Appendix Q

Landscape and visual impact assessment

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Narrabri Gas Project - Environmental Impact Statement
Landscape and Visual Impact Assessment

August 2016

Executive summary

GHD has been engaged by the Proponent to undertake a Landscape and Visual Impact Assessment (LVIA) for the Narrabri Gas Project in the Gunnedah Basin, New South Wales. This Landscape and Visual Impact Assessment identifies the potential environmental issues associated with construction and operation of the project and addresses the Secretary of the Department of Planning and Environment environmental assessment requirements for the project which is:

> ***Visual*** *– including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, and minimising the lighting impacts of the development;*

The project would include the construction and operation of a range of exploration and production activities and infrastructure. The components of the project that have potential to cause landscape or visual impacts are identified below:

- the central gas processing facility, centralised water management facilities, a communications tower, a safety flare and an optional power plant located at the Leewood property
- an infield compression facility, and a safety flare located within the State Forest to the south of the project area at a location known as Bibblewindi
- the gas field – exploration, appraisal and production wells, and associated gas and water gathering lines located throughout the project area. As well as associated access tracks, up to five water balance tanks and communications towers
- vegetation clearance associated with construction works within the proposed Bibblewindi to Leewood and existing Leewood to Wilga infrastructure corridors
- Westport workers' accommodation which currently provides temporary accommodation for up to 64 workers. As part of the project, the capacity would be tripled to provide accommodation for up to 200 people
- surrounding roads which may be exposed to increases in additional traffic from the project.

The central purpose of the LVIA is to identify potential adverse impacts at the project planning stage and to propose measures to mitigate or ameliorate such impacts. Major facilities such as the central gas processing facility and central water management facility at Leewood have been assessed at their planned location. Gas field infrastructure would be sited in accordance with a Field Development Protocol, which would provide flexibility in their location. No gas field infrastructure would be located on a property without written agreement from the landholder, while its precise location would be decided in consultation with landholders and formalised in farm management plans. As such, the assessment of gas field infrastructure has been undertaken with consideration of this flexibility.

The methodology for the LVIA has been set out to respond to particular project requirements and constraints including the scale and nature of the project. The methodology draws on the *Guidelines for Landscape and Visual Impact Assessment, Third Edition, (2013)* published by The Landscape Institute and the Institute for Environmental Management and Assessment (IEMA) in the UK. It also draws on *Guideline for Landscape Character and Visual Impact Assessment (*2013) by the NSW Roads and Maritime Services.

Generally, the assessment process includes:

- description of the landscape and visual environment (in terms of character, features, views, and visual amenity), with consideration of its existing state, recent and known future changes.
- identification of sensitive landscape and visual receptors (informed by GIS based viewshed mapping and site survey), and subsequent rating of key receptors in terms of their sensitivity to change and capacity of the landscape to accommodate change.
- identification of potential impacts on key receptors, and subsequent rating of the magnitude of impacts, in terms of the extent to which they will modify the visual environment, and including consideration of duration and extent of impacts.
- determination of the significance of impacts, combining the assessment of receptor sensitivity and impact magnitude.
- identification of potential cumulative impacts, through consideration of the visibility of other developments in the vicinity of the study area.
- identification of potential mitigation measures, particularly for impacts of higher significance.

To assist with the description of the landscape and understanding of potential impacts, five landscape character units (LCU's) were identified and described:

- LCU 1 – Baradine - Coghill Channels and Floodplains.
- LCU 2 – Bugaldie Uplands.
- LCU 3 – Cubbo Uplands.
- LCU 4 – Coghill Alluvial Plains.
- LCU 5 – Yarrie Lake Flora and Fauna Reserve.

All of the LCU's were determined to have a medium sensitivity to change. LCU 1 and LCU 5 were determined to have a low capacity to accommodate the type of change proposed, while the remaining had a medium capacity to accommodate the type of change proposed.

In order to undertake an assessment of visual impacts, sensitive receptors were grouped into five representative zones based on typical types of view experiences. The representative sensitive receptor zones (RSRZ) consist of areas where full or screened views of the project may be possible and human activity would be undertaken. The five RSRZ are:

- RSRZ 1 – Northern Plains
- RSRZ 2 – Channels and Floodplains
- RSRZ 3 – Forest
- RSRZ 4 – Old Mill Road
- RSRZ 5 – Forest (Bibblewindi)

It was determined that RSRZ 1, RSRZ 2 and RSRZ 4 each had a high to medium sensitivity to change in the visual environment, while the remainder had a medium sensitivity to change.

Based on the observations of receptor sensitivity and potential impacts, the significance of impacts on receptors from each of the identified project components was determined. Generally, it was found that:

- The gas field would generate small impacts on all RSRZ during the construction phase and small to negligible impacts during the operation phase.
- Communication towers throughout the gasfield would generate small impacts on all RSRZ.

- Project components associated with the Leewood Property and the Bibblewindi site, and with the infrastructure corridors would generate no, or only small impacts on the RSRZ.
- Impacts from other project components are also likely to be small to negligible for all RSRZ.

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Glossary of terms

Term	Definition
Background view	Landscape visible in distance (six to 20 kilometres) where textures are no longer visible but mountain and valley forms, skylines and ridgelines are important.
Cumulative impact	An impact produced by the accumulation of successive additions of individual impacts, which may not themselves be significant.
Ecological community	An assemblage of populations of different species, interacting with one another.
Ecosystem	A natural unit consisting of all organisms in an area functioning together with all the non-living physical factors of the environment.
Flora	The plant life occurring in an area.
Foreground	Zero to one kilometre is the visual zone where colour contrast and textural detail are most clearly perceived.
Footprint	The imposition of a building or structure on the ground plane – typically a reference to the size of a structure
Intervisibility	Two points in the landscape that are mutually visible.
Landscape Character Unit (LCU)	Considers common landscape types (defined by typical features and characteristics) and highlights principal landscape features. The Landscape Character Units for this assessment are based on the NSW Landscapes Biogeographic units at a finer scale than sub-bioregions. Also referred to as 'Mitchell Landscapes'.
Landscape feature	A component, part or feature of the landscape that is prominent or eye-catching (e.g. hills, buildings, vegetation).
Landscape quality	Judgement of landscape value based on particular characteristics that influence the way in which the environment is experienced, including special interests such as cultural associations or heritage interests, the presence and/or type of elements and condition.
Landscape sensitivity	The extent to which landscape can accept a change of a particular type and scale without unacceptable adverse impacts on its character.
Landscape value	Areas of formally designated landscape that through national or local consensus, reflect the value placed by society on particular environments and/or their features.
Matters of National Environmental Significance (MNES)	MNES as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* which include World/National Heritage properties, Ramsar wetlands, nationally threatened species and ecological communities, migratory species, Commonwealth marine areas, nuclear actions and national heritage places.
Middle ground view	The visual zone from one to six kilometres – different elements in the landscape are visually apparent.
Sensitive visual receptor	Person and/or viewer group that would experience an impact.
Viewing locations	Viewing locations are used in this report to typify the views experienced by sensitive visual receptors throughout the visual catchment of the Project. Viewing locations in this report often represent a viewing area, rather than one exact point.

Term	Definition
Visual amenity	The value of a particular area or view in terms of what is seen.
Visual impact	Changes in the appearance of the landscape or in the composition of available views as a result of development, to people's responses to these changes, and to the overall impacts in regard to visual amenity. This can be positive (i.e. beneficial or an improvement) or negative (i.e. adverse or a detraction).
Visual catchment (study area)	Extent of potential visibility to or from a specific area, feature or project.

Abbreviations

Abbreviation	Description
3D	Three dimensional
DECC	Department of Environment Climate Change
EPBC	Environment Protection and Biodiversity Conservation Act
GIS	Geographic Information Systems
LCU	Landscape Character Unit
LGA	Local Government Area
LVIA	Landscape and visual impact assessment
RSRZ	Representative Sensitive Receptor Zone
SRTM	Shuttle Radar Topography Mission
ZTV	Zone of Theoretical Visibility

1. Introduction

1.1 Overview

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri (refer Figure 1-1).

The Narrabri Gas Project (the project) seeks to develop and operate a gas production field, requiring the installation of gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), approximately 25 kilometres south-west of Narrabri. The gas would then be piped via a high-pressure gas transmission pipeline to market. This pipeline would be part of a separate approvals process and is therefore not part of this development proposal.

The primary objective of the project is to commercialise natural gas to be made available to the NSW gas market and to support the energy security needs of NSW.

The project is subject to the assessment and approval provisions of Division 4.1 of Part 4 of the NSW Environmental Planning and Assessment Act 1979. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

This Landscape and Visual Impact Assessment (LVIA) forms part of a broader Environmental Impact Statement being prepared for the project. The assessment identifies and describes impacts on the landscape and visual environment that would potentially arise from the construction or operation of the project. This assessment addresses the Secretary's environmental assessment requirements for the project, being:

> ***Visual*** *– including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, and minimising the lighting impacts of the development;*

Although the Secretary's requirements only seek assessment of visual impacts, it is usual for visual impacts to be assessed in combination with assessment of landscape impacts. The two issues are integrally related. As such, this assessment includes both:

- an assessment of development impacts upon the landscape as a resource, in terms of character, features and values, and
- an assessment of development impacts on the visual environment, in terms of impacts on views and visual amenity.

The central purpose of the LVIA is to identify potentially significant adverse impacts at the project planning stage and to propose measures to mitigate or ameliorate such impacts.

The specific elements of the project for which planning approval is being sought, and those that are therefore considered as part of this assessment, are: the gas field, a central water management facility, a central gas processing facility, an optional power plant, in-field gas compression, and supporting infrastructure.

1.2 Description of the project

The project would involve the construction and operation of a range of exploration and production activities and infrastructure including the continued use of some existing infrastructure. The key components of the project are presented in Table 1-1, and are shown on Figure 1-1.

Table 1-1 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.
Bibblewindi	• 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	• 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	• installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor
Gas field	
Gas 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 of existing exploration and appraisal wells to production.

Component	Infrastructure or activity
Ancillary	• upgrades to intersections on the Newell Highway • expansion of worker 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) offsite from Leewood • operation of the irrigation scheme.

