



Chapter 2

Location and setting

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Chapter 2 Location and setting

2.1 Overview

This chapter provides a description of the location and setting of the Narrabri Gas Project. Section 2.2 and Section 2.3 provide an overview of some of the key features of the project area and the surrounding region, including the gas resource. Section 2.4 describes the existing and / or approved associated infrastructure in the project area, and its relationship to the project. Section 2.5 presents the key project components.

In summary:

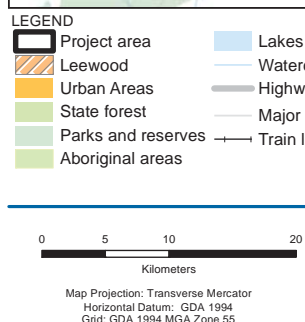
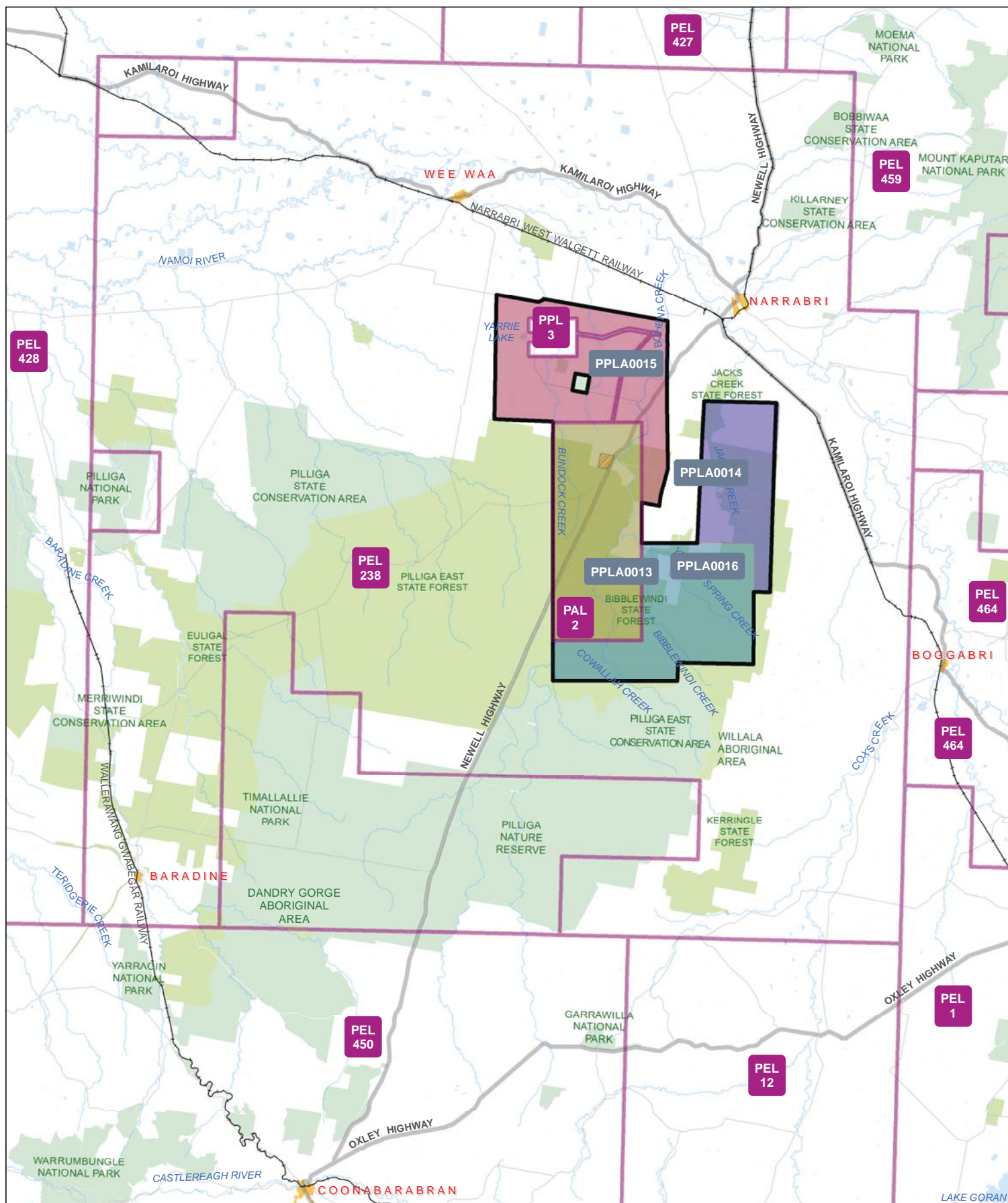
- The project located in north-western NSW, about 20 kilometres south-west of the nearest town, which is Narrabri.
- The disturbance footprint would directly affect up to 1,000 hectares, or around one per cent of the project area.
- Approximately 66 per cent of the project area comprises State forests which are reserved for recreation and conservation, commercial timber production, mining, petroleum production and extractive industry.
- Wells will only be drilled on a landholder's property where there is a landholder agreement in place. A Farm Management Plan will be developed with these landholders to minimise and manage project activities.
- It is estimated that about two per cent of agricultural land within the project area would be impacted during construction, reducing to around one per cent during operation following partial rehabilitation.
- The coal seams that would be targeted for gas production are predominantly located between 500 metres and 1,200 metres below ground level in the project area. They are far below, and isolated from, the surface aquifers which provide town, agricultural and environmental water supplies by several hundred metres of relatively impervious rock.

