engineered spillway.

Monitoring of storage levels is undertaken with the use of pressure sensors that continuously measure and record storage depth, volume and surface area based on hydrostatic pressure. Automated meters are submersed in the pond to a depth as close to the base of the pond as reasonably practicable, and are used in conjunction with surveyed data to determine the water level of the pond. Telemetry is used to allow for remote real-time monitoring of the pond levels and this is used to monitor storage capacity in conjunction with other parameters such as upstream pilot or well-head water production data.

Field operators are required to record the pond level and volume on a daily basis. Other operating markers / indicators may also be used in conjunction with the pressure sensor monitoring, such as volume and maximum operating level indicator markers on storage facility walls. The level sensors system used in the existing ponds undergoes regular assessment and, when necessary, recalibration occurs six-monthly in order to ensure the accuracy of readings.

A Dam Safety Emergency Plan has been provided to the NSW Dam Safety Committee in accordance with the requirements of the *Dams Safety Act 1978*. The plan provides emergency response procedures for the management of the Leewood ponds in the event of an imminent or actual uncontrolled release from the ponds.

Chemical composition of produced and amended water

The submission stated that there was not a thorough discussion of hydrocarbons or metals in produced or amended water. It sought confirmation that treated water or amended water would not contain these pollutants though laboratory testing of water from existing wells.

The submission stated that the characterisation of treated water indicated it would exceed 84th percentile Bohena Creek baseline water quality for:

- Boron
- Sodium
- Calcium
- Electrical conductivity
- Total dissolved solids
- Sodium adsorption ratio.

The submission requested clarification of potential impacts to Bohena Creek from managed release, accumulation in the creek bed or accumulation in nearby soil from dust suppression.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities, including recreation and long-term irrigation. The data also shows the treated water meets drinking water and stock watering guidelines. No hydrocarbons, nor metals, have been detected (above the laboratory limit of reporting) in treated water from the plant.

In relation to the managed release to Bohena Creek under specified flow conditions, the results show the following maximum concentrations in treated water:

- Boron - 0.11 mg/L, which is above the recorded value of less than the limit of reporting (<LOR) for Bohena Creek (i.e. <0.05 mg/L) though below the calculated site specific trigger value established using the ANZECC/ARMCANZ (2000) direct toxicity assessment (DTA) methodology which determined a protection concentration (PC_{95}) of 1.8 mg/L (refer to Appendix B of EIS Appendix G1) and the ANZECC/ARMCANZ (2000) default water quality guideline trigger value of 0.37 mg/L for NSW lowland rivers.
- Sodium - 17 mg/L, which is below the 84th percentile value for Bohena Creek of 42 mg/L.
- Calcium - <1 mg/L, which is below the 84th percentile value for Bohena Creek of 24 mg/L.
- Electrical conductivity – calculated at 83 microSiemens/cm, which is below the 84th percentile value for Bohena Creek of 384 microSiemens/cm.
- Total dissolved solids - 56 mg/L which is below the 84th percentile value for Bohena Creek of 270 mg/L.
- Sodium adsorption ratio of 29 which is above the 84th percentile value for Bohena Creek of 2.2, though with the low sodium levels indicated above, complete mixing would occur within a few metres of the discharge diffuser.

Table 7-2 in Chapter 7 of the EIS (Produced water management), assessed the target treated and treated and amended water quality against applicable water quality guidelines aligned with proposed beneficial reuse options. Section 7 of the amended Water Baseline Report (Appendix D of this RTS) includes comparison against the ANZECC/ARMCANZ (2000) long-term irrigation and recreation trigger values against the results of the treated and treated and amended water from the Leewood Water and Brine Treatment Plant.

The assessment shows that the treated and treated and amended water quality data meet all water quality guidelines for all proposed beneficial reuses.

As stated in Chapter 7 of the EIS, treated water would only be released to Bohena Creek during flow conditions equal to, or greater than, 100 megalitres per day as measured at the Newell Highway gauging station. The potential environmental impacts of managed release on the water quality, hydrology and geomorphology and aquatic ecology of Bohena Creek were assessed in Appendix G1 and Appendix H and summarised in Chapter 12 (Surface water quality), Chapter 13 (Hydrology and geomorphology) and Chapter 16 (Aquatic ecology).

The assessment found that potential impacts on hydrology and geomorphology were negligible. The assessment also found that impacts from managed release on water quality and aquatic ecology would be low when considering baseline water quality under the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000).

The analysis using Leewood treated water data (refer Appendix D of this RTS) is consistent with the findings of the EIS.

Bohena Creek managed release point and Newell Highway gauging station

The submission noted that the Newell Highway gauging station receives flows from Killen creek and Sawpit Creek, which are downstream from the Bohena Creek managed release point. It sought clarification that flows at Newell High gauging station would be representative of flows at the Bohena Creek managed release point or installation of a representative gauging station.

Modelling of the catchment and use of upstream-downstream monitoring of the discharge site during discharge events will calibrate the site to the Newell Highway gauge. No gauging will be required at, or upstream of, the discharge site. The variable nature of the stream bed at the proposed discharge site does not lend itself to the establishment of a permanent gauge. The site at the Newell Highway bridge, however, presents as a competent, defined channel and thereby provides an ideal location to calibrate flow down Bohena Creek. The distance of 8 kms from the proposed discharge site is not excessive and can be accurately calibrated to the Newell Highway gauge.

The proponent acknowledges that the current gauge at the Newell Highway gauging station has poor sensitivity below 1,000 megalitres per day and that a refined gauge may need to be installed at that site.

Bohena Creek managed release and predicted cadmium levels

The submission noted that the characterisation of treated water indicated it would have cadmium levels of 1.0 microgram per litre and exceed the ANZECC/ARMCANZ (2000) water quality guideline of 0.2 micrograms per litre. It sought clarification of whether cadmium levels would be reduced below trigger levels or alternative mitigation measures.

Recent samples from the Leewood water treatment facility in operation for the approved exploration and appraisal program in the project area show that cadmium concentrations in treated water are <0.0001 mg/L (0.1 micrograms per litre), which is less than the ANZECC/ARMCANZ (2000) water quality guideline of 0.2 micrograms per litre. Refer to Section 7 of the updated Water Baseline Report attached to this RTS as Appendix D.

Water quality monitoring

The submission requested an independent water quality monitoring program with sampling of treated and amended water and Bohena Creek upstream and downstream of the managed release point with results provided to Narrabri Shire Council annually.

The submission also stated it may be necessary to sample the creek bed at Bohena Creek to demonstrate that accumulation of contaminants has not occurred.

A Water Monitoring Plan was provided as Appendix G3 of the EIS. The Plan includes surface and groundwater monitoring networks including locations upstream and downstream of the proposed location for the managed release to Bohena Creek.

Each year a concise report will be prepared that outlines the details of the monitoring completed during the preceding year, including all measurements undertaken for the monitoring program, synthesis of water sampling and analytical results and an evaluation of these data. The purpose of the report will be to catalogue the monitoring results and review observed changes in the condition of water sources, if discernible, against those predicted in the Groundwater Impact Assessment (EIS Appendix F).

In addition to the annual reporting, after the first three years of operations and every five years thereafter, a periodical review will be conducted. In the periodical review the annual reports will be collated for additional review. If there is an identified trend in the observed groundwater responses that indicate a Level 2 trigger is, or is likely to be exceeded, then a more detailed report will be prepared, which may involve updating of the numerical model with data from the field development program (e.g. realised well locations and water production volumes) and further predictive simulations to assess trends.

An important component of the periodical reviews, if appropriate, will be assessing the sufficiency of monitoring and identifying whether additional monitoring infrastructure is required. The Water Monitoring Plan will be updated to reflect changes in the monitoring program that result from the periodical reviews.

In addition to monitoring in accordance with the Water Monitoring Plan, within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.
- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.
- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

The project would operate under an Environment Protection Licence (EPL) issued pursuant to the *NSW Protection of the Environment Operations Act* 1997 including water monitoring requirements.

Construction of natural gas wells

The submission requested that natural gas wells be constructed based on detailed analysis of site geological conditions including permeability, faults and potential movement.

As stated in Chapter 6 of the EIS (Project description), gas wells would be constructed in accordance with the *Code of Practice for Coal Seam Gas – Well Integrity* (NSW Trade and Investment 2012). The practices to be implemented in the construction of wells would also be informed by local site and well conditions.

Monitoring of natural gas wells and gathering lines

The submission requested independent monitoring of well integrity and gathering lines during and after the project. They requested that meters be installed to detect losses.

As stated in Chapter 6 (Project description) of the EIS, gas wells would be constructed in accordance with the *Code of Practice for Coal Seam Gas – Well Integrity* (NSW Trade and Investment 2012). Gas gathering lines would be constructed in accordance with the *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*.

During operation, gas wells would be fitted with remote telemetry that monitors operating parameters and well pressure at the well head and gas and water separator. Produced water gathering lines would also be subject to continuous pressure monitoring.

Within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.
- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.
- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

Once the wells have reached the end of their functional lives or are considered to have no further recompletion potential, they would be plugged and decommissioned in accordance with the NSW *Code of Practice for Coal Seam Gas – Well Integrity*, or the applicable code in place at the time of decommissioning; and final rehabilitation would take place. This would include removing the well head, surface infrastructure and fencing; capping the well at a minimum depth (1.5 metres under the *NSW Code of Practice for Coal Seam Gas – Well Integrity*); revegetating the lease site; and weed control.

As part of relinquishment processes under the NSW *Petroleum (Onshore) Act 1991*, records of the plug and decommissioning process undertaken for each well are provided to the NSW Petroleum Inspector. Further, final rehabilitation and relinquishment reports are provided for each well site to the NSW Government for assessment through the Division of Resources and Energy. The relinquishment must be approved prior to release of the security deposit held in relation to the infrastructure.

At the cessation of production, gathering systems and pipelines would be isolated at their connection points. The pipelines would then be isolated, drained, vented and capped in accordance with the Australian Pipeline Industry Association (APIA) *Code of Environmental Practice for Onshore Pipelines* (2013), or the applicable code in place at the time of decommissioning. After the well sets are decommissioned, the subsurface components of the gathering system would remain *in situ* as described above, and vegetation maintenance within the gathering system corridor would cease. All above ground components of the gathering system would be removed, including all pipeline marker signs.

Rehabilitation fund

The submission requested that the NSW Government establish a fund for unforeseen impacts to land and groundwater for a duration of 100 years after the project has ended.

The proponent does not consider that the establishment of such a fund is necessary due to the adequacy of existing arrangements in this regard. In accordance with NSW Government policy, all title holders engaged in coal, mineral and petroleum exploration as well as mining and petroleum production activities are required to lodge a security deposit to cover the cost of undertaking rehabilitation (Department of Planning and Environment 2017b).

The security deposit must cover the Government's full cost in undertaking rehabilitation in the event of default by the titleholder. The Department is responsible for determining when rehabilitation has met the required standard, taking into account the rehabilitation objectives and completion criteria, and compliance with the title conditions, before the title is relinquished and the security deposit released. Additionally, the Department requires the titleholder to undertake progressive rehabilitation over the exploration, mining or production operation. If the rehabilitation obligations have not been met to the satisfaction of the Minister or Secretary of the Department, then all or part of the security deposit shall be forfeited, with the funds to be used by the Government to meet the rehabilitation requirements.

Project activities would be undertaken in accordance with relevant codes of practice including

- *Code of Practice for Coal Seam Gas – Well Integrity*
- *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*
- *Exploration Code of Practice: Produced Water Management, Storage and Transfer.*

Principles of land access

The submission requested that the proponent adhere to the *Agreed Principles of Land Access* (DRE 2015) as a condition of consent.

As discussed in Chapter 17 of the EIS (Property and land use), the proponent is a signatory to the *Agreed Principles of Land Access* (DRE 2015).

Air quality impacts near Leewood

The submission requested information on additional mitigation measures to prevent air quality impacts at the identified sensitive receptor near Leewood. It recommended that the proponent outline a timeframe for consultation with the occupier of the sensitive receptor.

The Air Quality Impact Assessment (EIS Appendix L) found that the air quality criteria could potentially be exceeded during construction activities occurring at the eastern side of the Leewood property at one sensitive receptor near Leewood (Receptor 126). However, the likelihood of an exceedance occurring was found to be very low as the exceedance may only occur during certain weather conditions that occur rarely (one day per year on average). The assessment was conservative as local site conditions such as vegetation were not taken into account in the assessment.

As stated in Chapter 18 of the EIS (Air quality), the potential for this impact to occur would be considered in construction planning and additional mitigation would be incorporated in the Air Quality Management Plan as necessary to mitigate the potential for impacts when the construction activities were being undertaken on the eastern side of Leewood during the identified weather conditions.

Chemical composition of dust suppressant

The submission requested information on the chemical composition of dust suppressants and the potential environmental impacts of the use of these suppressants.

As discussed in Chapter 18 of the EIS (Air quality), standard construction dust control measures that would be implemented include watering or the application of commercial dust suppressants. The specific commercial dust suppressants that would be used will be finalised during construction of the project. However, it should be noted that the use of commercial dust suppressants is standard practice for construction activities and would not be expected to introduce adverse environmental impacts.

Characterisation of natural gas

The submission requested the reasoning for the assumptions used in the Air Quality Impact Assessment instead of using analysis of natural gas from existing pilot wells.

> The Air Quality Impact Assessment (EIS Appendix L) considered the composition of natural gas based on data from existing exploration and appraisal wells and the predicted products of the processing and combustion of the natural gas.

Air Quality Management Plan

The submission requests that an Air Quality Management Plan be prepared within an appropriate timeframe in consultation with Narrabri Shire Council and the community.

> As stated in Chapter 18 (Air Quality) of the EIS, an Air Quality Management Plan would be implemented during construction and operation of the project. The Air Quality Management Plan would include an air quality monitoring program.
>
> The monitoring program would be carried out by suitably qualified air quality practitioners and would serve to validate the findings of the Air Quality Impact Assessment and the effectiveness of the proposed mitigations and management measures.

Road maintenance agreement

The submission noted the EIS states workers would access Westport workers' accommodation via X-Line Road and argues that the best and shortest route is via Westport Road.

It also noted that workers accessing the Narrabri Operations Centre would increase traffic on Kiandool Lane, Cains Crossing Road and Yarrie Lake Road.

The submission requested an agreement with the proponent to address the cost of additional maintenance on roads maintained by Narrabri Shire Council.

> The expected traffic generation and proposed access routes to the accommodation camps and field areas were confirmed by the proponent for impact assessment. For the purposes of a conservative assessment of the impacts to the X-Line Road intersection with the Newell Highway, it was assumed that X-Line Road would be the main access point to the Bibblewindi field area and Westport workers' accommodation.
>
> The Traffic Impact Assessment (EIS Appendix P) included an assessment of the expected operation of Yarrie Lake Road under the forecast ultimate peak traffic generation scenario. It was assumed that all vehicles accessing the Narrabri Operations Centre would do so via Yarrie Lake Road. The assessment identified that Yarrie Lake Road is expected to continue to operate within its functional classification under the ultimate peak traffic scenario for the project.

Kiandool Lane and Cains Crossing Road generally have similar or lower traffic volumes than Yarrie Lake Road. As such, these roads are also expected to operate within their functional classifications under the ultimate peak traffic scenario for the project.

Timing of intersection upgrades

The submission seeks confirmation that proposed upgrades to Newell Highway/Old Mill Road and Newell Highway/X-Line Road intersections would occur before significant construction.

The proposed upgrades to the Newell Highway/Old Mill Road and Newell Highway/X-Line Road intersections would be provided following a final investment decision on the production project and before significant construction commences.

Light at Siding Spring Observatory

The submission stated that light from the operation of the project should not detrimentally affect the operation of Siding Spring Observatory. It also stated that light from flares or project lighting should be screened or otherwise situated to prevent impacts at residences.

In response to the submission, the proponent commissioned a Gas Flare Light Assessment to assess the light impacts of the project flares and their potential to contribute to skyglow that would affect observing conditions at the Observatory. The Gas Flare Light Assessment is Appendix K to this RTS.

The Gas Flare Light Assessment included light monitoring at the Observatory in addition to monitoring in the vicinity of the pilot flares operating for the existing Narrabri exploration and appraisal operations. Modelling was then undertaken to determine the light emissions from flares that would operate as part of the project including up to six pilot flares within the project area and a safety flare at Leewood (approximately 100 km north, north-east of the Observatory) and Bibblewindi (approximately 90 km north, north east of the Observatory). The assessment included modelling for the safety flares operating in both routine (pilot flame) and non-routine (maximum flow rate) scenarios during maintenance or other non-routine activities.

The *Dark Sky Planning Guidelines* (Department of Planning and Environment 2016) are a matter for consideration for State significant development that is within 200 kilometres of the Observatory and likely to impact the night sky. The guidelines state that “at the Observatory a threshold figure of 10 per cent of the natural skyglow at 30^0 above the horizon has been adopted as the maximum tolerable level of artificial light”, as this is critical to the assessment of impacts on the observing conditions at the Observatory. The guideline also refers to the cumulative effect of artificial skyglow within the region caused by rural industries and intensive livestock agriculture operations, urban development including sports fields, industrial and commercial buildings, housing development and street lights and other development including mining and extractive industries and gas flares.

The assessment found that for routine flaring operations for the project, the extent of the horizontal skyglow with up to six pilot flares will be limited to bearings $N22^0E$ - $N55^0E$ from the Observatory. The vertical extent of skyglow will remain at the same altitude currently perceived from the Observatory, which is less than 1^0 above the horizon. Low lying cloud cover and aerosols (<500 m altitude) will influence the extent of skyglow emitted throughout the atmosphere, however this affect would be negligible compared to natural skyglow produced by starlight.

The safety flare would be directly visible from the Observatory during a non-routine safety flaring event in which it was required to operate at the maximum gas flow rate. From the flare, the extent of skyglow would progressively decrease in intensity reaching natural skyglow conditions approximately 12 kms horizontally and 4 kms vertically from the flare on a clear night, equating to 2.5^0 above the horizon. In cloudy conditions this event would contribute to artificial skyglow to a maximum extent of 7.4^0 above the horizon. Thus, the project would not make a contribution to skyglow conditions at the 30^0 reference location adopted in the guidelines and would have negligible impact on the Observatory's operations.

Lighting at Leewood, Bibblewindi, Westport workers' accommodation and well pads will comply with *Australian standard AS/NZS 4282 – 1997 Control of the obtrusive effects of outdoor lighting*. This may include the use of narrow beam floodlights with spill light limited either through appropriate luminaire selection or through the use of "barn door" or similar shading devices fitted to the light fittings. To minimise skyglow, the standards require no light output above the horizontal plane.

The design and operation of night lighting would also consider the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring*.

As stated in the Visual Impact Assessment in Appendix Q and summarised in Chapter 23 of the EIS, visual impacts of safety flares would be considered during their siting to minimise potential impacts.

Social impacts on vulnerable groups

The submission stated that the Social Impact Assessment has limited identification and discussion of potential impacts on vulnerable groups citing Hajkowicz, Heyenga and Moffat (2010), while emphasising the importance of social outcomes to the local Indigenous community.

The potential for localised inequality in the distribution of potential socio-economic benefits or impacts is acknowledged. The Hajkowicz, Heyenga and Moffat (2010) paper found a positive correlation between mining activity and socio-economic indicators such as incomes, housing affordability, education and employment but noted that socio-economic impacts could affect "specific economic sectors, localities, families……or individuals".

In terms of the potential socio-economic benefits or impacts of the project, these may include the distribution of employment (and income) generated by the project or the potential impacts on social infrastructure and housing and accommodation on particular groups or individuals.

With regard to the distribution of employment, and as highlighted in the submission, it was considered that Indigenous participation would be an important aspect of the project. As discussed in the Social Impact Assessment in Appendix T1 of the EIS, the proponent will implement its Diversity and Equal Opportunity Policy to achieve representative Aboriginal employment.

Further, Aboriginal employment opportunities would be part of ongoing Native Title negotiations with the Gomeroi Applicants, with final details subject to the finalisation of a Native Title agreement.

With regard to social infrastructure and services, the proponent will engage with providers on an ongoing basis to monitor changes to social infrastructure and services (as required). Social impact monitoring would be undertaken in line with the proponent's Social Impact Management Plan.

The proponent will invest in social infrastructure and services through operation of the Gas Community Benefit Fund, as determined through consultation with relevant stakeholders.

With regard to housing, as discussed in Section 4.4.6 of the Social Impact Assessment in Appendix T1 of the EIS, construction accommodation demand from the project can be met through the existing and future capacity of the CIVEO workforce accommodation in Narrabri and Boggabri, and the proposed expansion of Westport workers' accommodation. During operations, it is expected that approximately 50 workers will relocate to Narrabri during 2018-2021 who would rent or buy within the private market.

As discussed in the Social Impact Assessment, Narrabri has had a generally low rental vacancy rate since 2009 that is balanced by a higher availability of houses for purchase. In late 2017 there were 32 properties for rent and 341 properties for sale (compared to 32 properties for rent and 195 properties for purchase in September 2014).

Further, consultation undertaken for the Social Impact Assessment identified three housing developments which were likely to increase housing availability around Narrabri. While it is possible that operational staff relocating to Narrabri may increase demand, given the current availability of properties to rent and buy, along with proposed housing developments and considering that demand from the project would be over a period of years, it is unlikely that housing demand from 50 workers would affect the housing needs of vulnerable groups. In addition, project workers seeking rental accommodation would likely be competing for a different market sector than the vulnerable groups referred to in the question, thereby further lowering the likelihood of conflicting demand.

Social impacts on vital health services

The submission stated that the social impacts of the project workforce on health services was understated and required further assessment informed by qualitative fieldwork.

The Social Impact Assessment in Appendix T1 of the EIS does acknowledge that there will be an increase in demand on local health services as a result of workers accessing services for non-routine medical issues or in emergencies, though this is not expected to be significant. Project workers will be required to provide a 'fit for work' certificate; the assumption being therefore that non-resident workers will be in generally good health and will have their regular health checks at their usual place of residence.

As stated in Section 6.3.5 of the Social Impact Assessment in Appendix T1 of the EIS, impacts on health services were determined based on consultation with the Narrabri District Health Service and other medical practitioners. The consultations indicated that local health services had sufficient capacity to cater for population growth in the region including the project workforce.

The Social Impact Assessment presented mitigation measures for managing the potential for additional demand on medical and health services, including:

- Engagement with service providers on an ongoing basis through various forums initiated by the proponent to monitor change in demand on services from the project.
- Investment in community infrastructure services through the Gas Community Benefit Fund, in consultation with key stakeholders.

Aboriginal employment agreement

The submission noted the employment policy cited in the EIS but requested an Aboriginal employment agreement with a measurable commitment to employment.

A Diversity and Equal Opportunity Policy would be implemented to achieve representative Aboriginal employment, including for contractors (refer to Appendix A of Appendix T1 of the EIS).

The Policy outlines capacity building strategies for Aboriginal people including specific employment, training and procurement initiatives to:

- Increase the number of Aboriginal employees within the proponent and service providers.
- Develop partnerships with Aboriginal peoples, government and community organisations in the delivery of Aboriginal employment and training outcomes.
- Create, where possible, enterprise development and procurement opportunities as part of the project and operations for Aboriginal companies.
- Facilitate the development of the community to build capacity which is aligned with proponent operations and activities.

Further, Aboriginal employment opportunities would be part of ongoing Native Title negotiations with the Gomeroi Applicants, with final details subject to the finalisation of a Native Title agreement.

Local skills development

The submission requested that options be investigated to utilise training facilities in the Narrabri local government area to provide opportunities for local people to acquire the necessary skills to work in the natural gas industry. It also requested that the proponent consider a local skills package catering to school leavers seeking access to skilled positions.

Education and training facilities in the region of the project were identified as part of the Social Impact Assessment in Appendix T1 of the EIS. As stated in Section 4.4.7 of the Social Impact Assessment, a number of relevant education and training facilities were identified in the region including TAFE campuses at Narrabri, Tamworth, Gunnedah, Inverell and Moree.

To provide long term career pathways for locals and ensure that an appropriately skilled workforce is employed, the proponent will provide scholarships and develop suitable training and apprenticeship programs in consultation with local TAFE and other training institutions. It is expected that those seeking education and training to participate in the project may also be eligible for various Federal and State government financial assistance or loan schemes.

It is considered that the availability of education and training facilities in combination with the schemes, scholarships and programs described above would be adequate to provide long term career pathways to school leavers seeking skilled employment by the project.

Monitoring of social impacts

The submission stated that Social Impact Assessment should continue over the life of the project including an ongoing and independent social impact monitoring program as a condition of approval.

As discussed in the Social Impact Assessment in Appendix T1 of the EIS, social impacts would be monitored and managed over the life of the project through engagement with landholders, the community, service providers, industry bodies and government.

Measures to monitor and manage social impacts would be collated in a Social Impact Management Plan. The development and implementation of the plan would be overseen by a suitably qualified practitioner and would be publicly available.

The framework of the Social Impact Management Plan would likely include:

- A list of identified impacts and issues.
- Targets and outcomes sought.
- A monitoring strategy, including:
  - Responsibility—documenting the party responsible for the implementation of each monitoring strategy
  - Timing and frequency—document how often monitoring of the impact should take place
  - Key performance indicators—informative, relevant, measurable, useful, widely recognised, simple to report and easily understood
  - Reporting – identify methods for reporting on each of the impacts and mitigation measures.

The Social Impact Management Plan will also include details on a grievance management mechanism that will be put in place for the project. It will include information on how feedback will be received, recorded, actioned, responded to and closed out.

Adjoining landholders

The submission requested confirmation that the 200 metre buffer to residences in the Field Development Protocol would apply to residences on adjacent properties.

Unless a written agreement is in place with the relevant landholder, no project infrastructure will be located within 200 m of an occupied residence on that property.

Chemical monitoring for health impacts

The submission requested an independent chemical monitoring program for health impacts under the direction of the NSW Environment Protection Authority; funded by the proponent.

The potential health impacts of the project were assessed in the Health Impact Assessment and Chemical Risk Assessment in Appendices T2 and T3 of the EIS, respectively.

The assessments concluded that the risk to human health was very low. It is noted that findings were in agreement with the submission from NSW Health who stated “based on the nature and scale of the operation and distance from townships, we expect there will be minimal impact on human health”.

The Environmental Management Strategy for the project includes a number of sub-plans with chemical monitoring requirements including surface water, groundwater and air quality. As such, specific chemical monitoring for health impacts is not considered to be necessary.

Verification of gas price assumption

The submission noted the gas price in the cost benefit analysis is $8.70 per gigajoule and requested independent third party verification of this assumption.

The cost-benefit analysis in Appendix U2 of the EIS was undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (Department of Planning and Environment 2015).

As noted in the submission, the cost-benefit analysis assumed a gas price of $8.70 per gigajoule. The analysis included a gas price sensitivity analysis that showed the project would create a net economic benefit for a range of scenarios including 10 and 20 per cent reductions in gas price.

It is noted that the NSW Division of Resources and Geoscience noted in its EIS submission that the forecast gas price used in the cost-benefit analysis (Appendix U1 of the EIS) of $8.70 GJ lies within the range of expected future gas prices in the east coast market over the more than 20-year project life.

Gas community benefit fund

The submission stated the Gas Community Benefit Fund should not be accessed for project costs such as land access or road maintenance. It stated a portion of the fund should be dedicated to infrastructure to encourage industry including roads, rail, gas, electricity and water networks.

The Gas Community Benefit Fund will be established as per the *Gas Community Benefits Fund Funding Guidelines* (NSW Government 2016) and will be administered by the NSW Government Rural Assistance Authority and the Community Benefits Fund Committee. The NSW Rural Assistance Authority (Fund Administrator) was appointed under the *NSW Petroleum (Onshore) Act 1991* to administer the Fund.

In accordance with the above guidelines, the fund will be available for individuals, organisations or enterprises that deliver local and social community development initiatives in the areas of:

- health
- education
- environment
- economic development and heritage
- sport, arts and culture.

Local employment and procurement

The submission stated that the project workforce and procurement of construction materials and other supplies should be focussed on the local area.

The proponent has engaged, and will continue to engage with, the Narrabri Shire Council and other relevant stakeholders for their input and feedback into the project’s regional and local employment and business development initiatives and workforce management strategies.

Capacity of local waste facilities for waste salt

The submission requested confirmation that local waste facilities have capacity to receive the expected volumes of waste salt over the life of the project.

As stated in Chapter 31 (Project commitments) of the EIS, the mixed solid salt product would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

As discussed in Chapter 28 (Waste management) of the EIS, estimated average daily salt volumes would be about 115 tonnes per day during the peak period in around years' two to four and about 47 tonnes per day for the remaining years of the assessment period. The salt would be temporarily stored on site in a weather proof structure prior to being collected and transported to an appropriately licensed facility in accordance with all regulatory requirements.

As outlined in the response above, the composition of the mixed solid salt product was forecast based on water quality analysis of both the produced water generated through exploration and appraisal activities and the brine produced at the Leewood water treatment facility.

Testing was undertaken in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) based on the chemical contaminants known or likely to be present in the produced water. The results are summarised in Table 5-3, Table 5-4 and Table 5-5 which show it would classify as general solid waste, with contaminants significantly below relevant thresholds.

There are a substantial number of waste facilities available, including government and privately owned facilities that are licensed to receive general solid waste in the order of hundreds of thousands of tonnes per annum. The average volume of salt produced annually by the project would be a very small proportion of the overall capacity of any one such facility.

As part of the ongoing development of salt management, options for alternative beneficial reuse applications are being investigated.

Composition and classification of waste salt

The submission requested confirmation of the composition of salt waste including the potential for other chemicals to be present that would affect its classification as general solid waste.

As stated in Chapter 31 of the EIS (Project commitments), the mixed solid salt product would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

The composition of the mixed solid salt product was forecast based on water quality analysis of both the produced water generated through exploration and appraisal activities and the brine produced at the Leewood water treatment facility.

Testing was undertaken in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) based on the chemical contaminants known or likely to be present in the produced water. The results are summarised in Table 5-3, Table 5-4 and Table 5-5 of this RTS and show it would be classified as general solid waste, with contaminants significantly below threshold values.

As stated in Chapter 31 of the EIS, a Waste Management Plan would be implemented for the project. The Plan would include the testing program for the salt product generated by the water treatment process, including the frequency of testing in accordance with the *Waste Classification Guidelines* (NSW EPA 2014).

Waste management

The submission stated that the proponent should take all feasible measures to reduce waste generated by the project, including Westport workers' accommodation, and increase the proportion of waste able to be reused and recycled.

As stated in Chapter 31 of the EIS (Project commitments), a Waste Management Plan would be implemented for the project.

The Plan would incorporate statutory requirements under the *Protection of the Environment Operations Act 1997* and *Protection of the Environment Operations (Waste) Regulation 2014* including waste classification, recording, transport and tracking.

The Waste Management Plan would be structured around the waste management hierarchy defined under the *Protection of the Environment Operations Act 1997*. That is, opportunities to avoid, reduce, reuse, recycle and treat waste would be investigated in order to reduce the volumes waste and minimise potential environmental impacts.

The Plan would also detail the project waste inventory and for each waste stream identify appropriate containment, collection regimes management and waste management facilities to be utilised. The Plan would also outline testing and monitoring regimes and corrective actions.

Westport workers' accommodation

The submission requested Westport workers' accommodation be limited to drillers and the main construction phase to maximise economic benefits of using accommodation in Narrabri.

As stated in Chapter 6 of the EIS (Project description), Westport workers' accommodation would be expanded to provide accommodation for up to 200 people so that work crews could be housed. In addition to Westport workers' accommodation, work crews would be accommodated in privately operated workers' accommodation or other facilities in the Narrabri region.

Worker numbers accommodated at Westport workers' accommodation would expand and contract based on the drilling schedule, number of rigs and construction schedule. The site will be decommissioned at the completion of drilling activities.

Westport workers' accommodation bushfire risk

The submission raised a concern regarding the potential bushfire risk to occupants of Westport workers' accommodation given its remote location.

The project is State Significant Development and is exempt under section 4.41 and 4.14(1B) of the *Environmental Planning and Assessment Act 1979* and does not require a Bush Fire Safety Authority under the *NSW Rural Fires Act 1997*. It is, however, recognised that the project would be situated on bush fire prone land and that *Planning for Bushfire Protection* (2006) is an important guideline in the design of bushfire protection measures.

Westport workers' accommodation would provide accommodation for up to 200 people and would warrant proportionate bush fire protection. The existing accommodation was granted a bush fire safety authority that prescribed bush fire protection specifications and requirements including asset protection zones, water supplies for firefighting and emergency procedures. It is expected that a similar level of bush fire protection would be provided to the expanded facility. An updated bushfire response and evacuation plan would also be prepared.

Environmental management plans

The submission requested further details of the content of proposed environmental management plans including procedures and timing and opportunities for Narrabri Shire Council and public involvement.

It also requested that the consent authority review the environmental management plans to confirm they contain the necessary measures.

The proponent has committed to developing and implementing a project-wide Environmental Management Strategy, comprising of a number of management plans. These plans will include:

- Produced Water Management Plan
- Erosion and Sediment Control Plan
- Noise and Vibration Management Plan
- Soil Management Plan
- Air Quality Management Plan
- Cultural Heritage Management Plan
- Biodiversity Management Plan
- Pest, Plant and Animal Control Plan
- Historic Heritage Management Plan
- Traffic Management Plan
- Waste Management Plan
- Bushfire Management Plan
- Community and Stakeholder Management Plan
- Decommissioning Management Plant
- Rehabilitation Plan.

The Plans would reflect EIS management and mitigation measures, conditions of approval, statutory obligations and landholder agreements.

Indicatively, the Plans would also include details of existing environmental values and potential impacts, management objectives, performance criteria, management and mitigation measures and monitoring requirements and corrective actions.

Independent monitoring

The submission stated environmental monitoring should be undertaken by an independent third party and that results should be made publically available and easy to understand. The submission specified the following monitoring parameters:

Air quality — particulate matter, volatile organic compounds, hydrogen sulfide, nitrogen dioxide, sulfur dioxide, sulfuric acid mist, molecular weight of stack gases, odour.

Noise — annual monitoring of premises and flaring events in accordance with the *NSW Industrial Noise Policy* and *AS 1055.1-1997 Acoustics - Description and measurement of environmental noise General procedures*.

Soil — cation exchange capacity, electrical conductivity, pH, petroleum hydrocarbons, polyaromatic hydrocarbons, heavy metals, sodium adsorption ratio, boron, sodium, calcium, potassium, benzene, toluene, ethylbenzene and xylene.

Sediment (Bohena Creek) — cation exchange capacity, electrical conductivity, pH, petroleum hydrocarbons, polyaromatic hydrocarbons, heavy metals, sodium adsorption ratio, boron, sodium, calcium, potassium, benzene, toluene, ethylbenzene and xylene.

Water quality — suspended solids, biochemical oxygen demand, oil and grease, polyaromatic hydrocarbons, phenols, organic carbon, petroleum hydrocarbons, recoverable hydrocarbons, electrical conductivity, pH, sodium adsorption ratio, boron, sodium, calcium, potassium, heavy metals (particularly cadmium), benzene, toluene, ethylbenzene and xylene.

The project's Environmental Management Strategy includes a number of management plans to demonstrate compliance with the relevant statutory criteria and approval conditions. The plans would include monitoring requirements for matters including air quality, noise and water quality.

Within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.
- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.
- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

5.18 Warrumbungle Shire Council

Destination of waste salt

The submission requests confirmation of the destination of waste salt.

As stated in Chapter 31 of the EIS (Project commitments), the mixed solid salt product would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

Transport of product gas

The submission stated that the EIS did not include information on the movement of gas to markets and requested information on this.

The submission is incorrect in stating that the EIS does not include information on the movement of gas to markets. As stated on Page 1-1 of the EIS, “the gas would be made available to the NSW market via a high-pressure gas transmission pipeline which would connect to the existing Moomba to Sydney gas pipeline”. At the time of writing, APA Group as the proposed pipeline provider were preparing the environmental impact statement for the Western Slopes Pipeline. The Western Slopes Pipeline would be a buried, steel gas transmission pipeline running 450 kilometres in a south west direction from the Narrabri Gas Project to its connection with the Moomba to Sydney gas pipeline. The key environmental issues of the pipeline were identified in the Preliminary Environmental Assessment prepared by APA Group and included potential impacts on biodiversity and ongoing land use including agriculture, as well as potential soil, water, heritage and hazard and risk issues.

For more information on the Western Slopes Pipeline refer to:
http://www.majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=8272

The Western Slopes Pipeline Preliminary Environmental Assessment can be accessed at:
https://majorprojects.accelo.com/public/95ba8b7700e6626f48cefb1e424c996c/Western%20Slopes%20Pipeline%20-%20Preliminary%20Environmental%20Assessment.pdf

The gas from the project may also be made available to optimise opportunities for its use as a source of energy including, for example, at the Wilga Park Power Station.

Location of offset sites

The submission requests confirmation of offset sites proposed as part of the project.

A number of properties have been nominated as offsets and these are being actively considered by the proponent. The locations of these prospective offset sites are currently confidential, as most of the candidate properties are privately owned.

The proponent will, in the course of finalising the offsets program, discuss these matters further with the NSW Office of Environment and Heritage.

The working draft Biodiversity Offset Strategy is attached to this RTS as Appendix F.

Chapter 6 Response to non-agency submissions

6.1 Introduction

This section addresses submissions from special interest groups, organisations and individuals. The following sections summarise and respond to the issues raised in these submissions.

A statistical overview of these submissions and the issues they raised is provided in Section 3.

6.2 Location and setting

The project is located in north-west NSW, about 20 kilometres south-west of Narrabri. The project area covers about 95,000 hectares however the project footprint would only occupy about one per cent of that area. About two-thirds of the project area is State forest while the remaining third is predominantly cleared land used for agriculture. The location and setting of the project was described in Chapter 2 of the EIS.

21 submissions raised issues specifically relating to the location and setting of the project as broadly described in Chapter 2 of the EIS. All of the submissions that raised these issues were unique as this issue was not explicitly raised in the form submissions (refer Figure 6-1).

A large number of submissions raised issues more specific to particular values of the project area such as the ecological values of the Pilliga or the use of the project area for logging and agriculture. These issues are discussed in sections Section 6.15 and 6.15 (ecological values) and 6.17 (logging and agriculture).

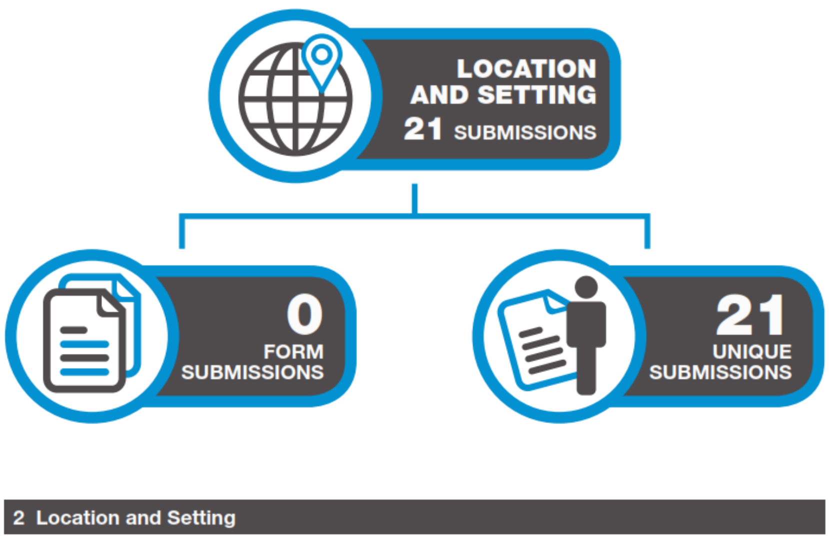


Figure 6-1 Summary of submissions on location and setting

Location of the project and community conservation area

Submissions stated that the project area was a suitable location for the project given the presence of the natural gas resource and zoning for mineral extraction in the community conservation area under the *Brigalow and Nandewar Community Conservation Area Act 2005*.

Some submissions also queried whether the project would be developed in areas that were not zoned for extractive industry and sought justification for locating the project in these areas.

As discussed in Chapter 4 (State legislation and approvals) of the EIS, the project is subject to the State significant development assessment process under the *Environmental Planning and Assessment Act 1979* and the petroleum title process under the *Petroleum (Onshore) Act 1991*. It is also noted that the project is permissible under the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* as development for the purposes of petroleum production on land where development for the purposes of agriculture or industry are permissible.

As discussed in Chapter 1 (Introduction) of the EIS, the project area is the subject of four petroleum production lease applications being PPLA 13, 14, 15 and 16 under the *Petroleum (Onshore) Act 1991*. Under Section 16 of the Act the Minister may grant a petroleum title over land of title or tenure except in areas declared by the Minister not to have petroleum titles or where there is another petroleum title. The petroleum title process under the *Petroleum (Onshore) Act 1991* is the relevant process for the project.

The relationship of the project area and the community conservation area under the *Brigalow and Nandewar Community Conservation Area Act 2005* is shown in Figure 4-1 in Chapter 4 of the EIS. As shown, the project area is partly within Zone 4 of the community conversation area, which is zoned for forestry, recreation and mineral extraction. These are essentially areas of State forest that make up about two-thirds of the project area. The remaining third of the project area is not part of the community conservation area. This area is nonetheless necessary for extraction of the identified natural gas resource.

Submissions regarding the suitability of the location for the project are noted.

Location of the project and the Pilliga

Submissions queried whether the 988.8 hectares of direct disturbance stated in the location and setting chapter would be limited to the Pilliga or was across the project area. They also queried whether the project footprint included or excluded partially rehabilitated areas.

The total direct disturbance would be up to 988.8 hectares distributed across the project area and not limited to the Pilliga. The total disturbance would include areas that would be subject to partial rehabilitation.

6.3 Strategic context and need

The strategic context and need for the project was discussed in Chapter 3 of the EIS.

Natural gas is an important natural resource for both domestic and industrial use, with over 300,000 jobs relying on a safe and secure supply. NSW is highly dependent on other states for natural gas and imports more than 95 per cent of its supply. The Australian Energy Market Operator (AEMO) is an Australian government and industry body that provides energy planning, forecasting and security advice.

Successive reports published by AEMO have forecast domestic gas shortages that would put upward pressure on gas prices. In the most recent *Gas Statement of Opportunities* (AEMO 2017a), AEMO found that the shortfall of domestic gas supply would be in the order of 50 to 100 petajoules in 2018 and 2019.

18,218 submissions raised issues specifically relating to the strategic context and need for the project as described in Chapter 3 of the EIS. The majority of these submissions were form submissions, however, slightly over 2,000 unique submissions were also received.

The majority of these submissions concerned the strategic need for the project with regard to the need for gas or the preference for investment in renewable energy. A smaller number concerned the need for further gas development in the region to justify the project.

The division of submissions by issue and submission type is depicted in Figure 6-2.

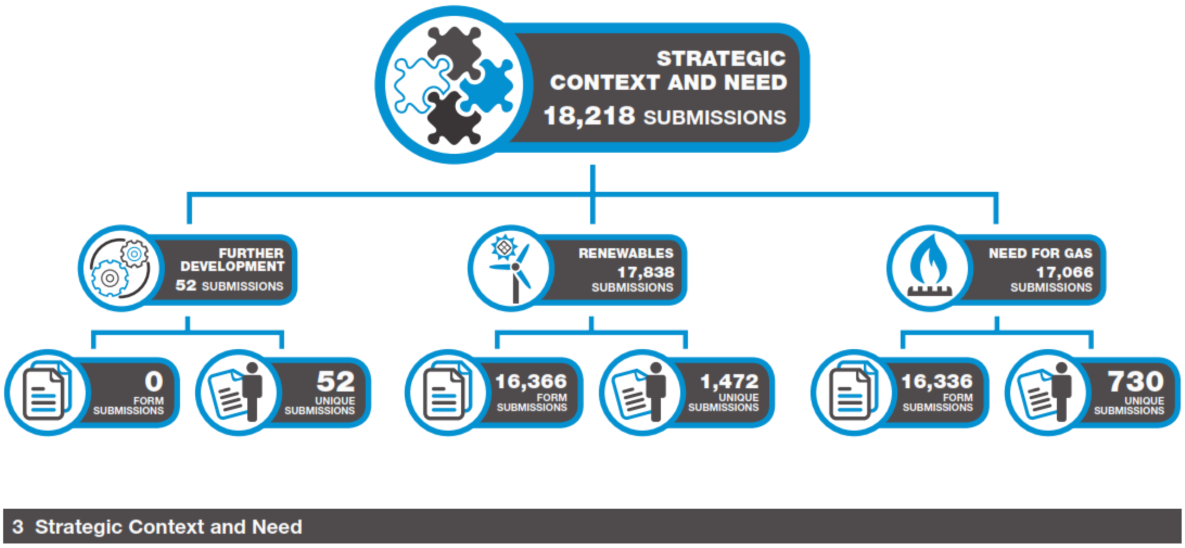


Figure 6-2 Summary of submissions on strategic context and need

6.3.1 Further development

Increased project scale

Submissions stated that the scale of the project infrastructure would justify more production wells in the Pilliga than anticipated in the EIS and have associated environmental impacts.

> The issue raised in the submission is not relevant to the assessment of the project under consideration.
>
> The proponent is seeking development consent for the project as described in Chapter 6 (Project description) of the EIS, including installation of up to 850 wells on up to 425 well pads with associated gas processing and water management facilities and ancillary infrastructure.

If the proponent intended to undertake development over and above what was assessed in EIS, it would need to make a development application or apply for a modification under the *Environmental Planning and Assessment Act 1979*. A development application or modification process would require an assessment of environmental impacts of the development, including potential cumulative impacts.

Approximately 75 per cent of the project area is native vegetation. Project infrastructure would be situated on approximately one per cent of the project area, therefore, around 99 per cent of the native vegetation will not be directly impacted.

Proposed direct impacts to native vegetation have been assessed, and following avoidance and mitigation, residual impacts will be offset in accordance with relevant policies. Refer to Appendix J1 and Appendix J2 of the EIS.

Well pad locations would be planned with regard to ecological constraints identified through field surveys including those for the Ecological Impact Assessment in Appendix J1 of the EIS. As detailed in the constraint matrix in Table 7-1 of the Field Development Protocol EIS Appendix C), the process will result in the majority of well pads being located outside of high and moderate ecological sensitivity class.

A reporting framework to manage and document upper disturbance limits is included in the Field Development Protocol (Appendix C of the EIS). The framework includes the following safeguards:

- A Plan of Operations, including direct impacts on vegetation communities, to be prepared and submitted to the NSW Department of Planning and Environment and the Commonwealth Department of Environment and Energy prior to implementation.
- An annual review to ensure compliance with the Field Development Protocol, management plans and procedures, the Plan of Operations, and State and Commonwealth approvals.
- An independent third-party environmental audit every three years from commencement to ensure compliance with the Field Development Protocol, Plan of Operations, State and Commonwealth approvals, management plans, relevant licences and the annual compliance review.

Broader gas development

Submissions also stated the project was the first stage of broader natural gas development across the Taroom, Bellata, Maules Creek, Bando, Tooraweena and Murrurundi basins. They cited information on the proponent's website indicating an intention to develop these basins.

Submissions stated the proponent had overestimated the natural gas reserves of their Queensland project and that this would motivate broader gas development to meet contracts.

They also stated that broader gas development would be required to justify the investment in project infrastructure and the associated gas export pipeline.

They requested that the proponent explain their plans to broad gas development or otherwise make a commitment against it. They stated that petroleum exploration licenses held by the proponent should be relinquished if broader gas development is not planned.

The proponent has reported its gas reserve for the project area in accordance with industry standard *Guidelines for Application of the Petroleum Resources Management System*. The NSW Division of Resources and Geoscience stated in its submission on the project that it is satisfied the gas reserve is as reported. The submission also stated that the proposed method of production is “the most efficient way to produce gas … at significant commercial quantities”.

The proponent is seeking development consent for the project as described in Chapter 6 of the EIS, including installation of up to 850 wells on up to 425 well pads with associated gas processing and water management facilities and ancillary infrastructure.

If the proponent intended to undertake development over and above what was assessed in EIS, it would need to make a development application or apply for a modification under the *Environmental Planning and Assessment Act 1979.* A development application or modification process would require an assessment of environmental impacts of the development, including potential cumulative impacts.

The cost-benefit assessment (CBA) undertaken for the EIS and reported in Appendix U1 (Economic Assessment) and Chapter 27 (Economics) assessed the project as a stand-alone development. It reported a benefit-cost ratio of 1.39 to 1.43 depending on the electricity supply option adopted.

The NSW Division of Resources and Geoscience noted in its EIS submission that the forecast gas price used in the EIS CBA of $8.70 GJ lies within the range of expected future gas prices in the east coast market over the more than 20-year project life.

Assessment of further development

Submissions stated that once the project is approved, further development would then be pursued either as separate projects or modifications for additional wells.

They stated further development would have broader impacts on the Pilliga and other locations such as the Warrumbungles and that their cumulative impacts should be considered.

The issue raised in the submission is not relevant to the assessment of the project under consideration. The proponent is seeking development consent for the project as described in Chapter 6 of the EIS, including installation of up to 850 wells on up to 425 well pads with associated gas processing and water management facilities and ancillary infrastructure.

If the proponent intended to undertake development over and above what was assessed in EIS, it would need to make a development application or apply for a modification under the *Environmental Planning and Assessment Act 1979.* A development application or modification process would require an assessment of environmental impacts of the development, including potential cumulative impacts.

6.3.2 Renewables

Preference for renewable energy

Submissions expressed a preference for renewable energy such as wind, solar or hydroelectric. Other forms of gas production such as green gas or gas from sewage were also raised.

They questioned the need for gas as a transition fuel stating that costs of renewable energy were decreasing. They stated that continued investment in fossil fuels would slow the transition to renewables.

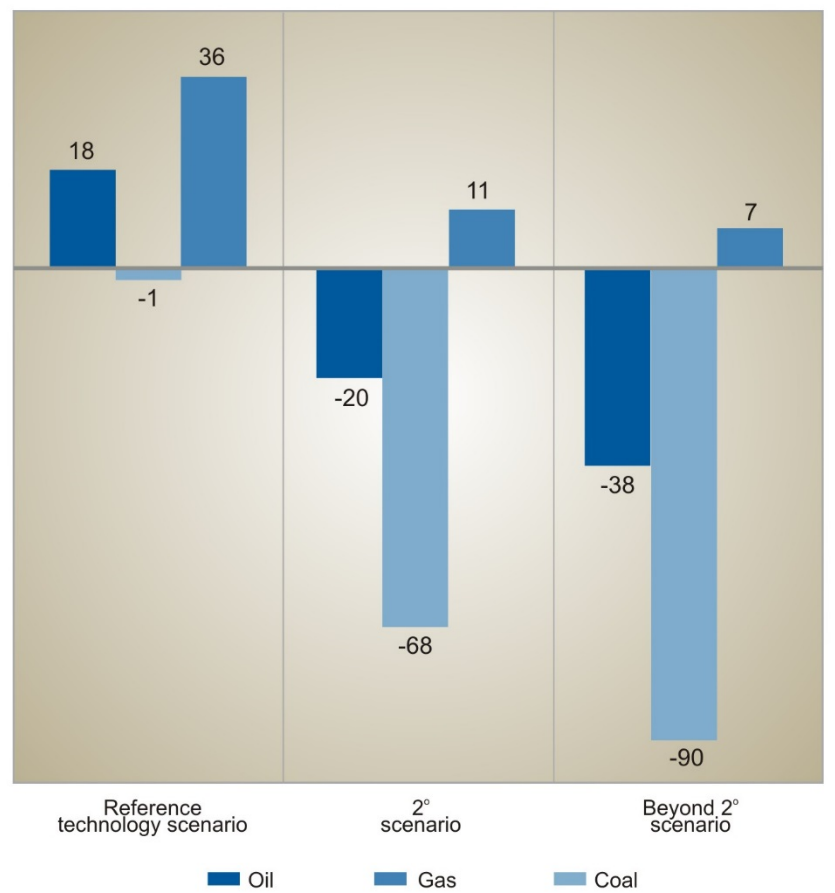
They stated that continued investment in fossil fuels meant a slower transition to renewables and potential for Australia to not meet its international obligations regarding global warming.

Natural gas is part of the solution to meet future energy demand growth. As a flexible, scalable dispatchable energy source, gas can provide reliable, affordable energy, reduce greenhouse gas emissions and improve air quality across Australia and Asia. It is the natural partner for renewable energy for power generation as the world moves away from higher-emission fuels such as diesel and coal. In June 2017, the International Energy Agency (IEA) released its Energy Technology Perspectives 2017 report, which explored three pathways for energy sector development to 2060.

The IEA is an autonomous intergovernmental organisation that works to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA acts as a policy adviser to its members and non-members as well as providing transparent data to the public. These pathways represent three energy mix scenarios that reflect different global climate change outcomes:

- The Reference Technology Scenario takes into account the commitment governments have made to limit emissions and improve energy efficiency, including the Nationally Determined Contributions pledged under the Paris Agreement. Under this scenario, the world does not achieve global climate mitigation objectives, resulting in an average temperature increase of 2.7°C by 2100. Under this scenario, energy demand is projected to grow by 20 per cent by 2030 and almost 50 per cent by 2060.
- The 2°C Scenario (2DS) provides a pathway to a 50 per cent chance of limiting average global temperature increase to 2°C by 2100. Annual energy-related CO_2 emissions are reduced by 70 per cent from today's levels by 2060 and will reach carbon neutral by 2100. Under this scenario, total energy demand is projected to grow by 4 per cent by 2030 and 17 per cent by 2060, underpinned by widespread deployment of energy efficiency initiatives.
- The Beyond 2°C Scenario (B2DS) explores how far deployment of technologies can take us beyond the 2DS and is consistent with the globally agreed goal of limiting temperature rise to "well below" 2°C. Delivery of this scenario is supported by significant negative emissions through deployment of bioenergy with carbon capture and storage. Under this scenario, energy demand is projected to remain flat in the near to medium-term, and grow by 10 per cent by 2060.

The importance of natural gas in the global energy mix to 2060 is recognised in all three scenarios. Gas demand is forecast to grow under all three of the IEA's energy mix scenarios to 2030, as gas is required to displace coal and oil in the energy mix to reduce greenhouse gas emissions and improve air quality. This is shown in Figure 6-3.



Adapted from *Energy Technology Perspectives* (IEA 2017)
Demand growth 2014 to 2030, EJ (1 EJ = 1 Exajoule = 1,000 Petajoules)

Figure 6-3 Fossil fuel demand growth to 2030 under Reference Technology Scenario, 2DS and B2DS

As shown in Figure 6-3, gas demand is forecast to grow under all IEA scenarios. Under the Reference Technology Scenario, global gas demand is projected to grow by 30 per cent by 2030, faster than overall energy demand growth and gas' market share increases from 21 per cent to 23 per cent. By 2060, gas demand is projected to grow by almost 60 per cent. Under the 2DS and B2DS, gas demand grows by 9 per cent and 6 per cent respectively by 2030.

Natural gas has a critical role to play in providing energy in a lower-carbon future. This is because natural gas is a reliable and affordable source of energy that produces 50 per cent less greenhouse gas emissions than coal when used to generate electricity and is much cleaner with regards to local air pollutants. Even under the most carbon-constrained scenario, the IEA projects that gas will be an important part of the energy mix well into the future, and even after the world reaches carbon neutrality.

The proponent is also playing its part in meeting global climate targets, and is actively pursuing initiatives to reduce the emissions across its operations and invest in opportunities that the lower-carbon future presents. The incorporation of new but proven technology, such as renewable energy, into existing operations to reduce fuel usage and emissions is an example of this. The proponent will continue to identify and pursue opportunities to offset greenhouse gas emissions where relevant in further support of achievement of emissions targets.

6.3.3 Need for gas

Strategic justification not up to date

Submissions stated the strategic justification for the project did not reflect market conditions.

They cited the Australian Energy Market Operator (AEMO 2017a) *Gas Statement of Opportunities* and supplement (AEMO 2017b), which stated that there would be no shortfall of gas supply.

They also cited *A Short Lived Gas Shortfall* (Forcey and McConnell 2017) which stated that domestic demand for gas was falling and additional supply was not required.

Since the release of the EIS, the Australian Energy Market Operator (AEMO) has released a further update to the 2017 *Gas Statement of Opportunities* where the predictions for gas shortfalls was significantly increased. In the update, AEMO (2017b) stated:

> *In real terms and based on no further response to today's information, the projected shortfall risk for 2018 is between 54 petajoules (PJs) to 107 PJs, and in 2019 between 48 PJs to 102 PJs. To put this into context, total projected demand for domestic gas is expected to be approximately 642 PJs in 2018, and 598 PJs in 2019.*

The Australia Competition and Consumer Commission (ACCC) confirmed this outlook in its *Gas Inquiry 2017–2020 Interim Report* in September 2017 (ACCC 2017). The updated outlook similarly increased the urgency for additional new gas supplies, highlighting the critical strategic need for the project.

Support for the project

Some submissions expressed support for the project as a means to improve gas security in NSW and help to relieve cost pressures on domestic and industrial users.

Support for the project is acknowledged. The Australian Competition and Consumer Commission (ACCC 2017) has stated the importance of additional sources of gas supply to assist in putting downward pressure on prices.

It found that domestic users are facing very high gas prices, largely as a result of the expected supply shortfall in the areas south of Queensland. Prices could be significantly reduced if additional sources of supply are developed south of Queensland.

Project would not address domestic gas price issues

Submissions stated that project would not address domestic gas price issues.

Submissions stated that domestic gas price issues were due to opening of the domestic market to the international market and consequent parity of domestic and international gas prices. The proponent export activities were a strategic manoeuvre to increase gas prices in this way.

Submissions stated the proponent and other gas producers would sell their gas at the highest price available and therefore price would remain at parity with international prices.

Some stated that the project would increase domestic gas prices due to the relatively high cost of producing coal seam gas in the Pilliga and associated cost of a gas export pipeline.

The Australian Competition and Consumer Commission (ACCC) have stated the importance of additional sources of gas supply to assist in putting downward pressure on prices.

The ACCC found that domestic users in the south are facing very high gas prices, largely as a result of the expected supply shortfall in the areas south of Queensland and lack of competition between the southern gas suppliers. Prices in the south, which includes NSW, could be significantly reduced if additional sources of supply are developed to increase the level of supply and diversity of suppliers.

Project would not address domestic gas supply issues

Submissions stated the project would not produce sufficient gas to affect current gas supply.

They stated that the gas produced by the project would be in the order of five per cent of the volume contracted to be exported to the international market from Queensland.

Submissions also stated that the duration of time until the project is constructed and ramps up to full production would mean gas supply and demand would likely be different.

They stated alternative measures were available to address gas security issues including domestic reserves, controls on exports, price regulation or energy policies.

Some submissions stated that there was a global oversupply of liquid natural gas and that international gas exports from Queensland were likely to stop operating in response.

As documented in recent publications by the Australian Energy Market Operator (AEMO 2017a) and Australian Competition and Consumer Commission (ACCC 2017) there is expected to be a significant shortfall in the domestic supply of gas that needs to be addressed by increasing domestic supply. The project would address these gas supply issues by making product gas available to the NSW market.

The project has the potential to supply up to 50 per cent of gas demand in NSW, reducing its reliance on gas production facilities in other states and importantly reducing the distance gas needs to travel along transportation pipelines, with associated reductions in cost and delivery risk.

Rod Sims as Chairman of the Australian Competition and Consumer Commission, on the release of the *Gas Inquiry 2017–2020 Interim Report* (ACCC 2017), stated:

> *Steps are needed to address the underlying problems of lack of gas supply and lack of diversity of suppliers in the east coast gas market. Supply-side solutions are needed to bring more supply and suppliers into the domestic market, particularly in the southern states.*

In the gas market, the ‘southern states’ are considered anything south of Queensland. The project meets the criteria that the Australia Competition and Consumer Commission have identified for essential supply side solutions and would accordingly address gas supply issues for NSW.

Commitment to domestic use

Submissions were sceptical of whether the proponent will supply gas to NSW. They also stated that the proponent had indicated that the destination of product gas would be the decision of the wholesale purchaser and stated this would likely be export from Queensland.

> The project has the potential to supply up to 200 terajoules of natural gas per day; which is sufficient gas to meet up to half of NSW's natural gas demand. The gas would be made available to the NSW market via a high-pressure gas transmission pipeline which would connect to the existing Moomba to Sydney gas pipeline.

6.4 State legislation and approvals

The state legislation and approvals relevant to the project were explained Chapter 4 of the EIS.

The project is State significant development requiring assessment under Part 4 of the *Environmental Planning and Assessment Act 1979*. A central part of that assessment process is the production of an EIS and RTS. The chapter also identified a series of other relevant laws, planning instruments and policies relevant to the assessment of the project including the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* and the *Water Management Act 2000*.

233 submissions raised issues specifically relating to State legislation and approval as described in Chapter 4 of the EIS. Of those, 191 submissions (41 form submissions and 150 unique) raised issues pertaining to the NSW *Environmental Planning and Assessment Act 1979*.

In addition, 51 submissions (all unique) raised issues relating to other State legislation, while 27 submissions (1 form and 26 unique) raised matters relating to the project gas export pipeline.

Figure 6-4 provides an overview of the submissions for State legislation and approvals.

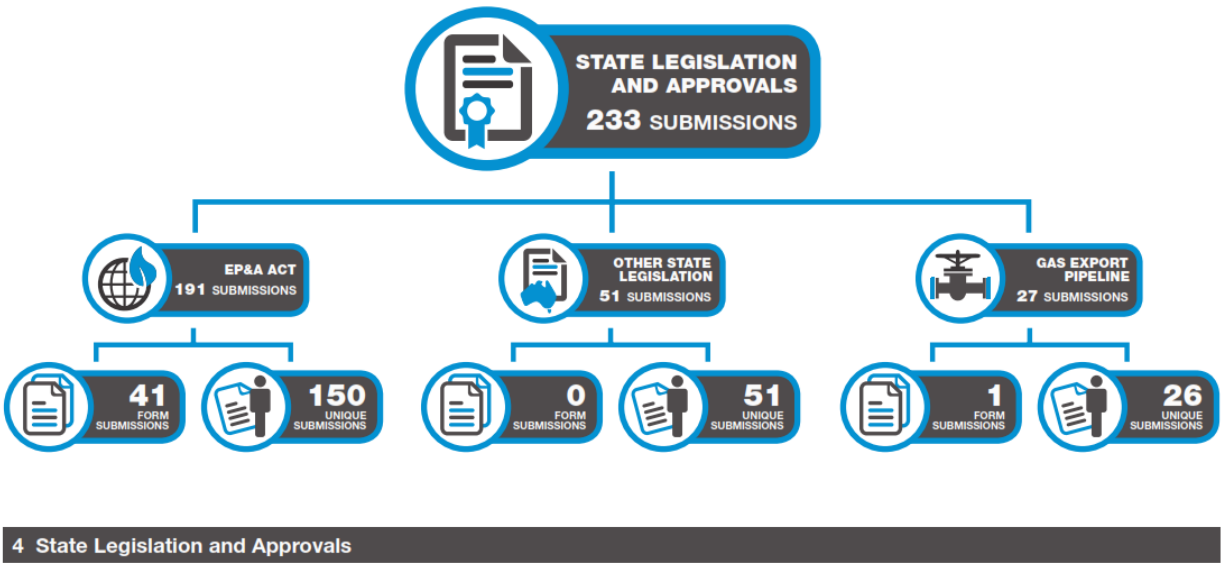


Figure 6-4 Summary of submissions on State legislation and approvals

6.4.1 Environmental Planning and Assessment Act 1979

Location of field infrastructure

Submissions stated that the employment of a Field Development Protocol to site field infrastructure meant that the project could not be adequately assessed under the *Environmental Planning and Assessment Act 1979*. They stated a layout of field infrastructure should be provided.

They expressed concern that the project would create a precedent for other environmental assessments and requested that layouts be released to the public and landholders.

The proponent disagrees with the assertion in the submission that the project could not be adequately assessed under the *Environmental Planning and Assessment Act 1979* using the Field Development Protocol.

The proponent is seeking consent for the project as described in Chapter 6 (Project description) of the EIS, including installation of up to 850 wells on up to 425 well pads with associated gas processing and ancillary water management infrastructure located in accordance with the Field Development Protocol. The potential environmental impacts of the project, including locating the project infrastructure in accordance with the Field Development Protocol, have been assessed under the Environmental Planning and Assessment Act 1979.

Field infrastructure including gas wells, gas and water gathering lines, roads and access tracks, water storages and telecommunication towers would be sited in accordance with the Field Development Protocol. The Field Development Protocol incorporates rules and constraints for the siting of field infrastructure whereby environmental impacts are systematically avoided, minimised and managed.

The carrying out of the project in accordance with the Field Development Protocol, which sets upper disturbance limits and other locational criteria, has been assessed in the EIS. The carrying out of the project consistently with the Field Development Protocol, including implementing the first eight steps of the Protocol, ensures the project and its potential impacts are as assessed in the EIS and in accordance with the conditions of approval for the project.

The Field Development Protocol was provided as Appendix C of the EIS. An updated version of the Field Development Protocol is provided as Appendix C of this RTS. Submissions relating to the Field Development Protocol are discussed further in Section 6.10.2 of this RTS.

Certainty of irrigation areas

Submissions stated that the proposal to irrigate treated and amended water was not adequate as irrigation areas had not been delineated.

They stated that irrigation areas should be assessed separately and not be approved until suitable irrigation areas are determined and irrigation contracts are signed.

As discussed in Chapter 7 of the EIS (Produced water management), treated and amended water is expected to be fit for purpose for beneficial reuse by irrigation and is similar to water sources currently accessed and used for irrigation in the region.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

In addition to the suitability of the treated and amended water, the availability of local soils to utilise the treated and amended water for irrigation has also been assessed (refer to EIS Appendices G2 (Concept irrigation design), G4 (Water baseline report) and I1 (Interpretive soils report)). The assessments found that there is around 9,000 hectares of irrigable land within 20 kilometres of Leewood that could accommodate the 12 megalitres of treated and amended water per day.

Appendix G2 of the EIS (Concept irrigation design) provided a conceptual assessment of the irrigation scheme and found it could support a productive crop yield with minimal impacts to soil and water. It found that a nominal irrigation area of 500 hectares would be sufficient to irrigate treated and amended water at peak production.

Site selection and assessment would be in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (DEC 2004), with irrigation proceeding in accordance with an Irrigation Management Plan, which would seek to ensure:

- the structure, stability and productive capacity of the soils are maintained
- erosion is minimised
- there are effective surface water and stormwater runoff controls.

Irrigation would also include a program of regular monitoring, with the irrigation schedule being adjusted as needed to address trends identified through the monitoring system.

There will be two forms of treated water monitoring to ensure appropriate water quality is maintained. Continuous monitoring for pH and electrical conductivity would be undertaken using real time on-line equipment. If the treated water quality does not meet the required specifications, the dedicated control system will ensure the water is re-treated.

In addition to the automated monitoring system, samples of the treated water would be analysed on a monthly basis by a National Association of Testing Authorities (NATA) accredited laboratory. A broad range of parameters would be analysed including compounds indicative of the chemicals used for treatment, cleaning and disinfection such as total residual chlorine.

This approach to ensuring the treated water quality meets the ANZECC/ARMCANZ (2000) long term (greater than 20 years) irrigation trigger values, including continuous on-line monitoring systems, ensures that the water to be used for irrigation is appropriate and ongoing soil monitoring is not warranted.

As committed in Chapter 31 of the EIS, irrigation of treated water during production will be undertaken in accordance with an irrigation framework under the Produced Water Management Plan.

Bias toward resource projects

Submissions argued the planning and approval system was biased toward resource projects over other projects and productive industries such as agriculture and forestry.

Submissions stated that the NSW Government had fast tracked the project as a Strategic Energy Project and stated that this decision was no longer pertinent given market conditions.

The project has been assessed under the *Environmental Planning and Assessment Act 1979* and in accordance with the Secretary's environmental assessment requirements as is required of all major projects in NSW. Major projects are determined based on size, economic value and potential impacts and are assessed on their merits under the relevant legislative process. The status of the project as a Strategic Energy Project under the *NSW Gas Plan* does not affect the assessment process.

The public exhibition and submission period for the EIS occurred for 90 days from 21 February to 22 May 2017. The minimum statutory exhibition and submission period for State significant development under the NSW *Environmental Planning and Assessment Act 1979* was 30 days.

Statutory consultation process

Submissions stated that the statutory consultation process was not adequate given the length and complexity of the EIS.

The public exhibition and submission period for the EIS occurred for 90 days from 21 February to 22 May 2017. The minimum statutory exhibition and submission period for State significant development under the *NSW Environmental Planning and Assessment Act 1979* was 30 days.

Future modification of approval

Submissions stated that the project approval would be open to future modification. They provided the example of fracture stimulation as a future modification.

The issue raised in the submission is not relevant to the assessment of the project under consideration.

The proponent is seeking development consent for the project as described in Chapter 6 (Project description) of the EIS, including installation of up to 850 wells on up to 425 well pads with associated gas processing and water management facilities and ancillary infrastructure.

The proponent is not seeking approval for fracture stimulation (also known as hydraulic fracturing or 'fracking') in the development application.

Existing approval of Narrabri Operations and Logistics Centre

Submissions stated the assessment of the project as State significant development was made to bypass the authority of Narrabri Shire Council under the *Local Government Act 1993*, including the approval process for the Narrabri Operations Centre.

Submissions stated that the project bypassed local government approval processes for the Narrabri Operations and Logistics Centre by incorporating it in State significant development.

The proponent disagrees with the assertion in the submission.

The Narrabri Operations and Logistics Centre was assessed and approved by Narrabri Shire Council under development applications DA 546/2013 and DA 769/2013.

The Narrabri Operations and Logistics Centre would be utilised by the project but is not part of the State significant development application as it is an existing approved facility. The proposed use of the Narrabri Operations and Logistics Centre would be consistent with the development consents.

As explained in Chapter 4 of the EIS (State legislation and approvals), the project is State significant development requiring development consent under the NSW *Environmental Planning and Assessment Act 1979*.

Independent monitoring panel

Submissions requested the establishment of an independent monitoring panel that would oversee environmental management and monitoring of the project, reporting to the Department of Planning and Environment. It was proposed that the panel would also assess the environmental performance of the project in reference to approval conditions and environmental standards.

The project's Environmental Management Strategy includes a number of management plans to demonstrate compliance with the relevant statutory criteria and approval conditions. The plans would include monitoring requirements for matters including air quality, noise and water quality.

Within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.
- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.
- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

Management plans and approval conditions

Submissions stated that management plans and approval conditions for the project under the *Environmental Planning and Assessment Act 1979* would not be sufficiently detailed for effective enforcement by regulators or review by members of the community. They requested that plans and supporting baseline data be sufficiently detailed and made publicly available for these purposes.

They also stated that adequate environmental baseline data must be required to enable enforcement and adaptive management if changes in baseline conditions are detected.

The project's environmental management plans described in the EIS would be developed to achieve compliance with relevant approval conditions and environmental standards and guidelines. These would include environmental constraints outlined in the Field Development Protocol, vegetation community disturbance limits discussed in Appendix J2 of the EIS (Biodiversity Assessment Report), and standards and guidelines for other environmental values such as soils, air quality and noise and vibration as discussed in Chapter 30 (Environmental management and monitoring) of the EIS. It is considered that these parameters as outlined in the EIS would mean the management plans would not be generic and would be sufficiently detailed to inform management of potential impacts.

The individual management plans would be developed in consultation with the relevant regulatory agencies while Land Access Agreements and Farm Management Plans would be developed in consultation with landholders. The implementation of the plans would be a condition of approval and would be subject to oversight by the relevant regulatory agencies as discussed above.

Should the project be approved, an Environment Protection Licence (EPL) would be required under the *Protection of the Environment Operations Act 1997*.

Environmental baseline data is set out in the EIS, including the Ecological Impact Assessment (Appendix J1) and the Water Baseline Report (Appendix G4 of the EIS and Appendix D of this RTS). The data would be used to assist in monitoring for potential project impacts.

6.4.2 Other State legislation

Under-regulation of natural gas

Submissions stated that the natural gas industry was under-regulated and that potential impacts of the activity could not be adequately regulated.

The proponent disagrees with the assertion in the submission. In NSW, the natural gas industry is regulated under a system of codes, policies and legislation, including, but not limited to:

- The NSW *Petroleum (Onshore) Act 1991* which regulates onshore gas activities including the issuance of exploration and production licences.
- The *Code of Practice for Coal Seam Gas Well Integrity* which includes standards on natural gas well construction, production and decommissioning.
- The *NSW Aquifer Interference Policy* that concerns potential impacts on aquifers by particular aquifer interference activities including natural gas development.
- The State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 which includes provisions for the protection of biophysical strategic agricultural land.
- The *Environmental Planning and Assessment Act 1979* that requires consideration of potential impacts of State significant development and compliance with conditions of consent.
- The *Protection of the Environment Operations Act 1997* that requires an Environment Protection Licence for particular developments.
- The *Water Management Act 2000* that requires a water access licence for extraction of water resources (in this case groundwater)
- The *Work Health and Safety (Mines and Petroleum Sites) Act 2013* that covers health and safety requirements at petroleum sites.

Further, the *Final Report of the Independent Review of Coal Seam Gas Activities in NSW* (NSW Chief Scientist and Engineer 2014) made a series of recommendations with regard to the regulation of the natural gas industry in NSW. The recommendations included matters relating to land access and compensation to landholders, security deposits and environmental monitoring requirements.

In line with the *NSW Gas Plan* (NSW Government 2014), in July 2015 the NSW Environment Protection Authority became the lead regulator for compliance with and enforcement of conditions of approval for gas activities in NSW, including consent conditions and activity approvals issued by other agencies.

The NSW Government continues to develop the regulatory system for natural gas in line with those recommendations and other measures and has introduced stringent policies and codes of practice to guide the development of the natural industry into the future. An overview may be viewed at: http://www.resourcesandenergy.nsw.gov.au/landholders-and-community/coal-seam-gas/codes-and-policies.

In addition to the regulatory system in NSW, the project is regulated under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* including an expert technical review by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development.

Water licensing

Submissions stated that the groundwater extraction for the project would be close to 16 per cent of the current licenced extraction from the Gunnedah-Oxley groundwater source. They stated the project would require a licence under the *Water Management Act 2000*. Some submissions also referred to planned amendments water sharing plans under the *Water Management Act 2000*.

All water extraction for the project will be under a Water Access Licence issued by DPI Water for the water source in accordance with the *Water Management Act 2000*, as is the case for other water users in NSW, including irrigators and industrial users. For the Gunnedah Oxley Basin MDB Groundwater Source that the project will extract from, the long term annual extraction limit is around 206 gigalitres per year. This is the amount of water that the NSW Government makes available for extraction by users under the water sharing plan licensing system. This is about half of the average volume that is recharged into this groundwater source each year through rainfall. The other half of the volume is not available for extraction and is maintained in the system for environmental purposes.

The average volume of water extracted by the project of 1.5 gigalitres per year. This equates to around 0.7 per cent of long term annual extraction limit from the Gunnedah Oxley Basin MDB Groundwater Source.

Minimal harm provisions

Submissions cited Section 63 of the *Water Management Act 2000* requiring adequate arrangements to ensure no more than minimal harm to water sources.

They stated that the project would cause a reduction in aquifer pressure and cause stock and domestic bores to fail. They stated that the project should not be approved on this basis and would be subject to challenge under the *Water Management Act 2000*.

The submissions' assertion about groundwater impacts as a result of the project are incorrect.

The Groundwater Impact Assessment found that the project would generate a maximum drawdown of less than 0.5 metres occurring gradually over 200 years in the Namoi alluvium and Pilliga sandstone. Impacts were expected to be indiscernible from existing variations in groundwater that occur from existing extraction, replenishment from the environment and seasonal fluctuations.

All water extracted for the project will be under a Water Access Licence issued by DPI Water for the water source in accordance with the Water Management Act 2000, as is the case for other water users in NSW, including irrigators and industrial users. For the Gunnedah Oxley Basin MDB Groundwater Source that the project will extract from, the long term annual extraction limit is around 206 gigalitres per year. This is the amount of water that the NSW Government makes available for extraction by users under the water sharing plan licensing system. This is about half of the average volume that is recharged into this groundwater source each year through rainfall. The other half of the volume is not available for extraction and is maintained in the system for environmental purposes. The average volume of water extracted by the project of 1.5 gigalitres per year. This equates to around 0.7 per cent of long term annual extraction limit from the Gunnedah Oxley Basin MDB Groundwater Source.

The Groundwater Impact Assessment included an assessment against the NSW *Aquifer Interference Policy* under the *Water Management Act 2000* and significant impact guidelines for the water trigger under the *Environment Protection and Biodiversity Conservation Act 1999*. The assessment concluded that the residual risk to groundwater was low and complied with the policy and guidelines.

Environmental record of proponent

Submissions referred to a report from the NSW Environment Protection Authority under freedom of information laws. The submissions stated that the report indicated the proponent did not have adequate safety procedures, maintenance and monitoring in place. Submissions also stated that the proponent had been prosecuted for not reporting environmental events.

The environmental record of the proponent was discussed in Section 5.4 of Chapter 5 of the EIS (Commonwealth requirements) as required under the Secretary's environmental assessment requirements for the project.

Rural Fires Act 1997

Submissions stated that the project and the broader industry should be subject to the provisions of the *Rural Fires Act 1997* including restriction of flaring in high fire danger conditions.

The project is State Significant Development and is exempt under section 4.41 and 4.14(1B) of the *Environmental Planning and Assessment Act 1979* from requiring a Bush Fire Safety Authority under the *NSW Rural Fires Act 1997*. Although a Bush Fire Safety Authority is not required, *Planning for Bushfire Protection 2006* is being used to guide bushfire protection measures.

Other parts of the *Rural Fires Act 1997* apply in the same manner as to other private land owners and managers e.g. Section 63(2) "It is the duty of the owner or occupier of land to take the notified steps (if any) and any other practicable steps to prevent the occurrence of bush fires on, and to minimise the danger of the spread of a bush fire on or from, that land”. This obligation will be met by the actions discussed in Chapter 25 (Hazard and Risk) and Section 6.25 of this RTS report.

The assessment committed the proponent to prepare a Bushfire Management Plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire Management Plan currently in place for the exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project’s activities. As stated in Chapter 6 (Project description) of the EIS, safety flares at Leewood and Bibblewindi would be surrounded by a vegetation free zone of up to 130 metres radius, and pilot flares would be surrounded by a vegetation free zone of up to 40 metres radius. The maximum radiant heat flux at the nearest vegetation would be 6.31 kW/m^2 at both ground level and at the tree canopy under a catastrophic bushfire danger level (FFDI 120). As such, the radiant heat flux would be less than 10k/Wm^2 in accordance with the NSW Rural Fire Service submission.

6.4.3 Gas export pipeline

Assessment of gas export pipeline

Submissions stated the assessment of the project should have included the gas export pipeline. They stated the assessment was incomplete as it excluded transport of product gas to market.

Submissions also stated that the pipeline would have potential impacts on agricultural land and that there was significant opposition to the pipeline on these and other grounds. Another submission also stated that alternative gas pipelines should be considered than what was discussed in the EIS.

As stated in Chapter 1 of the EIS (Introduction), product gas would be made available to the NSW market via a high-pressure gas transmission pipeline that would connect to the existing Moomba to Sydney gas pipeline.

The Western Slopes Pipeline is proposed by the APA Group to connect the project to the existing Moomba to Sydney Gas Pipeline. The Western Slopes Pipeline would be a buried, steel gas transmission pipeline running 450 kilometres in a south west direction from the Narrabri Gas Project to its connection with the Moomba to Sydney gas pipeline. The APA Group is a specialist gas pipeline company and is considered a suitable proponent for the purpose of pipeline planning and assessment.

The Western Slopes Pipeline is currently being assessed under the *Environmental Planning and Assessment Act 1979*. The key environmental issues of the pipeline were identified in the Preliminary Environmental Assessment prepared by APA Group and included potential impacts on biodiversity and ongoing land use including agriculture, as well as potential soil, water, heritage and hazard and risk issues. The Secretary’s environmental assessment requirements for the pipeline require a detailed assessment of potential impacts on land use and soil as well as feasible alternatives.

The public exhibition and submission period for the environmental impact assessment of the pipeline will allow for submissions regarding potential impacts to these matters.

For more information on the Western Slopes Pipeline refer to:
http://www.majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=8272

The Western Slopes Pipeline Preliminary Environmental Assessment can be accessed at:

https://majorprojects.accelo.com/public/95ba8b7700e6626f48cefb1e424c996c/Western%20Slopes%20Pipeline%20-%20Preliminary%20Environmental%20Assessment.pdf

6.5 Commonwealth requirements

The Commonwealth requirements relevant to the project were discussed in Chapter 5 of the EIS. The project was referred to the Minister administering the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The project was subsequently determined to be a controlled action due to potential impacts to matters of national environmental significance under the EPBC Act including water resources in relation to coal seam gas development, threatened species and ecological communities and Commonwealth land – namely Siding Spring Observatory.

Potential impacts on those matters of national environmental significance were assessed in detail in the EIS including the Groundwater Impact Assessment, Ecological Impact Assessment and Visual Impact Assessment in EIS Appendices F, J1 and Q respectively .The findings of those assessments were summarised in Chapter 11 (Groundwater and geology), Chapter 15 and 16 (Terrestrial and Aquatic ecology), and Chapter 23 (Landscape and visual impact) of the EIS respectively. Those findings were also summarised at a high level in Chapter 5 (Commonwealth requirements).

Further assessment on these matters was undertaken between the publication of the EIS and this RTS report as discussed in Section 2.3 of this RTS report. The assessments concluded that the project would be unlikely to have a significant impact on a matters of national environmental significance.

10 submissions raised issues specifically relating to Commonwealth requirements as described in Chapter 5 of the EIS. Of those, one was a form submission, with the remaining nine being unique submissions. Many related to comments regarding the project and The Australian Constitution while some others regarded the depth of consideration of Commonwealth matters.

Figure 6-5 provides an overview of the submissions for Commonwealth requirements.

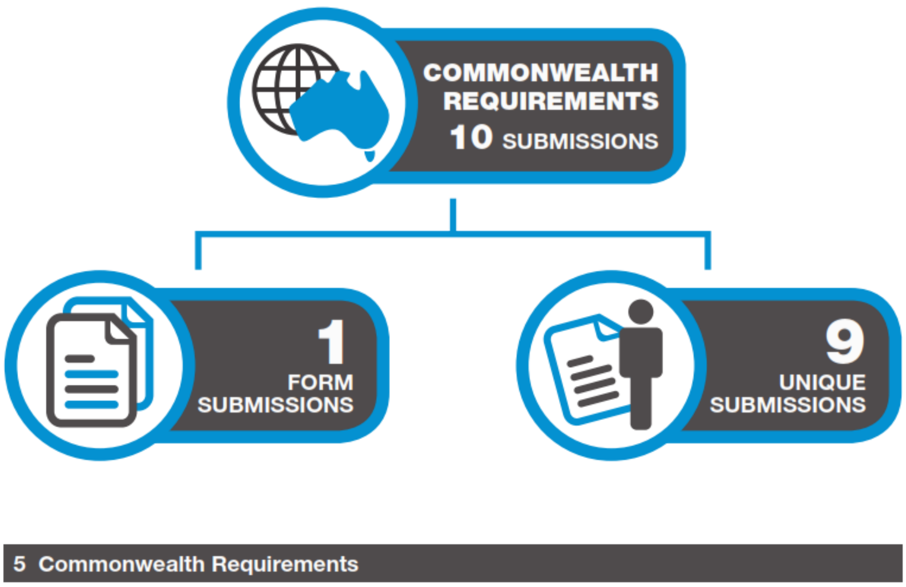


Figure 6-5 Summary of submissions on Commonwealth requirements

Commonwealth matters

Submissions stated the EIS did not provided adequate consideration of matters of national environmental significance including threatened ecological communities. They also stated that the proposal to offset the potential environmental impacts of the project was not in accordance with the Commonwealth offsets policy under the *Environment Protection and Biodiversity Conservation Act 1999*.

As discussed in Chapter 5 of the EIS (Commonwealth requirements), the project was deemed a controlled action with the controlling provisions being threatened species and ecological communities, water resources and Commonwealth land with reference to Siding Spring Observatory. Potential impacts on these matters were assessed in the EIS in accordance with the Secretary's environmental assessment requirements for the project, the relevant Commonwealth significant impact guidelines (DoTE 2013a, 2013b, 2013c) and the information requirements of the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC 2015).

The relevant assessments include the Ecological Impact Assessment in Appendix J1 of the EIS, Biodiversity Assessment Report (Appendix J2) and Groundwater Impact Assessment in Appendix F of the EIS. These assessments concluded that the project would not be likely to have a significant impact on threatened species and ecological communities or a water resource. Submissions with regard to potential impacts on these matters are discussed further in Sections 6.11, 6.15 and 6.16.

The Biodiversity Offset Strategy has been prepared to ensure that the residual impacts of the project are adequately compensated for and that long-term conservation outcomes are achieved in recognition of the NSW *Offsetting Principles* and the NSW *Biodiversity Offset Policy for Major Projects*. The *EPBC Act Offset Policy* requires 'offset measures to be considered for residual impacts that cannot be mitigated to ensure the protection of Matters of National Environmental Significance (MNES) in perpetuity'. The Biodiversity Offset Strategy has been prepared to generally be consistent with the EPBC Act *Offset Guide*. As the NSW *Biodiversity Offset Policy for Major Projects* was developed as a whole-of-government policy and includes MNES, offsets determined under the NSW *Biodiversity Offset Policy for Major Projects* are considered to satisfy EPBC offset requirements.

The potential for impacts at Siding Spring Observatory were discussed in Appendix Q of the EIS and have been assessed further in the Gas Flare Light Assessment provided as Appendix K of this RTS. The assessment found that vertical extent of skyglow from safety flares and up to six pilot flares would be limited to less than one degree above the horizon for routine flaring operations and 2.5 degrees for non-routine flaring operations on a clear night or up to 7.4 degrees in cloudy conditions. For context, the frequency and extent of light from a non-routine flaring event occurring is significantly less than the frequency of a quarter moon rising over the northeast horizon on a clear night, which would produce significantly greater skyglow.

Lighting at Leewood, Bibblewindi, Westport workers' accommodation and well pads would comply with Australian standard *AS/NZS 4282 – 1997 Control of the obtrusive effects of outdoor lighting* in order to limit light spill through implementation of appropriate directional lights and shading devices. The findings indicated that the project would comply with the *Dark Sky Planning Guidelines* (Department of Planning and Environment 2016) for protecting the observing conditions.

Based on the findings of the assessment, nature of the project and the significant distance to Siding Spring Observatory, direct, indirect, cumulative, facilitated or residual impacts on the environment of Commonwealth land on which the Siding Spring Observatory is situated were not predicted. Given this, no secondary social or cultural impacts on people and communities who work, visit or otherwise benefit from Siding Spring Observatory were predicted to occur.

In relation to other Commonwealth land in the vicinity of the project area, the Australia Telescope Compact Array (ATCA) at the Paul Wild Observatory is an array of six, 22 metre antennas used for radio astronomy. The facility is located approximately 3 kms north of the northern boundary of the project area, about 25 kms west of Narrabri; operated by CSIRO. Project activities are not expected to impact the Paul Wild Observatory's operations or upon the Commonwealth land on which it is located.

Radio telescope facilities like Paul Wild Observatory employ long baseline interferometry to record signals at frequencies typically in the range of 8 – 88 GHz.

As discussed in the project description in Chapter 6 of the EIS, the project would involve the establishment of a number of telecommunication towers across the project area. Based on current standards, the telecommunication towers would employ 2G to 4G LTE cellular systems and legacy VHF systems. Operating frequencies of these systems are typically in the range of about 700 MHz to 2.6 GHz for cellular systems and 148 – 174 MHz for VHF systems; much lower than the radio-astronomy frequencies.

Light emitted from the project would be in the range of 430 – 770 THz; that is, considerably higher frequencies that those being monitored by the Observatory.

As such, the proposed telecommunications and lighting for the project would occupy greatly different frequencies to those signals recorded by radio telescopes and would not be a source of interference with the Observatory's operations or land on which it is located.

Independent expert scientific committee

Several submissions stated that the Groundwater Impact Assessment did not adequately meet the checklist requirements published by the Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development in relation to the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) guidelines, in particular in relation to the "water trigger".

Submissions stated that the assessment should have been referred to the Independent Expert Scientific Committee under the *Environment Protection and Biodiversity Conservation Act 1999*.

They stated that the project should be refused as it would have a significant impact on a water resource as defined under the EPBC Act with respect to the *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources* (DoTE 2013c).

The proponent disagrees with the assertion in the submission that the Groundwater Impact Assessment (EIS Appendix F) did not adequately meet the checklist requirements of the Independent Expert Scientific Committee (IESC). The Groundwater Impact Assessment was undertaken in accordance with the information requirements of the IESC. A checklist cross referencing the content of the Groundwater Impact Assessment and the IESC information requirements was provided as Appendix E to the Groundwater Impact Assessment.

The project was referred to the IESC by the Commonwealth Department of the Environment and Energy and the New South Wales Department of Planning and Environment in June 2017. The IESC reviewed the project documentation including the EIS and provided advice on the project to the Minister in August 2017, which it is available on the IESC's website (IESC 2017). Refer to: http://www.iesc.environment.gov.au/committee-advice/proposals/narrabri-gas-project-advice-2017-086

Responses to the IESC's project advice are contained in Chapter 5.1, above.

The EIS has been prepared taking into consideration *Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments - Impacts on Water Resources* (DoTE 2013c), and specifically, the EPBC Act water trigger. A summary of predicted impacts of the project on water resources, relative to the significant impacts guidelines, is presented in the Groundwater Impact

Assessment (EIS Appendix F), including Section 6.13 "Implications in Relation to the Water Trigger of the EPBC Act" and Section 8.6 "Significant Impact Guidelines of the EPBC Act.

Constitutionality

Submissions stated the project was challengeable under Section 100 or Section 109 of the Australian Constitution. Section 100 states the Commonwealth cannot abridge the right of a State of its residents to reasonable use of water of rivers for conservation or irrigation. Section 109 states that Commonwealth law prevails of State law to the extent of an inconsistency.

The Constitutional matters referred to in submissions relate to the sharing of legislative powers between the Commonwealth and the States and are not relevant to the assessment of the project.

The project was assessed in accordance with the Secretary's environmental assessment requirements and was found not to have a significant impact on water resources. Extraction of groundwater would be in accordance with the water licensing provisions of the NSW *Water Management Act 2000*.