The project is expected to generate approximately 1,300 jobs during the construction phase and sustain around 200 jobs during the operational phase; the latter excluding an ongoing drilling workforce comprising approximately 100 jobs.

Subject to obtaining the required regulatory approvals, and a financial investment decision, construction of the project is expected to commence in early 2018, with first gas scheduled for 2019/2020. Progressive construction of the gas processing and water management facilities would take around three years and would be undertaken between approximately early/mid-2018 and early/mid-2021. The gas wells would be progressively drilled during the first 20 or so years of the project. For the purpose of impact assessment, a 25-year construction and operational period has been adopted.

1.3 Project location

The project would be located in north-western NSW, approximately 20 kilometres south-west of Narrabri, within the Narrabri local government area (LGA) (see Figure 1-1).

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.

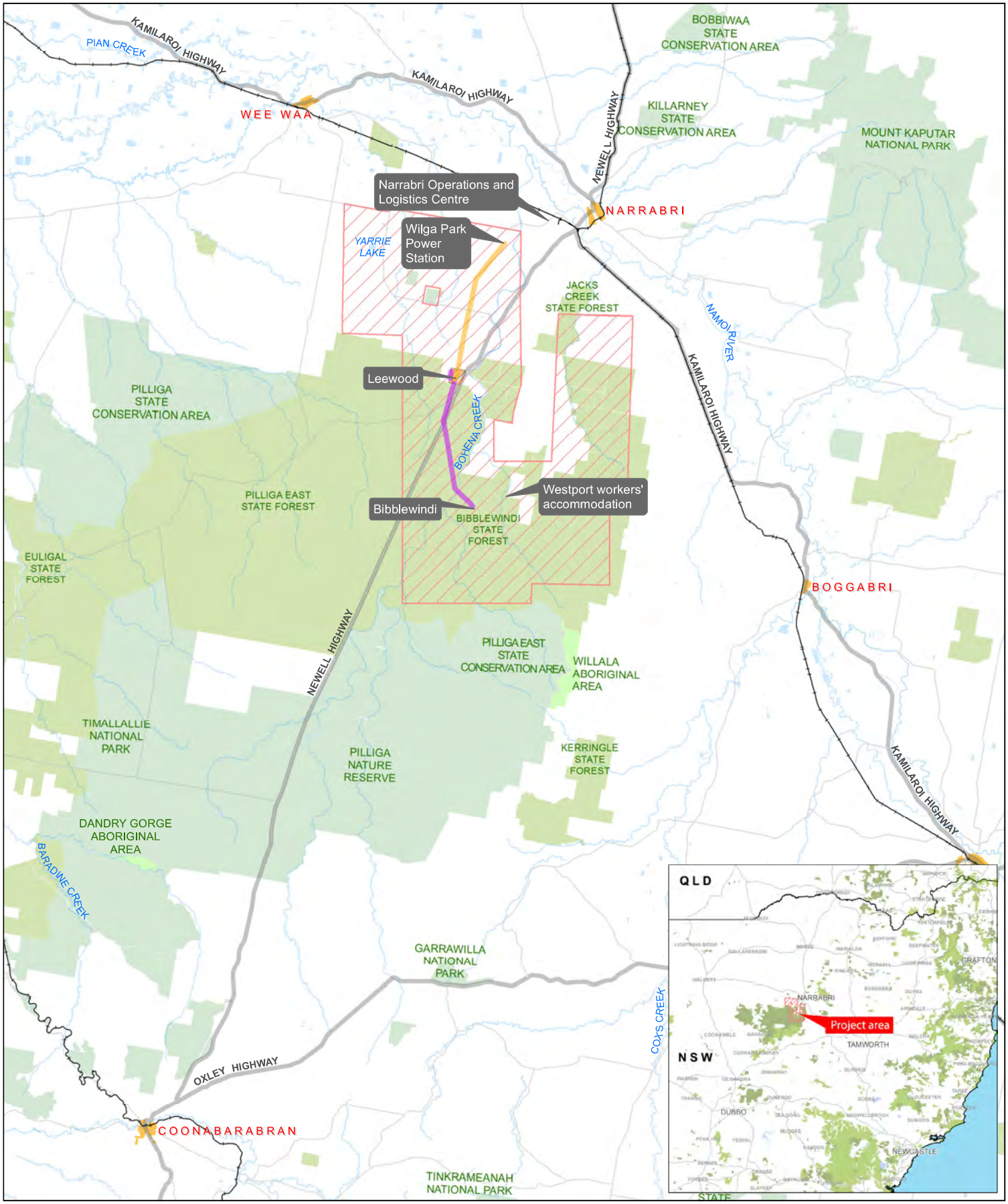
The project area contains a portion of the region known as 'the Pilliga', which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation, managed under the NSW *National 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.

The semi-arid climate of the region and general unsuitability of the soils for agriculture have combined to protect the Pilliga from widespread clearing. Commercial timber harvesting activities in the Pilliga were preceded by unsuccessful attempts in the mid-1800s to establish a wool production industry. Resource exploration has been occurring in the area since the 1960s; initially for oil, but more recently for coal and gas.

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and related 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 drought and wildfire.



LEGEND

- Project area
- Leewood
- Urban
- 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

0 5 10 20
Kilometers

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

N

Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Job Number 21-22463
Revision A
Date 12 Mar 2015

Regional context and location of key infrastructure

Figure 1-1

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The project area avoids the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve and Brigalow Park Nature Reserve. Brigalow State Conservation Area is within the project area but would be protected by a 50 metre surface exclusion zone.

Agriculture is a major land use within the Narrabri LGA; about half of the LGA is used for agriculture, split between cropping and grazing. Although the majority of the project area would be within State forests, much of the remaining area is situated on agricultural land that supports dry-land cropping and livestock. 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 issuance of a BSAL Certificate for the project area by the NSW Government.

1.4 Study area

There is a distinction between the project area and the *study area* for this assessment. The project area takes in all exploration, construction and production activities described above.

The study area takes in the landscapes associated with the project area *and* visual environments that may be affected by the project. This includes viewing locations up to three kilometres from the project area. Based upon previous studies of a similar nature, it is considered that viewing locations further than three kilometres from the study area would be extremely unlikely to be affected by the project. Figure 4-1 distinguishes the boundaries of the project area and study area.

The Narrabri township is located approximately one kilometre outside of the northern and eastern limits of the study area boundary. The Newell Highway dissects the centre of the study area along a southwest to northeast axis. The Kamilaroi Highway intersects the north-eastern edge of the study site along a northwest to southeast axis. The Mungindi rail line runs through Narrabri and traverses the northern sections of the study area.

Similar to the project area, the study area is characterised largely by forest area to the south and agricultural plains to the north. A detailed description of the landscape character throughout the study area is provided in Section 4.2.

This assessment is only concerned with ground-based viewing locations. Whilst the project may be visible from aircraft, impacts on such receptors have not been considered in this assessment.

1.4.1 Gas Field Development Protocol

Within the context of this landscape and visual assessment, it is important to recognise that development of the gas field would be undertaken in accordance with a Field Development Protocol. The Protocol would, among other things, establish procedures and controls on the specific siting of gas field infrastructure and project operation.

Specifically, it is expected that:

- non-linear and major infrastructure will be excluded from dedicated watercourse buffer zones, which will extend across 20 to 80 metre wide riparian zones (plus channel widths)
- no petroleum activities will occur within two kilometres of an existing urban area or township / land zoned residential
- petroleum activities are not permissible within Nature Reserves and National Parks (a nature reserve is located within the boundaries of PEL238 but this area has been specifically excluded from the project area and petroleum activities will not impact on these areas)

- the project will not occur within or impact upon the Brigalow State Conservation Area - the State Conservation Area will be a surface development exclusion zone (plus a buffer of at least 50 metres) and wells drilled from adjacent areas outside of the buffer must be at least 110 metres under the State Conservation Area
- known cultural heritage sites will be regarded as surface development exclusion zones
- use of existing access tracks, roads and installed infrastructure (gas and water gathering and transmission pipelines) will be maximised.

The above gas field development constraints were considered when undertaking this landscape and visual impact assessment.

1.5 Structure of report

This report comprises the following sections:

- **Chapter 1 – Introduction.** This chapter introduces the project and the proponent and describes the project area and study area.
- **Chapter 2 – Methodology.** This chapter describes the study area assessed in this report and describes the process employed for the assessment of impacts.
- **Chapter 3 – Legislative context.** This chapter outlines the relevant Commonwealth and State legislation relating to the assessment. Guidelines and assessment criteria (where applicable) relevant to the gas field construction, operation and decommissioning are also identified.
- **Chapter 4 – Existing environment.** This chapter describes the existing environmental values of the study area relevant to Landscape and Visual Impact Assessment; including results of desktop assessments and field investigations.
- **Chapter 5 – Impact assessment.** This chapter describes the existing landscape and visual environment and values of the study area. It also identifies, describes, and rates the potential impacts on the landscape and visual environment resulting from the construction and operation of the project.
- **Chapter 6 – Mitigation measures.** This chapter outlines the proposed mitigation strategies to be implemented during the life of the project to manage or reduce adverse impacts regarded as significant.
- **Chapter 7 – Conclusion.** This chapter presents a conclusion to the report and presents the next steps in the advancement of the project.

2. Methodology

2.1 Overview

2.1.1 Guidelines

There is no general (legislated) guidance on the assessment of landscape and visual impacts produced by an independent body specific to Australia. As such, this assessment employs the assessment process set out in the *Guidelines for Landscape and Visual Impact Assessment, Third Edition, (2013)* published by The Landscape Institute and the Institute for Environmental Management and Assessment (IEMA) in the UK. The assessment also draws on *Guidelines for Landscape Character and Visual Impact Assessment (*2013) prepared by the NSW Roads and Maritime Services.