2.2 Regional setting

The project would be located in north-western NSW, about 20 kilometres south-west of the town of Narrabri within the Narrabri Shire local government area (LGA). All project activities would occur within an area defined as the project area—being about 950 square kilometres (95,000 hectares) in size (refer to Figure 2-1). Within the project area, the disturbance footprint resulting from the development of project infrastructure would directly impact about one per cent, or up to 1,000 hectares.

The project would be developed primarily in State forest with some development also on privately owned land, subject to the landowner's consent. The entirety of the project area is under a native title claim by the Gomeroi people.

The project area is located within the Namoi River Catchment, part of the Murray Darling Basin. Major drainage lines within the project area include Bohena, Bibblewindi, Cowallah, Yellow Spring, Bundock and Jacks creeks. The creeks are intermittent (also known as ephemeral), and flow only after significant rainfall events.



Narrabri Gas Project
Environmental Impact Statement

Regional setting of the project area
and petroleum titles

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Figure 2-1

Groundwater in the vicinity of the project is within the Gunnedah Basin, which contains some of the most intensively developed groundwater resources in Australia for agricultural purposes. Shallow groundwater sources are generally good quality and used for a diverse range of activities. Deeper groundwater sources are less exploited due to their depth and poorer quality. The project area is located just within the eastern edge of the Great Artesian Basin; however, the target coal seams are several hundred metres below the Great Artesian Basin aquifers; the base of which is represented by the Purlawaugh Formation in Figure 2-2.