6.6 Project description

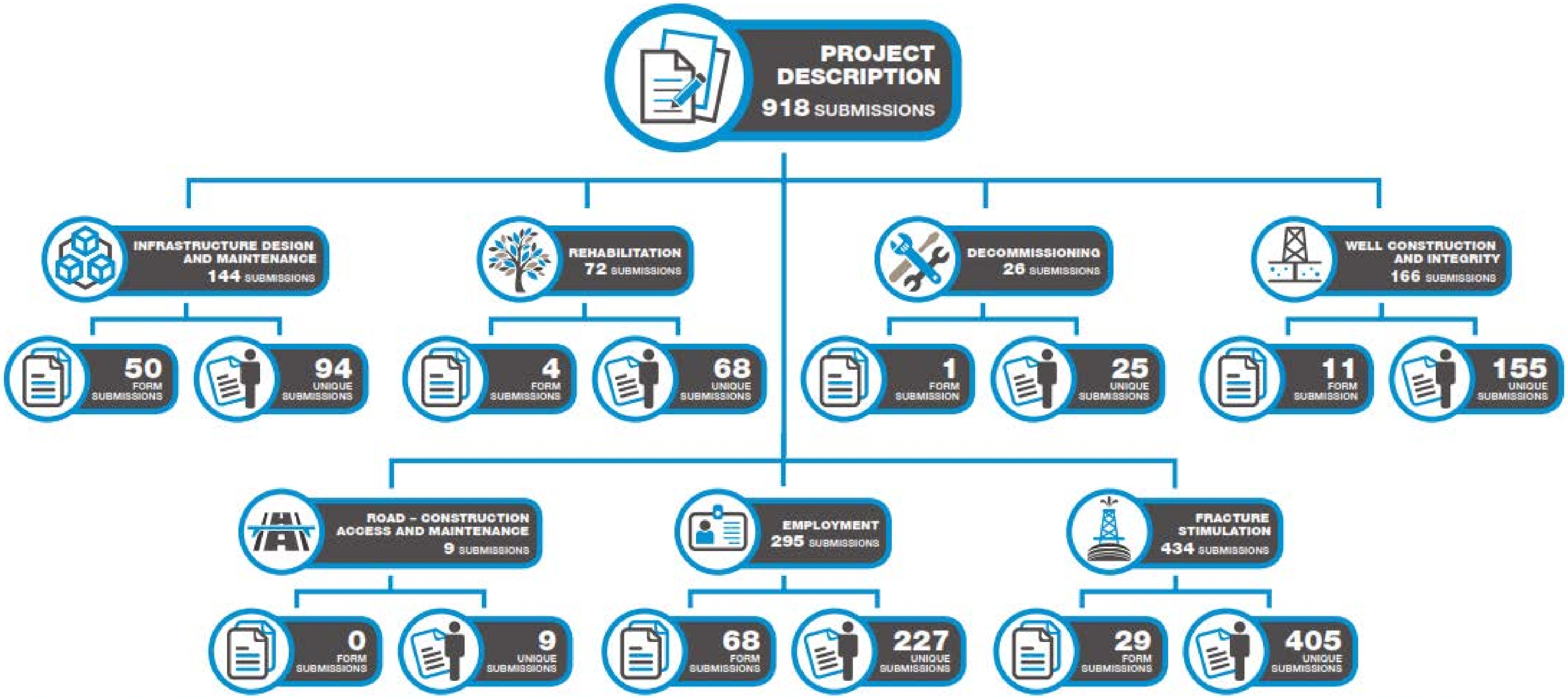
The project would involve the construction and operation of up to 850 new exploration, appraisal and production wells located on up to 425 well pads as well as the construction and operation of major gas processing and water treatment facilities. The project has the potential to produce up to 200 terajoules per day of product gas. The project is described further in Section 4 of this document.

918 submissions raised issues relating to the project description as provided in Chapter 6 of the EIS. 434 of those concerned the use of fracture stimulation, which is not proposed as part of the project.

295 submissions raised issued relating to the estimate of employment generated by the project. 166 submissions concerned well construction and integrity while 144 submissions raised other issues relating to infrastructure design and maintenance. Fewer submissions raised issues relating to rehabilitation (72 submissions) and decommissioning (26 submissions).

The division of submissions by issue and submission type is depicted in Figure 6-6.

A number of submissions raised issues more specific to the layout of the project as regarding the environmental assessment or approval under the *Environmental Planning and Assessment Act 1979*. These issues are discussed in Section 6.4.



6 Project Description

Figure 6-6 Summary of submissions on project description

6.6.1 Infrastructure design and maintenance

Clarification of number of flares

Submissions sought clarification of the number of flares proposed for the project.

They stated that the EIS contained contradictory information about the number of flares. They stated that Chapter 5 referred to six flares but Chapter 24 referred to up to 25 flares.

Some submissions stated that the total number of pilot flares proposed was unrealistic and disproportionately low to the number of wells that would be constructed and operated.

Chapter 6 of the EIS (Project description) describes the infrastructure for which approval is being sought. It states that the proponent is seeking approval for up to 25 new pilot wells, spaced at least 250 m apart. The pilot wells are typically, although not always, in sets comprising up to six wells.

In some circumstances, generally depending on the physical location of a pilot well relative to gas compression and treatment equipment, pilot wells can be directly connected into the production well's gas (and water) gathering lines. This may negate the need to have a pilot flare at a pilot well set.

Generally, each set of six wells would host a pilot flare. Therefore, approval for up to six pilot well flares is being sought.

In addition, two safety flares are proposed, one at Leewood and one at Bibblewindi. The proposed safety flare at Bibblewindi would replace the existing pilot flare.

Clarification of frequency of flaring

Submissions disputed the statement in the EIS that safety flaring would be rare. They stated that safety flaring could be occurring whenever the market is not drawing gas from the project.

The Leewood and Bibblewindi safety flares proposed in Chapter 6 of the EIS (Project description) are required to safely manage gas during commissioning and maintenance activities, or in non-routine situations (expected to occur infrequently).

The safety flares are required to operate with a pilot flame of average height of 1.5 m continuously for the safe management of gas. They may be required to operate at a higher flow rate during commissioning and maintenance activities or in non-routine situations (expected to occur infrequently).

During commissioning of the facilities and infrastructure, gas may be required to be flared to ensure safe management. The required timing and duration of these activities will be determined during detailed design and installation, although the volume of gas to be flared is likely to be minimised for commercial reasons.

Routine facility maintenance requiring the use of the flare beyond its standard operation is expected to occur relatively infrequently. For example, in similar operations, scheduled maintenance for critical function tests and vessel inspection activities that require a total planned outage requiring the use of the flares, are scheduled to occur once every two years. The duration of these activities is generally up to seven days, however depending on well operating scenarios, well production may be able to be reduced significantly during the shutdown, minimising the volume of gas that is required to be flared.

Non-routine flaring operations are required to safely manage gas in the event of an occurrence where gas is required to be flared rather than processed. In such an instance the safety flares at Bibblewindi and / or Leewood would be required to be used. The flaring of the maximum gas throughput (200 TJ) would produce a flame height of up to 30 m flame in calm conditions. By its nature, it is difficult to predict the timing of these required uses of the safety flares. Similar to planned maintenance activities that require the use of the flares, well production may be able to be reduced to minimise the volume of gas to be flared.

Clarification of number of gas compression units

Submissions queried whether more than two gas compression units would be eventually installed in the project area.

Chapter 6 of the EIS (Project description) details gas compression for the project. The project seeks approval to construct in-field gas compression at the Bibblewindi site, and a central gas processing facility at Leewood; the latter including gas compression.

The Bibblewindi in-field compression facility is required to boost gas pressure to enable it to be transported via a buried gas pipeline to the Leewood central gas processing facility. Gas from the field would flow through an inlet separator into the compression unit. There would be up to 20 compressors (refer to Figure 6-12 of Chapter 6 for an indicative layout), which would be installed on concrete pads. The installation of the 20 compressors would be staged to meet demand from the evolving field development.

The central gas processing facility has been strategically located at the Leewood site to minimise impacts to vegetation and fauna habitats. The central gas processing facility would treat gas through additional compression, carbon dioxide removal and dehydration. A schematic of the various stages of gas processing is shown in Figure 6-6 of Chapter 6 with a more detailed layout shown in Figure 6-7 of Chapter 6.

Up to five of the 20 compressors from the Bibblewindi in-field gas compression may be relocated to Leewood during the project, commensurate with demand.

Clarification of number of wells

Submissions noted that the EIS stated that 850 wells in total would be established. They queried whether the total represented productive wells or also included failed wells.

The project seeks approval for the establishment of up to 850 new production wells – regardless of their productivity – on a maximum of 425 well pads. The project also seeks to convert, as required, existing or approved exploration and appraisal wells in the project area into production wells.

Clarification of number of water storage ponds

Submission stated that the number of water storage ponds was not clear in the EIS. They stated that two additional produced water ponds at Leewood were not discussed but shown in a figure.

In addition to the two existing ponds at Leewood (each containing two cells), an additional 300 megalitre double-lined produced water and brine pond comprised of two cells would be established at Leewood. The pond would meet the standards set out in *Exploration Code of Practice: Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015). Table 6-2 of EIS Chapter 6 (Project description) provided information on the proposed water management infrastructure at Leewood including both the existing and new ponds. Figure 6-5 in EIS Chapter 6 showed footprints of existing and proposed produced water and brine ponds at Leewood.

As set out in Section 6.2.2 of EIS Chapter 6, the larger existing pond at Bibblewindi (Pond 3) would be upgraded to meet the standards set out in *Exploration Code of Practice: Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015).

Potential for leaks

Submissions stated that project infrastructure including wells, pipelines and ponds have potential to leak.

The potential for the project to cause spills or leaks was assessed in Chapter 14 (Soils and land contamination) and Chapter 25 (Hazard and risk) of the EIS. The assessments found that the likelihood of the project causing a spills was low.

The project would be designed in accordance with the relevant codes of practice to minimise the risk of spills or leaks occurring. These would include:

- *Code of Practice for Coal Seam Gas – Well Integrity*
- *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*
- *Exploration Code of Practice: Produced Water Management, Storage and Transfer.*

As discussed in Chapter 6 of the EIS (Project description), and in accordance with the codes of practice, produced water ponds would be designed to incorporate double lining, leak detection and seepage collection. In addition to this, the NSW Dam Safety Committee would review and confirm the dam design.

The project would also incorporate a range of monitoring systems that would enable quick detection and rectification in the unlikely event of a leak or spill, including continuous pressure monitoring of produced water gathering lines, and leak detection and monitoring bores for produced water ponds. Further, exploration, appraisal and production gas wells would be remotely monitored and controlled and would automatically shut down in the event of non-routine operational conditions.

Chemicals will be stored and handled in accordance with the relevant Australian Standards, including *AS 1940-2004 The storage and handling of flammable and combustible liquids.* Refuelling would occur with suitable containment for volumes greater than 50 litres and not within 40 metres of a watercourse. Bunding, drip trays and other preventative measures would be implemented as necessary and spill kits would be situated as appropriate in areas where there is potential for spills to occur. Regular inspection of plant, equipment and infrastructure would be carried out in accordance with operational procedures.

The proponent will be responsible to develop a Pollution Incident Response Management Plan in accordance with *Protection of the Environment Operations Act 1997.* A response plan is currently in place for exploration and appraisal activities in accordance with these requirements.

In summary, a significant number of design, construction and operational measures are proposed or already in place that mean there is a low risk of spills or leaks. As demonstration of this, the proponent has conducted exploration and appraisal activities in the project area, including operation of the water treatment plant at Leewood, without a reportable incident in over 4.5 years.

Clarification of power supply option

Submissions stated that the assessment should have provided more certainty about the power supply option that would be selected for the project.

Power for the project would be supplied by an optional power generation facility to be installed at the Leewood property, from the grid and/or the Wilga Park Power Station. To facilitate power being sourced from the grid and/or the Wilga Park Power Station, a power line would be installed within the existing Leewood to Wilga Park Power Station infrastructure corridor. Gas for the power generation facility at Leewood and the Wilga Park Power Station would be sourced from the project gas field and gas transfer to Wilga Park Power station would utilise the existing gas flow line, riser and gathering system as described in Section 2.4 and Table 2-1 of the EIS. Both power supply options for the project were assessed in line with the *Environmental Planning and Assessment Act 1979*.

6.6.2 Rehabilitation

Objection to the Rehabilitation Strategy

Submissions raised a number of issue objecting to the proposed Rehabilitation Strategy, including:

- It being aimed at defined environmental outcomes.
- The use of reference sites.
- It being aimed at restoration of wilderness and old growth values of Willala Wilderness Area over the long term.
- That it should start in more disturbed, less sensitive areas and progress to less disturbed, more sensitive areas to gain the benefit of trial and error.
- Existing rehabilitation was not successful.

The Rehabilitation Strategy for the project was presented in Appendix V of the EIS. As stated in the assessment, a Rehabilitation Plan containing detailed rehabilitation measures would be prepared post-approval consistent with the Rehabilitation Strategy and relevant approval conditions.

Rehabilitation material would comprise topsoil and cleared / mulched vegetation generated during construction. The cleared and mulched material may be used to improve soil organic matter.

Seeds and seedlings would be preferentially collected from the project area in consultation with an appropriate seed collection authority or experienced botanist to identify appropriate species.

As topsoil to be used in rehabilitation would be stripped and stockpiled during construction it is not expected to be subject to compaction. As stated in the Rehabilitation Strategy, ripping would be undertaken as necessary encourage revegetation and successful rehabilitation.

Perimeter fencing would be considered on a case by case basis depending on the risk of grazing animals entering rehabilitation areas, including linear rehabilitation areas.

Partial rehabilitation areas would be vegetated with shrubs and grasses. Following decommissioning of well pads, areas of partial rehabilitation would be fully rehabilitated.

Planning for closure and rehabilitation will commence at least two years ahead of decommissioning of wells and other infrastructure. Both the project and preparation for rehabilitation would occur progressively and not only during the two-year period in advance of first rehabilitation.

As stated in the Rehabilitation Strategy, rehabilitated areas would be monitored and assessed against completion criteria with regard to reference sites. Reference sites would be selected to be representative of the same plant community type in the vicinity of the rehabilitation area.

As discussed in Section 6.2 of the Rehabilitation Strategy in Appendix V of the EIS, a series of quantifiable data would be collected and would serve as completion criteria. The data would include vegetation structure and condition and presence of habitat features such as hollow bearing trees.

As shown in Table 11 of the Rehabilitation Strategy, monitoring of rehabilitation sites would occur over multiple years to ensure rehabilitation success. A two year natural regeneration period would occur following initial rehabilitation. Rehabilitation intervention would occur during that period in the event of a bushfire or if after the two year natural regeneration period there is little evidence of germination. If seasonal conditions during the two year natural regeneration period are poor, such as drought, an additional twelve months may be allowed for natural regeneration before rehabilitation intervention.

Rehabilitation undertaken to date shows similar numbers of native species to reference sites, a dense shrub layer, relatively low weed cover and regeneration of overstory species through coppice regrowth. It is expected that as midstory and canopy species continue to grow, with continued weed monitoring and management, rehabilitated areas will attain similar composition and structure to adjacent remnant woodland, and are on a trajectory to attaining (preliminary) completion criteria.

As stated in Appendix V of the Rehabilitation Strategy, Forestry Corporation NSW will be consulted to provide advice on rehabilitation techniques and management in State forest to encourage restoration of vegetation communities compatible with Forestry Corporation NSW land use objectives.

Rehabilitation seed bank

Submissions stated that the topsoil seed bank would germinate during stockpiling and would therefore limit the topsoil seed bank available for rehabilitation.

It has not been the experience of the proponent in the project area to date that stockpile seedbanks have germinated. Rather, the experience has been that stockpiled topsoil including seedbanks have been successfully used in rehabilitation within the project area.

Cost of rehabilitation

Submissions stated the proponent will not be able to effectively rehabilitate disturbed areas due to financial risk including the investment risk of the project.

The cost-benefit assessment for the EIS (Appendix U1) included consideration of rehabilitation costs and returned a benefit cost ratio of between 1.39 and 1.43, depending on which power source was utilised.

Independent rehabilitation panel

Submissions stated that an independent panel should oversee rehabilitation.

The project's Environmental Management Strategy includes a number of management plans to demonstrate compliance with the relevant statutory criteria and approval conditions. The plans would include monitoring requirements for matters including rehabilitation.

Within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.
- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.
- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

6.6.3 Decommissioning

Decommissioned infrastructure

Submissions stated that the assessment did not consider the failure of project infrastructure after decommissioning. Submissions stated that materials such as pipes or well casings would eventually decay and fail and stated that saline environments may accelerate this decay.

They stated that effects of failure of infrastructure over the long term had been seen in Condamine River.

Submissions stated that adherence to the *Code of Practice for Coal Seam Gas Well Integrity* would not guarantee the long-term performance of decommissioned wells.

Submissions questioned how the proponent will manage this risk and stated that the proponent should have a long-term management strategy for decommissioned wells.

Submissions stated that the natural gas industry had demonstrated it would not remove fences, tanks, dams, access roads, accommodation and other infrastructure.

Decommissioning and Rehabilitation Strategies have been developed for the project (refer to Appendices W and V respectively), that aim to:

- undertake decommissioning of assets and rehabilitation in a manner that complies with legislative requirements and approval conditions
- undertake decommissioning activities and rehabilitation in a manner that meets stakeholder expectations
- leave a landform that is safe, stable and non-polluting and compatible with the intended post closure land use to enable effective transfer to third parties
- provide for the retention and beneficial reuse of project infrastructure to third parties (i.e. landholders and local authorities), where there is an appropriate agreement in place and regulatory authorities are satisfied.

Specifically, the proponent has committed to undertaking infrastructure decommissioning and rehabilitation in line with leading practice policy and guidelines including but not limited to:

- *The NSW Code of Practice for Coal Seam Gas – Well Integrity* (NSW Trade and Investment 2012).
- *The Australian Pipelines and Gas Association (APGA) Code of Practice for Upstream Polyethylene Gathering Networks - CSG Industry*.
- Australian Pipeline Industry Association (APIA) *(2013). Code of Environmental Practice for Onshore Pipelines.*
- NSW Department of Industry, Skills and Regional Development (2015*). Exploration Code of Practice: Produced Water Management, Storage and Transfe*r.
- NSW Department of Industry, Skills and Regional Development (2015a). *Exploration Code of Practice: Rehabilitation.*

The NSW Government's *NSW Code of Practice for Coal Seam Gas – Well Integrity* (NSW Trade and Investment 2012) outlines methods to decommission wells such that 'risks to the environment (surface water and groundwater, air, vegetation, fauna) are identified, eliminated where possible, or minimised through appropriate management practices'. It states 'CSG well abandonment must ensure the environmentally sound and safe isolation of the well, protection of groundwater resources, isolation of the productive formations from other formations, and the proper removal of surface equipment. Titleholders are responsible for the well until the Department is satisfied that the titleholder can demonstrate that the well is safe and non-polluting.'

The proponent has committed to meeting the Government's requirements in this regard. The fact that the Department will not sign off on decommissioned wells until it is satisfied that wells are safe and non-polluting provides further assurance.

With reference to the Condamine River, GISERA has conducted extensive studies of the Condamine River in recent years and a summary of the results of these studies can be found on a fact sheet at: https://gisera.csiro.au/news/methane-seeps-in-the-condamine-river-fact-sheet/

A Decommissioning Management Plan would be established for the decommissioning of gas wells that would be decommissioned in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (NSW Trade and Investment 2012). The Plan would be developed in consultation with key stakeholders such that key infrastructure valued by those stakeholders may be ultimately gifted to the landholders, with other infrastructure being decommissioned in line with regulatory requirements, including approval conditions.

6.6.4 Well construction and integrity

Well integrity

Submissions stated that well integrity should be managed and monitored throughout the life of the project including drilling, operation and decommissioning.

Submissions statistics on the failure of well casings that ranged between 1 in 50 and 1 in 16 wells or between 1.9 and 75 per cent of wells. They also stated that lateral junctions also known as 'kick off points' were a particular risk of failure as they were more difficult to seal.

Submissions stated that measures to manage well integrity were not detailed in the EIS. They provided the example of monitoring casing pressure.

Gas wells (and gathering lines) would be constructed, operated and decommissioned in accordance with the relevant codes of practice administered by the NSW Government. The purpose of the codes of practice is to the environmentally sound gas production.

As stated in Chapter 6 (Project description) of the EIS, Gas wells would be constructed in accordance with the *Code of Practice for Coal Seam Gas – Well Integrity* (NSW Trade and Investment 2012). Gas gathering lines would be constructed in accordance with the *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*.

During operation, gas wells would be fitted with remote telemetry that monitors operating parameters and well pressure at the well head and gas and water separator. Produced water gathering lines would also be subject to continuous pressure monitoring

Within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.
- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.
- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

6.6.5 Roads – construction access and maintenance

Length of roads

Submissions stated the project would double the length of existing roads in the project area in order to access previously undisturbed areas.

The project area has around 1,000 kilometres of existing roads, tracks and trails. As stated in the EIS, linear infrastructure will be aligned with existing roads and tracks wherever possible.

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and other human activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of wildfire.

The proponent has designed access to that part of the field that would be located within the Pilliga with a priority on minimising vegetation disturbance. Clearing for new access tracks has been included in the upper vegetation disturbance limits and has been assessed in the EIS.

To minimise disturbance, access to well pads would be via existing roads and access tracks where practicable. Where this is not the case, new tracks would be constructed. New access tracks would generally be co-located in the same corridor as required gas and water gathering lines. The corridor would be on average 10 metres wide, up to a maximum of 12 metres.

The corridor would be reduced to a five metre access track for the operational phase following partial rehabilitation, slightly wider on intersections and bends as required for safety.

6.6.6 Employment

Accuracy of employment estimate

Submissions stated that the assessment overestimated project employment. They also cited a prior report for the project that had estimated fewer jobs for a larger development. They also stated that estimated employment did not account for reduced or diverted employment in industries such as agriculture, hospitality and tourism.

Some cited work by the Gas Industry Social and Environment Research Alliance in stating 1.3 agricultural jobs were lost for each job created in the gas industry in Queensland.

Some submissions also stated that the existing number of local jobs was overstated and that the proponent currently employed 22 people rather than 50 people.

Economic modelling was undertaken to meet the Secretary’s environmental assessment requirements to estimate employment for the EIS, using relevant NSW guidelines being the *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Department of Planning and Environment 2015).

Two EIS appendices were included in the EIS; Appendix U1 (Economic Assessment) and Appendix U2 (Economic Impact Report), that assessed the cost benefit of the project and the macroeconomic impacts of the project respectively. Appendix U2 included an assessment of employment, income and gross regional and state product benefits likely to accrue as a result of proceeding with the project.

Appendix U2 (and Chapter 27 – Economics) reported that:

'Over the life of the project it is projected that an average of 540 full time equivalent direct and indirect jobs will be created in New South Wales. More specifically, over the period 2017 to 2042 it is projected that the project will increase employment (by place of residence) in:

- the Narrabri region by an average of 127 full-time equivalent (FTE) jobs
- the Narrabri surrounds region by an average of 161 FTE jobs
- New South Wales as a whole by an average of 512 FTE.'

The method used for modelling employment estimations is explained in Section 3 of Appendix U2 of the EIS. Input assumptions used in the modelling, including estimates of employment numbers; were based on real data scaled from other projects the proponent has in operation.

With regard to the previous report that had estimated fewer jobs for a larger project, specifically, *The Economic Impacts of Developing Coal Seam Gas Operations in Northwest NSW* (The Allen Consulting Group (ACG) 2011), Section 5 of Appendix U2 of the EIS discusses the differences. Of note amongst several differences between the assessments was that the ACG report considered a larger project area than the project EIS, in addition to the project EIS considering a peak production rate around 35 per cent that of the AGC modelling (74 PJ per annum as against 210 PJ per annum).

Further, the data available for project analysis had the benefit of three years of scope development by the proponent, thereby enabling the incorporation of additional data that was not available to ACG. For example, the peak employment specified in the ACG report was 1,800 jobs with an average construction spend of $614 million (although the corresponding peak construction spend is unknown). The data provided by the proponent for the project EIS showed peak construction labour at 1,300 with an average construction spend of just $261 million. This suggests that direct labour intensity has risen from an index of 3.0 to 5.0 peak jobs per million dollars, representing a 70 per cent increase in direct labour intensity. Additionally, the proponent provided a breakdown of construction spend at a level of detail not available for the ACG modelling. It is these factors that are likely to account for the variation in employment outcomes in the construction phase.

The previous analysis undertaken by ACG used the Monash Multi-Regional Forecasting Model (MMRF) model. In the MMRF model, as in Tasman Global model used in the project EIS, there is an existing representation of the gas industry. In the absence of additional project specific data, the existing MMRF gas industry was used to represent the project, which may explain the difference in production phase employment estimates. This is as the MMRF database is based on a representation of the Australian economy in the 2005-06 financial year, therefore the gas industry was based on the basic underlying technology of 2005-06. The modelling for the project EIS, being dynamic, has projected the economy forward to 2042, and this projection incorporates labour productivity growth, and, more importantly, the modelling in the EIS uses the latest proponent data which was unavailable to ACG.

In summary, the differences in employment results between the two analyses are likely due to the additional project data available for this analysis. By having detailed project specific data and by incorporating that data into the analysis though the "micro industry" approach, the project EIS has been able to incorporate the additional project detail that was unavailable for the previous analysis undertaken by ACG, thereby making the output a truer reflection of the likely scenario.

With regard to reduced or diverted employment in industries such as agriculture, hospitality and tourism, Appendix U2 of the EIS assessed the impacts from labour competition between local industries, noting that while the project will provide job opportunities for local and regional workers, the source of labour for the project is expected to be widely dispersed. The assessment noted that the peak levels of construction labour demand will be short lived: two to three years, with the much longer operations phase represented a relatively minor drain on the local labour supply. It went onto note that the job opportunities created by the proposed project will be highly skilled and well paid, but they are not of a magnitude, particularly in the long lasting operations phase, that will cause a significant drain on local businesses access to skilled labour. The modelled results showed that on both an employment and output level the impacts of the project are positive on most of the sectors shown. The negative impacts shown to agriculture and forestry, mining and manufacturing are small and are likely mainly due to the competition for labour and small increases in local costs (refer to Table 11 of Appendix U2 for additional information).

Section 6.27.2 of this RTS discusses spill over jobs and the redistribution of labour in coal seam gas regions. The findings were that overall, there was a positive impact on employment numbers.

At the time of writing the EIS, there were 50 project employees in the Narrabri area. It is acknowledged that since the time of writing the EIS this number has reduced.

Transparency of employment estimation

Submissions requested transparency of the employment estimation method and provide a list of position descriptions that would be generated by the project.

The method used for modelling employment estimations is explained in Section 3 of Appendix U2 of the EIS. Table 8 in Appendix U2 provides input assumptions used in the modelling, including estimates of employment numbers; themselves based on real data scaled from other projects the proponent has in operation.

A full list of position descriptions would be made available if the project was approved, at the appropriate hiring time, consistent with the project schedule. An overview of positions as reported in Appendix T1 of the EIS includes:

- technical and tradesmen skills
- trades assistant
- welders
- leading hand
- drivers
- machinery operators
- painters
- riggers
- concreters
- scaffolders
- carpenters
- steel fixers
- drillers
- construction/civil labour both skilled and unskilled
- clerical and administration staff
- management staff
- supervisory staff
- accounting staff
- engineers
- technicians / professionals in OHSE, environmental support, landholder support, etc.

Chapter 6 (Project description) of the EIS provides information regarding the location of project jobs through operations, with some 45 ongoing roles to be based at both Bibblewindi and Leewood, with the balance of local jobs being at the proponent's Narrabri shopfront or the Narrabri Operations Centre. Remaining jobs would be resident in the proponent's corporate offices in Sydney, Adelaide and Brisbane.

Source of workforce

Submissions stated that only a small proportion of the project workforce would be sourced locally due to the specialist nature of many of the roles. They stated that the commitment to employ local residents where possible was not sufficiently binding.

Appendix T1 of the EIS (Social Impact Assessment) provides an estimated breakdown of the labour sources for both peak and ongoing construction, and also for operation of the project.

Peak construction being around 1,300 workers, with around 1,050 workers sourced from:

- 10% (approximately 105 workers) from the regional study area within one hour of driving distance from project area (this will include LGAs like Narrabri, Gunnedah and Moree).
- 20% (approximately 210 workers) from the wider area of influence including the surrounding 14 LGAs.
- 65% (approximately 685 workers) from rest of the state of NSW.
- 5% (approximately 50 workers) from interstate.

The 250 drilling and completions workers that make up the balance of the 1,300 peak construction jobs have a specialised skill set, therefore, it is anticipated that these workers would all travel from outside the regional study area, most likely interstate.

The ongoing (beyond the first 3 to 4 years) construction workforce, comprising general construction workers and drilling and completions workers, would total around 145. Preference will be given to appropriately skilled workers residing in the regional study area within one hour of driving distance from project area (this will include LGAs like Narrabri and Gunnedah and Moree) and the wider area of influence including the surrounding 14 LGAs described in Appendices T1 and U2 of the EIS. In the absence of suitable regional workforce candidates, the proponent will seek workers from rest of NSW.

The general operations workforce, numbering around 200 full time equivalents, is estimated to be sourced as follows:

- 25% (approximately 50 workers) existing Narrabri operations team.
- 20% (approximately 40 workers) existing Narrabri residents or residents within one hours driving distance.
- 25% (approximately 50 workers) workers based in Sydney / Brisbane / Adelaide.
- 5% (approximately 10 workers) Fly-in-fly-out workers (FIFO).
- 25% (approximately 50 workers) workers relocating to Narrabri from elsewhere.

The 200 general operations workers required for the project would include a mix of existing roles already based in Narrabri, support roles based in Sydney / Brisbane / Adelaide and new roles that would be created over the life of the project. Generally, employees would be sought from the local area, with training programs instigated where skills are not currently available. It is likely however that some specialist positions would remain FIFO, although this is expected to be small.

Local workers and parts and service procurement would be favoured by the proponent where appropriate.

Employer of workforce

Submissions stated that the employment estimate was inaccurate, as the proponent will directly employ only a small proportion of the total workforce.

The project would employ a mix of full time employees, part time employees, casual employees and contractors. The EIS used the term 'full time equivalents' to account for this mix of employment options under the proponent's flexible work policy. Notwithstanding the legal nature of the employment contract, the employment estimate remains accurate and as published in the EIS.

Duration of employment

Submissions stated that the majority of jobs created by the project would be during construction and therefore would be short term.

Chapter 6 (Project description) of the EIS provides an overview of the construction and operational workforce requirements of the proponent, with additional detail available in Appendix T1 (Social Impact Assessment) of the EIS. In summary there would be approximately:

- 1,300 jobs during peak construction, being around the first 3 to 4 years.
- 150 ongoing construction jobs beyond the peak construction period.
- 200 jobs through the operational stage of the project.

Figure 6-37 of EIS Chapter 6 showed the project's full time equivalent jobs as they relate to the project schedule, incorporating the peak construction period.

Preference for employment

Some submissions welcomed employment from the project and stated it would increase employment diversity in the region.

Submissions welcoming employment to increase employment diversity in the region are noted. The Economic Impact Report (EIS Appendix U2) noted that the project would generate an average of 127 full-time equivalent jobs in the Narrabri LGA, 161 full-time equivalent jobs in the wider region, and 224 full-time equivalent jobs in the rest of NSW over the 25-year assessment period. The project would therefore provide a net benefit to employment in the Narrabri LGA, the wider region and NSW.

6.6.7 Fracture stimulation

Potential for fracture stimulation in the future

Submissions asserted potential for the project to involve fracture stimulation in the future. They cited fracture stimulation undertaken by the previous operator in the project area. They requested explanation of how it was concluded fracture stimulation was not required.

Submissions argued that fracture stimulation would have potential impacts on the environment and human health including groundwater contamination, fugitive emissions and earthquakes.

Submissions sought a legally enforceable guarantee that fracture stimulation would not occur.

Submissions stated that the project should not be approved if fracture stimulation could occur. Some also stated it was not possible for the regulator to prohibit it over the life of the project.

Submissions raised the concern that other companies may seek approval to undertake fracture stimulation in the project area after the proponent has ceased operations.

> The proponent is not seeking approval for fracture stimulation (also known as hydraulic fracturing or 'fracking') in the development application.

6.7 Produced water management

Produced water management was described in Chapter 7 of the EIS. As described, the project would extract an average 1.5 gigalitres of groundwater from target coal seams per year.

The extracted groundwater, termed 'produced water', would be treated and amended as necessary for beneficial reuse. Beneficial reuses would include crop irrigation, stock watering, firefighting, dust suppression and construction. Some treated water (up to 12 megalitres per day) would be released to Bohena Creek when the flow in Bohena Creek is greater than 100 megalitres per day as recorded at the gauging station at the Newell Highway.

The produced water management approach and corresponding impact assessment demonstrated that effective and efficient produced water management can be achieved with minimal environmental impact.

207 submissions raised issues specifically relating to the management of produced water as described in Chapter 7 of the EIS. The majority of these submissions concerned the quality and quantity of the produced water (101 submissions) and the means of disposal (or beneficial reuse), being 101 submissions. A smaller number (26 submissions) concerned the specifics of the produced water treatment process.

The division of submissions by issue and submission type is depicted in Figure 6-7.

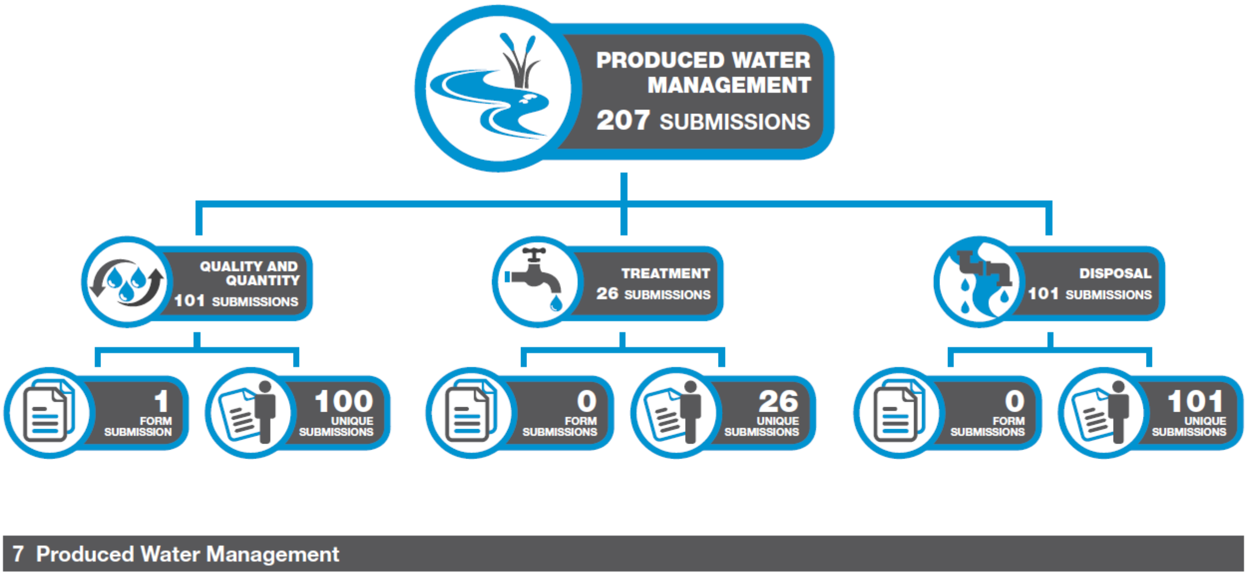


Figure 6-7 Summary of submissions on produced water management

6.7.1 Quantity and quality

Breakdown of quantities

Submissions stated the assessment did not provide a clear explanation of the quantities of produced water and the way they would be managed.

EIS Chapter 7 (Produced water management), provided information on the quantities of produced water from the project. Section 7.4.1 stated that it is expected that produced water volumes will peak at around 10 megalitres per day in at around years' two to four, gradually declining over the life of the project. The long term average would be around four megalitres per day, which equates to 1.5 gigalitres per year over the 25-year assessment period. The estimated total volume of produced water over the project assessment period is around 37.5 gigalitres. Figure 7-2 in Chapter 7 provided the indicative produced water production curve by year.

With regard to the way that produced water would be managed, Section 7.5 of Chapter 7 titled 'Produced water management operating system' and Section 7.7 – 'Produced water management' explain the water treatment infrastructure that the proponent is planning to install at the centralised Leewood water treatment facility and the beneficial reuse options for the treated (and amended) water post-treatment respectively. These include irrigation, dust suppression, drilling, construction, stock watering and fire-fighting. There would also be the option for managed release to Bohena Creek under appropriate flow conditions.

Water balance risk

Submissions stated there was limited discussion of risk with regard to the management of produced water and scenarios where the proposed management strategies may be challenged. They provided examples of a breakdown of the water treatment facility, insufficient flow in Bohena Creek, insufficient demand for irrigation or produced, greater production volumes, or water storages being at capacity. They stated that such events could lead to excessive releases of Bohena Creek or overfilling of water storages.

The management of produced, treated and amended water was assessed in detail in Appendix G1 and Appendix G2 and summarised in Chapter 7 (Produced water management) of the EIS. The assessments were undertaken for the predicted peak volumes of produced water of 10 megalitres per day which provided a measure of conservatism to the assessments given that average volumes be about 4 megalitres per day.

As discussed in Chapter 7 of the EIS, a range of options would be available for management of produced, treated and amended water including storage, construction, dust suppression, drilling, stock watering, irrigation and managed release to Bohena Creek. In addition to the range of management options that would be available, the proponent will have a high level of operational control over the volume of produced, treated and treated and amended water being generated. Together, these factors would greatly limit the risk that produced, treated and treated and amended water could not be adequately managed.

The water treatment facility is designed in line with industry standard practice to incorporate a predicted downtime of around 10 per cent of the time. As the facility would need to treat peak water production at 10 megalitres per day, this amounts to a design capacity of around 11 megalitres per day. As stated in Chapter 7 of the EIS, the water treatment facility is modular and allows for an even larger capacity of 14 megalitres per day if required. This approach would provide for water treatment in excess of predicted peak production as well as accounting for potential downtime. The modular design of the water treatment facility also means that the facility provides a level of redundancy that would maintain water treatment capacity even while the facility undergoes maintenance.

Appendix G2 of the EIS provided a conceptual assessment of the irrigation scheme and found it could support a productive crop yield with minimal impacts to soil and water. It found that a nominal irrigation area of 500 hectares would be sufficient to irrigate treated and amended water at peak production. The proponent has identified that around 9,000 hectares of suitable land is located within a 20 km radius of Leewood. Actual irrigation areas would be determined as the project develops.

Appendix G1 of the EIS assessed the potential impacts of managed release to Bohena Creek and included a water balance model that considered the potential for managed release to occur in light of climatic conditions and other management options including storage, construction, dust suppression, drilling, stock watering and irrigation. It found that managed release to Bohena Creek under required flow conditions of at least 100 megalitres per day as measures at Newell Highway gauging station was feasible as part of the overall produced and treated water management strategy. As set out in the project commitments (EIS Chapter 31), treated water would not be released to Bohena Creek unless the required flow conditions are met. The volume released when flow conditions are met would be consistent with that assessed in the EIS.

The forecast water production is based on reservoir modelling based on data collected from exploration and appraisal activities that have been carried out in the project area for over a decade. As such, the forecast water production is considered accurate for the purpose of project planning and assessment.

Existing and future water management ponds are designed in accordance with the relevant codes of practice including: *Exploration Code of Practice: Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015). In line with the guidelines, the ponds include significant additional storage capacity that ensures produced, treated and treated and amended water could be safely stored in the unlikely event of a contingency event. In the unlikely event that water levels approached the maximum storage capacity of a pond, water production can also be ceased.

Thus, in summary, the water management system would be designed and operated to ensure that there is sufficient storage capacity to contain produced water in extreme rainfall events, in accordance with the relevant Codes of Practice and guidelines. In addition, pond levels are monitored and field operations can be managed to control the volume of produced water if this is necessary. As an experienced oil and gas operator, the proponent has considerable expertise in managing water balances and storage and management infrastructure, to ensure the water is appropriately managed.

Salinity of produced water

Submissions requested clarification of the salinity of produced water. They requested salinity to be expressed in terms other than electrical conductivity. They also stated that produced water salinity stated in the assessment of around 9 g/L (14,000 microSiemens/cm) was lower than previously published estimates of salinity for Bibblewindi exploration at around 14.5 to 31 g/L with an average of 18 g/L.

Electrical conductivity (EC) is considered to be an acceptable method of expressing salinity. Section 6 of the updated Water Baseline Report in Appendix D of this RTS contains water quality data from produced water collected at the existing water treatment facility at Leewood and salinity is presented in terms of electrical conductivity and total dissolved solids, with a break-down of the anions and cations constituting this salinity.

Table 6-1 of the updated Water Baseline Report provides for the Leewood produced water ponds the field measured TDS ranges from around 2,750 mg/L to 24,400 mg/L, with a mean of around 14,700 mg/L.

Composition of produced water

Submissions stated there was no chemical analysis of produced water from the proponents existing exploration activities in the project area. They stated the assessment should have contained detailed chemical characterisation of produced water sampled during exploration. They also stated that produced water could contain hydrocarbons.

Section 6 of the updated Water Baseline Report in Appendix D of this RTS now provides water quality data for produced water stored in the ponds at the existing water management facility at Leewood. Data is presented for a wide range of parameters. The updated Water Baseline Report also includes water quality of the treated water and shows it complies with the relevant guidelines including long-term irrigation and stock watering guidelines (ANZECC/ARMCANZ 2000).

No hydrocarbons have been detected in treated water from the Leewood Water and Brine Treatment Plant.

Chemical analysis of produced water that was provided in the EIS used groundwater quality from the target formations as described in the following locations in the EIS:

- Table 11-7 in Chapter 11 – Groundwater and geology
- Appendix F – Groundwater impact assessment – Section 5.8 Coal seam water quality, including summary tables 5-14 and 5-15 for the Black Jack coals and the Maules Creek Formation respectively
- Appendix T2 – Health impact assessment that assesses the health risk of the average concentrations of a range of analytes in the produced water.

It is important to note that the produced water varies by seam and location across the project area. Therefore, produced water quality as presented in Appendix F in the EIS, and the updated Water Baseline Report in Appendix D to this RTS, is shown as minimum, average and maximum values.

6.7.2 Treatment

Treatment and amendment process

Submissions noted the proposed treatment and amendment of produced water and stated that with appropriate design and management, the treatment process could provide water of suitable quality for beneficial reuse applications including irrigation, stock watering, dust suppression, construction, or managed lease to Bohena Creek.

Some submissions raised concerns about the adequacy of treatment for removal of contaminants and bacteria, temperature control and the blending of permeate and distillate. Others concerned the management of waste streams from the treatment and amendment process.

Submissions stating that the treatment process could provide water of suitable quality for beneficial reuse applications including irrigation, stock watering, dust suppression and construction, or managed release to Bohena Creek are noted.

Produced water from current exploration and appraisal operations in the project area undergoes treatment at the existing water treatment facility at Leewood. Analysis of that water is presented in Section 7 of the updated Water Baseline Report at Appendix D of this RTS and shows it complies with the relevant guidelines including long-term irrigation and stock watering guidelines (ANZECC/ARMCANZ 2000).

The potential environmental impacts of managed release on the water quality, hydrology and geomorphology and aquatic ecology of Bohena Creek were assessed in Appendix G1 and Appendix H and summarised in Chapter 12 (Surface water quality), Chapter 13 (Hydrology and geomorphology) and Chapter 16 (Aquatic ecology) of the EIS.

The assessment found that potential impacts to hydrology and geomorphology were negligible. The assessment also found that impacts from managed release on water quality and aquatic ecology would be low when considering baseline water quality under the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000).

The water treatment facility has been designed by suitably qualified water treatment engineers and implements leading-practice water treatment technologies. The facility is monitored and maintained to ensure produced water is treated and amended to the quality necessary for beneficial reuse under the relevant statutory guidelines and as assessed in the EIS. The facility includes monitoring instrumentation for multiple parameters, including temperature.

Section 6 and 7 of the updated Water Baseline Report in Appendix D of this RTS contain water quality data from produced, treated and treated and amended water at the existing water treatment facility at Leewood. Data is presented for a wide range of parameters including pH, total suspended solids, metals, nutrients, anions and cations and hydrocarbons. The majority of parameters in the treated and amended water were very low and below levels detectable by the laboratory analysis (i.e. below the laboratory limit of reporting).

As stated in Chapter 31 of the EIS (Project commitments), a Waste Management Plan would be implemented for the project. The plan would incorporate statutory requirements under the *Protection of the Environment Operations Act 1997* and *Protection of the Environment Operations (Waste) Regulation 2014* including waste classification, recording, transport and tracking. Waste from the water treatment facilities would be classified, recorded, transported and tracked in accordance with the plan and disposed of at an appropriately licensed facility in accordance with regulatory requirements.

Storage of produced water

Submissions stated that the potential for water storage ponds to leak through lining or during flood events (overtopping) was not clearly identified or discussed in the assessment and may be a health hazard.

Submissions also stated that water storage ponds should be lined and monitored for failure.

Submissions objected to the proposed ponds and stated they were not materially different to evaporation ponds that were banned in NSW insofar as the risk of spills.

Consistent with the findings of the Chief Scientist's report that the risks associated with coal seam gas are no greater than that associated with other extractive industries (NSW Chief Scientist and Engineer 2014), the potential for impacts related to spills have been independently assessed as very low to low.

The risk of accidental spills of fuel, drilling additives, produced water, chemicals and cement affecting surface water (Chapter 12), groundwater (Chapter 11), soils (Chapter 14) and sensitive receivers (Chapter 25) are assessed in each of the relevant chapters of the EIS. Management and mitigation measures to minimise potential impacts are also identified.

As demonstration of the low risk, the proponent has operated the Narrabri Field, including the construction and operation of the Leewood Water Treatment Plant without a single reportable incident in over 4.5 years.

In addition, and importantly, the EPA has designated the Narrabri operations as a Level 1 risk (being the lowest level of risk) since commencement of the Narrabri operations risk assessment framework in 2015. This designation is based on the operations being conducted on site, the risk of a pollution incident and the performance of the licensee (the proponent).

The proponent has operated water treatment facilities as part of its activities across a wide range of operating environments and fields and, as such, has considerable experience in effectively managing produced water volumes and operating water storages. Most notably in relation to coal seam gas operations, there are currently around 18 water storage facilities of maximum operating volume larger than 150 megalitres (the approximate volume of each cell in the Leewood Water Management Facility) operating for the GLNG project in Queensland.

The approach to water management ensures there will be adequate storage capacity in the system. In the highly unlikely scenario that ponds are approaching levels that would result in an overtopping event, controls on water production can be exercised to limit or suspend water production. That said, the management procedures (as outlined below) mean that this scenario is not likely as the pond design and operational management practices, include capacity for storage of extreme rainfall events.

The produced water storage at Leewood includes the use of the existing two storage ponds (four cells) with a total storage volume of approximately 600 megalitres, as well as the construction and operation of a further pond (two cells) with approximate volume of 150 megalitres per cell. The total storage volume at Leewood would be approximately 900 megalitres.

Consistent with the existing ponds at Leewood, the new pond would be designed, constructed and operated to meet best practice standards. Details of the operational requirements of the existing ponds is set out below to demonstrate the approach taken to the design, construction and operational management of the ponds to ensure the produced water is stored appropriately. This approach would continue for the production project.

The facility meets the requirements of the NSW Government's Code of Practice *Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015). The current ponds include primary and secondary lining, leak detection and collection and an engineered spillway.

In addition, the NSW Dam Safety Committee reviewed the design of the ponds and confirmed construction was to specification.

Water storage levels have been defined for each of the ponds for monitoring and management purposes. These definitions are based on the Queensland guidelines '*Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*' (Queensland Department of Environment and Heritage Protection 2016), and include:

- Wet Season Containment (Maximum Operating Level (MOL)) – Includes a minimum spare storage capacity (Design Storage Allowance) required at the nominal start of the wet season (1 November each year) to give the regulatory agency confidence that wet season inputs can be managed without loss of containment (i.e. spillway discharge).
- Storm Event Containment (Emergency Reporting Level (ERL)) – The dam level at which loss of containment could potentially occur within a single storm event (72-hour duration event) triggering notifications and further action.
- Spillway Capacity (Full Supply Level (FSL)) – Sufficient spillway capacity is required to ensure that the design flood event can be conveyed by the spillway without causing overtopping of the dam embankment which could lead to catastrophic failure of the dam structure.

Monitoring of storage levels is undertaken with the use of pressure sensors that continuously measure and record storage depth, volume and surface area based on hydrostatic pressure. These automated meters are submersed in the pond to a depth as close to the base of the pond as reasonably practicable, and are used in conjunction with surveyed data to determine the water level of the pond. Telemetry is used to allow for remote real-time monitoring of the pond levels and this is used to monitor storage capacity in conjunction with other parameters such as upstream pilot or well-head water production data.

Field operators are required to record the pond level and volume on a daily basis. Other operating markers / indicators may also be used in conjunction with the pressure sensor monitoring, such as volume and maximum operating level indicator markers on storage facility walls. The level sensors system used in the existing ponds undergoes regular assessment and, when necessary, recalibration occurs six monthly in order to ensure the accuracy of readings.

A Dam Safety Emergency Plan has been provided to the NSW Dam Safety Committee in accordance with the requirements of the *Dams Safety Act 1978*. The plan provides emergency response procedures for the management of the Leewood ponds in the event of an imminent or actual uncontrolled release from the ponds.

Importantly, in respect of capacity to store in the event of sustained rainfall, the Leewood ponds have, consistent with the *Produced Water Code of Practice*:

- a spillway capacity designed to pass 0.01 per cent Annual Exceedance Probability (AEP) flows

- wet season design storage allowance (the volume between the maximum operating level (MOL) and full supply level (FSL/spillway level) sized to provide storage for a volume equivalent to the 1:100 AEP and a storm event containment of 1:100 AEP 72-hour duration.
- pond level and collection sump monitoring
- an implemented regular inspection and monitoring program.

The Leewood ponds also operate under Trigger Action Response Plans (TARPs), approved by the (now) Division of Resources and Geoscience under the *Petroleum (Onshore) Act 1991*.

TARPs are developed to identify, assess and respond to abnormal conditions and are implemented to manage risk to operations, personnel and the environment. Two TARP documents have been developed to address the requirements of the *Produced Water Code of Practice*:

- Produced water storage pond level TARP provides the actions to be taken if defined pond management levels are reached.
- Leewood pond leakage management TARP provides actions to be taken if defined leakage rates are reached.

In addition to the trigger points and associated actions to be undertaken, these documents also detail the delegation of responsibility at each trigger points and contact details for both internal and external notification requirements.

Analyses of raw production water (sampled from storage ponds) are provided in the revised Water Baseline Report (refer Appendix D of this RTS). Analyses are reported from samples taken from the storage ponds as well as at the reverse osmosis plant intake (and hence a blend of the ponds).

Only a limited number of the total catalogue of analytes analysed recorded concentrations greater than the limit of reporting. Whilst salinities ranged up to 40,000 parts per million (ppm – equivalent to mg/L) for total dissolved solids (TDS), the mean and 84th percentile (one standard deviation above the mean) were 16,000 and 20,000 ppm, respectively. Only barium (maximum level of 14.5 mg/L, mean 3.35 mg/L), fluoride (11.8 mg/L; 7.6 mg/L), nickel (0.79 mg/L; 0.17 mg/L), arsenic (1 mg/L; 0.1 mg/L), cadmium (0.14 mg/L; 0.02 mg/L) and molybdenum (0.073 mg/L; 0.02 mg/L) report values that would be significant if the water to be used directly for stock or domestic purposes. Organics (as total organic carbon) are present in concentrations up to 2,870 mg/L. Numerous species of bacteria, protozoa and cyanobacteria are recorded as the ponds are open and used by local wildlife. No radionuclides were recorded above the limit of reporting (e.g. <0.001 mg/L for uranium).

Thus, in summary, the Leewood ponds are designed and operated to ensure that there is sufficient storage capacity to contain produced water in extreme rainfall events, in accordance with the relevant Codes of Practice and guidelines. In addition, pond levels are monitored and field operations can be managed to control the volume of produced water if this is necessary. As an experienced oil and gas operator, the proponent has considerable expertise in managing water balances and storage and management infrastructure, to ensure the water is appropriately managed.

Limitations of produced water treatment

Submissions stated there was potential for contaminants to remain in treated or amended water due to limitations of produced water treatment processes. Submissions stated that treatment may not effectively remove all salts, metals, radioactive elements and more specifically boron, silver, chlorine, copper, cadmium, cyanide, zinc, methane, bromine, methanol and ethylene glycol.

Table 7-2 in EIS Chapter 7 (Produced water management) assessed the target treated and amended water qualities against applicable water quality guidelines aligned with proposed beneficial reuse options. This table has now been revised to include actual water quality data from the commissioned Leewood Water and Brine Treatment Plant (WBTP) and is presented in Table 6-4 of this RTS and in the updated Water Baseline Report at Appendix D to this RTS.

The results show the reverse osmosis plant has exceeded design criteria and produces treated water with all analytes below drinking water guidelines and most below the limits of laboratory reporting, demonstrating that the plant effectively removes contaminants of concern.

Concentration of contaminants

The submission stated that produced water would contain contaminants present in coal seams including heavy metals (such as arsenic, mercury, lead and chromium), BTEX (benzene, toluene, ethylbenzene and xylene), radioactive substances such as uranium and hydrocarbons.

They also stated the produced water would contain residual drilling fluid. Submissions stated that treatment of produced water would concentrate these contaminants.

Produced water is collected in ponds at the Leewood Water Treatment Facility prior to treatment through the reverse osmosis plant. Water is routinely (monthly) sampled from the ponds and analysis results are presented in Table 6-1 of the updated Water Baseline Report (Appendix D to this RTS). The results provide that the listed contaminants of concern report at, or below, the laboratory limit of reporting.

Treated and treated and amended water quality results from the operating Leewood water treatment facility are also now presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS). The results show the reverse osmosis plant has exceeded design criteria and produces treated water with all analytes below drinking water guidelines and most below the limits of laboratory reporting.

No hydrocarbons have been detected in treated water from the Leewood Water and Brine Treatment Plant.

As set out in Chapter 28 of the EIS (Waste Management), solids removed during the water treatment process and used filter cartridges and reverse osmosis membranes from the water treatment facility would be classified in accordance with the *Waste Classification Guidelines* and disposed of at an appropriately licensed facility in accordance with regulatory requirements.

Monitoring of produced water treatment

Submissions requested independent monitoring of produced water treatment by the NSW Environment Protection Authority citing previous environmental incidents.

Within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.

- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.
- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

6.7.3 Disposal

Disposal of produced water

Several submissions expressed concerns that the produced water may have detrimental impacts on ecology, water supplies and agriculture due to high levels of salts, metals and other chemicals used in its treatment and the potential for spills into the environment.

Consistent with the findings of the Chief Scientist's report that the risks associated with coal seam gas are no greater than that associated with other extractive industries (NSW Chief Scientist and Engineer 2014), the potential for impacts related to spills have been assessed as very low to low.

The risk of accidental spills of fuel, drilling additives, produced water, chemicals and cement affecting surface water (Chapter 12), groundwater (Chapter 11), soils (Chapter 14) and sensitive receivers (Chapter 25) are assessed in each of the relevant chapters of the EIS. Management and mitigation measures to minimise potential impacts are also identified.

As demonstration of the low risk, the proponent has operated the Narrabri field, including the construction and operation of the Leewood Water Treatment Plant without a single reportable incident in over 4.5 years.

In addition, and importantly, the EPA has designated the Narrabri operations as a Level 1 risk (being the lowest level of risk) since commencement of the Narrabri operations risk assessment framework in 2015. This designation is based on: the operations being conducted at the site; the risk of a pollution incident, and the performance of the licensee (the proponent).

Management of the produced water remains unchanged from that described in Chapter 7 (Produced water management) of the EIS. Thus, as the maximum volumes of produced water are stipulated for the project, this can be assigned to the various beneficial use categories and risks and management strategies determined. Peak and routine volumes of produced water production are assessed and estimated volume distributions between the different disposal options (irrigation and stock watering; construction, dust suppression and drilling; and conditions under which discharge may occur to Bohena Creek) are outlined and management strategies detailed.

Analytical results from the commissioned reverse osmosis plant indicate much lower concentrations of carbonate and sodium have been achieved than was expected in the EIS. These are reported in Table 6-4 of this RTS and the revised Water Baseline Report attached to this RTS as Appendix D.

Levels of bicarbonate are expected to be very low (~30 ppm HCO_3 – based on demonstrated performance and existing water quality data from the Leewood treatment facility), hence produced carbonate will also be low as the pH of the water favours bicarbonate stability over carbonate. (Note, this is based on commissioned concentrations of 34 ppm alkalinity, not the expected – modelled –

value of 139 ppm used in the EIS, and assumes bicarbonate breakdown to carbonate will be minimal as temperatures in the reverse osmosis plant are unlikely to reach decomposition temperatures of 80°C.).

The addition of bicarbonate to the local sodosols and vertisols will act to improve local soil structure and the bio-availability of nutrients in the soil.

The proponent has extensive experience in the use of treated water for irrigation in its Queensland GLNG project operations. Irrigation activities are carried out by the proponent on ten properties across the Roma, Fairview and Scotia fields, including on a number of private landholders' properties. Over 1,700 hectares are under irrigation, utilising a range of irrigation methods such as pivot and above and below ground drip irrigation, for a broad selection of crop types from Chinchilla White gums, Leucaena and Rhodes grass to cereal and grain crops. The irrigation operations are undertaken in accordance with the requirements of Beneficial Use Agreements, which provide standards for water quality and general monitoring and operating conditions.

Some general information on how the beneficial use of treated water framework in Queensland operates is set out below. There is further detail here: https://www.ehp.qld.gov.au/management/non-mining/csg-water.html

The Queensland Gas Fields Commission is the independent statutory body formed to manage and improve sustainable coexistence between rural landholders, regional communities and the onshore gas industry in Queensland, Australia. The Gas Field Commission's Technical Communication states:

> *Where properly managed and treated, CSG water can be reused in a range of different ways including irrigation. The Coal Seam Gas (CSG) Water Management Policy 2012 sets out the Queensland Government's framework for the management of CSG water. The objective of the policy is "To encourage the beneficial use of CSG water in a way that protects the environment and maximises its productive use as a valuable resource".*

Installation of gauging station

Submissions stated that the existing gauging station at Bohena Creek was too far downstream to adequately represent flow conditions at the Bohena Creek managed release point.

Submissions stated that a purpose built gauging station should be installed at the managed Bohena Creek managed release point prior to the start of operation.

Modelling of the catchment and use of upstream-downstream monitoring of the discharge site during discharge events will calibrate the site to the Newell Highway gauge. No gauging will be required at or upstream of the discharge site. The variable nature of the stream bed at the proposed discharge site does not lend itself to establishment of a permanent gauge.

The site at the Newell Highway bridge, however, presents as a competent, defined channel and thereby provides an ideal location to calibrate flow down the Bohena Creek. The distance of eight kilometres from the proposed discharge site is not excessive and can be accurately calibrated to the Newell Highway gauge. The proponent appreciates that the current gauge at the Newell Highway gauging station has poor sensitivity below 1,000 megalitres per day and acknowledges that a refined gauge may need to be installed at that site.

Quantification of high flow events in Bohena Creek

Submissions requested clarification of how flow events greater than 100 megalitres per day as measured at the Newell Highway gauging station were quantified.

Quantification of the flow events is reported in Appendix G1 – Managed release study (Bohena Creek). Rainfall and evaporation data recorded at the Narrabri post office rain gauge between 1963 and 2013 was used to inform the development of a rainfall-runoff model as described in Section 6.4 of Appendix G1. The modelling also considered geological conditions and flow processes as described in Section 6.3.1 of Appendix G1. It considered historic continuous streamflow responses to rainfall events as measured on Bohena Creek at the Newell Highway gauging station between 1997 and 2004. These data showed that even a relatively small event over three days yielded a mean discharge of 116 megalitres per day.

The calibrated rainfall-runoff model uses a range of technical parameters to best approximate conditions in Bohena Creek as to how flow would behave following a rainfall event including:

- sub-catchment area
- slope
- surface roughness
- surface permeability.

The modelled analysis indicates that the release of 12 megalitres per day does not result in significant differences in water level, flow or velocity over the 5 and 100 years average recurrence interval (ARI) events. Differences in peak water levels are less than one mm in the 5-year ARI, and there is no change in the 100-year ARI event. There is no change in velocity in the 5 and 100 year ARI events.

Therefore, there is high confidence in the data used in the managed release assessment.

Suitability of treated and amended water for irrigation

The submissions stated that potential for contaminants to remain in treated or amended water due to limitations of produced water treatment processes.

Submissions stated presence of contaminants presented risks to soil and water and cited that AGL abandoned irrigation plans due to presence of salt and heavy metals.

The proponent will use leading practice water treatment technologies with suitably qualified water treatment engineers. Real time instrumentation including temperature sensors would report to automated temperature adjustment controls to maintain target water quality.

The EIS assessed the target treated (and amended) water quality against a range of proposed beneficial reuse options including stock watering and irrigation and found that the target water quality met the applicable ANZECC/ARMCANZ (2000) guidance values.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities; including long-term irrigation. Further detail on the treated water quality is provided in the updated Water Baseline Report.

With regard to the comment regarding AGL abandoning its irrigation plans, publically available information indicates that AGL were blending produced water with fresh water for application to perennial lucerne crops (AGL 2014). This is a different water management strategy to that proposed by the proponent, which treats the produced water by a range of technologies, including reverse osmosis. Refer to Table 7-2 in EIS Chapter 7 (Produced water management) for more information.

Additionally, AGL's target water quality post-blending was 1,500 microSiemens/cm (or around 1,200 mg/L total dissolved solids (AGL 2014)), whereas the proponent's target water quality for irrigation is around one-third that of AGL's, being approximately 566 microSiemens/cm (or around 368 mg/L total dissolved solids), broadly consistent with regional irrigation water quality from farm bores. Actual data reported since mid-2017 at the Leewood water treatment facility shows values of 149 microSiemens/cm (refer to Table 6-4 and Appendix D of this RTS).

Suitability of treated water for stock watering

Submissions objected to the use of treated water for stock watering due to contamination risk.

The EIS assessed the target treated (and amended) water quality against a range of proposed beneficial reuse options including stock watering and irrigation and found that the target water quality met the applicable ANZECC/ARMCANZ (2000) guidance values.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities, including stock watering. Further detail on the treated water quality is provided in the updated Water Baseline Report.

6.8 Assessment of alternatives

An assessment of alternatives to the project was provided in Chapter 8 of the EIS. The assessment considered the 'do nothing' alternative of not proceeding with the project, alternative project sizes in terms of energy output, alternative gas resources and project locations and alternative field development and infrastructure technologies. The assessment found the 'do nothing' alternative was less preferable due to the strategic need for the project. It stated that a range of project sizes were considered but that the size of the project at 200 terajoules per day was adequate to meet project gas supply objectives.

The project gas resource and location was preferred due to the quality of the resource, the separation of the project area from residential zones, its separation from biophysical strategic agricultural land and its proximity to the proponent's existing infrastructure. With regard to alternative field development and infrastructure technologies, the project was considered to be based on the most viable and / or proven options for matters such as field development, in-field processing, power supply and water management.

The assessment noted that the project took advantage of technological improvements such as stacking of lateral wells to minimise surface disturbance and would consider other optimisations in detailed design.

110 submissions raised issues specifically relating to assessment of alternatives as described in Chapter 8 of the EIS. Of those, 68 were form submissions with the remaining 42 being unique submissions.

Submissions related to comments about the EIS not adequately focussing on objective of addressing gas security and the relatively high cost of extracting gas in Narrabri, in addition to not adequately considering the 'do nothing' approach.

Figure 6-8 provides an overview of the submissions for assessment of alternatives.

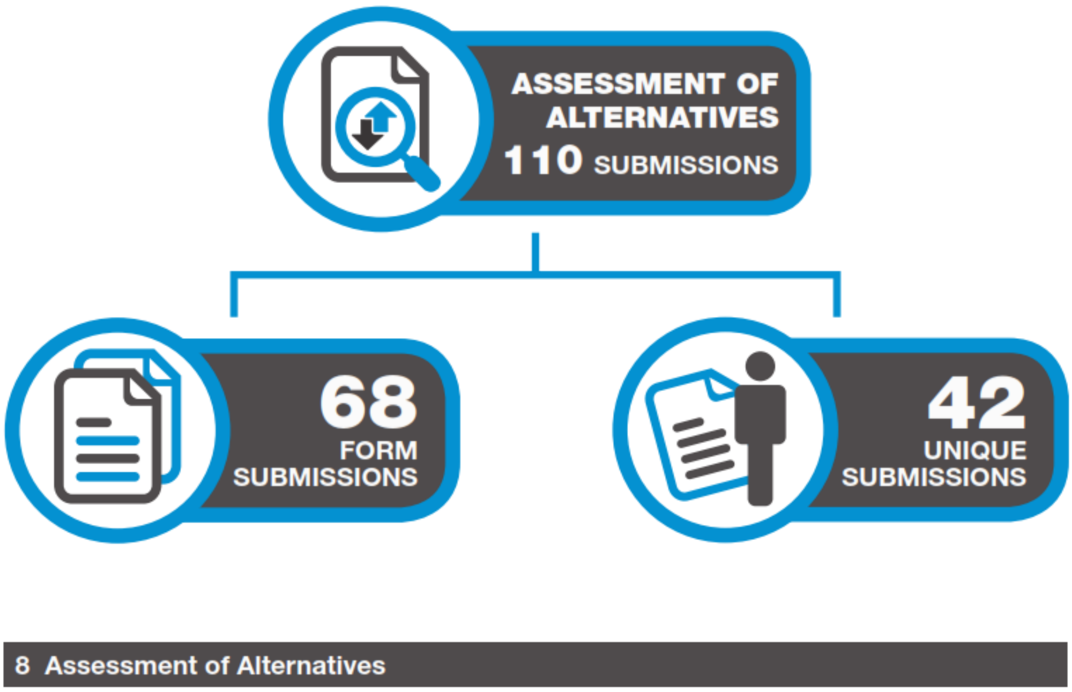


Figure 6-8 Summary of submissions on assessment of alternatives

Assessment of alternatives

Submissions stated the assessment of alternatives was not adequately focussed on an objective of addressing gas security and the relatively high cost of extracting gas in Narrabri.

The Secretary's Environmental Assessment Requirements, issued by the NSW Department of Planning to inform EIS content, asked for *'justification as to why the proposed development is preferred over other alternatives'.*

Chapter 8 – Assessment of alternatives therefore discussed the proposed project relative to:

- The 'do nothing' approach.
- Alternative project sizes.
- Alternative gas resources and project locations.

- Alternative field development and infrastructure technologies.

Alternative project options were evaluated against the objective of protecting environmental values, providing a domestic gas supply to the region, improving safety, providing efficiency in design and delivering a commercially viable project. The assessment concluded that the proposed development has been put forward due to the following benefits:

The project has the capacity to deliver up to 200 terajoules of gas per day, or about 50 per cent of current gas demand in NSW.

The project would help ensure that NSW can take advantage of the many opportunities arising from utilisation of its natural resources. The project's capacity to supply up to half of NSW's natural gas needs would promote balance across the NSW, east coast and export markets. A well-balanced market that allows both consumers and producers to respond to price signals efficiently is critical in ensuring maximum benefit to all stakeholders.

There are favourable geological and hydrogeological conditions, including the presence of thick aquitards that separate the target coal seams from the overlying freshwater aquifers accessed by groundwater users.

The area has been strategically set aside in anticipation of a gas project under the NSW Government's own planning processes, being the Brigalow and Nandewar Community Conservation Area Act 2005, and has the following strategic advantages:

- The project is compatible with existing land use—being predominantly forestry and agriculture.
- A large proportion of the Narrabri host community is supportive of the project.
- There is no Government mapped Biophysical Strategic Agricultural Land (BSAL) in the project area, nor was BSAL found during a soil survey undertaken over the project area under the Government's methodology as outlined in the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (NSW Government 2013). This has been confirmed by the issue of a BSAL Certificate for the project area by the NSW Department of Planning and Environment (refer to Chapter 14 and Appendix I2).
- Gas would be made available to the NSW market via a high-pressure gas transmission pipeline. The pipeline will be constructed and operated by a specialist pipeline company and is not part of the EIS for this project. It is likely that the gas transmission pipeline, starting at Leewood, would tie into the Moomba to Sydney pipeline located to the south-west of the project area.

  The Western Slopes Pipeline Preliminary Environmental Assessment can be accessed at: https://majorprojects.accelo.com/public/95ba8b7700e6626f48cefb1e424c996c/Western%20Slopes%20Pipeline%20-%20Preliminary%20Environmental%20Assessment.pdf
- The project area excludes the Brigalow Nature reserve.
- Yarrie Lake reserve (plus a buffer of at least 50 metres) will not host surface infrastructure.
- The two Brigalow State Conservation areas located within the project area will not host surface infrastructure.
- There is ease of access to Bibblewindi and Leewood as the Newell Highway passes through the project area. There is also an extensive network of existing tracks throughout the forest, thereby minimising the need for clearing.

The objective of addressing gas security is discussed in Chapter 3 (Strategic context and need), rather than in Chapter 8 (Assessment of alternatives).

The cost of extracting gas in Narrabri was considered in Appendix U1 (and summarised in Chapter 27 – Economics), which contained the cost-benefit assessment for the proposed development. Appendix

U1 reported that the project has a benefit-cost ratio of between 1.39 and 1.43, depending on which power supply option is progressed.

Incomplete discussion of the 'do nothing' alternative

Submissions stated that the discussion of the 'do nothing' alternative did not consider that the majority of Australian gas supplies were exported.

The analysis of the 'do nothing' approach provided a comparison of the proposed development against no action by the proponent in Chapter 8 (Assessment of alternatives). It should be considered against the backdrop of the global and domestic gas markets, and the need for gas in the east coast gas market, presented in Chapter 3 (Strategic context and need).

As documented in recent publications by the Australian Energy Market Operator (AEMO 2017a) and Australian Competition and Consumer Commission (ACCC 2017) there is expected to be a significant shortfall in the domestic supply of gas that needs to be addressed by increasing domestic supply. The project would address these gas supply issues by making product gas available to the NSW market.

6.9 Community and stakeholder consultation

Community and stakeholder consultation undertaken for the project and the EIS were described in Chapter 9 of the EIS. At the time of the production of the EIS, around 2,800 stakeholders and stakeholder groups had been consulted through mechanisms including community briefings, face-to-face meetings, project area tours, the project Community Consultative Committee. Stakeholders consulted included local, state and federal agencies; industry groups; regional organisations; Aboriginal parties and land councils; community groups; local businesses and landholders.

The public exhibition of the EIS and RTS process are the most recent phase of community and stakeholder consultation for the project. Other community and stakeholder consultation activities that would continue include provision of project information from the project website, newsletters and fact sheets; feedback mechanisms including a free call service and project email; attendance at community events; community sites tours; and the continued operation of the proponent shopfront.

60 submissions raised issues specifically relating to community and stakeholder as described in Chapter 9 (Community and stakeholder consultation) of the EIS. Of those, 59 were unique submissions and the remaining submission was a form submission that contains some additional remarks regarding consultation.

Submissions related to the adequacy of consultation undertaken for the EIS as well as consultation with specific groups including observatories and Aboriginal parties.

A number of submissions raised issues more specific to the layout of the project as reflected in the content of the Agricultural Impact Statement, Aboriginal Cultural Heritage Assessment Report or Social Impact Assessment. These issues are discussed in Section 6.17, Section 6.20 and Section 6.26 respectively.

Figure 6-9 provides an overview of the submissions for community and stakeholder consultation.

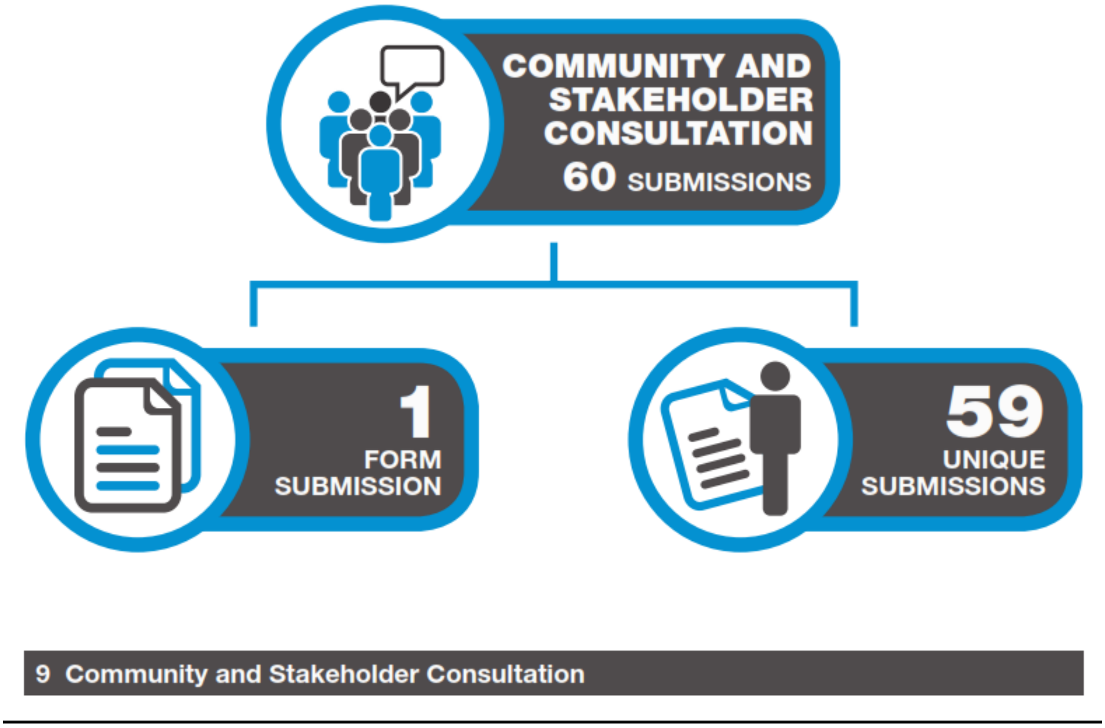


Figure 6-9 Summary of submissions on consultation

Definition of stakeholders

Submissions stated that stakeholders were narrowly and selectively defined and should have included the broader population of NSW.

Appendix D to the EIS – Stakeholder and community consultation outlined the significant work undertaken by the proponent for the years leading up to EIS lodgement. This included:

- engaging with around 2,800 individual stakeholders and stakeholder groups between July 2013 and June 2016
- engaging with Aboriginal stakeholders including over 550 registered Aboriginal parties
- the proponent being a signatory to the Principles of Land Access to ensure landholder's wishes are respected
- establishing a project website that to date has received around 60,000 page views over some 22,150 separate visits
- more than 420 attendees at project briefings hosted by the Narrabri Chamber of Commerce
- around 150 face-to-face meetings with landholders from the project area
- over 4,000 individual visits to Santos shopfronts in Narrabri and Gunnedah
- over 1,000 visitors to our information stand at AgQuip
- over 350 field site tours and community events
- 40 meetings to date for the Narrabri Community Committee which became the project Community Consultative Committee (CCC)

- key community issues being addressed in the EIS are largely consistent with the NSW Chief Scientist's report (NSW Chef Scientist 2013)
- community and stakeholder feedback influenced project design
- ongoing consultation throughout the EIS assessment period and beyond.

Section 2 of this RTS updates consultation activities since EIS lodgement.

Stakeholders were identified and consulted with under a Stakeholder Consultation Strategy developed using leading practice guidelines including from the International Association for Public Participation (IAP2). In addition, the general principles that guided ongoing consultation and engagement activities meet or exceed the requirements documented in the NSW Government's Strategic Regional Land Use Policy Delivery Guidelines - *Guideline for community consultation requirements for the exploration of coal and petroleum, including coal seam gas* (NSW Trade and Investment 2012a) which includes:

- Detailed identification of all stakeholders.
- Undertaking activities to ensure all stakeholders are informed of the proposed program of work.
- Ensuring that stakeholders are aware of real or potential impacts.
- That the purpose of the consultation activities is clear – this includes what can be incorporated into project planning and what is non-negotiable.
- That the community is informed about expected levels of participation and commitments.
- Establishing channels of communications that allow good community feedback and identification of potential issues.
- Provision of feedback to the community on how their input has influenced decisions.
- Maintaining a register of complaints and feedback and actions taken to respond.

In March 2016, new guidelines were issued by the NSW Department of Industry (Division of Resources and Energy) titled *Exploration code of practice: community consultation.* The requirements of the code were incorporated into consultation and engagement planning and implementation by the proponent.

Duration of consultation

Submissions stated that the duration of consultation including exhibition of the EIS was inadequate given the length and complexity of the assessment.

The public exhibition and submission period for the EIS occurred for 90 days from 21 February to 22 May 2017. The minimum statutory exhibition and submission period for State significant development under the *NSW Environmental Planning and Assessment Act 1979* was 30 days.

Effectiveness of consultation

Submissions argued that consultation was inadequate as it did not represent the opinions of the community and did not influence project outcomes.

Submissions stated the broader community was informed of the project rather than consulted. They stated that consultation activities did not provide answers to questions.

Appendix D to the EIS (Stakeholder and community consultation) outlined the significant work undertaken by the proponent for the years leading up to EIS lodgement. Consultation undertaken for the project was not limited to statutory consultation required under the *Environmental Planning and Assessment Act 1979*. Consultation has included significant consultation activities that have informed project planning and shaped the project presented in the EIS. Consultation to date has included:

- engaging with around 2,800 individual stakeholders and stakeholder groups between July 2013 and June 2016
- engaging with Aboriginal stakeholders including over 550 registered Aboriginal parties
- the proponent being a signatory to the Principles of Land Access to ensure landholders wishes are respected
- establishing a project website that to date has received around 60,000 page views over some 22,150 separate visits
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- key community issues being addressed in the EIS are largely consistent with the NSW Chief Scientist's report (NSW Chef Scientist 2013)
- community and stakeholder feedback influenced project design
- ongoing consultation throughout the EIS assessment period and beyond.

Section 2 of this RTS updates consultation activities since EIS lodgement.

Consultation was undertaken consistent with leading practice guidelines including from the International Association for Public Participation (IAP2), and NSW Government guidance documents.

Chapter 9 of the EIS (Community and stakeholder consultation) describes how the consultation and engagement process has provided opportunity for stakeholders and members of the community to learn about the project, and for the proponent to capture and respond to the matters being raised. Examples of community feedback considered by the proponent and included in the project are:

- 'Landholder compensation information was ambiguous'. The landholder compensation information was subsequently reviewed in consultation with the Santos Community Committee on CSG to simplify the wording. The Fact Sheet and website page were subsequently republished.
- 'Concerns regarding truck movements on roads with school buses'. Routes for heavy vehicle movements are now planned to avoid bus routes during school bus times.
- 'Potential for facility lighting to interfere with the Siding Spring Observatory'. Lighting will be planned in consultation with the Australian Astronomical Observatory and a specialised lighting technician. Light generated during construction and operation of the project would be designed so it complies with Australian Standard AS 4282-1997 *Control of the Obtrusive Effects of Outdoor Lighting*, and designed considering the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (NSW Department of Planning and Environment 2016). Generally, lighting would be designed to minimise off-site light spill. (Note that a Gas Flare Light Assessment commissioned for this RTS (Appendix K) indicates that there will be no skyglow impacts to Siding Spring from the project).
- Yarrie Lake reserve (plus a buffer of at least 50 metres) will not host surface infrastructure in recognition of the recreational, cultural and environmental values of this area.

- The proponent has committed to avoid all currently known Aboriginal cultural heritage sites and the most sensitive site types following consultation with registered Aboriginal parties.

Evidence of support for the project

Submissions noted that the EIS indicated majority support for the project in Narrabri. It stated that the community engagement report did not provide evidence of this support.

The purpose of Appendix D to the EIS (Stakeholder and community consultation) is to report on stakeholder and community consultation activities leading up to submission of the EIS.

Section 3.1 of this RTS provides an overview of support for the proposed development more broadly, and also in the Narrabri Local Government Area (LGA). Analysis of the 23,007 submissions indicates that, of the 303 unique submissions from the 527 received from within the Narrabri LGA, there was around 58 per cent support for the project.

Social licence to operate

Submissions stated there was widespread public opposition to the project.

Submissions cited regional surveys of 101 communities in nine local government areas that indicated 96 per cent opposition to the project. They also cited moratoriums on natural gas in Mullaley, Coonamble, Coonabarabran, Gilgandra, Narromine, Moree and Walgett and support for such moratoriums from residents across NSW and other states.

Submissions also cited protest activities and the number of submissions on the EIS.

Other submissions expressed support for the project. They stated there was a strong local base of support in Narrabri as well as ongoing engagement from proponent with local businesses and community organisations. Some stated opposition to the project was enhanced by the media.

Regional surveys of the 101 communities in nine local government areas that indicated 96 per cent opposition to the project are noted. Moratoriums on natural gas in Mullaley, Coonamble, Coonabarabran, Gilgandra, Narromine, Moree and Walgett are also noted.

Recent surveys undertaken by the Gas Industry Social and Environment Research Alliance (GISERA) found that residents of Narrabri and surrounds held significantly more positive views toward natural gas development than those from around Wee Waa or Boggabri. About 15 per cent and 13 per cent of respondents indicated they would ‘embrace’ or ‘approve of’ natural gas development; 27 per cent and 15 per cent of respondents indicated they would ‘tolerate’ or ‘be ok with’ natural gas development; while the remaining 30 per cent would not accept natural gas development.

Section 3.1 of this RTS provides an overview of support for the proposed development more broadly, and also in the Narrabri Local Government Area (LGA). Analysis of the 23,007 submissions indicates that, of the 303 unique submissions from the 527 received from within the Narrabri LGA, there was around 58 per cent support for the project.

Consultation with Siding Spring Observatory

Submissions stated that consultation with Siding Spring Observatory was inadequate as it involved only the telescope business and did not involve other stakeholders including associated business, the science community and tourism operators.

Consultation with senior staff at the Siding Spring Observatory (Commonwealth Department of Industry, Innovation and Science – Australian Astronomical Observatory) was undertaken during the project assessment, including:

- Face-to-face meetings.
- Field tours.
- Technical consultations for preparation of the project EIS, particularly in relation to facility lighting for Dark Sky Region planning.
- Monthly Activity Updates.

Consultation with other business and tourism groups was completed for the EIS and is reported in Appendix T1 (Social impact assessment). This assessment included regional tourism generated by Siding Spring Observatory and also impacts to local business. The assessment concluded that 'it is not anticipated that the project would have direct social impacts on the Observatory'.

Consultation with Paul Wild Observatory

Submissions stated that consultation had not been undertaken with the Commonwealth Scientific and Industrial Research Organisation at Paul Wild Observatory. They stated that consultation as necessary given the potential for impacts to occur.

Consultation for the project was undertaken in accordance with the *Environmental Planning and Assessment Act 1979*, the Secretary's environmental assessment requirements and the relevant NSW Government community consultation guidelines. The proponent has held consultation activities in relation to the industry, the project and its exploration and appraisal activities since late 2011—over five years prior to the lodgement of the EIS. Numerous consultation activities have been undertaken across the local Narrabri area and surrounds prior to and during production of the EIS as discussed above.

Consultation specifically with the Paul Wild Observatory was not considered to be necessary as project activities are not expected to impact the observatory's operations.

Radio telescope facilities like Paul Wild Observatory employ long baseline interferometry to record signals at frequencies typically in the range of 8 – 88 GHz.

As discussed in the project description in Chapter 6 of the EIS, the project would involve the establishment of a number of telecommunication towers across the project area. Based on current standards, the telecommunication towers would employ 2G to 4G LTE cellular systems and legacy VHF systems. Operating frequencies of these systems are typically in the range of about 700 MHz to 2.6 GHz for cellular systems and 148 – 174 MHz for VHF systems; much lower than the radio-astronomy frequencies.

Light emitted from the project would be in the range of 430 – 770 THz; that is, considerably higher frequencies that those being monitored by the observatory.

As such, the proposed telecommunications and lighting for the project would occupy greatly different frequencies to those signals recorded by radio telescopes and would not be a source of interference with the observatory's operations or land on which it is located.

6.10 Approach to the impact assessment

The approach to the impact assessment was described in Chapter 10 of the EIS. The chapter explained the assessment process including defining the project, gathering baseline information, assessing potential impacts, refining the project and identifying mitigation and management measures.

Potential environmental impacts were identified and then assessed according to environmental compliance, risk or significance. Environmental compliance was considered where the environmental impacts related to known guidelines or standards. Environmental risk was considered where impacts may occur depending on how activities or materials are managed. Environmental significance was considered where the sensitivity of the environmental value would be important in determining the nature of impact.

The approach to the impact assessment also provided a description of the Field Development Protocol and how it was applied to assess potential environmental impacts. The protocol determines constraints on field infrastructure including wells, access tracks, gas and watering gathering lines, water storages and telecommunication towers may be sited. Constraints applied to a range of environmental values such as occupied residences, watercourses, ecological values, Aboriginal cultural heritage values, nature reserves and conservation areas and Yarrie Lake Flora and Fauna Reserve. The constraints were informed by regulatory requirements and the findings of the environmental impact assessment. The Field Development Protocol including rules regarding constraints was detailed in Appendix C of the EIS, and a revised version is attached to this RTS as Appendix C.

121 submissions raised issues specifically relating to the approach to the impact assessment as described in Chapter 10 of the EIS. The majority of submissions that raised this issue were unique as the issue was not usually presented in form submissions. However, a subset of form submissions include some additional remarks regarding the approach to the impact assessment.

The division of submissions by issue and submission type is depicted in Figure 6-10.

Some submissions questioned the suitability of the Field Development Protocol as an impact assessment tool with regard to providing certainty for project approval under the *Environmental Planning and Assessment Act 1979*. These issues are discussed in Section 6.4.1.

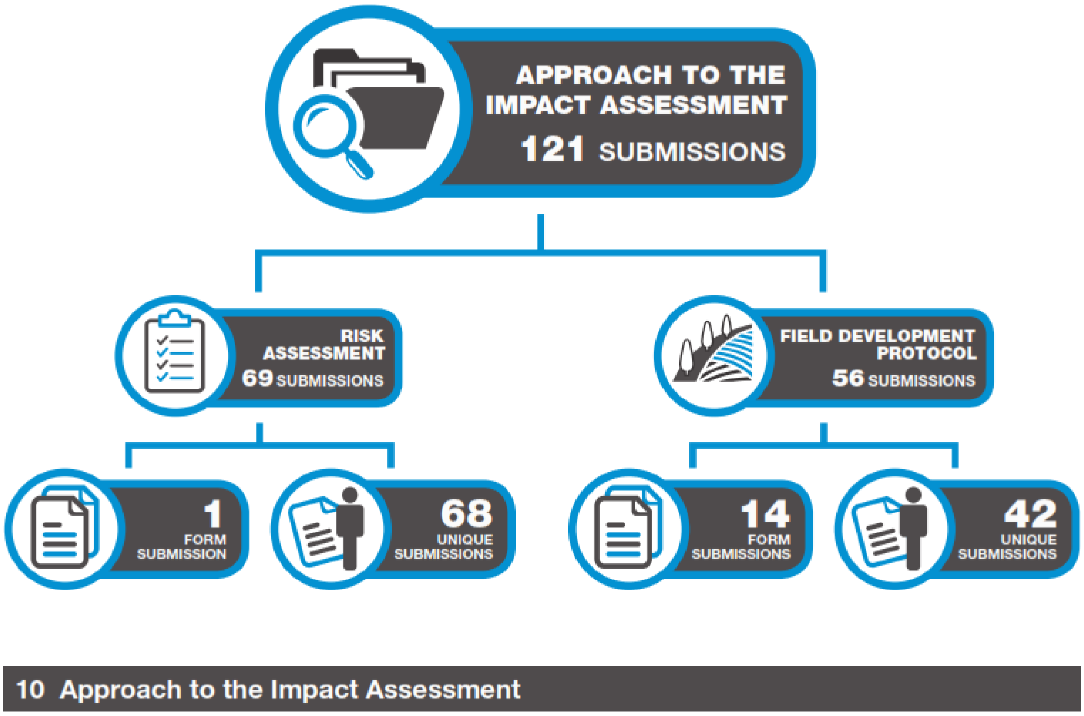


Figure 6-10 Summary of submissions on approach to the impact assessment

6.10.1 Risk assessment

Independence of assessment

Submissions stated that the environmental impact assessment lacked independence from the proponent and requested an independent environmental impact assessment including an independent Social Impact Assessment.

> The EIS assessed the potential impacts of the project on the environment in accordance with Secretary's environmental assessment requirements under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Conservation Act 1999*. The technical assessments, including the Social Impact Assessment (EIS Appendix T1), which comprised the EIS were undertaken by suitably qualified practitioners and in line with relevant guidelines and standards.

Risk assessment matrix

Submissions stated the risk assessment matrix used to determine risk levels in the environmental impact assessment was flawed and not transparent.

The EIS assessed the potential impacts of the project on the environment in accordance with Secretary's environmental assessment requirements under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Conservation Act 1999*. The technical assessments which comprised the EIS were undertaken by suitably qualified practitioners and in line with relevant guidelines and standards.

The process by which the impact assessment was undertaken in the project EIS is described in Chapter 10 of the EIS, including the use of assessing identified social and environmental issues using either a compliance, risk or significance assessment approach. This approach is consistent with impact assessment ethos and method as described by global leading practice advocates the IAIA (refer to http://www.iaia.org/fasttips.php). Section 10.2.1 within Chapter 10 of the EIS outlines the logic and rationale of the demarcation of assessment method by environmental and social discipline.

Assessment period

Submissions disputed the 25-year assessment period and stated that potential impacts should be quantified over a longer 100-year period.

A 25-year assessment period was adopted for the EIS and is considered adequate to assess the potential impacts of the construction, operation and decommissioning of the project. The commercial life of an individual gas well can be greater than 20 years, however, gas wells would be progressively decommissioned or converted to monitoring bores and well pads would be rehabilitated over the life of the project. Separately, it is noted that the Groundwater Impact Assessment (EIS Appendix F) assessed impacts out to around 1,000 years to fully understand the groundwater impacts from the proposed development.

6.10.2 Field Development Protocol

Field Development Protocol information

Submissions stated the assessment did not adequately describe the Field Development Protocol.

The Field Development Protocol was provided as Appendix C of the EIS and an updated version is attached as Appendix C of this RTS. It was developed based on impact assessment throughout the preparation of the EIS, and is therefore based on assessed risk. Section 6.3.2 of Chapter 6 of the EIS (Project description) summarised some of the constraints included in the Field Development Protocol that were derived from the impact assessment undertaken for the EIS, including:

- no project infrastructure within 200 metres of an occupied residence, unless otherwise agreed with the landholder
- no surface infrastructure within the Brigalow State Conservation Area and/or a 50 metre surface exclusion zone around the Brigalow State Conservation Area
- no surface infrastructure within 200 metres of Yarrie Lake (since updated to 'Exclusion of surface infrastructure from Yarrie Lake reserve (plus a 50 m buffer from Yarrie Lake reserve')
- production well pads would be spaced at least 750 metres apart
- maximum ecological disturbance limits by vegetation community and for individual threatened flora

- surface development exclusion areas for the 90 known Aboriginal cultural heritage sites
- surface development exclusion areas for identified historic heritage sites
- major facilities, non-linear field infrastructure and large ponds and dams are excluded from watercourses and a watercourse buffer zone, with widths determined by Strahler stream order
- large ponds and dams will be located outside of the one percent annual exceedance probability flood extent
- compliance with noise criteria at occupied residences, unless otherwise agreed with the landholder
- The Brigalow Nature Reserve is excluded from the project area.

The Field Development Protocol provides a framework that ensures the development of the project, particularly the siting of field infrastructure, minimises impacts on the environment and takes place in accordance with:

- relevant State and Commonwealth legislation, including:
  - Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
  - *Petroleum (Onshore) Act 1991* (NSW)
  - *Environmental Planning and Assessment Act 1979* (NSW);
  - *Protection of the Environment Operations Act 1997* (NSW)
  - *National Parks and Wildlife Act 1974* (NSW)
  - *Biodiversity Conservation Act 2016* (NSW)
- environmental impacts identified in the impact assessment reports that accompany this EIS
- environmental management plans or procedures
- conditions of approval.