Terminology, assessment methods and nomenclature have also been incorporated from the *Visual Landscape Planning in Western Australia,* produced by the Western Australian Planning Commission (2007) and the Forest Practice Board of Tasmania's, *A Manual for Forest Landscape Management (2006).*

2.1.2 Desktop Analysis

A desktop study was undertaken to obtain relevant publically available data on landscapes and visual impact at a national, regional and local level for the study area. The study included a comprehensive review of GIS data sets and an aerial photography based identification of potential sensitive visual receptor locations. Identified locations were subsequently validated by field teams.

The following GIS data sets were reviewed for the LVIA:

- aerial photography (Santos 2013)
- topographical data. (Santos 2013)
- hillshade (Shuttle Radar Topography Mission Shaded Relief)
- road networks (NSW LPI 2014)
- existing rail networks (NSW LPI 2013)
- cadastre (NSW LPI 2013)
- watercourses (Santos 2013)
- protected areas (DERM 2011)
- nature refuges (DERM 2010)
- local government areas (Santos/NSW LPI 2013)
- Interim Biogeographic Regionalisation for Australia Version 6.1 regions and subregions (SEWPAC 2005)
- Mitchell Landscapes V3 (DECC 2008).

2.1.3 Site Survey

A site survey of the study area was undertaken by a landscape architect from GHD to verify the desktop study, enable characterisation of the landscape, enable identification of sensitive visual receptors and observe how receptors might view the landscape. The site visit was conducted

between the 5th and 10th of February 2014 with conditions of bright sunny weather with good distance visibility.

During the site survey, the landscape architect traversed the study area (refer to Appendix A) from publicly accessible viewpoints. At each location a photographic record of landscape features, key views and sensitive visual receptors obtained along with coordinates, bearings, field notes and sketches were documented.

2.1.4 Photomontages

A series of five viewing locations were selected for the production of photomontage images. The photomontages were prepared in order to visually represent the views available from the selected locations during operational phase of the project. Views were selected specifically to illustrate potential impacts of gas well surface infrastructure in the relatively open agricultural plains to the north of the study area and of the major infrastructure at Leewood.

The photomontages prepared for the project are included in Appendix B and summarised in Table 2-1:

Table 2-1 Summary of photomontage view locations

View point location reference	View location description	Proposed infrastructure
View location 01 (Figure B1)	Looking over ploughed agricultural land	Gas well pad and surface infrastructure (close and distant locations in view)
View location 02 (Figure B2)	Looking over agricultural land with medium density vegetation	Gas well pad and surface infrastructure (close and distant locations in view)
View location 03 (Figure B3)	Looking over cropped agricultural land	Gas well pad and surface infrastructure (close and distant locations in view)
View location 04 (Figure B4)	Newell Highway – looking southwest toward Leewood property	The proposed infrastructure at Leewood property
View location 05 (Figure B5)	Looking over agricultural land with low density vegetation	Gas well pad and surface infrastructure (close and distant locations in view)

It is important to understand that the photomontages are representative of single static views, while visual or viewing experiences comprise of a variable sequence of views.

All photographic images were captured using a 50 millimetre (mm) fixed focal length lens on a 35 mm format (digital equivalent) camera, with a camera height of 1.7 metres as recommended in the UK Landscape Institute guidelines (LI 2011).

The software that has been utilised for modelling and rendering the photomontages was Autodesk 3D Studio Max. In order to achieve an accurate photomontage of the structure and surrounding landscape, 1 metre contours were used to model the surrounding landform.

Once the 3D model encapsulating both the landscape and new project elements was created, a virtual camera was placed in the software at the same location that the photographs were taken from. The film (35 mm), focal lens (50 mm) and height (1.7 m) of the virtual camera matches the real camera utilised to take the photos.

The photos of the site were used in 3D Studio Max as a background to accurately match the 3D model with the project elements to the perspective of the photos.

Rendered images of the project were produced from the camera view in order to match the daylight exposure of the photographs. The rendered images were imported into Adobe Photoshop for post-production editing and collation of the photomontages. The final result is the

3D model of the project shown in the correct 3D location in the photographs. The final images were produced to a high resolution, suitable for printing.

The 3D model included indicative locations for the proposed gas field infrastructure based on a worst case scenario. Visibility in the resultant photomontages of these elements is dependent upon topography (i.e. not all elements modelled will be visible from every location).

2.2 Assessment Process

The following figure (from *Guidelines for Landscape and Visual Impact Assessment, Third Edition, (2013)* describes the general process followed for the assessment of landscape and visual impacts. Each of the key steps is described further below.

As illustrated in Figure 2-1, the significance of impacts is evaluated as a product of:

- the sensitivity or value of the environment or receptor being affected
- the magnitude of impact on that environment or receptor.

To enable consistency and comparability of the rating, the sensitivity of each receptor and magnitude of impacts have been rated in accordance with set criteria. Whilst assessment of landscape and visual impacts and effects is largely a qualitative matter, assessment against a scale enables more relevant and reproducible evaluation and comparison of sensitivity of receptors and magnitude of effects.

2.2.1 Identifying Receptors

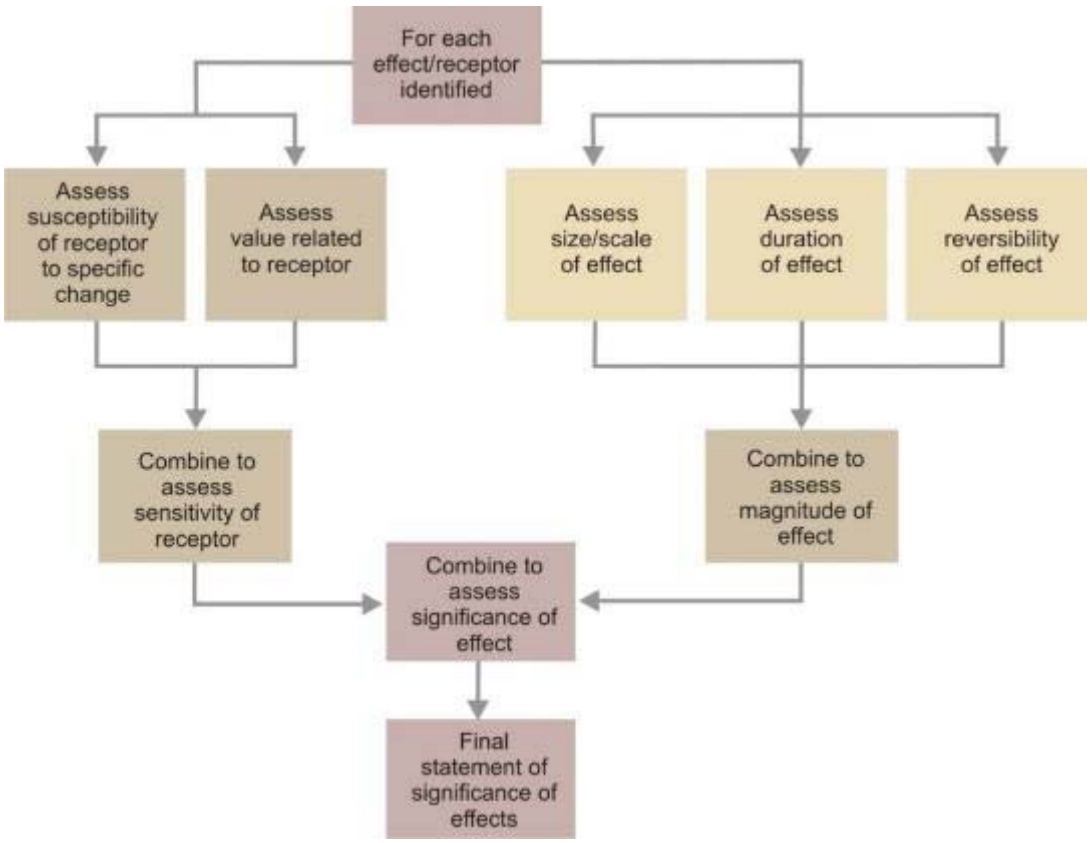
Landscape Receptors

In accordance with the Guidelines for Landscape and Visual Impact Assessment (LIIEMA 2013) landscape is defined as features (such as vegetation, built elements, topography, etc.) either within the project site or on land adjacent. The features of the landscape are considered as an integral part of the landscape and visual context of the area and therefore, are important contributors to the overall character of the environment.

Landscape receptors are those aspects of the landscape that are likely to be affected by the proposal. In this case they include overall landscape character, and a number of key landscape features (such as watercourses and ridgelines).

To assist with describing and describing the landscape and landscape receptors, the project area has been classified into five landscape character units (LCUs):

- LCU 1 – Baradine - Coghill Channels and Floodplains
- LCU 2 – Bugaldie Uplands
- LCU 3 – Cubbo Uplands
- LCU 4 – Coghill Alluvial Plains
- LCU 5 – Yarrie Lake Flora and Fauna Reserve.



Source: LIIEMA (2013)

Figure 2-1 Assessment process

The features, qualities and values associated with each LCU are described at Section 4.2 below.

The factors that have been considered in categorising the landscape character units include landform, land use vegetation and intensity and character of land. The categorisation process was informed through a review of the information assembled in the desktop study and the site survey described. The assessment also included a comprehensive review of the NSW (Mitchell) Landscapes (DECC 2008). The data set was reviewed as it considers climate, geomorphology, landform, lithology and characteristic flora and fauna which are attributes important to defining landscape character.

As assemblages of landscape elements, the LCUs cannot be singularly defined. Rather, each LCU presents a range of qualities (landform, vegetation, etc.) which collectively and in specific combination define it and distinguish it from other LCUs. The LCUs are often, but not always defined by physical divisions such as roads or topographical features.

Visual Receptors

Visual receptors are people or groups of people that may be affected by the proposal. It is relevant to keep in mind that different receptors have different types of views available to them and have different levels of interest in the views available to them.

In this assessment, a range of sensitive visual receptors have been identified:

- residential receptors
- commercial or industrial receptors
- recreational receptors
- road users.

Employees of the project have been excluded as visual receptors.

Due to the expanse of the study area and the fact that a number of receptors would experience the area as part of a journey along a transport route, a series of Representative Sensitive Receptor Zones (RSRZs) were identified. Specifically, the RSRZ were selected in order to:

- characterise areas where views of particular landscape and /or visual features of importance are represented
- represent areas where:
  - views from key sensitive visual receptors who spend extended amounts of time are possible such as residents; and
  - other locations from which fixed or transient views would be possible, but where the time of stay is shorter. These include residents, road and sensitive recreational receptors.