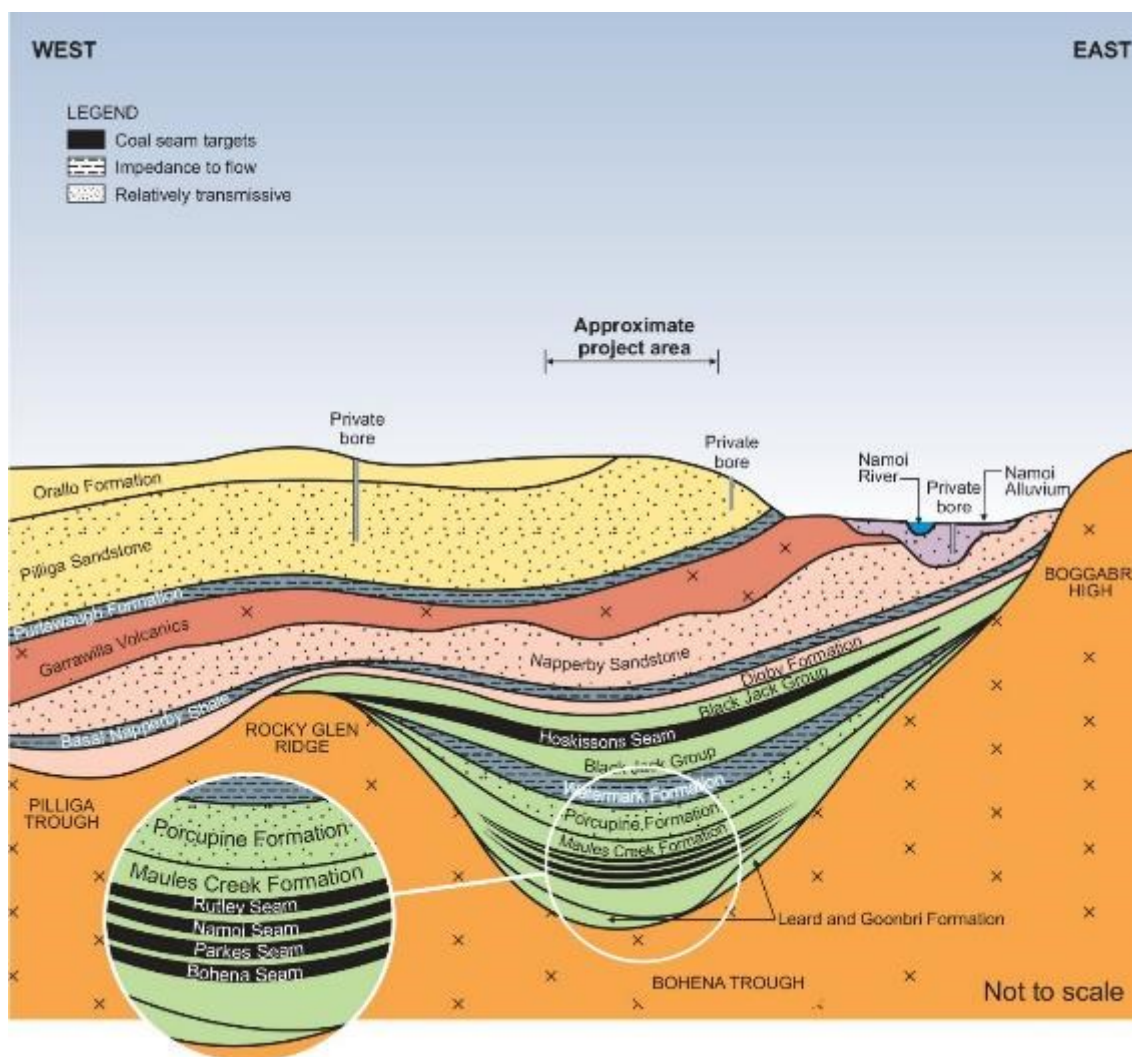


Figure 2-2 Schematic of geology of the project area showing target coal seams

The Newell Highway, which runs in a north–south direction through the project area, provides a major link between Queensland, NSW and Victoria. The Kamilaroi Highway is located to the north-east of the project and connects Narrabri with Gunnedah.

Agriculture is the major land use within the Narrabri Shire LGA; about 65 per cent of the LGA is used for agriculture, split between cropping and grazing. The remainder of the LGA is predominately used for residential purposes (about 20 per cent) and native vegetation (about 15 per cent) in the form of State forests, national parks, nature reserves and conservation areas.

The project would co-exist with the existing land uses in the project area during all project stages including construction, operation, and decommissioning and rehabilitation. It has been estimated that approximately two per cent of the agricultural land within the project area would be impacted through

construction, reducing to around one per cent during operation following partial rehabilitation. Approximately 1.5 per cent of the estimated 80,398 hectares of native vegetation within the project area would be impacted through direct and indirect impacts. For context, there is an estimated 297,204 hectares of native vegetation in the region. There would be no impact to residential land use, which comprises slightly under three per cent of the project area.

The Narrabri Shire LGA is central to the agricultural industry and is home to the Australian Cotton Research Institute and the I.A. Watson Wheat Research Centre. Within the project area, the agricultural land supports dry-land cropping and livestock. No agricultural land within the project area is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL) and a detailed soil assessment undertaken during this project has confirmed the absence of BSAL. A Site Verification Certificate acknowledging the absence of BSAL was issued by the NSW Department of Planning and Environment on 1 December 2015 (refer to Appendix I2).

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, and is managed under the *National Parks and Wildlife Act 1974*. The majority of the remaining area is State forest. There are places and values within the Pilliga that have spiritual meaning and cultural significance for the Aboriginal peoples 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.

The semi-arid climate of the region and general unsuitability of the soils for agriculture have combined to protect the Pilliga from widespread clearing. Selective commercial timber harvesting activities in the Pilliga were preceded by unsuccessful attempts in the mid-1800s to establish a wool production industry. As a result, the Pilliga represents the largest block of remnant vegetation in NSW west of the Great Dividing Range.

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.

In 2005, the NSW Government completed a comprehensive review of land use in the Pilliga, including a regional assessment of the Brigalow and Nandewar Bioregions. The regional assessment was a landscape scale land-use planning project and entailed multidisciplinary studies. The assessment sought to balance conservation, recreation, cultural values, extractive land uses and commercial activities.

A key outcome of this regional assessment resulted in around 240,000 hectares, or almost half of the Pilliga, being protected as reserves under the *National Parks and Wildlife Act 1974* in 2005. The location and area of the new national park reserves were explicitly determined on the basis that this gas project would be developed.

2.3 Resource definition

Resource exploration has been occurring in the area since the 1960s; initially for oil, but more recently for coal and gas. A number of existing gas exploration and production wells are located within Petroleum

Exploration Licence (PEL) 238, Petroleum Assessment Lease (PAL) 2, and Petroleum Production Lease (PPL) 3. The wells are present in varying stages of development with some active, some suspended and others decommissioned and rehabilitated. The project area is completely within PEL 238 and incorporates PAL 2 and PPL 3 (refer to Figure 2-1).

The project area is located in the central portion of the Gunnedah Basin. Exploration by Santos and others has confirmed the presence and location of known coal seams that contain natural gas in this area. An important geological feature identified within the Gunnedah Basin is the Bohena Trough (refer to Figure 2-2), within which, gas bearing coal seams include:

- the Rutley Namoi, Parkes and Bohena seams within the early-Permian Maules Creek Formation
- the Hoskissons seam in the late-Permian Black Jack Group.