The Field Development Protocol would apply for the life of the project, including each phase of field infrastructure development planning and design, construction, operation, and decommissioning and rehabilitation.

Developing the project through the implementation of the Field Development Protocol provides the necessary flexibility for locating field infrastructure, whilst ensuring environmental performance objectives are met throughout the life of the project.

In practice, the Field Development Protocol, along with other environmental requirements imposed through conditions of consent, would inform the micro-siting of well pads and field infrastructure. The process would also occur in consultation with relevant landholders and would be subject to landholder agreement. Well micro-siting, in accordance with the procedure set out in the Field Development Protocol, would be undertaken during detailed site surveys to further minimise the impact of the activity. Micro-siting refers to the practice of precisely locating a piece of field infrastructure to maximise avoidance of the most sensitive features and minimise impacts.

Once the Field Development Protocol has been used to microsite field infrastructure, a Plan of Operations detailing the location of the proposed infrastructure and other project activities will be prepared and submitted to the NSW Department of Planning and Environment and the Commonwealth Department of Environment and Energy prior to implementation. Government departments will have 28 days to review compliance with the approval conditions, and then implementation can commence.

Field Development Protocol variation

Submissions stated that the constraints contained in the Field Development Protocol could be varied in the future following approval.

The proponent is seeking consent for the project as described in Chapter 6 (Project description) of the EIS, including installation of up to 850 wells on up to 425 well pads with associated gas processing and ancillary water management infrastructure located in accordance with the Field Development Protocol as described in the EIS (or as amended by conditions of consent). Proposed variation to the Field Development Protocol if development consent is granted would require further assessment and approval under the *Environmental Planning and Assessment Act 1979*.

Field Development Protocol and landholder issues

Submissions stated the Field Development Protocol did not include adequate consideration of potential impacts to, and consultation with, landholders.

Landholder engagement and consultation is an important component of all stages of development. As stated in the commitments in Chapter 31 of the EIS, Land Access Agreements and Farm Management Plans would be developed in consultation with affected landholders.

In accordance with the *Agreed Principles of Land Access* (DRE 2015), gas wells will only be drilled on a landholder's property where there is a Land Access Agreement in place.

A Land Access Agreement will be required with each landowner before infrastructure may be located on the landholder's property.

A Farm Management Plan will be developed in liaison with landholders to document planned activities and indicative timing of these for both the landholder and the proponent to enable coexistence of activities to be managed effectively.

Assessment of Field Development Protocol

Submissions stated that the first eight steps outline in the Field Development Protocol should have been carried out as part of the environmental impact assessment.

The proponent is seeking consent for the project as described in Chapter 6 (Project description) of the EIS, including installation of up to 850 wells on up to 425 well pads with associated gas processing and ancillary water management infrastructure located in accordance with the Field Development Protocol. The potential environmental impacts of the project, including locating the project infrastructure in accordance with the Field Development Protocol, have been assessed under the *Environmental Planning and Assessment Act 1979*.

Field infrastructure including gas wells, gas and water gathering lines, roads and access tracks, water storages and telecommunication towers would be sited in accordance with the Field Development Protocol. The Field Development Protocol incorporates rules and constraints for the siting of field infrastructure whereby environmental impacts are systematically avoided, minimised and managed.

The carrying out of the project in accordance with the Field Development Protocol, which sets upper disturbance limits and other locational criteria, has been assessed in the EIS. The carrying out of the project consistently with the Field Development Protocol, including implementing the first 8 steps of the Protocol, ensures the project and its potential impacts are as assessed in the EIS and in accordance with the conditions of approval for the project.

The Field Development Protocol was provided as Appendix C of the EIS. An updated version of the Field Development Protocol is provided as Appendix C of this RTS.

6.11 Groundwater and geology

The Groundwater Impact Assessment was provided in Appendix F and summarised in Chapter 11 of the EIS. The Groundwater Impact Assessment was based on a regional groundwater model developed by a suitable qualified hydrogeologist in line with the relevant guidelines. The groundwater model was reviewed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), which concluded that it was ‘state of the art’ and suited to assess potential impacts of water extraction by the project.

The Groundwater Impact Assessment found that the project would generate a maximum drawdown of less than 0.5 metres occurring gradually over 200 years in the Namoi Alluvium and Pilliga Sandstone. Impacts were expected to be indiscernible from existing variations in groundwater that occur from existing extraction, replenishment from the environment and seasonal fluctuations.

Groundwater would be extracted in accordance with the water licensing provisions of the *Water Management Act 2000* and associated water sharing plans. The Act and plans set groundwater extraction limits to safeguard groundwater for environmental purposes that based on rainfall recharge. The project is estimated to extract around 1.5 gigalitres per year on average over 25 years. This amounts to around 0.7 per cent of the extraction limit under the *Water Management Act 2000*.

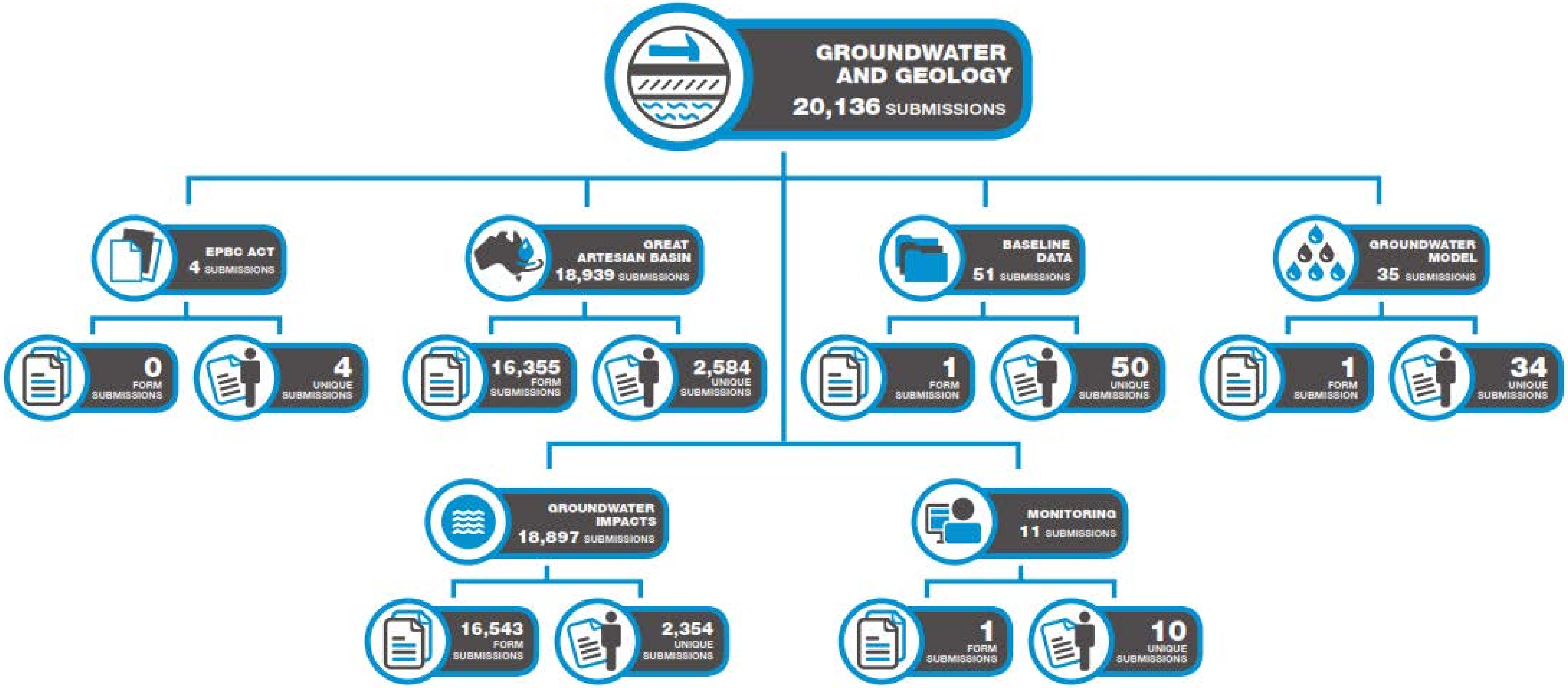
The proponent has committed to undertaking a groundwater monitoring program outlined in Appendix G3 of the EIS. The groundwater monitoring program would include monitoring bores installed to detected changes in the Namoi alluvium and Pilliga sandstone.

20,136 submissions raised issues specifically relating to groundwater and geology as described in Chapter 11 of the EIS. The majority of the submissions were form submissions however similar issues were also raised in a substantial number of other unique submissions.

The submissions primarily concerned potential impacts to the Great Artesian Basin or groundwater impacts more generally. Relatively few submissions specifically concerned baseline data, the groundwater model or proposed monitoring.

A number of submissions raised issues more specifically relating to potential impacts to human health through groundwater which are discussed in Section 6.26.

Figure 6-11 provides an overview of the submissions relating to groundwater and geology.



11 Groundwater and Geology

Figure 6-11 Summary of submissions on groundwater and geology

6.11.1 Great Artesian Basin

Project will not extract groundwater from the Great Artesian Basin

Several submissions mistakenly believed groundwater was to be taken from the Great Artesian Basin aquifers, causing drawdown and pressure loss and that drilling through the southern recharge area of the Great Artesian Basin will impact artesian conditions while the drilling will pose an unacceptable risk to the Great Artesian Basin from potential cross-contamination from polluted coal seam waters.

The submissions' assertion that the project will extract groundwater for use from the Great Artesian Basin is incorrect. There will be no extraction of groundwater from the Great Artesian Basin for the project.

Water extracted for gas development will come from the coal seams which are part of the Gunnedah-Oxley Basin (see Figure 6-12). This deeper water resource is referred to in NSW legislation as the Gunnedah Oxley Basin MDB Groundwater Source, which is a water source that is not used widely in the vicinity of the project area due to its depth and higher salinity.

Nevertheless, all water extracted for the project will be taken under an access licence issued by the NSW Department of Primary Industries, just as is the case for other water users including irrigators, industrial users, other resource developments and those drawing under licence for stock and domestic use.

Figure 6-12 represents a schematic of the hydrogeology of the region and illustrates the stacked nature of the aquifers and aquitards and the relationship between the target coal measures in the Gunnedah Basin sediments below the sediments of the Great Artesian Basin. Note the presence of impeding aquitards between the coal measures and the productive aquifers of the GAB and the Namoi Alluvium.

As the extraction of groundwater from the coal seams reduces the pressure in those formations, this results in a reduced vertical pressure gradient that indirectly results in groundwater exchange between the aquifers that are stacked upon each other.

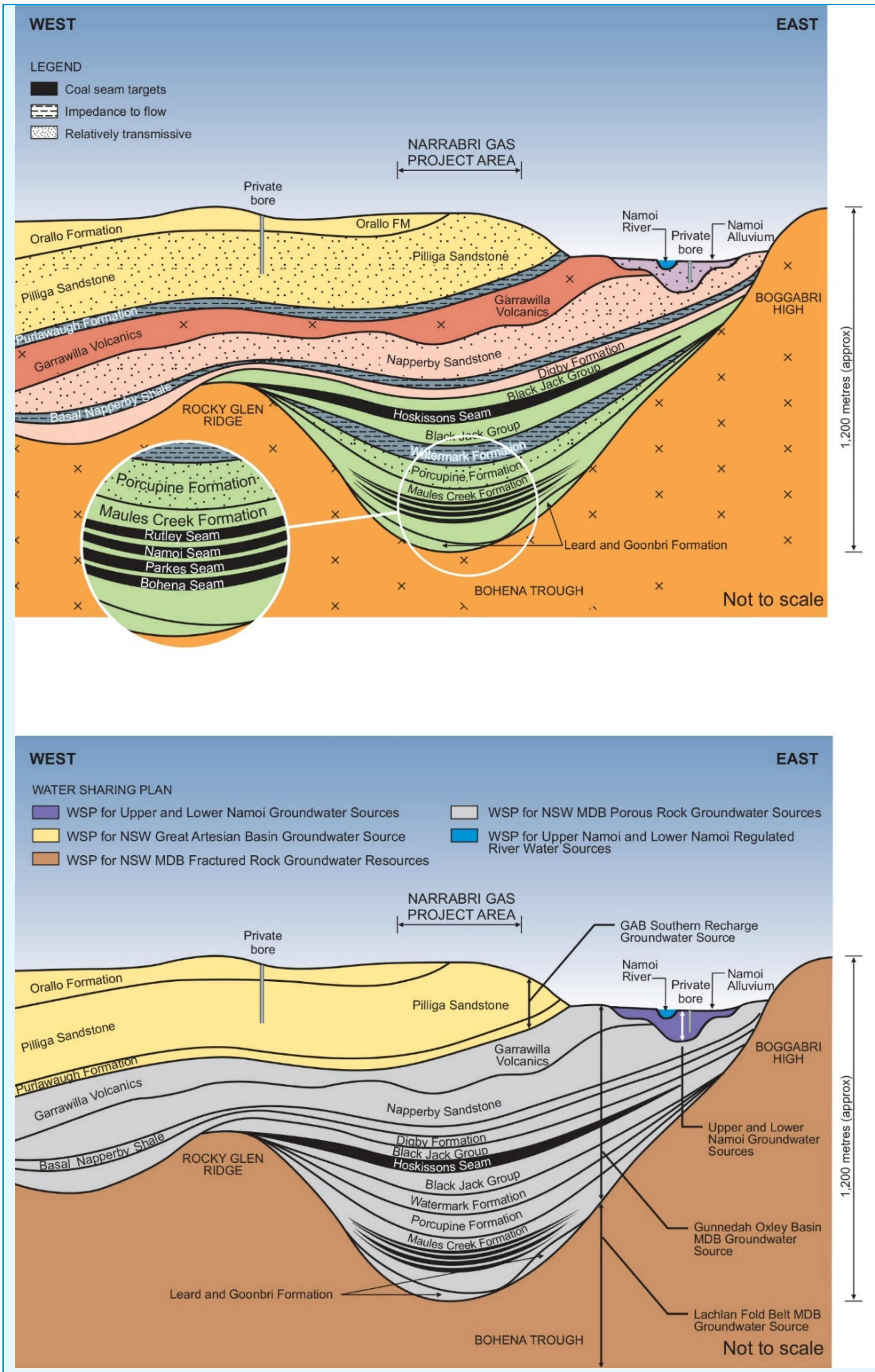


Figure 6-12 Schematic of the hydrostratigraphy of the project area

Modelling of existing groundwater transfer across the region (EIS Appendix F) indicates that about 100 megalitres per year is lost from the Pilliga Sandstone after all inputs and outputs are considered (Figure 6-13). Recent independent modelling of an alternative version of the project modelled an average 85 megalitre per annum loss from Great Artesian Basin aquifers (Sreekanth *et al*. 2017).

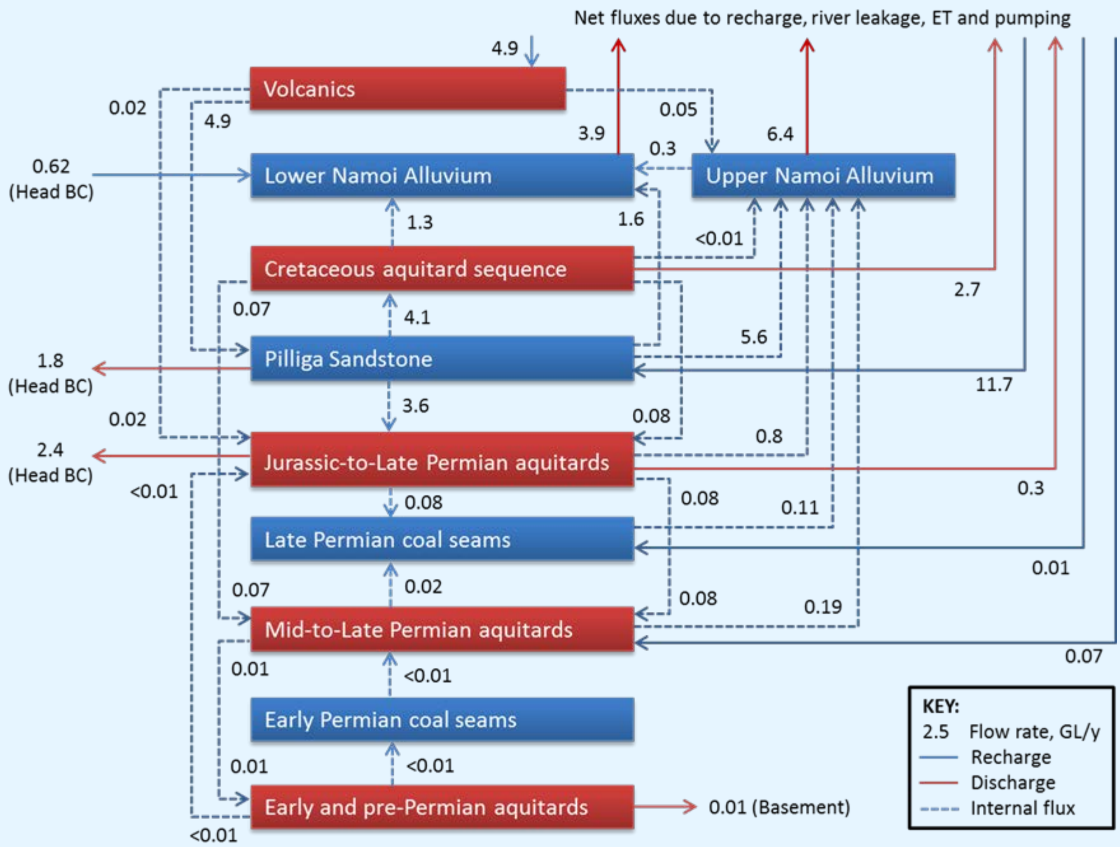


Figure 6-13 Steady-state water mass balance for the project area

As the flux is predominantly out of the Great Artesian Basin and other units and towards the coal measures, induced transfer of potential contaminants is towards the coal seam aquifers and not toward the Great Artesian Basin or alluvial aquifers.

The EIS (Appendix F) presents the net flux (take) to each groundwater source; Table 6-1, below, reports the maximum take from the base of each source, directly comparable to the definition of water take in the water sharing plans.

Further, analysis of the chemistry of the groundwaters, presented in the revised and updated Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS), demonstrates that there are no contaminants of concern in coal measures waters, though salinity levels are high and this results in elevated fluoride, lithium and barium levels. Radioactive elements were not detected above detection limits.

All water extracted for the project will be taken under an access licence issued by the NSW Department of Primary Industries, just as is the case for other water users including irrigators, industrial users, other resource developments and those drawing under licence for stock and domestic use.

Current predictive modelling indicates that the project will have no impact on existing entitlement holders. If it becomes apparent through modelling and monitoring reviews that any project water management actions are having an impact, the proponent will enter into a 'make good' arrangement with that licence holder.

Table 6-1: Peak induced flows (maximum take) for the EIS Base Case

Groundwater source	EIS Base Case (37.5 GL) Peak flux change at source base	
	ML/y	Time (years after start of FDP, to nearest model time step)
Gunnedah-Oxley Basin	3,553	3
GAB Southern Recharge	57.3	190 - 200
GAB Surat	0.16	950 – 1,000
NSW GAB Surat Shallow	<0.16	>1,000
Lower Namoi Alluvium	4.19	250 – 300
Upper Namoi Alluvium (UNA) UNA Zone 2 UNA Zone 5	1.00 0.16 0.90	250 – 300 550 – 600 250 - 300

In relation to well construction activities, the wells will be constructed in accordance with the NSW *Code of Practice for Coal Seam Gas Well Integrity*. Chapter 6 (Project description) of the EIS (page 6-54) provides details on the process for well installation. The process includes:

- The surface hole will be drilled to isolate aquifers and prior to interception of hydrocarbon zones. Surface casing will then be run into the hole and cemented with cement returns back to surface to isolate aquifers.
- The production hole will then be drilled to the required depth. Production casing will then be run into the hole and cemented with cement returns (as a minimum requirement as per the *NSW Code of Practice for CSG Wells*) back inside the previous casing string of the surface casing.
- These two cemented casing strings help minimise the chance of aquifer contamination from production casing well failure.

All mandatory requirements outlined in the *NSW Code of Practice for Coal Seam Gas Well Integrity* will be adopted. In general, the proponent will also adopt all of the good industry practices outlined in the *NSW Code of Practice for CSG Wells*, with local site and well conditions and operations dictating the final set of best industry practice measures that will be implemented.

Great Artesian Basin recharge in the project area

Submissions questioned the assessment that the project was not in a major recharge zone of the Great Artesian Basin and requested supporting evidence. They asserted that the project was in the southern recharge zone of the Great Artesian Basin with some stating the highest recharge rates were in Pilliga East State Forest.

Submissions cited research including Soilfutures (2015), Habermahl *et al.* (1997), Brownbill (2000), Herczeg *et al*. (2008) Smerdon and Ransley (2012) that mapped the project area as being within a recharge zone of the Great Artesian Basin (refer to Currell (2017) for references).

They stated that the assessment should have demonstrated field validation of recharge processes to the Great Artesian Basin.

Studies by the Bureau of Rural Sciences and Geoscience Australia on the recharge beds of the southern Great Artesian Basin determined that the area immediately in the vicinity of the project constitutes a low recharge area as the Pilliga Sandstone outcrop is limited and rainfall is relatively low for the region.

Primary recharge to this region occurs via the Warrumbungles, located south of the project area, where higher rainfall and greater outcrop area exists (Figure 6-14).

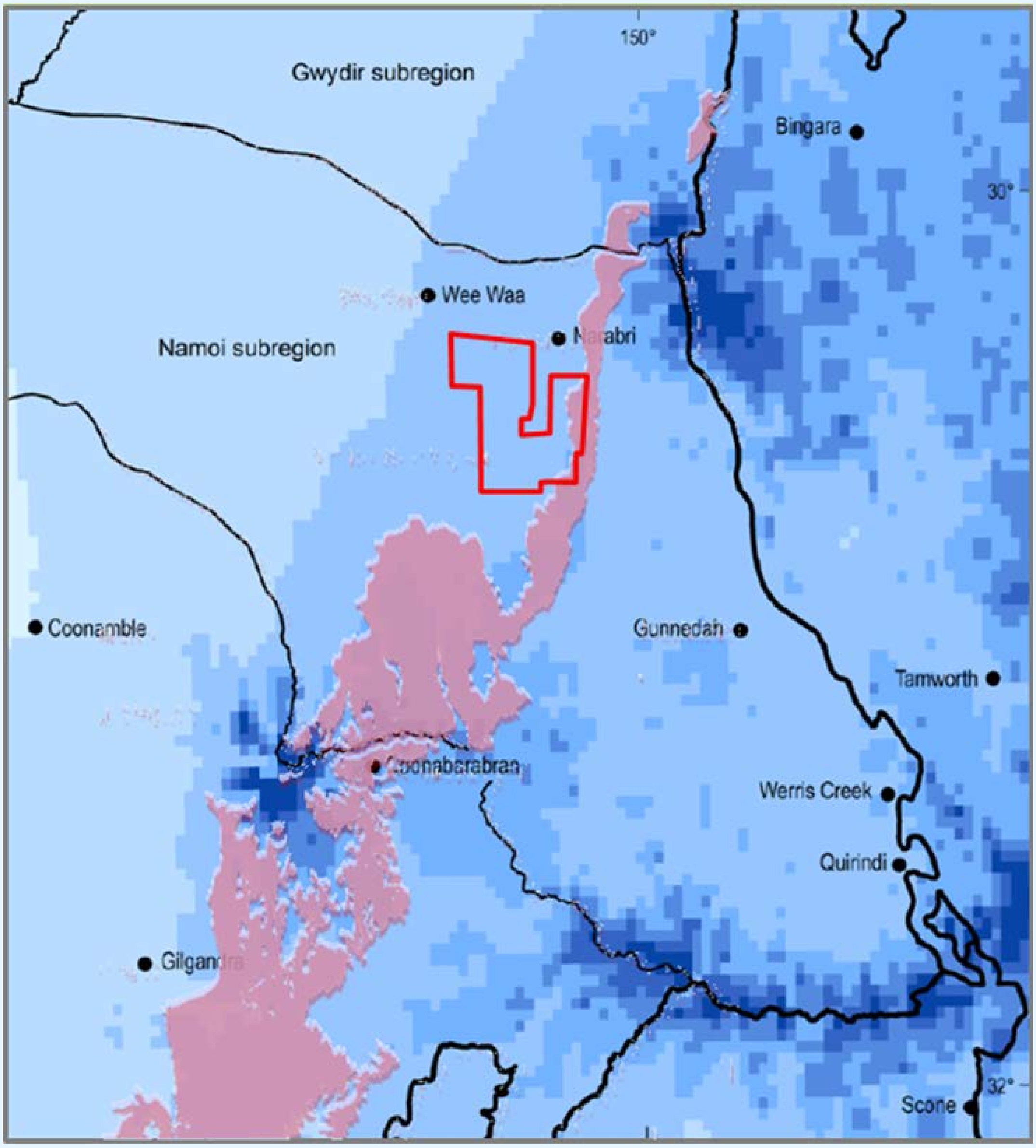


Figure 6-14 Rainfall (blue gradient) and Pilliga Sandstone outcrop (pink shading) in the Narrabri - Gunnedah region

Indirect recharge does occur via the overlying colluvium (soils and weathered materials overlying the Pilliga Sandstone) in the area, though this is impeded and reduced due to poor transmissivity soils and high evaporation rates during the wettest months (summer).

A recent modelling exercise by GISERA (Sreekanth *et al*. 2017) re-designated the entire region as a recharge zone, but differentiated between low and high recharge areas (Figure 6-15), based on the recharge assessments carried out by Geoscience Australia and CSIRO for the Great Artesian Basin Water Resource Assessment project (Smerdon and Ransley 2012). The project is clearly defined within a low recharge zone (<5 mm/year) of the Southern Recharge Area of the Great Artesian Basin (blue areas of high recharge (>40 mm/year) grade to low areas in brown (<5mm/year) on Figure 6-15.

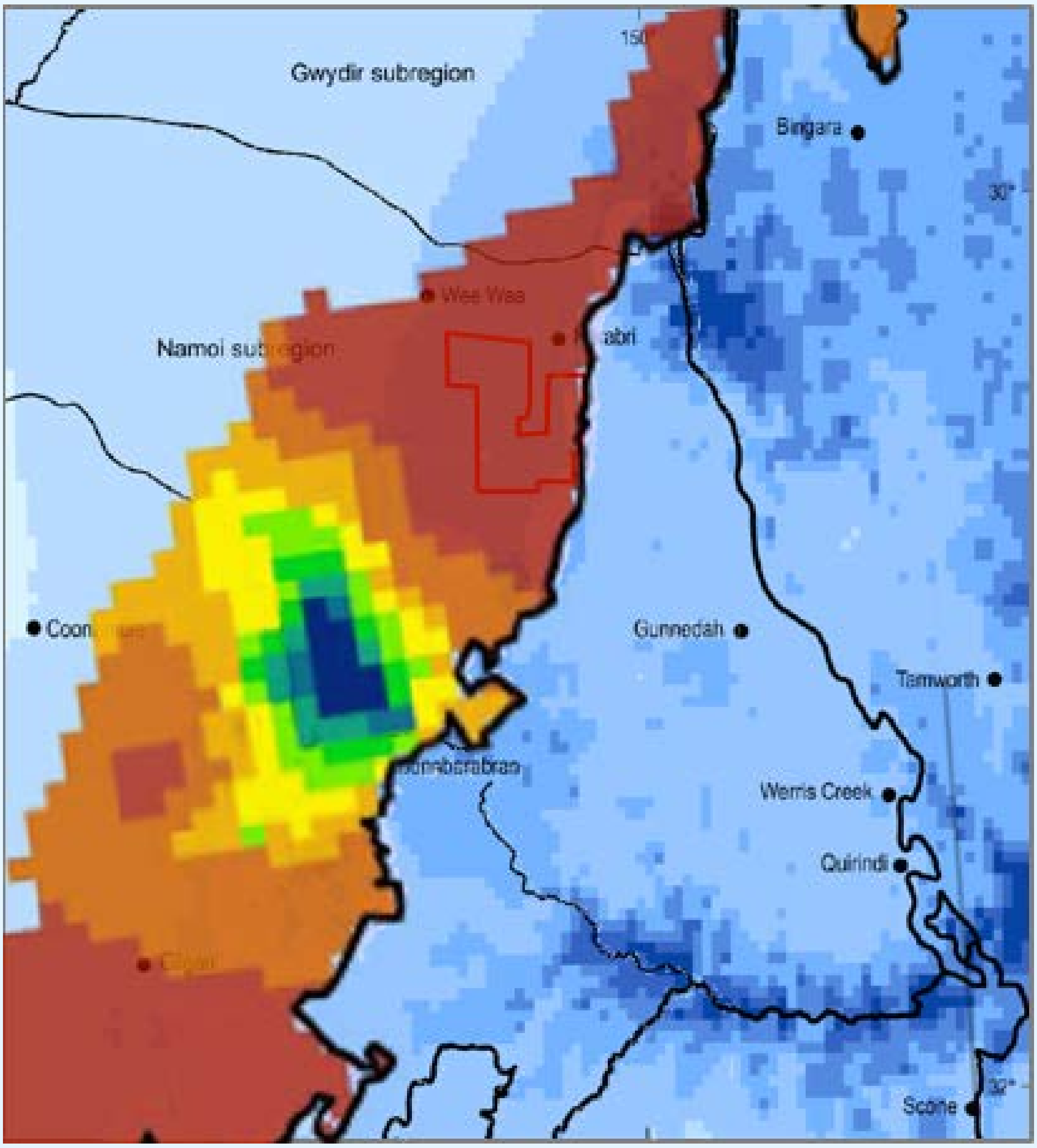


Figure 6-15 Modelled recharge to the sub-crop areas of the Pilliga Sandstone within the Southern Recharge Zone for the Great Artesian Basin

This evidence is not in contradiction to the work cited in the submissions. At the appropriate scale and location of the project, as shown above, it can be observed that the project is not in a major recharge area of the GAB.

Impacts to the Great Artesian Basin

Submissions stated that drilling of coal seam gas wells through the Great Artesian Basin into the underlying Gunnedah-Oxley Basin will depressurise the Great Artesian Basin and cause contamination of Great Artesian Basin groundwater sources.

Submissions stated that drilling through shallow aquifers into target coal seams would provide flow pathways. They stated flow pathways would allow for diversion of groundwater flows and cross contamination between the coal seams and aquifers of the Great Artesian Basin.

Submissions stated that the impacts of the project on the Great Artesian Basin would have flow on effects to bores, springs, wetlands and other dependent ecosystems. Submissions also stated that drawdown in the Great Artesian Basin would reduce resilience during drought.

Submissions stated that the project and other natural gas projects were undermining the successes of the Great Artesian Basin Sustainability Initiative (GABSI). They stated that the GABSI involved capping and sealing of bores to increase groundwater pressure and secure groundwater resources in the Great Artesian Basin. They stated that around 300 known wells were leaking water from the Great Artesian Basin.

They stated that the project and other natural gas projects were undoing the progress made by the GABSI by draining or diverting water from the Great Artesian Basin.

Submissions stated the project and other projects such as the Carmichael Coal Mine and other natural gas projects would have cumulative impacts on the Great Artesian Basin. Submissions stated that about 80 per cent of the Great Artesian Basin was covered by exploration licenses and production leases in NSW. They stated that about 69 per cent of the Great Artesian Basin was covered by exploration licenses and production leases in Queensland.

Coal seam gas wells will be installed through the Great Artesian Basin into the Gunnedah-Oxley Basin where water will be extracted from target coal seams in the Gunnedah-Oxley Basin. There will be no direct extraction of water from the Great Artesian Basin, and therefore, a very limited potential to indirectly depressurise the Great Artesian Basin. Potential indirect (induced) effects on water pressure in the Great Artesian Basin due to propagation of depressurisation in the underlying Gunnedah-Oxley Basin are assessed in detail in the Groundwater Impact Assessment (EIS Appendix F). Groundwater monitoring bores installed into the Great Artesian Basin and Gunnedah-Oxley Basin will intersect the Great Artesian Basin but will not extract water.

The EIS commits to installing all coal seam gas wells in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* and all water bores in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC 2012) including the mandatory requirements and the recommendations for good industry practice.

Potential for contamination of groundwater by drilling activities and drill holes is assessed in the risk assessment of the Groundwater Impact Assessment in Section 7.4.2 “Aquifer Connectivity via Wells”. The risk assessment concludes that properly constructed coal seam gas wells and groundwater monitoring bores pose a very low risk for gas or water migration between formations due to unlikely occurrence of leakage and the minor consequence of leakage. In general, the construction of drill holes for the project poses less risks than the drilling of water bores by existing users throughout the Great Artesian Basin.

Additionally, the proponent notes that the Great Artesian Basin Sustainability Initiative considers the entire Great Artesian Basin, whereas the project is located within the Coonamble Embayment, located at the extreme south-east margin of the Great Artesian Basin (Figure 6-16). The Coonamble Embayment represents a very small fraction of the Great Artesian Basin, and the water resource assessment for the Surat region conducted by the Commonwealth Government (Smerdon and Ransley 2012) concluded the Coonamble Embayment is “an isolated part of the Great Artesian Basin, with discharge and recharge occurring within the embayment and little connection (if at all) to the remainder of the Great Artesian Basin outside of New South Wales.”

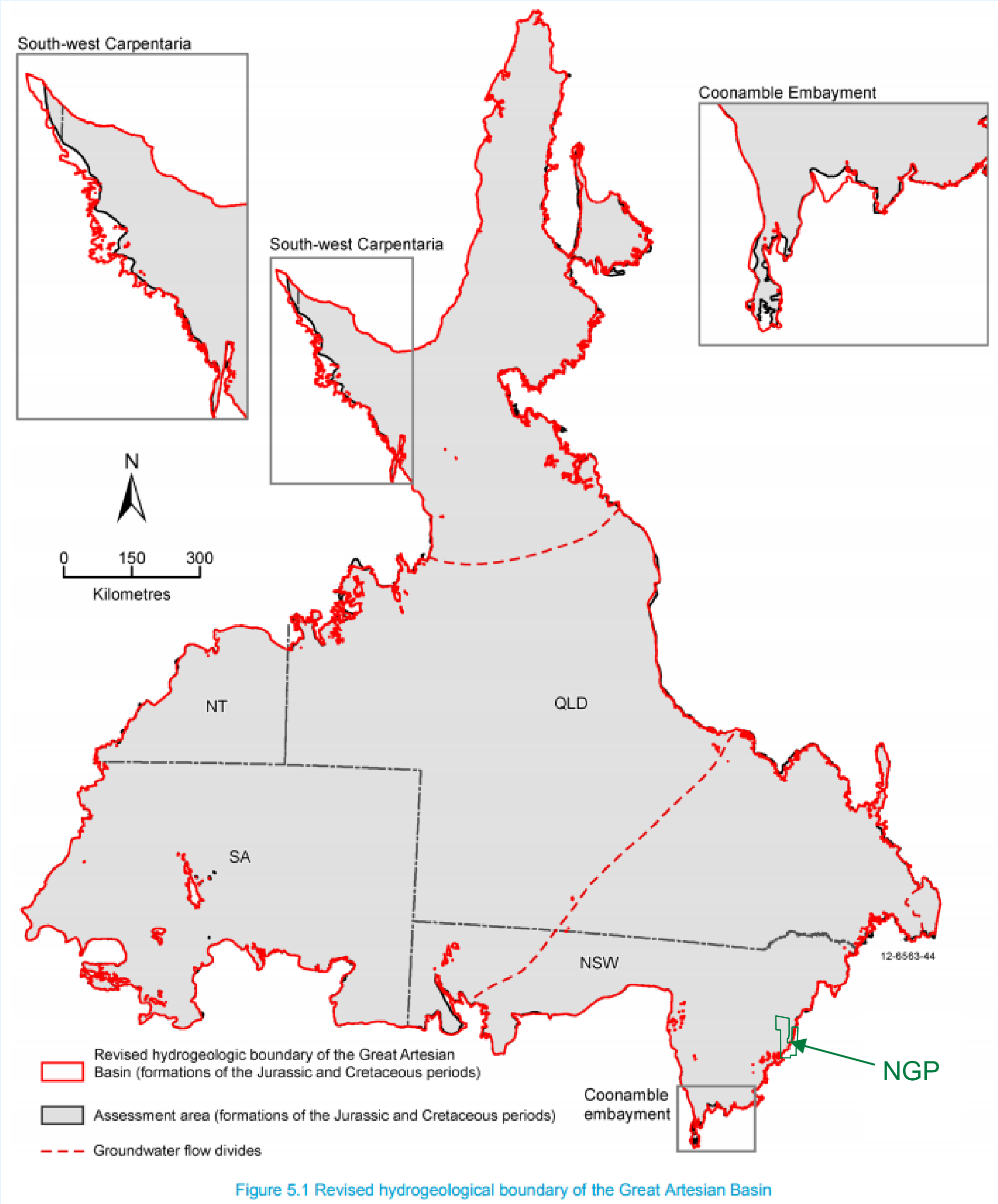


Figure 6-16 Location of the project in relation to the Great Artesian Basin (cf. Smerdon *et al*. 2012)

Within this context, the proponent considers there is negligible potential for the project to compromise the success of the Great Artesian Basin Sustainability Initiative. Even within the Coonamble Embayment, the projected impacts on the Pilliga Sandstone will not compromise the significant gains made by the local cap and pipe program of GABSI. This is because the maximum drawdown in the Pilliga Sandstone is predicted to be less than 0.5 metres in around 200 years’ time. Potential impacts are expected to be indiscernible from the existing variations in groundwater pressures and storage volumes that occur in response to existing uses and replenishment with seasonal variations.

Future groundwater extraction by other developments located within the Gunnedah-Oxley Basin and Great Artesian Basin are considered in the Groundwater Impact Assessment (EIS Appendix F) in

Section 5.5.6 “Existing and Approved Mine Dewatering”. The Narrabri Coal Mine is identified as the only existing or approved development with predicted groundwater impacts that may coincide with potential groundwater impacts of the project. Potential cumulative impacts of the Narrabri Coal Mine and the project are assessed in the Groundwater Impact Assessment in Section 6.9.4 “Narrabri Coal Mine and Base Case Simulated Water Production”.

The proponent notes that the proposed Carmichael Coal Mine is located in the north of the Galilee Basin in Central Queensland and is hydraulically not connected to the groundwater of the Coonamble Embayment.

Connectivity of Purlawaugh formation

Submissions disputed the groundwater assessment finding that the Purlawaugh Formation was not part of the Great Artesian Basin. They stated that this finding was in contradiction to the Namoi Water Study. They also stated that the finding was based on qualitative descriptions and requested hydrogeochemical data to support the finding of the assessment.

The proponent agrees that the Purlawaugh Formation is included in the Great Artesian Basin sequence and the EIS does not find or conclude that the Purlawaugh Formation was not part of the Great Artesian Basin.

The Great Artesian Basin Water Resource Assessment for the Surat region conducted by the Commonwealth Government (Smerdon and Ransley 2012) classifies the Purlawaugh Formation as an aquitard of the Great Artesian Basin. The Namoi Water Study (SWS 2010) also classified the Purlawaugh Formation as part of the Great Artesian Basin (Surat Basin) with reference to Tadros (1993).

6.11.2 Baseline data

Adequacy of baseline data

Submissions stated that the presentation and interpretation of hydrogeological baseline data in the EIS are inadequate. One submission questioned whether all data relating to the hydrogeological properties of the Great Artesian Basin and Gunnedah-Oxley Basin strata were used to inform the EIS (e.g. information from aquifer pumping tests).

The proponent has updated, and re-issued the Water Baseline Report (Appendix D) as part of this Response to Submissions.

Specifically, the proponent notes:

- All available hydrogeological data is presented in the revised Water Baseline Report with assessment of its capability to provide interpreted surfaces. This includes all water level / water pressure data and hydraulic properties reported by hydro-geological formation and described spatially in relation to the project.
- The data on hydrogeological properties summarised in Section 5.3 and Appendix C of the Groundwater Impact Assessment (EIS Appendix F) (for target seams and overlying geological

units) are referenced to their sources and are publicly available. Relevant data compilations are explicitly described and presented in the updated Water Baseline Report.

All available hydrogeochemical data has been analysed and revised, expanded and up-dated summaries of this data is presented in the Water Baseline Report. This includes data for all analytes raised in submissions.

Monitoring for methane

Submissions stated the assessment did not consider the potential for methane to enter groundwater through gas wells or geological faults. They stated the assessment should have included measures to minimise pathways for fugitive methane to enter groundwater and a plan to monitor methane in groundwater. They stated the plan to monitor methane in groundwater should have included recording of baseline methane, other dissolved gases and their isotopic characteristics. They referred to baseline methane monitoring undertaken as part of the Gippsland Bioregional Assessment project that included isotopic characteristics to determine gas origin.

Some also stated that other pathways for fugitive methane to enter groundwater would include other wells in the project area whether active, inactive or abandoned such as groundwater wells. They stated that rapid response programs would be required to remedy detected leaks.

The proponent notes that most gas data from waters have been collected recently by the proponent via its network of dedicated monitoring bores, augmented by sampling of local landholder bores and DPI Water monitoring bores. This data is incorporated into the revised Water Baseline Report (EIS Appendix G4 and Appendix D to this RTS).

In general, methane is observed at low and varying levels in all formations above the target formations, though most groundwater samples from across the monitoring network do not record hydrocarbons above limits of reporting. There is no spatial coincidence between elevated levels in different formations, though elevated levels in deeper formations may relate to underlying conventional gas reserves or seepage losses from deeper coal measures.

Alluvium groundwaters with elevated methane occur along the Namoi River, north-east of the project. Alluvium- and colluvium-sourced groundwaters above and adjacent to gas exploration sites show negligible to below background methane levels, indicating that gas is not escaping to the surface related to these development activities.

Results of analyses conducted for dissolved methane in collected produced water samples are included in Section 6 (Produced Water Quality) in the updated Water Baseline Report (Appendix D to this RTS). Sampling is carried out using different procedures for water table bores, deep confined bores, artesian bores and production bores (including pilot wells). In all cases, sampling is carried out to minimise potential cross-contamination and exposure to the atmosphere and analyses are undertaken at NATA-accredited laboratories that are in analysing samples from oil and gas fields.

Gas sampling has been undertaken by GISERA (https://gisera.csiro.au/research/greenhouse-gas-and-air-quality/) and other academics and this data has been variously reported in the academic and white literature. Notably, no emissions were detected from recent analysis at 32 mobile sites across the project area (Ong, *et al*. 2017), though earlier surveys did record slightly elevated levels at some wells (up to 10 ppm), though the same wells recorded no elevated levels on other occasions (Day *et al*. 2016).The Commonwealth Scientific and Industrial Research Organisation (CSIRO) conducted a study that aimed to develop methods for characterising methane and other gaseous emissions from different area sources in NSW, particularly the coal seam gas industry (Day et al. 2016). The study showed that methane levels attributed to coal seam gas operations were low relative to other sources.

Sustainable diversion limits

One submission stated that Table 11-1 in the Geology and Groundwater chapter of the EIS contained incorrect information; specifically, that there are no proposed sustainable diversion limit reductions for Upper and Lower Namoi Alluvium, and the sustainable diversion limit for the Gunnedah-Oxley Basin has been reviewed under the Northern Basin Review.

The proponent acknowledges that the stated reductions in sustainable diversion limits for the Lower Namoi Alluvium and Upper Namoi Alluvium in Table 11-1 are outdated, and instead represent the proposed reductions to guide sustainable diversion limits that were under consideration at the time of the proposed Basin Plan. There are currently no sustainable diversion limit changes proposed for the Lower Namoi Alluvium and Upper Namoi Alluvium.

An adjustment of the sustainable diversion limits for the Gunnedah-Oxley Basin from 114.5 gigalitres per year to 127.5 gigalitres per year was recommended under the Northern Basin Review but is not adopted (https://www.mdba.gov.au/basin-plan-roll-out/basin-plan-amendments/basin-plan-amendments-groundwater).

6.11.3 Groundwater model

Adequacy the of model

Several submissions considered the groundwater model used for the EIS is not fit-for-purpose and is based on inadequate estimates of hydrogeological properties.

Submissions stated that the groundwater model was not calibrated against field observations. They stated that this undermined the credibility of the model and its predictions.

They stated that there were insufficient field observations to validate assumed or generic values and conclusions including the geological separation of target coal seams.

Submissions made reference to specific baseline parameters including vertical hydraulic conductivity particularly in deeper hydro-stratigraphic units.

They stated that the proponent should be required to establish local and regional models with a higher level of confidence to satisfy Geosciences Australia and the National Water Commission.

A submission stated that the groundwater model does not match the finer resolution MODFLOW models developed by Merrick (2001) and McNeilage (2006).

The EIS groundwater model has been reviewed by the CSIRO against the review criteria established in the Australian Groundwater Modelling Guidelines (Barnett *et al* 2012). In relation to whether the model was considered fit for purpose, the review stated:

- “The groundwater flow model presented is an adequate representation of the regional groundwater flow system in the Gunnedah Basin and the model is suited to make simulations to meet the above stated model objectives”; and
- “The reported impacts are a good summary of, and true to, the model simulated values. Considering the availability of data and the limitations of numerical modelling, the reported conclusions on the impacts of the proposed coal seam gas development of the proponent on changes in water balance, pressure head and water table are justified.”

Alternative simulation scenarios

Submissions stated that the modelling does not consider alternative hydrogeological conceptual models, and the modelling fails to present a ‘worst case’ scenario.

Section 5 “Conceptual Hydrogeological Model” of the Groundwater Impact Assessment (EIS Appendix F) explains the conceptual model for the EIS is based on the conceptualisations of existing studies, including modelling of shallow alluvial sources within the Lower Namoi alluvium (Merrick 1999, 2000, 2001), the Lower Gwydir alluvium (Bilge 2002), the Upper Namoi alluvium (McNeilage 2006) and the Lower Macquarie alluvium (Bilge 2007).

Conceptualisation of the deeper groundwater sources in the EIS is based on investigation and modelling of the Great Artesian Basin (Radke *et al*. 2000; Welsh 2000, 2006) and modelling of the Gunnedah-Oxley Basin for the Namoi Catchment Water Study (SWS 2011, 2012). To the proponent’s knowledge, alternative hydrogeological conceptualisations of the Gunnedah Basin have not been proposed and the conceptualisation used in the EIS is directly comparable to that used in groundwater modelling of the area by the CSIRO’s Gas Industry Social and Environmental Research Alliance (GISERA) and for the bioregional assessments undertaken by the Commonwealth Government.

To the proponent’s knowledge, therefore, the conceptual hydrogeology of the project area is not disputed by the hydrogeological community and the use of alternative groundwater conceptual models for the project area is therefore not justified.

The method used for assessing predictive uncertainty in the EIS groundwater modelling is presented in Section 6.10 “Model Uncertainty and Sensitivity” of the Groundwater Impact Assessment (EIS Appendix F).

The independent review of the EIS groundwater modelling by CSIRO states “The sensitivity analysis can be considered a qualitative uncertainty analysis, showing the extremes of the plausible ranges of parameter values. In this case, it is a valid alternative to a formal uncertainty analysis in which estimates of the probability of each prediction (corresponding to a particular plausible combination of parameter set and water production curve) are provided.”

A more recent groundwater modelling exercise of the project by GISERA (Sreekanth *et al*. 2017) considered probabilistic results based on 500 realisations of the model parameters. For a range of water production volumes between 4.4 gigalitres and 107 gigalitres (compared to the EIS Base Case of 37.5 gigalitres) the GISERA report concluded “…changes to the water balance components induced by the gas development are relatively small compared to the probabilistic estimates of their baseline values.” Overall, the findings and conclusions of the GISERA report regarding potential impacts of the project on high-valued water sources are consistent with the conclusions in the project EIS.

The GISERA modelling did, however, assume water extraction from coal seams in the ratio of 50 per cent from Late Permian (shallowest) coal seams and 50 per cent from Early Permian (deepest) coal seams. This modelling differs from the field development plan for which approval is sought under the EIS, which is based on water extraction from coal seams in the ratio 5 per cent from Late Permian (shallowest) coal seams and 95 per cent from Early Permian (deepest) coal seams. Thus, the GISERA modelling extracted more water than is proposed from coal seams located closer to the Great Artesian Basin, and thereby over-estimated potential impacts on the Great Artesian Basin.

The existing sensitivity and uncertainty assessment in the Groundwater Impact Assessment of the EIS considers model parameters that result in significantly larger drawdowns than the EIS Base Case; however, the sensitivity simulations with the largest impacts also represent the leakiest conditions that would be unlikely to support gas production.

Determination of model parameters

Submissions stated the assessment did not provide adequate baseline data for vertical hydraulic conductivity and that this would lead to inaccurate estimations.

Submissions stated the assessment used inaccurate methods to estimate groundwater recharge in the project area. They also queried the adoption of one per cent of rainfall.

They stated that chloride mass balance was a more accurate method and estimated recharge of Pilliga Sandstone at 28.5 mm/year using this method.

They note their estimate value was higher than that of the conceptual model. They stated the potential underestimation of groundwater recharge indicated that risks to groundwater may have been underestimated in the groundwater impact assessment.

Submissions stated that localised core analysis and short term hydraulic pump tests would underestimate the hydraulic connectivity of groundwater units at the regional scale.

Submissions stated that there are inconsistencies between the estimates of vertical groundwater flux between the Great Artesian Basin and Namoi Alluvium as simulated in the EIS groundwater modelling compared to the existing estimates by McNeilage (2006) and Merrick (2001) which inform the water sharing plans for the Upper and Lower Namoi Alluvium Groundwater Sources.

Numerous lines of evidence were used to derive values that could best parameterise the formations and zonation in the groundwater model. After consideration of all available information and comparison to previous studies and models for the region, it was determined that many of the derived parameters were in comparable ranges to those reported in the literature for comparable lithologies. This realisation provided both confidence that regional and local modelling studies are in agreement with theoretical considerations and that parameterisation of units for which there are insufficient field data is likely to be appropriate for the numerical modelling exercise.

To provide further justification and explanation for the specific parameterisation of the numerical model, this question is best answered by separate consideration of the Great Artesian Basin and alluvial aquifers, as discussed below.

Great Artesian Basin

A review of groundwater modelling of the Great Artesian Basin (Smith and Welsh 2011) found that there is no available data on the spatial distribution of hydrogeological properties within the project area. Subsequent modelling of the Great Artesian Basin and Gunnedah-Oxley Basin for the Namoi Catchment Water Study (SWS 2012) adopted uniform hydrogeological properties in the Great Artesian Basin of this area. More recent groundwater modelling, specifically considering the project area by GISERA (Sreekanth *et al*. 2017 – published subsequent to the project EIS), implemented a spatially-uniform, but depth-dependent, relationship for horizontal hydraulic conductivity and specific storage in the Great Artesian Basin and Gunnedah-Oxley Basin. The spatial distribution of vertical hydraulic conductivity was not described in that report.

Within the EIS, Table 5-2 in the Groundwater Impact Assessment (EIS Appendix F) describes a limited number of very localised (falling head) measurements of hydraulic conductivity in Great Artesian Basin and Gunnedah Basin strata. These, however, are local-scale point measurements that do not directly scale to model cells, which represent a minimum area of one square kilometre in the EIS groundwater model.

There are, thus, insufficient data to support a defensible regional-scale interpolation of the spatial distributions of hydrogeological properties in the Great Artesian Basin.

In this circumstance, order-of-magnitude values of hydrogeological properties informed by existing estimates is considered the only practicable choice for groundwater modelling. It is worthwhile noting that while hydraulic conductivity and specific storativity are assigned as uniform values within aquifer layers, the transmissivity and storage coefficients for the layers derived from these properties are not uniform because they also depend on layer thickness, which varies spatially.

Estimates of hydrogeological properties in Table 5-3 of the Groundwater Impact Assessment, therefore, are values adopted specifically for groundwater modelling studies and do not constitute measurements or field-based estimates of these parameters.

Namoi alluvium

The scale of the EIS groundwater modelling is such that the Namoi alluvium is represented with a single model layer. It is impracticable in this model to directly adopt spatial distributions of hydrogeological properties from the multi-layered Upper Namoi and Lower Namoi aquifers as has been done for more local-scale models. Specifically:

- The Upper Namoi groundwater model (McNeilage 2006) and Lower Namoi groundwater model (Merrick 2001) used two and three layers, respectively, to represent the Narrabri, Gunnedah and Cubaroo formations within the alluvium.
- Other differentiating factors between the alluvial groundwater models and the EIS groundwater model include the relative sizes of model cells and the extent of coverage of the alluvium by each model due to different model boundaries.

In this circumstance, therefore, order-of-magnitude values of hydrogeological properties, informed by the existing estimates, is considered the only practicable choice for assigning hydrogeological properties in the single layer representing the alluvium in the EIS groundwater model.

Modelling predicts that no significant impacts will occur in high value groundwater sources, therefore, local scale models will not provide additional information.

Further, local nested models would not work well within the basin setting of the project because predicted depressurisation in the deep coal seams first spreads laterally at depth within the target seams before much slower vertical propagation into over lying strata. In this situation, it is not practical to ‘cookie cut’ a local scale model since the local boundary conditions over time are not defined. More generally, there is no advantage in developing a local-scale model unless additional local-scale data are available to inform better representation of geometry or better representation of the proposed stresses on the local water source. Neither of these circumstances applies to the EIS groundwater modelling.

Simulated vertical flux between the Great Artesian Basin and Namoi Alluvium

Submissions stated that there are inconsistencies between the estimates of vertical groundwater flux between the Great Artesian Basin and Namoi Alluvium as simulated in the EIS groundwater modelling compared to the existing estimates by McNeilage (2006) and Merrick (2001) which inform the water sharing plans for the Upper and Lower Namoi Alluvium Groundwater Sources.

It should be noted that the EIS model only considers the Namoi Alluvium as a single layer and hence does not treat the Lower Namoi Alluvium and Upper Namoi Alluvium separately. However, investigation into the spatial variability of the Lower Namoi Alluvium and Upper Namoi Alluvium and consideration of the separate consequences of leakage between the alluvium and the underlying Great Artesian Basin has been undertaken. These investigations and comparison to others' work is summarised below.

Part 1 – Great Artesian Basin to Lower Namoi Alluvium

Several previous estimates of artesian leakage between the Great Artesian Basin and Lower Namoi Alluvium are reported in the hydrogeological literature, predominantly for the area of alluvium located between Narrabri and Wee Waa. Aquitards that elsewhere separate the Great Artesian Basin and Lower Namoi Alluvium are largely absent in this area, which creates a stronger vertical connection between the Great Artesian Basin and Lower Namoi Alluvium groundwater sources. The EIS groundwater modelling represents this area of enhanced connection through the absence of aquitards and computes vertical leakage between the Great Artesian Basin and Lower Namoi Alluvium that is broadly consistent with the existing estimates reported in the literature (noting that there is a flux accounting error in Figure 6-18 of the Groundwater Impact Assessment (EIS Appendix F) that is corrected in Table 6-2, below).

Calf's (1978) finding was qualitative and inferred there was artesian recharge of the alluvium based on geochemical evidence. Subsequent estimates of the rate of artesian leakage in Williams (1985), Merrick *et al*. (1986) and Merrick (2001) were all modelling based. The recent geochemical findings by Iverach *et al*. (in press) based on chloride concentration are also qualitative regarding the leakage rate between the Great Artesian Basin and Lower Namoi Alluvium. No direct measurements of artesian leakage rates were reported in these studies. On this basis, the existing modelling-derived estimates can be considered as benchmarks rather than as calibration targets.

A tabulated summary of leakage estimates is presented in Table 6-2, with each estimate briefly discussed.

Table 6-2 Estimates of artesian leakage from Great Artesian Basin to the Lower Namoi Alluvium

Estimate	Rate ML/d	Area km^2	Rate mm/y	Comment
Calf (1978)	Not calculated	N.A.	Not calculated	Qualitative regarding leakage rate
Williams (1985)	2 - 10	79	9 - 46	Estimate provided to the study by Merrick
Merrick (1986)	10.1	62.5	59	Area based on 10 cells × 625-ha. per cells

Merrick (2001)	20 - 25	143.75	51 - 63	Area based on 23 cells × 625-ha. per cells
Merrick (2001)	0.2 - 0.35 per cell	6.25 one cell	12 - 24 per cell	Based on the statement "the inflows generally reduce from east to west (from about 3.5 ML/d per cell to 0.2 ML/d per cell"
Iverach *et al*. (in press)	Not calculated	N.A.	Not calculated	Qualitative regarding leakage rate
EIS modelling - GAB direct	4.5 net	1,153 total	-67 - +93 per cell	Water Sharing Plan reporting area 29 and adjacent alluvium (Narrabri to Wee Waa); consisting of 8.5 ML/d artesian recharge and 4 ML/d artesian discharge
EIS modelling - GAB via aquitards	3.6 net	5461 total	-0.26 - +0.78 per cell	Water Sharing Plan reporting area 29 (Wee Waa to Walgett)

Calf (1978)

Based on environmental isotope data from groundwater sampling, it was concluded in this study that these data "…may indicate that part of the deeper water in the Namoi Valley aquifers originated from leakage of water from the Great Artesian Basin, underlying the Namoi Valley." The study was conducted in an area of the Lower Namoi Alluvium located predominantly between Narrabri and Wee Waa (Figure 6-17). The results and conclusions of the study were qualitative regarding the leakage rate.

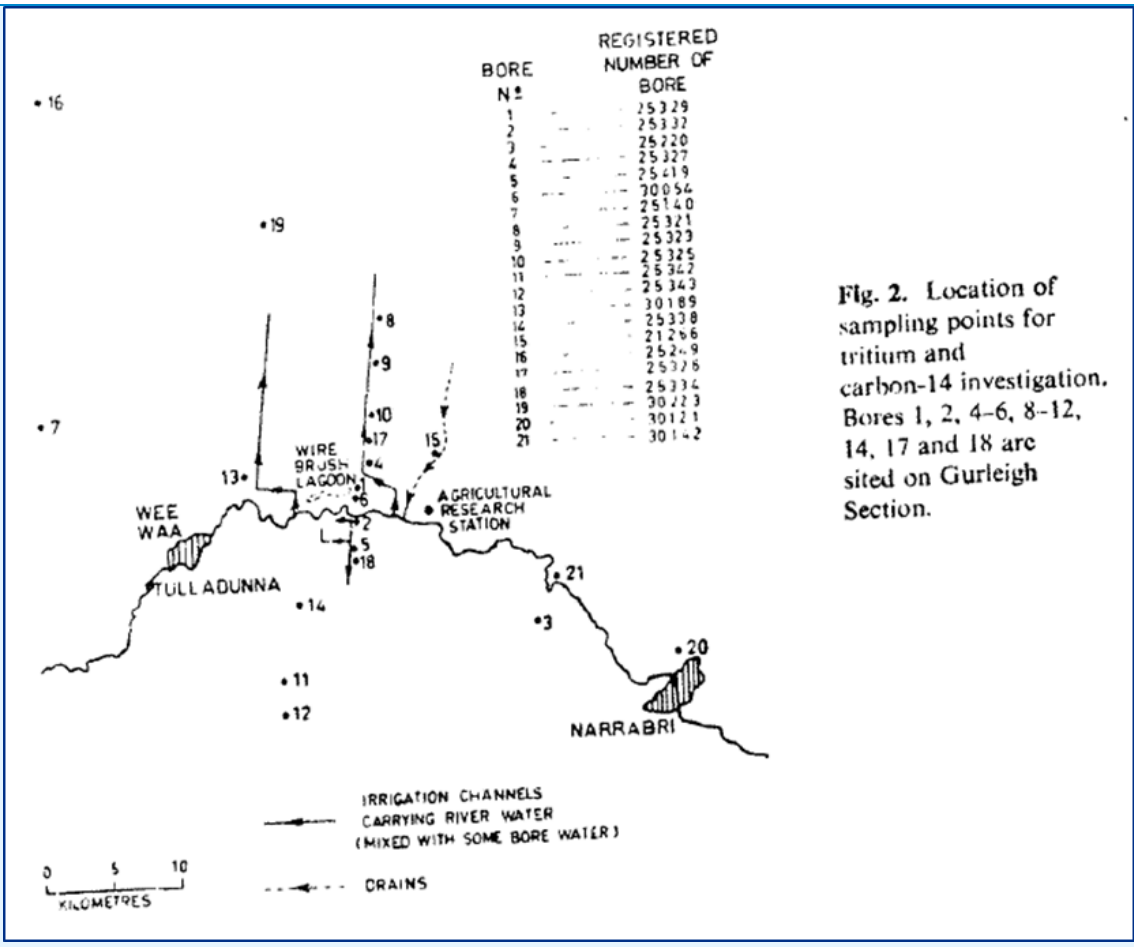


Figure 6-17 Map of groundwater sampling locations in Calf (1978)

Williams (1985)

Williams *et al*. (1985) used an estimate of net artesian recharge provided to the author by Merrick as personal communication. The estimate of 2 to 10 ML/d artesian leakage into the Lower Namoi Alluvium applied to an area of approximately 79 km^2 and was based on a “…quasi-three-dimensional model for recharge of the alluvium by losses from the underlying Cretaceous sandstone aquifers.”

The estimate of leakage reported within the study (Figure 6-18) is equivalent to an average artesian recharge depth of 9 to 46 mm/yr.

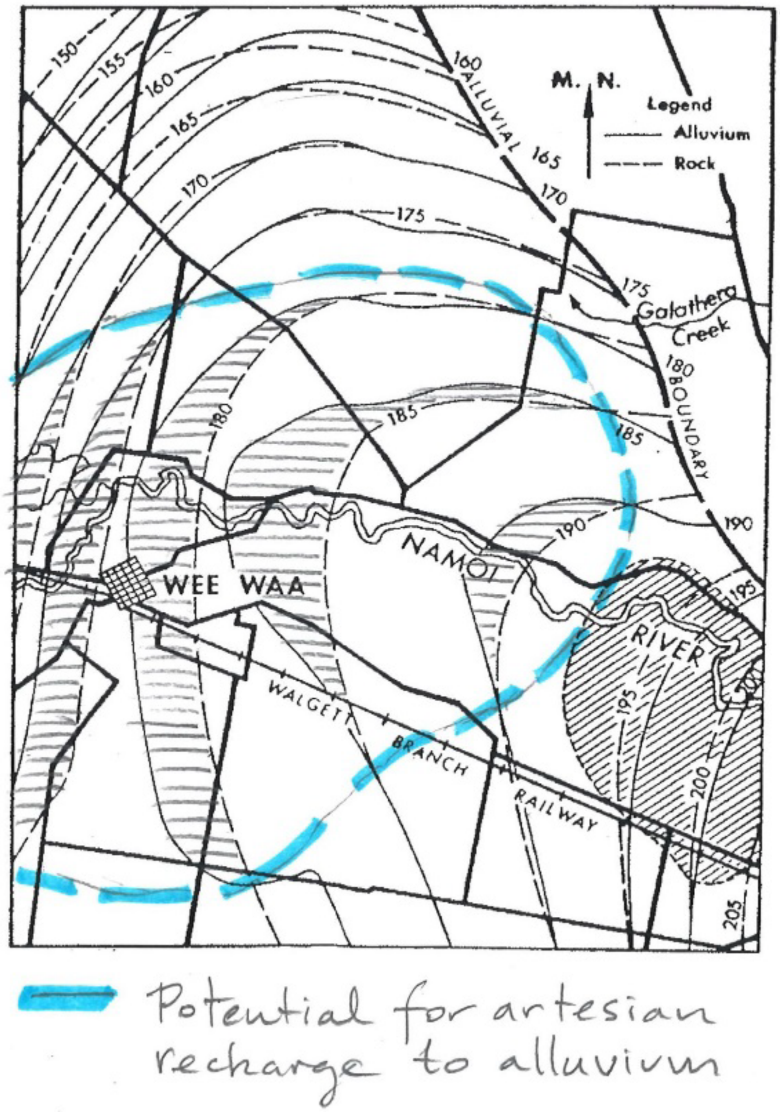


Figure 6-18 Area of potential artesian recharge in Williams (1985)

Merrick *et al*. (1986)

A two-layer groundwater model of the Lower Namoi Alluvium was developed using a uniform grid with a 2.5 × 2.5 km (6.25 km^2) cell size. It was stated that “On the basis of radiocarbon dating (Calf 1978), piezometric heads and bore logs, artesian leakage was attributed to 10 cells in the south-eastern part of the study area” (Figure 6-19).

Artesian leakage of 10.1 ML/d was applied over an area of 62.5 km^2, equivalent to an average artesian recharge depth of 59 mm/yr.

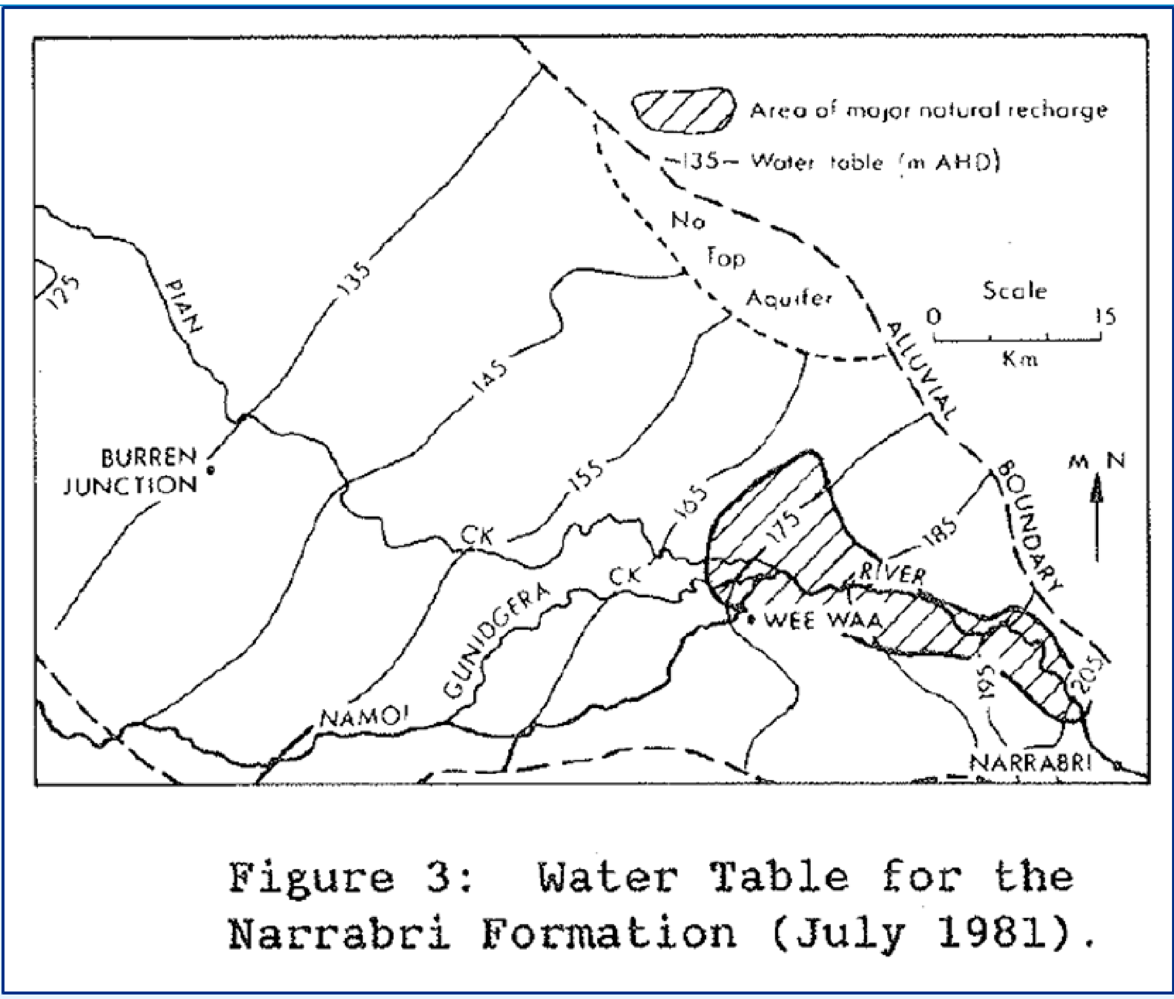


Figure 6-19 Study area of Merrick *et al*. (1985)

Merrick (2001)

This updated groundwater model for the Lower Namoi Alluvium introduced a head dependent boundary condition to represent artesian recharge from the Great Artesian Basin. A uniform model grid with 2.5 × 2.5 km (6. 25 km^2) cell size was used (Figure 6-20).

Artesian boundary conditions were assigned in 23 cells, equivalent to an area of artesian recharge of 143.75 km^2. The artesian leakage rate was estimated to be 20 to 25 ML/d over this area, equivalent to an average artesian recharge depth of 51 to 63 mm/yr.

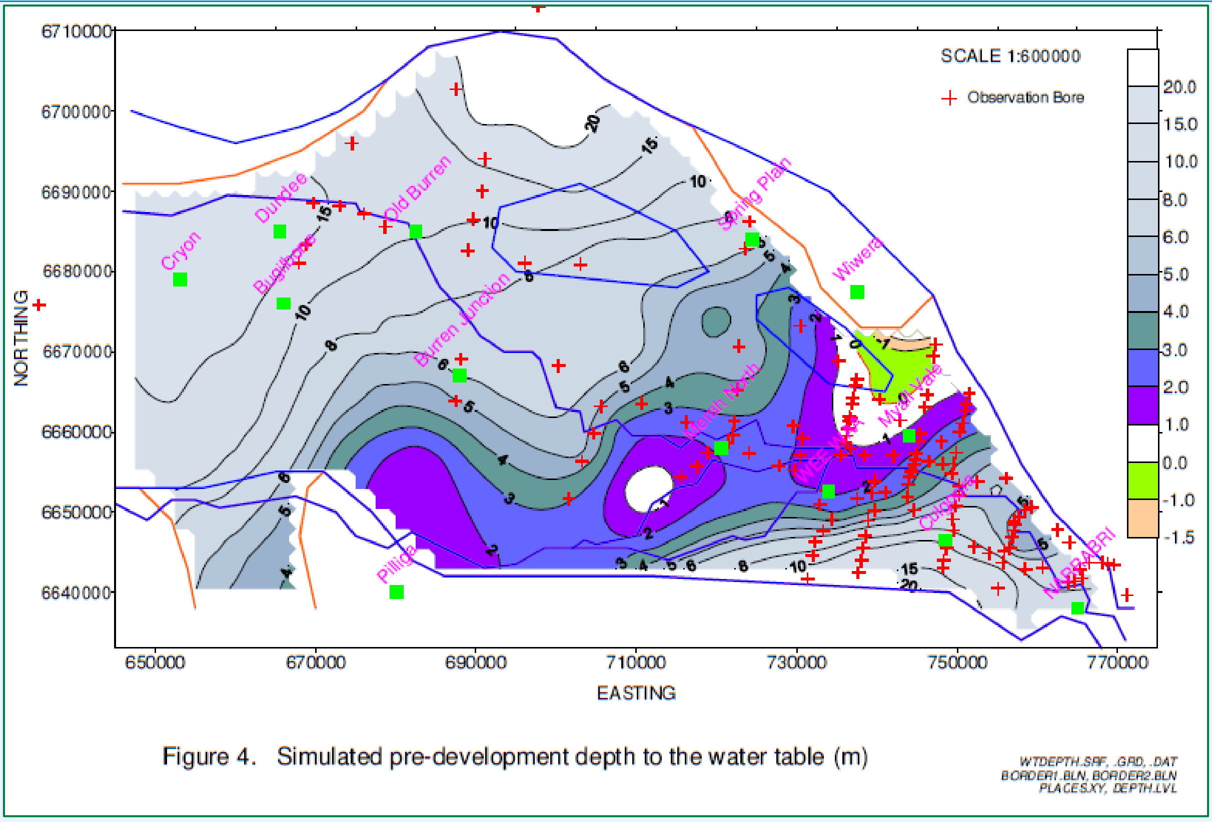


Figure 6-20 Groundwater model area of Merrick (2001)

Iverach *et al.* (in press)

This study estimated the proportions of Great Artesian Basin groundwater contributing to samples of alluvial groundwater collected in the Lower Namoi Alluvium in the region between Narrabri and Wee Waa. Chloride was used as the tracer. Estimated Great Artesian Basin contributions to the alluvial groundwater samples were between 0 per cent and 70 per cent (Figure 6-21).

The estimates cannot be directly compared to existing estimates of artesian recharge to the Lower Namoi Alluvium (e.g. Merrick 1986 and 2001) as they are point samples collected over a large area of potential mixing and do not take into consideration inputs from irrigation waters drawn directly from the Great Artesian Basin. Alluvial groundwater samples showing 0 per cent contribution from Great Artesian Basin groundwater indicate either no significant vertical flux between the groundwater sources at those locations due to local barriers, or the direction of vertical leakage is from the alluvium to the Great Artesian Basin.

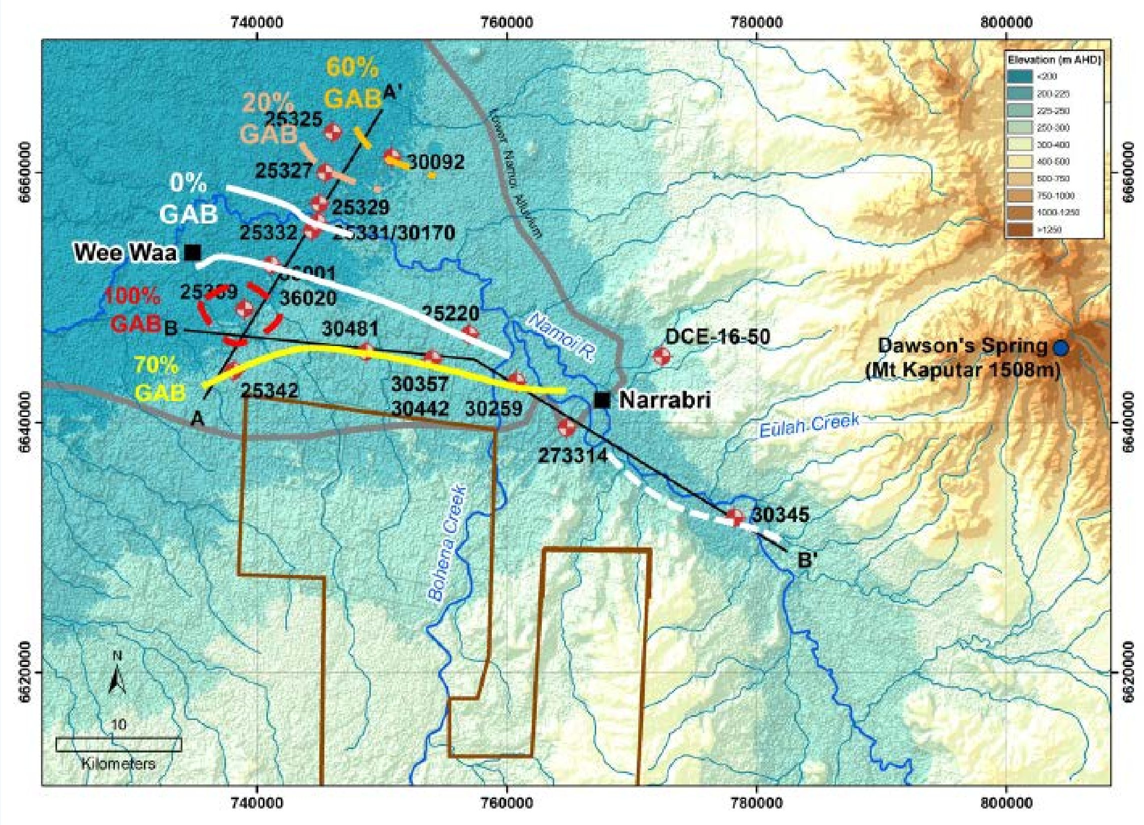


Figure 6-21 Approximate percentages of Great Artesian Basin contribution to the Lower Namoi Alluvium (Iverach *et al*. in press)

Narrabri Gas Project groundwater modelling

The groundwater modelling for the EIS incorporates enhanced vertical connection between the Great Artesian Basin and Lower Namoi Alluvium in the area between Narrabri and Wee Waa where the Pilliga Sandstone directly underlies the Lower Namoi Alluvium (Figure 6-22). A map of steady-state artesian leakage between the Great Artesian Basin and Lower Namoi Alluvium from the modelling is shown in Figure 6-23 and the simulated steady-state water balance (corrected from that issued in the EIS) is reproduced in Figure 6-24.

Figure 6-23 was not presented in the EIS, whilst Figure 6-24 differs from the EIS version (Appendix F; Figure 6-18) with respect to the groundwater flux of 1.6 GL/y (4.5 ML/d), now shown by the additional arrow extending from the Pilliga Sandstone to the Lower Namoi Alluvium. The original figure contains an accounting error, whereby this flux to the Lower Namoi Alluvium was included in the flux component from the Pilliga Sandstone to the Upper Namoi Alluvium.

The map of steady artesian leakage in Figure 6-23 shows areas of both artesian recharge and discharge from the Lower Namoi Alluvium, with overall net artesian recharge. The direction of leakage is controlled by the vertical head difference between the Pilliga Sandstone and Lower Namoi Alluvium, such that contours with negative values indicates head in the alluvium is less than head in the Pilliga Sandstone with potential for artesian recharge. Simulated values of head difference vary from around - 35 m near the northwest extent of the alluvium to ±5 m in the region between Narrabri and Wee Waa. It should be noted that enhanced vertical connection acts to reduce vertical head gradients.

The modelled net rate of artesian recharge for Water Sharing Plan reporting area 29 (Narrabri to Wee Waa) and adjacent alluvium (outside of area 29) is 4.5 ML/d, consisting of 8.5 ML/d vertical leakage from the Great Artesian Basin and Lower Namoi Alluvium and 4 ML/d vertical leakage from the Lower Namoi Alluvium to Great Artesian Basin. The associated leakage rates in model cells vary between - 67 mm/y (leakage out) and +93 mm/y (leakage in). These rates of leakage are broadly consistent, though on the low side, compared to the estimates from other studies.

Outside the area of direct connection between Pilliga Sandstone and Lower Namoi Alluvium, the EIS modelling simulates net artesian recharge of 3.6 ML/d through the Rolling Downs Group aquitards over a large area of 5,461 km^2 (Water Sharing Plan reporting area 17). This is equivalent to an average artesian recharge depth of 0.24 mm/y.

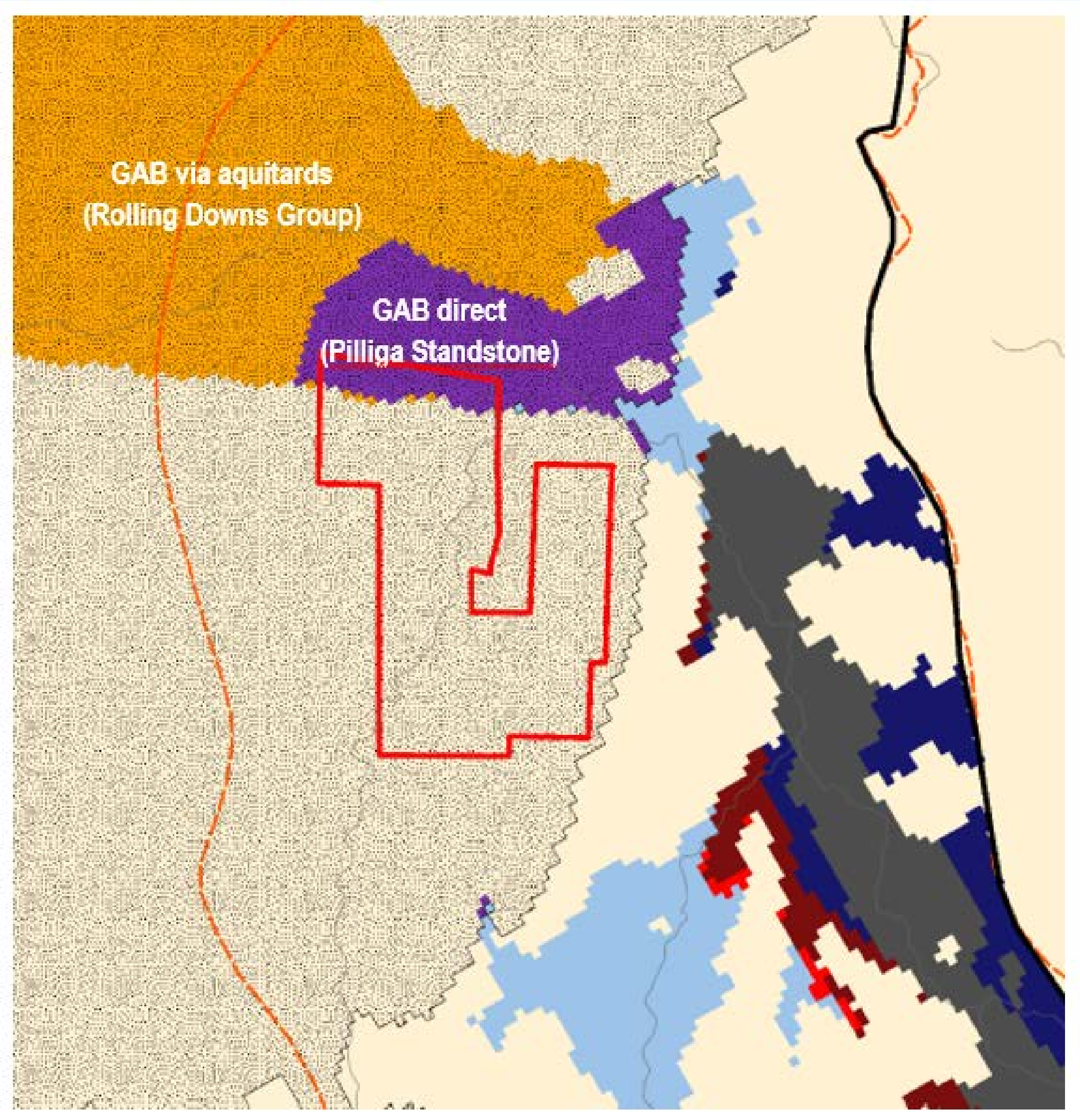


Figure 6-22 EIS groundwater modelling – Lower Namoi Alluvium sub-crop units

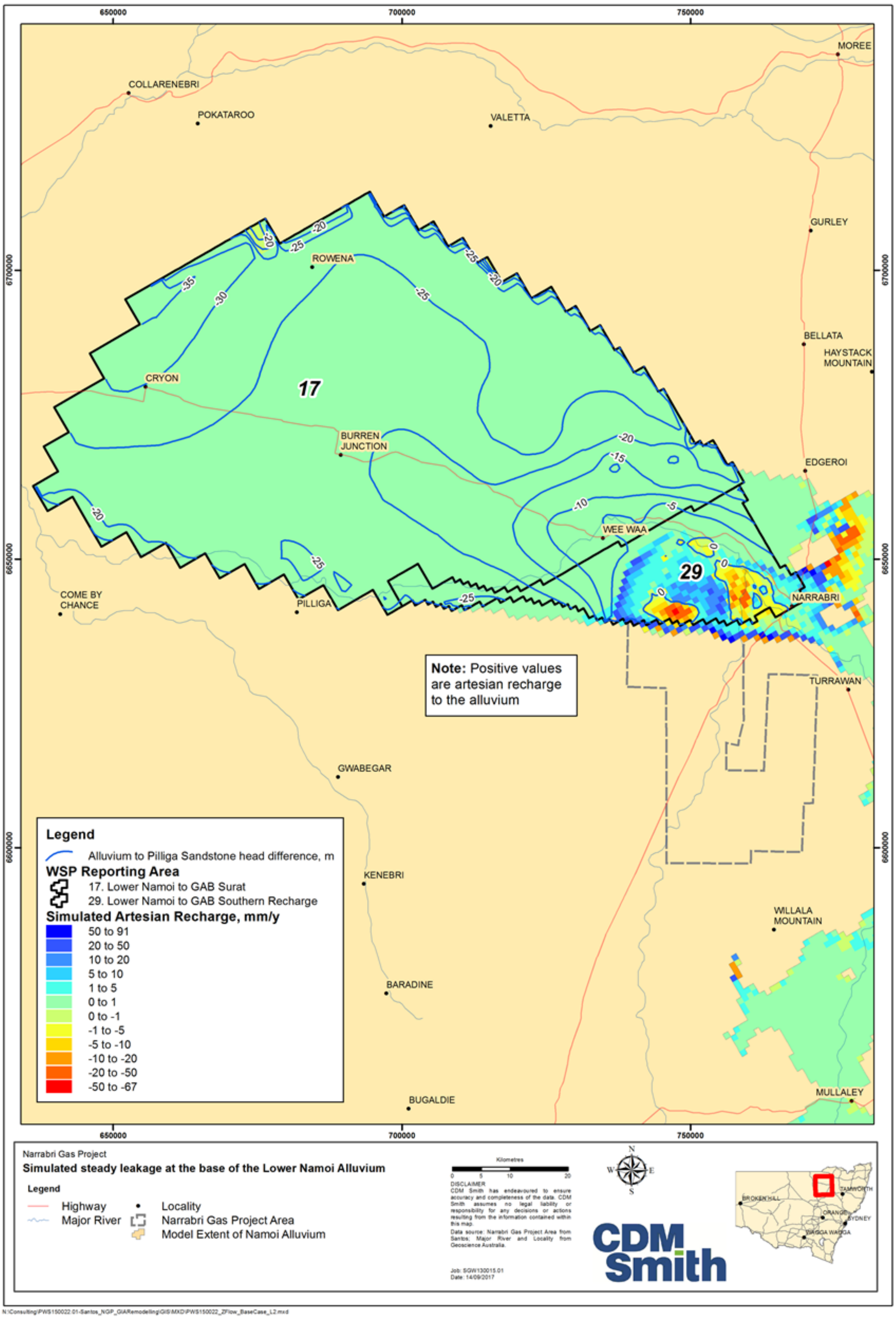


Figure 6-23 EIS groundwater modelling – simulated steady leakage at base of Lower Namoi Alluvium

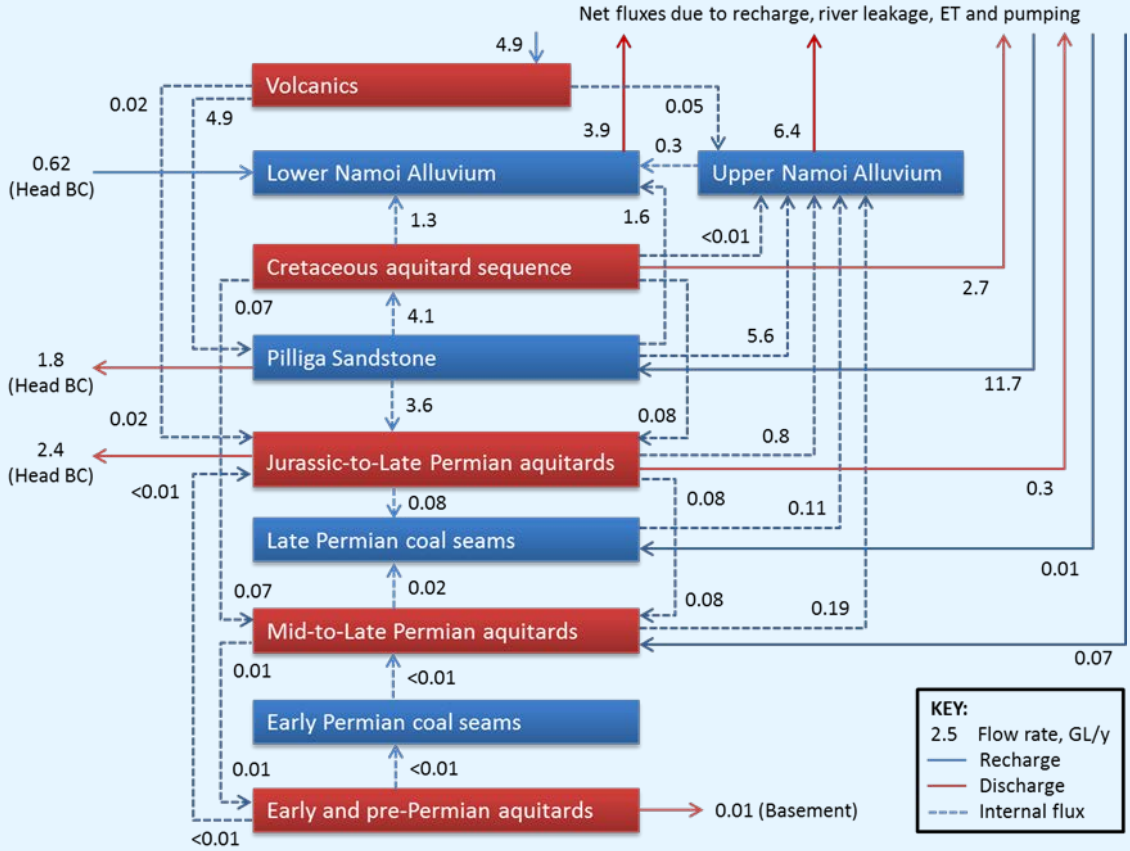


Figure 6-24 EIS groundwater modelling – simulated steady-state water balance

Part 2 – Great Artesian Basin to Upper Namoi Alluvium

There are differences in reported vertical leakage between the Great Artesian Basin and Upper Namoi Alluvium leakage as represented in the Upper Namoi groundwater model of McNeilage (2006) and the EIS groundwater model which can be explained by:

- the different extent of the Upper Namoi alluvium covered by each model
- the assumption of zero artesian leakage in the Upper Namoi groundwater model.

Specifically, the Upper Namoi groundwater model covers Zones 2, 3, 4, 5, 11 and 12 within GMA 004. In contrast, the EIS groundwater model includes all the Upper Namoi alluvium, inclusive of the area where Pilliga Sandstone (Oxley Basin) forms a sub-crop to the alluvium, which is outside the geographic extent of the Upper Namoi groundwater model. The EIS steady-state model computes a value of artesian recharge from the Oxley Basin to the Upper Namoi alluvium of approximately 15 ML/d (5.6 GL/y) in the sub-crop area.

The proponent is not aware of other estimates of this flux as a basis for comparison. Elsewhere, the EIS model computes minor (non-zero) vertical leakage from the Gunnedah Basin to the Upper Namoi Alluvium, which is consistent with, but not identical to, the assumption of zero artesian leakage implemented by the Upper Namoi groundwater model (McNeilage 2006).

6.11.4 Groundwater impacts

Volume of water to be extracted

Submissions questioned whether the proposed volume of water to be extracted for the project is certain or could change.

The project EIS seeks approval for extraction of a fixed maximum water volume from the target coal seams over the life of the project. The maximum extraction volume under the Base Case for which approval is sought is 37.5 gigalitres over 25 years.

Impacts on existing users of high-value groundwater source

Several submissions disagreed that the project's proposed water extraction from the Gunnedah-Oxley Basin would not have unacceptable impacts on existing users of high-value groundwater sources in the Great Artesian Basin and Namoi Alluvium, including agricultural and community needs. The submissions were concerned that the proponent's water extraction would induce a large diversion of water from the existing users.

Submissions stated that potential groundwater impacts of the project could result in reduced surface water flows of connected systems. This could also impact groundwater dependent ecosystems.

Submissions stated that make good arrangements were not practicable as alternate water supply may be too distant or other uneconomic to secure and provide to affected landholders.

They stated that financial compensation would not be adequate and queried where it would include impacts such as the expense of deepening bores. They also stated that compensation for permanent impacts could not be provided in perpetuity and queried how this would be accounted given that potential impacts extended beyond the anticipated life of the project.