The RSRZs were identified through desktop mapping, including mapping of Zones of Theoretical Visibility (ZTV maps). A ZTV is the area around a designated point in the landscape from which that point is visible. The ZTV was calculated using elevation data such as a Digital Elevation Model. The ZTV maps were calculated on two metre contour intervals, with an observer eye height of 1.7 metres. ZTV mapping does not take into account vegetation screening and therefore represents a worst-case representation of potential visibility. These are presented in Appendix C. A zone of theoretical visibility of a single well pad and surface infrastructure has not been created; however, it would be no greater than 1 kilometre within a cleared and flat landscape setting. Visibility, however, would be substantially reduced with the presence of intervening vegetation.

The preliminary RSRZs were confirmed through site surveys. Photographs were taken to illustrate the visual experience and range of typical views of each RSRZ (refer to section 4.3).

The visual constraints that define the extent of each RSRZ's have been determined through field survey, including assessment of vegetation structure and distribution, and topography mentioned above. The five zones were selected as these represent the different types of viewing experiences through the study area.

The identified receptor zones include:

- RSRZ 1 – Northern Agricultural Plains
- RSRZ 2 – Channels and Floodplains
- RSRZ 3 – Forest
- RSRZ 4 – Old Mill Zone
- RSRZ 5 – Forest (Bibblewindi)

These zones have been identified as they represent the open viewing experience of the agricultural areas (RSRZ1); the enclosed / filtered viewing experience in the forestry and river corridor (RSRZ 2 and RSRZ 3 respectively). RSRZ 4 and RSRZ 5 have been selected as separate zones from those listed above, as these were identified as areas with potential increased development activities. To best assess and describe these impacts a 3km zone was identified around the Leewood and Bibblewindi Facility. This was considered to be the area where the potential greatest impacts may occur from the impact generators at both facilities. As some of the site infrastructure locations have not been determined at the time of writing, representing the receptors in this manner provides a method for assessing all potential receptors and the types of impacts likely to be experienced.

The views and visual experience of each RSRZ are described at Section 4.3.

2.2.2 Assessing Impacts

Receptor Sensitivity

Landscape Sensitivity and capacity to accommodate change

Landscape is assessed in terms of its sensitivity by combining judgements of its susceptibility to the type of development proposed and the value attached to that landscape. A landscape that is highly susceptible to change, or that is highly valued, would be regarded as a highly sensitive receptor.

The capacity of a particular landscape to accommodate change means the ability of the landscape to accommodate the proposed development without undue consequence of maintaining the baseline situation and/or the achievement of the landscape planning policies and strategies. Table 2-2 defines the rating categories for a landscapes capacity to accommodate change.

The value of an LCU would to some degree reflect landscape designations and the level of importance which they signify, although this would not be the sole indicator of the value. Table 2-3 defines the different value levels that are associated with a landscape.

Table 2-2 Landscape capacity to accommodate change

Landscape capacity	Definition
Low potential capacity	The landscape is highly susceptible to the type of development proposed. Mitigation measure unlikely to reduce the impacts of the change.
Medium potential capacity	Landscape has medium susceptibility to the type of change proposed. Change caused by the proposed development would be unlikely to have a significant adverse effect on the landscape character or value that could not be mitigated.
High potential capacity	The landscape would have low susceptibility to this type of change and few constraints imposed by landscape elements. Development of this type is very unlikely to have an adverse effect on the landscape character. Mitigation measures would be effective in neutralising adverse effects and / or may improve the landscape character.

Table 2-3 Landscape value

Landscape value	Definition
High	Landscapes of international designation that are highly valued, or distinctive.
Medium	Landscape of national or regional designation that are valued more locally and tolerant of moderate levels of change.
Low	Locally valued landscapes, designation by local authorities or where these do not exist, landscapes assessed as being equivalent value that are more commonplace and potentially tolerant of noticeable change or are undergoing substantial development, such that their character is one of change.
Neutral	Landscapes that are not nationally or locally designated, or judged to be of equivalent value but are valued.

Visual Sensitivity

For the purposes of this assessment, key visual receptors comprise residents, users of transport routes (road and access tracks), workers, and users of public recreation areas. All of the aforementioned receptor groups have differing sensitivities to their visual environment. In general terms, sensitivity is derived from a combination of factors including:

- the receptors' interest in the visual environment i.e. high, medium or low interest in their everyday visual environment and the duration of the effect

- duration of receptors' viewing opportunity and frequency of viewing opportunity (i.e. prolonged, regular viewing opportunities or fleeting view)
- the number of viewers and their distance / angle of view from the source of the impact, extent of screening / filtering of the view, where relevant.

For the purposes of this assessment, the terminology set out in Table 2-4 has been used to define visual sensitivity.

Table 2-4 Visual sensitivity definitions

Sensitivity	Definition
High	Occupiers of residential properties with long viewing periods, within close proximity to the proposed development. Visitors to scenic lookouts, on scenic routes, or at heritage sites. Communities that place value upon the landscape and enjoyment of views of their landscape setting.
Medium	Outdoor workers who have a key focus on their work that may also have intermittent views of the project area. Road users on routes that are not scenic routes, but where views contribute to the amenity or memorability of the journey. Viewers at outdoor recreation areas located within close proximity but where viewing periods are limited. Occupiers of residential properties with long viewing periods, at a distance from or with screened / filtered views of the project area.
Low	Road users in motor vehicles that are passing through the study area and have short term / transient views. Viewers indoor at their place of work, or similar.
Neutral	Viewers from locations where there is screening by vegetation or structures where only occasional views are available and viewing times are short. People who undertake work or recreation where the view is not an important factor.

Impact Magnitude

Impact magnitude was evaluated based on variables such as: the scale of impacts, the geographic extent of the impacts, the duration and reversibility of particular impacts, and the likelihood of occurrence of impacts.

As for landscape or receptor sensitivity, the nature and the magnitude of impacts was rated. The definitions are outlined in Table 2-5 have been used to describe both landscape and visual impacts.

Table 2-5 Assessment of Impact Magnitude

Impact Magnitude	Definition
Large	A substantial / obvious change to the landscape due to total loss of, or change to, elements, features or characteristics of the landscape. Such changes would cause a landscape or view to be permanently changed.
Moderate	Discernible changes in the landscape due to partial loss of, or change to the elements, features or characteristics of the landscape. May be partly mitigated. The change would be out of scale with the landscape and at odds with the local pattern and landform and will leave an impact on the landscape or view.
Small	Minor loss or alteration to one or more key landscape elements, features, or characteristics, or the introduction of elements that may be visible but may not be uncharacteristic within the existing landscape or view.
Negligible	Almost imperceptible or no change in the view as there is little or no loss of / or change to the elements, features or characteristics of the landscape.

Impact Significance

As explained previously, the significance of impacts is evaluated as a product of:

- the sensitivity or value of the environment or receptor being affected
- the magnitude of impact on that environment or receptor.

Again a rating is assigned, based on the matrix presented at Table 2-6 with a definition of significance in Table 2-7. The ratings themselves are not a determination of the acceptability of the proposal; they are simply a means of comparing impacts on different receptors, and with consideration of different impacts.

The process of assessment and the use of ratings tables reflect typical outcomes for visual impacts, particularly:

- impacts on receptors that are particularly sensitive to changes in views and visual amenity are more likely to be significant
- impacts on receptors at scenic routes or lookouts are more likely to be significant
- impacts that constitute a substantial change to the visual environment a likely to be more significant than impacts that do not cause substantial change.

Table 2-6 Significance of impact

		Impact Magnitude			
		Large	**Moderate**	**Small**	**Negligible**
Landscape value / Receptor Sensitivity	**High**	Major significance	High significance	Moderate significance	Minor significance
	Medium	High significance	Moderate significance	Minor significance	Not significant
	Low	Moderate significance	Minor significance	Not significant	Not significant
	Negligible	Minor significance	Not significant	Not significant	Not significant

Table 2-7 Description of significance of impact

Significance of impact	Description
Major	Large reduction (modification) in the amenity for receptors of high visual sensitivity
High	Large reduction (modification) in the amenity of a view for receptors of medium visual sensitivity, or a moderate reduction for receptors of high sensitivity
Moderate	Moderate reduction (modification) in the amenity of a view for viewers of a medium level visual sensitivity; or Large reduction (modification) in the amenity of a view for receptors of low visual sensitivity,
Minor	Moderate reduction (modification) in the amenity of a view for receptors of low sensitivity; or Small reduction (modification) in the amenity of a view for receptors of moderate sensitivity
Not significant	Small reduction (modification) in the amenity of a view for receptors of low sensitivity

2.3 Identifying Mitigation Measures

Once the significance of impacts on all receptors were identified and rated, potential mitigation measures have been identified. Mitigation measures are developed specifically for the project and are appropriate in terms of scale, effort, expense, and applicability. Mitigation measures would include responses to either: avoid, minimise, rehabilitate, manage, or offset impacts, as described below.

- **Avoidance** - Avoid developments in sensitive or prominent landscapes, and avoid insensitive or visually intrusive designs. Prevention of adverse effects at source.
- **Reduction** – Reduction of adverse effects that cannot be eliminated by avoidance. The significance of adverse impacts is lessened. Seeks to limit the exposure of the receptor. Reduce the visual intrusiveness of the design and reduce the visibility of the Project (e.g. by installing barriers between the location(s) of likely receptors and the source of the impact).
- **Remedy** – Remedy serves to improve adverse conditions by carrying out further works which seek to restore the environment e.g. increased planting of trees/shrubs to offset unavoidable loss of vegetation.
- **Offsetting -** The provision of alternative or compensatory measures where appropriate and feasible (e.g. offset planting).

If it is not possible or practical to mitigate an impact entirely, this is described as a Residual Impact.