The depth and thickness of the seams vary across the project area. Generally, the target seams are located between 500 and 1,200 metres below ground level in the project area; however, in some areas the Hoskissons seam rises to around 300 metres below ground level.

2.4 Existing and approved infrastructure

A number of approvals have been received for natural gas exploration and appraisal activities within the project area. Some of the infrastructure constructed for these activities may also be used for the project; including the existing produced water and brine ponds at Leewood (refer to Figure 2-3).



Figure 2-3 Existing produced water and brine ponds at Leewood

Table 2-1 details existing approvals, applications for exploration and appraisal activities, and the proposed use of this infrastructure in this project. The location of this infrastructure is shown in Figure 2-4.

The existing and approved infrastructure located at Bibblewindi and Leewood is shown in Figure 2-5 and Figure 2-6 respectively. In addition to the planning approvals outlined in Table 2-1, the existing petroleum activities are regulated under Environment Protection Licence number 20350.

The proposed drilling fluid recycling facility at the Narrabri Operations Centre would operate under Environment Protection Licence 20378.

The Narrabri Coal Seam Gas Utilisation Project (Wilga Park Power Station and associated infrastructure) operates under an existing Part 3A approval under the NSW *Environmental Planning and Assessment Act 1979*. Section 2.5 provides further detail on the new infrastructure and activities being proposed in the EIS for the Narrabri Gas Project.

Table 2-1 Current and previous Santos exploration and appraisal approvals relevant to this project

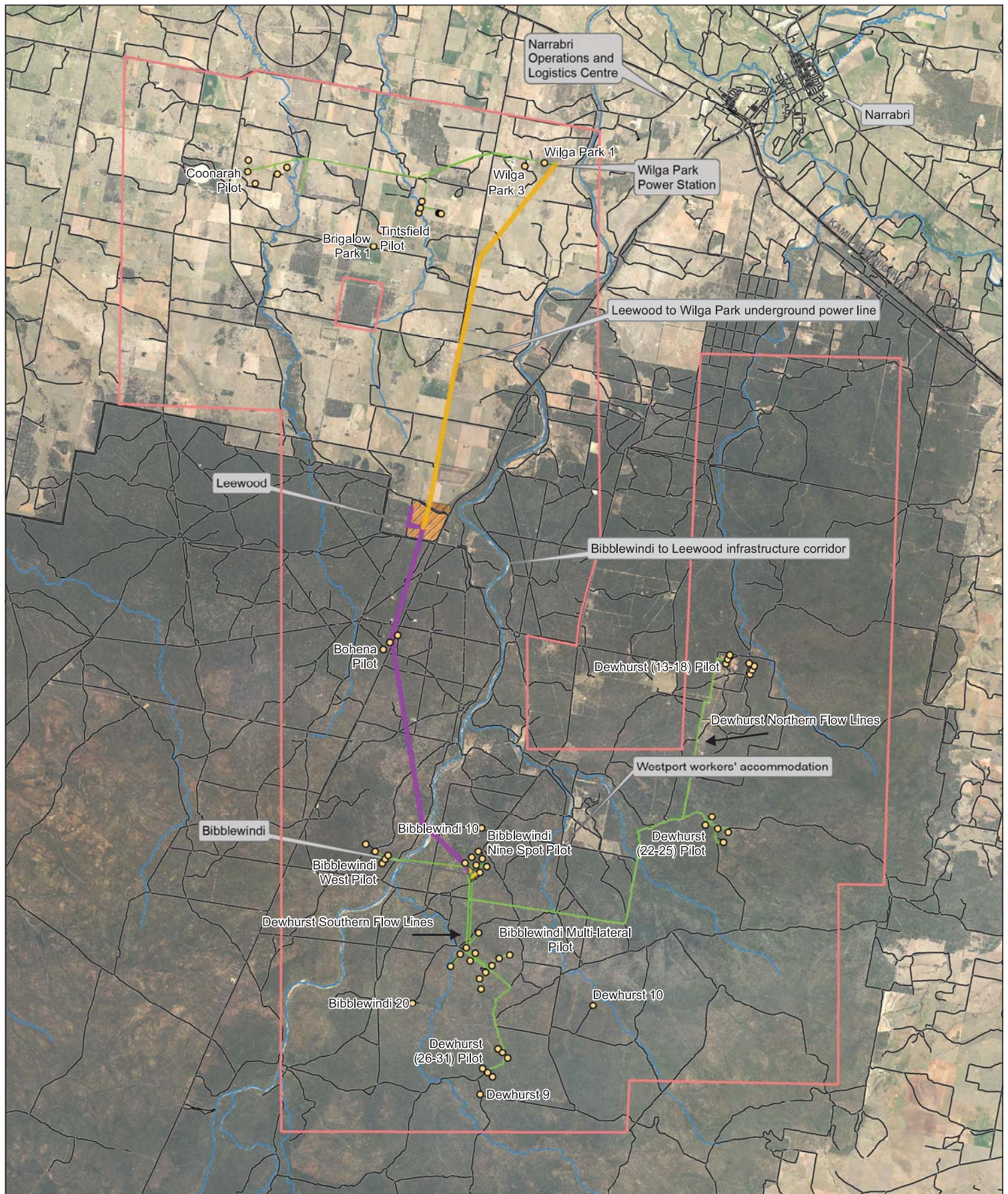
Project	Application / report number	Utilised during this project?
<p><i>Leewood Produced Water and Brine Management Ponds</i></p> <p>This project includes the construction and operation of a 300 ML brine pond, a 300 ML produced water pond, a 16 km water flow line and return flow line from the Bibblewindi facility to Leewood, a 5 ML balance tank at Bibblewindi, and associated infrastructure. The Review of Environmental Factors (REF) was approved by DTIRIS on 19 March 2013.</p>	R00070569	<p>Yes.</p> <p>The use of these facilities for production purposes would be part of the project.</p>
<p><i>Leewood Produced Water Treatment and Beneficial Reuse Project, Phase 2</i></p> <p>This project includes the construction and operation of a water treatment facility to treat, manage and beneficially reuse produced water and brine from exploration and appraisal activities. An application under Part 5 of the EP&A Act was approved in August 2015.</p>	R00070789	<p>Yes.</p> <p>The modular water and brine treatment plants would continue to be used.</p>