Submissions stated that potential impacts on groundwater may take tens to hundreds of years to occur and therefore prevent early detection and remediation.

Potential effects of the project on high-valued groundwater sources are assessed in detail in the Groundwater Impact Assessment (EIS Appendix F), including potential maximum predicted diversions induced by the project water extraction in the Gunnedah-Oxley Basin.

The groundwater modelling predicts that impacts to the good quality, shallow water sources would be negligible, with a maximum drawdown of less than 0.5 metres in the Namoi Alluvium and the Pilliga Sandstone of the GAB, predicted to occur in around 200 years' time. Potential impacts are expected to be indiscernible to other users (such as irrigators and farmers) from the existing variations in groundwater pressures and storage volumes that occur in response to existing uses and replenishment with seasonal fluctuations.

The requirement for the proponent to acquire sufficient water entitlements under the water sharing rules established in water sharing plans is designed to ensure that unacceptable diversions from potentially affected groundwater sources do not occur, including the Great Artesian Basin and Namoi Alluvium.

Should monitoring indicate a trend toward a changing water resource condition that is inconsistent with the magnitude of effect predicted by the Groundwater Impact Assessment; is reasonably attributed to being a potential effect of the project, and which may ultimately reduce water access to users, the early-detection strategy incorporated into the Water Management Plan (EIS Appendix G3) will allow the proponent to take appropriately-scaled management actions to avoid adverse effects, including “make good” actions if required.

Make good provisions for existing bore owners will be determined by an assessment of the impact on a groundwater supply due to project activities. The make good measures which are decided upon must be agreed with the affected bore owner and may involve one, or a number, of the following make good measures:

- Lowering the pump setting in the bore
- Increasing the water column above the pump
- Improving the pressure at the bore head, if the bore is artesian (e.g. new headworks and piping)
- Changing the type of pump to suit the lower water level in the bore
- Deepening the bore to allow it to draw groundwater from a deeper part of the aquifer
- Bore reconditioning to improve hydraulic efficiency
- Drilling a new bore
- Other modifications to the bore that will mitigate the impairment
- Providing an alternative water supply
- Providing compensation, which could be monetary, for impairment of the water supply.

Influence of faulting on predicted impacts

One submission considered that the potential effects of geological faulting on the predictions is inadequately assessed in the groundwater modelling.

Submissions stated the groundwater model did not include representation of heterogeneity in hydrostratigraphy including pathways in confining layers, faults or leaks from wells.

They stated that a hydraulic connection between target coal seams and overlying aquifers would cause potential impacts to propagate at a faster rate and greater magnitude.

Submissions cited a Narrabri Faulting Study (SS125 R00021480) and reports from the Cooper basin where faulting had occurred as evidence that faults may occur in the project area.

Multiple lines of evidence indicate most known faulting within the project area is of small scale and does not extend into the overlying formations. Potential impacts to groundwater flow due to faulting is therefore considered to be highly unlikely. There is no evidence to contradict this view.

Connectivity between target coal seams and high-valued groundwater sources

One submission was critical that the Groundwater Impact Assessment (EIS Appendix F) states that coal seams and high-valued groundwater sources are not connected but at the same time predicts impacts in the groundwater sources due to the project’s proposed water extraction from the coal seams. They cite work by John Hillier that notes the connectivity between the coal seams and the GAB.

Section 5.6 of the Groundwater Impact Assessment (EIS Appendix F) states “The Groundwater Impact Assessment study area can be conceptualised as consisting of three connected hydrological systems with distinguishing spatial extents and hydrological regimes…1. Deep groundwater sources…, 2. Shallow alluvial groundwater sources…and 3. Surface water sources…”

Section 11.5.4 of the Geology and Groundwater Chapter (Chapter 11) provides a detailed description of how depressurisation in deep coal seams is expected to propagate very slowly into overlying strata—including strata hosting high-valued groundwater sources—with depressurisation eventually reaching the water table. Chapter 11 also states “The project would require extraction of approximately 37.5 gigalitres…from deep groundwater sources that are hydrologically disconnected from the Namoi Alluvium…significant impacts on the water balance of the Namoi Alluvium from the project are not anticipated.”

The proponent acknowledges that the choice of word “disconnected” used only once in this context in Chapter 11 could be replaced by “very poorly connected” or similar; however, there are ample statements elsewhere throughout Chapter 11 and the Groundwater Impact Assessment explaining the conceptualisation of connections between all groundwater sources present within the project area and boundary of the groundwater model.

The proponent notes that the research by John Hillier (ex-QDNRM hydrogeologist) demonstrated the connectivity between the Great Artesian Basin and coal seam gas rich coal seams in Queensland. Those seams, however, are not present in the Coonamble Embayment and Mr. Hillier’s research is therefore not relevant to this project, which targets seams in the deeper, Gunnedah Basin sequence.

Methane contamination of bores and well integrity

One submission stated there is no consideration in the Groundwater Impact Assessment (EIS Appendix F) of potential methane contamination of existing bores.

A submission stated the assessment did not consider the potential for methane to infiltrate groundwater. Submissions cited studies in support of this statement including Osborne *et al*. (2011), Howarth *et al*. (2011), Jackson *et al*. (2013), Vengosh *et al*. (2014), Jackson *et al*. (2014), Bair (2010), Groundwater Water Protection Council (2012) and Darrah *et al*. (2014).

They also cited studies from Queensland and the USA that found a correlation between methane content in groundwater and proximity and intensity of field development. They stated the main cause of methane infiltration had been failure of well casings or cementing.

Submissions cited industry statistics that between five and seven per cent of wells leaks in the first year, 30 per cent leak within 20 years and stated that all wells would leak eventually. Submissions stated that in the event of a well failure connectivity would be established between the coal seams and overlying aquifers.

The risk of induced subsurface gas flows from the project is considered in Sections 7.4.2.4 and 7.4.4.6 of the Groundwater Impact Assessment (EIS Appendix F).

The proponent notes that the references quoted by the submission refer to shale gas development in the United States and specifically to the impacts related to fracture stimulation to release the gas. As the Narrabri Gas Project involves a different project, resource type, operating environment, approach and site conditions and that fracture simulation is not proposed, the references cited are of limited relevance.

Notwithstanding this, the proponent recognises the risks associated with leakage in well design and construction. All mandatory requirements outlined in the *NSW Code of Practice for CSG Wells* will be applied. In general, the proponent will also adopt all the good industry practices outlined in the *NSW Code of Practice for CSG Wells*, with local site and well conditions and operations dictating the final set of best industry practice measures that will be implemented.

Further, the proposed well design and installation process has considered the range of gas compositions that may be encountered within the project area. To date there are no known gas constituents (e.g. H_2S) which give rise to longevity concerns.

A 'basis of well design' will be completed for each well. This process considers well parameters of pressure, temperature and fluid properties (water and gas composition) to inform material selection (such as casing and cement) and the approach for the safe installation and operation of the well for its designated design life.

The fluid properties (water and gas composition) are monitored and analysed though an Integrity Management Program utilising a variety of information sources such as corrosion coupons, tubing / vessel and pipeline inspections, calliper logs, etc.

The Integrity Management Program, in conjunction with the 'basis of well design', are used to ensure that learnings are fed back into future well designs. Therefore, if the fluid properties change to levels outside the project standard well design then the material selection will be reviewed for suitability and / or control measures implemented to maintain well-bore barrier integrity.

Specifically, as outlined in Chapter 6 (Project description) of the EIS, the well construction process entails:

- The surface hole will be drilled to isolate aquifers and prior to interception of hydrocarbon zones. Surface casing will then be run into the hole and cemented with cement returns back to surface to isolate aquifers.
- The production hole will then be drilled to the required depth. Production casing will then be run into the hole and cemented with cement returns (as a minimum requirement as per the *NSW Code of Practice for CSG Wells*) back inside the previous casing string of the surface casing.
- These two cemented casing strings help minimise chances of aquifer contamination from production casing well failure.

As evidence of the proponent's capability in well integrity, the proponent has not had loss of well control in a Surat Basin Well. In accordance with the Queensland *Code of Practice for CSG Well head emissions, detection and reporting* (Version 2, June 2011), the proponent provides a report to the Queensland Government on an annual basis that summarises results from its leak detection and reporting program.

Economic assessment of groundwater impacts

One submission stated there is no economic assessment of potential impacts on water resources.

Submissions stated the initial groundwater balance model did not match the modelling that would inform the regulators water sharing plans.

A cost benefit analysis and the regional economic assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and the Secretary's environmental assessment requirements. Submissions on the cost benefit analysis and the regional economic assessment are discussed further in Section 6.27 of this RTS.

The Groundwater Impact Assessment reported in Appendix F of the EIS identified a number of possible impacts to groundwater as a result of the project, all of which were expected to not be significant. A corresponding risk assessment found all residual risks to be low. The risk of not maintaining water quality during drilling will be mitigated by compliance with the NSW Government's *Code of Practice for Coal Seam Gas Well Integrity*. Surface water impacts are also assessed as very low risk. Due to the low likelihood of water related impacts occurring and the difficulty in valuing and apportioning probabilities to such events, they were not quantified in the cost benefit analysis.

Water extraction of water for the project will be conducted under the water sharing rules established in the relevant water sharing plans.

Alignment with the Namoi Catchment Water Study

Submissions stated the Groundwater Impact Assessment (EIS Appendix F) was not aligned with Namoi Catchment Water Study Phase 2.

The Groundwater Impact Assessment (EIS Appendix F) has been undertaken to achieve consistency with the Namoi Catchment Water Study to the extent possible. The Namoi Catchment Water Study is referenced throughout the Groundwater Impact Assessment along with other relevant hydrogeological investigations and groundwater modelling projects, as referenced in Section 5 "Conceptual Hydrogeological Model" of the Groundwater Impact Assessment.

Hydrogeological properties adopted in the Namoi Catchment Water Study for groundwater modelling are incorporated (and referenced) within the review of hydrogeological properties presented in Section 5.3.1 "Interpretation of Hydraulic Conductivity Data" of the Groundwater Impact Assessment (see Table 5-3).

The proponent notes that the extreme scenario for the Namoi Catchment Water Study included greater produced water extraction than is proposed for the project and this did not generate a significant impact on other water users.

Potential impacts to groundwater dependent ecosystems

A few submissions expressed concern for the health of groundwater dependent ecosystems.

One submission stated that the project would have the potential to affect groundwater levels in the Great Artesian Basin and associated groundwater dependent ecological communities such as those occurring along Bohena Creek as well as the known mound springs of western NSW, southern Queensland and north-east South Australia.

A submission stated the assessment did not adequately identify Bohena Creek and associated waterholes as groundwater dependent ecosystems.

It cited the *Groundwater Dependent Ecosystem Atlas*, which finds that Bohena Creek is moderately dependent on surface expression of groundwater. It also cited satellite photography that indicated around 30 associated waterholes and springs along Bohena Creek.

Submissions raised the potential presence of stygofauna in groundwater units potentially affected by the project, particularly in shallower overlying aquifers rather than target coal seams.

The submissions cited results of 2012-13 and 2016-17 stygofauna surveys by Dr Serov that detected stygofauna within the Pilliga Sandstone and alluvial aquifers of the Pilliga.

The proponent notes that groundwater modelling has demonstrated that there will be negligible impact to the Namoi alluvial groundwater from the project and hence very unlikely to have impacts on stygofauna. The maximum probable drawdown on groundwater over the life of the project is less than 0.5 metres (which is within the error of the modelling), and as such, impacts on groundwater and their respective communities is considered to be negligible.

The main Groundwater Dependent Ecosystems (GDEs) in the project area are the Type 2 waterholes on Bohena Creek, which were sampled and reported in the Bohena Creek reports in Appendix B of Appendix F of the EIS.

The risk of impact to GDEs will be monitored and managed throughout the life of the project, with the Water Monitoring Plan (WMP) is focussed on early detection of a specific and measurable change that can be easily and objectively related to the proposed project activities. The WMP for the project does not propose to monitor GDEs because they are not predicted to be impacted. There is an insignificant risk of impact to GDEs due to the large degree of physical separation, both vertically in the sub-surface and horizontally at the surface, and therefore lack of connectivity between the target coal seams and GDEs. Hence, additional baseline data would not be of benefit to aid GDE protection.

In the long term, monitoring results may trigger monitoring closer to GDEs. The monitoring program is designed, however, that such a management response would occur many years, and potentially decades, in advance of measurable change to aquifers that support GDEs and could be objectively linked to project activities.

Dr Serov collected preliminary samples from bores and wells in 2012 and 2013, and subsequently undertook further surveys, collecting invertebrate taxa that were identified as stygofauna, including *Annelida* (worms) and *Acarina* (mites). However, while both *Annelidia* and *Acarina* have representatives found in groundwater environments, they are overwhelmingly more common in the soil community. Soil invertebrates are sometimes encountered in groundwater bores that are uncased, have cracks in the casing, or are uncovered.

From the list of stygofauna provided from these surveys, and at the taxonomic level identified, three are definitely stygofauna (*Amphipoda, Psammaspididae and Parabathynellidae*) and these were collected within the Namoi Alluvium. The diverse stygofauna of the Namoi Alluvium are acknowledged by the proponent (Section 4.4.4 in Appendix G1).

Three other listed crustacean groups may be stygofaunal, but could also be members of the surface water community that entered shallow aquifers when water level fell. *Collembola*, for example, generally live on the soil surface, and this is acknowledged by Dr Serov, although he suggests they may be stygofauna.

Reinjection and dewatering risks

Submissions stated that reinjection of groundwater would have potential impacts relating to the rate of reinjection and the removal of stygofauna in the treatment process. They also stated that aquifer reinjection would have the potential to cause earthquakes.

Some submissions requested that reinjection not occur.

Submissions stated that dewatering of coals seams would create voids that would cause coal seams to collapse and potentially cause subsidence at the surface with secondary impacts to surface water, ecological values and land uses. They also stated that the creation and collapse of voids had the potential to cause earthquakes and noted the presence of the Hunter-Mooki fault line. They stated that earthquakes could compromise wells and lead to contamination.

No groundwater re-injection is proposed for the project.

The coal seams are de-pressurised, not de-watered. That is, they remain saturated, even when under production and hence voids are not created.

The potential for the project to cause subsidence at depth and at the land surface due to depressurisation of the target coal seams was assessed in the Groundwater Impact Assessment (EIS Appendix F). The assessment concluded the potential magnitude of subsidence due to the project is likely to be minor and not a concern. The maximum predicted compaction at the depth of extraction is 205 millimetres and is not likely to cause subsidence at the land surface due to the depth below ground surface of the target coal seams, and the presence and thickness of structurally-competent rock formations above the coal seams.

Risks of spills and leaks

Submissions stated that storage of produced water and other substances presented a risk of groundwater contamination through spills or leaks.

Submissions referred to historic spills and leaks from existing infrastructure in the project area including detection of uranium, lead, aluminium, arsenic and barium in aquifers.

All facilities including gas and water gathering lines would be designed to the relevant Australian Standards and protocols, including the Australian Pipeline Industry Association (APGA) *Code of Practice for Upstream Polyethylene Gathering Networks-CSG Industry*. In the unlikely event that a spill or leak did occur, design and engineering controls along with monitoring systems would enable leaks to be detected and rectified quickly.

The design of the Leewood and Bibblewindi produced water ponds would comply with the NSW Government's *Code of Practice* requirements with double lined ponds, leak detection and seepage collection and an engineered spillway as standard. Ponds are designed as multi cell facilities which improves maintenance ability and limits volume release in the event of an issue. Pond levels and collection sumps are monitored with telemetry to a control centre and in addition there are several shallow monitoring bores installed adjacent to the ponds as part of the monitoring network.

There is continuous pressure monitoring of produced water pipelines for indications of a leak and wells can be shut in remotely if required to minimise volumes of water released in the event of a leak. Note that water pressures at well heads and within water gathering lines is low.

Regular plant, equipment and pipeline checks and inspections and an Equipment Maintenance Plan would be developed that includes the proactive programmed maintenance of produced water transfer and storage infrastructure.

Chemicals will be stored and handled in accordance with the relevant Australian Standards, including *AS1940*. Maintenance requirements would be carried out in accordance with operational procedures that would minimise the potential for spills or leaks to occur. Bunding, drip trays and other preventative measures would be utilised as necessary and spill kits would be in place as appropriate.

In summary, there are a significant number of design controls and operational management procedures to minimise the risk of leaks or spills occurring.

In the event a spill or leak did occur, risk to groundwater is negligible. Design and engineering controls along with monitoring systems would enable leaks to be detected and rectified quickly. There is a low risk of bores being affected as these generally take from water sources more than 50 metres below perched or shallow water bodies that could be (though unlikely) impacted by a spill. Further, the presence of relatively impermeable geological units, in addition to perched water bodies having very low transmissivity, further minimises the risk.

The Chemical Risk Assessment (Appendix T3) undertaken for the EIS concluded that the potential for releases of chemicals to groundwater as a result of the storage and conveyance of produced water, brine and treated water is considered to be negligible. This is due to the limited mass of these chemicals in the produced water, the loss mechanisms (biotic and abiotic decay) and the design, engineering and monitoring of operations in pipelines and ponds. Refer to Appendix T3 for additional information.

6.11.5 Monitoring

Adequacy of the groundwater monitoring plan

Submissions considered that the proposed groundwater monitoring network for the project is not fit for purpose.

The proponent is committed to implementing a groundwater monitoring program capable of early detection of impacts of the project on groundwater resources and dependent users. The Water Monitoring Plan (EIS Appendix G3) is founded on the principle of early detection monitoring (Section 3.1) and identifies monitoring thresholds and trigger levels and associated management actions for mitigation of potential impacts (Section 3.7). The thresholds and trigger levels in the Water Monitoring Plan are designed to reflect the concept of Level 1 and Level 2 impacts defined in the *NSW Aquifer Interference Policy*. Table 3-11 of the Water Monitoring Plan outlines the proposed management actions for Level 1 and Level 2 impacts, and lists the proposed make-good provisions for existing bore owners.

The proponent’s proposed water monitoring network comprises sentinel monitoring bores that are strategically located both within deeper formations close to target coal seams and centralised around the first phase of production. The monitoring plan includes trigger values for early warning and threshold actions for impacts to local receptors.

All monitoring data is compiled into a reporting framework, such that sufficiency of monitoring will be continuously assessed to allow identification of additional monitoring requirements. The Water Monitoring Plan is to be updated to reflect changes that are considered to be required.

6.12 Surface water quality

Potential surface water quality impacts were discussed in Chapter 12 of the EIS based on detailed assessment in Appendices F, G1, G2, G3 and G4 of the EIS. The assessments considered the potential impacts of the project on surface water quality including erosion and sedimentation, spills and leaks, the beneficial reuse of treated water such as dust suppression, the beneficial reuse of treated and amended water such as irrigation and the managed release of treated water to Bohena Creek.

The assessment found that erosion and sedimentation and spills and leaks would be readily avoided, mitigated and managed through the implementation of standard mitigation and management measures. The beneficial use of treated water for activities such as dust suppression, construction and drilling was also found to have limited impacts due to the quality of the water and management of its application.

Similarly, the assessment concluded that irrigation of treated and amended water would be carried out in accordance with an irrigation management strategy that would seek to ensure that the structure, stability and the productive capacity of receiving soils are maintained, erosion is minimised and runoff controls are in place. The performance of irrigation systems would be monitored to ensure they perform as expected.

Managed release of treated water to Bohena Creek would only occur when flow is equal to or greater than 100 megalitres per day at Newell Highway gauging station. A mixing zone analysis in Appendix G1 of the EIS found that managed release under the required flow conditions would provide for rapid mixing and dilution. Even prior to dilution, an analysis of the quality of the water to be released found it would comply with the ANZECC/ARMCANZ (2000) trigger values aside from electrical conductivity that would exceed the upper value by about 7 microSiemens/cm.

Subsequent to the EIS being lodged in February 2017, the Leewood Water and Brine Treatment Plant commenced operations. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS). The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

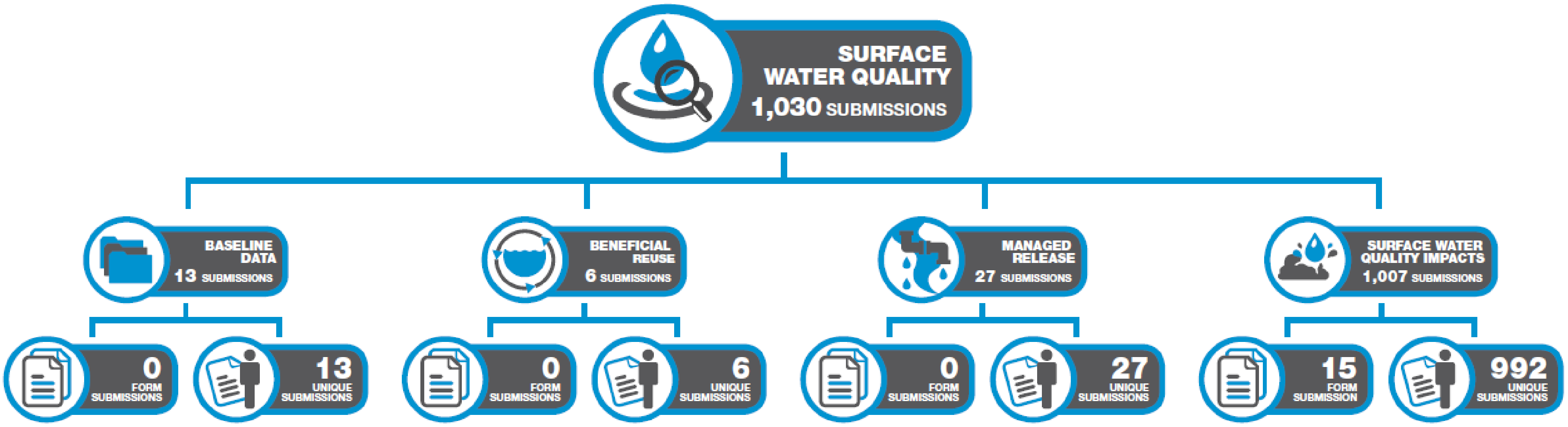
As such, impacts to water quality and associated ecological risks were found to be low and / or manageable in the EIS. Managed release to Bohena Creek would only be carried out in accordance with an environment protection licence to be sought from the NSW Environment Protection Authority.

1,030 submissions raised issues specifically relating to surface water quality as described in Chapter 12 of the EIS. The majority of the submissions were unique however similar issues were also raised as additional remarks in a small number of form submissions.

The submissions primarily concerned potential impacts to surface water quality generally while relatively few submissions specifically concerned baseline data, beneficial reuse or managed release (as they regard water quality specifically).

A number of submissions raised issues more specifically relating to the operation of managed release or potential impacts on aquatic ecology which are discussed in Section 6.7 and Section 6.16.

Figure 6-25 provides an overview of the submissions relating to surface water quality.



12 Surface Water Quality

Figure 6-25 Summary of submissions on surface water quality

6.12.1 Baseline data

Bohena Creek baseline condition

Submissions noted the assessment found that Bohena Creek was slightly to moderately disturbed under the Australian and New Zealand Environment and Conservation Council *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. They stated the condition was underestimated to justify managed release to Bohena Creek.

Classifying Bohena Creek as a 'slightly to moderately disturbed ecosystem' was undertaken consistent with the ANZECC/ARMCANZ (2000) guidance notes from Section 3 of Volume 1 – Aquatic ecosystems. ANZECC/ARMCANZ (2000) define three ecosystems, being:

1. High conservation/ecological value system – effectively unmodified or other highly-valued ecosystems, typically (but not always) occurring in national parks, conservation reserves or in remote / inaccessible locations. While there are no aquatic ecosystems in Australia and New Zealand that are entirely without some human influence, the ecological integrity of high conservation/ecological values is regarded as intact.

2. Slightly to moderately disturbed systems – ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically, freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation; marine systems would have largely intact habitats and associated biological communities. Slightly-moderately disturbed systems could include rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism, or marine ecosystems lying immediately adjacent to metropolitan areas.

3. Highly disturbed systems - these are measurably degraded ecosystems of lower ecological value. Examples of highly disturbed systems would be some shipping ports and sections of harbours serving coastal cities, urban streams receiving road and stormwater runoff, or rural streams receiving runoff from intensive horticulture.

Considering the three descriptors shown above, Bohena Creek is best described as a 'slightly to moderately disturbed ecosystem', with corresponding target water quality values adopted for the purposes of impact assessment. The 'slightly to moderately disturbed ecosystem' descriptor broadly aligns with the NSW Government's Namoi River Water Quality and Flow Objectives (refer to: http://www.environment.nsw.gov.au/ieo/Namoi/report-02.htm) and supporting target water quality data (which defer to ANZECC/ARMCANZ (2000) values).

Baseline water quality of other creeks

Submissions stated that baseline water quality data should have been provided for Jacks Creek, Mollee Creek and Bundock Creek as they were within the project area.

As explained in EIS Chapter 12 (Surface water quality), impact assessment, and therefore, the collection and analysis of baseline water quality, was focused on Bohena Creek as this is where it is proposed that managed release of treated water would occur. All creeks within the project area are ephemeral in nature and only run following significant rainfall events. Bohena Creek is the only 6th order stream within the project area, with Jacks Creek being 5th order, Bundock 3rd and Mollee 2nd. As such, only Bohena Creek flows with sufficient regularity to be classified as intermittent in nature (flows greater than 15 per cent of the time). The other creeks flow for less time and this precludes consistent sampling protocols. All creeks feed to the Namoi River, however, and water sampling points are located at all of these locations and are reported in the Water Baseline Report.

In accordance with the Field Development Protocol, riparian corridor buffers will be applied to all watercourses in the project area. Non-linear infrastructure and large ponds and dams will be excluded from these buffers.

Extensive work was undertaken to map watercourses in the project area at a scale of 1:15,000. Stream order was assigned to each watercourse in accordance with the Strahler system. To account for the need to include channel widths as part of the total riparian corridor width, top of bank was digitized for watercourses with larger channels that could be identified at a scale of 1:15 000 (including all 5th and 6th order watercourses). For all other watercourses, an average channel width was applied based on their stream order. Average channel widths for 1st to 4th order streams were determined by identifying the average channel width for 10 per cent of the watercourses within each of these classes. The average channel width was identified by measuring the width of the top of bank (where visible in high-resolution contour data) at a few locations along each reach. The average widths for 10 per cent of each stream order class were then combined and a mean determined for each class.

Riparian corridors were determined in accordance with the riparian corridor widths were detailed in the Field Development Protocol (Appendix C to this RTS), consistent with the NSW *Guidelines for riparian corridors on waterfront land* (NSW Office of Water 2012). The riparian corridor widths in the Field Development Protocol are reproduced in Table 6-3.

Table 6-3 Riparian corridor widths

Strahler Order	Riparian corridor width
1st order	20 m plus channel width
2nd order	40 m plus channel width
3rd order	60 m plus channel width
4th order and greater	80 m plus channel width

Bohena Creek surface water monitoring locations (refer to EIS Chapter 30) have been strategically located up and down catchment of the proposed managed release point adjacent to Leewood to monitor water quality in accordance with the Water Monitoring Plan (EIS Appendix G3).

Baseline water quality parameters

Submissions stated that baseline water quality include components based on a detailed chemical characterisation of produced water. They also requested that Bohena Creek baseline water quality be divided into continuous flow and ceased flow datasets.

Key surface water analytes for baseline water quality analysis, impact assessment undertaken for the EIS, and ongoing monitoring were focused on ions that may affect stream salinity, certain nutrients, and metals and metalloids.

Table 12-4 in Chapter 12 (Surface water quality) and Appendix E to Appendix G1 (Managed release study (Bohena Creek)) compared target treated water quality against baseline surface water quality data in Bohena Creek to assess managed release risk. Table 7-2 in Chapter 7 (Produced water management) compared target treated and amended water quality data against applicable water quality guidelines for proposed beneficial reuse activities.

Baseline produced water quality data were provided in Tables 5-14 and 5-15 of Appendix F – Groundwater impact assessment.

Updated water quality data are included in Appendix D to this RTS and in Table 6-4.

Ongoing data collection

Submissions stated that the Water Monitoring Plan in Appendix G3 of the EIS did not quantify the frequency of data collection of demonstrate that the frequency of ongoing data collection would be sufficient to monitor for potential impacts against the baseline data.

The frequency of monitoring for the relevant groundwater and surface water resources was detailed in Table 3-2 through Table 3-7 of the Water Monitoring Plan in Appendix G3 of the EIS.

The proponent will work with DPI Water and relevant Commonwealth and State Government stakeholders to refine the groundwater monitoring program for the project.

6.12.2 Beneficial reuse

Suitability of water

Submissions stated prior analysis of produced water from the prior operator at EastWest EnviroAg laboratory had found the produced water unacceptable for beneficial reuse.

Produced water will not be used directly for beneficial reuse. Rather, as discussed in Chapter 7 (Produced water management) of the EIS, the produced water would be treated and amended as necessary to be suitable for a range of beneficial uses including irrigation, stock watering, dust suppression and construction.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project’s EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

6.12.3 Managed release

Opposition to managed release to Bohena Creek

Submissions expressed general opposition to the managed release to Bohena Creek. Submissions variously referred to the managed release as being of produced water or treated water. They stated the release posed risks to downstream users, industries and environmental values.

Produced water will not be directly released to Bohena Creek. Rather, as set out in the EIS, it is proposed that under specified flow conditions, produced water that has been treated through the reverse osmosis plant at Leewood may be released to Bohena Creek.

The EIS used water quality and hydrological science to assess the risk of managed release of treated water to Bohena Creek. See specifically the Appendix G1 - Managed release (Bohena Creek). The assessment showed that once the water is treated to the target water quality, it is largely compatible with background water quality in Bohena Creek.

Table 7-2 in Chapter 7 (Produced water management) of the EIS assessed the target treated and amended water qualities against applicable water quality guidelines aligned with proposed beneficial reuse options. This table has now been revised to include actual water quality data from the commissioned Leewood Water and Brine Treatment Plant (WBTP) and is presented in Table 6-4 and in the updated Water Baseline Report at Appendix D to this RTS.

The results show that the treated water quality data meet relevant water quality guidelines for the proposed managed release and proposed beneficial reuse activities.

Table 6-4 Target and actual treated and treated and amended water quality from the Leewood Water and Brine Treatment Plant (WBTP) against relevant guidelines

Parameter	Australian Drinking Water and Recreational Guidelines (NHMRC, NRMMC 2008, 2011, 2017)	ANZECC / ARMCANZ (2000) Irrigation Guidelines (Long Term > 20 years)	ANZECC / ARMCANZ (2000) Stock watering	Target treated water[a]	Target treated and amended water[b]	Treated water[c] (Leewood WBTP) (2017)	Treated and amended water[d] (Leewood WBTP) (2017)
		(mg/L)		Target (mg//L)		Actual (mg/L)	
pH (pH units)	6.5 – 8.5	6.0 - 9.0	Not referenced	7.1	7.1	7.9	7.1
Electrical conductivity (laboratory) (µS/cm)	Not referenced	Crop specific – Lucerne (2,700 in loamy soils)	Not referenced	357	566	NA	107
Total dissolved solids	Health: Not referenced Aesthetic as follows: <600 Good quality 600-900 Fair quality 900-1,200 Poor quality >1,200 Unacceptable	Crop specific – Lucerne: 1,273 – 3,015	No adverse effects to: Beef cattle, pigs and horses: 4,000 Sheep: 5,000	232	368	56	71
Sodium Adsorption Ratio (SAR)	Not referenced	<1 Excellent 1-2 Good 2-4 Fair 4-8 Poor	Not referenced	130	3.3	29	3.7

Parameter	Australian Drinking Water and Recreational Guidelines (NHMRC, NRMMC 2008, 2011, 2017)	ANZECC / ARMCANZ (2000) Irrigation Guidelines (Long Term > 20 years)	ANZECC / ARMCANZ (2000) Stock watering	Target treated water[a]	Target treated and amended water[b]	Treated water[c] (Leewood WBTP) (2017)	Treated and amended water[d] (Leewood WBTP) (2017)
		(mg/L)		Target (mg/L)		Actual (mg/L)	
		8-15 Very poor >15 Unacceptable					
Sodium (filtered)	Health: Not referenced Aesthetic: 180	Crop specific – Lucerne (230 - 460)	Not referenced	77	77	17	18
Magnesium (filtered)	Not referenced	Not referenced	Not referenced	<0.01	<0.01	<1	<1
Aluminium	Health: Not referenced Aesthetic: 0.2	5.0	5.0	<0.001	<0.001	<0.01	<0.01
Silica (SiO_2) (µg/L)	80	Not referenced	Not referenced	23	0.15	<0.1	<0.1
Potassium (filtered)	Not referenced	Not referenced	Not referenced	0.8	0.8	<1.0	<1.0
Calcium (filtered)	Health: Not referenced Aesthetic as follows: <60 Soft 60-200 Good quality >200 Increased scaling	Not referenced	1,000	0.01	40.01	<1.0	6.0
Chromium (III+VI)	0.05	0.1 (Cr^{VI})	1.0	<0.001	<0.001	<0.001 (Cr^{VI})	<0.001 (Cr^{VI})
Manganese	0.5 Aesthetic: 0.1	0.2	Not sufficiently toxic	<0.001	<0.001	<0.001	<0.001

Parameter	Australian Drinking Water and Recreational Guidelines (NHMRC, NRMMC 2008, 2011, 2017)	ANZECC / ARMCANZ (2000) Irrigation Guidelines (Long Term > 20 years)	ANZECC / ARMCANZ (2000) Stock watering	Target treated water[a]	Target treated and amended water[b]	Treated water[c] (Leewood WBTP) (2017)	Treated and amended water[d] (Leewood WBTP) (2017)
	(mg/L)			Target (mg//L)		Actual (mg/L)	
Iron	<1 Aesthetic: 0.3	0.2	Not sufficiently toxic	<0.001	<0.001	<0.05	<0.05
Boron	4.0	Crop specific: 0.5 (sensitive) to 15 (very tolerant)	5.0	0.12	0.12	0.11	0.09
Cobalt	Not referenced	0.05	1.0	<0.001	<0.001	<0.001	<0.001
Nickel	0.02	0.2	1.0	<0.001	<0.001	<0.001	<0.001
Copper	2.0 Aesthetic: 1.0	0.2	0.4 (sheep) 1 (cattle) 5 (pigs)	<0.001	<0.001	<0.001	<0.001
Zinc	Health: Not referenced Aesthetic: 3.0	2.0	20	<0.001	<0.001	<0.005	<0.005
Arsenic	0.01	0.1	0.5 – 5	<0.001	<0.001	<0.001	<0.001
Selenium	0.01	0.02	0.02	<0.001	<0.001	<0.01	<0.01
Molybdenum	0.05	0.01	0.15	<0.001	<0.001	<0.001	<0.001
Cadmium	0.002	0.01	0.01	<0.001	<0.001	<0.0001	<0.0001
Barium	2.0	Not referenced	Not referenced	<0.001	<0.001	<0.001	<0.001
Mercury	0.001	0.002	0.002	0.0000067	<0.001	<0.0001	<0.0001
Lead	0.017	2.0	0.1	<0.001	<0.001	<0.001	<0.001
Uranium	0.017	0.01	0.2	<0.0028	<0.0028	<0.001	<0.001

Parameter	Australian Drinking Water and Recreational Guidelines (NHMRC, NRMMC 2008, 2011, 2017)	ANZECC / ARMCANZ (2000) Irrigation Guidelines (Long Term > 20 years)	ANZECC / ARMCANZ (2000) Stock watering	Target treated water[a]	Target treated and amended water[b]	Treated water[c] (Leewood WBTP) (2017)	Treated and amended water[d] (Leewood WBTP) (2017)
		(mg/L)		Target (mg//L)		Actual (mg/L)	
Alkalinity (total as $CaCO_3$)	Not referenced	Not referenced	Not referenced	139	139	34	28
Ammonia (as N)	Health: Not referenced Aesthetic: 0.5	Crop specific: 25-125 (As N)	Not referenced	0.005	0.005	0.25	0.29
Nitrate (as N)	11	Crop specific: 25-125	400	0.005	0.005	0.04	1.02
Total N	Not referenced	25-125	Not referenced	0.005	0.005	0.3	0.3
Sulfate	500	Not referenced	1,000	0.003	95.9	<1.0	<1.0
Chloride	Health: Not referenced Aesthetic: 250	Crop specific: Lucerne (350 – 700)	Not referenced	15	15	10	19
Fluoride	1.5	2.0	Not referenced	0.08	0.08	<0.1	<0.1
Total phosphorous	Not referenced	Crop specific: 0.8-12.0	Not referenced	0.01	0.01	<0.01	<0.01

Not referenced: No value provided in applicable guidelines. NA: Not analysed.

[a] theoretical composition based on manufacturers specifications.

[b] calculated composition based on theoretical treated water and amendment with 1 mol gypsum.

[C] all values reported as maximum recorded values, except pH reported as average.

[d] treated water amended with calcium chloride.

Impacts of managed release on Bohena Creek water quality

Several submissions considered that the managed release of treated water to Bohena Creek would still pose a contamination and environmental degradation impact. They questioned the chemistry of the discharged waters compared to natural creek water and the process of monitoring the impacts.

Modelled results presented in the EIS were based on treated water quality targets. Analytical results from the commissioned reverse osmosis plant indicate lower concentrations of carbonate and sodium and levels at or below detection limits for most analytes, including radioactive elements and contaminants-of-concern. These are reported in the revised Water Baseline Report (Appendix D of this RTS).

The proponent notes that Bohena Creek is an ephemeral creek and exhibits variability in its salinity and chemistry dependent on antecedent conditions and local sources of elements. Bohena Creek has been sampled during multiple flow events since 2012 to provide baseline characterisation of the natural levels and variability of all constituents.

An ecotoxicological assessment of the potential impacts of the managed release has also been undertaken and findings were included in the EIS (Appendix G1). The study found no potentially detrimental impacts would occur from the managed release to the creek during the managed release scenario flow event that requires greater than 100 megalitres per day down Bohena Creek.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

Impacts of managed release on drinking water or stock water

Submissions stated that manage release of treated water could affect water sources used for drinking water or stock water. They stated Narrabri Shire Council operated a water supply bore targeting Bohena Creek alluvium. They stated that release to Bohena Creek should therefore be assessed against other water quality guidelines including drinking water.

Table 7-2 in Chapter 7 (Produced water management) of the EIS compared the target treated water quality proposed for managed release against the (then current) Australian drinking water quality guidelines (NHMRC 2011), short term (<20 years) irrigation guidelines (ANZECC/ARMCANZ 2000) and the stock watering guidelines (ANZECC/ARMCANZ 2000). The assessment found that the target treated, and treated and amended water quality is better than relevant guidelines for drinking water, irrigation and stock watering.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

Impacts of managed release on Bohena Creek stream bed

The submission stated that Bohena Creek would not flow rapidly during flow events when managed release would occur and that chemicals in treated water may accumulate in the Bohena Creek streambed and waterholes.

Appendix G1 – Managed release (Bohena Creek) discusses Bohena Creek's hydrologic response to rainfall based on historic climate and flow data. Modelling of the proposed managed release considered basin scale hydrogeological processes, and local scale groundwater flow in permeable alluvial and colluvial sediments typical of Bohena Creek.

Analysis of Bohena Creek, including flow hydrographs, indicates the alluvium becomes saturated relatively quickly during a flow event. This would especially be the case during a relatively large flow event during which managed release might occur. The managed release would occur during a rising hydrograph, as flows increase, or peak, to a level above 100 megalitres per day flow and release would cease during a lowering hydrograph as daily flows drop below that volume. As such, managed release would not occur during conditions where ponding or water accumulation in the alluvium would occur.

Section 6.3.1.3 of Appendix G1 describes the duration of historic flow events upon which the managed release protocol was based. The longest flow events can be seen to result in substantial natural discharges of many thousands of megalitres, whilst even the shortest recorded continuous flow event during the historic period yielded a calculated total flow of 300 megalitres over three days, with a mean discharge of 116 megalitres per day. The data shows that the mean discharge rate throughout the 14 recorded continuous flow events from 1997 to 2004 was 497 megalitres per day. The proposed managed release will be up to 12 megalitres per day of treated water during a flow event of over 100 megalitres per day and would therefore only result in a marginal increase in streamflow.

A rainfall-runoff model was run to understand the wetting and drying patterns of Bohena Creek. Based on rainfall and creek wetting and drying cycles, the model predicted the onset of flows within Bohena Creek with an accuracy of +/- one day in the majority of cases. Therefore, the proponent has high confidence in the accuracy of the modelling used in the EIS to inform environmental impact assessment of the managed release. The modelling found that if releases to flowing streams cease during the period when stream flow is occurring, then stream drying patterns will not be affected. Modelling results found that the managed release of 12 megalitres per day did not result in significant difference in water level, flow or velocity over the five or 100 year events. Differences in peak water levels were shown to be less than one millimetre in the five year event, with no discernible change for a 100 year event. There was no change in flood velocity in either the five or 100 year events.

Modelling of managed release to Bohena Creek

Submissions stated that modelling of manage release to Bohena Creek assumed the streambed formed a constant gradient and did not account for shallow aquifers or intermittent waterholes.

Appendix G1 – Managed release (Bohena Creek) discusses Bohena Creek's hydrologic response to rainfall based on historic climate and flow data. Modelling of managed release considered basin scale hydrogeological processes, and local scale groundwater flow in permeable alluvial and colluvial sediments typical of Bohena Creek. Modelling showed that local-scale processes have a relatively fast response time, with the water table in the alluvium responding rapidly to rainfall and runoff events. It therefore accounted for the influence of differing permeabilities and shallow aquifers.

For the modelling, the resolution, or cell size, of the hydraulic model was one metre by one metre, with spatial data collected at a time when Bohena Creek was dry. Bohena Creek was broken into 400 metre sections for modelling purposes. This allowed for sufficient detail such that changes in channel and floodplain geometry were captured, and therefore, that changes in water conveyance along the river thalweg were also captured. Therefore, the characteristics of Bohena Creek are represented in the modelled dataset with high accuracy.

Analysis of Bohena Creek, including flow hydrograph analysis, indicates the alluvium becomes saturated very quickly during a flow event. This would especially be the case during a relatively large flow event during which managed release might occur, being a flow of 100 megalitres per day as measured at Newell Highway gauging station. Managed release would be planned to occur during a rising hydrograph, as flows increase or peak to a level above 100 mega litres per day and would cease during a lowering hydrograph, as flows drop below that volume. As such, managed release would not occur during conditions where ponding or accumulation in alluvium would occur.

Noncompliant release to Bohena Creek

The submission indicated that the planned managed release to Bohena Creek would not be practicable due to the infrequency of high flow events. Some stated that zero flow years comprised 40 per cent of the years used as a design basis for the scheme.

Submissions raised the risk that an uncontrolled release during low flow events would occur as a result of the infrequency of flow conditions of more than 100 megalitres per day. They stated in this case residual chemicals in treated water may be concentrated in waterholes or pools.

Other submissions stated that during high rainfall events where irrigation capacity is exceeded larger volumes of produced water would be required to be discharged than predicted. They stated in this case larger volumes of residual chemical may be released.

Treated water would only be released to Bohena Creek at the managed release point during periods when the flow in Bohena Creek is equal to, or greater than, 100 megalitres per day, as measured at the Newell Highway gauging station. The managed release would complement the beneficial reuse options such as during wet weather events when demand for the beneficial reuse options may be limited.

Water management ponds would be designed in accordance with the relevant codes of practice including *Exploration Code of Practice: Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015). In line with the guidelines, storage levels would be defined for each of the ponds for monitoring and management purposes and include capacity for containment of extreme rainfall events. Storage levels are continuously monitored using pressure monitors and telemetry systems and field operations can be managed to control the volume of produced water if this is necessary.

6.12.4 Surface water quality impacts

Contamination of surface water

Submissions stated that the project would have the potential to cause spills or leaks of chemicals that could contaminate surface water. They stated that spills or leaks could occur from project infrastructure including gas wells, gas and water gathering lines or produced water ponds. They stated that chemicals could include produced water, drilling fluid and salt as well as other substances.

The potential for the project to cause spills or leaks was assessed in Chapter 14 (Soils and land contamination) and Chapter 25 (Hazard and risk) of the EIS. The assessments found that the likelihood of the project causing a spills was low.

The project would be designed in accordance with the relevant codes of practice to minimise the risk of spills or leaks occurring. These would include:

- *Code of Practice for Coal Seam Gas – Well Integrity*
- *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*
- *Exploration Code of Practice: Produced Water Management, Storage and Transfer.*

As discussed in Chapter 6 of the EIS (Project description), and in accordance with the codes of practice, produced water ponds would be designed to incorporate double lining, leak detection and seepage collection. In addition to this, the NSW Dam Safety Committee would review and confirm the dam design.

The project would also incorporate a range of monitoring systems that would enable quick detection and rectification in the unlikely event of a leak or spill, including continuous pressure monitoring of produced water gathering lines, and leak detection and monitoring bores for produced water ponds. Further, exploration, appraisal and production gas wells would be remotely monitored and controlled and would automatically shut down in the event of non-routine operation conditions.

Chemicals will be stored and handled in accordance with the relevant Australian Standards, including *AS 1940-2004 The storage and handling of flammable and combustible liquids*. Refuelling would occur with suitable containment for volumes greater than 50 litres and not within 40 metres of a watercourse. Bunding, drip trays and other preventative measures would be implemented as necessary and spill kits would be situated as appropriate in areas where there is potential for spills to occur. Regular inspection of plant, equipment and infrastructure would be carried out in accordance with operational procedures.

Lastly, the proponent will be responsible to develop a Pollution Incident Response Management Plan in accordance with *Protection of the Environment Operations Act 1997*. A response plan is currently in place for exploration and appraisal activities in accordance with these requirements.

In summary a significant number of design, construction and operational measures are proposed or already in place that mean there is a low risk of spills or leaks. As demonstration of this, the proponent has conducted exploration and appraisal activities in the project area, including operation of the water treatment plant at Leewood, without a reportable incident in over 4.5 years.

Issues regarding managed release to Bohena Creek are discussed in Section 6.12.2.

Methane infiltration into surface water

Submissions raised concerns about the potential for methane to escape coal seams and infiltrate surface water in rivers or springs.

In general, methane is observed at low and varying levels in all formations above the target formations, though most groundwater samples from across the monitoring network do not record hydrocarbons above limits of reporting. There is no spatial coincidence between elevated levels in different formations at different depths, though elevated levels in deeper formations are more likely to relate to underlying conventional gas reserves, or seepage losses from deeper coal measures.

Groundwaters in alluvium aquifers with elevated methane occur along the Namoi River, north-east of the project, a significant distance from gas-related activities. Alluvium and colluvium sourced groundwaters above, and adjacent to, gas exploration sites show negligible to below background methane levels, indicating that gas is not escaping to the surface related to these development activities nor migrating from coal seams into overlying water resources.

Monitoring for methane has been undertaken by the proponent and others, including the Gas Industry Social and Environment Research Alliance (GISERA). With reference to the concerns raised about methane seeps in the Condamine River in Queensland, GISERA has conducted extensive studies of the Condamine River in recent years and a summary of the results of these studies can be found on a fact sheet at: https://gisera.csiro.au/news/methane-seeps-in-the-condamine-river-fact-sheet/

6.13 Hydrology and geomorphology

Potential impacts to hydrology and geomorphology were assessed in Appendix H and summarised in Chapter 13 of the EIS. The assessment included the development of a flood model across the project area for the ten per cent and one per cent annual exceedance probability flood events and the probable maximum flood. The assessment found that the effect of project infrastructure on flood flows would be negligible in most cases including throughout the field and at Bibblewindi. Very localised changes to flood behaviour including depth and afflux were predicted in the vicinity major infrastructure at Leewood but would not pose an increased level of threat to people or property.

Potential impacts on geomorphology of watercourses in the project area including Bohena Creek were also considered. Those potential impacts were found to be minimised through the use of existing crossings where practicable, construction of new crossings during periods of no flow and appropriate erosion and sedimentation controls, The potential impacts of managed release to Bohena Creek were found to be negligible given the release would be from an appropriately designed diffuser structure during periods of significant flow of equal to or greater than 100 megalitres per day at Newell Highway gauging station.

33 submissions raised issues specifically relating to the assessment of hydrology and geomorphology presented in Chapter 13 and Appendix H of the EIS. The submissions that raised these issues were unique as the issue was not presented in form submissions.

The division of submissions by issue and submission type is depicted in Figure 6-26.

A number of submissions raised issues regarding surface water quality in Bohena Creek or other watercourses in the project area. These issues are discussed in Section 6.12

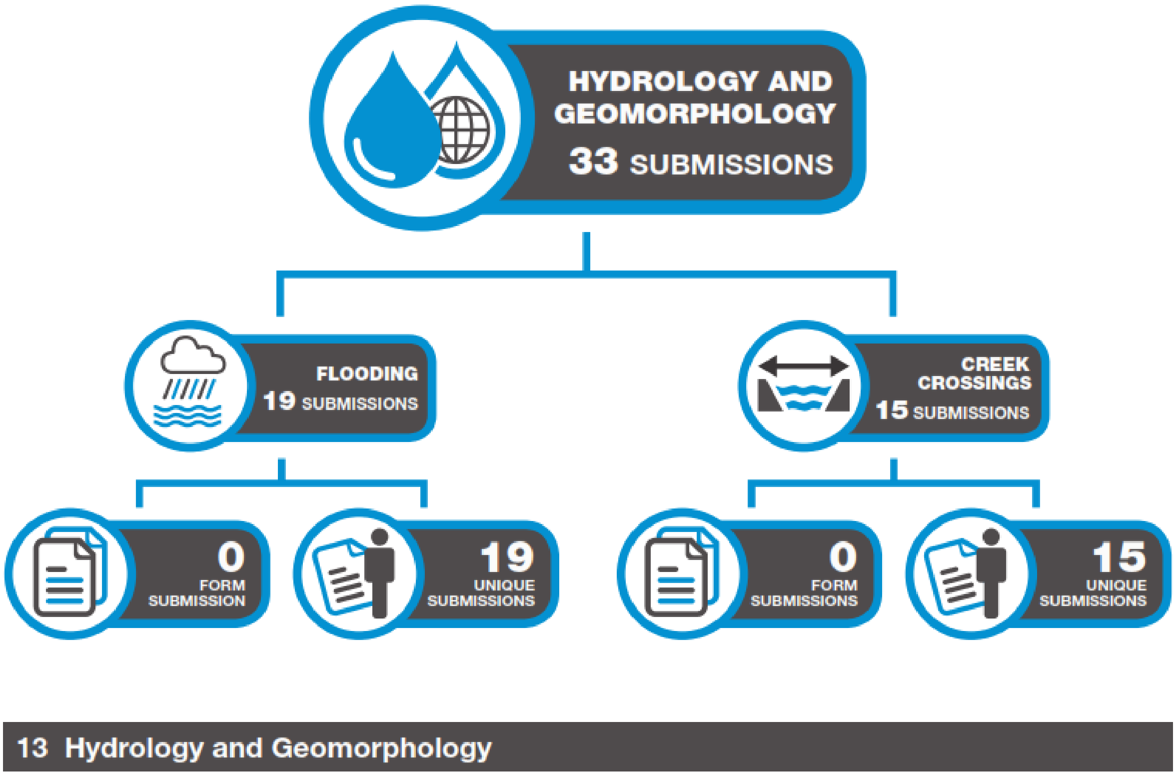


Figure 6-26 Summary of submissions on approach to the impact assessment

6.13.1 Flooding

Increase in flood intensity

Submissions stated that removal of vegetation and establishment of project infrastructure including well pads, gas and water gathering lines and access tracks would increase flood intensity.

As discussed in the EIS, project infrastructure and associated clearing would be occupy around one per cent of the project area. The increase in impermeable areas from the construction of the project would result in very limited changes in flood levels.

These results were provided in Section 5.4 of Appendix H (Hydrology and geomorphology) of the EIS.

Flooding of produced water ponds

Submissions stated that flooding presented a risk of significant losses of containment of produced water and would comprise a risk to human safety and the environment. Submissions stated that produced water ponds would be situated in flow paths during high rainfall.

Produced water and brine ponds are and will be constructed as stand-alone structures. They are designed to avoid the addition of surface run-off from surrounding landscape during wet weather events. Their catchment area is thus limited to the area of the pond itself. As such, the only additional storage that would be required during wet weather would be the rain that falls directly into the pond structure itself.

In respect of capacity to store in the event of sustained rainfall, the Leewood ponds have, consistent with the *Produced Water Code of Practice*:

- a spillway capacity designed to pass 0.01 per cent Annual Exceedance Probability (AEP) flows
- wet season design storage allowance (the volume between the maximum operating level (MOL) and full supply level (FSL/spillway level) sized to provide storage for a volume equivalent to the 1:100 AEP and a storm event containment of 1:100 AEP 72-hour duration
- located and designed to be structurally stable in all events up to and including the probable maximum flood
- pond level and collection sump monitoring
- an implemented regular inspection and monitoring program.

The ponds are designed and operated to ensure that there is sufficient storage capacity to contain produced water in extreme rainfall events, in accordance with the relevant Codes of Practice and guidelines. In addition, pond levels are monitored and field operations can be managed to control the volume of produced water if this is necessary.

Alteration of flow paths or regimes in Bohena Creek

Submissions stated managed release of treated water could alter the natural flow paths or regimes of Bohena Creek and have consequential geomorphic or environmental impacts.

As discussed in Chapter 7 of the EIS (Produced water management), up to 12 megalitres per day of treated water would be released to Bohena Creek during flow conditions of at least 100 megalitres per day. Further, the treated water would be released through a suitably designed diffuser.

Under such conditions, managed release of treated water to Bohena Creek would not be expected to alter the natural flow paths or regimes of Bohena Creek. This has been assessed and reported in Appendix G1; specifically, Appendix A to Appendix G1 (Ecological Risk Assessment) and Appendix D to Appendix G1 (Fluvial Geomorphology Engineering Impact Assessment).

The hydraulic modelling in the assessment found that release of 12 megalitres per day into Bohena Creek when flowing at greater than 100 megalitres per day, does not result in significant differences in water level, flow or velocity over the five and 100 year average recurrence interval events.

6.13.2 Creek Crossing

Creek crossings

Submissions objected to the project on the grounds it would cross watercourses and have associated impacts on hydrology, geomorphology, water quality and habitat value.

The residual risk of creek crossings to the environment including associated impacts on hydrology, geomorphology water quality and habitat value was found to be low.

Gas and water gathering lines would be designed to avoid impacts to watercourses. Where they are required to cross watercourses selection of crossing points will, where practical:

- use existing vehicular crossings
- be located on straight sections of channel
- maximise avoidance of steep, unstable banks, permanent pools and waterholes.

All gas and water gathering lines would be designed to the relevant Australian Standard including the APGA *Code of Practice for Upstream Polyethylene Gathering Networks- CSG Industry*. Where gas and water gathering lines occur within the one per cent annual recurrence interval flood they will be designed and installed to ensure that there will be negligible modification of flows. The residual risk of creek crossings to the environment including associated impacts on hydrology, geomorphology water quality and habitat value was found to be low.

6.14 Soil and land contamination

Potential impacts regarding soils and land contaminations were discussed in Chapter 14 of the EIS. The assessment found that soils were generally limited in their fertility and productive capacity and that none of the soils in the project area comprised biophysical strategic agricultural land under the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*.

The assessment considered the potential impacts of the project soil structure and quality including erosion and sedimentation, spills and leaks, the beneficial reuse of treated water such as dust suppression and the beneficial reuse of treated and amended water such as for irrigation.

The assessment found the erosion and sedimentation and spills and leaks would be readily avoided, mitigated and managed through the implementation of standard mitigation and management measures.

The beneficial use of treated water for activities such as dust suppression, construction and drilling was also found to have limited impacts due to the quality of the water and management of its application.

Similarly the assessment concluded that irrigation of treated and amended water would be carried out in accordance with an irrigation management strategy that would seek to ensure that the structure, stability and the productive capacity of receiving soils are maintained, erosion is minimised and runoff controls are in place. The performance of irrigation systems would be monitored to ensure they perform as expected.

Existing land contamination in the project area was also assessed. The assessment found that existing sources of potential land contamination were sparsely distributed through the project area and that overall risk of interacting with existing land contamination was low partly due to the flexibility of the location of field infrastructure afforded by the Field Development Protocol (EIS Appendix C).

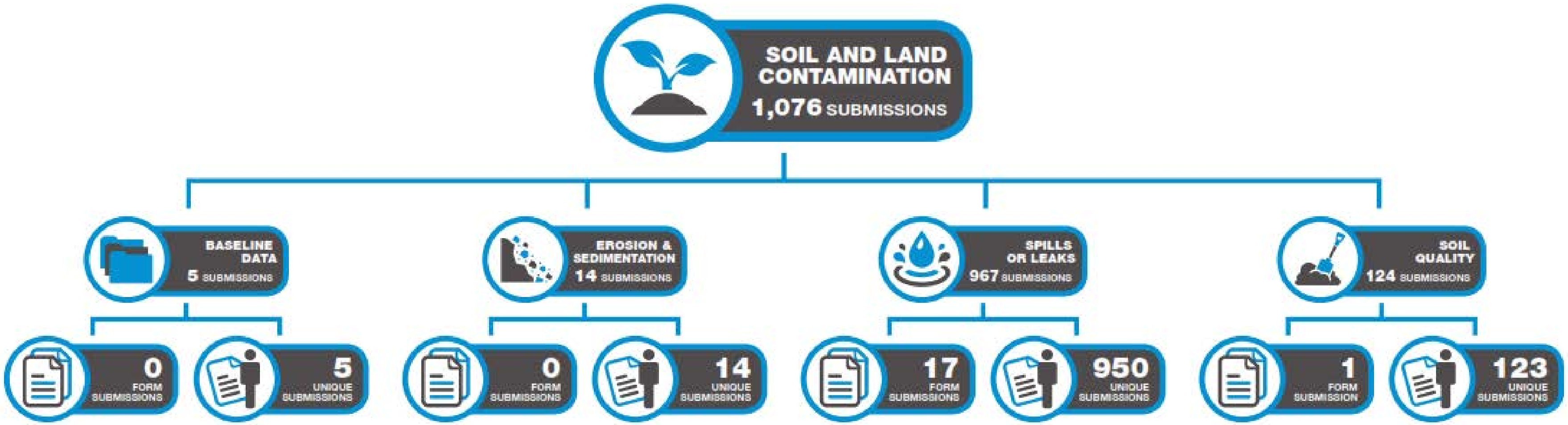
1,076 submissions raised issues specifically relating to soils and land contamination as described in Chapter 14 of the EIS. Of those:

- 5 submissions raised issues relating to baseline data (all unique submissions).
- 14 submissions discussed erosion and sedimentation issues (all unique).
- 967 submissions pertained to spills or leaks (17 form and 950 unique).
- The balance, being 124 submissions, raised issues relating to soil quality (1 form and 123 unique).

Submissions related to baseline data were in relation to the mapping of soil hazards for adequate protection and management. Erosion and sedimentation submissions sought assurance that soils would be adequately managed given their nature.

The bulk of the submissions discussed the risk of spills or leaks, and sought assurance that historic performance by the proponent in the Pilliga and in Queensland would be improved. The soil quality submissions were concerned about impacts to soil should spills or leaks occur.

Figure 6-27 provides an overview of the submissions for soils and land contamination.



14 Soil and Land Contamination

Figure 6-27 Summary of submissions on assessment of alternatives

6.14.1 Baseline data

Mapping of soil hazard areas

Submissions requested that mapping of soil erosion and siltation hazard areas be produced so that they may be avoided by the project.

> The soils assessment for the project was provided as Appendix I1 and summarised in Chapter 14 (Soils and land contamination) of the EIS. Soils in the project area were mapped in Figure 4-1 and potential hazards associated with the mapped soil types were identified in Table 5-2 of Appendix I1.
>
> The information generated through soil sampling and analysis carried out for the soil assessment will be used to inform a Soil Management Plan and an Erosion and Sediment Control Plan for the project. The management plans are discussed in Chapter 30 (Environmental management and monitoring) of the EIS.
>
> The purpose of the Erosion and Sediment Control Plan is to minimise sedimentation to surface watercourses as a result of construction activities. The Interpretative Soils report (refer to Appendix I1) identified pockets of dispersive soil in the project area that would require appropriate management during construction.
>
> Erosion and sediment controls for the project will be implemented based on *Managing Urban Stormwater – Soils and Construction Vol. 1* (Blue Book – Landcom 2004).

6.14.2 Erosion and sedimentation

Erosion and sedimentation

Submissions stated the project would generate erosion and sedimentation. Submissions noted the potential issues of erosion and sedimentation during construction especially for soils in forested areas that may have problematic characteristics. They stated that project access roads in particular would need to be constructed in a manner that prevents erosion and sedimentation. They requested that roads:

- be constructed from local materials
- not require cut and fill activities
- include rollover mounds instead of table drains.

> As stated in Chapter 14 of the EIS (Soils and land contamination), the proponent will develop an Erosion and Sediment Control Plan to avoid, mitigate and manage potential erosion and sedimentation impacts.
>
> Erosion and sediment controls for the project will be implemented based on *Managing Urban Stormwater – Soils and Construction Vol. 1* (Blue Book – Landcom 2004).

6.14.3 Spills or leaks

Potential for spills and leaks

Submissions stated that the project would have the potential to cause spills or leaks of chemicals that could contaminate land. They stated that spills or leaks could occur from project infrastructure including gas wells, gas and water gathering lines or produced water ponds. They stated that chemicals could include produced water, drilling fluid and salt as well as other substances.

The potential for the project to cause spills or leaks was assessed in Chapter 14 (Soils and land contamination) and Chapter 25 (Hazard and risk) of the EIS. The assessments found that the likelihood of the project causing a spills was low.

The project would be designed in accordance with the relevant codes of practice to minimise the risk of spills or leaks occurring. These would include:

- *Code of Practice for Coal Seam Gas – Well Integrity*
- *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*
- *Exploration Code of Practice: Produced Water Management, Storage and Transfer.*

As discussed in Chapter 6 (Project description) of the EIS, and in accordance with the codes of practice, produced water ponds would be designed to incorporate double lining, leak detection and seepage collection. In addition to this, the NSW Dam Safety Committee would review and confirm the dam design.

The project would also incorporate a range of monitoring systems that would enable quick detection and rectification in the unlikely event of a leak or spill, including continuous pressure monitoring of produced water gathering lines, and leak detection and monitoring bores for produced water ponds. Further, exploration, appraisal and production gas wells would be remotely monitored and controlled and would automatically shut down in the event of non-routine operation conditions.

Chemicals will be stored and handled in accordance with the relevant Australian Standards, including *AS 1940-2004 The storage and handling of flammable and combustible liquids*. Refuelling would occur with suitable containment for volumes greater than 50 litres and not within 40 metres of a watercourse. Bunding, drip trays and other preventative measures would be implemented as necessary and spill kits would be situated as appropriate in areas where there is potential for spills to occur. Regular inspection of plant, equipment and infrastructure would be carried out in accordance with operational procedures.

The proponent will be responsible to develop a Pollution Incident Response Management Plan in accordance with *Protection of the Environment Operations Act 1997*. A response plan is currently in place for exploration and appraisal activities in accordance with these requirements.

In summary a significant number of design, construction and operational measures are proposed or already in place that mean there is a low risk of spills or leaks. As demonstration of this, the proponent has conducted exploration and appraisal activities in the project area, including operation of the water treatment plant at Leewood, without a reportable incident in over 4.5 years.

Remediation at Bibblewindi

Submissions stated Bibblewindi had not been adequately remediated from historic spills and that produced water had been piped to another disposal site within State forest.

Targeted surveys and monitoring of the Bibblewindi rehabilitation site undertaken by a suitably qualified ecologist during autumn and spring 2017 have found the revegetated area is generally in a good condition and progressing on a trajectory towards self-sustaining native plant communities.

Produced water is managed in accordance with the *Exploration Code of Practice: Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015), including storage in purpose built double-lined ponds with leak detection systems installed.

6.14.4 Soil quality

Potential impacts of salt on soil quality

Submissions noted that the assessment did not identify a disposal option for waste salt and stated that the waste salt could nonetheless negatively affect district soil productivity.

As stated in Chapter 31 (Project commitments) of the EIS, waste salt would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

Prior to routine load out to an off-site licenced waste management facility, the salt would be temporarily stored at Leewood in a weather proof, appropriately bunded storage facility.

Potential impacts of treated and amended water on soil quality

Submissions stated that the beneficial reuse of treated and amended water would cause an accumulation of contaminants that could affect soil quality in areas where it is applied, including irrigation areas.

They stated accumulation of contaminants could be increased if irrigation or other activities occur on soils that are compacted or prone to waterlogging as it would limit flushing and drainage.

The EIS assessed the target treated (and amended) water quality against a range of proposed beneficial reuse options including stock watering and irrigation and found that the target water quality met the applicable ANZECC/ARMCANZ (2000) guidance values. That data was updated to include drinking water and long term irrigation trigger values in Table 6-4 and Appendix D of this RTS.

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

When selecting a property for irrigation, a range of factors would be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscape (including geological and hydrological features), and water and soil management through typical irrigation management practices. As committed in Chapter 31 (Project commitments) of the EIS, irrigation of treated water during production will be undertaken in accordance with an irrigation framework under the Produced Water Management Plan.

6.15 Terrestrial ecology

The assessment potential impacts of the project on terrestrial ecological values were assessed in Appendix J1 and Appendix J2 of the EIS and summarised in Chapter 15. The Ecological Impact Assessment was based on more than 13,000 hours of flora and fauna surveys.

The Ecological Impact Assessment found that the project was unlikely to have a significant impact on threatened flora, fauna or ecological communities due to:

- the small proportion of habitat being removed relative to that retained in the project area
- the removal of habitat not being at a scale likely to result in isolation or fragmentation of populations
- it being unlikely that the project would result in invasive species or diseases becoming established
- the progressive rehabilitation of disturbed areas as part of the project.

The Ecological Impact Assessment found that impacts would be less than two per cent of total threated and migratory fauna habitat in the project area and less than 1.6 per cent of the total threatened flora abundance estimated to occur in the project area. The assessment found that a number of measures included in the design of the project would minimise potential impact on terrestrial flora and fauna. These include placing infrastructure in previously cleared or disturbed areas where practicable including collocating linear infrastructure with already disturbed areas such roads or access tracks.

The assessment discussed how the Field Development Protocol operating in combination with an ecological scouting framework would identify the most suitable areas for field development in order to minimise potential impacts to terrestrial ecological values.

19,124 submissions raised issues specifically relating to terrestrial ecology as described in Chapter 15 of the EIS. The majority of the submissions were form submissions, however, terrestrial ecology issues were raised in a substantial number of other unique submissions. The submissions primarily concerned impacts to the flora and fauna impacts generally while relatively few submissions concerned baseline data or offsetting, management and monitoring. Figure 6-28 provides an overview of the submissions relating to terrestrial ecology.

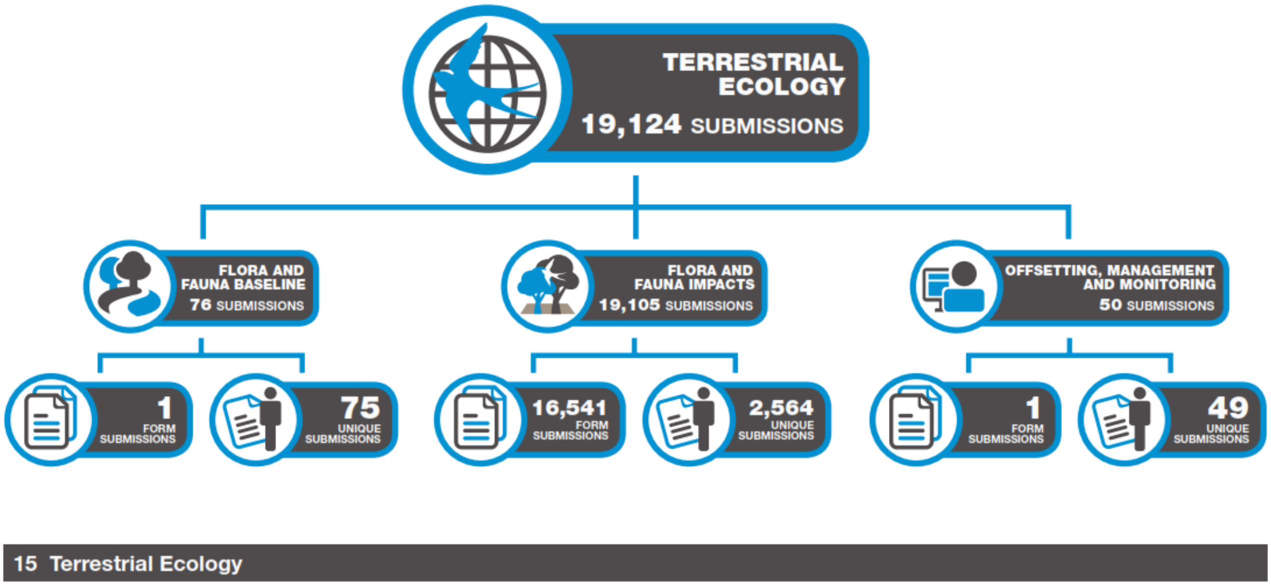


Figure 6-28 Summary of submissions on terrestrial ecology

6.15.1 Flora and fauna baseline data

Survey effort

The submissions raised a number of issues related to survey effort, including:

- compliance with *Framework for Biodiversity Assessment* or threatened species guidelines
- sufficiency of survey timing or effort for specific fauna species
- absence of detailed modelling for species including *Lepidium aschersonii*, *Lepidium monoplocoides* and *Myriophyllum implicatum*, and how it relates to the justification of impacts
- determination of locations of hollow-bearing trees used by hollow-dependent fauna to enable appropriate protection measures
- low capture rates are in contrast to the Northern Inland Council for the Environment (NICE) and Coonabarabran and Upper Castlereagh Catchment and Landcare Group (CUCCLG) (2012) survey results and as a consequence of previous and on-going gas mining explorations.

The project is being assessed under Part 4.1 of the NSW *Environmental Planning and Assessment Act 1979* which requires the proponent to complete an assessment in accordance with the *Framework for Biodiversity Assessment* and *Biodiversity Offset Policy for Major Projects* (Offset Policy) (OEH 2014a; OEH 2014b). Both the *Framework for Biodiversity Assessment* and Offset Policy are still in transition (OEH 2017), and while they are compulsory, a flexible approach is permitted to appropriately deal with technical issues, practical implementation issues, or potential perverse outcomes that may arise.

As part of the *Framework for Biodiversity Assessment*, surveys for threatened species are to be undertaken in accordance with the NSW Office of Environment and Heritage *Threatened Species Survey Guidelines* (DEC 2004b), and they must be undertaken during the period of time specified in the Threatened Species Profile Database. Following results of the threatened species survey, credits (offset requirements) for those threatened species which cannot be reliably predicted based on habitat requirements ('species credit' species) are calculated.

The DEC (2004b) *Survey Guidelines* were released as a working draft and have not been formally endorsed by the Government. They are guidelines intended to be adapted to fit the requirements of individual animal and plant surveys by outlining the field techniques and considerations, relevant legislation, and the relevant method of impact assessment for threatened biodiversity (DEC 2004b). The *Survey Guidelines* are not intended to be applied for landscape scale projects over many tens of thousands of hectares of vegetation and habitat.

For most threatened species, the DEC (2004b) *Survey Guidelines* have a maximum stratification unit of between 100 and 200 hectares (depending on faunal group), with an 'additional effort' required for additional areas of stratification unit. This 'additional effort' required is not defined and can be tailored to the specific needs of the project taking into account the survey methods and stratification rules. Furthermore, the EPBC Act *Threatened Species Survey Guidelines* (DEWHA 2010a-c, DSEWPaC 2011a-b) only apply for areas up to approximately 50 hectares, which highlights the deficiencies in applying the guidelines for landscape scale projects.

The surveys undertaken as part of the EIS have however been undertaken in accordance with the methodology, habitat stratification and replication as outlined in the State and Commonwealth *Survey Guidelines*, with specific consideration of the scale and distribution of threatened species habitat across the landscape and the amount of habitat likely to be directly impacted by the project.

Flora species

A threatened flora modelling report was prepared to investigate threatened flora populations in the North-east Pilliga Forest for the proponent. The scope of the study was to provide statistically robust modelled estimates of population size and distribution, and outline habitat requirements for threatened flora populations to adequately address the potential impacts of the project.

However, only a portion of the species known to occur in the project area were detected during targeted flora surveys, namely *Diuris tricolor*, *Polygala linariifolia*, *Pterostylis cobarensis*, *Commersonia procumbens* and *Tylophora linearis*. These species are the subject of the modelling report.

Furthermore, within the project area, detailed mapping and population estimates have been previously developed for *Bertya opponens* and *Pomaderris* queenslandica (EIS Appendix F4 of Appendix J1). However, modelling for *Lepidium aschersonii*, *Lepidium monoplocoides* and *Myriophyllum implicatum* was not undertaken due to insufficient records and poor seasonal conditions during the surveys in which they were detected.

The impacts on the two *Lepidium* species were calculated as 1.55 per cent of the total known population within the project area at the time of the assessment, similar to the average proportional impact to other threatened flora species. This resulted in a very low impact, with a proposed upper disturbance limit for these species of less than five each.

The two *Lepidium* species were identified late in the survey strategy in the north-western portion of the project area outside of the main body of the Pilliga Forest. They were identified during poor seasonal conditions and while some targeted survey occurred in suitable habitat, they were not part of the broader threatened flora modelling project for the reasons stated above.

Targeted surveys and population estimates for the two *Lepidium* species have been completed and are presented in Appendix H of this RTS. This has resulted in the development of revised upper disturbance limits for each of these species as detailed below.

An estimated 8,264,623 *L. aschersonii* occur within the project area based on an average density of 0.45 plants per square metre and an occupancy of 74 per cent of suitable habitat. An estimated

218,265 *L. monoplocoides* occur within the project area based on an average density of 0.07 plants per square metre an occupancy of 82 per cent of suitable habitat.

The revised upper disturbance limit for *L. aschersonii* is 77,691 which represents 0.94 per cent of the total population estimated within the project area. The revised upper disturbance limit for *L. monoplocoides* is 1,116 which represents 0.37 per cent of the total population estimated within the project area.

Both limits are well below the proportional impact of 1.55 per cent assessed in Appendix J1 of the EIS. The revised upper disturbance limits to these species are considered conservative and do not change the underlying assessment of impact to these species contained in Appendix J1 and Appendix J2 of the EIS. A revised working draft Biodiversity Offset Strategy is provided as Appendix F to this RTS.

Myriophyllum implicatum is an aquatic plant restricted to gilgai wetlands and soaks which are restricted in the project area. Its habitat preferences place it outside of likely direct impacts of the project and as such, there is limited risk associated with impacts to this species. There is no proposed impact on *Myriophyllum implicatum* as outlined in the Ecological Impact Assessment, and therefore no clearing limits have been determined for this species.

Hollow-bearing trees

A detailed analysis of the total number of hollow-bearing trees in three size classes (< 200 mm; 200–300 mm; and > 300 mm) to be impacted by the project was undertaken as part of the EIS using hollow class data collected at over 300 vegetation plots.

It is not feasible to determine the location of specific hollow-bearing trees being utilised by threatened fauna species across the entire 95,000 hectares project area. It is estimated that there are more than 800,000 hollow-bearing trees in the project area. The ecological scouting framework which is implemented through the Field Development Protocol prioritises the avoidance of large hollow bearing trees during site scale micro-siting of infrastructure.

Low capture rates

Surveys undertaken by Northern Inland Council for the Environment and the Coonabarabran and Upper Castlereagh Catchment and Landcare Group (NICE and CUCCLG 2012) were not undertaken during precisely the same period as surveys undertaken for the EIS, however they were undertaken during the overall preparation of the EIS. It is considered most likely that the high capture rates reported by NICE and CUCCLG (2012) were due to exceptional seasonal conditions following widespread rainfall and flooding in 2010/2011, with surveys undertaken as part of the EIS representative of less favourable conditions in the boom-bust population cycle in Western NSW.

The NICE and CUCCLG (2012) report was used to inform the field survey and impact assessment for the EIS. All threatened species recorded in the 2012 survey were also recorded in the EIS and helped inform the detailed understanding of ecological values present in the project area. Commentary that low capture rates reported in the EIS are related to previous and on-going gas mining exploration activities is both speculative and highly unlikely given the overall disturbance is significantly less than 0.1 per cent of the overall Pilliga. The NICE and CUCCLG surveys were undertaken within the overall survey period for the project, and the EIS surveys were undertaken across the entire 95,000 hectare project area which includes considerable areas not subject to direct, indirect or cumulative impacts of gas exploration.

Presence of Koala

Submissions raised the following matters in relation to Koala:

- recent Koala records from an independent survey is inconsistent with the conclusion in the EIS that Koalas are not present in the project area
- survey effort for the Koala was insufficient and did not meet the relevant survey guidelines
- the survey methodology did not adequately assess Koala core habitat or feed trees
- the EIS did not adequately assess impacts on the Koala, and that the ‘non-significant impact’ conclusion from the EIS is incorrect
- the Koala is declining in the Pilliga.

The Koala and potential habitat were assessed and described in detail in the EIS. The EIS included appropriate surveys for the Koala in the project area and identified the likely presence of the Koala, based on potential habitat. Surveys for the Koala and habitat mapping (modelling) were conducted as required by the *Framework for Biodiversity Assessment* (OEH 2014a), State and Commonwealth legislation and impacts were assessed in accordance with the former *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*. Furthermore, a regional Koala survey, including significant areas of the Pilliga outside of the project area was undertaken by Koala experts (Rod Kavanagh *et al*, as part of the Niche 2014 survey (Niche Environment and Heritage 2014) and these results informed the EIS.

The EIS concluded that the impacts of the project on the current Koala population will not lead to a long-term extinction of a viable local population. However, the submissions disagree in part with the habitat and impact assessment and questions the lack of Koala sightings that were reported in the EIS.

Offset requirements have been determined for the Koala and are included in the working draft Biodiversity Offset Strategy (BOS) which is included Appendix F to this RTS. In addition to the offsetting requirements, the EIS has provided a commitment to undertake a Koala research project to identify where the remnant populations of Koala are in the Pilliga in order to effectively target resources for the maintenance and improvement in the health of the population.

Community stakeholder concern for the Koala is high and submissions highlighted the recent decline of the species. All surveys of the Koala in recent times (for the Pilliga) have noted the declining population, this is acknowledged in the EIS. The declining population and low correlation between Koala habitat and the presence of Koalas are the primary reasons why the regional Koala survey was commissioned.

Habitat mapping was conducted as required by legislation, and the mapping of primary and secondary habitat relates only to *State Environmental Planning Policy No 44—Koala Habitat Protection*. As stated in Appendix J of Appendix J1 of the EIS, around to 33,000 hectares of potential foraging and breeding habitat for Koala was mapped in the study area. It is noted in the EIS that *State Environmental Planning Policy No 44—Koala Habitat Protection* is a State based policy and it refers to local government consent. The policy was not the only tool for Koala impact assessment, and has been used to supplement the other material appropriate to a State significant development that is provided in the EIS. Koala habitat has also been mapped and assessed in accordance with Commonwealth requirements.

Plant community types including Box-Gum Woodland

Submissions stated Box-Gum Woodland listed as a threatened ecological community under State and Commonwealth legislation was present in the project area. They stated Box-Gum Woodland was incorrectly identified in the EIS and that the corresponding plant community type 544 was present in the project area. Some submissions also stated that plant community types 399/401 and 544 were incorrectly identified in the EIS.

The submission has been carefully considered, along with further field assessment of the data presented in the EIS. Based on the information or data currently available, the assemblage of species and soil types is not consistent with the description of the community in the listing advice or final determination.

White box - yellow box - Blakely's red gum grassy woodlands and derived native grasslands is listed as critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*), while White Box Yellow Box Blakely's Red Gum Woodland listed as endangered under the former NSW *Threatened Species Conservation Act 1995* and current NSW *Biodiversity Conservation Act 2016*. These communities are collectively known as Box-Gum Woodland. Box Gum Woodland was not identified in the project area because the assemblage of species and soil type was not consistent with the description of this community in the listing advice or final determination. A review against the Box-Gum Woodland criteria under the *Environment Protection and Biodiversity Conservation Act 1999* and *Biodiversity Conservation Act 2016* is provided as Appendix E to this RTS.

Detailed vegetation mapping including 327 floristic plots and over 1,300 rapid vegetation plots have been conducted in the project area. Vegetation has been mapped according to the plant community type as shown in Appendices D and F1 of Appendix J1 of the EIS. Plant communities types were assigned in the project area based on the NSW Vegetation Classification and Assessment conducted by Benson *et al* (2010). The vegetation classification undertaken by Benson *et al*. (2010) has been adopted as part of the state-wide system for classifying plant community types. Vegetation was assessed against the listing criteria for threatened ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999* and *Threatened Species Conservation Act 1995* in Appendices F1 and F2 of Appendix J1 of the EIS.

Box-Gum Woodland was not found to be present in the project area as the assemblage of species and soil type was not consistent with the descriptions in the final determination under the *Biodiversity Conservation Act 2016* or listing advice under the *Environment Protection and Biodiversity Conservation Act 1999*. Detailed assessment of Box Gum Woodland has been prepared to inform the vegetation mapping and is attached at Appendix E to this RTS.

A review of both plant community type 399 (Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga) and plant community type 401 (Rough-barked Apple - red gum - cypress pine woodland on sandy flats) were provided in Appendix F2 of Appendix J1 (of the EIS) and the difficulty in determining boundaries between these communities was noted.

As outlined in the EIS, biometric vegetation types for plant community types 399 and 401 were the same in 2008, but changed in 2014 (Table 33 in Appendix J1 of the EIS). As such they are entered as separate plant community types and biometric vegetation types in the Major Project Credit Calculator which determines offset requirements for the project. Both plant community types 399 and 401 are excellent matches for the vegetation mapped, and neither are a threatened ecological community.

Plant community type 399 was determined as occurring in the project area along drainage lines through a quantitative analysis of vegetation plot data and the plant community type database. Plant community type 399 occurs on deep siliceous alluvial sand and loamy sand derived from sandstone in stream beds, benches and banks mainly in the Pilliga Scrub forest region between Coonabarabran and Narrabri in the Brigalow Belt South Bioregion.

Vegetation adjoining plant community type 399 in the project area has largely been mapped as plant community type 401 through a quantitative analysis of vegetation plot data and the plant community type database. Plant community type 399 and 401 are well described by Benson *et al*. (2010) as occurring in the locations as mapped in the EIS.

Plant community type 544 does not occur in the project area and is confined to the Nandewar and west New England Tablelands. Plant community type 544 occurs on a variety of alluvial or colluvial soils from sand to loamy-clay soil along stream banks and on valley flats throughout the Nandewar and west New England Tablelands Bioregions, well outside the project area which occurs in the Brigalow Belt South Bioregion.

All of the information presented in the submissions has been carefully considered, along with further field assessment of the data presented in the EIS. The information or data currently available is consistent with the conclusion that the assemblage of species and soil types is not consistent with the description of this community in the listing advice or final determination.

One of the submissions makes note of the controlled action decision for the project under the *Environment Protection and Biodiversity Conservation Act 1999* that mentioned Box Gum Woodland. The decision stated that this community along with a suite of other species and communities may occur in the vicinity of the proposed action, many of which do not occur. This is due to the coarse nature of the *Environment Protection and Biodiversity Conservation Act 1999* databases and does not specifically mean that the community occurs in the project area. Detailed surveys for the EIS conducted since the referral have determined that Box-Gum Woodland is not present in the project area.

6.15.2 Flora and fauna impacts

Impact assessment and modelling impacts

Submissions raised concerns regarding impact assessment, in particular, the locations of field infrastructure. The submissions questioned the adequacy of the assessment of the likely impacts and questioned the methodology for assessing impacts. Submissions dispute the assertion that there would be no significant impacts to NSW and Commonwealth listed threatened species.

The legislative context for the assessment of biodiversity impacts for the project includes both State and Commonwealth legislation, policies and methodologies. A key aspect of the legislative context for the project is consideration of the project under the assessment bilateral agreement between the NSW and Commonwealth governments. The agreement allows for the accreditation of NSW processes (including the *Framework for Biodiversity Assessment* and *NSW Biodiversity Offset Policy for Major Projects*) for assessment of proposed actions that would otherwise be assessed by the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999*. Therefore, only one assessment is undertaken by NSW, accounting for both NSW biodiversity values and Commonwealth matters of national environmental significance. The Commonwealth would consider relevant NSW conditions when deciding whether to attach their own conditions to an approval.

The project was referred to the Minister administering the *Environment Protection and Biodiversity Conservation Act* in October 2014. The referral was precautionary and prepared prior to the detailed impact assessment of the project, therefore at the time of referral it was considered that there was potential for significant impacts to matters of national environmental significance. The referral triggered a controlled action decision which required detailed assessment through the EIS. The impacts of the project have been assessed in the EIS following principles of avoidance, minimisation and mitigation.

Following the detailed assessment in the EIS, potential impacts to matters of national environmental significance (as well as state matters) and were determined to be non-significant for a number of reasons including:

- The amount of habitat removed is only a small proportion (generally 2 per cent or less) of all available habitat within the project area.
- Removal of habitat is not at a scale likely to result in isolation or fragmentation of populations.
- Implementation of the Field Development Protocol (including the ecological scouting framework) will avoid and minimise impacts at the site scale.
- Up to half of the impacted area would be progressively rehabilitated following clearing and construction (generally within six to 12 months).
- Proposed minimisation and mitigation measures such as feral animal control strategy.

Despite the determination of non-significant impacts, offsets requirements have been calculated for all vegetation and habitat for threatened species using the *Framework for Biodiversity Assessment*. All impacts from the project, including direct, indirect and cumulative impacts have been used to calculate the total offset liability for the project.

The determination of a disturbance footprint to inform the impact assessment has been undertaken using a conservative approach, with a defined upper disturbance limit. Habitat and impact modelling to inform an upper disturbance limit has been undertaken through a scientifically proven, repeatable, peer reviewed and conservative method. The upper disturbance limit represents the maximum area that the project can disturb and is effective to assess impacts. The proponent has committed to offsetting this upper disturbance limit. The models take a conservative approach and are based on substantial field surveys, desktop reviews and technical expertise.

Field infrastructure locations will be informed by the Field Development Protocol and ecological scouting framework. These final locations are made available for review prior to construction commencing. These protocols (and frameworks) are based on substantial field surveys (following legislative guidelines), desktop reviews and technical expertise.

Detailed assessments have been provided in the EIS for each threatened species listed under State and / or Commonwealth legislation that may potentially be significantly impacted by the project. Assessments of significance under the former NSW *Threatened Species Conservation Act 1995* (against 7 part tests) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (against significant impact criteria) were conducted for each species and ecological community, as per the relevant guidelines and regulations. The upper disturbance limit was applied in the species and ecological communities’ impact assessments. These assessments provide detailed rationale for the support of the findings of non-significant impacts to threatened species and ecological communities.

Indirect impacts and key threatening processes

The submissions raised a number of concerns relating to indirect impacts including but not limited to weed invasion, feral animals, noise, light, pollution, fragmentation, dust, erosion, accidental spills and vehicle strikes. Submissions stated that indirect impact calculations were under-estimated, the benefits of mitigation measures overestimated, and that consequently the applied buffers for impact calculation were inappropriate.

The *Framework for Biodiversity Assessment* (OEH 2014a) requires proponents to demonstrate minimisation of indirect impacts on biodiversity values using reasonable onsite measures. The Ecological Impact Assessment and Biodiversity Assessment Report presented in Appendix J1 and Appendix J2 of the EIS respectively included demonstration of these measures. The type and magnitude of indirect impacts with reference to relevant literature to support the indirect impact calculations are described in detail in Section 4.11.2 and Section 6.4 of Appendix J1 of the EIS.

Due to the diffuse nature of the project across the landscape where indirect impacts are likely to be a more significant issue, the EIS proposed a method for calculating the likely proportion of indirect impacts which should contribute to the offset liability for the project. This acknowledgement and calculation of potential indirect impacts across the landscape is not a requirement of the *Framework for Biodiversity Assessment* or the offset policy and is above and beyond other regulatory requirements for the project.

Significance of Pilliga and biodiversity values

Submissions stated that potential impacts on the Pilliga and its values were not adequately assessed. They stated the Pilliga had value as the largest relatively undisturbed remnant area of dry sclerophyll forest in eastern Australia. They stated the Pilliga was habitat to a large number of threatened flora and fauna and provided an important refuge for biodiversity in a landscape largely cleared for agriculture (NICE and CUCCLG 2012, Lunney *et al*. submitted 2017). They stated the values of the Pilliga were recognised as an important biodiversity area, important bird area and national biodiversity hotspot.

The submissions stated that a large area of the Pilliga would be affected by the project with direct impacts of clearing and development and indirect impacts such as noise, traffic, fencing, light and pest species. They claimed the potential impacts were understated by presenting them as a fraction of a larger area.

The EIS provided a review of the biodiversity values of the project area in line with the Secretary's environmental assessment requirements and *Framework for Biodiversity Assessment*. The EIS included detailed literature reviews including the results of ecological surveys previously undertaken in the area, including those conducted by community groups.

Detailed assessments have been provided in the EIS for each threatened species listed under State or Commonwealth legislation that may potentially be impacted by the project. Respective assessments of significance under the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999* were conducted for each species in line with the relevant guidelines and regulations and are presented in Appendices J and K of Appendix J1 of the EIS.

Detailed assessment of biodiversity values has first considered the avoidance, minimisation and mitigation principles before offsetting has been considered. Avoidance of significant biodiversity values occurs during the design stages utilising the Field Development Protocol, ecological scouting framework and Ecological Sensitivity Analysis. Impacts to significant biodiversity values have been minimised as far as practicable through the reduction in construction footprints to the minimal operational requirements and co-location of infrastructure with existing roads and access tracks wherever practicable. Impacts to significant biodiversity values have been mitigated through measures such as progressive rehabilitation and the feral animal control strategy.

Detailed assessments have not only considered the direct impacts of the project, but also the indirect and cumulative impacts. Following avoidance, minimisation and mitigation, the direct, indirect and cumulative impacts of the project will be offset in accordance with the Biodiversity Offset Strategy.

The conservative upper disturbance limit was used for threatened species and ecological communities' impact assessments. These assessments provide detailed rationale for the support of the non-significant impact conclusions to threatened species and ecological communities primarily due to:

- the small proportion of habitat being removed relative to that retained in the project area
- the removal of habitat not being at a scale likely to result in isolation or fragmentation of populations
- it being unlikely that the project would result in invasive species or diseases becoming established
- the progressive rehabilitation of disturbed areas as part of the project.

Detailed and appropriate mitigation measures were outlined in Section 7 of Appendix J1 of the EIS, as well as a process for minimising impacts to the Pilliga Forest through the implementation of the ecological scouting framework in the Field Development Protocol.

The Biodiversity Offset Strategy will be implemented to secure offsets to compensate for impacts to biodiversity values which in accordance with the offset policy includes all biodiversity values, not just threatened species and communities.

Avoidance, minimisation and mitigation of impacts will be achieved through the siting of infrastructure (ecological scouting framework and ecological sensitivity analysis), feral animal control strategy, revegetation strategy and Field Development Protocol, thus reducing the impacts predicted by the upper disturbance impact model.

Potential impacts on wilderness values

Submissions identified the project area as part of the Willala wilderness area. Submissions noted that the Willala wilderness area was not a formally defined wilderness area but was capable of formal identified under the *Wilderness Act 1987*.

The submissions stated that the EIS did not assesses potential impacts on wilderness values of the Willala wilderness area. They stated the wilderness values of Willala wilderness area were defined in the draft Pilliga Wilderness Assessment Report.