2.4 Limitations and Assumptions

The assessment process aims to be objective and describe changes factually. However, assessing the significance of the changes to the landscape and visual environment inevitably requires qualitative (subjective) judgements to be made. The conclusions made in this assessment therefore combine objective measurement and professional interpretation.

This assessment is based on a number of assumptions, including:

- The assessment is based on the project description described in Chapter 6 of the EIS. Should the project description change significantly during detailed design, additional assessment may be required.
- The detailed design and vendor selection for the project has yet to occur and as such assumptions have been made regarding the likely size and scale of infrastructure based on typical natural gas from coal seam fields.
- Potential impacts of gas field infrastructure were assessed with consideration to the flexibility of their location outlined in the Field Development Protocol.
- A large event from the safety flares at the Leewood property and Bibblewindi facility would be rare.
- Clearance required for well pads is limited to approximately one hectare.
- Well pads would be rehabilitated to approximately 0.25 hectares in size during the operation.
- Potential lighting impacts were assessed with reference to similar projects.
- If required, the number of telecommunication towers throughout the gas field is expected to either be ten 60 metre towers, or twenty 30 metre towers, or a combination of both.
- The number of well pads expected to be constructed in a particular RSRZ is assumed to be directly proportional to the size of the RSRZ, compared to entire project area.

3. Legislative context

The relevant legislation and state and local policies that apply to the project and that are of relevance to considerations of landscape and visual impacts include those set out below.

3.1 National Legislative Framework

3.1.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* protects those aspects of the environment that are of national significance and heritage value. The protection of the environment includes the qualities and characteristics of locations; places and areas; and heritage values of places.

3.2 State Legislative Framework

3.2.1 Environmental Planning and Assessment Act 1979

In the event of the proposed development and land use change, the impacts to the environment (natural and built) and the community are considered under the *Environmental Planning and Assessment Act 1979*. This legislation relates to this assessment through the objectives which encourage:

- *The proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.*
- *The protection, provision and co-ordination of communication and utility services.*
- *The provision of land for public purposes.*

The project is permissible with development consent under the *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*, and is identified as 'State significant development' under section 89C(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *State Environmental Planning Policy (State and Regional Development) 2011*.

The project is subject to the assessment and approval provisions of Division 4.1 of Part 4 of the EP&A Act. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

This Landscape and Visual Impact Assessment identifies the potential visual and landscape issues associated with construction and operation of the project and addresses the Secretary's environmental assessment requirements for the project. The assessment will be used to support the EIS for the project. The Secretary's requirements relevant to this report include:

> ***Visual** – including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, and minimising the lighting impacts of the development.*

3.2.2 Environmental Planning and Assessment Regulation 2000

The *Environmental Planning and Assessment Regulation (Siding Spring Observatory) Regulation* came into effect in 2016. The objective of the Regulation was to amend the *Environmental Planning and Assessment Regulation 2000* to:

(a) require the consent authority to take into consideration the *Dark Sky Planning Guideline* prepared by the Secretary of the Department of Environment and Planning when determining a development application for:

  (i) development on land within the local government area of Coonamble, City of Dubbo, Gilgandra or Warrumbungle Shire (being the local government areas closest to the Siding Spring Observatory near Coonabarabran), or

  (ii) regional development, State Significant development or designated development on land within 200 kilometres of the observatory, and

(b) require the proponent to take into consideration the *Dark Sky Planning Guideline* when preparing an environmental impact statement for State significant infrastructure on land within 200 kilometres of the observatory, and

(c) to provide that a certifying authority cannot issue an occupation certificate in relation to a dwelling house, dual occupancy or secondary dwelling that is complying development on land within the local government area of Coonamble, City of Dubbo, Gilgandra or Warrumbungle Shore unless certain standards are met with respect to outside lighting so as to limit the amount of light pollution generated by such buildings in order to protect the observing conditions at the observatory, and

(d) to include a savings and transitional provision and to make statute law revision amendments.

The *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* also came into effect in 2016. The Guideline informs development controls that apply to land within the local government areas of Coonamble, Dubbo, Gilgandra and Warrumbungle and the assessment of significant development within 200 kilometres of the observatory. It supports the design and operation of development in the region and provides key information to ensure that lighting used in development does not impact on the effectiveness of the observatory.

3.2.3 Strategic Regional Land Use Policy (SRLUP)

In NSW, the *Strategic Regional Land Use Policy* has been implemented to identify, map and protect valuable residential and agricultural land across the State from the impacts of mining and Coal Seam Gas (CSG) activity. The proposed area is located in the New England North West region and managed under the New England North West Plan.

Chapter 7 (Community Health and Amenity) of the New England North West Plan outlines a set of actions aimed at minimising impacts of mining and coal seam gas development, including visual amenity. This chapter identifies that the growth of coal seam gas infrastructure in the region will require careful management in terms of both scale and nature to avoid adverse visual impacts arising from the development of surface infrastructure such as well heads, access roads and pipelines.

The Objective for Community Health and Amenity seeks to '*ensure that the growth of the mining and coal seam gas industries do not significantly impact on community health and amenity'.*

3.2.4 State Environmental Planning Policy (Rural Lands)

The *State Environmental Planning Policy (SEPP)* for rural lands is an environmental planning instrument designed to:

- *To facilitate the orderly and economic use and development of rural lands for rural and related purposes.*
- *To identify the Rural Planning Principles and the Rural Subdivision Principles so as to assist in the proper management, development and protection of rural lands for the purpose of promoting the social, economic and environmental welfare of the State.*
- *To implement measures designed to reduce land use conflicts.*
- *To identify State significant agricultural land for the purpose of ensuring the ongoing viability of agriculture on that land, having regard to social, economic and environmental considerations.*

3.2.5 NSW Forest Management Policy 2013-14

The NSW Forest Manage Policy aims to conserve and advance a range of forest values such as forest productivity and biodiversity.

3.3 Local Planning Policy Framework

The following sections from the Local Planning Policy Framework are considered to be relevant to the project.

3.3.1 Narrabri Local Environmental Plan 2012

The proposed gas field is located within the Narrabri Local Government Area. Therefore, the Narrabri Local Environmental Plan 2012 (Narrabri LEP) regulates the land use within the Local Government area. The land within the study area is contained within three zones that have been identified having regard to the Narrabri LEP as it affects the study area. The objectives relevant to the respective zones and the assessment generally are outlined in Table 3-1, below.

Table 3-1 Land use zones of the study area.

Zone	Description
RU1 – Primary Production	**Strategy:** This is a rural zone located in the northern section of the study area and coincides with agricultural land uses such as grazing and cropping. Some parts of the zone comprises native vegetation which are not part of the state forest, state conservation area or nature reserve.
	Objectives: • *To minimise the fragmentation and alienation of resource lands.* • *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
RU3 - Forestry	**Strategy:** This is a rural zone located in the southern area of the study area and coincides with the Pilliga East, Bibblewindi and Jacks Creek state forests. Permitted uses in this zone are authorised under the *Forestry Act 2012*.
E1 – National Parks and Nature Reserves	**Strategy:** This is an environmental zone with two areas located in the north of the study area. The E1 zoned land and is surrounded by the RU1 zoned land. Those areas coincide with the Brigalow State Conservation Area and Brigalow Park Nature Reserve. The land in this zone is protected under the *National Parks and Wildlife Act 1975*.
	Objectives: • *To enable uses authorised under the National Parks and Wildlife Act 1974.* • *To identify land that is to be reserved under the National Parks and Wildlife Act 1974 and to protect the environmental significance of that land.*

3.3.2 Brigalow Park Nature Reserve - Plan of Management

The Brigalow Park Nature Reserve - Plan of Management provides specific objectives for the management of the Nature Reserve. Specific objectives include the protection of the nature reserve as a representative sample of the 'transition zone' of vegetation on the north western slopes and plain and the associated animal communities. It also specifies the protection of threatened and/or isolated plant and animal species and communities, particularly Brigalow spiny peppercress and black-striped wallaby.

3.3.3 Brigalow and Nandewar Community Conservation Area Agreement

The Brigalow and Nandewar Community Conservation Area Agreement was developed to manage the land in the area in consultation with communities. The strategic aims for the area are designed to create a resilient and functioning landscape system for people visiting, living and working in the area. The Agreement also allows for the utilisation of minerals and petroleum in the Conservation Area.