Project	Application / report number	Utilised during this project?
<p><i>Bibblewindi Ponds 1, 2 and 3</i></p> <p>Approved by DPI August 2006.</p>	R00070422	<p>Yes.</p> <p>The design and construction of Ponds 2 and 3 would be reviewed and necessary upgrades undertaken to ensure they meet relevant regulatory requirements and standards. The ponds would be used for water storage as part of this project. Pond 2 would store fresh or treated water for use in construction and/or drilling.</p> <p>Refer to Bibblewindi Water Management Facility Upgrade application, immediately below.</p> <p>Pond 1 has been decommissioned.</p>
<p><i>Bibblewindi Water Management Facility Upgrade</i></p>	In preparation	<p>Yes.</p> <p>Bibblewindi Pond 3 would be upgraded to meet the standards set in the <i>Exploration Code of Practice: Produced Water Management, Storage and Transfer</i> (NSW Department of Industry, Skills and Regional Development 2015c). This would include double lining the pond and the installation of electronic leak detection and warning systems.</p>
<p><i>Bibblewindi Gas Exploration Pilot Expansion Project (Bibblewindi multi-lateral)</i></p> <p>This project includes two additional wells at the existing Bibblewindi multi-lateral pilot (wells 31-32) and combined operation of the Bibblewindi well set. The EIS was approved by NSW Department of Planning and Infrastructure (DPI) on 18 July 2014.</p>	SSD-5934	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Dewhurst Pilot Expansion</i></p> <p><i>This project involves drilling additional laterals from the existing Dewhurst 13-18 wells, drilling two additional wells (Dewhurst 30-31) and operating the Dewhurst 13-18 and 26-31 well sets. The EIS was approved by DPI on 18 July 2014.</i></p>	SSD 6038	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Dewhurst 9</i></p> <p><i>This project includes Dewhurst 9. This single well was approved by DPI in June 2009.</i></p>		<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>

Project	Application / report number	Utilised during this project?
<p><i>Dewhurst 10</i></p> <p>This project includes Dewhurst 10. This single well was approved by DPI in June 2009.</p>		<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Dewhurst 22-25 Pilot</i></p> <p>This project involves drilling four appraisal wells, converting an existing core hole (Dewhurst 6) to an appraisal well and operating the pilot set. The REF was approved by Department of Trade and Investment, Regional Services (DTIRIS) on 16 August 2013.</p>	R00070647	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Dewhurst 26-29 Pilot</i></p> <p>This project involves drilling and operating four appraisal wells. The REF was approved by DTIRIS on 16 August 2013.</p>	R00070648	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Tintsville 2-7 Pilot</i></p> <p>A supplementary REF to construct a flare was approved by DTIRIS on 25 October 2013.</p>	R00070710	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p> <p>Ongoing use of the flare would be consistent with project's assessment.</p> <p>The approved and established Tintsville water storage facilities would also be used.</p>
<p><i>Dewhurst Northern Flow Lines</i></p> <p>This project involves the construction of gas and water gathering lines and the operation of the water lines only. The REF for this project was approved by DTIRIS on 18 September 2013.</p>	R00070695	<p>Yes, including the operation of both the gas and water flow lines.</p>
<p><i>Dewhurst Southern Flow Lines</i></p> <p>This project involves the construction of gas and water gathering lines, and operation of the water lines. The REF for this project was approved by DTIRIS on 18 September 2013.</p>	R00070696	<p>Yes, including the operation of both the gas and water flow lines.</p>
<p><i>Bibbiewindi West Pilot</i></p> <p>This project includes drilling and operating five wells: Bibbiewindi 22-26. The REF for this project was approved by DPI in May 2009.</p>	R00070370	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>