There is no declared wilderness in the project area and therefore no assessment of wilderness values is required.

Potential impacts on threatened ecological communities

The submissions stated that the location, type and area of threatened ecological communities and their habitats affected by the project could not be accurately determined without an impact footprint, making assessment of impacts difficult. Some stated that impacts to the threatened ecological communities mapped within the project area should not be allowed, and all potential impacts should be avoided.

One submission stated that the Brigalow threatened ecological community was inappropriately mapped and assessed against the State and Commonwealth listing advice. They suggested the extent of this threatened ecological community should have been greater, and more closely resemble the amount of Brigalow dominant woodland mapped as plant community type 35.

A scientifically robust, repeatable, and peer reviewed model was used to calculate the upper disturbance limit including the ability of the project to maximise avoidance of native vegetation by relocating infrastructure to nearby cleared areas. This approach was effective in the north-west of the project area where previous clearing for agriculture has resulted in a mosaic of cleared and remnant patches of native vegetation.

The peer review of the model stated that the upper disturbance limit can be accurately determined. As stated in Chapter 31 (Project commitments) of the EIS, the proponent has committed to offsetting this upper disturbance limit.

A wealth of information was used to inform the impact model, including all field data, literature reviews, the Field Development Protocol and importantly the ecological sensitivity analysis, which focused on threatened ecological communities.

In regard to the Brigalow threatened ecological community, the submissions have incorrectly interpreted the information in the EIS. A total of 6,695 hectares of plant community type 35 was mapped in the project area, of which 4,227 hectares was derived native grassland, and which does not comprise a threatened ecological community under State or Commonwealth legislation.

Complete avoidance of threatened ecological communities is not feasible considering their spatial extent across the project area. Impacts to threatened ecological communities would be avoided and minimised wherever practicable as part of the Field Development Protocol and ecological scouting framework. The upper disturbance limits for the project will not be exceeded.

Matters of national environmental significance

Submissions stated that the assessment omitted a consideration of the potential for significant impacts on threatened flora and fauna that were matters of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999*. They noted assessments were provided for Pilliga Mouse and Koala but stated the assessment omitted other species including Black-striped Wallaby and threatened bat species.

They also stated that significant impacts on matters of national environmental significance had occurred from the operation of the project under the previous operator in the project area with regard to loss of foraging, refuge and breeding habitat for the Pilliga Mouse and South-eastern Long-eared Bat.

Impacts on matters of national environmental significance were assessed in the Ecological Impact Assessment in Appendix J1 of the EIS. The potential impacts of the project in combination with existing activities in the project area were assessed in the cumulative impact assessment in Section 6.5 of Appendix J1 of the EIS.

A detailed assessment of existing development within the project area was also considered by the Commonwealth and not considered to have significant impacts provided the activity was undertaken in the manner prescribed (DoTE 2013a).

Potential impacts on Pilliga Mouse

Submissions disagreed with the vegetation types and categories used for the habitat mapping for the Pilliga Mouse, and questioned the differences in habitat mapping between the EIS and a 2013 report.

Submissions suggested that further survey be conducted to establish the Pilliga Mouse's use of habitat in the project area, particularly as refugia and for breeding. In addition, submissions questioned the statements in the EIS around the taxonomic status of the Pilliga Mouse.

Detailed and extensive surveys for the Pilliga Mouse were conducted to inform the EIS. Survey effort was consistent with the *Framework for Biodiversity Assessment* and State and Commonwealth survey guidelines.

The EIS provides a detailed assessment of Pilliga Mouse habitat. Habitat was modelled and mapped as two categories (primary and secondary). The EIS describes the vegetation communities in each of these categories. Various woodland types, including woodland, shrubby woodland and heathy woodland all fall within primary habitat. The habitat model was ground truthed and the EIS recorded the Pilliga Mouse during targeted surveys. Information captures of the species and the habitat model were used to map habitat across the project area, inform the sensitivity analysis and impact assessments.

The status of the Pilliga Mouse is still unresolved based on the most recent scientific literature, which indicates that it is not a separate species. Separate genetic studies on the Pilliga Mouse were conducted with data obtained from the surveys conducted for the EIS. Nevertheless, the EIS has treated the species as currently listed under State and Commonwealth legislation. The Commonwealth survey guidelines for Australia's threatened mammals specifically state:

> *'…this species is now considered a southern population of the widespread delicate mouse P. delicatulus (Breed and Ford 2007; Ford 2008). Recent trapping in fauna surveys in northern NSW have revealed a continuous distribution of the delicate mouse to the Pilliga region. Under the EPBC Act this latest taxonomic change has not been formally recognised. Therefore, this species profile considers the Pilliga population of the delicate mouse'* (DSEWPaC 2011a).

The original 2013 review report under the *Environment Protection and Biodiversity Conservation Act 1999* mapped Pilliga Mouse habitat at a broad scale using mapping available at the time. This work was undertaken in 2012 prior to the targeted surveys, and prior to the vegetation and habitat mapping conducted for the EIS. The 2013 report used only broad vegetation types mapped for the project area at that time. However, following extensive vegetation surveys, a more detailed literature review, habitat mapping and a targeted survey, Pilliga Mouse habitat was mapped and described in more detail. This has led to the refined mapping and differences between the 2013 report and the EIS. The updated Pilliga Mouse habitat mapping is at a 1:15,000 scale and is considered fit for purpose.

Threatened bird species

Submissions stated that the Pilliga forests and woodlands constitute an important refuge and stronghold for numerous threatened bird species including Regent Honeyeater, Painted Honeyeater, Superb Parrot, Swift Parrot, Turquoise Parrot, Grey-crowned Babbler, Speckled Warbler, Varied Sittella, Diamond Firetail and Glossy Black Cockatoo. They stated these areas formed part of the eastern Australian bird migration system, providing seasonal foraging and movement habitat. The submissions stated that project activities would likely further contribute to the declining trend of threatened bird populations.

Of particular note is the impact assessment for the Regent Honeyeater and Swift Parrot. Submissions disagreed with the conclusion that the habitat in the project area that would be modified is not occupied by these species and that no breeding or foraging habitat (Regent Honeyeater) is present. This is despite records for the Regent Honeyeater in the Pilliga Forests, albeit outside the project area.

Detailed targeted survey and assessment of potential impacts for all threatened birds likely to occur in the project area were described in detail in the EIS. Total bird census survey effort used for the EIS included over 170 hours of diurnal bird surveys. In addition, song meter analysis with Regent Honeyeater and Swift Parrot call data of 81 trap nights was undertaken.

Specific migratory bird surveys for Regent Honeyeater and Swift Parrot were described in detail in the EIS, and neither species was identified. Furthermore, there are no records for the Regent Honeyeater in the project area and no records of Regent Honeyeater in the broader Pilliga since 2003. There are also no records of the Swift Parrot in the broader Pilliga Forest. Surveys by NICE and CUCCLG (2012) did not find these species. The National Recovery Plan for the Regent Honeyeater stated that habitat critical to the survival of the Regent Honeyeater includes:

- breeding or foraging habitat in areas where the species is likely to occur; and
- newly discovered breeding or foraging locations.

Suitable potential foraging habitat consistent with the recovery plan definition does not exist in the project area. It is acknowledged that some tree species used by the Regent Honeyeater for foraging are present and scattered across the project area, but they do not occur in substantial enough stands to constitute favourable foraging habitat. Given the paucity of Regent Honeyeater records despite targeted surveys, the absence of potential foraging habitat as defined by the recovery plan, it is unlikely that the native vegetation in the project area would contribute to the recovery of this species.

Barking Owl

Submissions stated prior surveys of the Pilliga had shown it supported a significant population of the Barking Owl listed as vulnerable under the *Threatened Species Conservation Act 1995*. Submissions also stated that studies of field development in the USA had shown decline in owl species and stated that the project would cause such a decline.

Prior research on Barking Owl (Milledge 2004) was reviewed as part of the EIS. The research demonstrated that there is likely only one Barking Owl pair home range in the project area, being a forested area associated with Bohena Creek. Barking Owl is an ‘ecosystem credit’ species under the *Framework for Biodiversity Assessment* and therefore does not require assessment.

Nonetheless, surveys were undertaken in accordance with the State guidelines (DECC 2004b) and impacts to the species were assessed in an assessment of significance through a seven part test under the *Threatened Species Conservation Act 1995*.

Five-clawed Skink

Submissions questioned the adequacy of the survey effort and assessment of impacts on the Five-clawed Skink. A submission noted a record for the species on the NSW BioNet database near the project area.

The Five-clawed Skink was assessed as unlikely to occur within the project area, as suitable habitat for this species is not present. Nonetheless, targeted surveys in accordance with the State and Federal survey guidelines were undertaken for this species and other reptiles as part of the EIS. The locational information contained within BioNet for this specific record was thoroughly interrogated and the results are stated in the EIS.

Eastern Pygmy Possum

Submissions stated the Pilliga was important habitat for Eastern Pygmy Possum.

The Eastern Pygmy Possum was identified as part of the detailed ecological surveys undertaken for the EIS and impacts on the species were assessed in an assessment of significance through a seven part test under the *Threatened Species Conservation Act 1995*.

Threatened fauna species

Submissions stated the concern that survey effort was insufficient, and therefore the impact assessment could not be conducted properly and/or the impact assessments were incorrect. The submissions related to threatened fauna including Spotted-tailed Quoll, Rufous Bettong and Black-striped Wallaby.

Survey effort was consistent with the *Framework for Biodiversity Assessment* methodology as well as State and Commonwealth survey guidelines.

Detailed and extensive surveys for threatened species were conducted to inform the EIS.

The Spotted-tail Quoll was not identified during the surveys undertaken for the EIS. Details of targeted surveys and assessment of the Spotted-tail Quoll in accordance with State and Commonwealth legislation were included in the EIS and discussed in Sections 4.6, 4.7, 6 and Appendix K of the Ecological Impact Assessment in Appendix J1 in the EIS.

There are two records for Spotted-tail Quoll in the Pilliga, the latest in 2016 and the other from 2006. The 2016 record is from the project area, but is based on ‘tracks / scratching’ which is not considered adequate to identify a species which has not been recorded from an area previously. The 2006 record is more than 15 kilometres from the project area.

Spotted-tail Quoll is nominated as an 'ecosystem credit' under the *Framework for Biodiversity Assessment* and therefore species-specific offset requirements are not required. As an ‘ecosystem credit’ species, offsets provided for vegetation communities (as a habitat surrogate) are considered to provide like for like potential habitat for this species.

Surveys for Rufous Bettong conducted in accordance with the State and Commonwealth legislation. The Rufous Bettong was not identified during the surveys undertaken for the EIS. There are no Rufous Bettong records in the project area and the nearest record to the project area is 25 kilometres away. For the overall Pilliga there are only three Rufous Bettong records, with the latest record being in 2014 (others were in 1993 and 2008). As this species has not been recorded as part of the surveys undertaken for the EIS, the fact that there are very few records from the broader Pilliga, and none from within the project area, it has been assumed that this species does not occur for the purposes of the *Framework for Biodiversity Assessment*.

Detailed targeted surveys undertaken as part of the EIS identified that Black-striped Wallaby occurs in a wider range of habitats, across a much broader area of forest than previously known. These surveys have helped improve scientific understanding of this species in NSW.

The Black-striped Wallaby was included in the impact assessments as required under NSW legislation. Details of the survey methods, results and discussion relating to impacts and mitigation measures are provided throughout the EIS. As a 'species credit' species, offsets have been calculated for this species and will be secured in accordance with the Biodiversity Offset Strategy.

Impacts on non-threatened species

Submissions stated that the assessment of impacts to species not listed as threatened and migratory species under State and Commonwealth legislation but nonetheless with significant populations, or those at their distributional limits, should have been considered in the Ecological Impact Assessment.

They cited the Pilliga Forest's significance as a transition zone between Eyrean and Bassian faunas as an example of the potential value of the project area as the distributional limit of some species.

The Ecological Impact Assessment was carried out in accordance with the Secretary's environmental assessment requirements for the project and the NSW *Framework for Biodiversity Assessment*.

The detailed assessment of the project includes consideration of the direct, indirect and cumulative impact to all species through the upper disturbance limits to plant community types and therefore flora and fauna habitat within the project area. The assessment provides detailed rationale for the support of the non-significant impact conclusions to threatened species and ecological communities primarily due to:

- the small proportion of habitat being removed relative to that retained in the project area
- the removal of habitat not being at a scale likely to result in isolation or fragmentation of populations
- it being unlikely that the project would result in invasive species or diseases becoming established
- the progressive rehabilitation of disturbed areas as part of the project.

These conclusions equally apply to non-threatened species including those with significant populations, or those at their distributional limits.

Impacts on microbats

Submissions stated that the Pilliga is likely to be a stronghold or contain important populations of South-eastern Long-eared bat, and / or other microbats. Breeding for the South-eastern Long-eared Bat occurs in tree hollows and the species forages within a limited range (few kilometres) of roosting sites. Microbats are likely to be particularly susceptible to impacts from the project.

The results of detailed surveys and assessment of microbats including the South-eastern Long-eared bat were presented in the Ecological Impact Assessment in Appendix J1 of the EIS. The EIS recorded the presence of the South-eastern Long-eared Bat (otherwise known as Corben's long-eared Bat).

The conclusions of the impact assessment considered that the ecological scouting framework would minimise impacts to hollow-bearing trees at the site scale, and thereby reduce the number of potential roosting sites to be cleared.

Removal of hollow bearing trees

Submissions stated that up to 10,143 hollow-bearing trees will be cleared, which is likely to have a significant impact on hollow-dependent fauna, including woodland birds, arboreal mammals, and microbats, including threatened species such as Squirrel Glider, Pygmy Possum, Barking Owl, Masked Owl, and Glossy Black-Cockatoo. Submissions noted that the offset strategy identified that the loss of hollow trees will be compensated at a 1:1 ratio, presumably using nest boxes. The submissions stated that the impact of hollow removal could not be offset and stated that research on the use of nest boxes found that were not an adequate replacement.

As part of the EIS it was estimated that there are more than 800,000 hollow-bearing trees in the project area. The EIS committed to the compensation for removal of large hollows (>300 mm diameter) by at least a 1:1 replacement ratio. Large hollows will be replaced via a range of methods which may include artificial nest boxes, re-use of hollows (hollow relocation) or re-standing hollow-bearing trees where safe and practicable to do so.

The estimate of 10,143 hollows is an upper limit, with a significant reduction likely through the ecological scouting framework, which aims to maximise avoidance of significant hollow-bearing trees. Following mitigation, impacts are expected to be reduced by 20 to 80 per cent at the site scale. A detailed analysis of the total number of hollow-bearing trees in three size classes (<200 mm; 200–300 mm; and >300 mm) to be impacted by the project was undertaken as part of the EIS using hollow class data collected at over 300 vegetation plots.

The number of larger hollow sizes suitable for Turquoise Parrot and Barking Owl that are likely to be impacted (pre-mitigation and ecological scouting framework) are an order of magnitude lower than the total number of hollows affected. Following mitigation and management including implementation of the ecological scouting framework, impacts are expected to be reduced by 20 to 80 per cent at the site scale.

The use of artificial habitats such as nest boxes is a methodology recommended by the Office of Environment and Heritage (through the Framework for Biodiversity Assessment) to avoid and minimise direct impacts on biodiversity values at the operational phase of a project.

Impacts on riparian habitat

Submissions stated that the project is going to cause detrimental impacts on high value riparian habitat crucial for vertebrate refuges and movements.

The EIS commits to the avoidance of riparian corridors for non-linear infrastructure and following existing creek crossings wherever possible. Given the knowledge of watercourses in the project area and the associated commitment, the impacts to high value riparian habitat are expected to be low.

High quality watercourse mapping (at a 1:15,000 scale) was undertaken as part of the Ecological Impact Assessment in Section 4.10 of Appendix J1 to the EIS including definition and mapping of riparian corridors in accordance with the requirements of the NSW *Water Management Act 2000*.

Effect of air quality on fauna

Submissions stated that air emissions such as dust, BTEX (benzene, toluene, ethylbenzene and xylene), volatile organic compounds and other chemicals would affect fauna and stated there were no studies to examine these impacts.

The Air Quality Impact Assessment (EIS Appendix L) considered the maximum concentrations of priority pollutants at locations. The assessment showed the pollutants were well within the relevant air quality criteria at all locations beyond the emissions sources during operation. Air quality issues are discussed further in Section 6.18.

Effect of bushfire on flora and fauna

Submissions stated that changes to the fire regime or increased hazard reduction burns as a result of the project could alter the structure and species composition of the Pilliga, lead to the local extinction of some plants, destroy valuable hollow log and tree habitat, favour pest species and increase competition or predication on native species.

As discussed in the Hazard and Risk assessment in Appendix S of the EIS, the likelihood of the project causing a bushfire was remote. As such, the project is not expected to change the bushfire regime of the project area.

Effect of erosion and sedimentation on fauna

Submissions stated that erosion and sedimentation caused by the project would increase sedimentation in watercourses that may be ephemeral and important to the maintenance of vertebrate fauna populations.

As discussed in Chapter 14 of the EIS (Soil and land contamination), erosion and sedimentation would be managed through the implementation of an Erosion and Sediment Control Plan in accordance with relevant guidelines. The residual significance of potential erosion and sedimentation including ecological effects is low.

Effect of spills on flora and fauna

Submissions stated that the storage and handling of produced water, salt and other chemicals would have the potential to results in spills that harm flora and fauna.

As discussed in Chapter 14 of the EIS (Soil and land contamination), a number of mitigation measures are proposed regarding leaks and spills. These include chemicals being stored and handled in accordance with relevant Australian Standards, and refuelling to occur with suitable containment for volumes greater than 50 litres and not within 40 metres of a watercourse. The residual significant of potential leaks and spills including ecological effects was assessed to be low.

Effects of hydrological changes on flora and fauna

Submissions stated that hydrological changes caused by the project would have negative effects on flora and fauna.

As discussed in Chapter 13 of the EIS, the project would have negligible effects on flooding across the project area. Managed release to Bohena Creek under the required flow conditions of greater than 100 megalitres per day at the Newell Highway gauging station would not affect its natural flow paths or regimes. Accordingly, potential effects of hydrological changes on flora and fauna are not expected to occur.

Effect of fragmentation on flora and fauna

Submissions stated that the effects of fragmentation on flora and fauna were understated. They stated the project would almost double fragmentation in the project area based on the intactness index.

They stated that fragmentation was a key threatening process for threatened species. They stated it could have significant impacts including barriers to movement and edge effects. They also stated that the effects of fragmentation could affect species composition and favour pest species.

Fragmentation was discussed in Section 4.11.2 and Section 6.4.1 of the Ecological Impact Assessment in Appendix J1 of the EIS. The EIS concluded that fragmentation was not likely to significantly impact threatened species, population or community due to the proposed narrow linear infrastructure corridors averaging about 10 metres and progressive rehabilitation that would be employed.

There are over 1,000 km of existing roads, tracks and trails across the project area. As stated in the EIS, linear infrastructure will be aligned with existing roads and tracks wherever possible.

Cumulative impacts

Submissions stated that the EIS did not adequately quantify the cumulative impacts from the project on threatened species, and has not taken into account the activities of mines in the region, commercial forestry or agriculture.

The Ecological Impact Assessment in Appendix J1 of the EIS included a cumulative assessment that considered all existing and proposed exploration and production appraisal activities by the proponent. The cumulative assessment also included the Narrabri Coal Mine as it operates in the same ecological landscape (IBRA Subregions; Pilliga Outwash and / or Pilliga) as the project area.

The cumulative assessment did not include impacts from mines in the Liverpool plains as they were considered to be located in different landscapes and / or had different biodiversity values. Biodiversity values impacted by other activities in the region are not directly equivalent to the values in the project area, with the exception of a few broad ranging species such as Koala and Regent Honeyeater.

The assessment found that there are unlikely to be cumulative impacts from other activities in the project area on the majority of biodiversity values. Impacts from forestry activities were considered and are generally relatively short term in nature and patchy. In addition, ecological values including threatened species in the Pilliga have coexisted with forestry activities for over 100 years.

The assessments of significance concluded that the project is unlikely to have a significant impact on threatened and migratory species and ecological communities as the magnitude of direct, indirect and cumulative impacts are considered unlikely to effect the long-term survival of the species or ecological communities in the project area.

The existing exploration and appraisal activities by the proponent, where that infrastructure will be carried forward as part of the project, have been included in the Biodiversity Offset Strategy for the project (refer Appendix F of this RTS).

6.15.3 Offsetting, management and monitoring

Biodiversity offsets

Submissions raised the concern that no offsets had been secured or provided in the EIS. They stated the Biodiversity Assessment Report and Biodiversity Offset Strategy did not fully address the requirements of the *Framework for Biodiversity Assessment* or the *NSW Biodiversity Offset Policy for Major Projects*, in particular, the securing of land based offsets. Submissions also requested more information associated with the nominated use of supplementary measures such as feral animal control, Koala research and contribution to the biodiversity offset fund. They raised a concern with the ability of the proponent to deliver the offsets and the potential repercussions if the commitment in the EIS could not be met.

A revised working draft Biodiversity Offset Strategy is included as Appendix F of this RTS. Over 280,000 hectares of potential offsets on freehold land have been identified in the study area. Whilst no offsets have been secured at this stage, this process has sought to demonstrate the majority of the like-for-like offset liability of the project could be achieved through land based offset sites.

Offsets requirements for the project were calculated in accordance with the *Framework for Biodiversity Assessment* for all residual impacts on biodiversity values (ecosystem and species credits), following avoid, minimise and mitigate principles as outlined in the Biodiversity Assessment Report in Appendix J2 of the EIS. The Biodiversity Offset Strategy is the mechanism to provide the offsets and has been presented in the EIS as a commitment to deliver the Biodiversity Offset Package. The Offset Strategy is consistent with the principles of the *Framework for Biodiversity Assessment* and *Offset Policy*.

The offsets package includes a range of measures, including land-based offsets, supplementary measures (such as feral animal control and weed control), complementary measures (such as Koala research) and the use of the Biodiversity Offset Funds to acquit remaining offset liability following other measures. Specific detail on the feral animal control program and Koala research will be provided post-approval as part of the required management plans.

Indirect impacts and supplementary offsets

Submissions raised concern for the assessment and calculation of indirect impacts, and the subsequent offset calculations. They stated that the full credit value or liability of indirect impacts should be calculated for the project including a larger indirect impact buffer.

Submissions disagreed with the use of a feral animal control program as a supplementary measure for up to 30 per cent of the offset liability. Submissions also stated there was insufficient detail about the feral animal control program provided in the EIS.

The Biodiversity Offset Strategy included in the EIS is consistent with the *NSW Framework for Biodiversity Assessment* and *NSW Biodiversity Offsets Policy for Major Projects*.

The framework and policy do not require a proponent to determine offset requirements for indirect impacts, rather they require the proponent to detail measures on how indirect impacts can be minimised and managed. The calculation of potential indirect impacts across the landscape is not a requirement of the *Framework for Biodiversity Assessment* or the *Offset Policy* and is above and beyond other regulatory requirements for the project.

A regional scale nil-tenure feral animal control such as that proposed in the EIS is likely to be effective in reducing feral animal populations and promoting biodiversity conservation, and is based on a thorough literature review for all threatened species in the project area which identified feral animals as a significant threat to threatened biodiversity in the Pilliga.

Supplementary measures such as the nil-tenure feral animal control program are permitted under the *Framework for Biodiversity Assessment*. It is proposed to cap the proportional contribution of the nil-tenure feral animal control program to the offset liability at 30 per cent which is considered to provide an adequate level of funding to ensure feral animals can be effectively controlled over a 20-year lifespan. Further detail on the program will be developed subject to approval of the project.

Feral animal control

Submissions disagreed that a feral animal control program could reduce the risk of feral predation. They submission stated that large scale feral animal control programs were generally ineffective.

Submissions also stated that feral animal control would not be effective when considered against the potential increase in disturbance caused by the project. They stated that fox numbers in the Pilliga were already high and that the project will exacerbate their occurrences in the area.

Other submissions noted pest species were a problem in the project area and that test programs should have been established to inform the proposed programs. Furthermore, they stated monitoring surveys should be conducted to determine the density and distribution of feral animals in the project area.

The proponent has committed to the development of a nil-tenure feral animal control program as part of the Biodiversity Offset Strategy for the project. The program is based on detailed assessment of threatened species in the project area that identified feral animals as a significant threat. Feral animal controls such as those proposed has been scientifically proven to be effective.

Monitoring of feral animals has been undertaken since 2015 at a number of sites within the Pilliga Forest as part of existing environmental approvals. Control of feral animals within State Forest currently rests with Forestry Corporation of NSW as the landholder. The nil-tenure feral animal control program is above and beyond existing obligations placed on the landholders within the project area.

Koala research

Submissions agreed that more research needs to be done to determine the status of Koala in the project area and stated that is must be completed prior to project approval. They also stated that the Koala research project forming 10 per cent of the offset strategy would not be an adequate offset.

Surveys for the Koala and habitat mapping (modelling) were conducted as required by the *Framework for Biodiversity Assessment* (OEH 2014a), State and Commonwealth legislation and impacts were assessed in accordance with the former *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*. Furthermore, a regional Koala survey, including significant areas of the Pilliga outside of the project area was undertaken by Koala experts (Rod Kavanagh *et al*., as part of the Niche (2014) survey (Niche Environment and Heritage 2014) and these results informed the EIS.

Biodiversity offsets for Koala have been determined as part of the Biodiversity Offset Strategy in accordance with the *Framework for Biodiversity Assessment* (OEH 2014a). Considering the surveys, mapping and assessment undertaken to date in accordance with State and Commonwealth legislation, including provision of offsets, no further assessment of Koala in the project area is required.

A Koala Research Proposal is proposed as a part of the Biodiversity Offset Strategy to be undertaken post consent. The proposed compensatory measures directly relate to the conservation of Koala in the Pilliga and will be capped at 10 per cent of the total offset package in accordance with the *NSW Biodiversity Offset Policy for Major Projects*. Based on the likely total financial offset liability of the project, the Koala research proposal is likely to contribute much less than 10 per cent of the overall offset package. The Koala Research Proposal was developed by an internationally acknowledged authority on Koalas to determining the precise location and sizes of remnant Koala populations in the broader Pilliga region, prioritising conservation efforts for the species.

Avoidance and mitigation

Submissions stated that the methods and parties responsible for siting field infrastructure in accordance with ecological constraints were unclear. Some acknowledged the ecological scouting framework in the Field Development Protocol however they stated that it was not clear how the process would be followed and whether the person responsible had recourse to renegotiate or reject the proposed site location.

The ecological scouting framework provides for the minimisation of impacts on a range of ecological values as determined through baseline assessment and ecological sensitivity analysis. The ecological scouting framework would be implemented through the Field Development Protocol. Further details of the operation of the ecological scouting framework and Field Development Protocol were provided in Appendix G of Appendix J1 of the EIS and Appendix C of the EIS respectively.

An updated Field Development Protocol is attached as Appendix C to this RTS.

Field Development Protocol

Submissions stated that the Field Development Protocol was not provided, and the aspects of the Protocol described in the EIS were inadequate for avoiding high conservation value areas and key habitat features. Submissions stated that hollow-bearing trees must be retained and all streams should have substantial exclusion zones in addition to State Conservation Areas.

The Field Development Protocol was provided as Appendix C of the EIS. The ecological scouting framework that would inform the Protocol was described in Appendix G of Appendix J1 of the EIS.

Implementation of the Field Development Protocol will utilise high quality ecological baseline data: vegetation mapping, including threatened ecological communities, riparian corridors, and threatened species habitat and ecological sensitive analysis. The ecological baseline data along with extensive desktop reviews and field validation were utilised in the development of upper disturbance limits for the project.

All watercourses in the project area have been mapped at a fine scale. Riparian corridors have been specified based on State Government guidelines. Where it is necessary for gas and water gathering lines to cross watercourses, the selection of crossing points will, where practical:

- use existing vehicular crossings
- be located on straight sections of channel
- maximise avoidance of steep, unstable banks, permanent pools and waterholes.

Major facilities, non-linear field infrastructure and large ponds and dams are excluded from watercourses and riparian corridors.

The ecological sensitivity analysis maximises avoidance of hollow-bearing trees through the prioritisation of avoidance and retention of larger hollows over smaller hollows which are abundant in the project area.

The Field Development Protocol and underpinning ecological scouting framework have been field tested and maximise avoidance of the most sensitive ecological features.

An updated Field Development Protocol is attached as Appendix C to this RTS.

Residual risk to ecological values

Submissions stated that the EIS did not adequately consider the residual risk to ecological values including the risk that species assumed unlikely to be impacted actually are impacted or the risk that proposed mitigation and management measures are not implemented effectively.

The ecological risk assessment summarised in Chapter 15 of the EIS considered the potential impacts of the project on terrestrial ecology prior to mitigation and management and the residual risk after those mitigation and management measures were implemented.

Consideration of the likelihood of threatened species or communities becoming extinct as a result of the project is contained in the impact assessments for each species or community in Appendices J and K of Appendix J1 of the EIS. The assessments demonstrated that potential impacts are not likely to be significant.

Rehabilitation strategy

Submissions stated that the Rehabilitation Strategy would not adequately offset or mitigate the potential impacts of the project on ecological values including fragmentation and pest species. They questioned the likelihood of the rehabilitation plan succeeding. They requested more detail on the plans for rehabilitation including proposed activities, monitoring and success criteria. They stated that an adaptive approach would be necessary for the rehabilitation plan to be effective.

Partial rehabilitation represents areas of temporary disturbance, such as those cleared for the construction of well pads and linear infrastructure. The proponent is not proposing to use rehabilitated areas as an offset. Rather the best practice rehabilitation, including progressive partial rehabilitation of disturbed land, would reduce the overall impact and therefore offset liability of the project. These would include temporary areas of clearing for the construction of well pads and gas and water gathering lines.

Rehabilitation activities in the project area have been monitored since 2013. Rehabilitation monitoring undertaken over the past four years has shown that rehabilitation sites approximate 72 per cent of the condition of reference sites and are on a clear trajectory to becoming self-sustained plant community types representative of pre-occurring communities as discussed in the Rehabilitation Strategy (Appendix V of the EIS).

Due to the nature of the project where the topsoil seed bank, subsoil surface structure, nutrient cycling and water infiltration will be largely unaffected, prospects for successful rehabilitation of the project area are considered excellent and this has been demonstrated in monitoring to date.

Quantitative measures for rehabilitation success and monitoring were presented in the Rehabilitation Strategy in Section 9 of Appendix V of the EIS.

Ecological monitoring

The submissions stated it is expected that permanent monitoring plots have been established to gauge the effectiveness of proposed mitigation measures and to monitor biodiversity values.

Biodiversity monitoring has been undertaken since 2015 at a number of exploration sites. Further and expanded monitoring would be undertaken subject to project approval.

The location of all surveys undertaken for the project have been recorded using high quality GPS which will allow these same sites to be surveyed as part of a future biodiversity monitoring program.

Validation of ecological values

Submissions stated that the location of ecological values or areas to be avoided should be informed by independent preclearing surveys to the satisfaction of an independent monitoring panel reporting to the NSW Department of Planning and Environment.

The process to locate infrastructure in accordance with the various constraints is detailed in the Field Development Protocol.

As discussed in Appendix C of the EIS (and Appendix C of this RTS), through the implementation of the Field Development Protocol, the proponent will develop a Plan of Operations that would detail the proposed layout of field infrastructure.

The Plan of Operations will be prepared for each stage of development and provided to the NSW Department of Planning and Environment and the Commonwealth Department of Environment and Energy prior to implementation. Digital spatial data sets of existing and proposed infrastructure will also be provided. The Government will be provided a Plan of Operations no less frequently than at two-yearly intervals.

Management of threatened flora and fauna

Submissions stated management of threatened flora and fauna as not adequately addressed. They requested that the proponent develop a flora and fauna management plan to secure the biodiversity values of the Pilliga.

Submissions stated that flora and fauna management activities should be undertaken by an appropriately qualified team approved by the NSW National Parks and Wildlife Service to the satisfaction of an independent monitoring panel reporting to the NSW Department of Planning and Environment.

The EIS assessed the impacts on ecology in accordance with the Secretary's environmental assessment requirements and no impacts were found to be significant. A monitoring program will be developed post-approval as part of a Biodiversity Management Plan for the project. The Biodiversity Management Plan will include a Significant Species Management Plan.

Consideration of climate change in mitigation and management

Submissions stated the assessment should have considered climate change in identifying potential refuges and identifying mitigation and management measures for the project.

The EIS has considered the effect of a highly variable climatic cycles on the Pilliga. The Ecological Impact Assessment has been undertaken in accordance with the Secretary's environmental assessment requirements.

6.16 Aquatic ecology

The assessment of potential impacts of the project on aquatic ecological values and stygofauna were assessed in Appendix C of Appendix G1 of the EIS, while potential impacts on groundwater dependent ecosystems were assessed in Appendix B of Appendix F of the EIS. The assessments were informed by aquatic ecology and stygofauna baseline surveys in the project area. The findings of these technical assessments were summarised in Chapter 16 of the EIS.

The baseline surveys found that baseline condition of Bohena Creek, the Namoi River and other tributaries were generally in poor ecological condition with low invertebrate diversity. The riparian condition of some sites at Namoi River and Narrabri Creek was considered moderate to good.

The assessment found that the main potential impact to Bohena Creek was the managed release of produced water. Managed release of treated water to Bohena Creek would only occur when flow is equal to or greater than 100 megalitres per day at Newell Highway gauging station. A mixing zone analysis in Appendix G1 of the EIS found that managed release under the required flow conditions would provide for rapid mixing and dilution. Even prior to dilution, an analysis of the quality of the water to be released found it would comply with the ANZECC/ARMCANZ (2000) trigger values aside from electrical conductivity that would exceed the upper value by about 7 microSiemens/cm.

Subsequent to the EIS being lodged in February 2017, the Leewood Water and Brine Treatment Plant commenced operations. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS). The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities. Further detail on the treated water quality is provided in the updated Water Baseline Report.

As such, impacts to water quality and associated ecological risks were found to be low and / or manageable. Managed release to Bohena Creek would only be carried out in accordance with an environment protection licence to be sought from the NSW Environment Protection Authority.

Stygofauna were not identified through baseline surveys of groundwater monitoring bores of Bohena Creek alluvium. The assessment found that if stygofauna were to occur in Bohena Creek alluvium that managed release would have negligible impact as it would occur when the area is already saturated and would be subject to rapid mixing and dilution.

Groundwater dependent ecosystems were identified and evaluated within about five kilometres of the project area. The identified groundwater dependent ecosystems were found to have a low ecological value with a low likelihood of impact occurring in accordance with NSW Government's *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (NOW 2012).

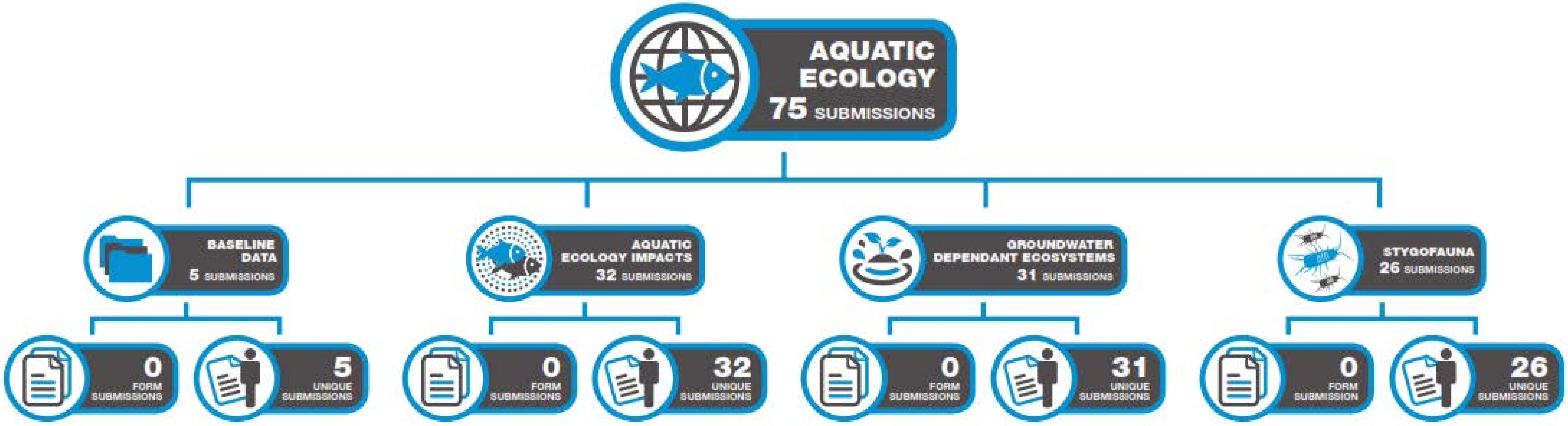
The assessments concluded that the project would present a low risk to aquatic ecological values including stygofauna and groundwater dependent ecosystems.

75 submissions raised issues specifically relating to aquatic ecology as described in Chapter 16 of the EIS. All of those submissions were unique.

The submissions primarily concerned potential impacts aquatic ecology generally, groundwater dependent ecosystems and stygofauna, while relatively few concerned baseline data.

A number of submissions raised issues more specifically relating to the operation of managed release or terrestrial ecology which are discussed in Section 6.7 and Section 6.15.

Figure 6-29 provides an overview of the submissions relating to aquatic ecology.



16 Aquatic Ecology

Figure 6-29 Summary of submissions on aquatic ecology

6.16.1 Baseline data

Assessed condition of Bohena Creek

Submissions disputed the assessment of poor ecological condition of Bohena Creek in the EIS. Submissions stated the creek and associated waterholes were mostly good condition and cited the presence of freshwater mussels as an indicator of good health.

The Aquatic Ecology and Stygofauna Assessment (Appendix C of Appendix G1) used a multi-criteria evaluation to assess ecosystem health based on accepted and proven techniques that assess river health in terms of riparian habitat, aquatic habitat, water quality, macroinvertebrate communities, fish surveys, stygofauna and riparian vegetation.

The Bohena Creek sites were deemed to be in AUSRIVAS assessment Bands of B and C, which indicated that aquatic habitat was either significantly or severely impaired. Invertebrate diversity was generally low for Bohena Creek, though the presence of aquatic invertebrates in groundwater, as eggs in the sand and diapausing stages in the moist sediment. Riparian vegetation condition was considered good.

Thus, whilst some of the assessed criteria were in good condition at the time of surveys (2013-2014), the average condition across all indicators realised an overall ecosystem health classified as in poor condition.

Survey of upstream sites

Submissions stated that survey sites were mainly downstream of the proposed managed release point and therefore omitted upstream control survey sites.

The Aquatic Ecology and Stygofauna Assessment (Appendix C of Appendix G1) was specifically designed to assess the potential impacts of managed release from the designated surface water release location in Bohena Creek and sampled from sites both up and down-stream of the proposed release location. The additional sites downstream constituted sites designated for the baseline study as potential impacts would be expected to occur downstream of the release, hence an adequate baseline is required to compare conditions before, during and after a release event. On this basis, fewer upstream sites are required to provide control survey sites.

Survey of waterholes and invertebrates

Submissions stated that surveys did not adequately target waterholes and associated species.

Submissions stated that targeted surveys of waterholes did not occur and the surveys that did occur were at times when waterholes were reduced or dry. Submissions cited satellite imagery indicating approximately 30 waterholes along Bohena Creek. They stated good condition waterholes on Bohena Creek should have been sampled and surveys omitted key species including the fresh water mussel *Velusunio ambiguous*.

Submissions stated that low macroinvertebrate diversity attributed to Bohena Creek was a consequence of sampling limitations of the surveys of waterholes. It stated these would provide refuge for fish, sponges and a range of other invertebrates.

Waterhole sites at Ted's Hole, Bohena Creek sites BCS02, BSC07 and BCS09 were specifically included in the survey as sites of permanent water along Bohena Creek to provide indicators for waterhole health. These sites contributed to the overall creek condition score and provided adequate information to determine the potential impacts from the proposed managed release under specified flow conditions.

Survey for river snails

Submissions stated that a targeted survey for the river snail *Notopala sublineata* should have been undertaken by an appropriately experience freshwater invertebrate specialist.

The last recorded sighting of *N. sublineata* in the study area was in 2007 and the last sighting in natural environments was more than 15 years ago (DPI Water 2007. *Recovery Plan for the endangered River Snail* (*Notopala sublineata*)). The techniques employed to collect invertebrate taxa would have retrieved snails if present at the survey sites. Neither the release point in Bohena Creek nor the pool at Mollee Weir are suitable habitat for this species, so the proposed release will not have impacts.

Macroinvertebrates and habitat condition

Submissions disputed the statement that *Leptoceridae* and *Arcarinae* macroinvertebrates were indicative of impaired habitat condition. They stated these were tolerant species and would therefore be present in both healthy and impaired habitats. They stated that presence of intolerant taxa was a more suitable proxy for determining habitat condition.

This statement was a qualification of a site that had a quite high macroinvertebrate diversity. The presence of these opportunistic taxa serves as an indicator that the system is degraded and allows them to flourish.

Macroinvertebrate scores

Submissions stated the identification of macroinvertebrate taxa with high SIGNAL scores was incorrectly attributed to impaired habitat condition and was instead due to the intermittent flow of Bohena Creek and consequent reduction of oxygen in pools by naturally occurring bacteria as opposed to pollution or other anthropogenic disturbance

Impaired habitat condition includes the state of the system at the time of survey. Thus, the score should be read in conjunction with the survey statement which highlights that surveys were carried out during a low-rainfall period and therefore a period of intermittent flow. Pollution in this sense is taken to include all natural as well as anthropogenic sources. Pollution may therefore include bacterial dominance as a by-product of poor water quality, and also would include salinity, temperature effects and oxygen levels.

6.16.2 Aquatic ecology impacts

Potential impacts of managed release to aquatic ecology including waterholes

Submissions stated that managed release to Bohena Creek would affect water quality and consequently affect fish breeding downstream.

Assessment of aquatic system resilience (Appendix C of Appendix G1 in the EIS) as well as ecotoxicological tests (Appendix B of Appendix G1) were undertaken and concluded that release of the treated water to Bohena Creek under the specified flow conditions in the Managed Release Study (Appendix G1) would have negligible impact to the ecosystem.

Further, the release would have no impact on water quality beyond three metres from the diffuser (Appendix E of Appendix G1), and does not trigger target levels of contaminants- of-concern. The assessments utilised target treated water quality values, whilst the analysis results of actual treated water quality produced by the operation of the commissioned Leewood Water and Brine Treatment Plant show that the treated water quality is better than the targeted water quality values (refer Table 6-4 and Appendix D to this RTS).

Potential impacts of groundwater drawdown on waterholes

Submissions stated that predicted groundwater drawdown would have significant impacts on the permanence of some waterholes and associated aquatic habitat values.

The proponent notes that groundwater modelling has demonstrated that there will be negligible impact to the Namoi alluvial groundwater from the project and hence very unlikely to have impacts on aquatic habitats. The maximum probable drawdown on groundwater over the life of the project is less than 0.5 m, occurring up to 200 years in the future, which is within the error of the modelling, and as such, impacts on groundwater and their respective communities are considered to be negligible.

Section 4.4.4 Surface Water–Groundwater Interaction of the Groundwater Impact Assessment (EIS Appendix F) presents information regarding baseflow to rivers and streams in the study area. Several assessments have mapped gaining (baseflow) and losing reaches of rivers and streams.

The potential for impact to baseflow in rivers is predicted, by proxy, from the degree of impact to shallow alluvial aquifers to which they are connected. The numerical groundwater model demonstrates that the predicted impact to shallow alluvial groundwater that is connected to rivers and streams (and forms the baseflow component of the water balance) is determined to be negligible. Hence, impacts to aquatic habitat ecosystems will also be negligible.

Uncontrolled releases to Bohena Creek

Submissions stated that uncontrolled releases to Bohena Creek would disrupt natural flow regimes and have potentially significant ecological impacts.

Release to Bohena Creek would only occur under specified flow conditions of greater than 100 megalitres per day and would be introduced at a rate of less than 12 per cent of total flow (EIS Appendix G1). Undertaking a managed release only when there is a considerable flow reduces the potential for impact to Bohena Creek aquatic ecology as it still allows for long periods of no flow and maintains the current intermittent flow regime.

No uncontrolled releases will occur.

Use of reference sites to detect impacts

Submissions stated that the Namoi River was not a suitable reference system to detect potential impacts to macroinvertebrates at Bohena Creek. They stated the watercourses were incomparable in terms of being perennial or intermittent and were mainly sodium chloride versus calcium carbonate.

The Water Baseline Report (EIS Appendix G4) lists the locations designated as reference sites for the project. These include six sites on Bohena Creek for water quality as well as one site (downstream of the proposed release point) for flow. Three of the water quality sites are upstream of the proposed release site and three downstream.

Analyses of treated and amended water from the commissioned Leewood water and brine treatment plant indicate that the concentrations of all analytes in the treated and treated and amended water are below levels observed anywhere in Bohena Creek during times of flow. The chemistry of the natural creek flow is a combination of sodium chloride, sodium bicarbonate and (calcium+magnesium) bicarbonate. This is similar in composition (though at higher salinity) to the treated water.

6.16.3 Groundwater dependent ecosystems

Potential impacts to regional groundwater dependent ecosystems

The submission stated that the project would have the potential to affect groundwater levels in the Great Artesian Basin and associated groundwater dependent ecological communities such as those occurring along Bohena Creek as well as the known mound springs of western NSW, southern Queensland and north-east South Australia.

Submissions stated the predicted 0.5 metre drawdown of groundwater in overlying aquifers had the potential to have impacts on waterholes and shallow groundwater aquifers. They noted that some alluvial groundwater aquifers may be as little as two metres in depth and stated drawdown could have effects on dependent flora and fauna such as macroinvertebrates at waterholes.

Predictive simulations in the EIS (Appendix F) include a High Case scenario for water production in which the total water volume extracted from the target coal seams is 87.1 GL over 25 years in the ratio 5 per cent from Late Permian coal seams and 95 per cent from Early Permian coal seams. This scenario is equivalent to average water production of approximately 3.5 GL per year for 25 years, and 2.3 times the extraction volume of the Base Case scenario. The High Case scenario predicts a maximum drawdown of 0.6 m in the Pilliga Sandstone and less than 0.5 m drawdown in the Namoi Alluvium. The High Case scenario can be considered to assess uncertainty in the water production volume of the Base Case up to a 230 per cent increase of the total extraction volume predicted by the reservoir modelling and sought under EIS approval.

The existing sensitivity and uncertainty assessment in the published Groundwater Impact Assessment of the EIS has tested model parameters that result in groundwater pressure drawdowns in the Great Artesian Basin and at the water table. The results are discussed in Section 6.10 of the Groundwater Impact Assessment and a summary of results for all simulations are presented in Section 6.11 of the Groundwater Impact Assessment in EIS Appendix F.

The predicted impacts of the project on groundwater pressure in high-valued groundwater sources of the Great Artesian Basin and Namoi Alluvium are too small to be discernible if presented as hydrographs spanning many hundreds of years and hence represent negligible potential impact to groundwater dependent ecosystems.

Section 4.4.4 Surface Water–Groundwater Interaction of the Groundwater Impact Assessment (EIS Appendix F) presents information regarding baseflow to rivers and streams in the study area. Several assessments have mapped gaining (baseflow) and losing reaches of rivers and streams.

The potential for impact to baseflow in rivers is predicted, by proxy, from the degree of impact to shallow alluvial aquifers to which they are connected. The numerical groundwater model demonstrates that the predicted impact to shallow alluvial groundwater that is connected to rivers and streams (that forms the baseflow component of the water balance) is determined to be negligible. Hence, impacts to groundwater dependent ecosystems will also be negligible.

The proposed Water Monitoring Plan is focussed on early detection of a specific and measurable change that can be reasonably attributed to project activities. The key principle of the Water Monitoring Plan is that monitoring activities are designed to inform an understanding of whether or not the project is contributing to changes in water quantity or quality within water assets, particularly the high valued groundwater sources in the Great Artesian Basin and alluvial aquifers.

This includes four monitoring bores in the Bohena Creek Alluvium, 18 wells in the Namoi Alluvium with one more proposed, and 26 wells in the Great Artesian Basin.

The approach utilises leading resource condition indicators for early warning of potential changes to water resource condition arising from the project. Sentinel monitoring locations are nominated at intermediate depths within the Gunnedah-Oxley Basin (seven existing wells with another six proposed in the Triassic and four existing in the Permian) to detect unexpected change in subsurface condition prior to potential impacts on receptors within shallow high-valued groundwater sources. Thus, the risk of impact to groundwater dependent ecosystems will be monitored throughout the life of the project. Groundwater dependent ecosystems are not proposed to be monitored because they are not predicted to be impacted due to a large degree of physical separation, both vertically in the sub-surface and horizontally at the surface, and therefore the lack of connectivity between the target coal seams and the groundwater dependent ecosystems. The sentinel monitoring approach ensures that any unexpected impacts are identified and management actions initiated well prior to any potential for impact to groundwater dependent ecosystems occurring.

Identification, characterisation and potential impacts to Bohena Creek groundwater dependent ecosystems

Submission stated the assessment did not adequately identify Bohena Creek and associated waterholes as groundwater dependent ecosystems.

It cited the *Groundwater Dependent Ecosystem Atlas*, which finds that Bohena Creek is moderately dependent on surface expression of groundwater. It also cited satellite photography that indicated around 30 associated waterholes and springs along Bohena Creek.

Submissions disputed that assessment of Bohena Creek groundwater dependent ecosystems as being of low significance. It stated the assessment did not consider the ecological valuation process in the NSW Department of Primary Industries guidelines. It contended the ecosystems would meet the definition of 'high environmental value' and 'high priority ecosystem'.

Submissions stated that the project would present a moderate to high risk to Bohena Creek groundwater dependent ecosystems based on the ecological risk assessment process in the NSW Department of Primary Industries guidelines.

A submission noted the groundwater dependence of some vegetation such as red gums along Bohena Creek. Submission stated that areas of vegetation dieback near Bohena Creek indicated their sensitivity to groundwater stresses such as contamination or drawdown.

A submission noted the groundwater dependence of some vegetation such as red gums along Bohena Creek. Submission stated that areas of vegetation dieback near Bohena Creek indicated their sensitivity to groundwater stresses such as contamination or drawdown.

The data sheets and report in Appendix C of Appendix G1 of the EIS follow the *NSW DPI Risk assessment guidelines for groundwater dependent ecosystems*. Evaluations made by remote sensing and high resolution imagery on the potential for sensitive species finds that whilst features may be groundwater dependent ecosystems, their potential for sustaining Matters of National Environmental Significance is low.

The proponent acknowledges that there is an omission of listing of Type 1 groundwater dependent ecosystems. The Namoi aquifer is, however, acknowledged as a groundwater dependent ecosystem in the Bohena Creek study, though it was not mentioned in the Groundwater Dependent Ecosystem Report as the focus for that assessment was on 'spring' ecosystems, not on all groundwater dependent ecosystems.

Two groundwater dependent ecosystems, Hardy and Eather Springs, were not sampled as access was not able to be obtained from the landholder.

The main groundwater dependent ecosystems in the project area are the Type 2 waterholes on Bohena Creek, which were sampled and reported in the Bohena Creek reports (EIS Appendix G1). The proponent notes that groundwater modelling has demonstrated that there will be negligible impact to the Namoi alluvial groundwater from the project and hence very unlikely to have impacts on stygofauna. The maximum probable drawdown on groundwater over the life of the project is less than 0.5 m which is within the error of the modelling, and as such, impacts on groundwater and their respective communities is considered to be negligible.

Using the methodology described by DPI (2016. - *Methods for the identification of high probability groundwater dependent vegetation ecosystems*), the Pilliga State Forest was not determined to be a groundwater dependent ecosystem. Bohena Creek and other major watercourses in the project area, however, were deemed to be high probability groundwater dependent ecosystems and this is acknowledged in the EIS.

6.16.4 Stygofauna

Consideration of stygofauna and potential impacts

Submissions stated potential impacts to stygofauna were not adequately assessed.

Submissions raised the potential presence of stygofauna in groundwater units potentially affected by the project, particularly in shallower overlying aquifers than target coal seams.

Submissions stated the stygofauna survey undertaken for the EIS were not adequate and site selection minimised likelihood of detection. They recommended further surveys and ongoing monitoring to understand stygofauna species present in the project area.

The submissions cited results of 2012-13 and 2016-17 stygofauna surveys by Dr Serov that detected stygofauna within the Pilliga Sandstone and alluvial aquifers of the Pilliga.

Submissions stated that changes in groundwater levels or groundwater quality had potential to impact stygofauna. They stated that predicted groundwater drawdown from the project would constitute a high impact on stygofauna in shallow aquifers. They stated that stygofauna would be sensitive to changes in water quality including salinity.

Submissions recommended ongoing monitoring of groundwater levels and groundwater quality to identify potential impacts to stygofauna.

Submissions stated that managed release of treated water to Bohena Creek would have effects on stygofauna through ponding and infiltration.

The proponent notes that groundwater modelling has demonstrated that there will be negligible impact to the Namoi alluvial groundwater from the project and hence very unlikely to have impacts on stygofauna. The maximum probable drawdown on groundwater over the life of the project is less than 0.5 metres which is within the error of the modelling, and as such, impacts on groundwater and their respective communities is considered to be negligible.

The proponent notes that more sampling in Bohena Creek alluvium may find stygofauna. Taxa in Bohena Creek alluvium, however, are also highly likely to be present in the Namoi Alluvium, and not new species, nor endemic.

Two groundwater dependent ecosystems, Hardy and Eather Springs, were not sampled as access was either denied by, or not able to be obtained from, the landholder.

Dr Serov collected preliminary samples from bores and wells in 2012 and 2013, and subsequently undertook further surveys, collecting invertebrate taxa that were identified as stygofauna, including *Annelida* (worms) and *Acarina* (mites). However, while both *Annelidia* and *Acarina* have representatives found in groundwater environments, they are overwhelmingly more common in the soil community. Soil invertebrates are sometimes encountered in groundwater bores that are uncased, have cracks in the casing, or are uncovered.

From the list of stygofauna provided from these surveys, and at the taxonomic level identified, three are definitely stygofauna (*Amphipoda, Psammaspididae, Parabathynellidae*) and these were collected within the Namoi Alluvium. The diverse stygofauna of the Namoi Alluvium are acknowledged by the proponent (Section 4.4.4 in Appendix G1 of the EIS).

Three other listed crustacean groups may be stygofaunal, but could also be members of the surface water community that entered shallow aquifers when water level fell. *Collembola*, for example, generally live on the soil surface, and this is acknowledged by Dr Serov, although he suggests they may be stygofauna.

The proposed Water Monitoring Plan is focussed on early detection of a specific and measurable change that can be reasonably attributed to project activities. The key principle of the Water Monitoring Plan is that monitoring activities are designed to inform an understanding of whether or not the project is contributing to changes in water quantity or quality within water assets, particularly the high valued groundwater sources in the Great Artesian Basin and alluvial aquifers.

This includes four monitoring bores in the Bohena Creek Alluvium, 18 wells in the Namoi Alluvium with one more proposed, and 26 wells in the Great Artesian Basin.

The approach utilises leading resource condition indicators for early warning of potential changes to water resource condition arising from the project. Sentinel monitoring locations are nominated at intermediate depths within the Gunnedah-Oxley Basin (seven existing wells with another six proposed in the Triassic and four existing in the Permian) to detect unexpected change in subsurface condition prior to potential impacts on receptors within shallow high-valued groundwater sources. Thus, the risk of impact to groundwater dependent ecosystems will be monitored throughout the life of the project. Groundwater dependent ecosystems are not proposed to be monitored because they are not predicted to be impacted due to a large degree of physical separation, both vertically in the sub-surface and horizontally at the surface, and therefore the lack of connectivity between the target coal seams and the groundwater dependent ecosystems. The sentinel monitoring approach ensures that any unexpected impacts are identified and management actions initiated well prior to any potential for impact to groundwater dependent ecosystems occurring.

In the long term, monitoring results may trigger monitoring closer to groundwater dependent ecosystems. The monitoring program is designed, however, that such a management response would occur many years, and potentially decades, in advance of measurable change to aquifers that support groundwater dependent ecosystems and could be objectively linked to project activities.

Release to Bohena Creek would only occur under high flow conditions and would be introduced at a rate of less than 10 per cent of total flow (EIS Appendix G1). Undertaking a managed release only in circumstances when there is flow considerably reduces the potential impact to Bohena Creek aquatic ecology as it still allows for long periods of no flow and maintains the current intermittent flow regime.

6.17 Property and land use

The potential impacts of the project on property and land use were discussed in Chapter 17 of the EIS.

The assessment found that land uses in the project area were agriculture, forestry and other activities in forested areas such as bee-keeping and recreation. Agricultural land and soil capability in the project area were found to be generally limited while forestry activities were found to be relatively small scale.

The assessment found that the project would occupy about one per cent of the project area and would comprise a relatively minor change in land use. Major facilities at Leewood and Bibblewindi would be consistent the existing land uses given existing infrastructure operated by the proponent.

Due to the diffuse nature of field development, potential impacts characterised by relatively small and discrete areas of land use change that could co-exist with other land uses including recreation.

Field development would only occur on private property if there is a Land Access Agreement with the landholder and a Farm Management Plan is in place regarding appropriate siting of infrastructure.

Potential impacts to forestry and the apiary industry would be managed through consultation with relevant stakeholders including the Forestry Corporation of NSW and the conditions of an Occupation Permit.

657 submissions raised issues specifically relating to property and land use as assessed in Chapter 17 of the EIS. 568 submissions concerned potential impacts of the project on private land including agricultural land use, while 113 submissions concerned potential impacts of the project on public land including State forests. One submission raised issues around Crown land.

The division of submissions by issue and submission type is depicted in Figure 6-30.

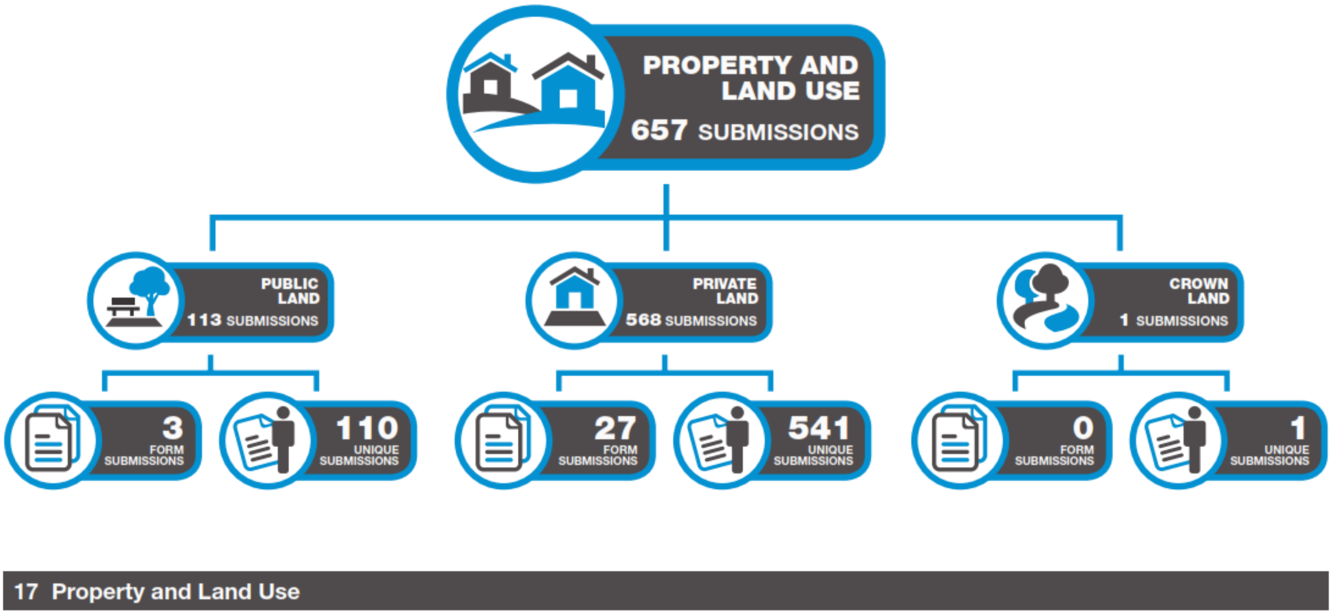


Figure 6-30 Summary of submissions on property and land use

6.17.1 Public land

Public access to the Pilliga

Submissions stated that project activities and infrastructure would limit public access to the Pilliga.

Project construction and operational areas would not be accessible to the public, however, public access to the Pilliga and the region would not be restricted. As discussed in Chapter 2 (Location and setting) of the EIS, the Pilliga is a large forested area covering more than 500,000 hectares. The project area would occupy about 95,000 hectares, about a third of which is not in forested areas. Further, project infrastructure would only occupy about one per cent of that area.

Forested areas would remain accessible by existing roads and access tracks in the project area. The project may also utilise existing roads and access tracks but not to the exclusion of the public. Linear infrastructure such as roads, access tracks and gas and water gathering lines would not typically be fenced and would therefore not limit access to the public. Infrastructure in forested areas such as

Bibblewindi and wells pads would be fenced for safety and security however given their relatively small footprint this would not be expected to affect public users of forested areas.

Impacts on Yarrie Lake

Submissions raised concerns about the potential impacts of the project on Yarrie Lake including the potential for wells to come as close as 200 metres.

It is considered that the design of the project including the constraints as set out in the Field Development Protocol is sufficient to prevent impacts on Yarrie Lake and its environmental and recreational value.

Yarrie Lake reserve is defined as the following land: Lot 51, DP 43308; Lot 52, DP 43308 and Lot 53, DP 43308. Parts of this reserve extend in the order of one kilometre from the boundary of Yarrie Lake. The reserve is a designated surface development exclusion zone (plus a buffer of at least 50 m) for the project. No surface infrastructure will be located within the Yarrie Lake reserve, or the 50 m buffer area.

It is noted that the submission from the Yarrie Lake Flora and Fauna Trust indicated that board members of the Trust had voted unanimously in support of the project and had not raised concerns about the project with regard to the lake and reserve.

Potential impacts on apiary industry

Submissions noted that the apiary industry utilises State forest for their activities.

Submissions stated the project would adversely affect the apiary industry. They stated that bee species are very sensitive to environmental changes.

Potential impacts of the project on other forest activities including bee-keeping were discussed in Chapter 17 – Property and land use of the EIS. Potential impacts to the apiary industry are also discussed in Appendix K – Agricultural Impact Assessment.

As discussed in Chapter 17 (Property and land use) and Appendix K (Agricultural Impact Assessment), potential impacts to the apiary industry were expected to be negligible. The proponent has, and would continue to, consult with the NSW Apiarists Association to ensure project activities do not directly disturb apiary installations.

6.17.2 Private land

Clarification of compensation to landholders

Submissions requested more detail of how compensation would be arranged with landholders. They stated that compensation should be provided through a transparent regime.

They stated that compensation should account for potential contamination and loss of amenity as well as loss of profits or decreased market value. They also stated additional protection should be considered similar to the Commonwealth *Land Acquisition Act 1989*, which determines the value of land to be the greater of the market value or the cost of relocating, including closure and reopening.

Compensation to landholders was discussed in the Social Impact Assessment in Appendix T1 of the EIS. The compensation process was detailed in the fact sheet *Working with landholders* provided as Appendix B of that assessment. Compensation with regard to agricultural productivity was also described separately in the Agricultural Impact Statement in Appendix K of the EIS.

As outlined in the EIS, compensation would not be limited to land value or agricultural productivity but would also include compensation for services provided and a share in a Landholders Incentive Fund.

Further, in accordance with NSW Government policy, all title holders engaged in coal, mineral and petroleum exploration as well as mining and petroleum production activities are required to lodge a security deposit to cover the cost of undertaking rehabilitation.

Effects on productivity or land values

Submission stated that project infrastructure would reduce income and land values. They cited research by the CSIRO that predicted losses of about $2.17 million over 20 years. They also cited a NSW Valuer General report that referred to reductions in land value between 2.5 and 20 per cent.

Potential impacts on productivity were assessed in the Agricultural Impact Statement in Appendix K of the EIS. The findings of the assessment are consistent with the research cited in the submission.

The CSIRO study stated that a sample area averaged a loss of $2.17 million over 20 years when the industry was present and found that the biggest cause of losses to agricultural production was from gas industry access tracks and lease areas. The value of $2.17 million over 20 years is consistent with the $243,000 per year as presented in the Agricultural Impact Statement. The Net Present Value (NPV) of $243,000 for each year over a 20 year period is approximately $3 million.

The reference to reductions in land value between 2.5 and 20 per cent by the NSW Valuer General were in relation to statutory allowances made by the Queensland State Valuation Service rather than actual losses. Further, the NSW Valuer General (2014) states with regard to Narrabri and Gunnedah:

> *Two property sales with CSG activity on them were analysed and the sales prices did not appear to be impacted. A total of 11 comparable sales were analysed at distances from one kilometre to 38 kilometres from well activity. There was no observable difference in the value levels of the comparable sales based on their distance from the well activity.*

Discussions with local property professionals indicated that the majority did not feel the industry was having an impact on property values but there had not been enough sales data to determine the true effect. It was acknowledged that the market was conscious of the industry and that there was some concern within the community, with some strong opposition to the industry. For some of those owning rural properties in the area, the prospect of having a well site on the property was believed to be a positive one with the potential for additional income, especially for marginal rural properties.

Appendix K outlined landholder compensation to be provided by the proponent to reflect the loss of agricultural production (see Section 6.1). The compensation package proposed by the proponent for individual landholders was assessed in Appendix K as being in excess of the value of the loss of income from agriculture as a result of coal seam gas development.

Effects on loans, insurance and liability for environmental impacts

Submissions stated loans and insurance regarding properties hosting project infrastructure would be denied or offered at increased premium due to perceived environmental risks.

Submissions stated that that the proponent should insure landholders for potential environmental impacts including those that may affect neighbouring properties.

Submissions stated that landholders may make liability claims for environmental impacts or other effects such as loss of third party accreditation.

Submissions also stated that landowners may also liable to their neighbours or regulators for environmental impacts and could be prosecuted in the event of contamination.

They stated that the proponent will seek legal indemnities through Land Access Agreements.

> The proponent takes great care, uses the best available science and works within strict and stringent requirements to ensure they explore for, and extract, natural gas safely without harm to the environment.
>
> In the unlikely event that there were to be a spill or leak the proponent will be responsible for the remediation and rehabilitation of contamination caused.
>
> The NSW Government also holds a bank guarantee from the proponent to cover the cost of undertaking rehabilitation.
>
> The bank guarantee amount is determined by the State to be sufficient to cover the full third party costs of rehabilitation. The proponent holds various insurance policies to cover its major risks and liabilities.

Compatibility with other land uses

Submissions stated the project would not be compatible with other land uses.

They stated gas and water gathering lines would occupy about 25 to 40 per cent of agricultural land and would permanently interfere with agriculture, recreation and tourism.

They stated that the project would prevent agriculture in particular through restriction of movement of vehicles and machinery throughout agricultural properties.

Other submissions stated that proponent exploration activities had successfully co-existed with organic certified beef production in the Cooper Basin demonstrating their compatibility.

> As discussed in Chapter 17 (Property and land use) of the EIS, the project is considered to be compatible with other land uses in the project area, including agriculture.
>
> The Agricultural Impact Statement in Appendix K of the EIS, quantified indicative areas that may be precluded from agriculture by the project. These areas were assessed as being up to 532 hectares during construction and up to 351 hectares during operation. These areas amount to about two per cent and 1.3 per cent of agricultural land in the project area respectively.

Project infrastructure would be located through Land Access Agreements and Farm Management Plans developed in consultation with relevant landholders to minimise potential impacts on agricultural operations. Following decommissioning, rehabilitation would be carried out to restore pre-existing land uses in consultation with the landholder.

Value of agriculture and natural gas

They stated that long-term security of agriculture in the project area was more important than relatively short term use of the project area for natural gas exploration and production. They stated that agriculturally productive areas were important to food security.

As discussed in Chapter 17 (Property and land use) of the EIS, the project is considered to be compatible with other land uses in the project area including agriculture. As such, the project is not considered to replace agriculture or reduce the long-term security of agriculture in the project area.

Project infrastructure would be located through Land Access Agreements and Farm Management Plans developed in consultation with relevant landholders to minimise potential impacts on agricultural operations. Following decommissioning, rehabilitation would be carried out to restore pre-existing land uses in consultation with the landholder.

Agricultural reputation and certification risks

Submissions stated clean land and water were important to the reputation of the agriculture in the region and necessary for certifications such as National Vendor Declarations for food safety.

They stated that contamination of land or water would undermine the viability of agriculture. Some stated that properties would not be able to maintain organic certification.

They stated that the proponent should refer to Meat and Livestock Australia guidelines that determine chemicals that cannot be used on agricultural land due to food safety risks.

The project is not expected to compromise the reputation or certification of agricultural production in the project area or region.

As discussed in Chapter 14 (Soils and land contamination) of the EIS, the likelihood of leaks and spills is considered low, while design and engineering controls along with monitoring systems would enable quick detection and rectification in the unlikely event of a spill.

As discussed in Chapter 7 (Produced water management) of the EIS, treated water may be used for stock watering, while treated and amended water may be used for irrigation. The treated, or treated and amended water, would meet relevant water quality guidelines to ensure suitability for beneficial reuse.

Produced water from current exploration and appraisal operations in the project area undergoes treatment at the existing water treatment facility at Leewood. Analysis of the treated water is presented in Table 6-4 and Appendix D of this RTS, which shows that it complies with relevant guidelines for irrigation and stock watering (ANZECC/ARMCANZ 2000).

Weeds and pathogens

Submissions stated the project would propagate weeds and pathogens on private land.

They stated that the assessment had not adequately considered the potential for increased traffic associated with the project to result in the propagation of weeds of agricultural land.

They also stated that proponent's weed hygiene certificates had been inaccurate in the past and did not reflect that weeds had been introduced on agricultural properties.

As discussed in Chapter 30 (Environmental management and monitoring) of the EIS, the project would implement a Pest, Plant and Animal Control Plan including identification, monitoring and control of weeds and pathogens prior to and following disturbance to reduce their establishment and ability to spread in the project area.

Lack of certainty for landholders

Submissions stated that absence of a detailed layout of project infrastructure and baseline information meant landholders were not able to manage their land or make financial decisions in relation to their properties.

As stated in Chapter 17 (Property and land use) of the EIS, the proponent will not undertake drilling on private land without a Land Access Agreement and Farm Management Plan in place.

Consideration of landholders through land access agreements

Submissions stated that negotiations of Land Access Agreements between the proponent and the landholders would disadvantage landholders relative to the proponent. They also stated that landholders would be disadvantaged by being bound to confidentiality clauses.

Submissions stated that land access negotiations should give priority to landholders and their rights over their land including agricultural operations.

As stated in chapter 17 (Property and land use) of the EIS, land access would be undertaken in accordance with the *Agreed Principles of Land Access*. The agreed principles are as follows:

- Landholders must be allowed to freely express their views on the type of drilling operations that should or should not take place on their land without criticism, pressure, harassment or intimidation. A landholder is at liberty to say “yes” or “no” to the conduct of operation on their land.
- Gas companies will respect a landholder's wishes and not enter onto a landholder's property to conduct drilling operations where that landholder has clearly expressed the view that operations on their property would be unwelcome.
- The parties will uphold a landholder's decision to allow access for drilling operations and do not support attempts by third-party groups to interfere with agreed operations. The parties condemn bullying, harassment and intimidation in relation to agreed drilling operations.

It is considered that the agreed principles would provide for equitable negotiations between the proponent and landholders with regard to project infrastructure.

Land access agreements for project infrastructure

Submissions stated that the proponent will only seek Land Access Agreements for gas wells but would not require agreements for other field infrastructure.

Field infrastructure including gas wells, gas and water gathering lines, access tracks, water balance tanks and communication towers would be subject to Land Access Agreements. In accordance with the *Agreed Principles of Land Access*, gas wells will only be drilled on a landholder's property where there is a Land Access Agreement in place. This agreement will be required with each landowner before infrastructure may be located on the landholder's property.

Consultation in Agricultural Impact Statement

Submissions stated that Agricultural Impact Statement (EIS Appendix K) had presented a non-representative group of landholders to create the impression of support.

As discussed in Section 2.2 of Appendix K (Agricultural impact assessment) of the EIS, five agricultural landholders as well as the NSW Farmers' Association and NSW North West Local Land Services were consulted for the preparation of the assessment.

The purpose of consultation for the Agricultural Impact Statement was to identify issues of concern to agricultural landholders in the project area. The assessment also drew on supplementary research (FPC Water Solutions 2014) to confirm issues of concern to the agricultural community, and identified opportunities to address those concerns.

Suitability of lucerne in proposed irrigation areas

Submissions stated that lucerne was not a suitable crop for proposed irrigation areas. They cited NSW agricultural guidance notes in finding that the crop exhibited:

- preference for milder climates
- preference for alluvial, well-drained soils
- sensitivity to waterlogging particular at high temperatures.

Submissions stated that assessment noted that soils in proposed irrigation areas may be waterlogged for durations up to a few weeks. Submissions also stated that lucerne in proposed irrigation areas could accumulate contaminants from treated and amended water.

The proponent disagrees with the submissions' assertion regarding the suitability of lucerne for irrigation. While the assessment indicated lucerne is a suitable crop and is already grown in the region, the assessment was not prescriptive and noted other crops were viable including wheat-cotton rotations, which are also grown in the region. Crop selection would be the decision of the irrigator.

The irrigation study in Appendix G2 of the EIS was intended to demonstrate the conceptual suitability of treated and amended water for irrigation in the region. The study identified land suitable for irrigation with a 20 kilometre radius of the water treatment facility at Leewood.

As discussed in Chapter 7 (Produced water management) of the EIS, produced water would be treated and amended to a standard suitable for beneficial reuse by irrigation. The suitability of the treated and amended water was demonstrated in Table 7-2 of the EIS with reference to the relevant water quality guidelines for irrigation (ANZECC/ARMCANZ 2000).

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with relevant water quality guidelines for proposed beneficial reuse activities, including irrigation. Further detail on the treated water quality is provided in the updated Water Baseline Report.

Financial risk to irrigators of proposed irrigation areas

Submissions stated that irrigators would be unlikely to invest in proposed irrigation areas. They stated that the proposed irrigation areas would have a number of risks including the potential for crop failure; the potential for treated and amended water to not be available during the project or after 25 years; and potential ongoing monitoring requirements imposed on the irrigators.

The proponent disagrees with the submissions' assertion regarding the likelihood of investment and the risk of crop failure. The availability of a reliable supply of irrigation quality water presents an opportunity for irrigation activities.

As discussed in Chapter 7 (Produced water management) of the EIS, produced water would be treated and amended to a standard suitable for beneficial reuse by irrigation. The suitability of the treated and amended water was demonstrated in Table 7-2 of the EIS with reference to the relevant water quality guidelines for irrigation (ANZECC/ARMCANZ 2000).

The Leewood Water and Brine Treatment Plant commenced operations in mid-2017 after the submission of the project's EIS. The Leewood Water and Brine Treatment Plant is treating water and brine from the Narrabri exploration and appraisal activities and the results of water quality generated in the process are presented in Table 6-4 of this RTS and in the updated Water Baseline Report (Appendix D to this RTS).

The results show that the water quality complies with ANZECC/ARMCANZ (2000) long-term (greater than 20 years) irrigation trigger values. Further detail on the treated water quality is provided in the updated Water Baseline Report.

The irrigation study in Appendix G2 of the EIS was intended to demonstrate the conceptual suitability of treated and amended water for irrigation in the region. The study identified that there is approximately 9,000 hectares of land suitable for irrigation available within a 20 kilometre radius of the water treatment facility at Leewood.

6.17.1 Crown land

Resource entitlements

Submissions stated the Crown had no entitlement to coal seam gas under Native Title laws and that consequently Native Title owners had a right to refuse development of their land.

The proponent is following due statutory procedures under Native Title laws. The proponent has engaged with the Gomeroi applicant group as the relevant Native Title applicant under the right to negotiate provisions of the Commonwealth *Native Title Act 1993*.

6.18 Air quality

The Air Quality Impact Assessment was provided in Appendix L and summarised in Chapter 18 (Air quality) of the EIS. The Air Quality Impact Assessment was carried out using industry standard meteorological and dispersion models, in accordance with the relevant statutory guidelines at the time of the assessment.

The assessment adopted a hierarchical approach whereby all potential pollutants were ranked according to their potential to approach their relevant air quality criteria. The pollutants with the greatest potential to approach their air quality criteria were then modelled. The distance from the project where all other pollutants met the relevant air quality criteria would thus be less than the modelled distance. This approach effectively assesses the potential impacts of all potential pollutants. Dust from construction would be readily managed through implementation of mitigation and management measures.

The main project emission during construction was found to be construction dust. The main project emissions during operation were found to be oxides of nitrogen from well pads, the Leewood gas processing facility, the Leewood power generation facility and safety flares at Leewood and Bibblewindi. These, and all other assessed emissions from the operation of the project, were found to meet air quality criteria at sensitive receptors.

337 submissions raised issues specifically relating to the air quality assessment in Chapter 18 of the EIS. The majority of these submissions raised issues relating to air quality impacts while a smaller number raised issues regarding baseline data and assessment method, or management and monitoring. The submissions that raised air quality issues were generally unique although some form submissions were received; some including additional remarks regarding air quality impacts.

Some submissions raised issues regarding potential health impacts of air emissions specific to the health risk assessment. These issues are discussed in Section 6.26.3.

The division of submissions by issue and submission type is depicted in Figure 6-31.

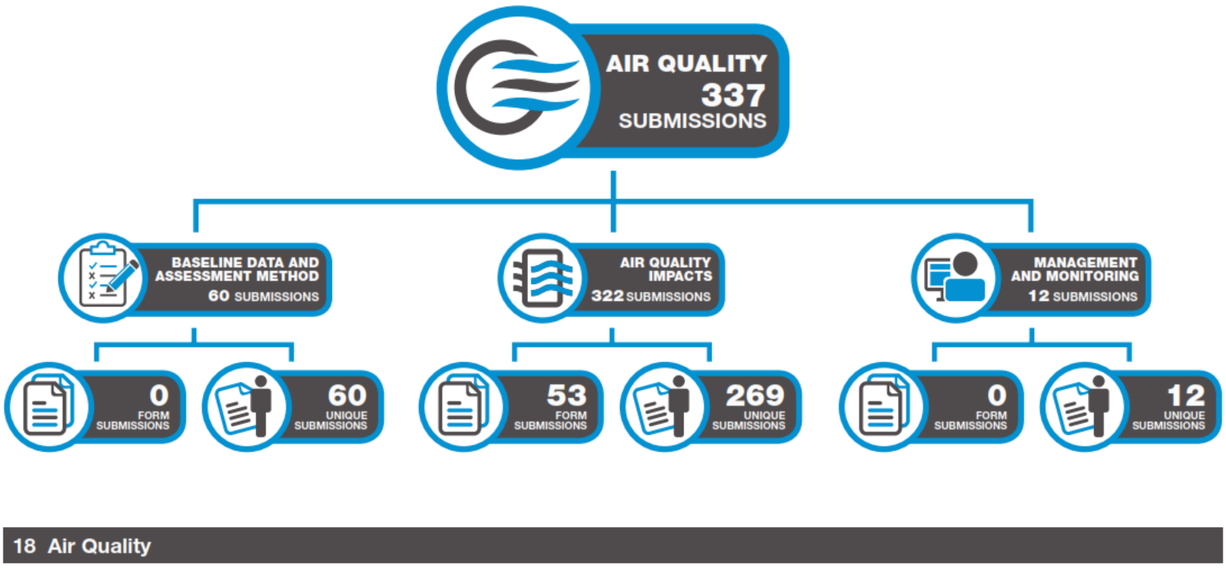


Figure 6-31 Summary of submissions on air quality

6.18.1 Baseline data and assessment method

Background monitoring

Submissions queried background air quality monitoring undertaken for the project. Specifically, they queried the positioning of monitoring sites for background methane. They requested independent background monitoring to be conducted prior to the project.

As stated in Chapter 18 (Air quality) of the EIS, the proponent commissioned the University of Adelaide to record baseline atmospheric methane concentrations in the project region over three years. The baseline concentrations were recorded at up to 1.8 parts per million with localised increases near roads, cattle yards, mining areas and farm bores. Localised increases were also recorded that were attributable to anthropogenic sources including roads near cattle saleyards (over 20 parts per million), roads near mining areas (over 30 parts per million) and farm bores (over 100 parts per million).

Baseline methane has also been investigated by the Commonwealth Scientific and Industrial Research Organisation including through the Pilliga forest region where natural gas development would occur (Ong *et al.* 2017).

Pollutants considered

Submissions stated the Air Quality Impact Assessment did not consider all pollutants. They stated the assessment focussed on nitrogen dioxide and a selection of air toxics. Some specified the pollutants that had not been assessed including $PM_{2.5}$, hydrogen sulphide, volatile organic compounds, radioactive gases and sulphur dioxide.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The Air Quality Impact Assessment accounted for all pollutants considered to have the potential to be emitted by the project. The assessment ranked all pollutants according to the ratio of its emission rate to its relevant air quality criteria. The rankings were presented in Appendix B of the Air Quality Impact Assessment.

It was assessed that if the top ranked pollutants complied with the relevant air quality criteria, lower ranking pollutants would also meet the criteria. As such, the top pollutants were assessed through dispersion modelling. The adopted approach thus streamlines the assessment process for all pollutants.

To demonstrate the adequacy of the approach, ground level concentrations of all pollutants that were considered are presented in the Air Quality Addendum in Appendix I to this RTS.

Consideration of data from existing wells

Submissions stated the Air Quality Impact Assessment did not substantiate the assessed composition of natural gas and that it did not consider monitoring data from existing wells and other gas infrastructure.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). The assessment considered the composition of natural gas based on data from existing exploration and appraisal wells and all of the predicted products of the processing and combustion of the natural gas.

Fugitive methane emissions

Submissions stated the Air Quality Impact Assessment did not consider fugitive methane emissions. They stated that dispersion modelling should have been undertaken for fugitive methane.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005). The assessment did not assess concentrations of methane in detail as it does not pose a risk to human health and has no published criteria.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) conducted a study that aimed to develop methods for characterising methane and other gaseous emissions from different area sources in NSW, particularly the coal seam gas industry (Day *et al.* 2016). The study showed that:

- Methane levels attributed to coal seam gas operations were low relative to other sources.
- Measurements of volatile organic compounds considered as major precursors to the formation of ozone in the atmosphere were shown to be lower at coal seam gas sites than in the vicinity of the other source types such as animal feedlots or waste facilities.

- Measurements of volatile organic compounds prioritised under United States Environmental Protection Agency ambient air quality guidelines for human and environmental health were shown to be lower at coal seam gas sites than in the vicinity of the other source types.

Further details of the study conducted by Commonwealth Scientific and Industrial Research Organisation are presented in the addendum to the Air Quality Addendum provided as Appendix I to this RTS.

Identification of sensitive receivers

Submissions stated that the assessment did not identify Narrabri West Primary School as a sensitive receiver, and therefore, did not adequately assess potential air quality impacts.

The Air Quality Impact Assessment (EIS Appendix L) found that all pollutants, including dust, would comply with the air quality criteria at all identified sensitive receivers, including those within the project area plus a three kilometre buffer zone. Narrabri West Public School would be situated in the order of six kilometres from the project area.

In demonstrating that pollutants would comply with the air quality criteria at the sensitive receivers in or near the project area, the assessment also demonstrates that pollutants would comply with air quality criteria to those situated even further away such as Narrabri West Public School or other sensitive receivers in the township of Narrabri. Moreover, the assessment found that pollutants would comply with relevant air quality criteria at all locations beyond the boundary of the emissions source during operation, e.g. the boundary of Leewood or a well pad.

6.18.2 Air quality impacts

General air quality and odour

Submissions stated the project would cause dust and other air quality impacts at residences. Some also stated that the project would generate odour noticeable to landholders and cited perceived odours from existing gas wells in the project area.

The Air Quality Impact Assessment (EIS Appendix L) was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The assessment considered all pollutants considered to have the potential to be emitted by the operation of the project. It found all pollutants, including dust, would be well within relevant air quality criteria at sensitive receivers.

Air emissions from natural gas infrastructure are not generally considered to be odorous or likely to cause odour nuisance at nearby sensitive receivers and communities. This is due to the primary constituents of natural gas (such as methane, nitrogen and carbon dioxide) being odourless. The proponent has not received odour complaints in relation to its activities in Narrabri.

Ozone formation

Submissions stated the assessment did not describe the potential impacts of the formation of ground level ozone from oxides of nitrogen and volatile organic compounds. They stated that estimates of ozone would be low due to underestimation of fugitive or vented gas releases. They also stated that ozone impacts could be worsened by climatic conditions such as still cloudy days or temperature inversions.

The Air Quality Impact Assessment (EIS Appendix L) found that ozone concentrations would be below the relevant air quality criteria at all locations beyond the boundary of the emissions source, e.g. the boundary of Leewood. The assessment of ozone included a number of conservative assumptions, including that predicted maximum 1-hour and 4-hour average incremental ground level concentrations of nitrogen dioxide would be transformed to ozone. The assessment also assumed various worst-case plume dispersion conditions including highly stable atmospheric conditions, temperature inversions and night-time katabatic winds to assess the potential impacts of formation of ozone.

Smog formation

Submissions stated the assessment did not describe the potential impacts of smog formation due to the combination of oxides of nitrogen, ozone, particulate matter and other pollutants.

The Air Quality Impact Assessment (EIS Appendix L) found that concentrations of oxides of nitrogen, ozone, particulate matter and other pollutants would be below the relevant air quality criteria at all locations beyond the boundary of the emissions source during operation, e.g. the boundary of Leewood. Potential for formation of smog and associated potential impacts on surrounding regions was therefore predicted to be low. The assessment took into consideration various worst-case plume dispersion conditions including highly stable atmospheric conditions, temperature inversions and night-time katabatic winds to assess the potential impacts of formation of pollutants and smog formation.

Flaring impacts

Submissions stated the assessment did not describe the potential impacts of flaring. Some stated that a number of recognised air toxins associated with flaring were omitted.

Potential air quality impacts of flaring were assessed with the results presented in Section 8 of the Air Quality Impact Assessment (EIS Appendix L). The assessment found that the contribution of safety flares and pilot flares to ground-level concentrations of pollutants would be negligible during both routine and non-routine operations and that all pollutants would comply with the relevant air quality criteria at all locations beyond the site boundary, e.g. the boundary of Leewood, Bibblewindi or well pads. Ground-level concentrations of all pollutants are presented in Appendix J.

Emissions from project infrastructure

The submission stated that the assessment incorrectly assumed there would be no emissions from the project gas compression infrastructure, water treatment facility or high point vents.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

All air emissions associated with gas compression and water treatment were assessed. Emissions from high point vents are considered negligible.

Cumulative air quality impacts

The submission noted increasing ambient emissions reported on the National Pollutant Inventory including carbon monoxide, nitrogen oxide and volatile organic compounds.

Submissions stated that emissions from the project in combination with other projects would have cumulative effects on air quality that should have been described further.

The air emission modelling was undertaken using a cumulative impact assessment approach with background air quality. Existing air quality was described with reference to NSW Office of Environment and Heritage data for regional localities, supplemented by four months of monitoring in the project area.

The assessment included modelling of the emissions of the project in combination with background air quality. The inclusion of this background data in the impact assessment of the project, coupled with a generally conservative approach to modelling, means that the assessment accounted for potential cumulative impacts associated with existing projects.

Impacts on air quality as a result of the project were found to be localised and low. The assessment included a discussion of existing facilities registered on the National Pollutant Inventory that could contribute to background air quality in the vicinity of the project area. Due to the distance between the project and other projects that may impact on air quality, cumulative air impacts are unlikely to occur.

Pollutants in fugitive emissions

Submissions stated fugitive methane releases could occur during drilling, extraction, transport, storage and processing. They also stated that fugitive methane may be degassed from produced water storage ponds or may escape through the ground.

Submissions stated that contaminants that could be present in fugitive emissions included volatile organic compounds, polycyclic aromatic hydrocarbons, benzene and toluene.

They also cited research indicating increases in concentrations of ethane, radon, carbon dioxide and methane in proportion to field development. It stated their presence could also indicate the presence of other emissions with potential effects and air quality and human health.

Some cited the *NSW Chief Scientific & Engineer Final Report* (2014) of the Independent Review of Coal Seam Gas Activities in NSW on the potential for contaminants in fugitive emissions.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The assessment considered the composition of natural gas based on data from existing exploration and appraisal wells and all of the predicted products of the processing and combustion of the natural gas. The composition of natural gas was not considered to contain pollutants of concern.

Most studies of unconventional gas production that were referred to were conducted in the United States and these studies cannot be directly compared to Australian projects due to differences in surface and subsurface conditions and gas composition (NSW Chief Scientist and Engineer 2014). The unconventional gas industry in the United States is primarily focused on shale gas formations with a reliance on hydraulic fracturing and as such the findings are not relevant for this project. In addition, the composition of the natural gas such as the fraction of methane compared to other gases (e.g. BTEX and PAHs), varies considerably between shale and coal seam gas development and therefore between these projects and the project.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) conducted a study that aimed to develop methods for characterising methane and other gaseous emissions from different area sources in NSW, particularly the coal seam gas industry (Day *et al.* 2016). The study showed that:

- Methane levels attributed to coal seam gas operations were low relative to other sources.
- Measurements of volatile organic compounds considered as major precursors to the formation of ozone in the atmosphere were shown to be lower at coal seam gas sites than in the vicinity of the other source types such as animal feedlots or waste facilities.
- Measurements of volatile organic compounds prioritised under United States Environmental Protection Agency ambient air quality guidelines for human and environmental health were shown to be lower at coal seam gas sites than in the vicinity of the other source types.

Further details of the study conducted by Commonwealth Scientific and Industrial Research Organisation are presented in the Air Quality Addendum provided as Appendix I to this RTS.

Diesel emissions from vehicles

Submissions stated the project would involve a large number of vehicle movements and stated that the associated increase in diesel emissions would be substantial.

Emissions from vehicles associated with the project would be very small and localised and were considered to have negligible potential to cause an exceedance of air quality criteria.

Temperature inversions

Submissions stated there was potential for still conditions or temperature inversions to increase the potential air quality impacts of the project on nearby residents.

The Air Quality Impact Assessment presented in Appendix L of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

The dispersion modelling carried out for the assessment considered worst-case plume dispersion conditions including still atmospheric conditions, temperature inversions, and night-time katabatic winds.

Volatilised produced water

Submissions stated the assessment did not adequately consider the potential for contaminants in produced water to volatilise and cause air quality impacts.

The risk of impacts to air quality associated with potential emissions from produced water storages were considered through the scoping of the Air Quality Impact Assessment in Appendix L of the EIS and were expected to be very low. No emissions of dissolved or suspended metals in the produced water were expected. Consequently, there is not expected to be impact beyond the boundary of the Leewood site from metals in the produced water.

Navi *et al.* (2015) conducted a review of the potential hazards to the human environment associated with produced water. Their research documented available information about potential exposure pathways for produced (i.e. untreated) water, including:

- Water used for municipal purposes.
- Recreational water activities in rivers.
- Occupational exposures.
- Extracting water from contaminated aquifers.
- Indirect exposure through the food chain.

Although the potential for onsite workers to be exposed to aerosols was identified, Navi *et al*. (2015) did not identify atmospheric diffusion and transport as a key exposure pathway.