4. Existing environment

4.1 Introduction

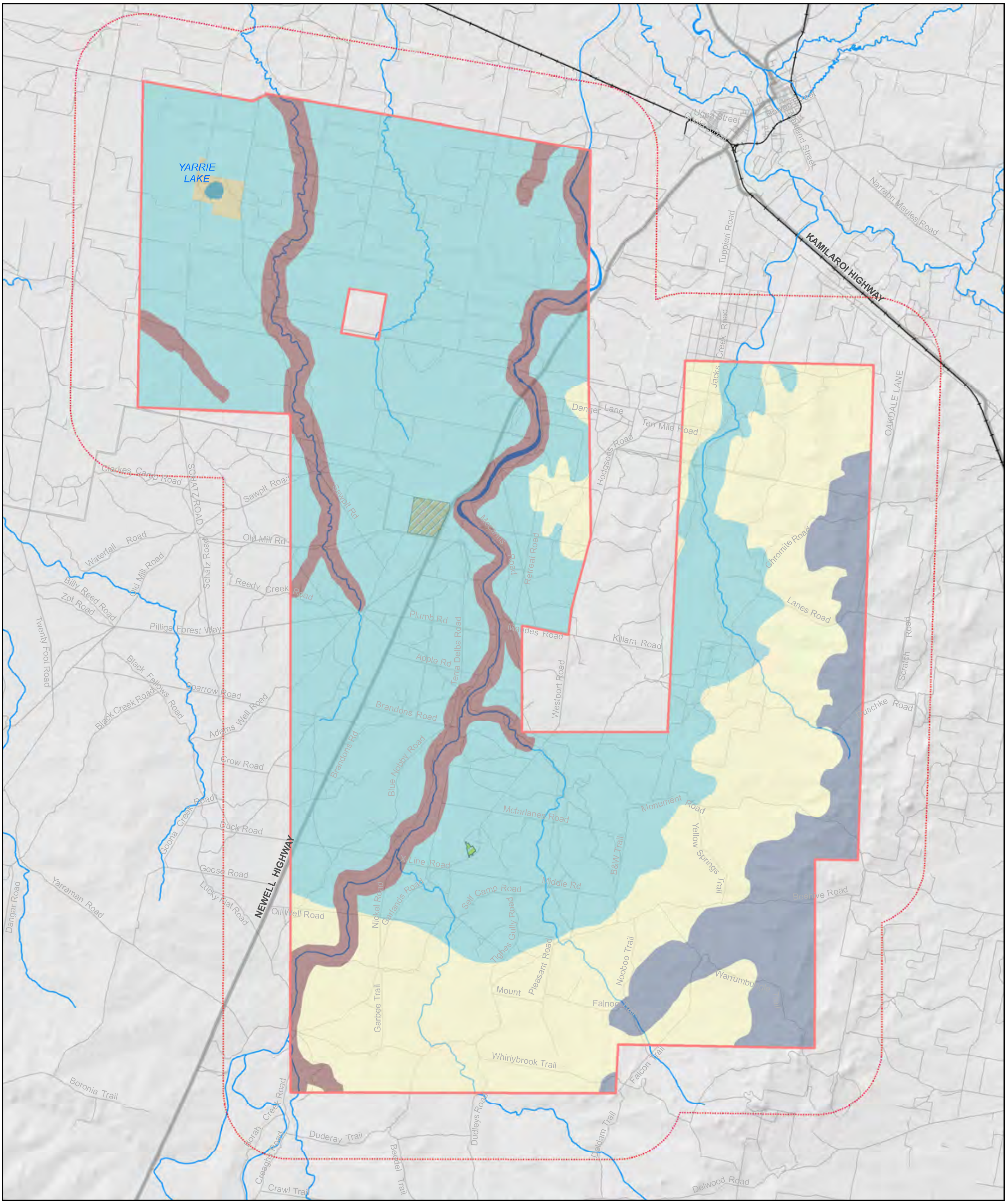
The following section provides an overview of the landscape and visual environment in the vicinity of the study area.

4.2 Landscape Receptors

As explained above, to assist with classifying and describing the landscape and landscape receptors, the project area has been classified into five landscape character units (LCUs):

- LCU 1 – Baradine - Coghill Channels and Floodplains.
- LCU 2 – Bugaldie Uplands.
- LCU 3 – Cubbo Uplands.
- LCU 4 – Coghill Alluvial Plains.
- LCU 5 – Yarrie Lake Flora and Fauna Reserve.

The LCUs are depicted on Figure 4-1 and are described below.



LEGEND

- Project area
- Leewood
- Bibblewindi
- Lakes and dams
- Watercourses
- Roads
- Train line
- Study area (3 Km project area buffer)

Landscape Character Units

- LCU 1 – Barradine - Coghill Channels and Floodplains.
- LCU 2 – Bugaldie Uplands.
- LCU 3 – Cubbo Uplands.
- LCU 4 – Coghill Alluvial Plains.
- LCU 5 – Yarrie Lake Flora and Fauna Reserve

0 1.75 3.5 7
Kilometers

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

N

GHD

Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Job Number 21-22463
Revision A
Date 11 Mar 2015

Landscape Character Units

Figure 4-1

C:\Users\AFoddy\Desktop\21_22463_KBM29.mxd [KBM: 123]

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

4.2.1 LCU 1 - Baradine – Coghill Channels and Floodplains

LCU 1 is located along the main drainage lines within the study area and is predominately comprised of channels and floodplains. An indicative description of LCU 1 is provided in Table 4-1 and shown in Photo 4-1 and Photo 4-2. The area is elevated between 170 to 210 metres with a local relief of 10 metres and is defined by the Quaternary alluvium of the Coghill and Baradine Creeks, featuring sandy incised channels and distributary streams. Baradine Creek is not located within the project area but is included in the assessment of the study area.

Photo 4-1 Bohena Creek from within dry channel

Photo 4-2 Vegetated floodplain of the area

Table 4-1 LCU 1: Baradine – Coghill Channels and Floodplains

Character element	Description
Landform	Valley
Drainage / water	Coghill Creek, Baradine Creek
Vegetation	Woodland dominated by river red gum along the channels. Other species include bimble box (Eucalyptus populnea), Pilliga box (Eucalyptus pilligaensis), Blakely's red gum (Eucalyptus blakelyi), white cypress pine (Callitris glaucophylla) and red ironbark (Eucalyptus sideroxylon) and occasional silver-leaved ironbark (Eucalyptus melanophloia).
Land Use	Channel and floodplain.
Buildings/Structures	None within the area.
Existing Infrastructure	This LCU is predominately traversed by unsealed Roads and local tracks which tend to run either parallel to the creeks or cross perpendicular over the creeks. The Newell Highway crosses the Bohena Creek to the north of the study area.
Cultural and recreational characteristics	The Coghill and Baradine Creeks provide an important natural amenity for the local community. There are limited recreational characteristics of this unit.
Spatial qualities	Strong linear characteristics bounded by sharp edges lined with trees. There are limited views outside of the river corridor and a sense of enclosure within this character unit. Vegetation is mature and the canopy tall. The riparian vegetation provides a separation from surrounding roads and residences.

4.2.2 LCU 2 – Bugaldie Uplands

LCU 2 is located in the south-eastern part of the study area, which is defined by Jurassic quartz sandstone with some conglomerate, shale and interbedded basaltic volcanic rocks formed to create a stepped stony ridge landscape. A description of the LCU is provided Table 4-2 and illustrated in Photo 4-3 and Photo 4-4. The area is elevated between 350 to 490 metres, exhibits a local relief of 50 to 150 metres and is defined by an extensive network of joined watercourses.

LCU 2 is a varied landscape which is characterised by thick canopy and understorey. Larger Mallee canopy overshadow the shrubby understorey of ferns, lilies and grevilleas. Vegetation also inhabits the stony slopes and sandy bottoms. There is an unrestricted view over the valley from the upper area of the LCU 2 unit.

Photo 4-3 View of LCU 2 from a high point looking east

Photo 4-4 View of LCU 2 from a high point looking north

Table 4-2 LCU 2: Bugaldie Uplands

Character element	Description
Landform	Steeply Sloping
Drainage / water	n/a
Vegetation	Patches of green mallee (Eucalyptus viridis) and white mallee (Eucalyptus dumosa), clumps of curracabah (Acacia concurrens) and motherumbah (Acacia cheelii) amongst red ironbark (Eucalyptus sideroxylon) and black cypress pine (Callitris endlicheri) with shrubby understorey including rusty spider flower (Grevillea floribunda), mint bush (Prostanthera sp.), nodding blue lily (Stypandra glauca) and rock fern (Cheilanthes sieberi) on ridges and stony slopes. Narrow-leaved ironbark (Eucalyptus crebra), red stringybark (Eucalyptus macrorhyncha), black cypress pine (Callitris endlicheri), brown bloodwood (Corymbia trachyphloia) and rough-barked apple (Angophora floribunda) on the sandy flats.
Land Use	State Forest
Buildings/Structures	Single dwelling residencies with associated farm buildings are present in the northern area of the unit.
Existing Infrastructure	The unit contains predominately unsealed roads and tracks which generally travel in an east west direction..
Cultural and recreational characteristics	The Coghill and Baradine Creeks provide an important natural amenity for the local community. The creeks provide indigenous cultural heritage values. The Pilliga East State Forest and Bibblewindi state Forest provide recreational values to the local community.
Spatial qualities	Views are dictated by the vantage point on the slope and presence of vegetation, with an overall sense of openness. Vistas range from short to long distance and are shielded in some directions, dependent on vegetation.

4.2.3 LCU 3 – Cubbo Uplands

LCU 3 is located in the central and south-eastern portion of the study area. LCU 3 is dominated by rocky outcrops consisting of Jurassic quartz sandstones and shales. The sandstone outcrops decline into stepped sandstone ridges with low cliff faces. Low gentle slopes intersect sandy streambeds and old channels. A further description of the LCU is provided in Table 4-3 and illustrated in Photo 4-5 and Photo 4-6. The area is elevated between 400 to 550 metres, with a local relief of 50 metres with a few patches of heavy clay.

There are various forest and woodland species supporting the outcrops, mallee species supporting the sloping hills and eucalyptus species in the harsh clay bottom. There is an unrestricted view over the valley from the upper area of the unit.

Photo 4-5 View of forest looking east

Photo 4-6 View of LCU 3 looking uphill on an access track

Table 4-3 LCU 3: Cubbo Uplands

Character element	Description
Landform	Rocky outcrop
Drainage / water	Various tributaries of Namoi River, Coghill, Bohena, Etoo, Talluba and Baradine Creeks.
Vegetation	The sandstone outcrop areas support various forests and woodlands including blue-leaved ironbark (Eucalyptus fibros spp. nubila), scribbly gum (Eucalyptus rossii), black cypress pine (Callitris endlicheri), whitewood (Atalaya hemiglauca), and rough-barked apple (Angophora floribunda). Stony hills in the north of the region support mallee patches with silver-leaved ironbark (Eucalyptus melanophloia), spotted gum (Corymbia maculata) and smooth-barked apple (Angophora costata). Gentler sandstone slopes over most of the region carry narrow-leaved ironbark (Eucalyptus crebra), white cypress pine (Callitris glaucophylla), red stringybark (Eucalyptus macrorhyncha), patches of green mallee (Eucalyptus viridis) and broombush heath (Melaleuca uncinata). In the western and northern sections on texture-contrast or more uniform harsh clay soils there are forests of Pilliga box (Eucalyptus pilligaensis), grey box (Eucalyptus microcarpa) and bimble box (Eucalyptus populnea). In addition, fuzzy box (Eucalyptus conica) are found with stands of bull oak (Allocasuarina luehmannii), rosewood (Alectryon oleifolium), whitewood (Atalaya hemiglauca), wilga (Geijera parviflora), belah (Casuarina cristata), yarran (Acacia homalophylla), and budda (Eremophila mitchellii).
Land Use	State Forest
Buildings/Structures	n/a
Infrastructure	Roads and tracks
Cultural and recreational characteristics	Jacks Creek State Forest provides natural recreational value to the local community.
Spatial qualities	Views are dictated by vantage position on the slope and presence of vegetation with an overall sense of enclosure. Vistas range from short to long distance and are shielded in some directions dependent on vegetation.