Project	Application / report number	Utilised during this project?
<p><i>Bibblewindi Nine Spot Pilot</i></p> <p>This project includes Bibblewindi 1-9. The REF was approved by DPI in August 2008.</p>	R00070497	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Bibblewindi 20 CSG well</i></p> <p>This project includes the single well at Bibblewindi 20. The REF was approved by DPI in May 2009.</p>		<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Coonarah Pilot</i></p> <p>This project was approved by DPI in November 2002 with the pilot expanded with additional wells in March 2005.</p>	R00070635	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Bohena Pilot</i></p> <p>This project includes Bohena 3, 7 and 9. It was approved by DPI between July 1998 and June 2004.</p> <p><i>Bohena South 1</i></p> <p>This project includes Bohena South 1. This single well was approved by DPI in June 2004.</p> <p><i>Wilga Park</i></p> <p>This project includes the Wilga Park wells (Wilga Park 1 and 3) which were approved by DPI in 1998.</p> <p><i>Brigalow Park</i></p> <p>This project includes Brigalow Park 1 which was approved by DPI in October 2004.</p>	R00070462	<p>Yes, if considered suitable for production.</p> <p>If converted, these wells would be additional to the 850 new wells under the project.</p>
<p><i>Westport workers' accommodation</i></p> <p>The accommodation is approximately 30 km south-west of Narrabri. It can accommodate up to 64 people and would be operated for up to four years. Development consent was issued by Narrabri Shire Council on 19 December 2012.</p>	DA 457-2013	<p>Yes.</p> <p>The use of the accommodation and its expansion to accommodate up to 200 people for the project duration would be part of the project.</p>
<p><i>Wilga Park Drillers' Camp</i></p> <p>The camp would accommodate up to 64 people for up to four years. Development consent was issued by Narrabri Shire Council on 19 December 2012.</p>	DA 458-2013	<p>Yes.</p> <p>If the camp were constructed, it would be likely to accommodate the workforce associated with the project.</p>

Project	Application / report number	Utilised during this project?
<p><i>Narrabri Operations Centre</i></p> <p>This project includes offices and the Drilling Fluids Treatment Facility. Development consent was issued by Narrabri Shire Council in April 2013 for the upgrade of the operations centre and in October 2013 for the Fluids Treatment Facility.</p>	<p>DA 546/2013</p> <p>DA 769/2013</p>	<p>Yes.</p> <p>The Narrabri Operations Centre would be utilised as part of the project to support construction and operational activities including delivery and laydown, equipment and chemical storage, concrete production, drilling fluid treatment and recycling and personnel offices. No changes to the development approval are anticipated.</p>
<p><i>Narrabri Coal Seam Gas Utilisation Project (Wilga Park Power Station)</i></p> <p>This project encompasses a gas gathering system, a gas flow line from Bibblewindi to Wilga Park within a 10 m corridor with a riser at Leewood and an expansion of the existing Wilga Park Power Station from 12 megawatts to 40 megawatts. The EIS was initially approved by DPI on 2 December 2008. Subsequent modifications were approved in February 2011 (Habitat Offsets), March 2012 (Temporary Water Transfer) and July 2014 (Pipeline Riser).</p>	<p>07_0023 (modified)</p>	<p>Yes.</p> <p>It is likely that the project would use the gas flow line, riser and gas gathering system. Further infrastructure to support the project is likely to be located on the same land the subject of the Part 3A approval. For example, linear infrastructure would be installed within the existing easement between Bibblewindi and Leewood and an underground power line may be installed within the existing easement between Leewood and Wilga Park power station. Modification to the existing Part 3A approval would be sought for use of the gas from the project in the power station.</p>



LEGEND

 Project area	— Watercourses	— Leewood to Wilga Park infrastructure corridor	● Existing wells
 Leewood	—+— Train line	— Bibblewindi to Leewood infrastructure corridor	
 Bibblewindi	— Existing flowlines	— Roads/tracks	