Contamination of tank water

Submissions stated the assessment did not consider the potential for contamination of tank water.

The Air Quality Impact Assessment (Appendix L in the EIS) found that ground-level concentrations of all pollutants would be well within their relevant air quality guidelines. Pollutants with the potential to affect tank water quality, such as particulate matter and metals, were predicted to be less than five per cent of the relevant criteria. As such, potential for contamination of tank water is considered to be negligible.

6.18.3 Management and monitoring

Mitigation and management of air emissions

Submissions stated that mitigation and management measures should have been proposed for all predicted air emissions. They specified emissions included nitrogen dioxide, particulate matter, volatile organic compounds, polycyclic aromatic hydrocarbons and other air toxics.

The Air Quality Impact Assessment in Appendix L of the EIS considered all pollutants considered to have the potential to be emitted by the operation of the project. It found all pollutants, including dust, would be well within relevant air quality criteria at residences.

As stated in Chapter 18 of the EIS (Air quality), an Air Quality Management Plan would be implemented to monitor air quality.

6.19 Noise and vibration

The Noise and Vibration Assessment was provided in Appendix M and summarised in Chapter 19 of the EIS. The Noise and Vibration Assessment was carried out using industry standard noise and vibration models and in accordance with the relevant statutory guidelines at the time of the assessment.

Noise sources, including traffic, were identified in accordance with the description of the project and the Traffic Impact Assessment in Appendix P of the EIS. Noise that would be generated from these sources was quantified with reference to various noise standards, manufacturer specifications and prior noise assessments. The propagation of the noise was then simulated in predictive noise models and assessed against relevant criteria for human comfort in accordance with relevant statutory guidelines.

The assessment found that with a small number of exceptions, construction of major facilities of the project were predicted to comply with noise management levels at all sensitive receivers at all times. Field development would occur in accordance with the Field Development Protocol that required consideration of noise management outcomes. Operational activities of the project comply with the noise management level of 35 dB(A), unless otherwise resolved through privately negotiated agreements.

A suite of mitigation and management measures available to minimise potential noise impacts from construction and operation will be considered through the implementation of a Noise Management Plan.

46 submissions raised issues specifically relating to the Noise and Vibration Assessment in Chapter 19 of the EIS. The majority (45) of these submissions raised issues relating to noise and vibration impacts while a smaller number raised issues regarding baseline data and assessment method (2) or management and monitoring (1). The submissions that raised noise and vibration issues were generally unique although one form submission included relevant additional remarks pertaining to noise and vibration.

The division of submissions by issue and submission type is depicted in Figure 6-32.

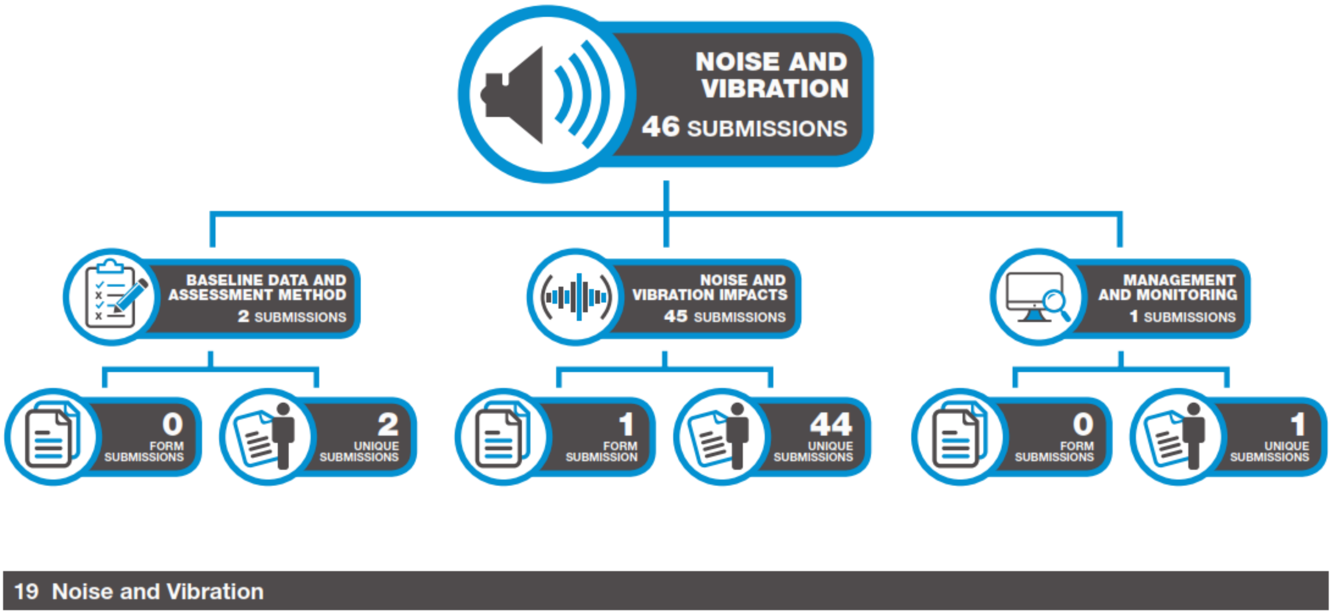


Figure 6-32 Summary of submissions on noise and vibration

6.19.1 Baseline data and assessment method

Noise propagation

Submissions stated the noise assessment was inadequate and that noise generated by the project would propagate further than stated in the assessment.

The Noise and Vibration Assessment in Appendix M of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements and the relevant guidelines including the *Interim Construction Noise Guideline* (DECC 2009) and the *Industrial Noise Policy* (EPA 2000).

A number of conservative assumptions were made throughout the assessment in the selection of model parameters, noise criteria and weather data. Findings of the assessment are therefore considered conservative and appropriate to identify potential noise exceedance scenarios and mitigation and management measures.

6.19.2 Noise and vibration impacts

General noise

Submissions stated that the project would cause noise impacts for residents.

As stated in the commitments in Chapter 31 of the EIS, noise from the project will meet the relevant noise criteria at occupied residences unless a written agreement is in place with the landholder.

Operational noise

Submissions stated that the 24-hour operation of gas processing and water management facilities would generate operational noise that would disturb people and livestock.

As stated in the commitments in Chapter 31 of the EIS, noise from the project will meet the relevant noise criteria at occupied residences unless a written agreement is in place with the landholder.

Noise from the operation of the gas processing and water management facilities would not be expected to affect livestock. It is noted the facilities are adjacent to Newell Highway and existing traffic noise is significant particularly during adverse weather conditions.

6.19.3 Management and monitoring

Mitigation and management

Submissions stated the proponent should mitigate and manage noise to ensure minimal impacts to sensitive receivers including residents and ecological values.

As stated in the commitments in Chapter 31 (Project commitments) of the EIS, noise from the project will meet the relevant noise criteria at occupied residences unless a written agreement is in place with the landholder. A range of mitigation and management measures would be considered by the proponent to minimise noise including enclosures, treatments and silencers if necessary.

Size of gas compressors

Submissions stated that smaller gas compression units would be louder than larger gas compression units due to limited opportunities for mitigation. They queried the size of the gas compression units and the potential for the noise they generate to be mitigated.

As stated in the commitments in Chapter 31 (Project commitments) of the EIS, noise from the project will meet the relevant noise criteria at occupied residences unless a written agreement is in place with the landholder.

As discussed in the project commitments in Chapter 31 of the EIS, a range of mitigation and management measures would be considered by the proponent to minimise noise including potential enclosures of gas compression units or treatment of the gas processing facility if necessary.

Impacts on neighbouring properties

Submissions stated that noise from the project would affect neighbouring properties that would not be subject to Land Access Agreements.

As stated in the commitments in Chapter 31 (Project commitments) of the EIS, noise from the project will meet the relevant noise criteria at occupied residences unless a written agreement is in place with the landholder. This commitment applies to all occupied residences.

6.20 Aboriginal heritage

The Aboriginal cultural heritage assessment was provided in Appendix N1 and summarised in Chapter 20 of the EIS. The assessment was undertaken in consultation with Registered Aboriginal Parties in accordance with *Aboriginal cultural heritage consultation requirements for proponents* (NSW Government 2010). Consultation activities included the distribution of project materials, community meetings, and review of the draft assessment report including the opportunity to make a submission.

The assessment found that the project area contained 90 known Aboriginal heritage sites but was also likely to contain additional sites that had not yet been identified. The assessment found that potential impacts on Aboriginal heritage sites would be mitigated and managed through the pre-clearance surveys and avoidance. The 90 known Aboriginal sites would be avoided as would the most sensitive site types.

Avoidance and management commitments, including procedures for the management of Aboriginal heritage identified during pre-clearance surveys, would be collated in the Cultural Heritage Management Plan for the project outlined in Appendix N2 of the EIS and Appendix J of this RTS, and in the Field Development Protocol outlined in Appendix C of the EIS and Appendix C of this RTS.

17,944 submissions raised issues specifically relating to Aboriginal heritage as described in Chapter 20 of the EIS. The majority of the submissions were form submissions, however, similar issues were also raised in a substantial number of unique submissions. The submissions primarily concerned potential impacts to Aboriginal heritage generally while relatively few submissions specifically referred to baseline data and assessment methods or management and monitoring of potential Aboriginal heritage impacts.

Figure 6-33 provides an overview of the submissions relating to Aboriginal heritage.

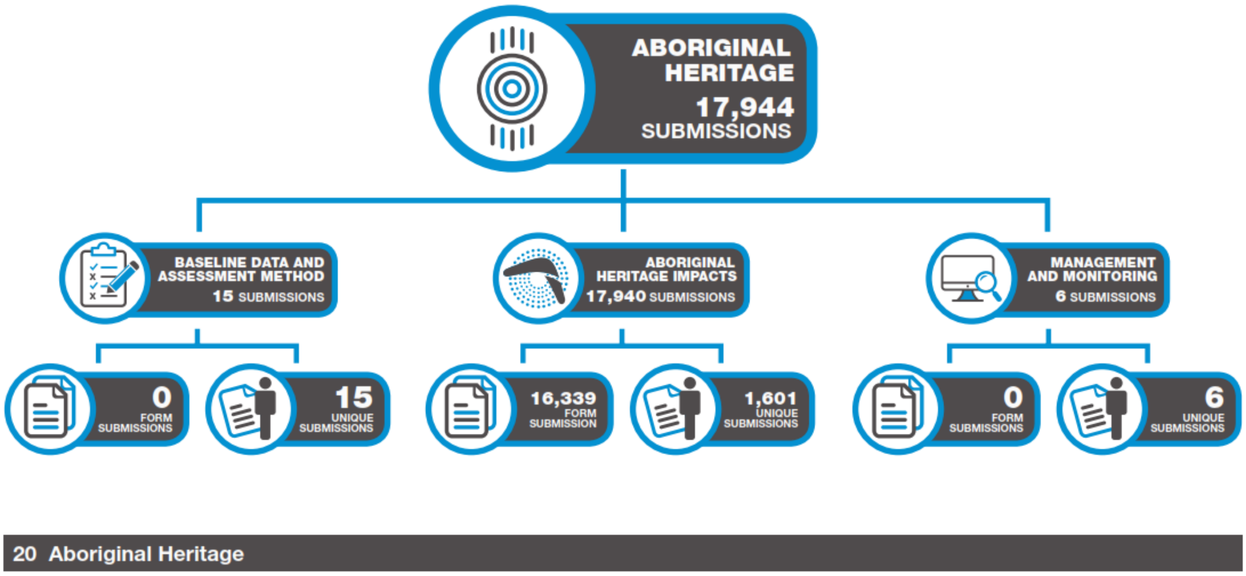


Figure 6-33 Summary of submissions on Aboriginal heritage

6.20.1 Baseline data and assessment method

Compliance with survey guidelines and Code of Practice

Submissions suggested that surveys undertaken with reference to the *Due Diligence Code of Practice* should not be relied upon for the purposes of the Aboriginal Cultural Heritage Assessment Report and would not have been undertaken in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal objects in NSW*.

Submissions stated that all known known impact areas should have been fully and appropriately assessed in accordance with the Code of Practice, and if not, it is a significant deficiency in the Aboriginal Cultural Heritage Assessment Report.

The proponent interprets this to mean opposition to the proposition that there will be no pre-clearance surveys on areas that have already been surveyed in accordance with the *Due Diligence Code of Practice*, or on areas that have already been subject to significant ground disturbance.

It is the proponent's view that reliance can be placed on previous surveys undertaken in accordance with the required standard and that little purpose would be served surveying areas where infrastructure already exists. It is important to note that all Aboriginal cultural sites identified by previous surveys have been avoided, and there has been no impact.

In addition to undertaking surveys for all areas where it has undertaken work to date, the proponent has further adopted the precautionary principle which will guarantee that areas to be subject to disturbance will be subject to pre-clearance surveys in accordance with the Cultural Heritage Management Plan (refer Appendix J to this RTS).

There would be no impact on high significance cultural heritage sites and the impact of the project on Aboriginal cultural values would be minimal to negligible. The proponent notes the NSW Office of Environment and Heritage submission endorsed the approach.

Consultation with Aboriginal parties

A number of submissions were concerned with the recognition, consultation and consideration of issues raised by Registered Aboriginal Parties and the reflection of this in the Aboriginal Cultural Heritage Assessment Report and Cultural Heritage Management Plan in Appendices N1 and N2 of the EIS respectively.

They stated that advertising to invite registration of Registered Aboriginal Parties was inadequate. Others stated that consultation had been limited and conducted in isolation with inadequate involvement of Elders.

Submissions also asserted that there was an absence of original correspondence from Registered Aboriginal Parties including evidence of a detailed consultation database outlining all consultations conducted. Appendix 3 of the Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS was recognised but it was argued it contents could not be verified without further detailed information.

It was asserted that there was a lack of presentation of all issues raised by Registered Aboriginal Parties (particularly Gomeroi Applicants). They stated this lack of information was inadequate in context of the *Aboriginal cultural heritage consultation requirements for proponents* (NSW Government 2010).

Some stated that particular issues raised during consultation regarding the findings of the Aboriginal Cultural Heritage Assessment Report were not referenced or addressed.

Consultation was undertaken in accordance with the Secretary's environmental assessment requirements and *Aboriginal cultural heritage consultation requirements for proponents* (NSW Government 2010). It is noted that the NSW Office of Environment and Heritage confirmed the assessment contained sufficient information to demonstrate compliance with these requirements.

The process captured responses from a very large geographical catchment, as is made clear in the Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS. There are over 550 Registered Aboriginal Parties from a wide geographic area, all of whom were provided with hard copies of the draft Aboriginal Cultural Heritage Assessment Report and draft Cultural Heritage Management Plan, and all of whom were given the opportunity to make a submission. At the request of Registered Aboriginal Parties, there was one consultation meeting in Narrabri regarding the draft Aboriginal Cultural Heritage Assessment Report and draft Cultural Heritage Management Plan. Buses were provided from Gunnedah and Wee Waa. At this consultation meeting there were formal presentations on both draft documents.

If a Registered Aboriginal Party did not attend the consultation meeting, the consultation material including draft Aboriginal Cultural Heritage Assessment Report, draft Cultural Heritage Management Plan and presentation material was mailed to them.

Schedule 3 of the Aboriginal Cultural Heritage Assessment Report summarised the issues that were raised in submissions and the response of the proponent. The assessment included numerous statements from Aboriginal people of the cultural value of places and objects. Feedback was considered in finalising the draft Cultural Heritage Management Plan or draft Aboriginal Cultural Heritage Assessment Report for the EIS. The Government then placed the EIS on public exhibition for 90 days between February and May 2017. The Aboriginal Cultural Heritage Assessment and Cultural Heritage Management Plan as presented in the EIS were discussed with Registered Aboriginal Parties at a meeting on 15 March 2017. This meeting was held in Narrabri and buses were provided for Registered Aboriginal Parties from Wee Waa and Gunnedah.

In parallel to the EIS, the proponent is undertaking confidential Native Title negotiations. The Right to Negotiate process is transacted through negotiations between the proponent, the State and the authorised representatives of the Gomeroi People. Since the completion of the consultation regarding the draft Cultural Heritage Management Plan there have been regular meetings with the Gomeroi People as well as field inspections. The Cultural Heritage Management Plan and its operation, including the selection of Cultural Heritage Officers to undertake pre-clearing surveys, continue to be reviewed and discussed. The position of the proponent has consistently been that the Aboriginal Community (the Cultural Heritage Working Group) should select the Cultural Heritage Officers, consistent with the Cultural Heritage Management Plan.

Engagement with the Aboriginal community was not confined to the specific requirements of the Secretary's environmental assessment requirements. Discussions were held at approximately 10 towns / localities across the Gomeroi Nation, often at the invitation of the local Aboriginal community including Toomelah in the north, Coonabarabran and Gunnedah in the south, and Walgett in the west. At some of these locations discussions were held on three or four occasions. Field tours or field inspections were also offered, including providing transport to Narrabri from various locations.

Individuals and groups were provided with the opportunity to register as a Registered Aboriginal Party throughout, and forms were provided for them to complete. Discussions were held in Walgett on a number of occasions, including the Walgett Local Aboriginal Land Council and a dialogue coordinated with the Dharriwaa Elders Group. The Dharriwaa Elders Group is not a Registered Aboriginal Party.

The proponent respects the individuals and groups that participated in project consultation and decided not to register as Registered Aboriginal Parties.

Opposition from Gomeroi people

Submissions stated the proponent did not have a social licence to operate nor will they get one due to the fact that they have ‘declared literal war on Gomeroi people who oppose the gas industry's atrocious annihilation of land’.

The proponent cannot respond to an assertion of this sort. It notes it has met the Secretary’s environmental assessment requirements, including consultation requirements, and has facilitated the participation of a large number of Registered Aboriginal Parties and others in the program of consultation and is in ongoing negotiations with the Gomeroi Native Title applicants.

Involvement of elders

The Gomeroi Traditional Custodians in their submission stated their elders had requested to be taken to site to undertake identification of cultural values and ethnobotanical mapping but were not afforded the opportunity to participate in this assessment as detailed in the EIS assessment requirements.

The Dharriwaa Elders Group in their submissions stated that they had not been involved in the development of the Cultural Heritage Management Plan.

The proponent had offered for Gomeroi Traditional Custodians to visit the site as discussed in this submission. The Gomeroi Traditional Custodians submission on the draft Aboriginal Cultural Heritage Assessment Report and draft Cultural Heritage Management Plan (part of Registered Aboriginal Party consultation) acknowledged this offer, but went on to say that the traditional custodians were unable to attend.

In addition to the Secretary’s environmental assessment requirements, special measures were taken to provide an opportunity for elders to participate in information sessions and field tours, including examination of elements of the project and to provide input. Elders from the region participated in field tours and information sessions.

The proponent held discussions with the Dharriwaa Elders Group at their invitation in Walgett. At this meeting a register was circulated inviting anyone interested to register as a Registered Aboriginal Party. The Dharriwaa Elders Group did not register as a Registered Aboriginal Party.

Narrabri Local Aboriginal Land Council

The Narrabri Local Aboriginal Land Council submitted that they were generally very supportive of consultation and reporting process undertaken for the project to date. They stated the assessment was considered to be robust and have practical mitigation and management measures. They also noted that they supported the approach taken to the assessment in giving them the opportunity to negotiate better outcomes for protection of our Aboriginal cultural heritage values.

The position of the Narrabri Local Aboriginal Land Council in relation to the Aboriginal Cultural Heritage Assessment Report and support of the principles and strategies the proponent has committed to implement is acknowledged. It is noted that the submissions from the Narrabri Local Aboriginal Land Council with the submissions from NSW Office of Environment and Heritage are in agreement in this regard.

Aboriginal heritage predictive model

Submissions stated that the predictive modelling and cultural sensitivity mapping and associated mitigation and management measures were flawed. They stated that the available data was inadequate to establish a predictive model. They stated that the zoning system presented in the assessment did not adequately reflect Aboriginal occupation, environmental values, and distribution of Aboriginal heritage evidence in the project area. They concluded that the proposed management was inadequate.

The data limitations were fully recognised and the proponent has expressly decided not to attempt to use it as a predictive model of which there is no positive mention in the Aboriginal Cultural Heritage Assessment Report. Instead, the proponent will apply the precautionary and avoidance principles to the management of Aboriginal cultural heritage. In no instance does the precautionary principle rely on application of a predictive model. All locations, of whatever current category, will be subject of pre-clearance survey in accordance with the Cultural Heritage Management Plan.

Other aspects of the precautionary principle will likewise be applied with no reference to the modelling. The Aboriginal Cultural Heritage Assessment Report makes clear that it is anticipated that the results of all elements of the precautionary approach will see the sensitivity model periodically revised over the life of the project

The proponent notes that NSW Office of Environment and Heritage considers that the modelling provided is satisfactory and uses the appropriate data sets. The data set used is the full data set available; as specified in the Secretary’s environmental assessment requirements. Significant efforts were made to address, and if possible, improve the limitations of the data. The limitations of the data were formally and expressly recorded in the Aboriginal Cultural Heritage Assessment Report, as noted in certain submissions.

The proponent is of the view that the list of possible sites that could be encountered is thorough, and includes several site types that have not been recorded within the study area but which it is possible could be encountered. The proponent notes that there is no suggestion in the submissions that there are additional site types that could be encountered. The strategy of avoidance to be adopted therefore seems appropriate. The proponent was aware that additional information about particular existing site types might exist and for this reason at various times it requested during the consultation process that Registered Aboriginal Parties provide information on such places. The opportunity was not taken by Registered Aboriginal Parties but the Additional Research Program is expressly intended to address this issue.

All areas that will be subject to disturbance will be subject to pre-clearance surveys in accordance with the Cultural Heritage Management Plan. The proposed approach to avoiding and minimising impact on Aboriginal cultural heritage, including a process involving representatives of the local Aboriginal community in systematic pre-clearance surveys, has already been tested and found to be effective. The NSW Office of Environment and Heritage has advised that the approaches to be adopted must comply with its standards. Other measures, such as the Additional Research Program, have also been proposed to improve data quality for the future. The commitment has been made to avoid currently known sites. Further, this same guarantee has been made for the vast majority of site types that have been identified in the study area as these are identified either during the Additional Research Program or as further surveys are undertaken. These measures are designed expressly to address the limitations of the existing data and to avoid dependence on a predictive model.

Testing of predictive model

Submissions asserted that a methodology to test the predictive model and relevant research questions were inadequately discussed in the Aboriginal Cultural Heritage Assessment Report.

As there is no intention to use a predictive model (and see general comment on this issue above), it is therefore not necessary to provide such a methodology. The proponent will apply the precautionary and avoidance principles to the management of Aboriginal cultural heritage. In no instance does the precautionary principle rely on application of a predictive model. All locations, of whatever current category, will be subject of pre-clearance survey in accordance with the Cultural Heritage Management Plan. The Aboriginal Cultural Heritage Assessment Report makes clear that it is anticipated that the results of all elements of the precautionary approach will see the sensitivity model periodically revised over the life of the project.

Qualifications of practitioners

Submissions stated that the practitioners involved in the production of the Aboriginal Cultural Heritage Assessment Report and their qualifications and experience were not stated consistent with the *Code of Practice*. The submissions requested that this information be provided.

The practitioners involved in the production of the Aboriginal Cultural Heritage Assessment Report held suitable qualifications and have successfully undertaken Aboriginal cultural heritage assessments for numerous projects in NSW and elsewhere. Details of their qualifications are provided below.

Qualifications

Dr Luke Godwin

- BA (UNE), 1979 – majors in Archaeology and Ancient History
- BA Hons (UNE), 1980 – Archaeology
- PhD (UNE), 1991 – Archaeology
- Associate Professor (Adjunct) School of Archaeology, Anthropology and Sociology – James Cook University
- Associate Professor (Adjunct) Discipline of Archaeology and Palaeoanthropology at the University of New England
- Active in archaeological and anthropological research, and Cultural Heritage Management (CHM) since 1981
- Has taught Archaeology and CHM at UNE, UQ and JCU since 1983
- Undertaken archaeological research in Queensland and NSW
- Undertaken cultural heritage management – archaeology and anthropology – in NSW, Qld, NT and SA
- Regional Manager (DEH), Cultural Heritage – Central Queensland – 1990-1996 - responsibilities for both Indigenous and historical heritage;

- Envisioned, managed and drafted material for stages 1 and 2 of the Bowen Basin Aboriginal Cultural Heritage Project. The project was supported of industry, government and 14 separate Aboriginal stakeholders. The Bowen Basin covers 82,500 km^2, is the largest coal-producing area in Australia and has outstanding Aboriginal cultural values. This project trialled approaches in CHM such as CHMPs and the use of GIS in site management, among other things, that have since become standard elements in CHM both in legislation and common practice
- Three-time recipient of Leila Haglund Award for excellence in CHM – 2001, 2002 and 2007
- Recipient of the Australian Archaeological Association Bruce Veitch Award for Excellence in Indigenous Engagement - 2009
- Regularly publishes in peer-reviewed journals on technical and policy issues in cultural heritage management, archaeology and Aboriginal history.

Scott L'Oste-Brown

- BA (UNE), 1991 – major in Archaeology
- Fellow - School of Archaeology, Anthropology and Sociology – James Cook University
- Active in archaeological research and Cultural Heritage Management since 1992
- Undertaken archaeological research in Western Australia, Queensland and NSW
- Undertaken cultural heritage management – archaeology and anthropology – in NSW, Qld, NT and SA
- Regional Manager (Acting) (DEH), Cultural Heritage – Central Queensland – 1997-1999 - responsibilities for both Indigenous and historical heritage
- Drafted material and built GIS for stages 1 and 2 of the Bowen Basin Aboriginal Cultural Heritage Project which had the support of industry, government and Aboriginal stakeholders
- Recipient of Leila Haglund Award for excellence in cultural heritage management – 2001 and 2002
- Regularly publishes in peer-reviewed journals on technical and policy issues in cultural heritage management, archaeology and Aboriginal history.

Andrew Border

- BA (UNE), 1985 – major in Archaeology
- BA Hons (UNE), 1986 – Archaeology
- Active in archaeological research and cultural heritage management since 1992
- Undertaken archaeological research in Queensland and NSW since 1987
- Prior to moving into consultancy work in 2006, he was the Regional Manager (Cultural Heritage), Northern Region in the Environmental Protection Agency for 10 years. He had responsibilities for both Indigenous and historical heritage in northern Queensland, including the Mt Isa minerals province
- Andrew was a co-researcher with the University of Sydney on the Riversleigh cultural heritage project. This study, involving close co-operation with the Waanyi People, involved the examination of this region's Aboriginal cultural heritage, and included the excavation (with Waanyi support and involvement) of a series of sites, some dating back to the Pleistocene
- Has been active in CHM as a consultant since 2006.

Experience

Central Queensland Cultural Heritage Management (CQCHM) has been established for 20 years. In that time it has completed commissions across Australia. They have expertise in Aboriginal cultural heritage, specialising in large mining and infrastructure projects. They design, negotiate and implement custom solutions for both exploration and development. They have a detailed understanding of Native Title issues and deep experience in the negotiation of native title agreements.

Major commissions include:

- Rio Tinto Coal Australia – Principal Consulting Adviser CHM (10 coal mines in Qld and NSW and associated infrastructure projects) and has done so for the last 13 years.
- Arrow Energy's Surat and Bowen Pipelines - project management CHM (550 km and 600 km respectively) 2009-2013.
- Queensland Water Infrastructure – Principal Consulting Adviser CHM (Traveston Crossing and Wyaralong Dams – and, prior to these, Paradise Dam near Bundaberg).
- APC Kutubu (PNG) to Gladstone (Australia) Gas Pipeline – Principal Consulting Adviser CHM.
- Epic Energy South West Queensland Pipeline Looping Project (950 km) - Principal consulting adviser CHM.
- Enertrade on Central and Northern Queensland Gas Pipeline Projects (each approx. 450 km) – Principal Consulting Adviser CHM.
- Analysis of Aboriginal cultural values of Great Artesian Basin springs in Queensland – Department of Natural Resources (Qld).

Other project commissions have included:

- North Parkes Gold Mine expansion project
- Curragh Coal Mine
- Anglo Dawson and Callide Mines
- APLNG Project (Origin and Conoco JV) – Gaangalu section
- GLNG (Santos) Fairview to Gladstone Project – Gaangalu section
- QGC Surat to Gladstone Project – Gaangalu section
- Cultural values of Ramsar-listed wetlands within the Darumbal native title claim area.

Nomination of stream order

Submissions stated that the nomination of stream orders in the Aboriginal Cultural Heritage Assessment Report was not in accordance with conventional approaches.

The rationale for this approach was fully explained in the Aboriginal Cultural Heritage Assessment Report. Strahler based stream ordering would have vastly reduced the relevant Aboriginal cultural heritage data set available for use in sensitivity modelling, thereby even further reducing its value.

Site verification

Submissions stated the rationale for the verification of 45 of 90 Aboriginal heritage sites was not clear, especially given this data was relied upon for development of a predictive model.

As recognised in the submissions, 50 per cent of known sites have been subject to field verification. This is a very healthy sample and the results demonstrate the value of continuing this approach to improve data quality. The proponent has committed to complete the verification program for the remaining 45 sites within 12 months of project sanction.

There is no intention to use a predictive model (see general comment on this issue above), therefore it is not necessary to provide such a methodology. The proponent will apply the precautionary and avoidance principles to the management of Aboriginal cultural heritage. In no instance does the precautionary principle rely on application of a predictive model.

Sub-surface material

Submissions stated that the possibility of sub-surface cultural material was not adequately considered in the Aboriginal Cultural Heritage Assessment Report.

The proponent notes that programs implemented under the Cultural Heritage Management Plan will conform to the relevant code. It will also be informed by the proponent developing a rationale for this based on the opinion of a technical expert appointed in accordance with the Cultural Heritage Management Plan.

Leewood and Bibblewindi

Submissions stated that survey assessments provided in the Aboriginal Cultural Heritage Assessment Report for Leewood, Bibblewindi and the Bibblewindi to Leewood infrastructure corridor did not provide information required under the *Code of Practice* and therefore were not adequate.

Leewood, Bibblewindi and the Bibblewindi to Leewood infrastructure corridor were the subject of reports submitted to the NSW Government and accepted as satisfactory. Representatives of the Narrabri Local Aboriginal Land Council and Gomeroi Applicant were involved in the assessment. These reports are publicly available on a Departmental web page.

Extent of field surveys

Submissions stated that repeated statements with respect avoidance of currently known sites and the small percentage these as a proportion of the project area were somewhat misleading given minimal systematic survey or test excavation and low numbers of known sites.

The Aboriginal Cultural Heritage Assessment Report clearly states the data used and its limitations. The very fact that that the submission can use those data to observe the low numbers of sites known across the project area clearly indicates that they are not misleading. Rather, they are an honest appraisal of the current situation. Based on this appraisal, the proponent has decided not to apply a predictive model but rather to implement an approach that relies on precaution and avoidance.

Cultural values of Aboriginal people

Submissions stated that while the Aboriginal Cultural Heritage Assessment Report was “relatively thorough in addressing the guidelines and requirements relating to archaeological assessment” it was also “not at all thorough or adequate when considering cultural values of Aboriginal people and the required integration of these findings to inform the assessment and its recommendations”. They asserted the assessment did not meet the EIS requirements in that regard.

During the consultation process all Registered Aboriginal Parties were expressly provided the opportunity to provide information regarding Aboriginal cultural values. The Aboriginal Cultural Heritage Assessment Report made clear that the data sets available were of limited quality. Consequently, the proponent committed to undertake an Additional Research Program to address this issue.

This, combined with commitments to avoidance, will ensure that the vast majority of site categories are protected in perpetuity. Further, the NSW Office of Environment and Heritage has indicated that the Aboriginal Cultural Heritage Assessment Report met the Secretary’s environmental assessment requirements.

Ethnobotanical mapping

The submission from the Gomeroi Traditional Custodians stated that the Aboriginal Cultural Heritage Assessment Report did not include mapping of watercourses and ethnobotanical values.

All watercourses in the project area were mapped and presented in the EIS.

The information compiled for the EIS provides new high quality ecological data that can be used by the Aboriginal community, and because the project occupies such a small proportion of the project area, ecological values including those with ethnobotanical values will not be impacted in approximately 99 per cent of the project area.

The Ecological Impact Assessment (EIS Appendix J1) undertaken for the EIS included over 13,000 hours of field survey effort. This has provided baseline data, including vegetation mapping, which was not previously available. Additionally, the project infrastructure occupies around one per cent of the project area, and none of the ecological impacts have been assessed as significant.

The submitter is referred to the Additional Research Program where this issue can be addressed in detail.

Place and passages

The submission from Gomeroi Traditional Custodians stated the Aboriginal Cultural Heritage Assessment Report did not adequately consider “place and the passages and walkways between places and objects”.

During the consultation process all Registered Aboriginal Parties were expressly provided the opportunity to provide information regarding Aboriginal cultural values. The Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS and related consultation were undertaken in accordance with the Secretary’s environmental assessment requirements. The Aboriginal Cultural Heritage Assessment Report documented the stages of consultation undertaken in accordance with the *Aboriginal cultural heritage consultation requirements for proponents* (NSW Government 2010).

Only the information provided by Registered Aboriginal Parties could be considered prior to submitting the Aboriginal Cultural Heritage Assessment Report. Despite the consultation process expressly providing all Registered Aboriginal Parties with the opportunity to provide information regarding

Aboriginal cultural values, the Aboriginal Cultural Heritage Assessment Report made clear that the data sets available were of limited quality. Consequently, the proponent committed to undertake an Additional Research Program to address this issue.

Connection to country

Submissions stated that the definition of cultural significance applied in the Aboriginal Cultural Heritage Assessment Report failed to consider the highly spiritual nature of connection to country.

The Aboriginal Cultural Heritage Assessment Report adopted a very broad definition of cultural significance. The assessment specifically addressed the issue of spiritual associations with the project area and has proposed mechanisms such as the avoidance principle and Additional Research Program to further address precisely this issue.

Significance of sky

Submissions stated that the Aboriginal Cultural Heritage Assessment Report had overlooked the significance of the sky (both day and night time) as an integral part of culture to Gomeroi people.

In almost all of the project area the effect of the project on the sky during routine operations, day and night, will be negligible.

The main sources of light from the project would be safety flares at Leewood and Bibblewindi and up to six small pilot flares operating during well appraisal, if required.

In response to concerns raised in submissions regarding the potential for the project to impact on the operations of the Siding Spring Observatory, an assessment of the potential for light impacts from the use of the pilot and safety flares was commissioned. In summary, the assessment found that the light generated during routine and non-routine flaring scenarios would result in limited vertical light impacts and would not make a contribution to skyglow conditions at the reference location.

The light emissions from the existing pilot well flares were also assessed. Measurements were taken near each of the flares (30 metres from flare base), then at 250 metre intervals up to one kilometre and every kilometre thereafter. The light decreased rapidly within 250 metres from the source and reached ambient light conditions within one kilometre from the source.

The Gas Flare Light Assessment is contained at Appendix K to this RTS.

Spiritual aspects of culture

Submissions stated that by limiting consideration of damage or destruction to only the 'physical' the Aboriginal Cultural Heritage Assessment Report is insulting and ignores spiritual aspects of culture and the significance of the project area. Submissions also stated that missing in this is consideration of spiritual and religious significance - the 'spirit of place'.

During the consultation process all Registered Aboriginal Parties were expressly provided the opportunity to provide information regarding Aboriginal cultural values and sites. The Aboriginal

Cultural Heritage Assessment Report adopted a very broad definition of cultural heritage which has also incorporated into the proposed Additional Research Program. Application of the avoidance principle includes places of the sort contemplated as beyond the physical.

Prior social impact

Submissions stated that evidence of prior social impact had been ignored and that there was a failure to identify social impacts specific to the Gomeroi People within the scope of the Aboriginal Cultural Heritage Assessment. Submissions raised various issues including 'if country gets sick, we get sick'.

The proponent observes that these issues have not been formally ventilated in the public sphere to the present. The consultation process expressly providing all Registered Aboriginal Parties with the opportunity to provide relevant information. If not already documented and reported, only the information provided by Registered Aboriginal Parties could be considered prior to submitting the Aboriginal Cultural Heritage Assessment Report. The Aboriginal Cultural Heritage Assessment Report made clear that the existing data sets available were of limited quality.

However, the issues raised can be explored further in the Additional Research Program while taking into consideration that the project will occupy around one per cent of the 95,000 ha project area, as well as the current levels of land development and modification. For example, there are currently over 5,000 km of mapped roads, tracks and trails in the Pilliga.

Community division

Submissions stated the proponent was invited by Dharriwaa Elders Group to present its project plans to the community and this occurred in June 2015. The proponent created damaging community division as part of this by paying Gomeroi Applicants from outside the Walgett area to make representations in favour of the project.

The proponent attended a meeting in Walgett coordinated with the Dharriwaa Elders Group and presumes that reference is made to this meeting. No payments were made by the proponent for Gomeroi Applicants to attend the meeting.

Referencing of sources

Submissions stated that referencing in the Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS including Section 4.3, and notably, Table 4.4 on previous archaeological research was inadequate.

The proponent notes that all reports referred to in Section 4.3 and Table 4.4 of the Aboriginal Cultural Heritage Assessment Report were fully referenced where a suitable reference is available.

6.20.2 Aboriginal heritage impacts

Impacts on water

Submissions stated that impacts upon water (including groundwater) and Aboriginal spiritual and cultural traditions (including women's business) associated with water had not been considered.

The consultation process complied with the Government's policy and therefore the Secretary's environmental assessment requirements, and the NSW Office of Environment and Heritage submission has formally stated this.

During the consultation process Registered Aboriginal Parties were expressly provided the opportunity to provide information regarding Aboriginal cultural values and sites. If not already documented and reported, only the information provided by Registered Aboriginal Parties could be considered prior to submitting the Aboriginal Cultural Heritage Assessment Report. The Aboriginal Cultural Heritage Assessment Report made clear that the existing data sets available were of limited quality.

The issue of what impact the project will have on water is addressed in detail in the EIS. The impacts on water resources overall are not assessed as significant, and while the target coal seams are deep with elevated salinity, the effects on the high quality shallow groundwater and surface water in the context of the currently licensed extraction from these water sources, including the Great Artesian Basin, will be negligible. Submitters are also referred to the Additional Research Program where this issue can be addressed in detail.

Great Artesian Basin

Submissions stated the Great Artesian Basin was a sacred site, and in one submission described as 'our most sacred of sites', and building in this area would disturb the ancient water and makes the development an uncertain potential risk to the water supply of the Gomeroi peoples. They stated they were unwilling to accept impacts to the water.

The effect of the project on the Great Artesian Basin (an induced flux rather than a direct extraction to surface) will effectively be negligible in comparison to the current extraction of water particularly when free flowing bores are considered.

According to Government records there are approximately 1,400 registered bores in NSW that currently extract water directly from the Great Artesian Basin in NSW. The Government has also reported over 200 of the current bores are free flowing to the surface.

The project will extract water from the coal seams deep beneath the Great Artesian Basin. Water extracted from the coal seams as part of the project will only be permitted if there is a water access license in place, and in accordance with the same rules that apply to other activities that extract water from a regulated water source in NSW.

Direct impacts

Submissions stated that the project would occupy around 950 hectares and cause direct and irreversible impacts to Aboriginal cultural heritage (including objects as well as intangible cultural values, and those associated with landscape features, flora and fauna).

The Aboriginal Cultural Heritage Assessment Report also notes that due to the measures designed to give effect to the precautionary and avoidance principles such as pre-clearance surveys in accordance with the Cultural Heritage Management Plan using enhanced survey techniques, the Additional Research Program as well as offsets, the impact on Aboriginal cultural heritage will be minimal, and the Aboriginal community will secure protection of sites now not protected and access to land that was otherwise unavailable to them.

Noting the commitment to the precautionary and avoidance principles the proponent challenges this assertion. The absence of detailed information in submissions hinders further consideration of the assertion. The Aboriginal Cultural Heritage Assessment Report details that the project would completely avoid highly significant sites and all 90 known sites within the project area.

The Aboriginal Cultural Heritage Assessment Report found that there would be a potential impact on four categories of sites - isolated stone artefacts, non-complex stone artefact scatters, non-complex shell middens and hearths or ovens identified during construction. However, impacts would be minimised by application of the avoidance principle to these four categories of sites. The impact of the project on Aboriginal cultural values would be minimal to negligible. The 950 hectares represents approximately one per cent of the project area, or put another way 99 per cent of the 95,000 hectare project area will not be directly impacted by project infrastructure. The one per cent will be subject to a program of progressive rehabilitation.

Cumulative impact

Submissions stated that cumulative impacts and intergenerational equity considerations were not considered in the Aboriginal Cultural Heritage Assessment Report. Some stated the cumulative impact on a highly culturally and spiritually significant geographical area from the project would come at the expense of the Gomeroi people.

The assessment has concluded that by application of the avoidance principle there would be no impact on cultural heritage sites that have been assessed of high significance. The proponent has committed not only to the precautionary and avoidance principles, but also an Additional Research Program and offset program. The proponent further notes that in the absence of details, the nature of cumulative impact of the sort asserted has not been and cannot be quantified.

In order to deliver these outcomes the Cultural Heritage Management Plan is not dependent on sensitivity mapping. Rather, as recommended in the Aboriginal Cultural Heritage Assessment Report, it relies on the principles of precaution and avoidance, and associated programs to give these effect.

As discussed in the Aboriginal Cultural Heritage Assessment Report in Appendix N1 of the EIS, by application of the avoidance principle there would be no impact on sites that have been assessed of high significance and the impact of the project on Aboriginal cultural values would be minimal to negligible. Therefore, the project will have minimal cumulative impacts, if at all. The assessment also concluded that in relation to Aboriginal cultural values the impact of the project would either be non-existent for some, minimal for others, and operate in the short to medium term to the extent that there is an impact for others.

The issue of intergenerational equity is expressly addressed through the use of offsets which guarantee, in perpetuity, access to and management of areas to which Aboriginal people currently have limited, or no, access. In addition intergenerational equity is addressed by the project being required to settle a Native Title agreement including compensation, and by the incremental development of the project where the precautionary and avoidance principles would be applied throughout.

Sacred and cultural places and objects

The submission from the Gomeroi Traditional Custodians stated that the project would result in “highly adverse culturally irreversible damage and destruction of sacred and cultural places and objects”.

The Aboriginal Cultural Heritage Assessment Report details that the project would completely avoid highly significant sites and all 90 known sites within the project area. The assessment found that there would be a potential impact on four categories of sites — isolated stone artefacts, non-complex stone artefact scatters, non-complex shell middens and hearths or ovens identified during construction. The impact of the project on Aboriginal cultural values would be minimal to negligible. However, as the consequence of impacting Aboriginal heritage sites would be minor to moderate (depending on the site type), the results would present a low to medium residual risk to Aboriginal cultural heritage.

The proposed approach to avoiding and minimising impact on Aboriginal cultural heritage, including a process involving representatives of the local Aboriginal community in systematic pre-clearance surveys, has already been tested and found to be effective. The proponent further notes commitment to the precautionary and avoidance principles, the principle and application of offsets, and a range of other management measures designed to improve quality and range of data. Finally, the proponent notes the absence of specific detail to support this contention.

Habits and vegetation

The submission from the Dharriwaa Elders Group stated that the project would threaten culturally significant habitats and native vegetation.

The project occupies such a small proportion of the project area, ecological values including those with ethnobotanical values will not be impacted across approximately 99 per cent of the project area. Aboriginal community access to land in the project area will be unaffected by the project over approximately 99 per cent of the 95,000 hectare project area.

The submitter is referred to the Additional Research Program where this issue can be addressed in detail. The information compiled for the EIS provides new high quality ecological data that can be used by the Aboriginal community. The Ecological Impact Assessment undertaken for the EIS (Appendix J1) included over 13,000 hours of field survey effort. This has provided baseline data, including vegetation mapping that was not previously available. Additionally, the project occupies around one per cent of the project area, and none of the ecological impacts have been assessed as significant.

Aboriginal cultural heritage values, such as important sites and places of traditional or recent significance, will be considered in the selection of offset sites. A number of properties have been nominated by the Aboriginal community and these are being actively considered by the proponent. It is proposed that some offset sites will be selected in consultation with the Aboriginal community, management arrangements will be negotiated with the Aboriginal community (including conserving cultural values and facilitating cultural activities) and this land managed in perpetuity by the Aboriginal community.

Hunting and other contemporary uses

Submissions stated that the project area included hunting and training ground for Aboriginal men and that continued use of its natural resource was vital to the survival of culture.

Submissions also stated that the assessment did not describe contemporary connections of Aboriginal people and the project including return to country, management of land and access to land for cultural purposes.

Aboriginal community access to land in the project area will be largely unaffected over approximately 99 per cent of the 95,000 hectares.

The project will occupy around one per cent of the project area, and none of the ecological impacts have been assessed as significant. The information compiled for the EIS provides new high quality ecological data that can be utilised by the Aboriginal community, and because the project occupies a small proportion of the project area ecology, including ecology with ethnobotanical values, will not be impacted across approximately 99 per cent of the project area.

The proponent notes that during project consultation the Aboriginal community frequently discussed their limited ability to gain entry to privately managed land including certain types of crown land that had previously been used to access riparian areas. The proponent also notes that offset areas will be secured that can be used precisely for the purposes mentioned.

Bohena Creek

Submissions stated that there had been past and continued impacts on Bohena Creek despite requests to avoid this precious and sacred water source. Submissions referred to Bohena Creek as part of a dreaming and songline network. Submissions also stated many industries downstream of Bohena Creek where the proponent will be permitted to release its toxic waste would be affected.

The existing condition of much of Bohena Creek has been assessed as poor or low, including significant sedimentation. The impacts of the project on the geomorphology, ecology, surface water quality and quantity, ground water quality and quantity, and flow patterns of Bohena Creek have been assessed in the EIS as negligible to very low.

For project implementation, Bohena Creek is buffered from top of bank and only linear infrastructure and the managed release diffuser will intersect with the creek and buffer. The information provided regarding the values of Bohena Creek is appreciated and respected. The Additional Research Program can assess the cultural values of Bohena Creek in further detail.

6.20.3 Management and monitoring

Offsetting

Submissions stated there was an unwillingness to leave “cultural survival in the hands of those who would suggest the possibility of ‘offsetting’ spiritual and religious significance”.

Aboriginal owned land and Aboriginal cultural heritage will be considered in the selection of biodiversity offset sites. It is also envisaged that Aboriginal people may manage and possibly own some of the offset sites. Offset lands are protected in perpetuity by a covenant attached to the title of the land.

This is an opportunity for land and sites significant to the Aboriginal community to be secured, and managed by Aboriginal people. These commitments are in addition to the commitments to the precautionary and avoidance principles that would be applied in the project area.

Compensation

Submissions stated that no compensation or benefits accruing to the Aboriginal communities for their loss had been offered in association with the project.

The proponent is currently negotiating with the Gomeroi Applicants as is required as part of the right to negotiate process under the Commonwealth *Native Title Act* 1993. The negotiations remain commercial in confidence at this stage.

Subsurface testing

Submissions stated that sub-surface potentiality issues had not been addressed in the Aboriginal Cultural Heritage Assessment Report either in respect the known or future planned impact areas. The submission questioned who defines, and by what methodological process and criteria, if there is sub-surface material that may be *in situ* in the absence of procedures or methodologies specified for sub-surface testing.

The proponent notes that programs will conform to the relevant code. It will also be informed the proponent developing a rationale for this based on the opinion of a technical expert.

Pre-clearance survey qualifications

Submissions stated the Aboriginal Cultural Heritage Assessment Report did not identify a role for an appropriately qualified and experienced archaeologist in the proposed heritage surveys.

The majority view of the Aboriginal community expressed during consultation is that they are experts in their heritage and that they, through the Aboriginal Cultural Heritage Working Group, should select the appropriate Cultural Heritage Officers to walk country and the appropriate technical expert as required for implementation of the Cultural Heritage Management Plan.

Under the terms of the Cultural Heritage Management Plan, a technical expert is a suitable qualified archaeologist or a person appointed by the Aboriginal Cultural Heritage Working Group.

Pre-clearance survey methodology

Submissions stated that processes discussed in Section 4.8(b) of the Cultural Heritage Management Plan were unacceptable in terms of the methodology for a heritage survey. It stated these details should be determined by a qualified and experienced archaeologist in consultation with Registered Aboriginal Parties and with consideration of the *Code of Practice*, and should form a Schedule to the Cultural Heritage Management Plan.

Submissions also stated that the proponent was not independent of the project and therefore was not suitable to resolve the methodology of the pre-clearance survey. Submissions also raised concern with the proposed dispute resolution process and the role of the proponent as an arbiter of that process. They stated that if the pre-clearance survey methodology was settled in advance of the approval of the Cultural Heritage Management Plan there would be no need for an internal dispute resolution process.

The survey requirements for different elements of the project will vary depending on the nature of the infrastructure required and the location in which this will take place. Noting that the project has an inherent flexibility designed to give effect to avoidance and the fact that location of infrastructure has not been finalised, it is sensible to leave settlement of the methodology until these questions have been settled.

The proponent believes that Aboriginal people should be responsible for the management of Aboriginal cultural heritage. The majority view of the Aboriginal community expressed during consultation is that they are experts in their heritage and that they, through the Aboriginal Cultural Heritage Working Group, should select the appropriate Cultural Heritage Officers to walk country and the appropriate technical expert as required for implementation of the Cultural Heritage Management Plan. Under the terms of the Cultural Heritage Management Plan, a technical expert is a suitable qualified archaeologist or a person appointed by the Aboriginal Cultural Heritage Working Group.

The Cultural Heritage Coordinator and Cultural Heritage Officers responsible for the implementation of the Cultural Heritage Management Plan would be selected by the Aboriginal community as represented in the Aboriginal Cultural Heritage Working Group. The pre-clearance survey methodology would involve the direct participation of the Cultural Heritage Coordinator and, where applicable, the technical expert appointed by the Aboriginal Cultural Heritage Working Group. The Cultural Heritage Coordinator would not be an employee of the proponent.

The proponent's experience for other projects is that sound processes provide for dispute resolution. The dispute resolution provisions of the Cultural Heritage Management Plan ultimately escalate to an expert who will be a suitably qualified archaeologist or anthropologist.

Significant ground disturbance

Submissions stated that definitions of 'significant ground disturbance' where no pre-clearance surveys are required would not be acceptable in the context of the precautionary or avoidance principles, or given lack of investigation and assessment of specific project impacts.

Locations where ground disturbance works are required will be subject pre-clearance surveys in accordance with the Cultural Heritage Management Plan. There is, however, no purpose served in requiring a survey where ground disturbance, in the form of already-constructed infrastructure, has already occurred.

Reliance of sensitivity mapping

Submissions stated that the Cultural Heritage Management Plan was reliant on sensitivity mapping developed for the Aboriginal Cultural Heritage Assessment Report. They stated that the sensitivity mapping could not be relied upon for the mitigation and management of cultural heritage impacts.

The Cultural Heritage Management Plan is not dependent on sensitivity mapping. Rather, as discussed in the Aboriginal Cultural Heritage Assessment Report, it relies on the principles of precaution and avoidance, and associated programs to give these effect.

Additional research program

Submissions stated that further information on the Additional Research Program should have been provided including the objectives, scope, methodology and participation of appropriate heritage experts and stakeholders. It noted that such details were provided in the Aboriginal Cultural Heritage Assessment Report but requested these details be provided in the Cultural Heritage Management Plan.

The proponent notes that the Cultural Heritage Management Plan makes clear the purpose of the Additional Research Program. Specifics of the program will be developed under the Cultural Heritage Management Plan.

New finds procedure

Submissions stated that the new finds procedure described in the Aboriginal Cultural Heritage Assessment Report was not clear. It referred to Section 4.9 and associated definitions and requested clarification with potential interpretations noted as being a significant deficiency. They also stated this section of the Management Plan did not adequately reference Schedules 3 and 4 of the Plan. Submissions also stated that the new finds procedure should include consultation with NSW Office of Environment and Heritage for direction on the management of the new find.

For the sake of clarity and to remove doubt, all new finds will be managed in manner consistent with the procedures specified for that category of site in the Aboriginal Cultural Heritage Assessment Report and Cultural Heritage Management Plan.

The proponent has committed to the application of relevant NSW Office of Environment and Heritage codes and guidelines. NSW Office of Environment and Heritage will be provided annual reports. The regulator would also participate in the five-year review of the Cultural Heritage Management Plan which will be undertaken by a third party auditor. The proponent will, as a matter of course, provide NSW Office of Environment and Heritage with the details of new finds through site registration.

Clarification of definitions

Submissions stated there were inconsistencies in definitions between Sections 4.2 and 4.9 of the Cultural Heritage Management Plan and that two paragraphs relating to the relocation infrastructure in Section 4.2 actually belong in Section 4.9.

> The proponent does not consider there are contradictions or errors in these references.

Management strategies

Submissions stated the level of detail (i.e. absent or very limited) about the process and methodology of the management strategies outlined in the third column of Schedule 4 is inadequate.

> The proponent notes that this is not a view shared by NSW Office of Environment and Heritage. Further, the details will be decided on a case by case basis, informed by opinion of technical expert where appropriate and consistent with the principles enunciated in the Aboriginal Cultural Heritage Assessment Report and Cultural Heritage Management Plan for that category of site.

Definition of artefacts

Submissions stated that the Cultural Heritage Management Plan did not adequately define a complex stone artefact concentration or shell midden as opposed to a regular concentration. They stated this required attention for management purposes.

> The boundaries of stone artefact scatters will be addressed on a case by case basis as circumstances require, and informed by results of sub-surface testing implemented at these locations. This has been explicitly addressed by the proponent in relation to engagement of a technical expert in accordance with the Cultural Heritage Management Plan.

Relocation of artefacts

Submissions stated that the Cultural Heritage Management Plan lacked procedures or methodology for the relocation of stone artefacts including who would undertake the relocation, where it would be relocated and what reporting would occur.

> As is appropriate, the specifics of this issue will be settled by the Aboriginal Cultural Heritage Working Group as part of process of management which will in turn be specified in the relevant report in accordance with the Cultural Heritage Management Plan.

Subsurface testing methods

Submissions stated that the Cultural Heritage Management Plan lacked detail and methods with respect sub-surface testing, including consideration of further management strategies that may be required on basis of results of this testing (e.g. salvage excavations).

Consistent with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (NSW Government 2010a) implementation of the Cultural Heritage Management Plan would include test excavation in areas associated with water features. The program rationale would follow the opinion of a suitable qualified technical expert appointed in accordance with the Cultural Heritage Management Plan. Details of the program are provided in Appendix J to this RTS.

The specifics of salvage, if required, would be discussed with NSW Office of Environment and Heritage.

Annual reports

Submissions noted that annual reports and all other heritage reports prepared under the Cultural Heritage Management Plan (including consultation about proposed material changes to the plan) must be provided to NSW Office of Environment and Heritage and Registered Aboriginal Parties.

Annual reports will be provided to NSW Office of Environment and Heritage in accordance with the terms of the Cultural Heritage Management Plan. The five-year review process will be undertaken by a third party auditor, and to notify the broader community, a review notice will be placed in a local paper in accordance with the terms of the Cultural Heritage Management Plan.

Representatives of the Narrabri and Wee Waa Local Aboriginal Land Councils and Gomeroi Applicant are the proposed members of the Aboriginal Cultural Heritage Working Group. The working group will be kept informed of all matters that relate to the implementation of the Cultural Heritage Management Plan, including the five-year review in which they will participate. The Aboriginal Cultural Heritage Working Group will also expressly be provided with a copy of the Annual report.

Confidentiality provisions

Submissions stated the confidentiality provisions in Section 6 of the Cultural Heritage Management Plan would be onerous and highly restrictive and are not consistent with acceptable heritage management practices or principles of recognition and respect for Aboriginal people.

The proponent observes that no Registered Aboriginal Party previously has raised this as an issue. The Aboriginal community has consistently raised that the proponent must have appropriate and effective arrangements in place to protect cultural information. All data will be subject to the confidentiality provisions of the Cultural Heritage Management Plan.

Aboriginal Cultural Heritage Working Group

The submission from the Gomeroi Traditional Custodians stated that that the small size of the Aboriginal Cultural Heritage Working Group is indicative of a desire by the proponent to avoid continued consultation and participation of people with an interest in the area, and to marginalise the voices of elders.

Other submissions stated that the working group was divisive and flawed. They stated it should not be financed directly by the proponent nor bound by confidentiality to the proponent.

Other submissions stated that the resourcing of the Aboriginal Cultural Heritage Working Group to perform its duties and support for activities is not outlined anywhere.

The Cultural Heritage Management Plan provides for the Aboriginal Cultural Heritage Working Group to represent the views and interests of the Aboriginal community, nominate Cultural Heritage Officers that will undertake the pre-clearance surveys, and appoint the Cultural Heritage Coordinator. The concept of the working group, and its role, was supported by the Aboriginal organisations that are proposed to be members. The proponent is committed to providing all appropriate resources (including financial) necessary for the working group to undertake their responsibilities in accordance with the Plan.

The Community Consultative Committee for the project will continue to meet after the planning assessment has been completed and throughout the operation of the project. The Committee’s agenda and minutes are made available to all of the community. The Narrabri Local Aboriginal Land Council, representing many members including elders, is a member of the Committee. In addition, it is proposed that membership of the Aboriginal Cultural Heritage Working Group includes nominees from the Wee Waa and Narrabri Local Aboriginal Land Councils and Gomeroi Applicant. The function of the Aboriginal Cultural Heritage Working Group is central to the implementation of the Cultural Heritage Management Plan throughout the life of the project.

The Aboriginal Cultural Heritage Working Group will be provided all correspondence received by the proponent regarding the Cultural Heritage Management Plan. The possible membership of the Aboriginal Cultural Heritage Working Group has many permutations, including a multitude of groups and individuals that are neither affiliated with a Local Aboriginal Land Council nor Gomeroi Applicant. The proponent has sought a balance, where both Local Aboriginal Land Councils and the Native Title group represent many people and their operations are underpinned by established governance with a legislative basis. It is important to note that many members of the community are affiliated with the relevant Local Aboriginal Land Councils as well as being Gomeroi. The Gomeroi Applicant have also been clear that they represent the broader Gomeroi Nation’s interest in the project, which extends well beyond the boundary of the Local Aboriginal Land Councils.

Sensitivity mapping

The submission from the Gomeroi Traditional Custodians asserted they harbour grave concerns that the cultural sensitivity mapping and development of protocols to investigate and manage project impact areas appears to be 'a table in the Aboriginal Cultural Heritage Assessment Report and an approval will take care of the rest', noting that this approach is inconsistent with archaeological practices and 'State significant considerations as defined by the EIS assessment requirements'.

The assessment has concluded that by application of the avoidance principle there would be no impact on cultural heritage sites that have been assessed of high significance. The assessment also concluded that in relation to Aboriginal cultural values the impact of the project would either be non-existent for some, minimal for others, and operate in the short to medium term to the extent that there is an impact for others.

In order to deliver these outcomes, the Cultural Heritage Management Plan is not dependent on sensitivity mapping. Rather, as recommended in the Aboriginal Cultural Heritage Assessment Report, it relies on the principles of precaution and avoidance, and associated programs to give these effect. The proponent notes the view of the NSW Office of Environment and Heritage that the assessment has met the Secretary's environmental assessment requirements and associated specifications. It further notes that NSW Office of Environment and Heritage states that the approaches are consistent with its standards. The proponent further notes that it has committed to meet all relevant codes and policies. It also notes under the terms of the Cultural Heritage Management Plan, a technical expert is a suitable qualified archaeologist or a person appointed by the Aboriginal Cultural Heritage Working Group.

Precautionary principle

It is contended that the Precautionary Principle has not been (nor will it be) applied.

The assessment has concluded that by application of the avoidance principle there would be no impact on cultural heritage sites that have been assessed of high significance. The assessment also concluded that in relation to Aboriginal cultural values the impact of the project would either be non-existent for some, minimal for others, and operate in the short to medium term to the extent that there is an impact for others.

In order to deliver these outcomes, the Cultural Heritage Management Plan is not dependent on sensitivity mapping. Rather, as recommended in the Aboriginal Cultural Heritage Assessment Report, it relies on the principles of precaution and avoidance, and associated programs to give these effect.

Compliance reporting

Submissions stated the proponent self-management / compliance monitoring as per the Cultural Heritage Management Plan (including the proposed cultural heritage compliance planning and reporting) was unacceptable. They stated that this function should be undertaken by the relevant regulatory authorities.

Implementation of the Cultural Heritage Management Plan is the responsibility of the proponent. Annual reports will be provided to NSW Office of Environment and Heritage in accordance with the terms of the Plan. The five-year review process will be undertaken by a third party auditor, and to notify the broader community a review notice will be placed in a local paper in accordance with the terms of the Plan. NSW Office of Environment and Heritage will also participate in the five-year review of the Cultural Heritage Management Plan which will be undertaken by a third party auditor. The proponent will, as a matter of course, provide NSW Office of Environment and Heritage with the details of new finds through site registration.

Mapping zones

Submissions stated that the mapping zones in the Cultural Heritage Management Plan were not accurate and should be validated by local Aboriginal knowledge holders, Aboriginal elders and NSW Office of Environment and Heritage. They stated that the process should be managed by the proponent.

The proponent presumes this is a reference to the land system sensitivity modelling. It was undertaken to the conditions specified in the Secretary’s environmental assessment requirements and has been endorsed by NSW Office of Environment and Heritage. The proponent has made clear that it is aware of the limitations of those data underwriting the analysis. It observes that the Additional Research Program will be able to address aspects of this issue as will pre-clearance survey work and the verification program. The proponent has stated that it expects the sensitivity model to be subject of significant modification as further, higher quality data become available.

Monitoring of avoidance

Submissions stated the avoidance and precautionary principles are admirable but must be monitored by relevant regulatory authorities. They stated the proponent could not be trusted to implement them.

The proponent has proposed the precautionary and avoidance principles. It notes the positive attitude to them. The application of these principles will be ongoing and will be monitored through the reporting and review processes identified in the Cultural Heritage Management Plan.

Annual Reports will be provided to NSW Office of Environment and Heritage in accordance with the terms of the Plan. The five-year review process will be undertaken by a third party auditor, and a review notice will be placed in a local paper in accordance with the terms of the Plan. NSW Office of Environment and Heritage will also participate in the five-year review of the Cultural Heritage Management Plan.

Intellectual property

The Aboriginal site registers must not remain the intellectual property of the proponent.

The site register will be compiled and appropriate data provided to the relevant regulatory Agency. Accordingly, intellectual property will not remain intellectual property of proponent. Nor was this ever intended to be the case.

Cultural Heritage Management Plan audit and compliance

An auditor undertaking a review of the Cultural heritage Management Plan should be approved by local Aboriginal communities and NSW Office of Environment and Heritage. Audit reports should be required to be endorsed by Aboriginal communities and NSW Office of Environment and Heritage and not just offered for their comment.

Submissions also stated the proponent self-management / compliance monitoring as per the Cultural Heritage Management Plan (including the proposed cultural heritage compliance planning and reporting) was unacceptable. They stated that this function should be undertaken by the relevant regulatory authorities.

Annual Reports will be provided to NSW Office of Environment and Heritage in accordance with the terms of the Cultural Heritage Management Plan. The five-year review process will be undertaken by a third party auditor, and a Review Notice will be placed in a local paper in accordance with the terms of the Cultural Heritage Management Plan. NSW Office of Environment and Heritage will also participate in the five-year review of the Cultural Heritage Management Plan.

Anyone that attends the review consultation meeting, including NSW Office of Environment and Heritage, will be able to provide written submissions. The auditor’s report and proposed revisions to the Cultural Heritage Management Plan will be provided to the Aboriginal Cultural Heritage Working Group and NSW Office of Environment and Heritage. In accordance with the Cultural Heritage Management Plan, NSW Office of Environment and Heritage can approve, reject or otherwise provide comments on the revised Plan.

Cultural Heritage Management Plan review

Submissions noted that the five-year review of the Cultural Heritage Management Plan is unacceptable. They considered this period of time to be too long and that 'breaches require immediate remedies'.

Annual Reports will be provided to NSW Office of Environment and Heritage in accordance with the terms of the Cultural Heritage Management Plan. Given there will be annual reports, and the nature of the five-year review process including a third party auditor, the timing of the five-year review process is considered appropriate.

Working group composition

The Narrabri Local Aboriginal Land Council submission stated it gives general support for the Cultural Heritage Management Plan and its implementation processes, although there are concerns with the Aboriginal Cultural Heritage Working Group.

The submission stated the composition of the Aboriginal Cultural Heritage Working Group should include:

- The proponent or other independent as chair.
- Three representatives from Narrabri Local Aboriginal Land Council.
- One representative from Wee Waa Local Aboriginal Land Council.
- Three Gomeroi Native Title representatives.
- One representative from the local (i.e. Narrabri-based) Gomeroi Narrabri Aboriginal Corporation, noting that there is no Narrabri-based applicant on the Gomeroi Native Title claim.

The proponent respects that the Gomeroi Applicant and the two Local Aboriginal Land Councils assert that they have a legitimate expectation to be involved in the management of culture and heritage including participation in pre-clearance surveys. The possible membership of the Aboriginal Cultural Heritage Working Group has many permutations, including a multitude of groups and individuals that are neither affiliated with a Local Aboriginal Land Council nor the Gomeroi Applicant. The proponent sought to find a balance, where both Local Aboriginal Land Councils the Native Title Applicant represent many Aboriginal people.

The proponent is aware that at the time the EIS was placed on public exhibition the membership of the Gomeroi Applicant did not include a current resident of Narrabri. After the project is determined the Cultural Heritage Management Plan will then be finalised. The proponent’s preference is that in the first instance this issue is discussed and negotiated between the Narrabri Local Aboriginal Land Council, Gomeroi Narrabri Aboriginal Corporation and Gomeroi Applicant.

Cultural heritage coordination

The Narrabri Local Aboriginal Land Council submission stated it should be engaged as the organisation to manage Aboriginal cultural heritage components of the project as well as performing the role Cultural Heritage Coordinator.

> There is not yet consensus within the Aboriginal community on the Cultural Heritage Coordinator. However, the draft Cultural Heritage Management Plan stipulates that the Cultural Heritage Coordinator will be employed by a third party and not the proponent.
>
> The role summary for the Cultural Heritage Coordinator is Schedule 8 of the Plan. The administrative arrangements for the implementation of the Plan, including the Cultural Heritage Coordinator, will be finalised following determination of the project when the Plan is finalised.

Use of geospatial data

The Narrabri Local Aboriginal Land Council submission stated that moving forward, the project should utilise the geospatial data currently established at the council.

> The proponent will consider this issue further in light of conditions that are ultimately attached to the project in relation to Aboriginal cultural heritage. The proponent notes that this is consistent with the confidentiality provisions of the Cultural Heritage Management Plan.

Field workers

The Narrabri Local Aboriginal Land Council submission stated that field workers should consist of people from Narrabri Local Aboriginal Land Council, Gomeroi Narrabri Aboriginal Corporation, and 'Gomeroi Claimants as Gomeroi Applicants' noting that there should not be 'only' Gomeroi people employed in this capacity. A register of field workers should be established and developed from all Registered Aboriginal Parties who were engaged in the process.

> Cultural Heritage Officers, or field workers, to be engaged under the terms of the Cultural Heritage Management Plan will be nominated by the Aboriginal Cultural Heritage Working Group. The proponent believes that Aboriginal people, through the working group, should decide who the appropriate people are to be the Cultural Heritage Coordinator and Cultural Heritage Officers.

Roles in management plan

The Narrabri Local Aboriginal Land Council submission stated it believes key 'roles' for the proponent that should be reflected in the Cultural Heritage Management Plan include:

- Avoidance.
- Commitment.
- Avoidance / Principle.
- Disturbance - gets surveyed.

- Work program.
- What, where, when, how.
- Pre meeting.
- Agree arrangements.
- Pre-clearance survey.
- Assessment, findings recommendations Aboriginal Cultural Heritage Working Group.
- A final step where the proponent updates Narrabri Local Aboriginal Land Council with new information relating to identified and recorded Aboriginal cultural heritage.

The proponent notes these suggestions. They appear to be largely consistent with the proponent's commitments with regards to Aboriginal cultural heritage and as recommended in the Aboriginal Cultural Heritage Assessment Report and provided for in the Cultural Heritage Management Plan. The proponent will consider them further and how they are best addressed in light of conditions that are attached to the project in relation to Aboriginal cultural heritage.

Direct engagement

The Narrabri Local Aboriginal Land Council submission stated it fully supports direct engagement between the proponent and Gomeroi native title applicants but also wants the land council to become a commercial business in the context of the project, with this enabling direct assistance by them of the Gomeroi Narrabri Aboriginal Corporation.

The proponent notes the comments. After the project is determined and the Cultural Heritage Management Plan is finalised, the proponent will initiate commercial discussions with the Narrabri Local Aboriginal Land Council including but not limited to Aboriginal owned land that may be suitable offset sites for the project.

Buffer zones

The Narrabri Local Aboriginal Land Council submission expressed the view that it is 'very important that the buffer zones are put in place as this provides more protection of existing sites and others that will be recorded throughout the project'.

The appropriate data for all currently verified sites has been incorporated into the assessment. The buffers for the remainder of the sites will be updated on completion of the verification program, and as new sites are identified and avoided in accordance with the Cultural Heritage Management Plan. All buffers will be applied in accordance with the avoidance principle and before design is finalised in accordance with the Field Development Protocol. The proponent will report on this to the Aboriginal Cultural Heritage Working Group and will make data available in annual reports.

Aboriginal cultural heritage site verification

The Narrabri Local Aboriginal Land Council submission expressed the view that high quality data is essential and thus emphasises the importance of the ground-truthing (field verification) process for accuracy of that information for verification and pre-clearance surveys.

The proponent concurs with this observation and has committed to complete the verification program within 12 months of project sanction. The proponent notes its commitment to the inspection of all areas in which ground disturbing works are proposed. It also notes its commitment to enhanced survey techniques to ensure quality data are collected.

Support for offsets

The Narrabri Local Aboriginal Land Council submission noted that offsets are an opportunity for Narrabri Local Aboriginal Land Council to be 'able to use some of it(s) land for offset as a way to ensure our land is there for future generations'.

The proponent notes this comment and will explore further with Narrabri Local Aboriginal Land Council how this might best be given effect.

6.21 Historic heritage

The Historic Heritage Impact Assessment was provided in Appendix O and summarised in Chapter 21 of the EIS. The assessment was undertaken in accordance with the relevant statutory assessment guidelines.

The assessment found that the project area contained 53 sites with heritage potential including timber extraction areas, a sawmill site, timber loading ramps, habitation sites, logging tracks, Sydney University Giant Air-shower Recorder pits and an oil well. The distribution of sites across the State Forest areas was also considered to form an overall cultural landscape termed the Pilliga East Logging Cultural Landscape; which was found to be of local heritage significance.

Appropriate avoidance, mitigation and management measures were developed to be included in a Historic Heritage Management Plan. A number of sites were selected to be avoided including a sawmill, logging camp, habitation complex and a hut and another 15 identified sites (or other sites of the same type within the landscape). It was assessed that avoidance of these sites would preserve the heritage values of the Pilliga East Logging Cultural Landscape The Sydney University Giant Air-shower Recorder pits and an oil well were also recommended for avoidance while further measures would be included in the Historic Heritage Management Plan to protect and managed unexpected finds.

16 submissions raised issues specifically relating to the Historic Heritage Impact Assessment presented in Chapter 21 and Appendix O of the EIS. All of the submissions that raised these issues were unique as this issue was not explicitly raised in the form submissions.

A large number of submissions raised issues more specific to the Aboriginal cultural heritage values of the project area. These issues are discussed in Section 6.20.

Figure 6-34 provides an overview of the submissions relating to historic heritage.

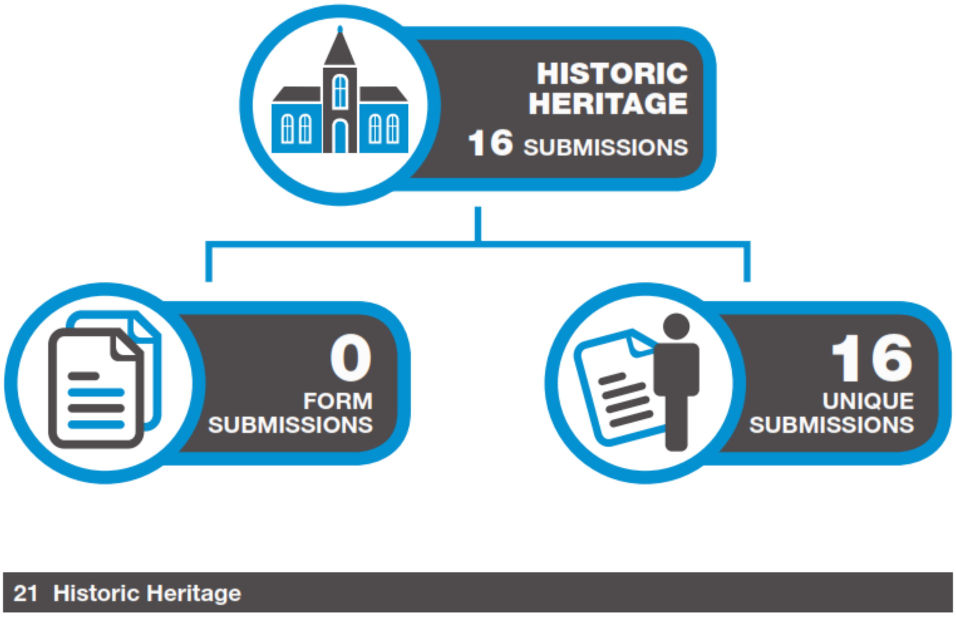


Figure 6-34 Summary of submissions on historic heritage

Historic value of the Pilliga

Submissions raised a general objection to the project in the Pilliga on the grounds that it had natural heritage or World Heritage value as a forest.

The Pilliga is not recognised as a World Heritage area.

The values of the Pilliga as a forest are recognised and assessed in the EIS in terms of its biodiversity values, Aboriginal heritage values and its value to the community.

It is recognised that parts of the Pilliga are protected as national park, nature reserves and state conservation areas. The majority of these protected areas are outside the project area. The Brigalow Nature Reserve is excluded from the project area while the Brigalow State Conservation Area would be a surface development exclusion zone.

Removal of historic heritage values

Submissions opposed the selective removal of historic heritage values from the project area including a proportion of the historic logging camps within the forested part of the project area.

The Historic Heritage Impact Assessment was undertaken by an accredited heritage consultant in accordance with NSW Heritage Division guideline *Assessing Heritage Significance* (2001). Historic heritage values were identified and assessed for their heritage significance.

As a result of avoiding surface development at the following sites, the assessment found there would be no impact to the assessed heritage significance of these sites from the project:

- Cowallah Parish Plan Sawmill
- Logging Camp 7
- Cowallah Sites Complex
- Hardys Hut
- Pilliga 1 Oil Well
- SUGAR pits - located at the Leewood site and the intersection of Plumb Road and No Name Road.

The assessment identified seven logging camps in the project area. Only Logging Camp 7 was identified as being of local significance as part of a collection of logger's habitation sites. As such, to preserve the assessed heritage significance of the Pilliga East Logging Cultural Landscape. Logging Camp 7 together with a number of other sites associated with logging in the area, will be surface development exclusion areas. This is included in the project commitments (Appendix B to this RTS).

In addition a Historic Heritage Management Plan will be implemented for the project.

6.22 Traffic and transport

The Traffic Impact Assessment was provided in Appendix P and summarised in Chapter 22 of the EIS. The assessment considered traffic generated by the project on the main routes providing access to the field, Bibblewindi, Leewood and Westport workers accommodation.

As traffic generated by the project would vary during construction an operation, the assessment estimated an absolute peak traffic volume to be assessed. The peak would occur on relatively few occasions during the peak construction period with lower daily peaks occurring at other times during construction. Traffic during operation was found to be significantly lower than during construction.

The assessment of absolute peak traffic volume indicated that traffic on all roads would be within their functional class and flow volumes while the level of service of key intersections would be unaffected. It was concluded that the project would have low to negligible impacts on road network efficiency and that significant traffic delays were not anticipated.

The assessment stated that measures to manage traffic, including measures to improve road safety, would be implemented in a Traffic Management Plan. As described in the project description in Chapter 6 of the EIS, the proponent will upgrade two Newell Highway intersections to maintain safety and efficiency.

27 submissions raised issues concerning to the Traffic Impact Assessment presented in Chapter 22 and Appendix P of the EIS. The majority of these submissions concerned the baseline data and impact assessment, while a smaller number related to management and monitoring of intersection upgrades proposed in the EIS.

The majority of submissions that raised these issues were unique as they were not usually presented in form submissions, however a small number of form submissions made additional remarks regarding the traffic and transport baseline data and impact assessment.

The division of submissions by issue and submission type is depicted in Figure 6-35.

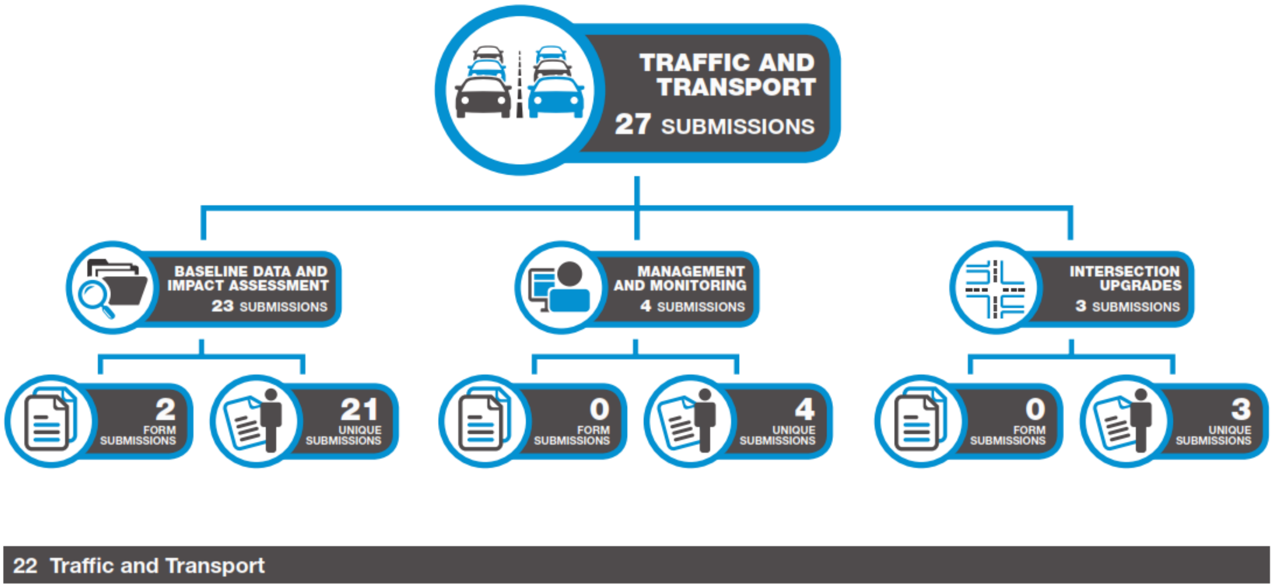


Figure 6-35 Summary of submissions on traffic and transport

6.22.1 Baseline data and assessment method

Baseline road condition

Submissions raised concerns that the project would affect road condition. They stated the assessment did not adequately characterise baseline road condition and that this would prevent effective monitoring.

> The Traffic Impact Assessment was undertaken in accordance with the Secretary's environmental assessment requirements.
>
> The potential impacts on road network efficiency and safety would be managed through the Traffic Management Plan and the Newell Highway intersection upgrades. Traffic and transport conditions would be monitored as part of the Traffic Management Plan and emergent issues addressed in consultation with the relevant road authorities, if necessary.

Impacts on road safety

Submissions stated that the assessment did not adequately assess potential impacts on road safety. They noted the increase in vehicle movements and cited other developments that demonstrated this increase led to an increase in traffic accidents.

> The Traffic Impact Assessment included potential impacts on road safety. This assessment is provided in Section 7.7.7 of Appendix P of the EIS.

The assessment included consideration of baseline accident statistics and the potential for traffic generated by the project to increase their frequency. The assessment found that the project would not be expected to increase the frequency of accidents.

Furthermore, upgrades are proposed at Newell Highway/Old Mill Road and Newell Highway/X-Line Road intersections in accordance with *Austroads Guide to Road Design* to improve the safety of project traffic accessing Leewood and Bibblewindi in particular.

The project Traffic Management Plan would also include a range of measures to mitigate and manage project traffic with regard to road safety. These measures would include safety inductions, speed limits, vehicle monitoring and appropriate signage.

Road condition at Westport workers' accommodation

Submissions stated the assessment did not consider the impact of vehicle movements to and from Westport workers' accommodation. They stated that NSW Roads and Maritime Services requested this in the Secretary's environmental assessment requirements.

The Traffic Impact Assessment in EIS Appendix P, summarised in Chapter 22 of the EIS, considered the potential impacts of vehicle movements to and from Westport workers' accommodation. The assessment considered daily and peak hour traffic during construction and operation and under a range of scenarios including absolute peak traffic generation. The assessment found that daily and peak traffic volumes on all assessed roads would be consistent with their functional class and associated flow volumes and would therefore be acceptable.

The potential impacts on road network efficiency and safety would be managed through the Traffic Management Plan and the Newell Highway intersection upgrades. Traffic and transport conditions would be monitored as part of the Traffic Management Plan and emergent issues addressed in consultation with the relevant road authorities, if necessary.

Assessed speed limits

A submission stated the assessment incorrectly stated the speed limit on Yarrie Lake Road intersection with Kiandool Lane was 80 kilometres per hour.

The Traffic Impact Assessment in Appendix P of the EIS stated that the sign posted speed limit of Yarrie Lake Road is 80 kilometres per hour. The statement is based on the sign-posted speed limit east of Bohena Lane. It is noted that other sections of Yarrie Lake Road have sign-posted speed limits of 100 kilometres per hour, reducing to 50 kilometres per hour toward the township of Narrabri. The variation of speed limit on Yarrie Lake Road does not materially affect the outcomes of the Traffic Impact Assessment.

Assessment of school bus turning points

Submissions stated the assessment did not consider potential impact to school bus turning points on Yarrie Lake Road.

The potential for the project to affect school bus routes was discussed in the Traffic Impact Assessment in Appendix P of the EIS. School bus routes were identified in Section 4.4 while potential impacts on these bus routes was discussed in Section 7.6.2.

As stated in Section 10.2 of Appendix P, the Traffic Management Plan would include consultation with relevant stakeholders including school bus services to confirm the school bus routes and determine appropriate measures to minimise potential impacts.

6.22.2 Management and monitoring

Wet weather mitigation and management

Submissions stated the assessment did not provide mitigation and management measures for project traffic during wet weather conditions on roads utilised by the project.

As stated in Chapter 31 of the EIS, a Traffic Management Plan would be implemented as part of the project. The Plan would be developed in consultation with key stakeholders and road authorities including Narrabri Shire Council and NSW Roads and Maritime Services.

The indicative content of the plan was discussed in the Traffic Impact Assessment in Appendix P of the EIS and included measures such as safety inductions, speed limits, vehicle monitoring and warning signage. These measures would include consideration of relevant hazards including potential wet weather conditions.

Maintenance of forestry roads

Submissions stated the assessment did not proposed a contribution to maintain or repair damage to roads including forestry roads caused by project vehicle movements.

The potential impacts on road network efficiency and safety would be managed through the Traffic Management Plan and the Newell Highway intersection upgrades. Traffic and transport conditions would be monitored as part of the Traffic Management Plan and emergent issues addressed in consultation with the relevant road authorities, if necessary.

Traffic Management Plan

Submissions stated the proposed Traffic Management Plan was not adequately described in the assessment. They requested further information on the measures that would be included including a program of road condition monitoring.

As stated in the project commitments in Chapter 31 of the EIS, a Traffic Management Plan will be implemented. Indicative content of the Plan is provided in Section 10.2 of Appendix P in the EIS.

As stated in Chapter 22 of the EIS, The potential impacts on road network efficiency and safety would be managed through the Traffic Management Plan and the Newell Highway intersection upgrades. Traffic and transport conditions would be monitored as part of the Traffic Management Plan and emergent issues addressed in consultation with the relevant road authorities, if necessary.

The Traffic Management Plan would be developed in consultation with relevant road authorities including Roads and Maritime Services, Forestry Corporation of NSW and Narrabri Shire Council.

6.22.3 Intersection upgrades

Concept plans of intersection upgrades

Submissions stated the assessment did not provide concept plans for intersection upgrades.

The proposed upgrades to the intersections of Old Mill Road and X-Line Road with Newell Highway were explained Section 6.4.1 of Chapter 6 (Project description) of the EIS. Figure 6-30 and Figure 6-31 of Chapter 6 presented schematic diagrams of the proposed intersection upgrades. Further detail would be prepared as part of the detailed design of the intersection upgrades. A works authorisation deed would be required in accordance with Roads and Maritime Services requirements.

6.23 Landscape and visual

The Landscape and Visual Impact Assessment was provided in Appendix O and summarised in Chapter 21 of the EIS. The Landscape and Visual Impact Assessment considered the potential impacts of the construction and operation of project infrastructure on landscape character and views experienced by residents, road users and recreational users. The potential impacts of the operation of the project, and of safety flares in particular, were also considered with regard to the operation of Siding Spring Observatory.

The Landscape and Visual Impact Assessment found that the construction and operation of the field would have moderate to negligible impacts on sensitive receivers. The moderate potential impacts would be from drill rigs during construction and communication towers during operation if views are unobstructed. The construction and operation of major facilities would have low to negligible impacts on nearby sensitive receivers. The operations of night time lighting would have the potential to generate light visible at sensitive receivers but would be minimised through design in accordance with relevant standards.

The operation of pilot flares and safety flares was found to have potential to generate light visible at sensitive receivers. It was found to be unlikely that receivers would be affected by the pilot flares given the small number of flares distributed through the project area, the presence of screening vegetation, the temporary nature of the flare operations and the consideration of impacts in the siting of pilot flares. Safety flares would also have the potential to be visible at sensitive receivers but would be operated infrequently during such times as commissioning, maintenance or non-routine situations.

Consultation with relevant representatives from Siding Spring Observatory indicated the potential for impacts to observing conditions at the observatory as result of the project was negligible given the limited flame height of safety flares, the small number and dispersed location of potential pilot flares, and the minimal operational night lighting requirements of the project.

17,475 submissions raised issues specifically relating to landscape and visual impacts as described in Chapter 23 of the EIS. The majority of submissions were form submissions, however, similar issues were also raised in a substantial number of unique submissions.

The submissions primarily concerned potential impacts to observing conditions at Siding Spring Observatory, while relatively few submissions concerned other landscape and visual impacts.

Figure 6-36 provides an overview of the submissions relating to landscape and visual impacts.

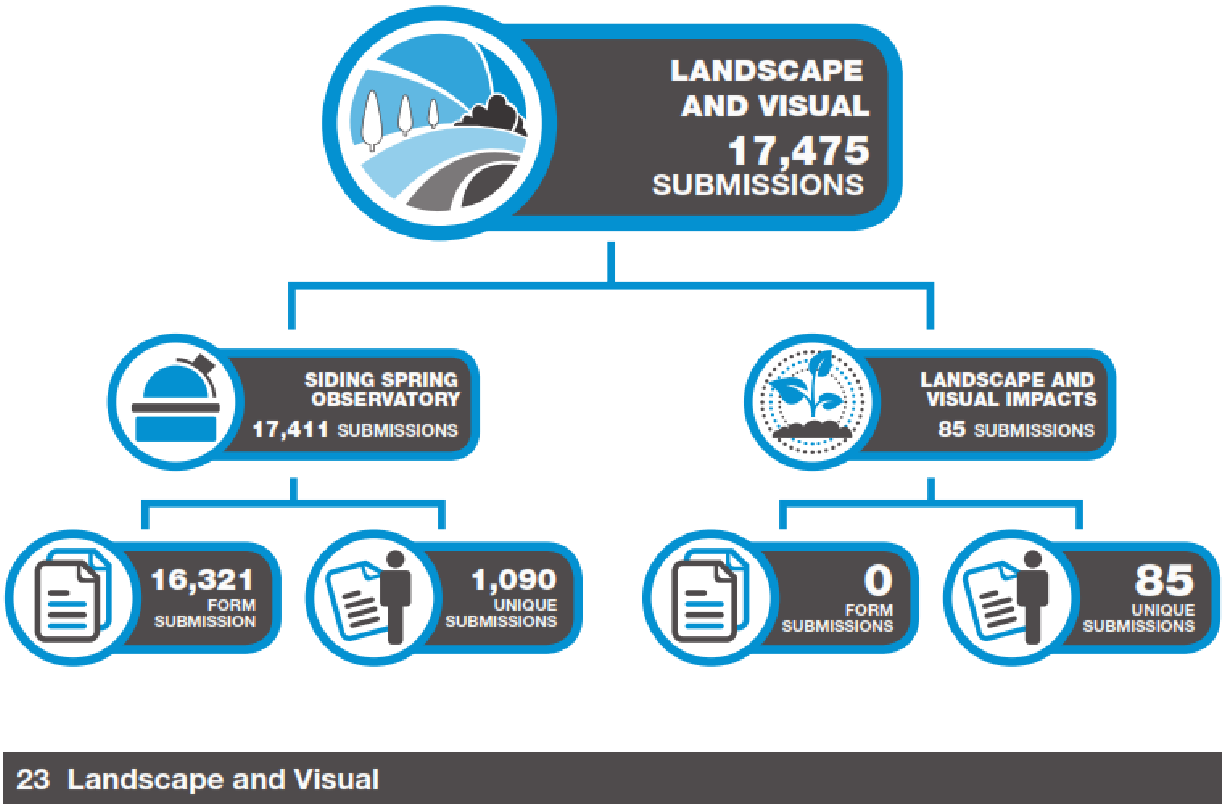


Figure 6-36 Summary of submissions on landscape and visual impacts

6.23.1 Siding Spring Observatory

Impact of light on observing conditions at Siding Spring Observatory

Submissions stated that light emissions from the project would have the potential to affect observing conditions at Siding Spring Observatory as well as the Warrumbungle Dark Sky Park with consideration to the *Dark Sky Planning Guideline*. Submissions were particularly concerned with light emitted from safety flares and pilot flares proposed as part of the project. They also concerned light from compressor stations and the water treatment plant and the project more generally.

In response to the submission, the proponent commissioned a Gas Flare Light Assessment to assess the light impacts of the project flares and their potential to contribute to skyglow that would affect observing conditions at the Observatory. The Gas Flare Light Assessment is included as Appendix K to this RTS.

The Gas Flare Light Assessment included light monitoring at the Observatory in addition to monitoring in the vicinity of the pilot flares operating for the existing Narrabri exploration and appraisal operations. Modelling was then undertaken to determine the light emissions from flares that would operate as part of the project including up to six pilot flares within the project area and a safety flare at Leewood (approximately 100 km north, north-east of the Observatory) and Bibblewindi (approximately 90 km north, north-east of the Observatory). The assessment included modelling for the safety flares operating in both routine (pilot flame) and non-routine (maximum flow rate) scenarios during maintenance or other non-routine activities.

The *Dark Sky Planning Guidelines* (Department of Planning and Environment 2016) are a matter for consideration for State significant development that is within 200 kilometres of the Observatory and likely to impact the night sky. The guidelines state that “at the Observatory a threshold figure of 10 per cent of the natural skyglow at 30^0 above the horizon has been adopted as the maximum tolerable level of artificial light”, as this is critical to the assessment of impacts on the observing conditions at the Observatory. The guideline also refers to the cumulative effect of artificial skyglow within the region caused by rural industries and intensive livestock agriculture operations, urban development including sports fields, industrial and commercial buildings, housing development and street lights and other development including mining and extractive industries and gas flares.