4.2.4 LCU 4 – Coghill Alluvial Plains

LCU 4 is located in the north and central sections of the study area. LCU 4 is defined by Quaternary alluvial fan predominately derived from Jurassic quartz sandstone from forest drained streams. Sandy abandoned stream channels are imbedded throughout the long gentle slopes. A description of the LCU is provided in Table 4-4 and illustrated in Photo 4-7 to Photo 4-10. The area is elevated between 200 to 280 metres, with a local relief of five to nine metres.

The stream channels are incised by heavy grey clay which is contrasted by the harsh clay subsoils and grey clay with Gilgai. Grass trees dominate the sandy stream channels and river red gum line the creek lines, whereas the remaining landscape is open forest.

Photo 4-7 View of LCU 4 of agricultural land

Photo 4-8 View of LCU 4 from the road

Photo 4-9 View of LCU 4 creek line

Photo 4-10 View of LCU 4 creek line

Table 4-4 LCU 4: Coghill Alluvial Plains

Character element	Description
Landform	Alluvial Plains
Drainage / water	Drainage lines of Namoi River
Vegetation	Open forest of white cypress pine (Callitris glaucophylla), bimble box (Eucalyptus populnea), Pilliga box (Eucalyptus pilligaensis), Blakely's red gum (Eucalyptus blakelyi) and red ironbark (Eucalyptus sideroxylon). Brown bloodwood (Corymbia trachyphloia) and grass trees (Xanthorrhoea sp.) on sand monkeys. Patches of bull oak (Allocasuarina luehmannii) or brigalow (Acacia harpophylla) on gilgai in heavy clay. Baradine red gum (Eucalyptus dealbata) and river red gum (Eucalyptus camaldulensis) along watercourse lines.
Land Use	Residential, Agriculture and National Park
Buildings/Structures	Single dwelling residencies with associated farm buildings as well as agricultural infrastructure dominate this unit.
Infrastructure	Roads, access tracks and power lines
Parks and open space	There are some public open spaces within the local area.
Cultural and recreational characteristics	The Brigalow Park Nature Reserve provides an important natural recreational value to local community.
Spatial qualities	Views in the area are predominately open with vistas ranging from short to long distance, dependent on the presence of vegetation.

4.2.5 LCU 5 - Yarrie Lake Flora and Fauna Reserve

Although the Yarrie Lake Flora and Fauna Reserve is within the Coghill Alluvial Plains LCU, it has been classified as a separate LCU due to the recreational and environmental value it provides to the community. LCU 5 is a significant reserve comprising of a three kilometre saucer shaped lake located centrally within the agricultural part of the study area. People are attracted to the area for its natural serenity and engage in a range of pursuits such as bird watching, picnics, boating, fishing and camping. A description of the LCU is provided Table 4-5 and illustrated in Photo 4-11 and Photo 4-12.

The lake is shallow, lined by a sandy base and obtains its colour from the sandy creeks and Pilliga scrub soil. It has a high diversity of native vegetation and high-quality remnants of the Brigalow open forest endangered ecological community and Bimble Box woodland. The reserve provides a recreational amenity to the local community.

Photo 4-11 View of Yarrie Lake from the edge of the lake

Photo 4-12 View of the public amenities adjoining Yarrie Lake

Table 4-5 LCU 5: Yarrie Lake Flora and Fauna Reserve

Character element	Description
Landform	Lake

Drainage / water	Yarrie Lake
Vegetation	Approximately 400 ha of remnant Brigalow open forest vegetation and bimble box woodland.
Land Use	Recreational
Buildings/Structures	Boat ramp, public amenities, picnic tables, single dwellings and holiday accommodation
Infrastructure	Roads, access tracks and power lines are located within the unit.
Parks and open space	LCU 5 is a recreational reserve.
Cultural and recreational characteristics	Yarrie Lake has significant indigenous heritage value with physical signs (such as scar trees) of the Kamilaroi people who inhabited the area. The reserve provides great recreational value to the community in the form of water sports, bird watching, boating, fishing and general serenity.
Spatial qualities	Open views are available across the lake, which is bounded by tall vegetation. The tall vegetation obstructs views into the wider landscape.

4.3 Representative Sensitive Receptor Zones

As explained previously, in order to undertake an assessment of visual impacts, the sensitive receptors have been grouped into representative zones based on typical types of views experienced. The representative sensitive receptor zones (RSRZ) consist of areas where full or screened views of the project may be possible and human activity would be undertaken.

Five RSRZ have been identified in the study area:

- RSRZ 1 – Northern Agricultural Plains
- RSRZ 2 – Channels and Floodplains
- RSRZ 3 – Forest
- RSRZ 4 – Leewood
- RSRZ 5 – Bibblewindi

The RSRZ that have been identified and assessed in this report are depicted on Figure 4-2**.**

4.3.1 Sensitive Receptors

In this assessment sensitive receptors have different visual sensitivities dependent on their proximity to the impacts of the project and their location in the landscape. The receptors range from low to high sensitivity to the impacts of the project.

Residential receptors

Residential receptors occur in the central to northern part of the project area, with the concentration in the North West area. The residences are in the form of single dwellings with associated farm buildings such as cattle shed, barns and storage facilities. These receptors have mostly unobstructed open vistas from their property, with some views impeded by treed areas and drainage line vegetation. Residences are typically bound by linear fencing and roads.

Commercial or industrial receptors

Commercial and industrial receptors occupy agricultural businesses including large sheds and buildings located through the study area.

Recreational receptors

Recreational receptors access the entire project area. The state forests attract visitors for bushwalking, camping, and picnics either in transient activities or for short stays. Views in these

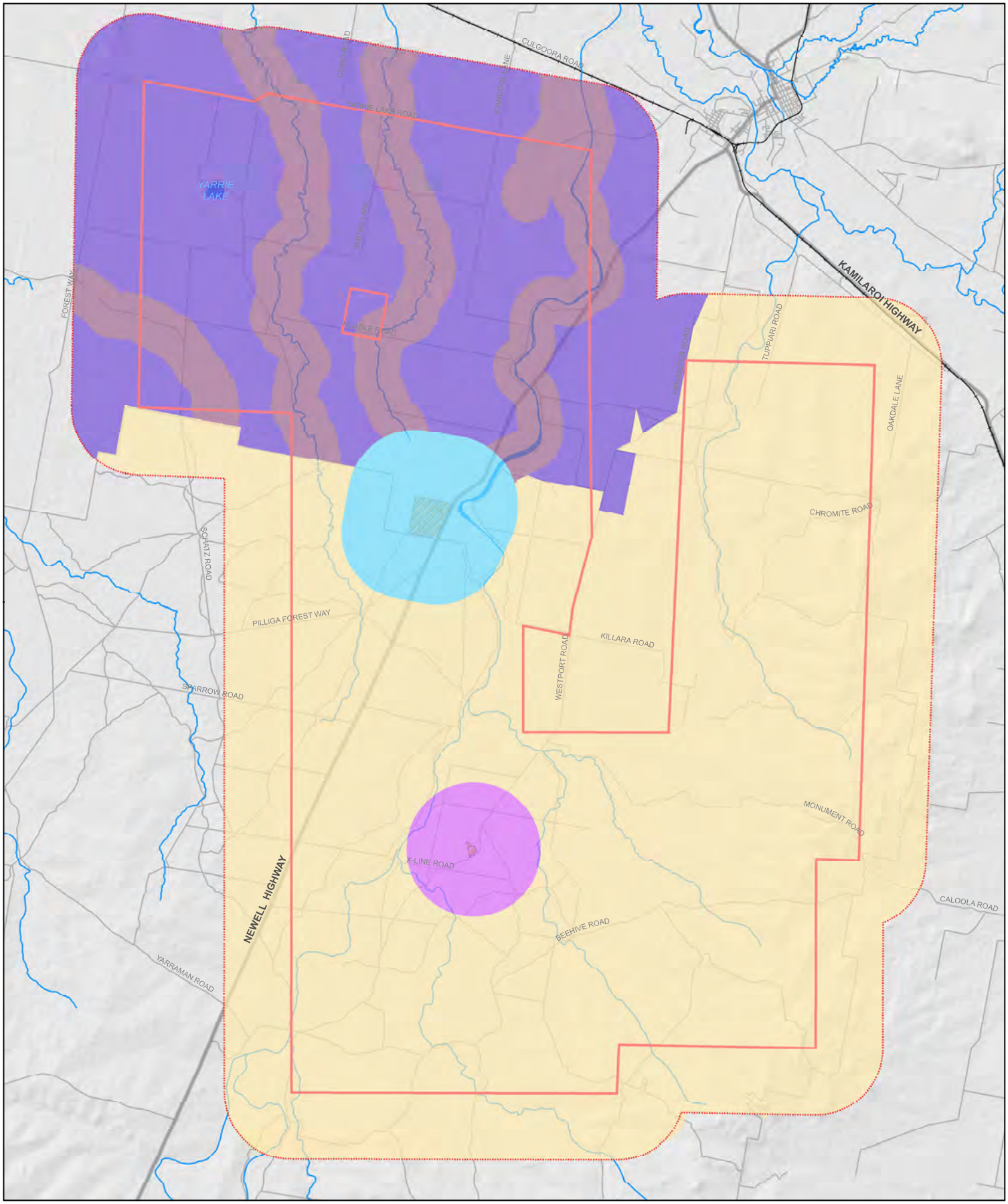
areas are generally short due to the presence of tall vegetation; however elevated areas provide longer views. In the northern part of the project area, Yarrie Lake attracts recreational receptors for camping, boating, fishing, picnicking and relaxing. Vistas from this area are of a short to medium distance being impeded by the lakeside vegetation.

Road users

Road users access much of study area. The Newell Highway dissects the study area within the northeast to southwest axis and carries the largest traffic volume of roads in the study area. Collector roads, local roads and unsealed access tracks also occur throughout the site.