0 1.75 3.5 7
Kilometers

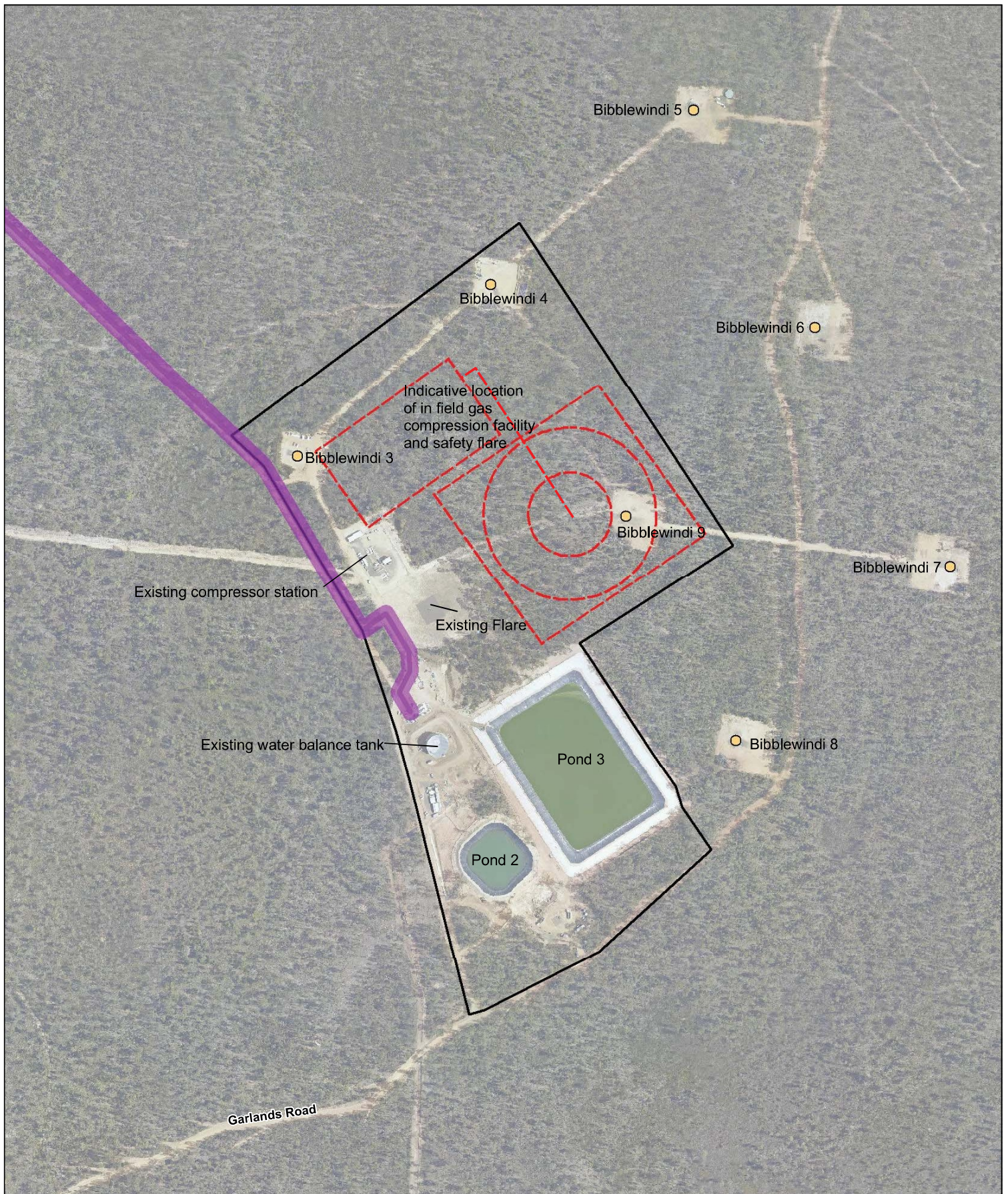


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Revision A
Date 06 Sep 2016

Existing infrastructure

Figure 2-4

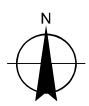


LEGEND

- Indicative Bibblewindi site boundary
- Bibblewindi to Leewood infrastructure corridor
- Indicative infrastructure location
- Existing wells