The assessment found that for routine flaring operations for the project, the extent of the horizontal skyglow with up to six pilot flares will be limited to bearings N22^0E - N55^0E from the Observatory. The vertical extent of skyglow will remain at the same altitude currently perceived from the Observatory, which is less than 1^0 above the horizon. Low lying cloud cover and aerosols (<500 m altitude) will influence the extent of skyglow emitted throughout the atmosphere, however this affect would be negligible compared to natural skyglow produced by starlight.

The safety flare would be directly visible from the Observatory, during a non-routine safety flaring event in which it was required to operate at the maximum gas flow rate. From the flare, the extent of skyglow would progressively decrease in intensity reaching natural skyglow conditions approximately 12 kms horizontally and 4 kms vertically from the flare on a clear night, equating to 2.5^0 above the horizon. In cloudy conditions this event would contribute to artificial skyglow to a maximum extent of 7.4^0 above the horizon. Thus, the project would not make a contribution to skyglow conditions at the 30^0 reference location adopted in the guidelines and would have negligible impact on the Observatory’s operations.

Lighting at Leewood, Bibblewindi, Westport workers’ accommodation and well pads will comply with Australian standard AS/NZS 4282 – 1997 *Control of the obtrusive effects of outdoor lighting*. This may include the use of narrow beam floodlights with spill light limited either through appropriate luminaire selection or through the use of “barn door” or similar shading devices fitted to the light fittings. To minimise skyglow, the standards require no light output above the horizontal plane.

The design and operation of night lighting would also consider the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring*.

Impact of air emissions on observing conditions at Siding Spring Observatory

Submissions stated that air emissions from the project would have the potential to affect observing conditions and instrumentation at Siding Spring Observatory. They stated that all pollutants including methane, ethane, butane, hydrogen sulphide and hydrocarbons should have been assessed. They also stated that the potential for smog to be generated should have been assessed.

Submissions stated that the assessment did not consider adverse weather conditions under which air emissions from the project may be concentrated and drift toward Siding Spring Observatory. They provided examples of temperature inversions or cloudy still nights.

The findings of the Air Quality Impact Assessment (Appendix L in the EIS) indicated that the risk of generating adverse effects in the surrounding region including long-distance visibility at Siding Spring would be very low.

The Air Quality Impact Assessment included a number of conservative assumptions including worst-case plume dispersion conditions, highly stable atmospheric conditions, temperature inversions and night-time katabatic winds. It also assumed that the predicted maximum 1-hour and 4-hour average incremental ground level concentrations of nitrogen dioxide would be transformed to ozone.

The Air Quality Impact Assessment considered all pollutants considered to have the potential to be emitted by the project including dust. The assessment showed that ground-level concentrations of all pollutants would be well within the relevant air quality criteria at locations beyond the site boundary. Precursor pollutants with potential to form ozone, aerosols and smog were predicted to be low. The potential for air emissions to enhance potential light impacts is therefore considered correspondingly low.

With the exception of drilling and completion and well workovers which are required to operate continuously, construction activities will generally be limited to day time hours.

The Air Quality Impact Assessment undertaken for the EIS (EIS Appendix L) reported that ground-level concentrations of dust associated with the construction at Leewood and Bibblewindi sites are predicted to be below the impact assessment criteria at all sensitive receptors. Concentrations of dust were found to be limited to the vicinity of the construction area for well pads, pipeline and access track construction.

An Air Quality Management Plan would be implemented during construction and operation of the project. The Plan would include an air quality monitoring program and a suite of measures that could be implemented to prevent or minimise air emissions, where necessary.

Standard construction dust control measures that would be reflected in the Air Quality Management Plan include watering or application of commercial dust suppressants on disturbed soil surfaces, covering erodible material prior to transport and vehicle speed controls.

Cumulative effects at Siding Spring Observatory

Submissions stated that development would significant cumulative effects on Siding Spring Observatory. They stated that mining and natural gas development including the project or other development in the region including Coonabarabran, Tooraweenah, Gilgandra, Gunnedah, Mullaley and Dubbo could be sufficient to result in closure of Siding Spring Observatory.

As discussed above, a Gas Flare Light Assessment was undertaken and is provided as Appendix K to this RTS. It found that operation of the flares would result in limited light impacts well below the threshold in the *Dark Sky Planning Guideline* (Department of Planning and Environment 2016). The assessment considered the cumulative effect of the project with existing background light sources including the towns of Narrabri, Baradine, Coonabarabran, Boggabri and mines in the region.

The assessment found that the artificial light sources were barely visible from Siding Spring Observatory due to their low altitude while skyglow was limited to less than 3 degrees above the horizon. The most significant background light sources that were identified were the moon and the stars of the Milky Way. Further technical detail on the assessment including background light sources are provided in Appendix K of this RTS.

Request to enclose flares and other measures

Submissions stated that the project should enclose flares and lighting to prevent potential impacts on observing conditions at Siding Spring Observatory. They also stated that other lighting should be enclosed as designed by a suitably qualified lighting engineer.

As discussed above, a Gas Flare Light Assessment was undertaken and is provided as Appendix K to this RTS. It found that operation of the safety flare would result in limited light impacts well below the threshold for observing conditions described in the *Dark Sky Planning Guideline* (Department of Planning and Environment 2016). As such, the enclosure of flares is not considered necessary.

Light spills from other project sources would be limited through compliance with Australian Standard *AS/NZS 4282 – 1997 Control of the obtrusive effects of outdoor lighting*. This may include the use of narrow beam floodlights with spill light limited either through appropriate luminaire selection or through the use of “barn door” or similar shading devices fitted to the light fittings. To minimise skyglow, the standards require no light output above the horizontal plane.

The design and operation of night lighting would also consider the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring.*

Other telescope facilities

Submissions stated that the project could affect other observatories such as optical observatories around Coonabarabran and radio telescope facilities in Narrabri.

As discussed above, a Gas Flare Light Assessment was undertaken and is provided as Appendix K to this RTS. It found that operation of the safety flare would result in limited light impacts well below the threshold for observing conditions described in the *Dark Sky Planning Guideline* and would thus not significantly contribute to skyglow (Department of Planning and Environment 2016).

As discussed in the project description in Chapter 6 (Project description) of the EIS, the project would involve establishment of a number of telecommunication towers across the project area. Based on current standards, the telecommunication towers would employ 2G to 4G LTE cellular systems and legacy VHF systems. Operating frequencies of these systems are typically in the range of about 700 MHz to 2.6 GHz for cellular systems and 148 – 174 MHz for VHF systems.

Radio telescope facilities like Paul Wild Observatory near Narrabri employ long baseline interferometry to record signals at much higher frequencies, typically in the range of 8 – 88 GHz. Light emitted from the project, on the other hand, would be at much higher frequencies again in the range of 430 – 770 THz. As such, the proposed telecommunications and lighting for the project would occupy greatly different frequencies to those signals recorded by radio telescopes and would not be a source of interference.

6.23.2 Landscape and visual impacts

Visual impacts at Yarrie Lake

Submissions stated that the project would have visual impacts at Yarrie Lake and requested that the exclusion zone be extended from 200 metres to 500 metres

Potential visual impacts at Yarrie Lake were assessed in Appendix Q of the EIS (Landscape and visual impacts). The assessment found that the project would not have a significant visual impact on Yarrie Lake during construction or operation due to screening vegetation and the separation distance to project infrastructure.

Yarrie Lake reserve is defined as the following land: Lot 51, DP 43308; Lot 52, DP 43308 and Lot 53, DP 43308. Parts of this reserve extend in the order of one kilometre from the boundary of Yarrie Lake. The reserve is a designated surface development exclusion zone (plus a buffer of at least 50 m) for the project. No surface infrastructure will be located within the Yarrie Lake reserve, or the 50 m buffer area.

6.24 Greenhouse gas

The Greenhouse Gas Assessment was provided in Appendix R and summarised in Chapter 24 of the EIS. The assessment was accordance with the relevant statutory instruments being the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* and *National Greenhouse Accounts Factors*.

The assessment quantified direct emissions from the project such as emissions from combustion of fuel, clearing of vegetation or gas processing (including venting or flaring). The assessment also quantified indirect emissions from sources not under the operational control of the proponent such as emissions embodied in purchased electricity from a third party. Lastly, the assessment provided consideration of downstream emissions from the combustion of product gas by end users.

The assessment found that annual direct emissions from the project would be equivalent to less than 0.2 per cent of Australia’s annual direct emissions, which is less than 0.002 per cent of annual global greenhouse gas emissions. The assessment also found that lifecycle emissions for energy produced by the project will be nearly 50 per cent less than for electricity that is currently supplied to the NSW grid.

The assessment stated that as a general principle, all reasonable and feasible measures to minimise greenhouse gas emissions will be considered in the development of the project.

14,671 submissions raised issues specifically relating to greenhouse gas as described in Chapter 24 of the EIS. The majority of submissions were form submissions however similar issues were also raised in a substantial number of unique submissions.

The submissions primarily concerned the potential greenhouse gas emissions of the project while relatively few submissions concerned the assessment methodology more specifically.

Figure 6-37 provides an overview of the submissions relating to greenhouse gas.

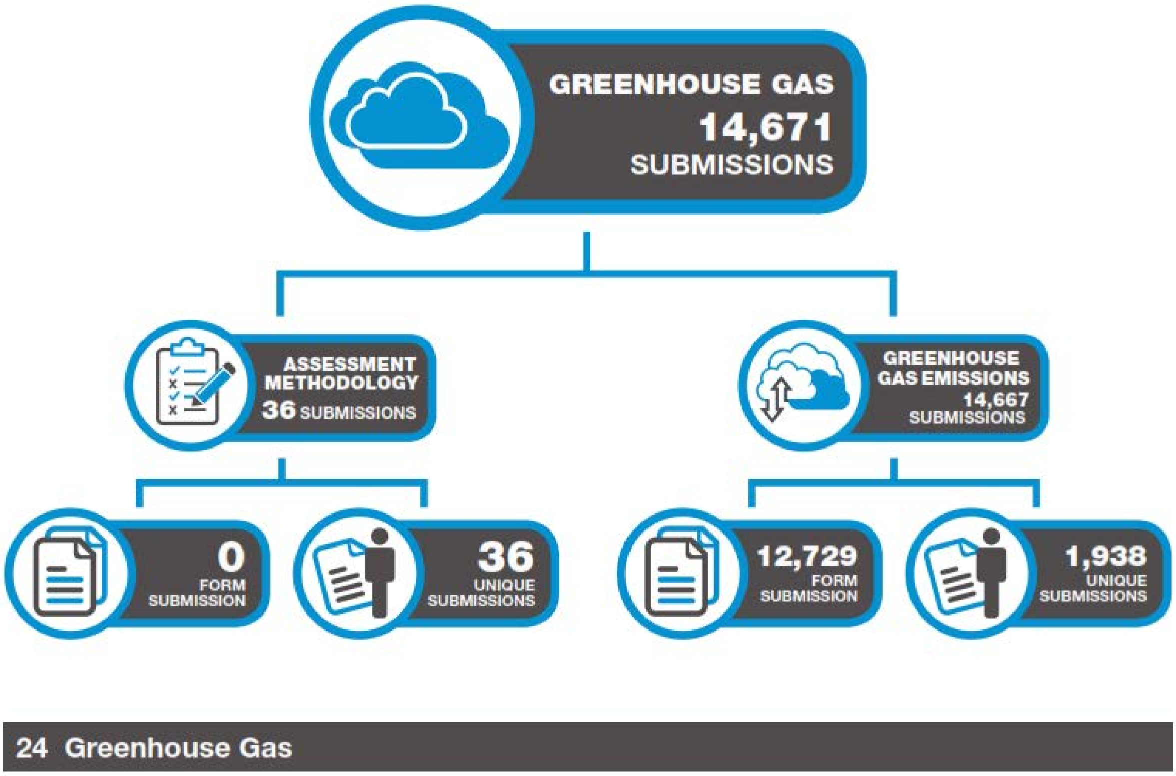


Figure 6-37 Summary of submissions on greenhouse gas

6.24.1 Assessment methodology

Assessment assumptions

Submissions stated the greenhouse gas inventory and underlying assumptions in Table 2-2 and Table 2-3 of Appendix R of the EIS were not adequately substantiated.

The Greenhouse Gas Assessment in Appendix R and summarised in Chapter 24 of the EIS was completed in accordance with the Secretary's environmental assessment requirements and the relevant determinations and guidelines under the *National Greenhouse and Energy Report Act 2007* in accordance with industry standard practice. The assumptions presented in the assessment were in accordance with these requirements including the emissions estimation techniques and accounting factors detailed in the *National Greenhouse and Energy Technical Guidelines* (DOEE).

Table 2-2 and Table 2-3 of the Greenhouse Gas Assessment provided details on the project parameters that were applied in undertaking the Greenhouse Gas Assessment and were based on project planning and equipment selection at the time of the assessment.

Background methane

Submissions stated the assessment omitted independently validated background methane data.

As stated in the Air Quality Impact Assessment in Chapter 18 of the EIS, the proponent commissioned the University of Adelaide to record baseline atmospheric methane concentrations in the project region over three years. The baseline concentrations were recorded at up to 1.8 parts per million with localised increases near roads, cattle yards, mining areas and farm bores. Baseline methane has also been investigated by the Commonwealth Scientific and Industrial Research Organisation including through the Pilliga forest region where natural gas development would occur (Ong *et al.* 2017).

Emissions factors

Submissions stated the greenhouse gas inventory was based on emissions factors and other guidelines that were both out of date and based in North America. They stated that the assessment should have been based on data collected from proponent activities. Submissions sought confirmation of the emissions factor for fugitives and sought clarification on the inclusion of high point vents.

The Greenhouse Gas Assessment in Appendix R and summarised in Chapter 24 of the EIS was completed in accordance with the Secretary's environmental assessment requirements and the relevant determinations and guidelines under the *National Greenhouse and Energy Report Act 2007* in accordance with industry standard practice. The emissions factors used in the assessment were in accordance with these requirements including the *National Greenhouse Accounts Factors*.

Sources of fugitive emissions were identified and quantified in accordance with the guidelines including general fugitive emissions from gas wells, gathering lines and associated infrastructure and processing facilities.

Carbon dioxide content of gas

Submissions stated the assumed 10 per cent carbon dioxide content of gas was underestimated. They cited GeoGas data that indicated higher percentages of carbon dioxide.

The Greenhouse Gas Assessment in Appendix R of the EIS considered the composition of natural gas based on data from existing exploration and appraisal wells. Gas composition varies across the project area.

The gas composition on which the assessment was based is typical of natural gas resources as evidenced in a report prepared for the Office of the New South Wales Chief Scientist and Engineer (Cook 2013), that found natural gas from coal seams is "in most cases…of pipeline quality and requires minimal treatment" but in some areas could have a carbon dioxide content of up "up to 10 per cent".

Duration of assessment

Submissions stated that the assessment should have considered the potential impacts of the project over the next 20 years (to align with the Paris Agreement) and the next 100 years. They noted the global warming potential of greenhouse gases vary over time.

The potential impacts of greenhouse gases are expressed in terms of their global warming potential relative to carbon dioxide. Global warming potential varies over time and therefore is calculated over a set timeframe. The values applied in the Greenhouse Gas Assessment were in accordance with the *National Greenhouse and Energy Reporting Regulations 2008* that align with Australia's international commitments and obligations.

For example, the regulations set a value for methane at 25 based on its 100-year global warming potential. The values adopted in the greenhouse gas assessment are consistent with the regulations and the manner in which emissions are reported by industries across Australia.

The proponent supports limiting global temperature rises to less than two degrees Celsius in line with the Paris Agreement - also known as the 450 Scenario. The proponent's natural gas portfolio strategically aligns with the transition to a low carbon economy. Under an International Energy Agency scenario consistent with 2 degrees (450 Scenario) global gas demand grows 14 per cent by 2040 compared to 2014, and forms 22 per cent of the global energy mix. Further information can be found at: https://www.santos.com/media/.../santos-statement-on-climate-change-disclosure.pdf.

6.24.2 Greenhouse gas emissions

Resource projects and climate change

Submissions stated that the project and other fossil fuel industry would cause climate change through deliberate and fugitive greenhouse gas emissions and compromise the ability of the Australian government to meet its international commitments under the Paris Agreement.

They stated that the climate change caused by the project and other fossil fuels would have impacts on the environment including water resources, flora and fauna and food production.

They stated the project had no clear plan to mitigate climate change.

The proponent supports limiting global temperature rises to less than two degrees Celsius in line with the Paris Agreement - also known as the 450 Scenario. The proponent's natural gas portfolio strategically aligns with the transition to a low carbon economy. Under an International Energy Agency scenario consistent with 2 degrees (450 Scenario) global gas demand grows 14 per cent by 2040 compared to 2014, and forms 22 per cent of the global energy mix. Further information can be found at: https://www.santos.com/media/.../santos-statement-on-climate-change-disclosure.pdf.

As discussed in the Greenhouse Gas Assessment in Appendix R of the EIS, the project was found to generate less than 0.2 per cent of Australia's annual emissions. Accordingly, the project is not expected to compromise the ability of the Australian Government to meet its commitments under the Paris Agreement. The Greenhouse Gas Assessment also identified a range of measures to mitigate and manage the greenhouse gas emissions of the project. The measures were discussed in detail in Appendix R of the EIS and included a number of project commitments in respect of energy use and efficiency in line with the proponent's Climate Change Policy, which is available at: https://www.santos.com/media/4331/climate-change-policy.pdf

The NSW Government policy on climate change is outlined in the *NSW Climate Change Policy Framework*. The aim of the policy is to "maximise the economic, social and environmental wellbeing on NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change." (NSW Government 2016). It identifies seven policy directions to guide government action in implementing the policy, including:

- Create a certain investment environment by working with the Commonwealth to manage transition

- Boost energy productivity, put downward pressure on household and business energy bills
- Capture co-benefits and manage unintended impacts of external policies
- Take advantage of opportunities to grow new industries in NSW
- Reduce risks and damage to public and private assets in NSW arising from climate change
- Reduce climate change impacts on health and wellbeing
- Manage impacts on natural resources, ecosystems and communities.

As discussed above the project strategically aligns with the policy directions set out in the Framework for the transition to a low carbon economy. For example:

- Lifecycle emissions for energy produced from the combustion of the natural gas delivered by the project will be nearly 50 per cent less than for electricity that is currently supplied to the NSW grid.
- Gas is the natural partner for renewable energy for power generation as the world moves away from higher-emission fuels such as diesel and coal.
- The project provides an opportunity for boosting energy and resource productivity in NSW that can reduce the impact of rising energy prices the cost of transition to a net-zero emissions economy.
- The use of gas for electricity generation is much cleaner with regards to local air pollutants. This is an example of a positive co-benefit from emissions savings efforts, improved health from reduced air pollution.
- As a flexible, scalable dispatchable energy source, gas can provide reliable, affordable energy, reduce greenhouse gas emissions and improve air quality across Australia and Asia.
- The project provides an opportunity to increase the resilience of our primary industries and rural communities by providing an additional local industry supporting regional development and local employment opportunities.
- The proposed beneficial reuse of treated water for irrigation and stock watering provides opportunities for accessing an alternative water source for local primary industries and rural communities.

Consistent with the Framework, the proponent is also playing its part in meeting global climate targets, and is actively pursuing initiatives to reduce the emissions across its operations and invest in opportunities that the lower-carbon future presents. The incorporation of new but proven technology, such as renewable energy, into existing operations to reduce fuel usage and emissions is an example of this. The proponent will continue to identify and pursue opportunities to offset greenhouse gas emissions where relevant in further support of achievement of emissions targets.

Fugitive methane releases

Submissions stated that fugitive methane releases from the project were underestimated and omitted some potential sources. They cited domestic and international research into fugitive emissions.

The Greenhouse Gas Assessment in Appendix R and summarised in Chapter 24 of the EIS was completed in accordance with the Secretary's environmental assessment requirements and the relevant determinations and guidelines under the *National Greenhouse and Energy Report Act 2007* in accordance with industry standard practice. The emissions factors used in the assessment, including for fugitive emissions, were in accordance with these requirements including the *National Greenhouse Accounts Factors*.

The assessment found that fugitive methane releases would make up a very small proportion of the project's greenhouse gas emissions. As shown in the Greenhouse Gas Assessment in Appendix R of the EIS, the fugitive emissions during the operation of the project would amount to about

0.002 Mt CO_2-e annually, or about 0.2 to 0.3 per cent of the inventory depending on the power supply option.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has conducted studies aimed at characterising methane and other gaseous emissions from different area sources in NSW, including the coal seam gas industry (Day *et al.* 2016; Ong *et al.* 2017). The studies have shown that methane levels attributed to coal seam gas wells are low relative to other sources, particularly coal mining but also agricultural livestock. The most recently published of these studies (Ong *et al.* 2017) states that measurements taken at 33 sites containing exploration bores or coal seam gas wells did not detect methane emissions. The study notes that further investigation is required but states that the data collected to date “indicates the levels of methane from boreholes were negligible” (Ong *et al.* 2017).

Scrubbed carbon dioxide as greenhouse gas

Submissions stated that the release of scrubbed carbon dioxide to the atmosphere during gas processing should have been quantified in the greenhouse gas inventory.

As stated in Table 2-2 in the Greenhouse Gas Assessment in Appendix R of the EIS, carbon dioxide emitted during gas processing was included in the assessment.

Downstream greenhouse gas emissions

Submissions noted that the assessment considered Scope 1 and 2 greenhouse gas emissions. They stated the assessment should have considered emissions from the gas export pipeline or burning of product gas by downstream domestic and industrial gas users.

Downstream emissions from burning of product gas by end-users were quantified in Section 5.3 of the Greenhouse Gas Assessment in Appendix R of the EIS.

Comparison to coal fired power

Submissions disputed the assessment that natural gas was a lower carbon energy source and less emissions intensive than coal fired power. They stated that natural gas was more emissions intensive if fugitive greenhouse gas emissions were accounted.

As stated in Chapter 24 of the EIS (Greenhouse gas), lifecycle emissions for energy produced from the combustion of the natural gas delivered by the project will be nearly 50 per cent less than for electricity that is currently supplied to the NSW grid. As discussed above, fugitive emissions were assessed in accordance with the determinations and guidelines under the *National Greenhouse and Energy Report Act 2007*.

Fugitive emission monitoring

Submissions stated that a fugitive emissions monitoring program should be proposed and include all potential sources of fugitive methane such as degassing from produced water ponds. They also stated the proponent should implement strategies to detect to mitigate fugitive emissions.

As stated in the project commitments in Chapter 31 of the EIS, a leak detection and repair program would be implemented to identify and minimise fugitive emissions. The program would be subject to approval by the NSW Environment Protection Authority.

As discussed above, fugitive emissions from the project are expected to make up a very small proportion of the greenhouse gas emissions inventory. This is research by the CSIRO (Day *et al.* 2016; Ong *et al.* 2017) that indicates fugitive methane emissions from wells in and around the project area are negligible.

6.25 Hazard and risk

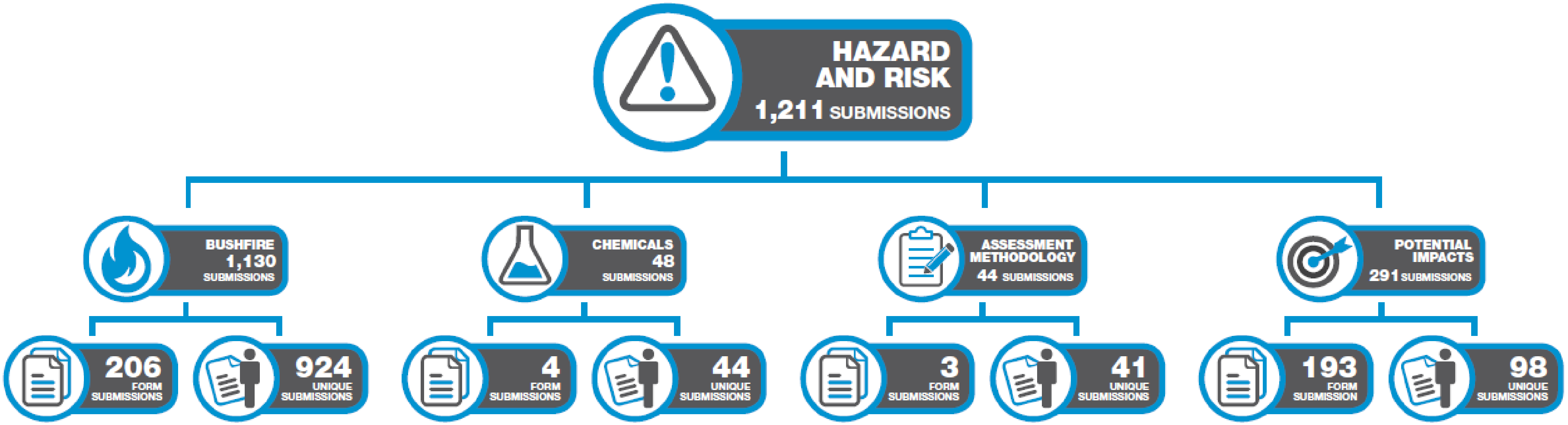
The Hazard and Risk Assessment was provided in Appendix S and summarised in Chapter 25 of the EIS. The assessment was undertaken in accordance with relevant industry and regulatory guidance being the:

- *Environmental Planning Policy No. 33 – Hazardous and Offensive Development*
- *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning*
- *Hazardous Industry Planning Advisory Paper No. 6.*

The Hazard and Risk Assessment involved a preliminary risk screening, preliminary hazard analysis and bushfire risk assessment. The preliminary risk screening identified the classes and quantities of all dangerous goods to be used, stored or produced by the project. This included consideration of natural gas, drilling fluids, and chemicals stored at Leewood and Bibblewindi. The preliminary hazard analysis then identified risks associated with the identified dangerous goods and assessed the likelihood and consequence of hazard events. The identified hazard events included uncontrolled loss of significant quantities of water from a pond, uncontrolled loss of gas leading to fire or explosion and uncontrolled loss of liquid chemicals. The analysis found that the risks associated with those events was generally low to very low due to the intrinsic risk of the event occurring and the potential for offsite consequences based on modelling. The likelihood of bushfire ignition from a project related activity was assessed to be remote, however the overall risk was assessed to be medium given the potential consequences.

The Hazard and Risk Assessment identified mitigation and management measures to control the identified risks, including a Bushfire Management Plan. The assessment committed the proponent to prepare the plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire Management Plan currently in place for the exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project's activities. The Bushfire Management Plan would formalise, and build on, measures already in place as informed by the proponent's participation in the Resource Industry Fire Management Group.

1,211 submissions raised issues relating to the Hazard and Risk Assessment. The majority of these submissions raised issues relating to bushfire (1,130), while a smaller number raised issues regarding assessment methodology (44), chemicals to be utilised by the project (48) and potential impacts more generally (291). The submissions that raised issues relating to the hazard and risk assessment were both form and unique submission types. The division of submissions by issue and submission type is depicted in Figure 6-38.



25 Hazard and Risk

Figure 6-38 Summary of submissions on hazard and risk

6.25.1 Bushfire

Risk of bushfire from facility

Submissions stated the risk of bushfire was not adequately assessed and was understated. They stated that the project would increase the risk of bushfire due to the presence of the project workforce, operation of project machinery and the general storage, transport and processing of natural gas. Some stated that safety flares or pilot flares were a hazard because wind-blown debris could be ignited.

Some submissions referred to the existing Narrabri and Moree *Bush Fire Risk Management Plan* (Narrabri / Moree Bush Fire Management Committee 2010), which rated the existing well sites and Westport workers' accommodation as extreme risk areas. They stated that this should be considered in the proposed Bushfire Management Plan.

Bushfire was assessed in the Hazard and Risk Assessment in Appendix S and summarised in Chapter 25 of the EIS. The assessment was undertaken in accordance with the Secretary's environmental assessment requirements by a suitably qualified bushfire specialist.

The following identifies the specific measures that minimise the risk of bushfire ignition associated with the construction and operation of the facility.

- Inherent in the design of all built components and operational systems of the facility are measures that minimise and potentially eliminate bushfire ignition risk. All potential ignition risks are a high priority management action at well heads and these actions automatically also manage bushfire ignition risks.
- Operational well pads are located within cleared areas of around one quarter of a hectare.
- Well head infrastructure is surrounded by blue metal / vegetation free areas as part of the Asset Protection Zone (APZ).
- Hot works permits identify requirements to adjust, modify or cease activities which may cause ignitions in response to predicted fire danger ratings. Restricted numbers of hot work permits are issued between October and February. Fire units are assigned at hot work sites during periods of higher fire danger ratings.
- Safety flares at Leewood and Bibblewindi would be surrounded by a vegetation free zone of up to 130 metres radius, and pilot flares would be surrounded by a vegetation free zone of up to 40 metres radius. The maximum radiant heat flux at the nearest vegetation would be 6.31 kW/m2 at both ground level and at the tree canopy under a catastrophic bushfire danger level (FFDI 120). As such, the radiant heat flux would be less than 10k/Wm2. (NB: there are no burning debris or embers generated by the gas fired flares)
- The potential for windblown debris to pass through safety flares or pilot flares and result in the ignition of a bushfire is considered negligible. This is because of the distance to potential ignitable sources of wind carried debris, and because the heavier debris types required to ignite and spread fire are most likely to be blown along or near the ground, not at the height of the flares. Small air-borne particles (if they were to pass through the flares) are expected to incinerate within the flare or burn-out prior to reaching vegetation (as is typical of smaller embers).
- All occupants of Westport workers' accommodation would be fully briefed on bushfire risks and appropriate bushfire response procedures. An emergency response and evacuation plan will be prepared to meet the proposed use. In the event that refuge is required on site, it will be provided in the general use buildings of the site and these buildings are/will be constructed to their Bushfire Attack Level appropriate for a refuge building.
- The assessment committed the proponent to prepare a Bushfire Management Plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire

Management Plan currently in place for the exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project's activities.

- A Bushfire Management Plan for the project will include a range of measures for staff and contractor safety including policy, operational protocols and training to minimise ignition risk. Construction and operational staff are therefore far less likely than other users of the region to ignite fires by accident or other means. The Bushfire Management Plan is described in further detail in Appendix S of the EIS.
- As occurs currently, the NSW Rural Fire Service would be consulted in the preparation of the Bushfire Management Plan including bushfire season preparedness activities. The plan would be produced in consultation with the NSW Rural Fire Service, Forestry Corporation of NSW and landholders. The assessment committed the proponent to prepare a Bushfire Management Plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire Management Plan currently in place for exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project activities. The plan would also reflect the proponent's participation in the Resource Industry Fire Management Group.

These fire prevention and mitigation measures reduce the likelihood of the project potentially starting a fire to 'remote', which is the lowest category of likelihood. However, based upon the historic incident of bushfires in the project area and the potential consequences including loss of life and property, and impacts to land uses, the overall risk associated with bushfire has been ranked as medium.

Risk to firefighters or residents in the event of bushfire

Submissions stated that firefighters would be at greater risk in the event of a bushfire due to the project. They stated new tracks and trails may be confusing to firefighters.

They also noted the resident population that may access their residences via long tracks with few exit points or water sources that would increase their vulnerability to bushfire.

The proponent has no expectation that the NSW Rural Fire Service perform bushfire response activities including firefighting functions for the defence or protection of project infrastructure. The EIS assessment explicitly considered that bushfires may significantly impact site operations and capability. However appropriate arrangements are in place to manage project infrastructure and risk in the event of a fire and these were detailed in the Hazard and Risk Assessment in Appendix S of the EIS.

Further, although bushfire protection measures will be adopted for the infrastructure, it is accepted that there would be a risk of loss of project infrastructure as a result of a bushfire.

The majority of the gas field infrastructure operates without the need for persons to be on site. As such, the potential for impacts on human life associated with the operation of the facilities is limited and these persons would operate under strict bushfire risk protocols and be trained accordingly.

Other arrangements detailed in the EIS include evacuation procedures which provide for orderly evacuations well in advance of bushfire impacts, including nominating and mapping access and egress routes that are suitable for use in an emergency.

As discussed in Chapter 6 (Project description) of the EIS, the project would utilise existing roads and access tracks where practicable and construct new access tracks where necessary in accordance with the Field Development Protocol. The project is not expected to alter the way in which the resident population in the project area would access their residences and is therefore not expected to increase their vulnerability to bushfire.

The potential for signposting of dead end access routes will be discussed with the local Bushfire Management Committee and implemented if deemed useful.

The facility itself poses no additional risk to firefighters or residents as gas shut off valves are activated by various means including a fail-safe final shutoff in the event of other systems not operating, as discussed in further detail below.

Ability to cease operations in the event of bushfire

Submissions queried how the project would shut down wells and cease operations promptly in the event of a bushfire to minimise risks to the public and project workforce.

As discussed in the Chapter 6 of the EIS (Project description), the project would include a number of systems that would enable the proponent to quickly cease operations in the event of a bushfire. Gas wells would be equipped with telemetry systems that provide real time information on well operations. The telemetry systems can be used to remotely shut in wells. Further, gas wells would have automated shutdown systems that would be triggered in the event of non-routine operating conditions. The response components of the Bushfire Management Plan would also be implemented including evacuation procedures.

These systems, in combination with automatic gas blowdown systems, would serve to isolate the gas and prevent its release as well as minimise the amount of gas stored in pipelines and gas processing infrastructure. These automated systems would minimise risks to the public and project workforce in the event of a bushfire.

The gas at the well head and in the gas gathering network is at a low operating pressure. In the event of a major bush fire threatening project infrastructure the wells would be 'shut in', that is, the valve on the discharge of the well head would close and the well would be isolated from downstream well head equipment.

The infrastructure downstream of the well head, including the gas gathering lines and vents or drains, would be depressurised to the gas compression units or flare system and, as such, the operating pressure in the gas gathering network would rapidly approach atmospheric pressure.

Wells can be 'shut in' remotely using the telemetry control system, however they would also have automated shutdown systems in the event of non-routine operating conditions. All vessels and pipework are protected by pressure safety valves (PSVs) and the pressure increase as a result of radiant heat exposure is considered in selection of the appropriate PSV capacity.

Bushfire Management Plan

Submissions stated that a Bushfire Management Plan should have been already prepared given its existing activities in the project area including gas exploration and flaring. They also recommended measures to be included in the plan including:

- enclosure of all flares to reduce ignition risk
- training and resourcing of firefighting staff

- asset protection zones and hazard reduction burning.

Submissions stated the proponent should consult with relevant stakeholders in the production of a Bushfire Management Plan including National Parks and Wildlife Service, Local Aboriginal Land Council and adjoining landholders.

Bushfire was assessed in the Hazard and Risk Assessment in Appendix S of the EIS. The assessment was in accordance with the Secretary's environmental assessment requirements.

The assessment committed the proponent to prepare a Bushfire Management Plan in consultation with the NSW Rural Fire Service and Forestry Corporation of NSW. There is a Bushfire Management Plan currently in place for the exploration and appraisal activities and this would be amended in consultation with NSW Rural Fire Service and Forestry Corporation to reflect the project's activities. As discussed previously, safety flares and pilot flares would be surrounded by appropriately sized vegetation free zones to prevent ignition and enclosure is not necessary for the burning debris ignition risk.

The project is not expected to increase fire incidents for the NSW Rural Fire Service given the remote likelihood of causing a bushfire. It is also not expected that resources would be deployed to protect project infrastructure in the event of a bushfire. Agreements will be reached with fire fighter agencies on measures to potentially minimise impacts on infrastructure in the event of back burning, for example fire retardant drops around well heads where feasible.

The project workforce would be provided induction training for bushfire including ignition control and response actions.

Indemnity for bushfire

Submissions stated that the proponent should indemnify landholders in the project area for loss of property or life associated with bushfire attributable to the project.

As stated in Appendix S (Hazard and Risk Assessment) of the EIS, the likelihood of the project causing a bushfire was considered to be remote given the implementation of the existing and proposed mitigation and management measures (also see the additional information on the likelihood above).

Flaring during peak bushfire season

Submissions sought a commitment to cease flaring during peak bushfire season.

Due to the large vegetation free zones that would be established surrounding safety flares, it is not necessary to cease flaring during peak bushfire season as ignition risk is insignificant as discussed above.

In its EIS submission, the NSW Rural Fire Service suggested a radiant heat flux limit of 10 k/Wm^2 from flares on vegetation for bushfire protection purposes. As stated in Chapter 6 (Project description) of the EIS, safety flares at Leewood and Bibblewindi would be surrounded by a safety zone of up to 60 metres radius and a vegetation free zone of up to 130 metres radius, and pilot flares surrounded by a safety zone of up to 15 metres radius and a vegetation free zone of up to 40 metres radius. The maximum radiant heat flux at the nearest vegetation would be 6.31 kW/m^2 at both ground level and at the tree canopy under a catastrophic bushfire danger level (FFDI 120). As such, the radiant heat flux would be less than 10k/Wm^2 in accordance with the NSW Rural Fire Service submission.

6.25.2 Chemicals

Presence of methane

Submissions stated that methane would be present above threshold levels at project infrastructure and that associated risks were not adequately assessed.

Risks associated with the presence of methane were assessed in accordance with the Secretary's environmental assessment requirements, *State Environmental Planning Policy No 33—Hazardous and Offensive Development* and relevant guidelines including *HIPAP No. 6 - Guidelines for Hazard Analysis* (NSW Department of Planning 2011).

Material safety data sheets

Submissions stated material safety data sheets for all chemicals used by the project should be made available to NSW Department of Planning and Environment before determination.

A Chemical Risk Assessment was provided as Appendix T3 of the EIS. The assessment considered the risks associated with chemicals that may be used for the project. Material safety data sheets for these substances were provided as Appendix B to Appendix T3 in the EIS.

6.25.3 Assessment methodology

Cumulative risk of uncontrolled loss of gas

Submissions noted that the risk of uncontrolled loss of gas leading to fire was low to very low but stated this did not consider the cumulative risk of 850 wells.

Hazards and risks were assessed in Appendix S and summarised in Chapter 25 of the EIS. The assessment was in accordance with the Secretary's environmental assessment requirements, *State Environmental Planning Policy No. 33—Hazardous and Offensive Development* and relevant guidelines including *HIPAP No. 4 - Risk Criteria for Land Use Planning* (NSW Department of Planning 2011a) *and HIPAP No. 6 - Guidelines for Hazard Analysis* (NSW Department of Planning 2011).

The assessment included consideration of the risk of an uncontrolled loss of containment of gas leading to fire or explosion at well pads and associated gas gathering lines and processing facilities. The assessment found that the likelihood of loss of containment of gas leading to fire or explosion at a well pad was remote.

The assessment also included consequence modelling that defined the spatial extent of consequences on the remote chance that such an event did occur and found that those consequences would extend in the order of 50 metres from the source. Based on the results of the consequence modelling, there would be no cumulative risk to a given sensitive receiver from multiple production well pads as they would be spaced at least 750 metres apart under the Field Development Protocol. The assessment concluded that the risk of an uncontrolled loss of containment of gas leading to a fire or explosion was very low and complied with the risk criteria under the relevant guidelines.

As discussed above, the overall risk of the project causing a bushfire was also assessed and was found to be remote given the implementation of existing and proposed mitigation and management measures under the project Bushfire Management Plan.

Major hazard facility

Submissions stated that assessment under *State Environmental Planning Policy No 33—Hazardous and Offensive Development* and *HIPAP No. 4 - Risk Criteria for Land Use Planning* was not adequate. They also stated the risk assessment matrix was not appropriate.

They stated the project should have instead been assessed as a major hazard facility under the *Work Health and Safety Act 2011* and subordinate regulations.

The Hazard and Risk Assessment in Appendix S of the EIS was undertaken in accordance with the Secretary's environmental assessment requirements, *State Environmental Planning Policy No 33—Hazardous and Offensive Development* and relevant guidelines including *HIPAP No. 6 - Guidelines for Hazard Analysis* (NSW Department of Planning 2011).

The project major facilities would be considered as a petroleum site regulated under the NSW *Work Health and Safety (Mines and Petroleum Sites) Act 2013,* and therefore, are not classified as a major hazard facility in accordance with clause 530 of the NSW *Work Health and Safety Regulation 2017*.

6.25.4 Potential impacts

Risk of uncontrolled release of gas

Submissions stated the assessment did not adequately assess the risks to the public, workforce, property and the environment from a catastrophic failure of project infrastructure leading to a release of methane and potential ignition or explosion.

Other submissions stated the risk of uncontrolled release and ignition of gas was assessed as being in the order of 50 chances in a million per year. They stated that over 25-year assessment period this would amount to an apparently larger probability of 1.25 chances in 1,000.

Hazards and risk were assessed in Appendix S and summarised in Chapter 25 of the EIS. The assessment was in accordance with the Secretary's environmental assessment requirements, *State Environmental Planning Policy No. 33—Hazardous and Offensive Development* and relevant guidelines including *HIPAP No. 4 - Risk Criteria for Land Use Planning* (NSW Department of Planning 2011a) and *HIPAP No. 6 - Guidelines for Hazard Analysis* (NSW Department of Planning 2011).

The assessment set out a range of potential hazard events associated with project activities. It undertook a rigorous assessment including a gas release likelihood and worst case consequence analysis. A range of release types, ignition sources, weather conditions and congestion scenarios were assessed and worst case consequences were presented.

Risk of methane build up

Submissions stated that methane may escape from target coal seams into overlying aquifers or the atmosphere. They stated that this may pose a hazard if the methane is allowed to build up in groundwater bores or in other enclosed spaces.

The risk of induced subsurface gas flows from the project is considered in Sections 7.4.2.4 and 7.4.4.6 of the Groundwater Impact Assessment (EIS Appendix F).

The proponent recognises the risks associated with leakage in well design and construction. All mandatory requirements outlined in the *NSW Code of Practice for CSG Wells* will be applied. In general, the proponent will also adopt all the good industry practices outlined in the *NSW Code of Practice for CSG Wells*, with local site and well conditions and operations dictating the final set of best industry practice measures that will be implemented.

The Hazard and Risk Assessment in Appendix S of the EIS considered the potential for methane to be released into the atmosphere and potentially accumulate in confined areas. This scenario was included in the assessment of an uncontrolled release of gas followed by accumulation in confined areas and delayed ignition. As stated in the assessment, the residual risk of such an uncontrolled release and ignition was found to be very low.

Risk associated with produced water

Submissions stated the assessment did not adequately assess the risks to the public, workforce, property and the environment from a catastrophic release of produced water.

Hazards and risk were assessed in Appendix S and summarised in Chapter 25 of the EIS. The assessment was in accordance with the Secretary's environmental assessment requirements, *State Environmental Planning Policy No. 33—Hazardous and Offensive Development* and relevant guidelines including *HIPAP No. 4 - Risk Criteria for Land Use Planning* (NSW Department of Planning 2011a) and *HIPAP No. 6 - Guidelines for Hazard Analysis* (NSW Department of Planning 2011).

The Hazard and Risk Assessment included an assessment of the sudden loss of containment of water from the failure of a pond. The assessment concluded that the risk was very low. Produced water and brine ponds would be designed in accordance with the relevant codes of practice including *Exploration Code of Practice: Produced Water Management, Storage and Transfer* and requirements of the NSW Dam Safety Committee.

Risk of air toxins

Submissions stated the assessment did not adequately assess the risks to the public, workforce, property and the environment from a catastrophic release of air toxins.

Hazards and risk were assessed in Appendix S and summarised in Chapter 25 of the EIS. The assessment was in accordance with the Secretary's environmental assessment requirements, *State Environmental Planning Policy No. 33—Hazardous and Offensive Development* and relevant guidelines including *HIPAP No. 4 - Risk Criteria for Land Use Planning* (NSW Department of Planning 2011a) and *HIPAP No. 6 - Guidelines for Hazard Analysis* (NSW Department of Planning 2011).

The Hazard and Risk Assessment included a dangerous goods inventory and preliminary risk screening assessment of chemicals that would be stored on site. It assessed the potential for a release of these substances to occur and for offsite consequences to follow. The assessment concluded that the risk of a release was low and complied with the risk criteria under the relevant guidelines.

Risk of other infrastructure failure

Submissions stated the assessment did not adequately assess the risk of well blowout, pipeline rupture, compressor failure, gas processing failure or other infrastructure failure.

Hazards and risk were assessed in Appendix S and summarised in Chapter 25 of the EIS. The assessment was in accordance with the Secretary's environmental assessment requirements, *State Environmental Planning Policy No. 33—Hazardous and Offensive Development* and relevant guidelines including *HIPAP No. 4 - Risk Criteria for Land Use Planning* (NSW Department of Planning 2011a) and *HIPAP No. 6 - Guidelines for Hazard Analysis* (NSW Department of Planning 2011).

Section 4 of Appendix S addressed the risk of failure of project infrastructure and uncontrolled release. The assessment included a register of risks with potential for offsite harm including their causes, inherent design standards, initial risk rating and residual risks with the mitigation measures and management plants applied to reduce the risk. The Risk Register is Appendix A to the assessment.

6.26 Social and health impacts

Potential impacts on social and health values were assessed in Appendix T1, T2 and T3 of the EIS and were summarised in Chapter 26 of the EIS. The assessments were prepared in accordance with the Secretary's environmental assessment requirements and relevant guidelines. The Health Impact Assessment drew on various other specialist assessments including the Groundwater Impact Assessment in Appendix F of the EIS and Air Quality Impact Assessment in Appendix L of the EIS.

The Social Impact Assessment identified a series of potential social impacts associated with the project workforce including changes to community characteristics, demand on housing and accommodation, and demand on social infrastructure and services. The assessment found that these impacts would be readily managed. The assessment also found that there would be significant economic benefits at the local, regional and state scales including employment, income generation and broader economic output.

Potential impacts on health were primarily related to air and water quality. Air quality impacts from operation of the project were found to meet air quality criteria for human health at sensitive receptors. As such, potential impacts from air quality on health were not expected. With regard to water quality, the assessment found that chemicals including drilling fluids posed a low risk to human health due to the engineering controls and monitoring that would be in place, the limited possibility for human contact with leaks or spills, and the dilution or degradation that would typically occur in the unlikely event of a loss.

The Social Impact Assessment recommended a range of measures to mitigate and manage potential social impacts including workforce management measures and an accommodation and housing strategy. Potential impacts to landholders would be mitigated and managed through measures such as negotiation and implementation of Land Access Agreements. Furthermore, social impacts will be monitored through the development and implementation of a Social Impact Management Plan.

18,245 submissions raised issues specifically relating to the social and health assessments summarised in Chapter 26 of the EIS. The submissions generally equally concerned social impacts and health impacts with a smaller number concerning the overall assessment methodology. The majority of submissions that raised social and health issues were form submissions although a substantial number of unique submissions were also made.

The division of submissions by issue and submission type is depicted in Figure 6-39.

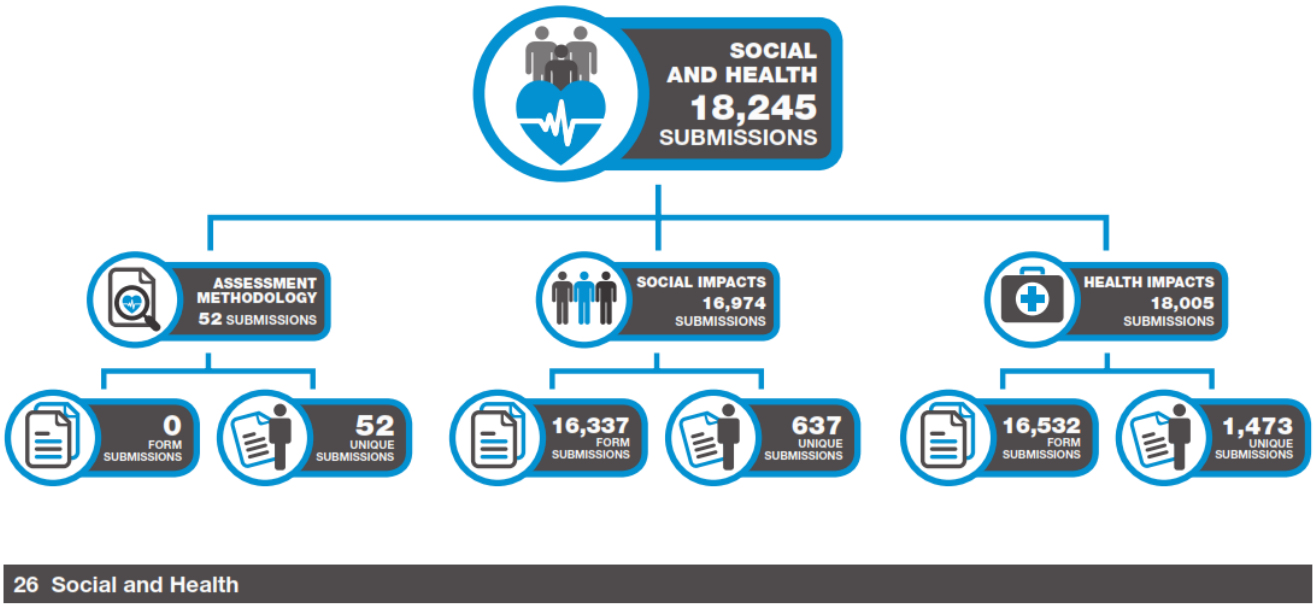


Figure 6-39 Summary of submissions on social and health

6.26.1 Assessment methodology

Social impact assessment methodology

Submissions stated the Social Impact Assessment did not adhere to the *Social Impact Assessment Guideline* (NSW Department of Planning and Environment 2017a).

Some stated the assessment did not clearly describe the methodology to rank social impacts in terms of their likelihood, consequence and significance.

The Social Impact Assessment presented in Appendix T1 of the EIS was prepared in accordance with the Secretary's environmental assessment requirements and the relevant guidelines at the time of preparation including the *International Principles for Social Impact Assessment* (Vanclay 2003).

At the time of printing and publication of the EIS, the *Social impact assessment (draft) Guidelines for State significant mining, petroleum production and extractive industry development projects in NSW* (NSW Department of Planning and Environment 2016a) had just been released. The final *Social Impact Assessment Guidelines for State significant mining, petroleum production and extractive industry development projects in NSW* were released in September 2017, postdating the February 2017 EIS lodgement.

Notwithstanding this, the Social Impact Assessment has been completed using methodology that is broadly reflective of the guidance provided by NSW DP&E (2016 and 2017a). The Social Impact Assessment uses leading practice guidance from appropriate guidelines as described in Section 2.1 of the Social Impact Assessment.

The methodology to rank social impacts including likelihood and consequence criteria were discussed in Section 2.4 of the Social Impact Assessment in Appendix T1 of the EIS, in addition to Section 10.2 of Chapter 10 (Approach to the Impact Assessment).

Social impact assessment qualifications

They also stated the assessment did not confirm the qualifications of the practitioners involved in the production of the Social Impact Assessment.

The Social Impact Assessment presented in Appendix T1 of the EIS was produced by suitably qualified practitioners in the field. The technical lead holds a Doctorate in Social Development.

Social baseline information currency

Submissions stated the Social Impact Assessment was not adequate as it was three years old and therefore did not present current social baseline information.

They cited current social baseline information including the Gas Industry Social and Environmental Research Alliance (GISERA) Stage 2 *Social Baseline Assessment* (Walton *et al*. 2017).

The Social Impact Assessment was prepared in accordance with the Secretary's environmental assessment requirements and was based on social baseline data current at the time of the assessment. The assessment is therefore considered to be adequate.

The assessment was based in part on Census 2011 data as Census 2016 data was not publicly available until after the publication of the EIS.

A comparison of some key demographic characteristics of the study area indicates that there has been minimal change and that the findings of the Social Impact Assessment remain valid. At the time of the assessment, the Narrabri local government area had a population of 13,438 persons with a workforce of 6,172 and 5.4 per cent unemployment. More recent data from the Australian Bureau of Statistics indicates the Narrabri local government area has a population of 13,481 persons with a workforce of 6,171 and 5.4 per cent unemployment (ABS 2017a). At the time of assessment private dwellings in Narrabri totalled 4,783 while more recent data indicates this number has climbed to 5,370, including 736 unoccupied (ABS 2017b).

Social baseline reporting subsequently released through the Gas Industry Social and Environment Research Alliance (GISERA) has been reviewed and is consistent with the findings of the Social Impact Assessment. Key findings of the Phase 2 report (Walton *et al.* 2017) were:

- the importance of good governance, industry standards and scientific research to fill knowledge gaps and engender community trust
- uncertainty associated surrounding issues including the long term management of the project, including by other proponents, and decommissioning
- concerns regarding the potential for broader gas development, particularly in agricultural areas, or the introduction of fracking as gas productivity declines
- concerns about the future of the region including the longevity of benefits from coal seam gas and its relationship with agricultural decline
- experience from the cotton industry in improved management of safety and the environment including production of best management plans
- importance of respecting divergent opinions on coal seam gas development and dislike for the effects of polarisation on community and business
- importance of unbiased information and benefits of the Community Consultative Committee while recognising opportunities to improve distribution of information
- importance of local receipt of benefits from royalties or community benefit funds as part of a social licence to operate
- lack of communication of broader context for coal seam gas development in terms of state or national energy security needs or transition fuel.

The Stage 3 report by Walton and McCrea (2017) found that wellbeing was rated highly by the participants across the Narrabri Shire community. Regarding community resilience, average survey results indicated a positive expectation that the community would get involved and persevere to find solutions in response to a proposed coal seam gas development. Expectations of local communities to be able to work together with local and state government and a coal seam gas company to address problems or to maximise benefits associated with coal seam gas development were, on average, positive. Responding strategically in terms of proactive planning and adequate leadership when dealing with change was viewed negatively / unfavourably on average.

The research found that there was a diversity of views regarding how participants felt their community would cope and adapt to possible coal seam gas development in the Narrabri Shire. These views ranged from people feeling their community would resist changes, through to feeling their community would change into something different though better. Residents in Narrabri and surrounds were significantly more likely to think their community would adapt to the changes, while residents in Boggabri and surrounds were significantly more likely to think their community would only just cope. Wee Waa was more likely to think their community would not to cope with possible coal seam gas development.

These findings are noted and are broadly consistent with the findings and intent of the Social Impact Assessment in the EIS, which emphasised the importance of adherence to industry standards, environmental monitoring and ongoing engagement with the community through the commitments made in Chapter 31 (Project commitments).

The proponent has also committed to producing and implementing a Social Impact Management Plan that would provide for ongoing management and monitoring of potential social impacts for the life of the project – including baseline social conditions and community attitudes.

Social Impact Assessment consultation

Submissions stated consultation undertaken for the Social Impact Assessment was inadequate.

They stated that insufficient time was spent consulting with people that may be affected by the project including Aboriginal people. They also stated that consultation with bird watching, bush walking and camping groups was not adequate and that no evidence had been provided of consultation with local businesses to support the conclusion that they supported the project.

Submissions also stated that the Social Impact Assessment did not clearly relate outcomes of consultation with the identification of social values and potential impacts.

Consultation was considered adequate for the purpose of the Social Impact Assessment in line with the Secretary's environmental assessment requirements.

A list of stakeholders consulted was provided in Section 2.6 of the Social Impact Assessment presented in Appendix T1 of the EIS.

Stakeholders consulted included the Narrabri Local Aboriginal Land Council, while further extensive consultation with Aboriginal people was undertaken as part of the Aboriginal Cultural Heritage Report discussed in Section 6.20 of this RTS report and reported in Appendix N1 and Chapter 20 of the EIS. Additional Aboriginal consultation remains ongoing as part of Native Title negotiations with the Gomeroi Applicants.

The Narrabri Visitor Centre was consulted with regard to the potential impacts of the project on recreational activities such as bird watching, bush walking and camping.

A number of institutions were consulted with regard to the potential impacts of the project on local business including Narrabri Shire Council, Narrabri Chamber of Commerce and the Narrabri Community Consultative Committee. It is noted that the Narrabri Chamber of Commerce expressed support for the project in their EIS submission.

As discussed in Section 2.6 of the Social Impact Assessment, the purpose of consultation was to gather baseline social information, existing and potential issues relevant to the project and inform the development of mitigation and management strategies. Social impact monitoring would be ongoing under the implementation of the Social Impact Management Plan.

Consideration of intangible social values

Submissions stated that Social Impact Assessment did not sufficiently address potential impacts on intangible social values such as sense of place, social norms, social cohesion and lifestyle.

The Social Impact Assessment considered that potential impacts on sense of place and lifestyle were mainly relevant to landholders that would be directly affected by the project. As discussed in the Social Impact Assessment, the proponent will adhere to the Agreed Principles of Land Access.

Impacts on social norms and cohesion due to the project were discussed in Section 6.3.3 of the Social Impact Assessment in Appendix T1 of the EIS. Consultation with Narrabri Police and community members revealed that workforce management measures implemented by resource companies had been sufficient to avoid these issues. The proponent has committed to a Workforce Management Plan and code of conduct to this effect.

The proponent has been operating across Australia for over 60 years, and therefore has substantial experience working with landholders and communities. The proponent has a commitment to establish and maintain enduring and mutually beneficial relationships.

The proponent has developed a robust Stakeholder Engagement Plan which, along with continued engagement with the Community Consultative Committee, would provide suitable ongoing mechanisms to understand and address community issues. The proponent has also committed to ongoing social impact monitoring and reporting under a Social Impact Management Plan.

Consideration of social impacts of closure

Submissions stated that the Social Impact Assessment did not adequately assess the potential social impacts of the closure of the project. They stated that the social impacts of closure should have been assessed in accordance with relevant guidelines and continually reviewed throughout the project.

The Social Impact Assessment presented in Appendix T1 of the EIS was prepared in accordance with the Secretary's environmental assessment requirements and the relevant guidelines at the time of preparation including the *International Principles for Social Impact Assessment* (Vanclay 2003). It considered the potential impacts of all stages of the project including construction, operation and decommissioning. The discussion of potential social impacts of the closure of the project is necessarily limited, as actual social impacts would depend on social baseline conditions at the time of closure.

As noted in the submissions, closure planning would occur through the life of the project to account for the changing nature of social baseline conditions. The Decommissioning Report in Appendix W of the EIS and the Rehabilitation Strategy in Appendix V of the EIS point to progressive decommissioning and rehabilitation of non-economic wells to reduce the environmental footprint and financial liability.

The Commonwealth Government leading practice guidance documents such as *Mine Closure – Leading Practice Sustainable Development Program for the Mining Industry* (Department of Foreign Affairs and Trade 2016) suggest the following closure-based activities were considered in the development of mitigation measures.

The Gas Community Benefit Fund is expected to provide inter-generational, sustainable and lasting benefits to the local community. The local community would be involved in decisions surrounding the Fund. The principal objective of the Gas Community Benefit Fund is the provision of benefit to the local community. The other objectives of the Gas Community Benefit Fund are to ensure that:

- lasting and mutually beneficial relationships are developed between gas companies and the communities in which they operate
- local communities are involved in decisions to fund projects in the local communities
- funding decisions promote community development projects that support local and social enterprise, are transparent and there is accountability for these decisions
- efficient, effective and transparent governance and administration arrangements for the Fund.

The NSW Rural Assistance Authority (Fund Administrator) has been appointed under the *NSW Petroleum (Onshore) Act 1991* to administer the fund.

The proponent is committed to monitoring impacts through the life of the project and undertaking closure planning, including impact assessment and management prior to cessation of the development, which will include managing potential unemployment and overall socio-economic dependencies of the community on project. The proponent has also committed to monitoring social impacts through the development and implementation of a Social Impact Management Plan.

Comparative analysis of social impacts

Submissions queried whether a comparative analysis of social impacts was undertaken. They stated the Social Impact Assessment should have provided a list of relevant studies and sources used in comparative analysis of their findings if such an analysis was undertaken.

The Social Impact Assessment was prepared in accordance with the Secretary's environmental assessment requirements and was based on social baseline data current at the time of the assessment. The assessment is therefore considered to be adequate.

Social baseline reporting subsequently released through the Gas Industry Social and Environment Research Alliance (GISERA) has been reviewed and is consistent with the findings of the Social Impact Assessment. The key findings of those reports are discussed above.

Work from GISERA or other literature or social monitoring data directly relevant to the project would be considered through the development of the Social Impact Management Plan as it becomes available.

Health impact assessment methodology

Submissions stated that the Health Risk Assessment was inadequate. Submissions stated that an independent Health Impact Assessment should have been undertaken including modelling exposure pathways, literature review and engagement with the community.

The potential health impacts of the project were assessed in the Health Impact Assessment and Chemical Risk Assessment in Appendices T2 and T3 of the EIS, respectively. The assessments were carried out in accordance with the Secretary's environmental assessment requirements and relevant guidelines including *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards* (enHealth 2012).

The assessments considered potential human health risks associated with environmental hazards including contamination of groundwater, surface water or air quality. The assessments drew on a review of the relevant literature and modelling of exposure pathways and predicted concentrations. The assessments concluded the risk to human health was very low. The findings of the assessments are in agreement with the submission from NSW Health that stated "based on the nature and scale of the operation and distance from townships, we expect there will be minimal impact on human health".

6.26.2 Social impacts

General social impact risk

Submissions objected to the project on the grounds that it would have adverse impacts on communities at the local, regional and state scales.

The Social Impact Assessment presented in Appendix T1 of the EIS was prepared in accordance with the Secretary's environmental assessment requirements and the relevant guidelines at the time of preparation including the *International Principles for Social Impact Assessment* (Vanclay 2003).

The Social Impact Assessment in Appendix T1 of the EIS considered the potential social impacts of the project at the local, regional and state scales. It found that the project would have a range of social benefits including economic output and income at the local, regional and state scales as well as the establishment of the Gas Community Benefit Fund.

The Social Impact Assessment also found there to be net positive social (financial) impacts to landholders who choose to host field infrastructure, economic benefits through income, the payment of taxes and royalties, employment, opportunities for local business development and positive population growth.

Social impacts including impacts to relevant landholders, housing and accommodation and social infrastructure would be managed and mitigated through a range of measures as discussed in Section 7.11 and Section 8.3 of the Social Impact Assessment.

Distribution of social impacts

Submissions stated that social impacts would be distributed unequally within the community.

Submissions stated as an example that the project would increase rental and housing costs that would disproportionately affect lower income earners.

The potential for inequality in the distribution of potential socio-economic benefits or impacts is acknowledged, including the distribution of employment and income or potential impacts on social infrastructure, housing and accommodation on particular groups or individuals.

The proponent has developed a number of impact management strategies to avoid or minimise adverse impacts affecting specific groups and individuals. Additionally, the proponent has a number of mechanisms in place to achieve equitable share of benefits, such as:

- the Diversity and Equal Opportunity Policy
- Gas Community Benefit Fund
- sponsorships and donations
- an impact monitoring program under the Social Impact Management Plan, including a commitment to implementing adaptive management strategies.

With regard to the distribution of employment and income, it was considered that Indigenous participation would be an important aspect of the project. As discussed in the Social Impact Assessment in Appendix T1 of the EIS, the proponent will implement its Diversity and Equal Opportunity Policy to achieve representative Aboriginal employment. It is also considered that education and training facilities in the region would provide long term career pathways to school leavers or others seeking skilled employment by the project.

Aboriginal employment opportunities would be part of ongoing Native Title negotiations with the Gomeroi Applicants, with final details subject to the finalisation of a Native Title agreement.

With regard to housing and accommodation, the majority of the project workforce would be existing residents or occupy private workers' camp accommodation and would therefore not be expected to affect the general housing and accommodation market. A proportion of the operations workforce would be expected to relocate to Narrabri and may generate demand on the general housing and accommodation market in competition with other residents. The proponent will implement an accommodation and housing strategy including engagement with Narrabri Shire Council to monitor changes in demand on the general housing and accommodation market and work to resolve issues if they arise.

It is expected that project workers seeking rental accommodation would likely be competing for a different market sector than the vulnerable groups referred to in the submission, thereby further lowering the likelihood of conflicting demand.

Potential impacts on cost of living and business

Submissions stated the project would have potential impacts on cost of living and business and that these potential impacts should be further modelled and assessed.

They also stated that the potential environmental impacts of the project could affect the viability of local industry such as agriculture or the operation of Siding Spring Observatory.

The potential economic impacts of the project were assessed in Appendix U2 of the EIS. The assessment found that the project would generate employment and income in the Narrabri region, Narrabri surrounds and New South Wales as a whole.

The impact of the project on costs in Narrabri and the wider region was expected to be minor. During peak construction, the project was projected to increase the consumer price index by 0.9 per cent in the Narrabri LGA and 0.2 per cent in the wider region. During the operations phase, the consumer price index is projected to remain only slightly higher at 0.4 per cent in the Narrabri LGA and 0.1 per cent in the wider region. Small increases such as these are not expected to present an impediment to industry or cost of living. For context, the average increase in consumer price index over eight capital cities in Australia between September 2016 and September 2017 was 1.8 per cent (Australian Bureau of Statistics 2017a).

Section 4.4 of the Economic Assessment in Appendix U2 of the EIS focused on the impacts on other industries including increased competition for labour and increased costs. The assessment found that the project would increase the economic output and employment of most other sectors assessed including utilities, construction, trade, transport and services. Relatively minor decreases of less than one per cent in economic output and employment were predicted in agriculture and forestry, mining and manufacturing due to labour demands and potentially small increases in costs. The assessment concluded there would be a net gain in economic output and employment in the Narrabri region, Narrabri surrounds and New South Wales as a whole.

As discussed in Section 6.17 of this RTS, the project is considered to be compatible with other land uses in the project area including agriculture. Project infrastructure would be located through Land Access Agreements and Farm Management Plans developed in consultation with relevant landholders to minimise potential impacts on agricultural operations.

As discussed in Section 6.23, the operation of the project is not expected to affect observing conditions on Siding Spring Observatory and would therefore not affect its operation.

Potential impacts on labour dynamics

Submissions stated the project would have potential impacts on labour dynamics and that these potential impacts should be further modelled and assessed.

They stated that the project would draw labour from other industries and cited studies indicating that for every job created by the natural gas industry, 1.7 or 1.8 jobs would be lost in agriculture. Others stated that seven jobs were lost in service sectors for every 10 created by natural gas.

The potential economic impacts of the project were assessed in Appendix U2 of the EIS. Section 4.4 of the assessment focused on the potential economic impacts of the project on other industries including increased competition for labour and increased costs. The assessment found that the project would increase the economic output and employment of most other sectors assessed including utilities, construction, trade, transport and services.

Relatively minor decreases of less than one per cent in economic output and employment were predicted in agriculture and forestry, mining and manufacturing due to labour demands and potentially small increases in costs. The assessment concluded there would be a net gain in economic output and employment in the Narrabri region, surrounds and NSW. Research cited in the submissions (Fleming and Measham 2015) aligned with the findings of the economic assessment of the project in showing a positive overall impact jobs and income.

Economic impacts and employment are discussed further in Section 6.27 of this RTS.

Potential impacts in neighbouring local government areas

Submissions stated the project would have potential impacts in neighbouring local government areas such as increased population, labour competition, accommodation demand and road use.

They stated these potential impacts were not adequately assessed for neighbouring local government areas such as Gilgandra Shire Council local government area.

The Social Impact Assessment provided as Appendix T1 of the EIS was based on project planning at the time of assessment. The study area for the assessment included the local government area of Narrabri and a wider area of influence including surrounding local government areas.

As stated in Section 7.7 of Appendix T1, about 90 per cent of the workforce during peak construction would be accommodated at private workers' camp accommodation in Narrabri and surrounds. Existing accommodation facilities in Narrabri and surrounds, including private workers' camp accommodation, were discussed Section 4.4.6 of the Social Impact Assessment. The assessment identified private workers' camp accommodation with capacity for the workforce in Narrabri and Boggabri. The decision on where to accommodate the project workforce would be subject to project needs and availability.

The potential regional economic impacts of the project were assessment in Appendix U2 of the EIS. The assessment considered the potential economic impacts at the local, regional and state scale and included assessment of the economic effects of the project in neighbouring local government areas.

The potential use of roads was assessed in the Traffic Impact Assessment in Appendix P of the EIS and was also based on project planning at the time of assessment. The planned routes and potential impacts of the project were described in that assessment and included consideration of local traffic in the project area and the Narrabri local government area as well as traffic from other regional centres.

Community conflict and cohesion

Submissions stated that the project would cause community conflict and affect community cohesion. They referred to publically available research, including research undertaken by the Gas Industry Social and Environmental Research Alliance, and stated it provided evidence the community was polarised by the project.

The proponent has been operating across Australia for over 60 years and thus has significant experience working with landholders and communities. Embedded in the approach to working with local communities is its commitment to establish and maintain enduring and mutually beneficial relationships. A key part of this is employing locally. The proponent's employees live and work in many of the communities in which it operates, and are actively involved in the community's programs and activities.

The proponent is committed to developing and maintaining strong working relationships with landholders and other stakeholders and is committed to contributing to community cohesion, evidenced by its approach in its Queensland GLNG project, and other operations.

The proponent has endeavoured to consult with the community and provide forums for discussion and resolution of conflicting views. The project Community Consultative Community was established for this purpose. The Committee includes a range of members with differing perspectives on the project. For example, the committee includes members of People for the Plains that oppose the project.

The Community Consultative Committee provides a forum for exchanges of differing views and its operation is consistent with the key finding of the GISERA report *Understanding local community expectations and perceptions of the CSG sector Social Baseline Assessment: Narrabri project - Phase 2* to "encourage respect for differing views and community cohesion" (Walton *et al*. 2017).

The proponent also has a shopfront on Maitland Street in Narrabri that is open to the public. This presence assists to provide accessible and responsive service to community members who have comments or are seeking information or advice on the project. A complaints and feedback telephone line is also available while updates are regularly published in the local paper and regular email updates distributed to people wishing to receive these. Site tours of the field's operations with local team members are offered regularly to allow people to access the operations and ask questions about the project.

Recent surveys undertaken by the Gas Industry Social and Environment Research Alliance (GISERA) found that residents of Narrabri and surrounds held significantly more positive views toward natural gas development than those from around Wee Waa or Boggabri. About 15 per cent and 13 per cent of respondents indicated they would 'embrace' or 'approve of' natural gas development; 27 per cent and 15 per cent of respondents indicated they would 'tolerate' or 'be ok with' natural gas development; while the remaining 30 per cent would not accept natural gas development.

As stated in the Stakeholder and Community Consultation Report (EIS Appendix D), issues and concerns of stakeholders and the community will remain focus areas for the proponent's ongoing commitment to open and transparent communication with stakeholders and the community. The proponent will continue to monitor and address matters relating to conflict and cohesion. This would include development of a grievance mechanism that would act as a strategy to avoid and / or manage conflict.

Estimated population growth

Submissions stated the assessment overestimated population growth.

They stated that the family multiplier applied to the workforce was unrealistic.

The population growth and family multiplier were based on project planning and Census data at the time of preparation of the Social Impact Assessment. As discussed in the Social Impact Assessment, around 50 workers were expected to relocate to Narrabri for the operation of the project. At the time of the assessment, the average household size was 2.6 and remained at this value in the 2016 Census data. As such, the estimated increase in population of 130 persons is considered to be appropriate for the purpose of the Social Impact Assessment.

Potential impacts on tourism and recreation

Submissions stated that the project would negatively affect tourism and recreation in the region. They specifically referred to values of the Pilliga, Yarrie Lake and Siding Spring Observatory.

Potential impacts on tourism and recreation were assessed in Section 6.3.4 of the Social Impact Assessment in Appendix T1 of the EIS. The assessment was based on findings of other technical studies including the Noise and Vibration Assessment, Traffic and Transport Impact Assessment and Landscape and Visual Impact Assessment (EIS Appendices M, P and Q respectively). The Social Impact Assessment was also informed by consultation with the Narrabri Visitor’s Centre.

The assessment found that the main recreational or tourism values in and around the project area included activities in the Pilliga such as bird watching or bushwalking, activities at Yarrie Lake Flora and Fauna Reserve and Siding Spring Observatory. The assessment found that the project would have low impacts on tourism and recreation.

Tourism and recreation values of the Pilliga would be largely preserved as the project as forested areas would remain accessible by existing roads and access tracks in the project area. Some limited areas such as well pads and major facilities would be fenced but would not preclude public access to forested areas or the Pilliga more broadly.

It is considered that the design of the project including the constraints set out in the Field Development Protocol is sufficient to prevent impacts on Yarrie Lake and its environmental and recreational value. Yarrie Lake reserve is defined as the following land: Lot 51, DP 43308; Lot 52, DP 43308 and Lot 53, DP 43308. Parts of this reserve extend in the order of one kilometre from the boundary of Yarrie Lake. The reserve is a designated surface development exclusion zone (plus a buffer of at least 50 m) for the project. No surface infrastructure will be located within the Yarrie Lake reserve, or the 50 m buffer area. It is noted that the submission from the Yarrie Lake Flora and Fauna Trust indicated that board members of the Trust had voted unanimously in support of the project and had not raised concerns with regard to the lake and reserve.

As discussed in Section 6.23 of this RTS, the operation of the project is not expected to affect observing conditions on Siding Spring Observatory and would therefore not affect its value to tourism.

Fly-in fly-out or drive-in drive-out workforce

Submissions stated that the utilisation of a fly-in fly-out or drive-in drive-out workforce would have negative impacts on the community compared to resident workers.

As discussed in the Social Impact Assessment in Appendix T1 of the EIS, it is expected that about 30 per cent of the workforce would be sourced for Narrabri or surrounding local government areas. Non-resident workers would be accommodated at private workers' camp accommodation.

With workforce accommodation strategy and workforce management strategies in place and based on the consultation with Narrabri Shire Council and local police, the assessment concluded that negative impacts from the fly-in fly-out or drive-in drive-out workforce are not anticipated.

Cumulative social impacts

Submissions noted the potential for cumulative impacts from the project and other resource projects in the region on labour and housing markets was identified in the Social Impact Assessment.

They stated that other potential cumulative impacts should have been identified including changes to demographic profiles, demands on social infrastructure, changes to community values, stress and anxiety due to uncertainty, crime and antisocial behaviour.

Some cited an increase in health service demand due to Maules Creek Mine and the potential for further increases due to the project workforce and potential incidents in the project area.

Submissions noted that proposed mitigation and management measures should have considered these potential cumulative impacts in addition to potential impacts from the project in isolation.

As discussed in the Social Impact Assessment in Appendix T1 of the EIS, the demographic increase in resident population was considered to be a positive effect of the project and would therefore not be expected to contribute to negative cumulative impacts.

Potential impacts on community values, including increased crime and antisocial behaviour, were considered to be unlikely with the implementation of workforce management measures and again would not be expected to contribute to negative cumulative impacts.

Potential impacts on landholders would be mitigated through the Agreed Principles of Land Access, Land Access Agreements and ongoing consultation with affected landholders.

As stated in Section 6.3.5 of the Social Impact Assessment in Appendix T1 of the EIS, impacts on health services were determined based on consultation with the Narrabri District Health Service and other medical practitioners. The consultations indicated that local health services had sufficient capacity to cater for population growth in the region including the project workforce.

Social cumulative impacts were reported in Chapter 29 of the EIS (Cumulative impacts) and included consideration of Maules Creek, Shenhua Watermark and Vickery Mines as a minimum.

Mitigation and management measures

Submissions recommended a range of mitigation and management measures, including:

- Maximise local involvement in procurement and employment, including
  - local advertisement for roles
  - engagement with educational institutions
  - payment incentives for local employees
  - disincentives for non-resident workforce.
- Funding of local training facilities or programs.
- Flexibility in rostering to encourage engagement in community events.
- Funding of social services including health services to accommodate demand.
- A gas rates program to improve affordability and industrial benefit from product gas.

Submissions stated that funding for mitigation and management measures such as these should come from the proponent rather than the Gas Community Benefit Fund.

The mitigation and management measures proposed in the Social Impact Assessment in Appendix T1 of the EIS were commensurate with the predicted impacts and are therefore considered suitable. The mitigation and management measures included:

- engagement with local recruitment agencies
- continued support for local vendors to provide goods and services to the project
- scholarships and other programs in consultation with education and training facilities
- opportunities for flexible and family friendly rosters.

The Gas Community Benefit Fund would be governed in line with the *Gas Community Benefits Fund Funding Guidelines* (NSW Government 2017c) as discussed below.

Monitoring for social impacts

Submissions stated that the proponent should monitoring for social impacts including engagement with social service providers to detect changes in demand. Some stated that monitoring for social impacts should be undertaken by an independent body.

The proponent has committed to preparing a Social Impact Management Plan for the project. The Plan will be provided to the Department of Planning and the Environment.

Governance of Gas Community Benefit Fund

They stated that the Gas Community Benefit Fund would provide opportunities to mitigate and manage potential social impacts. They stated that transparency in the governance of the fund would reduce anxiety in the community whilst building trust in the proponent. They stated that further information on the governance of the fund should have been provided.

The Gas Community Benefit Fund will be established as per the *Gas Community Benefits Fund Funding Guidelines* (NSW Government 2017c) and will be administered by the NSW Government Rural Assistance Authority as gazetted under the *NSW Petroleum (Onshore) Act 1991*.

In accordance with the above guidelines, the fund will be available for individuals, organisations or enterprises that deliver local and social community development initiatives in the areas of:

- health
- education
- environment
- economic development and heritage
- sport, arts and culture.

The role of the Committee includes:

- setting the annual strategic direction of the fund
- setting the specific focus of each funding round
- determining the successful grant funding project applications
- providing annual reports on finances and funded projects to the Minister.

Each Committee shall consist of an Independent Chair and at least five (but no more than six) representatives with:

- At least two representing different interests of the local community (not already holding a position on the existing Community Consultative Committee.
- One from the gas titleholder.
- One from the local Government.
- One from the NSW Government.

Appointment of members for a Committee will be made by the Minister of Industry, Resources and Energy in accordance with the *Appointment Standards - Boards and Committees in the NSW Public Sector* (July 2013).

Aboriginal employment and business opportunities

Submissions stated that Aboriginal employment and business opportunities would be an important aspect of the mitigation and management of potential social impacts.

They stated that further detail should have been provided regarding the implementation of the diversity and equal opportunity policy referenced in the social impact assessment.

As discussed in the Social Impact Assessment in Appendix T1 of the EIS, a Diversity and Equal Opportunity Policy would be implemented to encourage Indigenous participation in the development of the project and achieve representative Aboriginal employment including for contractors. The policy was provided as Appendix A of the Social Impact Assessment and outlines capacity building strategies for Aboriginal peoples including specific employment, training and procurement initiatives to:

- increase the number of Aboriginal employees of the proponent and service providers

- develop partnerships with Aboriginal peoples, government and community organisations in the delivery of Aboriginal employment and training outcomes
- create, where possible, enterprise development and procurement opportunities within the proponent's projects and operations for Aboriginal companies
- facilitate the development of the community to build capacity which is aligned with proponent operations and activities.

Further, Aboriginal employment opportunities would be part of ongoing Native Title negotiations with the Gomeroi Applicants, with final details subject to the finalisation of a Native Title agreement.

6.26.3 Health impacts

Likelihood of leaks and spills

Submissions stated the assessment underestimated the likelihood of leaks and spills and their potential impacts on human health. They cited publications in support of this view. Some requested further information on engineering controls that would prevent leaks and spills.

The potential for the project to cause spills or leaks was assessed in Chapter 14 (Soils and land contamination) and Chapter 25 (Hazard and risk) of the EIS. The assessments found that the likelihood of the project causing a spills was low.

The project would be designed in accordance with the relevant codes of practice to minimise the risk of spills or leaks occurring. These would include:

- *Code of Practice for Coal Seam Gas – Well Integrity*
- *Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*
- *Exploration Code of Practice: Produced Water Management, Storage and Transfer.*

As discussed in Chapter 6 of the EIS (Project description), and in accordance with the *Codes of Practice*, produced water ponds would be designed to incorporate double lining, leak detection and seepage collection. In addition to this, the NSW Dam Safety Committee would review and confirm the dam design.

The project would also incorporate a range of monitoring systems that would enable quick detection and rectification in the unlikely event of a leak or spill, including continuous pressure monitoring of produced water gathering lines, and leak detection and monitoring bores for produced water ponds. Further, exploration, appraisal and production gas wells would be remotely monitored and controlled and would automatically shut down in the event of non-routine operational conditions.

Chemicals will be stored and handled in accordance with the relevant Australian Standards, including *AS 1940-2004 The storage and handling of flammable and combustible liquids*. Refuelling would occur with suitable containment for volumes greater than 50 litres and not within 40 metres of a watercourse. Bunding, drip trays and other preventative measures would be implemented as necessary and spill kits would be situated as appropriate in areas where there is potential for spills to occur. Regular inspection of plant, equipment and infrastructure would be carried out in accordance with operational procedures.

The proponent will be responsible to develop a Pollution Incident Response Management Plan in accordance with *Protection of the Environment Operations Act 1997*. A response plan is currently in place for exploration and appraisal activities in accordance with these requirements.

In summary, a significant number of design, construction and operational measures are proposed or already in place that mean there is a low risk of spills or leaks. As demonstration of this, the proponent has conducted exploration and appraisal activities in the project area, including operation of the water treatment plant at Leewood, without a reportable incident in over 4.5 years.

Human health risk of air emissions

Submissions stated the assessment did not adequately assess the human health effects of air emissions including nitrogen oxides, sulfur dioxide, hydrogen sulphide, BTEX (benzene, toluene, ethylbenzene, xylene), hydrocarbons, ozone, methane and diesel emissions.

Some submissions specifically raised the potential health impacts of volatile organic compounds and hydrocarbons including polycyclic aromatic hydrocarbons. They stated the potential health effects of air emissions included headache, nausea, dizziness, loss of coordination, respiratory problems, cancers, heart and other organ issues.

The Air Quality Impact Assessment (Appendix L of the EIS) was undertaken in accordance with the Secretary's environmental assessment requirements and *Approved Methods for the Modelling and Assessment of Air Pollutants* in NSW (DEC 2005).

The assessment considered all pollutants considered to have the potential to be emitted by the project. It found all pollutants emitted by the operation of the project would be well within relevant air quality criteria for human health. Ground-level concentrations of all pollutants are presented in the Air Quality Addendum in Appendix I of this RTS.

General health risk

A series of comments were received on the potential that components of the project could adversely impact human health. The comments, in general, suggested a connection between natural gas development and localised health effects. The comments cited publications, some peer-reviewed, that indicate causality with unconventional gas production.

It is noted that submissions referenced a number of studies that looked at health impacts associated with unconventional gas production. Upon review of the cited studies, it was found that many of them were of limited applicability as they are based on different activities than those proposed (e.g. hydraulic extraction of shale gas) and are therefore of limited applicability. A number of the studies were inconclusive and did not provide evidence of causality. A number also cited studies regarding potential health impacts of fugitive emissions. On review, the studies reported that emissions were generally low and many of the cited publications were for hydraulic fracturing, a process not proposed as part of the project. A significant number of the cited studies were inconclusive and did not provide firm evidence.

A Health Impact Assessment (Appendix T2 of the EIS) was completed consistent with the Secretary's Environmental Assessment Requirements. Specifically, the Environmental Impact Statement (EIS) was required to include a human health risk assessment that considered the potential adverse effects from human exposure to project-related environmental hazards. The assessment was to be conducted in accordance with the approach described in *Environmental Health Rick Assessment: Guidelines for* *assessing human health risks from environmental hazards* (EnHealth 2012). The assessment considered the risks associated with human exposure to noise, air pollution and contamination of ground and surface water. The assessment considered risks during both the construction and operational phases of the project.

The Health Impact Assessment found that where the controls and environmental management measures outlined in the EIS are implemented, the assessment has not identified project related impacts that may adversely affect the health of the community.

Furthermore, a Chemical Risk Assessment was conducted for the project as part of the EIS. The assessment was conducted in accordance with the requirements of the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* using commonly accepted practices and methods. In addition, the assessment was developed to align with guidance provided by the Commonwealth and approved chemical risk assessments completed for other coal seam gas projects. The Chemical Risk Assessment focused on chemicals to be used in the drilling and development of gas wells, and those proposed for produced water and brine treatment. The goal of the chemical risk assessment was to demonstrate that potential risks have been eliminated or reduced as much as is reasonably practicable to potentially exposed human receptors and to Matters of National Environmental Significance (MNES), including water resources.

The assessment noted that the potential for releases of chemicals to groundwater was negligible. No persistent, bioaccumulative and toxic (PBT) or carcinogenic substances were identified among the chemicals proposed. Although exposures to human receptors showed some potential non-carcinogenic risks, no carcinogenic risks were identified. Exposure scenarios were highly conservative and were based on fencing and signage and operational monitoring. While potential hazards are associated with the transport, preparation and use of drilling chemicals, these activities will be undertaken in accordance with relevant requirements including the *NSW Code of Practice for Coal Seam Gas Well Integrity*.

Further considering the nature of the chemicals used and the existing management and risk mitigation practices no unacceptable risks were identified for terrestrial and ecological receptors and humans within the project area. Key findings included:

- No potential impacts on beneficial uses of groundwater and associated receptors from drilling, conveyance of produced water and treated water and beneficial uses of treated water.
- Implementation of transportation and spill prevent protocols and communication of hazards to emergency responders, health and safety managers and environmental clean-up protocols are integral components of management and mitigation strategies for the project.
- No unacceptable risks associated with the storage and management of drilling cuttings or drilling muds was identified on the well pads.
- No unacceptable risks associated with the storage and management of brine at the Leewood water treatment facility with short term exposure and unlikely to lead to chronic exposures.
- No unacceptable risks to aquatic and terrestrial receptors and humans from the potential discharge of treated water to Bohena Creek.

Consistent with the EIS process adopted on major projects, the project's potential impacts to human health have been assessed using relevant and applicable methods and regulatory standards. The approach involved:

- A baseline assessment of existing conditions.
- An assessment of compliance and risk.
- Refinement of project constraints to minimise risk.
- Identification of programs to manage the residual risks.

The EIS assessment process was informed by extensive data collected across several key environmental and social disciplines that have been undertaken across the project area. Along with an assessment of risk to human health and ecological receptors, the EIS assessed the impact to all environmental media including surface water, groundwater and air quality as well as quality of life metrics such as health, noise, traffic, visual and heritage impacts.

Risk assessments are multi-faceted undertakings that vary by the type of risk to be quantified (injury, monetary, etc.), the source of risk (natural occurrences, failures, chemical exposures, etc.) and the metric by which risk is measured. Chemical risk assessments are one component of the overall assessment of project risk. They are based on:

- An evaluation of the concentrations of select chemicals (measured or expected) in environmental media such as soil, groundwater, surface water and air
- Mechanisms by which these chemicals migrate through the environment
- A means to quantify the degree of exposure that a receptor (human and ecological) receives from each chemical through their contact with environmental media
- Based on the relative toxicity of the chemical of concern, a characterisation of effect.

As noted, chemical risk assessments focus on human and ecological exposures to chemicals in environmental media. The means to quantify the intake of a chemical is based on a conservative approach of “reasonable maximum exposure” from hypothetical (and in many cases worst case) release scenarios. The scenarios are usually based on a hypothetical construct that assumes that a receptor (human and ecological) has unfettered access to all areas of the project and unlimited contact with all media. These exposures are only possible if management and operational practices fail. In addition, the concentration of a chemical in environmental media that the receptor is assumed to be exposed to is a statistical upper confidence limit of the mean – higher than the average concentration and in some cases equal to the maximum detected concentration. Similarly, intake is usually quantified by an upper bound value (95th percentile) of the range of values from peer-reviewed studies. The use of conservative assumptions is also prevalent in the quantification of the toxicity of a given chemical; conservatism is expected to account for the uncertainty associated with toxicity studies. Risks are then calculated for each individual chemical under study and risks from multiple chemicals are summed thereby quantifying risks from multiple sources.

Chemical risk assessments use the upper bounds of exposure and therefore quantify the most severe exposure scenarios which given their conservative nature, are also the least likely to occur. They quantify the likelihood and severity of health effects of chronic (long term, low concentration) exposures to chemicals and are given their level of conservatism are not intended to be used as predictors of illnesses or medical ailments. More importantly, chemical risk assessments are focused on health impacts associated with chemical exposures only (both anthropogenic or geogenic). Studies have also shown that health effects can be also be related to urbanisation and changes to social and economic environment and as such these potential impacts on the community have been assessed in other relevant chapters of the EIS (air, noise etc.) and holistically the EIS addresses all significant modes of exposure and impact on the populace.

The findings of the Chemical Risk Assessment align with those of the NSW Chief Scientist and Engineer’s (2013) review of the risk associated with coal seam gas activities in NSW that concluded that “provided drilling is allowed only in areas where the geology and hydrogeology can be characterised adequately, and provided that appropriate engineering and scientific solutions are in place to manage the storage, transport, reuse or disposal of produced water and salts – the risks associated with coal seam gas exploration and production can be managed”.

The Chemical Risk Assessment is one part of the overall assessment of potential impacts of the project. The EIS process was informed by extensive data collected across several key environmental and social disciplines that have been undertaken across the project site. The potential impacts to human health have been assessed using relevant and applicable methods and regulatory standards. The Chemical Risk Assessment found limited potential for health impacts from chemicals. With appropriate engineering controls and management and monitoring measures in place, it is considered that the risks associated with the use of chemicals for the project can be managed. Issues raised in submissions have been thoroughly reviewed and nothing has been raised that changes the findings of the Chemical Risk Assessment.

Chemicals of concern

Concerns were raised regarding the potential for the activities to result in public exposure to fugitive gas emissions, general concerns with hydraulic fracturing (for which approval is not being sought under the project) and produced water extracted from coal seam formations.

Introduction

The Chemical Risk Assessment undertaken for the project (EIS Appendix T3) systematically and thoroughly assessed all chemicals proposed to be used for drilling and found that none of the chemicals exhibited the combination of persistence, bioaccumulation and toxicity that would make them major concerns for human health. Additionally The Australian Government Department of Health has not identified chemicals being used in the project to be an endocrine disruptor. Approval for hydraulic fracturing is not being sought under the project. The Chemical Risk Assessment found there was no human health impacts expected from produced water due to its characteristics and low likelihood of a loss of produced water due to the design and engineering controls in place to manage the transfer, storage and treatment of produced water.

Coal seam gas is a naturally occurring gas comprised of predominantly methane (NSW Chief Scientist and Engineer 2014), and therefore, fugitive gas emissions from coal seam gas would be dominated by methane. Methane is a simple asphyxiant (which is a hazard); but it is not toxic (TOXNET 2017, NIOSH 2017, OSHA 2017, Air Liquide 2017); the effects of methane are only related to oxygen deprivation that occurs when methane is present in air at a high concentration.

Shale gas (which is not being extracted as part of this project) is also mostly methane but generally also contains a significantly higher (>5 per cent) fraction of hydrocarbon condensates. Studies of the health impacts from other unconventional gas sources (including shale gas) are not applicable to coal seam gas given the disparity in the fraction and composition of chemicals other than methane.

Produced water extracted can be high in naturally occurring salts and organics. The composition of produced water is a function of geology. The design and construction of the water storage and treatment infrastructure for the project represents best practice infrastructure and has been conducted in accordance with the NSW Government's applicable *Code of Practice*. The treated water generated from the Leewood water treatment facility is of a quality suitable for the desired range of beneficial uses and managed release. This has been confirmed by operational and analytical testing data.

The other concerns raised regarding health impacts from groundwater quality relate to the use of chemicals for hydraulic fracturing. As hydraulic fracturing is not proposed for this project, there are no potential risks to groundwater from this activity.

Other health concerns raised are associated with non-chemical stressors such as noise, dust and quality of life issues. These elements are not part of the Chemical Risk Assessment framework and their mode of impact is significantly different from chemical stressors. These factors are often complicated by multiple contributing factors and causality with health concerns is generally uncertain.

There are strict regulatory frameworks in place in NSW to assess, monitor and regulate other emissions. The potential for such impacts and an assessment against the relevant guidelines has been undertaken for the project and is set out in the relevant chapter of the EIS together with mitigation and management measures that will be adopted in the design and operation of the project. Further, an Air Quality Impact Addendum has been prepared for this report (refer to Appendix I).

Other submissions raised the potential for impacts from the use of silica-based products. The only form of silica that is considered to be carcinogenic to humans and / or laboratory animals (and only by the inhalation route) is crystalline silica, and it has to be in a form that is respirable. Besides crystalline silica in sand which has some potential risks associated with worker inhalation, with risks managed in the work area (for example respiratory protection), potassium silicate is the only other silicate based chemical proposed for use on the project. Potassium silicate is an amorphous silicate and is widely used in household cleaning products and is not considered as a carcinogen.

Health effect studies and the distinction between coal seam gas and other unconventional gas production processes

Submissions citing studies attributing health effects to coal seam gas are generally based on studies of hydraulic fracturing and extraction from shale gas. Shale gas formations are not associated with the project and hydraulic fracturing is not proposed for the project. It is important to distinguish coal seam gas from other forms of unconventional gas production as there are fundamental differences in media, processes and sources of exposure. Hydraulic fracturing (if not properly implemented and managed) can create migration pathways for the movement of water and / or gas resulting in impacts to groundwater. Hydraulic fracturing is not proposed, and thus, the chemicals associated with hydraulic fracturing are not included in the list of chemicals assessed for the project.

Most studies of unconventional gas production that were referred to were conducted in the United States and these studies cannot be directly compared to Australian projects due to differences in surface and subsurface conditions and gas composition (NSW Chief Scientist and Engineer 2014). The unconventional gas industry in the United States is primarily focused on shale gas formations with a reliance on hydraulic fracturing, and as such, the findings are not relevant for this project. In addition, the composition of the natural gas such as the fraction of methane compared to other gases (e.g. BTEX and PAHs), varies considerably between shale and coal seam gas development, and therefore, between other projects and this project.

In addition, there are very few peer-reviewed publications that effectively assess health risks. Studies that have been completed are often inconclusive and do not provide firm evidence of causality with coal seam gas activities (NSW Chief Scientist and Engineer 2013, Adam 2013).

The initial report on the Independent Review of Coal Seam Gas Activities in NSW conducted by the NSW Chief Scientist (NSW Chief Scientist and Engineer 2013) reviewed many of the available Australian and international studies and highlighted their main health issues, conclusions and limitations. Select highlights of the initial report's findings were as summarised below (all references available in NSW Chief Scientist and Engineer 2013):

- Health effects of coal seam gas – Tara (Queensland Health 2013). The paper found no evidence that excessive exposure to emissions from the coal seam gas activities were the cause of reported symptoms. The paper also noted that available data were insufficient to properly characterise cumulative impacts on air quality.
- Investigation into health complaints relating to coal seam gas activity, Tara, Queensland (Hutchinson 2013). The study undertook consultations and examinations of clinical data from residents who had self-reported symptoms allegedly related to coal seam gas. The study found a low prevalence of symptoms and low exposure levels and highlighted other household factors such

as pets, open fires, use of generators for electricity and the use of tank and dam water for household supply as potential causes of the reported health concerns.

- Wieambilla Estates odour investigation (Queensland Government 2013). The study used air sampling devices for airborne chemicals including one that could be activated by the resident when an odour was detected. A number of volatile organic compounds (VOCs) were detected however the levels were generally below published health exposure guidelines.
- Analysis of health impacts and stressors from shale gas development in the Marcellus Shale region (Ferrer *et al*. 2013). The study interviewed respondents and their physical symptoms and complaints were recorded as were psychosocial stressors. The authors determined the participants were likely to be individuals opposed to shale gas development and therefore represented a biased sample group. This study has little relevance given that it was conducted in shale gas regions of the United States.
- An independent health survey in the Tara rural residential estates and environs (McCarron 2013). A survey of the reported health effects of 113 residents in the Tara region in the vicinity of a coal seam gas field was conducted. The study reported an increased incidence of symptoms compared to participants' recollection of their health in the two years prior to coal seam gas activities. The study acknowledges the limitations of its design, including the selection of participants and reliance on respondent recall of past symptoms.
- Potential exposure-related human health effects of oil and gas development (Witter *et al*. 2008). The paper focused on possible health, medical and social issues of Garfield County, Colorado, USA, associated with increasing oil and gas activity. The paper reported on studies of wells, springs, ponds and rivers with detectable levels of methane in 75 per cent of samples which the paper posited, were partially due to gas development activities. The NSW Chief Scientist's review of the report finds the associations between health effects and gas extraction activities to be inconclusive.
- Evaluation of impacts to underground sources of drinking water by hydraulic fracturing of coalbed methane reservoirs (United States Environmental Protection Agency 2004). The study reviewed information on 11 major coal basins with 10 co-located with underground sources of drinking water. The report could not find confirmed evidence that drinking water wells were contaminated by hydraulic fracturing fluid injection into coal seam gas wells. This study has little relevance given that it was conducted in the United States.
- Human health risk assessment of air emissions from development of unconventional natural gas resources (McKenzie *et al*. 2012). The study took air samples to measure 78 hydrocarbon chemicals emitted from four tight sands gas well pads during completion and production stages. The study found that cumulative cancer risk for people at the closer distances of < 800 m from well sites was 10 in a million over 30 years, compared with the people living > 800 m having a six in a million over 30 years' cumulative risk. The study was undertaken in a unique formation incompatible with the Narrabri project.

The general conclusion of the NSW Chief Scientist's initial report is that these studies were often inconclusive and do not provide firm evidence of correlations and causality with coal seam gas activities.

A medical review of individuals who believed their health has been adversely affected as a result of coal seam gas exploration in and around Tara, Queensland was conducted by a specialist in occupational medicine (Adam 2013, Narrabri Shire Council 2017). Affected individuals described a variety of symptoms including headache, nose bleeds and nausea. Air samples were also collected independently by the residents to assess air quality when odours were detected. None of the air samples registered contaminants above thresholds. Additionally, the sampling did not register concentrations of hydrogen sulphide despite reported odours (Narrabri Shire Council 2017). The specialist did not find clear and direct links between air exposure from coal seam gas and the complaints made by the residents. The specialist's report did note that coal miners have been, and are regularly exposed to coal seam gas. Despite regular monitoring of the health of coal miners both in

Queensland and internationally, no health effect from potential exposure to methane has been recognised.

A more recent literature review of unconventional gas developments found the strength of epidemiological evidence to be ‘tenuous’, with only seven highly relevant studies providing evidence of associations between environmental health hazards related to unconventional natural gas activities (not just coal seam gas) and health outcomes (Werner *et al*. 2016). The review recommended that further research be undertaken to credibly assess the extent of the risk posed to the public.

Fugitive emissions

Submissions raised health concerns regarding the potential for fugitive emissions from the project.

The focus of the Chemical Risk Assessment was on the chemicals proposed to be used for drilling and development of gas wells, and those proposed for produced water and brine treatment. Exposures to fugitive emissions of gas were considered to represent minor potential risks relative to direct exposure to these chemicals. Methane is an asphyxiant that requires careful management if released within confined or enclosed spaces, however it is not toxic. On the basis that access to well pads and infrastructure is limited there are no credible scenarios where the public is at risk from asphyxiation caused by fugitive emissions.

Studies have been conducted on fugitive gas emissions from coal seam gas development in Queensland and stringent reporting standards have been adopted using more sensitive urban environments to determine the acceptability of emissions. A scientific study of 43 wells in Queensland and New South Wales (Day *et al.* 2014) found that emissions were generally very low, especially when compared to the volume of gas produced. The sources of emissions were found to be equipment leaks, venting, pneumatic device operation and engine exhaust (areas that are often easy to repair), with none showing evidence of subsurface methane migration outside the well casing. The rates of emissions found in the study were much lower than those reported for unconventional gas production in the United States. Emissions can be better managed by implementation of engineering controls; the report noted that larger equipment leaks were found on seals, and that once identified and repaired, the emissions were effectively eliminated.

A 2016 study to better understand the sources of methane emissions in NSW (Day *et al.* 2016) noted that methane concentrations across the state were generally consistent with normal background levels with higher concentrations in urban areas compared to rural regions. The study identified numerous methane sources across NSW, and while there were uncertainties regarding emission estimates from these sources, the relative contribution of each showed that emissions from coal seam gas were small (as of 2016) in comparison to:

- coal mining and agriculture (large sources)
- landfills (moderate sources)
- Other small sources of methane emissions including wastewater treatment facilities and wetlands.

A more recent study focused on regional emissions from coal seam gas basins in NSW (Ong *et al*. 2017) to establish a baseline of methane emissions (both natural and anthropogenic) prior to large-scale gas development. As concluded by the earlier study, the latest study confirmed that the ambient methane concentrations are similar to background concentrations with no known sources of anthropogenic methane. However, transient elevated concentrations were detected which the study attributed to coal seam gas facilities, likely from gas-actuated pneumatic devices.

A survey in the vicinity of boreholes did not report elevated methane concentrations, with the study concluding that emissions from the boreholes examined to date have been negligible suggesting that, unlike some areas in Queensland, boreholes do not represent a significant methane source. The report also noted the presence of several large coal mines within the study area and indicated that an underground coal mining operation near Narrabri is the largest source of methane in the region, significantly greater than sources from other open-cut coal mines, agriculture (fermentation from livestock) and landfills.

A review of literature by Narrabri Shire Council (Narrabri Shire Council 2017) noted that published arguments regarding gas emissions for the Narrabri project were sourced from studies in the United States and from studies conducted in Queensland. As noted by Narrabri Shire Council, these studies are for distinct geology, landscapes and likely gas compositions that are not applicable to the development of the Narrabri project and conclusions should be viewed under such considerations.

In the comments provided on the project, cited publications discussing the health effects from fugitive emissions and their health implications are generally associated with other unconventional gas production processes including hydraulic fracturing, a process not proposed in this project. In addition, a significant proportion of the peer-reviewed articles were conducted for operations in the United States, primarily for shale gas developments, where volatile hydrocarbons such as BTEX and PAHs would have a more profound and supportable toxicological profile as compared to the (predominantly) methane emissions from NSW coal seam gas operations. In this context, all international cited references are not applicable to the assessment of potential risks associated with this project.

The proponent has committed to identifying and minimising fugitive emissions from its wells and facilities, with the leak detection and repair program currently implemented proposed to continue for the project. This program includes regular monitoring and manual inspection of field infrastructure and includes a notification, reporting and corrective action regime.

Endocrine disruptors

Submissions raised health concerns regarding potential exposure to endocrine disrupting chemicals.

Endocrine disrupting chemicals are chemicals that can affect the production, secretion and action of the body's hormones and have been proposed to be associated with adverse health effects. The Australian Government Department of Health acknowledges that the area of endocrine active chemicals is still growing and therefore an understanding of what they are, how they are defined, and how they work is evolving (Australian Government Department of Health 2017). The area is still subject to study with questions regarding causality by chemicals regarded as endocrine disrupting chemicals and unresolved trends in disease incidence or known risk factors (Lamb *et al*. 2014).

The Australian Government Department of Health has not identified chemicals being used in the project to be an “Endocrine Disruptor” based on the internationally accepted definition by the World Health Organisation - International Programme on Chemical Safety. This definition requires that chemicals should only be identified as an “Endocrine Disruptor” when relevant studies demonstrate clear adverse effects in intact organisms that are caused by a mode of action involving the endocrine system. None of the chemicals proposed for use in drilling or water treatment on the Narrabri project have been considered to be endocrine disrupting chemicals by regulatory agencies in Australia, the United States, The European Union or Japan.

Comments suggest an association between unconventional gas production and endocrine disrupting chemicals with a primary focus on methanol. One submission cited online resources that lists methanol as an endocrine disruptor, however, the references used to justify this claim do not provide evidence that methanol can alter the endocrine system or more specifically the estrogenic, androgenic or thyroid systems. In fact, one of the studies cited clearly shows that the endocrine system is not involved in developmental toxicity. Methanol has been extensively studied and reviewed, particularly because of its proposed use as a fuel additive. There is no scientific merit to the claim that methanol is an endocrine disrupting chemical. The Australian Government Department of Health has also concluded in its human health assessment that "[methanol] is not considered to have reproductive or developmental toxicity in humans".

6.27 Economics

The potential economic effects of the project were assessed in Appendix U1 and Appendix U2 and summarised in Chapter 27 of the EIS. The cost benefit analysis and the regional economic assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and in line with the Secretary's environmental assessment requirements.

The cost benefit analysis found that the project would create net benefit with a benefit cost ratio of 1.43. Sensitivity analyses confirmed a net economic benefit for a range of scenarios including 10 per cent discount rate, 10 per cent decreased gas production, 10, 20 and 30 per cent reduced gas price, and 10 per cent increased capital and operating costs. The sensitivity analysis showed positive outcomes under all modelled sensitivity analyses with the exception of a 30 per cent reduction in gas price.

The regional economic assessment indicated that the project would create economic benefits for the local economy of the Narrabri local government area (LGA), the wider region and NSW as a whole. The economic benefits predicted in the regional economic assessment included:

- real economic output of $11.9 billion (around $5.1 billion net present value), including
  - $11.0 billion (around $4.5 billion net present value) in the Narrabri LGA
  - $572 million (around $348 million net present value) in the wider region
  - $384 million (around $295 million net present value) across the rest of NSW
- real income of $6.0 billion (around $2.8 billion net present value), including
  - $526 million (around $250 million net present value) in the Narrabri LGA
  - $690 million (around $396 million net present value) in the wider region
  - $4.8 billion (around $2.1 billion net present value) across the rest of NSW
- establishment of a Gas Community Benefit Fund which would receive an estimated $120 million through the life of the project
- average direct and indirect employment over the 25-year assessment period of 512 full time equivalent jobs in NSW, including:
  - 127 full-time equivalent jobs in the Narrabri LGA
  - 161 full-time equivalent jobs in the wider region
  - 224 full-time equivalent jobs in the rest of NSW.

The assessment found the project would boost the NSW economy and deliver benefits at the local, regional and State level. Positive economic impacts would be leveraged toward local industry with the implementation of the Gas Community Benefit Fund and a procurement and logistics policy to support the involvement of local business and contractors in the project.

16,868 submissions raised issues specifically relating to the economics assessment presented in Chapter 27 and Appendices U1 and U2 of the EIS.

The majority of these submissions concerned the regional economic assessment as this matter was raised in a large number of form submissions. A smaller number concerned the cost benefit analysis or investment risk as unique submissions or additional remarks on form submissions.

A large number of submissions raised issues that were more specific to the social impacts of employment created by the project. These issues are discussed in Section 6.26.

The division of submissions by issue and submission type is depicted in Figure 6-40.

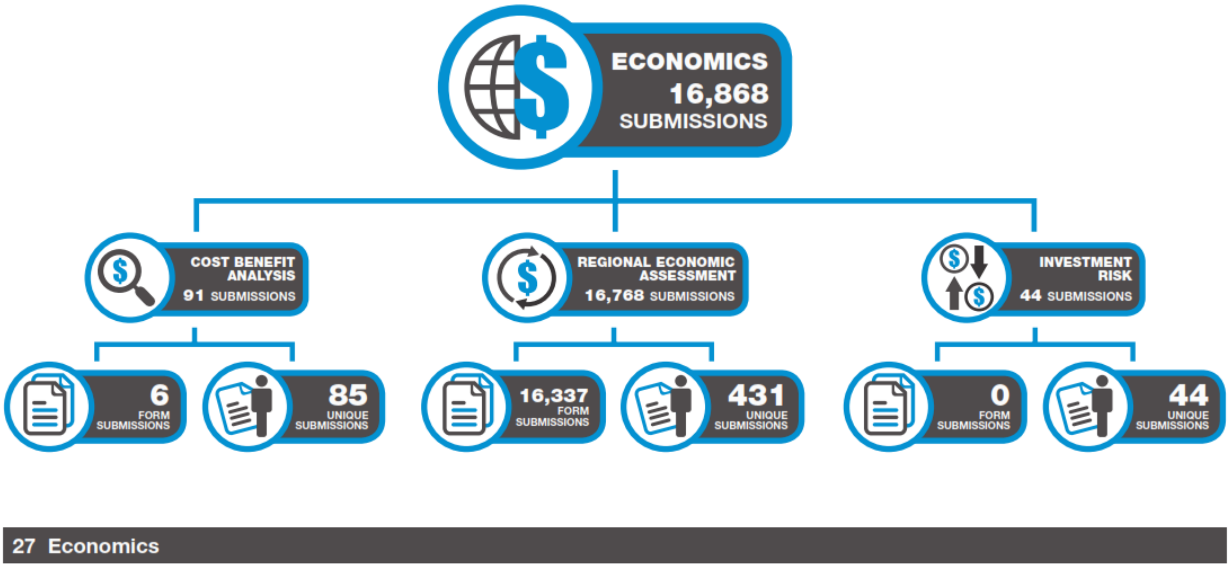


Figure 6-40 Summary of submissions on economics

6.27.1 Cost benefit analysis

Benefit to Australian population

Submissions raised issues regarding ownership of the proponent and its joint venture participants. They stated the benefit to the Australian community was overstated in the cost benefit analysis.

Submissions stated the economic benefits of the project would accrue overseas or to the proponent while the costs would be borne by communities and regulators.

Submissions stated that the project was 30 per cent foreign owned when the ownership of the proponent and its joint venture participants were both considered.

The *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) require analysis of net benefits flowing to Australian residents and therefore some understanding of the extent of foreign ownership of the project. The cost benefit analysis was undertaken from the perspective of Australian residents and is therefore consistent with the *Guidelines* in this respect.

It is also important to recognise that an EIS is a 'point-in-time' assessment. It is routinely necessary during impact assessment to make a number of informed assumptions, which is the case for the Economic Impact Assessment that uses modelling to estimate economic impacts from the project. The actual values of data represented by these assumptions are dynamic and subject to change throughout time, including during the assessment and operational phases of a project. Meaningful modelling results can therefore best be attained by apportioning a reasonable range within which those appropriate values might lie, and testing the significance of changes within that range to generate outcomes of the economic assessment.

Assumptions made for the purposes of conducting the economic impact assessment included Australian ownership being 87 per cent and that the Santos group was the beneficiary of the project.

The proponent, like many Australian publically listed companies, is partially owned by non-domestic institutional investors and, as a public company, its shares may be freely traded by individuals and other companies on the stock exchange. Therefore, the percentage of domestic ownership is constantly in flux. Whilst recognising this, the assumption of 87 per cent Australian ownership was utilised in the economic assessment which was reflective of the proponent’s share registry at the time the assessment was undertaken.

Changes in the assumed share of domestic ownership of the project may be assumed to result in proportional changes in the net present value of the project to the Australian community. Net present value measures only the direct impact of the project. However, the indirect flow-on effects of the project via employment, royalties and taxation may be less sensitive to ownership.

In response to the submissions, a sensitivity analysis undertaken on the Australian ownership and project beneficiary assumptions finds that:

- An increase from 87 per cent to 92 per cent Australian ownership of the Santos group would cause the net value of the project to NSW to increase by 6 per cent (equating to $24.6 million less for electricity option 1 - self-generated, and $26.2 million less for electricity option 2 - grid supplied).
- Conversely, a decrease in Australian ownership to 82 per cent would decrease the net value of the project by the same amounts as set out above.
- If the benefits of the project were shared 80 / 20 per cent between the Santos group (assuming 87 per cent Australian ownership of the Santos group) and another non-domestic company, the net value of the project would be 20 per cent lower than if the proponent was the sole project beneficiary (equating to $85.5 million less benefit to NSW for electricity option 1 and $91.3 million less for electricity option 2).

Compliance with assessment guidelines

Submissions stated the cost benefit analysis did not comply with NSW assessment guidelines. And that some of its assumptions were not transparent. They also stated that the guidelines require the assessment to provide an estimate of the benefit to the NSW population as well as the Australian population.

The *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) require an estimate of the net present value of benefits to New South Wales, and for this purpose, recommend the default attribution of 32 per cent of the Australian domestic net benefits to New South Wales (refer to Table 3.4 in T*he Guidelines*).

Determination of the benefit to the NSW population shows (depending on the choice of power Option 1 or Option 2 for the project):

- A net present value to NSW of $427.6 million for power generation Option 1 (on site power generation) or $456.4 million for Option 2 (grid supplied electricity) at a seven per cent discount rate.
- A benefit-cost ratio of 1.11 for power generation Option 1 (on site power generation) or 1.12 for Option 2 (grid supplied electricity).

These values increase to $775.4 million (Option 1) or $817.8 million (Option 2) at a four per cent discount rate, for a benefit-cost ratio of 1.16 or 1.17 respectively, and decrease to $215.2 million (Option 1) or $235.6 million (Option 2) at a ten per cent discount rate, for a benefit-cost ratio of 1.07 or 1.08 respectively.

Further sensitivity analysis shows:

- A ten per cent reduction in gas production estimates results in a net present value to NSW of $277.1 million (Option 1) or $306.0 million (Option 2), for a benefit-cost ratio of 1.07 or 1.08 respectively.
- A ten per cent reduction in gas price estimates results in a net present value to NSW of $277.1 million (Option 1) or $306.0 million (Option 2), for a benefit-cost ratio of 1.07 or 1.08 respectively.
- A twenty per cent reduction in gas price estimates results in a net present value to NSW of $126.7 million (Option 1) or $155.5 million (Option 2), for a benefit-cost ratio of 1.03 or 1.04 respectively.
- A thirty per cent reduction in gas price estimates results in a net present value to NSW of - $23.7 million (Option 1) or $5.1 million (Option 2), for a benefit-cost ratio of 0.99 or 1.00 respectively.
- A ten per cent reduction in gas production and also a ten per cent reduction in gas price estimates results in a net present value to NSW of $141.8 million (Option 1) or $170.6 million (Option 2), for a benefit-cost ratio of 1.04 or 1.04 respectively.
- A ten per cent increase in capital and operating costs results in a net present value to NSW of $218.9 million (Option 1) or $247.7 million (Option 2), for a benefit-cost ratio of 1.05 or 1.05 respectively.

Consideration of optimism bias

Submissions stated the assessment did not account for the optimism bias typical of large projects and documented in academic literature. They stated this bias was reflected in cost benefit analysis guidelines administered by the UK Government and had been considered by the Victorian Government as well as regulators in Switzerland, Denmark and the Netherlands.

The cost benefit analysis and the economic impact assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and in line with the Secretary's environmental assessment requirements. Appendices U1 and U2 of the EIS were also prepared using cost and production estimates, forecast gas prices and other information as provided by the proponent.

Validation of assumptions

Submissions stated that the proponent provided assumptions in the cost benefit analysis including capital and operating costs, gas prices, taxes and royalties. They stated the cost benefit analysis underestimated the cost of gas production. They concluded the cost benefit ratio of the project was marginal and high risk.

Submissions stated that the cost benefit ratio of the project was sensitive to change. They stated that a cumulative change of about 30 per cent in a single or combination of gas production volume, gas production cost, or gas sale price could make the ratio marginal.

Submissions stated that project capital expenditure and operational expenditure were underestimated. They stated that Sections 4.1.1 and 4.1.2 of the cost benefit analysis appeared to discount 2016/17 costs by around 16.5 per cent and 30.7 per cent and reduce the present value of the costs by about $1 billion.

They stated that these assumptions should have been independently validated. They recommended the use of reference class forecasting whereby assumptions are developed with reference to similar projects rather than advice from the proponent.

The cost benefit analysis and the Economic Impact Assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and in line with the Secretary's environmental assessment requirements. Appendices U1 and U2 of the EIS were also prepared using cost and production estimates, forecast gas prices and other information as provided by the proponent.

A large range of gas price outcomes is possible in the next 25 years. The assumed gas price of $8.70/GJ in real 2016 / 17 Australian dollars was provided by the proponent. The sensitivity of the net present value to lower gas prices was tested in the EIS (Appendix U1), finding that the project is still viable for gas prices up to 30 per cent lower than the central assumption (around $6.10/GJ).

It is noted that the NSW Division of Resources and Geoscience noted in its EIS submission that the forecast gas price used in the EIS cost benefit analysis of $8.70 GJ lies within the range of expected future gas prices in the east coast market over the more than 20-year project life.

Further, sensitivity analysis was undertaken in the cost-benefit analysis with respect to negative variation on (refer to EIS Appendix U1 – Economic Assessment):

- Discounting rate assumptions.
- Production estimates.
- Gas price estimates.
- Capital and operating costs.

The purpose of the sensitivity analysis was to test the assumptions behind the analysis and the robustness of the central result to changes in those assumptions. The positive outcome of the cost benefit analysis was found to be relatively insensitive to a range of variation in the in the input assumptions. The most extreme test was a reduction of 30 per cent in the gas price, which resulted in a net present value close to zero and a benefit cost ratio of close to one, under which circumstance the project would be of no economic value to the community. The sensitivity analysis demonstrates that the project returns a positive cost benefit ratio under most modelled scenarios and acts as validation of the potential for over inflated or overly optimistic assumptions.

The cost benefit analysis report considers various scenarios of reduced gas prices and gas production. The analysis shows that a 30 per cent reduction in the real gas price across all years is sufficient to erode almost all project net benefits, resulting in benefit-cost ratios close to one and net present values close to zero (refer to Tables 5-4 and 5-5 on pages 27 and 28 of EIS Appendix U1 respectively). Sensitivity around the cost benefit analysis therefore suggests that the project would be unlikely to be economically viable at a received gas price that is sustained below $6.10 / GJ in real 2016/17 prices.

By comparison, recent Sydney Hub Short Term Trading Market prices have averaged $9.70 / GJ - see https://www.aemo.com.au/Gas/Short-Term-Trading-Market-STTM/Data.

Project expenditure is distributed unevenly throughout the period 2016 to 2041. In real 2016/17 dollars, the total undiscounted value of capital expenditure is $2.98 billion and the total undiscounted value of operating expenditure is $3.79 billion. Applying a seven per cent discount rate to the years 2017/18 onwards (i.e. discounting from the standpoint of 2016 / 17), these amounts are $2.0 billion and $1.58 billion, respectively.

Further, the cost-benefit analysis was progressed on the assumption that if the gas price were so low that net benefits were expected to be negative, the project would be unlikely to proceed.

The NSW Department of Planning and Environment has appointed an independent third party technical specialist to peer review Appendices U1 and U2 from the EIS.

Financial valuation of project

Submissions noted alignment between investor discount rates used to write down project value and the discount rate in the cost benefit analysis. They stated this highlighted the inconsistency between the financial assessment of the project and the cost benefit analysis.

The cost benefit analysis and the Economic Impact Assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and in line with the Secretary's environmental assessment requirements. Appendices U1 and U2 of the EIS were also prepared using cost and production estimates, forecast gas prices and other information as provided by the proponent.

Cost of potential environmental externalities

Submissions stated that costs associated with potential impacts to groundwater, surface water, terrestrial ecology, air quality, non-Aboriginal heritage, Aboriginal heritage, visual amenity, Siding Spring, greenhouse gas emissions, waste, health, tourism and other industries was not reflected in the cost benefit analysis presented in the EIS.

They stated that low probability, high impact events such as groundwater impacts or health impacts involved a level of uncertainty that was not adequately costed. They also stated that fugitive or migratory greenhouse gas emissions were underestimated and inaccurately costed.

Submissions stated the cost benefit analysis did not include the cost of environmental insurance. They stated the cost benefit analysis should be recalculated to include this cost for all stakeholders in the short and long terms over the life of the project.

The cost benefit analysis and the regional economic assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and in line with the Secretary's environmental assessment requirements.

The Groundwater Impact Assessment reported in Appendix F of the EIS identified a number of possible impacts to groundwater as a result of the project, all of which were expected to not be significant. A corresponding risk assessment found all residual risks to be low. The risk of not maintaining water quality during drilling will be mitigated by compliance with the NSW Government's

Code of Practice for Coal Seam Gas Well Integrity. Surface water impacts are also assessed as very low risk. Due to the low likelihood of water related impacts occurring and the difficulty in valuing and apportioning probabilities to such events, they were not quantified in the cost benefit analysis.

Greenhouse gas emissions were costed as required under the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015).

Adverse impacts on air quality (e.g. due to well pad engine emissions, dust from land clearing, earthworks, diesel engine operations), Aboriginal and non-Aboriginal heritage, amenity (e.g. visual) and tourism / recreation were all considered to either low risk or of low significance or both. Residual biodiversity impacts were offset through the Biodiversity Offset Strategy (Appendix F to this RTS) which have associated costs factored into the cost benefit assessment. A Gas Flare Light Assessment (Appendix K to this RTS) shows no impact to Siding Spring, so no costs were therefore assigned to the cost benefit assessment.

Insurance is costed by multiplying the cost of a potential event should it occur by the expected probability of it occurring. This is the same as allowing for the expected cost of the event, and would therefore be double counting costs that are already included.

Cost of treating water

Submissions stated that removal of salt from produced water was an energy intensive process that would be fuelled by product gas. They stated that the proponent will not pay royalties on the gas utilised by the project for water treatment.

Clause 42 in Part 8 of the NSW *Petroleum (Onshore) Regulation 2016* states that ‘for the purposes of section 85 (2) of the Act, the prescribed annual rate of royalty is 10 per cent of the value at the well-head of the petroleum.

Cost of drilling fluid disposal

Submissions stated the cost benefit analysis did not reflect the cost of disposing drilling fluid.

The cost benefit analysis and the Economic Impact Assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and in line with the Secretary’s environmental assessment requirements. Appendices U1 and U2 of the EIS were also prepared using cost and production estimates, forecast gas prices and other information as provided by the proponent.

All capital and operating costs associated with the project were valued, including exploration costs during the lifetime of the project, and construction, operations and rehabilitation costs.

Cost of regulating natural gas development

Submissions stated the cost benefit analysis did not meet recommendation 4 of the NSW Chief Scientist and Engineer *Final Report of the Independent Review of Coal Seam Gas Activities in NSW*, which recommended including the full cost of regulating natural gas development.

The cost-benefit analysis (EIS Appendix U1) and Economic Impact Report (Appendix U2) were completed in accordance with the Secretary's Environmental Assessment Requirements including reference to the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015). The economic analyses included consideration of government revenues payable over the life of the project, being approximately $1.2 billion (net present value).

Cost of sales gas pipeline

Submissions stated that the cost of the gas pipeline should have been assessed. They stated the gas pipeline would be a significant cost including approvals, consultation and construction and operation of the pipeline itself.

In accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015), the cost benefit analysis for the EIS included costs likely to be borne by the proponent for the transportation of product gas via the sales gas pipeline as a component of the operating costs of the project. Operational cost is part of the calculation of net producer surplus as required by the Guidelines. The gas pipeline is therefore adequately represented in the cost benefit analysis in the EIS (refer Appendix U1).

The costs of construction and operation of the sales gas pipeline would be assessed in the EIS for the Western Slopes Pipeline. The Preliminary Environmental Assessment for the pipeline is available at: https://majorprojects.accelo.com/public/95ba8b7700e6626f48cefb1e424c996c/Western%20Slopes%20Pipeline%20-%20Preliminary%20Environmental%20Assessment.pdf).

Gas community benefit fund

Submissions stated that the $120 million valuation of the Gas Community Benefit Fund was based on outdated royalty estimates. They stated the royalty estimates were updated in the EIS but this was not reflected in the valuation of the Gas Community Benefit Fund.

The New South Wales Government will receive additional royalties (estimated to be $1.2 billion in nominal terms) and taxes from the project. The NSW Government has committed that for every two dollars paid by a gas producer into an authorised Gas Community Benefit Fund, the company is entitled to claim a one dollar rebate on its gas royalties, up to a maximum of 10 per cent of the royalty due in each year. (The total value of the Gas Community Benefit Fund is anticipated to be around $120 million in nominal terms).

6.27.2 Regional economic assessment

Economic benefits

Some submissions recognised the potential economic benefits of the project at local, regional and state levels through job creation and economic output.

Some submissions stated that opportunities such as the project are limited in regional NSW and were desirable. They cited feedback from local business in Narrabri stating they were expecting improved business opportunities. They also cited the Narrabri Chamber of Commerce stating they had received expressions of interest from gas using business to relocate to the region.

Submissions regarding the potential economic benefits of the project are noted. These include:

- real economic output of $11.9 billion (around $5.1 billion net present value), including
  - $11.0 billion (around $4.5 billion net present value) in the Narrabri LGA
  - $572 million (around $348 million net present value) in the wider region
  - $384 million (around $295 million net present value) across the rest of NSW
- real income of $6.0 billion (around $2.8 billion net present value), including
  - $526 million (around $250 million net present value) in the Narrabri LGA
  - $690 million (around $396 million net present value) in the wider region
  - $4.8 billion (around $2.1 billion net present value) across the rest of NSW
- establishment of a Gas Community Benefit Fund which would receive an estimated $120 million through the life of the project
- average direct and indirect employment over the 25-year assessment period of 512 full time equivalent jobs in NSW, including:
  - 127 full-time equivalent jobs in the Narrabri LGA
  - 161 full-time equivalent jobs in the wider region
  - 224 full-time equivalent jobs in the rest of NSW.

Impacts to regional economy

Submissions stated the project would have negative impacts on the Narrabri local economy in general including impacts on local business and employment.

Some submissions cited research on natural gas development in Queensland. They stated that local businesses had reported deterioration in financial capital, local infrastructure and local skills. They stated that for every ten jobs created by natural gas production, seven jobs were lost in service sectors. They also stated that the gas development produced no ‘spill over’ jobs in retail or manufacturing. They stated that the project would draw labour from other industries and cited studies indicating that for every job created by the natural gas 1.7 or 1.8 jobs would be lost in agriculture. Others stated that seven jobs were lost in service sectors for every 10 created by natural gas. They stated that jobs in the agriculture industry would be more sustainable than the project.

Submissions stated that the natural environment and particularly the Great Artesian Basin support agriculture and tourism that would be affected negatively by the project.

Submissions stated the project would be a risk for food security of agriculture reliant on the Great Artesian Basin due to reputational and environmental risks.

The research (Fleming and Measham 2015) showed that there were spill over jobs in retail and manufacturing; however, that these effects were small at the regional level (and statistically insignificant). Fleming and Measham (2015) showed positive impacts in the construction, professional services and accommodation and food services sectors in addition to the negative jobs outcomes in agriculture. Overall, their research showed a positive impact on local jobs from natural gas development.

Fleming and Measham's (2015) research showed that the overall impact was positive (p. 92). They noted that:

> *Overall, the analysis demonstrates that the CSG regions of the Surat and Bowen basins show benefits in terms of income and employment compared to non-CSG regions.*

Other research by Everingham *et al.* (2013) involved interviewing 35 stakeholder groups from a cross section of sectors in the Darling Downs (including the two LGAs of Toowoomba and Western Downs, combined population of 194,000). Concerning financial capital (economic benefits), the authors stated that:

> *Growth in the resources sector is seen to have added to financial capital in an uneven way. Associated costs were noted, for example, rising prices and competition for labour with 'have nots' seen to be falling further behind. The disparate financial fortunes are also linked to factors unrelated to resources development, such as drought and fluctuation prices for agricultural produce that are leading to other changes in the regional economy.*

Given the small sample size (35 stakeholder groups to represent the welfare of 194,000 people) and that other issues such as drought were concurrent factors, the research may be considered somewhat limited. However, perceptions such as rising labour costs as a result of natural gas development are supported by the analysis undertaken for the project and are to be expected as a result of resource projects generally.

The Economic Impact Report (EIS Appendix U2) did not assume negative impacts to agriculture other than those associated with the loss of available agricultural land resulting from the footprint of the project.

With regard to the sustainability of jobs in natural gas production versus agriculture, the analysis conducted for the EIS ran until 2042 and showed improved job outcomes in all regions of NSW over that time span. The agricultural jobs that relocate to other industries do so in response to higher wages than those they could earn in agriculture.

Potential impacts on tourism and recreation were assessed in Section 6.3.4 of the Social Impact Assessment in Appendix T1 of the EIS. The Social Impact Assessment was based on findings of other technical studies including the Noise and Vibration Assessment, Traffic Impact Assessment and Landscape and Visual Impact Assessment in EIS Appendices M, P and Q respectively. The assessment was also informed by consultation with the Narrabri Visitor Centre.

The assessment found that the main recreational or tourism values in and around the project area included activities in the Pilliga such as bird watching or bushwalking, activities at Yarrie Lake Flora and Fauna Reserve and Siding Spring Observatory. The assessment found that the project would have low impacts on tourism and recreation.

Tourism and recreation values of the Pilliga would be largely preserved as the project as forested areas would remain accessible by existing roads and access tracks in the project area. Some limited areas such as well pads and major facilities would be fenced but would not preclude public access to forested areas or the Pilliga more broadly.

Yarrie Lake reserve is defined as the following land: Lot 51, DP 43308; Lot 52, DP 43308 and Lot 53, DP 43308. Parts of this reserve extend in the order of one kilometre from the boundary of Yarrie Lake. The reserve is a designated surface development exclusion zone (plus a buffer of at least 50 m) for the project. No surface infrastructure will be located within the Yarrie Lake reserve, or the 50 m buffer area.

The project is therefore not expected to affect the social values of Yarrie Lake or its use by the community.

As discussed in Section 6.23, the operation of the project has been assessed in the Gas Flare Light Assessment (refer to Appendix K of this RTS) as not affecting observing conditions on Siding Spring Observatory, and would therefore not affect its value to tourism.

Benefits to local businesses

Submissions noted the predicted real income of $526 million in the Narrabri local government area.

They stated that this money would be transferred through local businesses to larger supply companies and would not represent a genuine local benefit.

The Economic Impact Assessment (EIS Appendix U2) notes that it is possible that some additional income would be earned by businesses with ownership outside of the region. However, a significant share of the additional local income will accrue to wage and salary earners in the region. In addition, it was estimated that $120 million will be transferred into the region as a result of the Gas Community Benefit Fund.

Impacts to Siding Spring Observatory

Submissions stated that tourism and jobs at Siding Spring Observatory would be negatively affected by the project. They noted the observatory associated facilities are utilised by over 30 universities, institutions and private businesses with plans to expand the site in the future.

A Gas Flare Light Assessment was undertaken and is provided as Appendix K to this RTS. The assessment found that operation of the safety flare would result in limited light impacts well below the threshold in the *Dark Sky Planning Guideline* (Department of Planning and Environment 2016).

During routine operation of the safety flare, the assessment found that vertical skyglow would remain at less than one degree above the horizon, which is the same as existing conditions. During non-routine operation of the safety flare, the assessment found that vertical skyglow would reach about 2.5 degrees across a narrow band of the horizon about 12 kilometres wide. The assessment also considered adverse cloud conditions that produced a maximum vertical skyglow of 7.4 degrees.

In all assessed scenarios, the predicted skyglow would be well below the 30 degree reference point in the *Dark Sky Planning Guideline* (Department of Planning and Environment 2016).

Lighting at Leewood, Bibblewindi, Westport workers' accommodation and well pads will comply with Australian standard AS/NZS 4282 – 1997 *Control of the obtrusive effects of outdoor lighting*. The purpose of the guideline is to limit light spill through appropriate directional lights and shading devices.

Consultation with other business and tourism groups was completed for the EIS and is reported in Appendix T1 (Social Impact Assessment). This assessment included regional tourism generated by Siding Spring Observatory and also impacts to local business. The assessment concluded that 'it is not anticipated that the project would have direct social impacts on the Observatory'.

6.27.3 Investment risk

Valuation of the project

Submissions stated that the project was not economic and that this was reflected in the proponents published accounts that have written down its value of $1.7 billion.

They stated that the proponent was currently exporting gas at a price that was around 80 per cent less than the cost of producing gas from the project.

They also stated the project would be a stranded asset due to a low return on investment and in part because surrounding properties would not permit access to project infrastructure.

The cost benefit analysis and the Economic Impact Assessment were undertaken in accordance with the *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (NSW DPE 2015) and in line with the Secretary's environmental assessment requirements. Appendices U1 and U2 of the EIS were also prepared using cost and production estimates, forecast gas prices and other information as provided by the proponent.

A large range of gas price outcomes is possible in the next 25 years. The assumed gas price of $8.70/GJ in real 2016/17 Australian dollars was provided by the proponent. The sensitivity of the net present value to lower gas prices was tested in the EIS (Appendix U1), finding that the project is still viable for gas prices up to 30 per cent lower than the central assumption (around $6.10/GJ).

It is noted that the NSW Division of Resources and Geoscience noted in its EIS submission that the forecast gas price used in the EIS cost benefit analysis of $8.70 GJ lies within the range of expected future gas prices in the east coast market over the more than 20-year project life.

Further, sensitivity analysis was undertaken in the cost-benefit analysis with respect to negative variation on (refer to EIS Appendix U1 – Economic Assessment):

- Discounting rate assumptions.
- Production estimates.
- Gas price estimates.
- Capital and operating costs.

The purpose of the sensitivity analysis was to test the assumptions behind the analysis and the robustness of the central result to changes in those assumptions. The positive outcome of the cost benefit analysis was found to be relatively insensitive to a range of variation in the in the input assumptions. The most extreme test was a reduction of 30 per cent in the gas price, which resulted in a net present value close to zero and a benefit cost ratio of close to one, under which circumstance the project would be of no economic value to the community. The sensitivity analysis demonstrates that the project returns a positive cost benefit ratio under most modelled scenarios and acts as validation of the potential for over inflated or overly optimistic assumptions.

The cost benefit analysis report considers various scenarios of reduced gas prices and gas production. The analysis shows that a 30 per cent reduction in the real gas price across all years is sufficient to erode almost all project net benefits, resulting in benefit-cost ratios close to one and net present values close to zero (refer to Tables 5-4 and 5-5 on pages 27 and 28 of EIS Appendix U1 respectively). Sensitivity around the cost benefit analysis therefore suggests that the project would be unlikely to be economically viable at a received gas price that is sustained below $6.10/GJ in real 2016/17 prices. By comparison, recent Sydney Hub Short Term Trading Market prices have averaged $9.70/GJ - see https://www.aemo.com.au/Gas/Short-Term-Trading-Market-STTM/Data.

Project expenditure is distributed unevenly throughout the period 2016 to 2041. In real 2016/17 dollars, the total undiscounted value of capital expenditure is $2.98 billion and the total undiscounted value of operating expenditure is $3.79 billion. Applying a seven per cent discount rate to the years 2017/18 onwards (i.e. discounting from the standpoint of 2016/17), these amounts are $2.0 billion and $1.58 billion, respectively.

Further, the cost-benefit analysis was progressed on the assumption that if the gas price were so low that net benefits were expected to be negative, the project would be unlikely to proceed.

The proponent considers landholder engagement and consultation as an important component of all stages of development and does not agree with the submission's assertion that the project would be a 'stranded asset'.

In accordance with the *Agreed Principles of Land Access* (DRE 2015), gas wells will only be drilled on a landholder's property where there is a Land Access Agreement in place. This agreement will be required with each landowner before infrastructure may be located on the landholder's property.

A Farm Management Plan will be developed in liaison with landholders to document planned activities and indicative timing of these for both the landholder and the proponent to enable coexistence of activities to be managed effectively.

Liability for risks

Submissions stated that the NSW government should ensure the proponent carries financial liability for environmental risks associated with the project.

In accordance with NSW Government policy, all title holders engaged in coal, mineral and petroleum exploration as well as mining and petroleum production activities are required to lodge a security deposit to cover the cost of undertaking rehabilitation (Department of Planning and Environment 2017).

6.28 Waste management

The potential impacts of waste generated by the project and its management were assessed in Chapter 28 of the EIS. The assessment included an inventory of potential waste streams during the construction and operation of the project and found would generate a range of wastes including green waste, waste construction materials, drill cuttings, drill fluids, waste maintenance materials, salt and sewage.

The assessment found that about half of the drill cuttings would be reused on site whilst the remainder would be disposed of at an appropriately licensed facility. Drilling fluid would be recycled, reducing the volume of drilling fluid for disposal by approximately 90 per cent while the remaining 10 per cent would disposed of to an appropriately licensed facility. Residual salt from the treatment of produced water was found to be classified as general solid waste under the NSW EPA *Waste Classification Guidelines* (2014) and would be disposed of at an appropriately licenced facility.

Waste generated by the construction and operation of the project would be managed through the implementation of a Waste Management Plan developed in accordance with the *Waste Avoidance and*

Resource Recovery Act 2001. The assessment found the residual environmental risk presented by waste generated by the project with the management plan in place would be low to very low.

18,006 submissions raised issues specifically relating to the waste assessment in Chapter 28 of the EIS. The majority (17,973) of these submissions concerned the management of waste salt generated by the project. However, 16,537 of those were form submissions.

A smaller number of submissions concerned management of drill fluids and cuttings (6) or general waste (48). The majority of submissions that raised waste issues were form submissions although 1,436 unique submissions were made that concerned the management of waste salt generated by the project.

The division of submissions by issue and submission type is depicted in Figure 6-41.

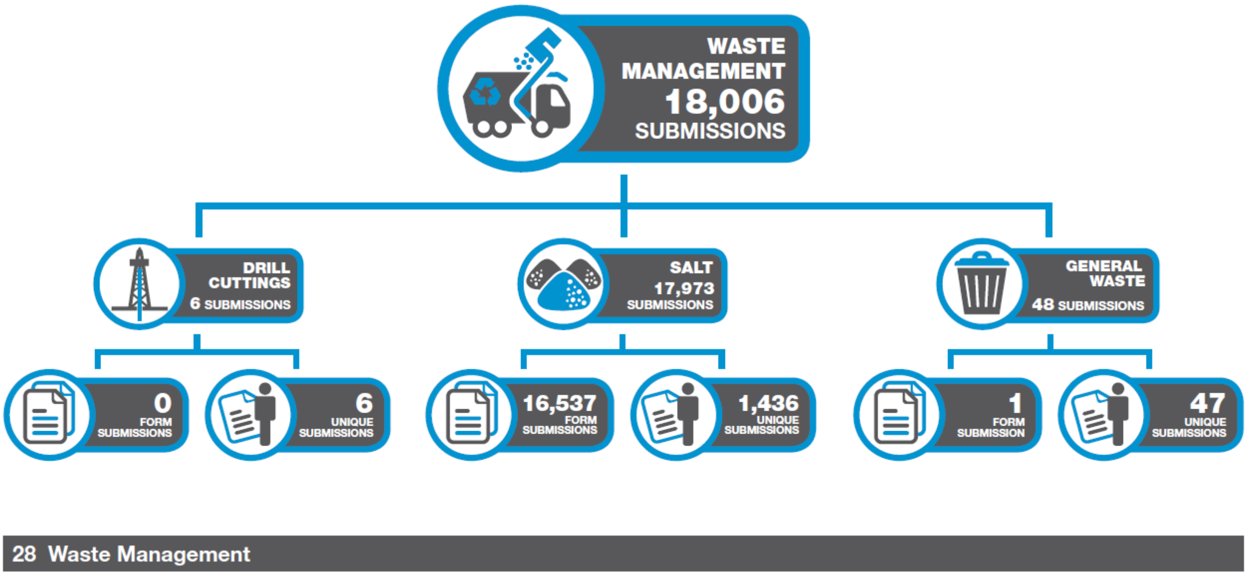


Figure 6-41 Summary of submissions on waste management

6.28.1 Drilling fluids and cuttings

Classification and management of drilling fluid

Submissions stated the assessment did not adequately describe the composition and classification of waste drilling fluids. Submissions also stated that management of waste drilling fluid was not sufficiently detailed in the assessment. They stated that detailed storage, transport and disposal protocols for waste drilling fluid should have been provided in the assessment.

As discussed in Chapter 28 of the EIS (Waste management), a Waste Management Plan would be implemented for the project. The Waste Management Plan would incorporate statutory requirements under the *Protection of the Environment Operations Act 1997* and *Protection of the Environment Operations (Waste) Regulation 2014* including waste classification, recording, transport and tracking.

Drilling fluids and cuttings would be classified and managed in accordance with all relevant statutory requirements through the implementation of the Waste Management Plan. Details of the composition of drilling fluid were provided in the Chemical Risk Assessment in Appendix T3 of the EIS.

As stated in Chapter 28 of the EIS, drilling fluids would be stored in suitable tanks which would be bunded in accordance with Australian Standards to prevent spills or leaks before being transported by an appropriately licensed contractor to the Narrabri Operations Centre, Leewood or Bibblewindi for recycling. The Narrabri Operations Centre is an existing facility with development consent to treat drilling fluids under the *Environmental Planning and Assessment Act 1979.*

Detail is provided in Chapter 4.3 of this RTS on the Leewood and Bibblewindi sites providing drilling fluid recycling facilities as alternatives to the Narrabri Operations Centre.

Classification and management of drill cuttings

Submissions stated the assessment did not consider whether drill cuttings could contain contaminants from coal seams such as naturally occurring radioactive materials (NORMs), BTEX (benzene, toluene, ethylbenzene, xylene), mercury, arsenic and lead.

As explained in Chapter 6 (Project description) and Chapter 28 (Waste management) of the EIS, two types of drill cuttings will be generated. These will be managed separately due their different composition.

The rock-based drill cuttings will predominantly be derived from the vertical wells, while the coal-based drill cuttings will predominantly be derived from the lateral wells which are drilled through the target coal seams. The rock-based drill cuttings will be beneficially re-used on the well pads, where appropriate.

The coal-based drill cuttings (and other drill cuttings not suitable for use on the well pads) will be transported off-site to a facility that can lawfully accept the material. The proponent is also investigating opportunities to beneficially reuse the coal-based drill cuttings in accordance with the regulatory framework.

Furthermore, a Chemical Risk Assessment was conducted for the project as part of the EIS (Appendix T3). The assessment was conducted in accordance with the requirements of the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* using commonly accepted practices and methods. In addition, the assessment was developed to align with guidance provided by the Commonwealth and approved chemical risk assessments completed for other coal seam gas projects. The Chemical Risk Assessment focused on chemicals to be used in the drilling and development of gas wells, and those proposed for produced water and brine treatment. The goal of the chemical risk assessment was to demonstrate that potential risks have been eliminated or reduced as much as is reasonably practicable to potentially exposed human receptors and to Matters of National Environmental Significance (MNES), including water resources.

The assessment noted that the potential for releases of chemicals to groundwater was negligible. No persistent, bioaccumulative and toxic (PBT) or carcinogenic substances were identified among the chemicals proposed. Although exposures to human receptors showed some potential non-carcinogenic risks, no carcinogenic risks were identified. Exposure scenarios were highly conservative and were based on fencing and signage and operational monitoring. While potential hazards are associated with the transport, preparation and use of drilling chemicals, these activities will be undertaken in accordance with relevant requirements including the *NSW Code of Practice for Coal Seam Gas Well Integrity*.

Further considering the nature of the chemicals used and the existing management and risk mitigation practices no unacceptable risks were identified for terrestrial and ecological receptors and humans within the project area. Key findings included:

- No potential impacts on beneficial uses of groundwater and associated receptors from drilling, conveyance of produced water and treated water and beneficial uses of treated water.
- Implementation of transportation and spill prevent protocols and communication of hazards to emergency responders, health and safety managers and environmental clean-up protocols are integral components of management and mitigation strategies for the project.
- No unacceptable risks associated with the storage and management of drilling cuttings or drilling muds was identified on the well pads.
- No unacceptable risks associated with the storage and management of brine at the Leewood water treatment facility with short term exposure and unlikely to lead to chronic exposures.
- No unacceptable risks to aquatic and terrestrial receptors and humans from the potential discharge of treated water to Bohena Creek.

As stated in Chapter 31 of the EIS (Project commitments), a Waste Management Plan would be implemented for the project. The Plan will detail the management of the cuttings, including their separation, storage and reuse or disposal. The management of drill cuttings will occur in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) and other relevant statutory requirements, including requirements with respect to sampling and frequency of testing.

It is noted that the NSW Environment Protection Authority have advised the proponent that excavated material generated as part of well establishment or drilling that is beneficially reused at the site would not trigger waste licensing requirements or require a resource recovery exemption. A letter from the NSW Environment Protection Agency to this effect was included as Appendix E of the EIS.

The mix, turn and bury strategy has been utilised for rock based drill cuttings on a number of the existing appraisal well pads. Inspections have found that the rehabilitation is progressing well at these well pads and consistent with conditions for the successful reestablishment of vegetation.

6.28.2 Salt

Disposal of waste salt

Submissions stated that the assessment did not identify a waste disposal strategy for waste salt including identifying waste management facilities with sufficient capacity. They stated local communities and receiving facilities had not been consulted regarding the disposal of salt.

As stated in Chapter 31 (Project commitments) of the EIS, waste salt would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

As discussed in Chapter 28 (Waste management) of the EIS, estimated average daily salt volumes would be about 115 tonnes per day during the peak period in around years two to four and about 47 tonnes per day for the remaining years of the assessment period. The salt would be temporarily stored on site in a weather proof structure prior to being collected and transported to an appropriately licensed facility in accordance with all regulatory requirements.

As outlined in the response below, the composition of the mixed solid salt product was forecast based on water quality analysis of both the produced water generated through exploration and appraisal activities and the brine produced at the Leewood water treatment facility.

Testing was undertaken in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) based on the chemical contaminants known or likely to be present in the produced water. The results are summarised in Table 5-3, Table 5-4 and Table 5-5, which show it would classify as general solid waste, with contaminants significantly below relevant thresholds.

There are a substantial number of waste facilities available, including government and privately owned facilities that are licensed to receive general solid waste in the order of hundreds of thousands of tonnes per annum. The average volume of salt produced annually by the project would be a very small proportion of the overall capacity of any one such facility.

As part of the ongoing development of salt management options for alternative beneficial reuse applications are being investigated

Quantification of waste salt

Submissions queried the quantification of waste salt in the assessment.

As noted in Section 7.1 of the EIS, the average salinity of produced water generated during exploration and appraisal activities within the project area to date from the Maules Creek Formation and Black Jack Group is around 14,000 micro Siemens per centimetre. It is important to note that the produced water varies by seam and location across the project area.

To determine the volume of solid salt product the project would generate, laboratory work was undertaken to imitate the Leewood water treatment process (explained in Section 6.2.1 of Chapter 6 of the EIS), using conditions likely to achieve a similar level of decomposition. Specifically, the produced water was heated in the laboratory to 180 degrees Celsius to simulate the thermal process used during water treatment. During heating, some salt in the produced water decompose, while the remainder become a solid salt product. After taking into account decomposition resulting from heating, the typical mass of salt produced is 11,700 milligrams per litre of water fed to the water treatment process. This factor has been used to determine the estimated salt production rate, and subsequently, its volume and weight.

Composition and classification of waste salt

Submissions stated that the assessment did not adequately describe the composition and classification of waste salt. They stated the salt could contain contaminants from coal seams or residues from drilling or water treatment processes and that the waste salt could therefore be a restricted or hazardous waste.

As stated in Chapter 31 (Project commitments) of the EIS, waste salt would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

The composition of the mixed solid salt product was forecast based on water quality analysis of both the produced water generated through exploration and appraisal activities and the brine produced at the Leewood water treatment facility.

Testing was undertaken in accordance with the *Waste Classification Guidelines* (NSW EPA 2014) based on the chemical contaminants known or likely to be present in the produced water. The results are summarised in Table 5-3, Table 5-4 and Table 5-5 of this RTS, which and show that it would classify as general solid waste, with contaminants significantly below relevant thresholds.

As stated in Chapter 31 of the EIS, a Waste Management Plan would be implemented for the project. The Plan would include the testing program for the salt product generated by the treatment process, including the frequency of testing in accordance with the *Waste Classification Guidelines*.

As stated in Chapter 31 (Project commitments) of the EIS, waste salt would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

Storage of waste salt

Submissions stated the assessment did not adequately discuss the storage of waste salt in the project area or the quantities that would be stored. They stated that inappropriate storage of salt in the project area or at disposal facilities could result in environmental impacts to soil or water quality.

The solid salt product would be stored in a covered interim storage facility at Leewood prior to its transfer and disposal off-site.

Potential impacts of disposed waste salt

Submissions queried the measures that would be in place to monitor the potential impacts of produced salt once it is disposed. They stated that produced salt and contaminants therein would pose a risk if leaching into surface water and groundwater including rain or flood events. They stated that the lifecycle risks of salt disposal should have been considered in the assessment to ensure the salt is managed appropriately on a permanent basis.

The Waste Assessment presented in Chapter 28 of the EIS was undertaken in accordance with the Secretary’s environmental assessment requirements for the project. As stated in Chapter 31 (Project commitments) of the EIS, waste salt would be disposed of at an appropriately licensed facility in accordance with regulatory requirements.

Licensed facilities that manage waste are required to ensure appropriate storage and management of the waste to prevent environmental impacts. This can typically involve measures such as the application of a barrier system and stormwater diversion works.

The licenced landfill facilities operate under Environment Protection Licences issued pursuant to the NSW *Protection of the Environment Operations Act 1997*.

6.28.3 General waste

Destination of waste

Submissions stated that the assessment did not identify waste management facilities with suitable capacity to handle waste generated by the project. They also stated that the project would put significant pressure on waste facilities.

Waste generated by the project would be disposed of at an appropriately licensed facility in accordance with regulatory requirements. The selection of a receiving facility would be subject to its capacity to accept the waste.

There are a substantial number of waste facilities available, including government and privately owned facilities that are licensed to receive general solid waste in the order of hundreds of thousands of tonnes per annum. The average volume of general waste produced annually by the project would be a very small proportion of the overall capacity of any one such facility.

Disposal of soil from Bibblewindi

Submissions stated that upgrade of existing produced water and brine pond at Bibblewindi would generate contaminated soil. They queried how this waste would be managed.

As discussed in Section 6.2.2 of Chapter 6 (Project description) of the EIS, the existing produced water and brine pond would be upgraded to meet the standard set out in the *Exploration Code of Practice: Produced Water Management, Storage and Transfer* (NSW Department of Industry, Skills and Regional Development 2015).

Waste generated during the upgrade of the existing produced water and brine pond at Bibblewindi would be classified and managed in accordance with all relevant statutory requirements.

As discussed in Chapter 28 (Waste management) of the EIS, a Waste Management Plan would be implemented for the project. The Waste Management Plan would incorporate statutory requirements under the *Protection of the Environment Operations Act 1997* and *Protection of the Environment Operations (Waste) Regulation 2014* including waste classification, recording, transport and tracking.

6.29 Cumulative impacts

The potential cumulative impacts of the project and other projects was discussed in Chapter 29 of the EIS. The cumulative assessment drew on various other specialist assessments including the Groundwater Impact Assessment in Appendix F of the EIS and Air Quality Impact Assessment in Appendix L of the EIS.

The potential for cumulative impacts was considered to be low to negligible given the few existing and / or proposed projects with potential to interact and the significant separation distances involved.

69 submissions raised issues specifically relating to cumulative impacts as described in Chapter 29 of the EIS. Of those, 50 were form submissions and 19 were unique.

Submissions asked about the lack of guidelines for cumulative impact assessment, consideration of other coal mining projects in the area, why the Namoi cumulative impact assessment tool was not used, and cumulative impacts with respect to State forests, noise and waste.

Figure 6-42 provides an overview of the submissions for cumulative impacts.

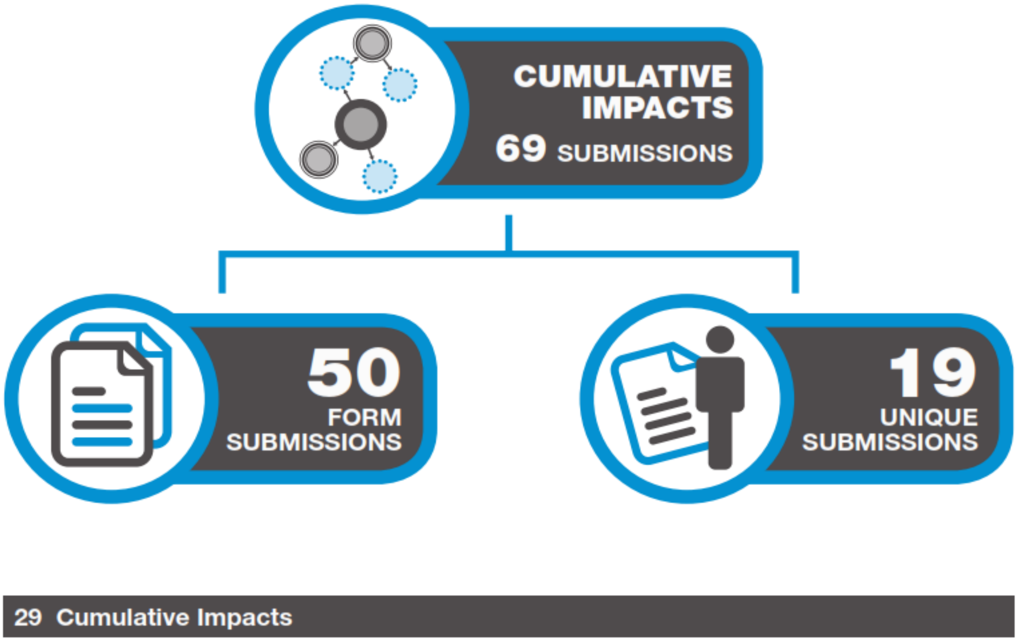


Figure 6-42 Summary of submissions on cumulative impacts

6.29.1 Assessment methodology

Statutory requirements or guidelines

Submissions stated that there was an absence of statutory requirements or guidelines for cumulative impact assessment.

> The Cumulative Impact Assessment presented in Chapter 29 of the EIS is typical of cumulative impact assessments for major projects. It utilised information about existing and proposed projects that were publicly available at the time of assessment.

Consideration of other coal mining projects

Submissions stated that the project's Cumulative Impact Assessment should have considered coal mining in the region including Maules Creek, Shenhua Watermark, Narrabri North and Caroona mines.

They stated that landholders situated between the project and Narrabri North Mine would be susceptible to cumulative impacts. They also stated the lease for Caroona Mine had been bought back by the NSW Government and thus questioned the currency of the assessment.

> Maules Creek, Shenhua Watermark, Narrabri North and Caroona mines were considered in the Cumulative Impact Assessment presented in Chapter 29 of the EIS.

The potential for cumulative impacts on landholders situated between Narrabri North Mine and the project would be mitigated in part as gas wells would only occur on private property if a Land Access Agreement is in place.

The Groundwater Impact Assessment for the project included Narrabri North Mine and the findings of the assessment would therefore reflect potential cumulative impacts on landholders in the region. As an existing mine its influence would be represented in background water quality, air quality and noise and would therefore be reflected in the impact assessment and / or proposed monitoring programs.

The Social Impact Assessment (Appendix T1) and Traffic Impact Assessment (Appendix P) specifically considered existing regional mines with respect to competition for labour, housing and traffic impacts. The remaining impact assessment studies considered existing and proposed coal mines, and other regional developments, in their baseline data sets.

The Cumulative Impact Assessment also reflected the NSW Government buy back with regard to Caroona Mine stating “in 2016 the NSW Government bought back the exploration licence … signalling the cancellation of the development.”

Namoi Cumulative Risk Assessment Tool

Submissions stated the EIS did not provided adequate consideration to the use of the Namoi Cumulative Risk Assessment Tool (NCRAT).

The Cumulative Impact Assessment presented in Chapter 29 of the EIS is typical of cumulative impact assessment for major projects and utilised information about existing or proposed projects that was publicly available at the time of assessment.

The Cumulative Impact Assessment considered all matters that were assessed under NCRAT as documented in the *Proposed Framework for Assessing the Cumulative Risk of mining on natural Resource Assets in the Namoi Catchment* (EcoLogical 2011), including land use, soil, flora and fauna, groundwater and surface water.

Cumulative ecological impacts

Submissions stated the Ecological Impact Assessment did not adequately consider the potential cumulative impacts of the project with other existing or proposed projects. Some specified that potential fragmentation of the Pilliga was not adequately assessed in this regard.

The Ecological Impact Assessment in Appendix J1 of the EIS was undertaken in accordance with the Secretary’s environmental assessment requirement and included a cumulative assessment of ecological impacts.

Cumulative impacts in forested areas

Submissions stated that the project would have cumulative impacts to users of forested areas. They stated that users would include bushwalkers, four-wheel drivers, birdwatchers and other recreational users.

As discussed in Chapter 2 (Location and setting) of the EIS, the Pilliga is a large forested area covering more than 500,000 hectares. The project area would occupy about 95,000 hectares, about a third of which is not in forested areas.

Project infrastructure would only occupy about one per cent of that area. The Cumulative Impact Assessment presented in Chapter 29 of the EIS did not identify other existing or proposed projects in the Pilliga and associated State forests. As such, potential impacts on the use of those State forests were not expected to occur.

Cumulative noise impacts

Submissions stated the adopted cumulative noise amenity criterion of 40 dB(A) was inappropriate to assess cumulative noise impacts in the Pilliga given the low background noise.

The Noise and Vibration Assessment in Appendix M of the EIS adopted a cumulative noise amenity criterion of 40dB (A). The adopted criterion is lower than the criteria in the relevant guidelines being the *Industrial Noise Policy* (NSW EPA 2000). The assessment therefore adopts a more conservative approach than would be required under the relevant guidelines.

Cumulative waste impacts

Submissions stated that the Waste Management Plan for the project should consider potential for cumulative impacts associated with waste generated by the project and other existing or proposed projects in the region.

As stated in Chapter 31 (Project commitments), waste generated by the project would be disposed at an appropriately licensed facility in accordance with regulatory requirements. The selection of a receiving facility would be subject to its capacity to receive the waste.

6.30 Environmental management and monitoring

The proposed environmental management and monitoring framework for the project was discussed in Chapter 30 of the EIS. The chapter detailed the framework and its accordance with:

- the proponent’s corporate approach to environmental management
- the conditions of approval
- relevant statutory obligations
- landholder agreements
- the findings of this EIS.

The chapter discussed sub-plans that would form part of the Environmental Management Strategy for the project and the measures and standards they would contain.

65 submissions raised issues specifically relating environmental management and monitoring as described in Chapter 30 of the EIS. All of those submissions were unique.

The submissions primarily concerned the management plans and associated overarching commitments while a small number concerned monitoring and audit.

A number of submissions raised issues concerning management and monitoring as discussed in other areas of the EIS. These issues are discussed in the relevant section of this RTS such as groundwater and geology in Section 6.11 or terrestrial ecology in Section 6.15.

Figure 6-43 provides an overview of the submissions relating to management and monitoring.

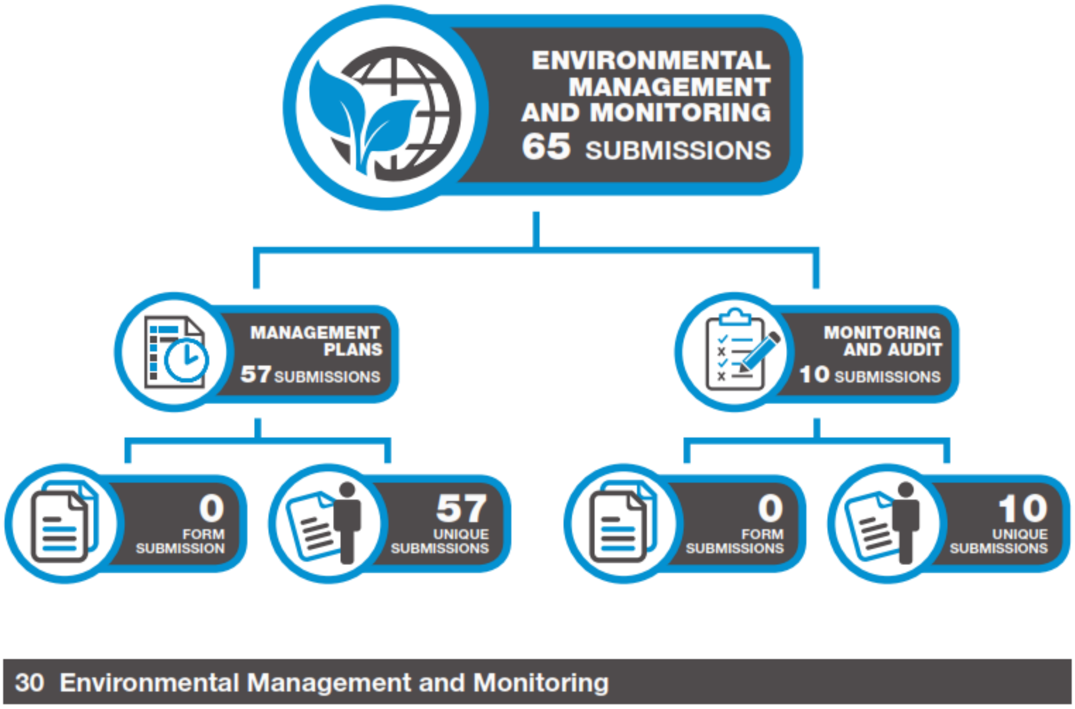


Figure 6-43 Summary of submissions on environmental management and monitoring

6.30.1 Management plans

Timing of management plan development

Submissions stated that the EIS omitted details of management plans and objected to the plans being developed post-approval without community involvement or visibility.

The EIS was completed in accordance with the Secretary's environmental assessment requirements. It included an assessment of the potential impacts of the project and identified a series of measures to avoid, mitigate and manage those potential impacts.

The EIS included an overview of the Environmental Management Strategy and committed to developing a number of management plans that would serve to implement and provide operational arrangement around the identified measures through construction and operation.

The plans would be developed post-approval allowing them to capture conditions of approval, in addition to the avoidance, mitigation and management measures already proposed in the EIS. The management plans proposed in the EIS include:

- Produced Water Management Plan
- Erosion and Sediment Control Plan
- Noise and Vibration Management Plan
- Soil Management Plan
- Air Quality Management Plan
- Cultural Heritage Management Plan
- Biodiversity Management Plan
- Pest, Plant and Animal Control Plan
- Historic Heritage Management Plan
- Traffic Management Plan
- Waste Management Plan
- Bushfire Management Plan
- Community and Stakeholder Management Plan
- Decommissioning Management Plant
- Rehabilitation Plan.

6.30.2 Monitoring and audit

General environmental monitoring and audit

Submissions made general remarks that the project would require environmental monitoring given its potential impacts on the environment. Some requested that online monitoring data be provided in real time for the duration of the project.

Submissions made general remarks that the project would require independent environmental compliance auditing given its potential impacts on the environment.

The project's Environmental Management Strategy includes a number of management plans to demonstrate compliance with the relevant statutory criteria and approval conditions. The plans would include monitoring requirements for matters including air quality, noise and water quality.

The project would also operate under an Environment Protection Licence issued pursuant to the NSW *Protection of the Environment Operations Act 1997* including water monitoring requirements. As is currently the case for the proponent's exploration and appraisal activities, the results of monitoring would be regularly reported to the NSW Environment Protection Authority.

Within three years of commencement of the project, and every three years thereafter, the proponent will facilitate a third-party environmental audit to ensure compliance with the following:

- Implementation consistent with the Protocol and Plan of Operations.
- Conditions of the Commonwealth and State government approvals and relevant licences and plans.
- Management plans.

- The annual compliance review obligations for the period.

The third-party auditor would be suitably qualified to conduct the audit. The audit report would be provided to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy.

Notification protocol

Submissions stated that the proponent and the NSW Environment Protection Authority should prepare a notification and response protocol to be triggered in the event of a pollution incident including immediate repair of relevant project infrastructure and rehabilitation of affected areas.

The proponent will operate in accordance with approval conditions and relevant statutory requirements including the NSW *Pollution of the Environment Operations Act 1997* which contain a duty to notify under Section 148.

A Pollution Incident Response Management Plan has been developed for the current exploration and appraisal activities in the project area to manage potential environmental emergencies or incidents in accordance with the requirements of the NSW *Protection of the Environment Operations Act 1997*.

The Pollution Incident Response Management Plan details responsibilities for site staff managing environmental incidents, regulatory and community notification requirements and provides details of potential pollutants and safety equipment. The Plan would be reviewed and updated to apply to the project. The proponent's internal management and governance standards would also be used for environmental incident emergency response preparedness.

Adaptive management

Submissions stated that the project should adopt an adaptive management approach that would monitor for potential environmental issues and take corrective action.

As detailed in Chapter 30 of the EIS (Environmental management and monitoring), the Environmental Management Strategy and sub-plans for the project would incorporate adaptive management.

The Environmental Management Strategy for the project will be implemented using ongoing environmental monitoring for specific sub-disciplines. This ongoing monitoring program would be used to guide the management of environmental impacts through early identification of environmental issues to allow for feedback into the environmental management process. This process is known as adaptive management.

The concept of adaptive management is a structured, iterative approach to decision making with the capacity to gradually reduce uncertainty over time through monitoring and adapting to environmental, economic and social changes. It allows the operator the opportunity for ongoing fine-tuning and continuous improvements to the overall management and monitoring strategy, using actual environmental data. An example would be adjusting dust suppression volumes and / or frequency commensurate with construction dust monitoring data to ensure optimal mitigation is achieved.

The individual monitoring plans that will drive the adaptive management process will include:

- Surface and groundwater (refer to Appendix G3 of the EIS).

- Biodiversity (refer to Appendices J1 and J2).
- Rehabilitation (refer to Appendix V).
- Air quality (refer to Appendix L).
- Noise and vibration (refer to Appendix M).

Adaptive management employs incremental improvements in confidence through the re-integration of environmental monitoring data into the forward planning process, thereby reducing risk. Therefore, in circumstances where potential impacts cannot be entirely avoided, the adaptive management approach allows for an evaluation of the preferred mitigation controls employed, such that they are progressively improved and refined, or alternative solutions adopted.

The feedback loop would report back to the Field Development Protocol for periodic fine-tuning to ensure that leading practice environmental management is maintained for the project.

6.31 Project commitments

Chapter 31 of the EIS listed the measures that formed the project commitments. The measures were collated from the assessments in chapters 11 to 28 of the EIS.

44 submissions raised issues specifically relating to project commitments as described in Chapter 31 of the EIS. All of those submissions were unique.

A number of submissions raised issues concerning project commitments as discussed in other areas of the EIS. These issues are discussed in the relevant section of this RTS such as groundwater and geology in Section 6.11 or terrestrial ecology in Section 6.15.

Figure 6-44 provides an overview of the submissions relating to project commitments.

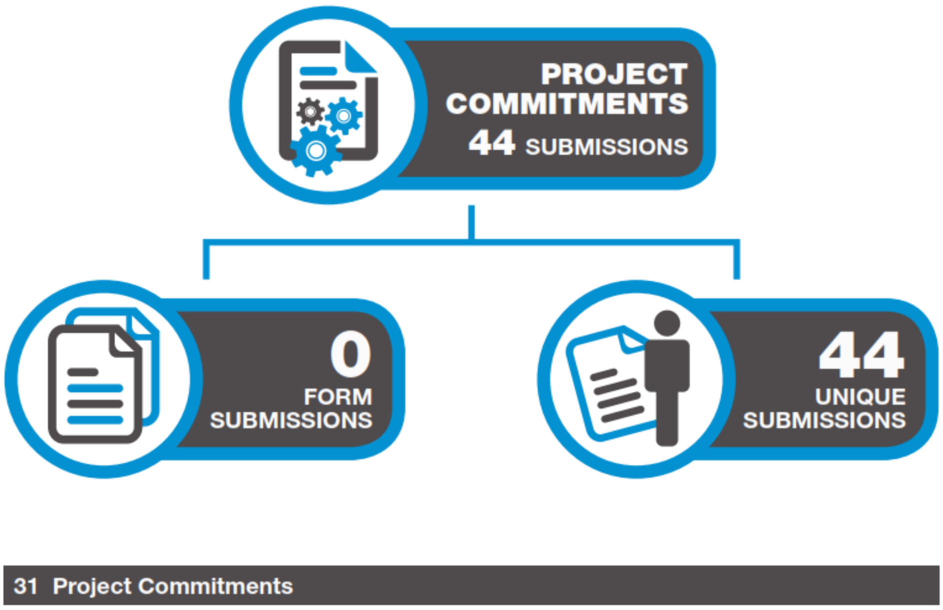


Figure 6-44 Summary of submissions on project commitments

Incorporation of new technology

Submissions stated that the project should include a commitment to apply new technologies as they become available in line with recommendations of the NSW Chief Scientist and Engineer.

The proponent is amenable to implementing new technologies when they add value to the project. Examples of this commitment include (refer to EIS Chapter 31 – Project commitments):

- The design of infrastructure and selection of plant, vehicles, equipment and fuels will be reviewed for energy efficiency.
- Transport logistics will be planned to minimise energy use, and the most fuel-efficient vehicles and equipment will be used where economically viable.
- Energy use will be considered when procuring plant, vehicles and equipment.
- Energy efficiency opportunities will be monitored and periodically reviewed.

Project insurance

Submissions stated that the project should include a commitment to seek insurance for potential environmental impacts.

In accordance with NSW Government policy, all title holders engaged in coal, mineral and petroleum exploration as well as mining and petroleum production activities are required to lodge a security deposit to cover the cost of undertaking rehabilitation (Department of Planning and Environment 2017).

Commitment to mitigation and management measures

Submissions stated that mitigation and management measures were couched in terms such as 'where possible', 'practical' or 'reasonable and feasible' that indicated a lack of commitment.

It is acknowledged that the commitments in Chapter 31 (Project commitments) of the EIS and Appendix B to this RTS are sometimes stated in terms of where possible, practicable, reasonable and feasible or similar.

It is necessary that commitments are realistic and account for the range of environmental conditions that would be encountered in the project area.

As an example, the commitment to use existing roads, tracks and corridors where practicable accounts for the fact that these existing features may not always be available for use.

Managed release

Submissions stated the project should include a commitment to never release more than 12 megalitres per day to Bohena Creek and only during appropriate flow conditions.

The project will be carried out consistent with the EIS, which assessed a maximum daily managed release to Bohena Creek of 12 megalitres per day under specified flow conditions.

As a result of the assessment carried out in the EIS, the project commitments (refer EIS Chapter 31 and Appendix B to this RTS) include Commitment 3.3, which states:

'Treated water will be released to Bohena Creek at the managed release point only during periods when the flow in Bohena Creek is equal to, or greater than, 100 megalitres per day as measured at the Newell Highway gauging station'.

6.32 Justification and conclusion

Chapter 32 of the EIS contained the conclusion of the EIS including the overarching argument for the justification of the project. The justification included a discussion of the projects predicted economic benefits and consistency with planning and approval requirements as discussed in the EIS. It also discussed residual risks to the environment given proposed environmental management measures.

132 submissions raised issues specifically relating to the justification and conclusion provided in Chapter 32 of the EIS. The majority of those raised issues relating to the consistency of the project with principles of ecology sustainable development.

Figure 6-45 provides an overview of the submissions relating to the justification and conclusion.

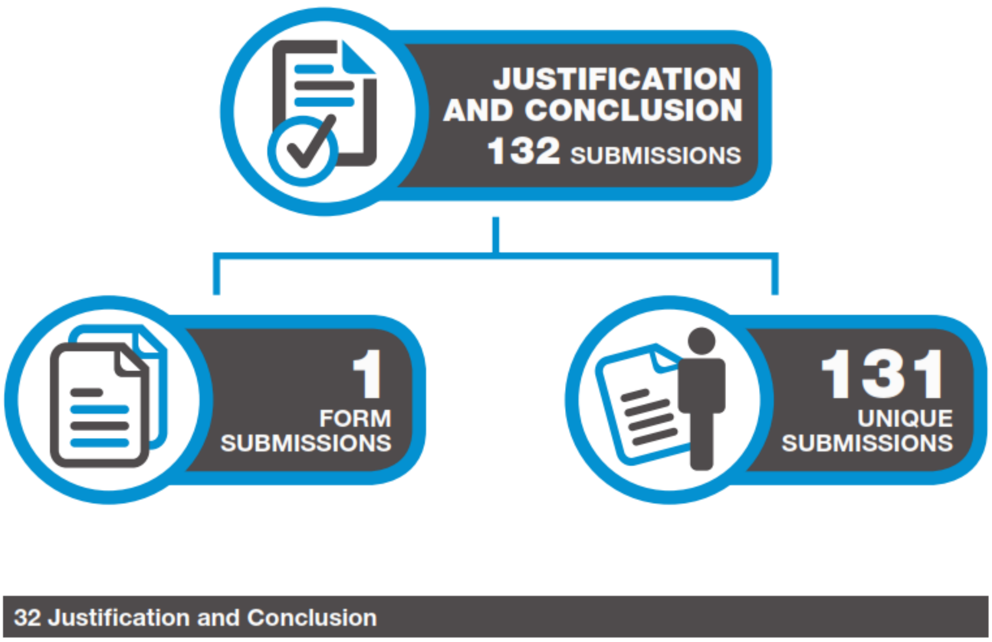


Figure 6-45 Summary of submissions on justification and conclusion

6.32.1 Ecologically sustainable development

Ecologically sustainable development

Submissions raised the concern that the project did not align with principles of ecologically sustainable development including the precautionary principle, intergenerational equity and conservation of biological diversity and ecological integrity. Some submissions stated the project did not satisfy the provisions under the *Environmental Planning and Assessment Act 1979*.

The EIS was completed in accordance with the Secretary's environmental assessment requirements. It included an assessment of the project against the principles of ecologically sustainable development including the precautionary principle, intergenerational equity and conservation of biological diversity and ecological integrity (refer to Section 32.2.2 in Chapter 32).

The assessment found that when balanced against its demonstrable social and economic benefits, it is considered that the project would be consistent with the principles of ecologically sustainable development.

Intergenerational equity

Submissions stated that the project represented a risk to intergenerational equity due to potential impacts and long-term infrastructure maintenance liability to groundwater supplies, Great Artesian Basin, agriculture and food production, and Aboriginal heritage values.

The EIS was completed in accordance with the Secretary's environmental assessment requirements. It included an assessment of the project against the principles of ecologically sustainable development including the precautionary principle, intergenerational equity and conservation of biological diversity and ecological integrity (refer to Section 32.2.2 in Chapter 32).

The assessment found that when balanced against its demonstrable social and economic benefits, it is considered that the project would be consistent with the principles of intergenerational equity.

Precautionary principle

Submissions stated that the precautionary principal should be employed in the decision of whether to approve the project given uncertainty of potential impacts to the environment including potential impacts to groundwater, surface water and biodiversity. Submissions particularly raised uncertainty regarding groundwater impacts and cited bans in France, Germany and USA (New York State) as evidence the principle was applied elsewhere.

The principles of ecologically sustainable development, including the precautionary principle, as adopted under the *Environmental Planning and Assessment Act 1979* were discussed in Chapter 32 (Justification and conclusion) of the EIS. The project is considered to be consistent with these principles due to the location of the project, the proposed mitigation and management measures including rehabilitation, adherence to the water licensing regulatory framework, and the anticipated economic benefits of the project. Further examples are discussed below.

The Groundwater Impact Assessment (EIS Appendix F) utilised conceptual and numerical models to simulate potential impacts. The assessment considered potential impacts to the Bohena Creek Alluvium, Namoi Alluvium, Pilliga Sandstone and a number of other relevant groundwater resources. The assessment also considered impacts on groundwater dependant ecosystems.

The assessment concluded that the project is unlikely to have a significant impact on groundwater resources in the project area and surrounds in terms of water availability and quality, as well as ecosystem functions. This is primarily due to:

- Relatively low value of groundwater in target coal seams and surrounding rock
- Limited groundwater drawdown in the higher value Pilliga Sandstone and Namoi Alluvium
- Negligible inter-aquifer flow rates and volumes and associated changes to groundwater quality
- Compliance with licensing requirements of the *Water Management Act 2000* and the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011*.

The extraction of groundwater from deep coal seams would require a license in accordance with a water sharing plan under the *Water Management Act 2000*. Water sharing plans are in place to protect the long term ecological integrity and productivity of the water source. All water taken would be extracted under this licensing framework established by the NSW Government, as applies to activities that extract water from a regulated water source in NSW. The project would take an average of 1.5 gigalitres each year over the life of the project, or approximately 1.3 per cent of the maximum limit identified for the Gunnedah-Oxley Basin water source (being 114.5 gigalitres). In this regard the ecological integrity of relevant groundwater sources has been considered, and the potential impacts would be well within the limits anticipated by the regulatory framework.

The precautionary principle was further applied in the Groundwater Impact Assessment undertaken for the project as follows. Predictive simulations in the EIS (Appendix F) included a High Case scenario for water production in which the total water volume extracted from the target coal seams was 2.3 times the extraction volume of the Base Case scenario. The primary difference between the Base Case and the High Case predictions on beneficial water sources is a slight increase in drawdown in the Pilliga Sandstone from less than 0.5 metres for the Base case to 0.6 metres in the High Case. Thus, based on the results of this sensitivity analysis, there is a high level of confidence that the potential impacts of the project have been conservatively assessed from a groundwater perspective.

The project's assessment was also consistent with the principle of biodiversity conservation that states that the conservation of biological diversity and ecological integrity should be a fundamental consideration of development proposals.

As discussed in the EIS, the project is situated in areas of the Pilliga that provide for exploration, mining, petroleum production and extractive industry under the *Brigalow and Nandewar Community Conservation Area Act 2005*. The project area was delineated to avoid Pilliga conservation areas including the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve, Brigalow Park Nature Reserve and the Brigalow State Conservation Area.

The project is also designed to minimise impacts on sensitive ecological areas and minimise clearing of native vegetation more generally. For example:

- the central gas processing facility and water management facilities would be situated on Leewood which is a previously cleared property outside the forested area, which is currently utilised for water management for gas exploration and appraisal activities
- the Field Development Protocol provides the framework to minimise impacts on more sensitive ecological areas including riparian zones, identified watercourses and buffer zones around Yarrie Lake

- clearing for field infrastructure would be minimised by the implementation of lateral well technology, co-location of up to three wells per well pad, limiting the construction footprint to approximately one hectare per well, and partial rehabilitation of well pads following construction.

Potential impacts on listed species and ecological communities were primarily assessed in the Ecological Impact Assessment in Appendix J1 of the EIS. The assessment draws on extensive field work in the project area, including more than 13,000 hours of flora and fauna survey effort carried out since 2002. The assessment concluded that the project would be unlikely to have a significant impact on listed species and ecological communities as the magnitude of direct, indirect and cumulative impacts would be unlikely to affect their long-term survival. This is primarily due to:

- the small proportion of habitat being removed relative to that retained in the project area
- the removal of habitat at a scale unlikely to result in the isolation or fragmentation of populations
- the project being unlikely to result in invasive species or diseases becoming established
- the progressive rehabilitation of disturbed areas as part of the project
- implementation of the Field Development Protocol and proposed avoidance, minimisation and mitigation measures.

Residual impacts on threatened species and endangered ecological communities would be offset as part of the Biodiversity Offset Strategy.

Field infrastructure including gas wells, gas and water gathering lines, roads and access tracks, water storages and telecommunication towers would be sited in accordance with the Field Development Protocol, which sets upper disturbance limits and other locational criteria. The Field Development Protocol incorporates rules and constraints for the siting of field infrastructure whereby environmental impacts are systematically avoided, minimised and managed.

The project would be subject to a comprehensive management and monitoring approach to be implemented during the construction, operation and decommissioning of the project. The environmental management framework for the project includes a number of discipline-specific sub-plans that would be implemented during each phase of the project. This would include the:

- Erosion and sediment control
- Soil Management Plan
- Air Quality Management Plan
- Noise and Vibration Management Plan
- Cultural Heritage Management Plan
- Biodiversity Management Plan
- Pest, Plant and Animal Control Plan
- Historic Heritage Management Plan
- Traffic Management Plan
- Waste Management Plan
- Bushfire Management Plan
- Produced Water Management Plan
- Water Monitoring Plan
- Decommissioning Management Plan
- Rehabilitation Strategy and Plans.

A number of the management plans involve extensive monitoring programs to monitor for potential impacts of the project. For example, the Water Monitoring Plan is focussed on early detection of a specific and measurable change that can be reasonably attributed to project activities. The key principle of the Water Monitoring Plan is that monitoring activities are designed to inform an understanding of whether or not the project is contributing to changes in water quantity or quality within water assets, particularly the high valued groundwater sources in the GAB and alluvial aquifers.

The approach utilises leading resource condition indicators for early warning of potential changes to water resource condition arising from the project. Sentinel monitoring locations are nominated at intermediate depths within the Gunnedah-Oxley Basin (seven existing wells with another six proposed in the Triassic and four existing in the Permian) to detect unexpected change in subsurface condition prior to potential impacts on receptors within shallow high-valued groundwater sources. This sentinel monitoring approach ensures that there is early warning of unexpected impacts and allows management actions to be initiated well prior to any potential for impact to high-valued groundwater sources occurring.

A broader project monitoring program is also proposed. As set out in the Field Development Protocol, annual compliance checks would be undertaken to monitor performance against the Protocol, and an independent audit is proposed to be undertaken every three years, to ensure compliance with the following:

- implementation consistent with the Field Development Protocol and Plan of Operations
- conditions of the Commonwealth and State Government approvals and relevant licences and plans
- relevant State and Commonwealth legislation
- management plans
- the annual compliance review obligations for the period.

A report on the audit findings will be provided to the NSW Department of Planning and Environment and the Commonwealth Government Department of Environment and Energy.

In addition to the management, monitoring, auditing and reporting measures proposed, the proponent commits to implementing the measures set out in the project commitments. For further detail refer to the updated project commitments set out in Appendix B of this RTS.

In summary, the project is consistent with the Precautionary Principle on the basis of:

- the location of the project area
- incorporation of rules and constraints for the siting of field infrastructure whereby environmental impacts are systematically avoided, minimised and managed
- the conservative nature of the impact assessments across the disciplines
- the adoption of avoidance, control and impact minimisation processes including through adoption of relevant standards and Codes of practices
- extensive management and mitigation measures that will be applied together with a comprehensive monitoring framework
- the proponent’s commitment to implement the project in accordance with the project commitments.

Chapter 7 Project evaluation

In February 2017, the Environmental Impact Statement (EIS) for the project was submitted to the NSW Department of Planning and Environment for consideration as part of development application number SSD 14_6456.

Consistent with requirements under the NSW *Environmental Planning and Assessment Act 1979*, the EIS was placed on public exhibition from 21 February to 22 May 2017, during which period the Department of Planning and Environment received 23,007 submissions.

Submissions were received from a wide range of stakeholders including government institutions, special interest groups, organisations and individuals.

The proponent (Santos) is now required to respond to the submissions. This response to submissions report (RTS) summarises the submissions and responds to the issues raised.

The structure and contents of the RTS reflect the draft guideline *Responding to Submissions* (NSW Department of Planning and Environment 2017).

The RTS will be considered in the determination of the project under the NSW *Environmental Planning and Assessment Act 1979*.

Since the lodgement of the EIS, additional assessment activities have been undertaken to assist with responding to submissions. These include assessments in relation to terrestrial ecology (RTS Appendices E, G and H), air quality (RTS Appendix I) and landscape and visual impacts (RTS Appendix K).

At completion of the RTS, and giving consideration to the additional assessment activities described above, there are no substantial changes to the project from what was described in Chapter 6 (Project description) of the EIS. Results of the additional assessment activities confirmed the overall low social and environmental impact of the project as assessed in the EIS, with manageable residual risk. The significant social and economic benefits of the project are as described in the EIS.

The proponent has, however, committed to one new, and one amended management and mitigation strategy to further lower residual risk, being:

- The proponent will prepare and implement a Social Impact Management Plan; and
- The exclusion of surface infrastructure from Yarrie Lake reserve (plus a buffer of at least 50 m).

These are included in an updated list of project commitments in Appendix B of this RTS.

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