Aerial Imagery: Dec 2013

0 0.05 0.1 0.2
Kilometers



Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

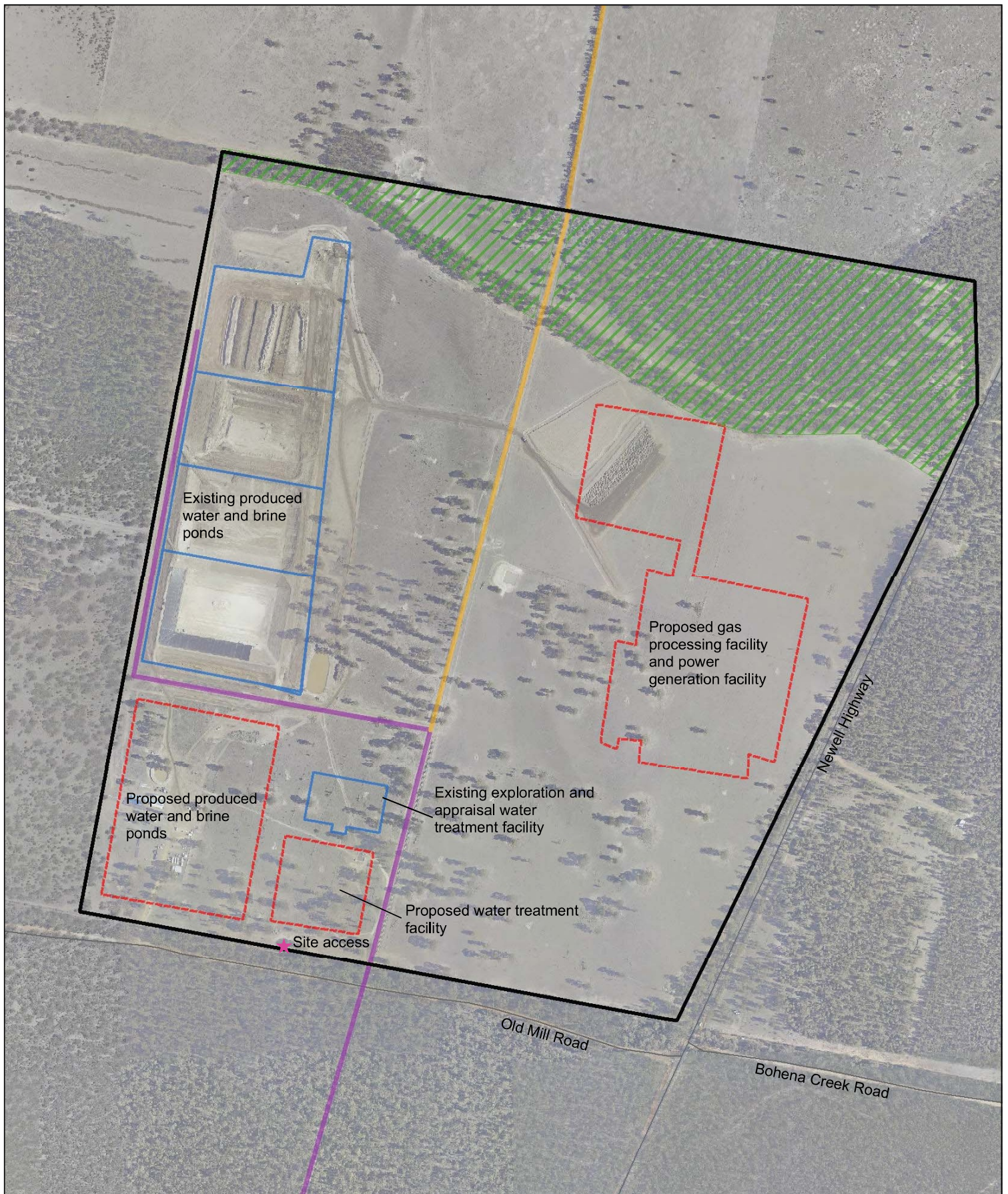
Job Number	21-22463
Revision	A
Date	15 Jul 2016

Existing and proposed infrastructure
at Bibblewindi

Figure 2-5

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

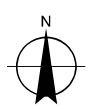


Aerial Imagery: Dec 2013

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

0 0.075 0.15 0.3
Kilometers

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



Narrabri Gas Project
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Existing and proposed infrastructure
at Leewood

Figure 2-6

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2.5 Narrabri Gas Project – key project components

The project would involve the construction, operation and decommissioning and rehabilitation of a range of exploration and production activities in addition to those outlined in Table 2-1 above. It would also involve the continued use of some existing infrastructure (as listed in Table 2-1). The key components of the project are presented in Table 2-2, and shown on Figure 2-4, Figure 2-5 and Figure 2-6.

Table 2-2 Key project components

Component	Infrastructure or activity
Major facilities	
Leewood	<ul style="list-style-type: none"> • 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
Bibblewindi	<ul style="list-style-type: none"> • in-field compression facility • a 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 recommissioning of two existing ponds • continued use of existing facilities such as the 5ML water balance tank • operation of the expanded facility
Bibblewindi to Leewood infrastructure corridor	<ul style="list-style-type: none"> • widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground (up to 132 kV) power, and buried communications transmission lines
Leewood to Wilga Park underground power line	<ul style="list-style-type: none"> • installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor

Component	Infrastructure or activity
Gas field	
Gas exploration, appraisal and production infrastructure	<ul style="list-style-type: none"> • seismic geophysical survey • installation of up to 850 new wells on a maximum of 425 well pads <ul style="list-style-type: none"> – 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	<ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> – pipeline(s) from Leewood to the irrigation area(s) – treated water storage dam(s) offsite from Leewood • operation of the irrigation scheme.