Observatory

The Anglo-Australian Telescope at Siding Spring, Coonabarabran on the edge of the Warrumbungle National Park is listed on Australian National University's heritage register under Section 341ZC. The Telescope is listed as holding historic, aesthetic and research significance. It is located approximately 78 km south west of the southernmost point of the Project area. The aesthetic values of the site will therefore not be impacted by the Project. The safety flares at Bibblewindi and Leewood facilities will be located approximately 90 and 100 kilometres respectively from the observatory. Optical or infrared observatory is susceptible to sky glow which can potentially negatively affect observations.



LEGEND

- Project area
- Leewood property
- Bibblewindi
- Lakes and dams
- Watercourses
- Roads
- Train line
- Study area (3 Km project area buffer)

Representative Sensitive Receptor Zones

- RSRZ 1 – Northern Plains
- RSRZ 2 – Channels and Floodplains
- RSRZ 3 – Forest
- RSRZ 4 – Old Mill Road
- RSRZ 5 – Forest (Bibblewindi)

0 1.75 3.5 7
Kilometers

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

N

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Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Representative Sensitive Receiver Zones

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Figure 4-2

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

4.3.2 RSRZ 1 – Northern Agricultural Plains

The Northern Agricultural Plains RSRZ is located in the northern part of the study area and is characterised by flat, agricultural plains and farm properties (Photo 4-13). A description of the different elements of the zone is outlined in Table 4-6.

Photo 4-13 Looking into an open paddock

Table 4-6 Character elements of RSRZ 1 – Northern Agricultural Plains

Character element	Description
Location	The zone is in the north-west part of the study area. It includes the Coghill Alluvial Plains. The majority of the zone is located north-west of Newell Highway. There are 95 identified residences within this RSRZ
Landform and Significant Landscape Features	Topography is generally flat in the northern area, with an increase in elevation further south of the zone.
Vegetation	Predominately cleared landscape with much of the remaining vegetation present along road corridors, property fence lines and along drainage lines. There are some isolated and small groups of vegetation and trees scattered throughout the properties.
Water	Yarrie Lake is located within the zone. Oakyhole Creek, Bundock Creek, Bohena Creek and Mollee Creek all flow through the zone. Bibblewindi Creek and tributaries of Bohena Creek flow south into the central part of the zone.
Land Use	The area is predominately utilised for agricultural purposes and includes rural residences. There are also recreational areas in the form of nature reserves and creek reserves.
Visual Context	The visual landscape (when viewed from the agricultural and residential properties) is open with medium distance views depending on constraints by localised vegetation. Views in the area are primarily composed of large areas of cleared agricultural exposed land with low vegetation. Views to the foreground consist of small groups of trees, residential properties, farm buildings, roads and fences. Some views are obstructed in the foreground by the tree corridors along watercourses. Views from this zone are experienced by: • Residents of the rural farms and agricultural properties • Road users • Recreational users of Yarrie Lake, Brigalow Park Nature Reserve and the local creeks.

4.3.3 RSRZ 2 – Channels and Floodplains

The Channel and Floodplains RSRZ is located in the northern areas of the project area and is characterised by linear watercourses and woodland floodplains (refer to Photo 4-14 and Photo 4-15). A description of the different elements of the zone is provided in Table 4-7.

Photo 4-14 Dry Bohena Creek channel with bordering woodland riparian vegetation

Photo 4-15 Looking north up the dry Bohena Creek from Nickel Road

Table 4-7 Character elements of RSRZ 2 – Channels and Floodplains

Character element	Description
Location	The zone comprises of four distinct areas located in the northern parts of the study area. The zone includes four watercourses that generally follow a north to south alignment. There are 59 identified residences within this RSRZ.
Landform and Significant Landscape Features	Linear channel and floodplains
Vegetation	Predominately native riparian vegetation and open woodland dominated by river red gum along the channels.
Water	The watercourses located in this zone are Oakyhole Creek, Mollee Creek, Bundock Creek and Bohena Creek.
Land Use	There are scattered residential properties located on the boundary of the zone.
Visual Context	The visual landscape, when viewed from this zone, is predominately short in nature due to the screening provided by the woodland vegetation. Views from the zone are dictated by the location of the receptor within the zone. On the channel edge or in the channel, the views are open and linearly continuous. However, the views from the floodplain are short due to the tall vegetation which blocks views. Views from this zone are experienced by: • Recreational users of watercourses • Residents of the properties.

4.3.4 RSRZ 3 – Forest

The Forest RSRZ is located in the central and southern part of the project area and is characterised by woodland forest (refer to Photo 4-16 and Photo 4-17). A description of the different elements of the zone is provided Table 4-8.

Photo 4-16 Looking east on Beehive Road

Photo 4-17 Looking uphill on an unnamed access track in the State Forest

Table 4-8 Character elements of RSRZ 3 –Forest

Character element	Description
Location	The zone is located in the central and southern half of the project area and is part of the Bibblewindi State Forest and Pilliga East State Forest. There are 53 identified residences within this RSRZ which are predominately located to the north-east of the zone.
Landform and Significant Landscape Features	Topography is flat to undulating, with some sloping areas with areas of ridges to the south-east. There are numerous forest roads running through the area.
Vegetation	Vegetation within the zone comprises of state forest, mixed woodland with mostly canopy, shrub and groundcover layers.
Water	Bohena Creek and Bundock Creek are the major watercourses in the zone. There are also a number of smaller tributaries located throughout the zone.
Land Use	The area is predominately utilised for forestry activities and recreational purposes due to its classification as a state forest. Activities include logging forestry and bushwalking,
Visual Context	The visual landscape, when viewed from the zone, is mostly short to medium distance and closed from vegetation screening - with the exception of the openness of the linear roads. In some elevated areas to the south-east on the top of slopes or ridges, a 360 degree view of the natural landscape is available. Views from the zone are experienced by: • Recreational users of the state forest • Road users of the highway passing through the area • Workers within the area, inclusive of forestry workers and those related to the project.

4.3.5 RSRZ 4 – Old Mill Road

The Old Mill Road RSRZ is located in the central west part of the project area and contains the Leewood property facility. RSRZ 4 is characterised by a mixture of State Forest and agricultural land (refer to Photo 4-18 and Photo 4-19). A description of the different elements of the zone is provided in Table 4-9.

Photo 4-18 View over cropped agricultural land

Photo 4-19 View looking north from the southern side of the Leewood property

Table 4-9 Character elements of RSRZ 4 – Old Mill Road

Character element	Description
Location	The Old Mill Road RSRZ is defined by a three kilometre radius around the Leewood property. The area to the north is predominately agricultural land. The area to the south is state forest. Bohena Creek and Newell Highway are located adjacent to the east of the Leewood property (which is itself situated in the centre of the RSRZ). There are 8 identified residences within this RSRZ.
Landform and Significant Landscape Features	Topography is a mixture of flat to gently undulating, with the Bohena Creek bed to the east.
Vegetation	The northern portion is predominantly cleared, with much of the remaining vegetation being present along road corridors, property fence lines and drainage lines. There are some isolated, small groups of vegetation and trees scattered throughout the properties. In the southern state forest area, there is mixed woodland with mostly canopy, shrub and groundcover layers.
Water	Bohena Creek is the major watercourse that flows through this zone. Smaller watercourses such as Dead Bullock Creek and Bibblewindi Creek also flow through the zone.
Land Use	The area to the south is predominately used for recreational purposes due to its classification as a State Forest. However, there are a few residential properties also located in the zone. They are nonetheless situated within a rural context. The area to the north is predominately used for agricultural purposes and includes rural residences.
Visual Context	The visual landscape in the zone is varied, with views being dependent on the location of the receptor. The visual landscape when viewed from the northern part of the project area is open. Views extend into the distance towards the mountainous landscape in the southern part of the area. The view within the state forest is short to medium and is screened, dependent on the vegetation and vantage point of the receptor. The background of the state forest provides a 'natural' vista of the steep slopes, whereas the flat area in the north provides a vast open vista. Views from the zone are experienced by: • residents of the rural farms and agricultural properties • workers with the area inclusive of those in and around the Leewood property • road users • recreational users of the state forests and local watercourses.

4.3.6 RSRZ 5 –Forest (Bibblewindi)

The Forest (Bibblewindi) RSRZ is located in the southern part of the project area and characterised by State Forest together with the Bibblewindi compression facility (refer to Photo 4-20, Photo 4-21 and Photo 4-22). A description of the different elements of the zone is provided in Table 4-10.

Photo 4-20 View looking south at the surrounding State Forest and some construction works at Bibblewindi

Photo 4-21 View looking at the Bibblewindi facility from the southern corner of the site

Photo 4-22 View looking south from the western side of the RSRZ on Bohena Road

Table 4-10 Character elements of RSRZ 5 – Forest (Bibblewindi)

Character element	Description
Location	The Bibblewindi forest RSRZ is defined by a three kilometre radius around the Bibblewindi facility. The entire zone is state forest. There are no identified residences within this RSRZ.
Landform and Significant Landscape Features	Topography is a mixture of flat to gently undulating.
Vegetation	Vegetation in the zone comprises of state forest, mixed woodland with mostly canopy, shrub and groundcover layers.
Water	Just outside of the three km radial zone are Bibblewindi Creek, Bohena Creek and Cowallah Creek, although none flow through the zone.
Land Use	The area is predominantly used for forestry purposes due to its classification as a State Forest. Accordingly, there are no residential properties in the zone.
Visual Context	The view within the zone is generally short and is screened, dependent on the vegetation and vantage point of the receptor. Views from this zone are experienced by: • Recreational users of the state forest • Workers with the area such as forestry workers • Road users.

5. Impact Assessment

5.1 Potential Impact Generators

The components of the project that have potential to cause impacts on the landscape and visual receptors are identified below:

- the central gas processing facility, centralised water management facilities, a communications tower, a safety flare and an optional power plant located at the Leewood property.
- an infield compression facility and a safety flare located within the State Forest to the south of the project area at a location known as Bibblewindi.
- the gas field –pilot and production wells, and associated gas and water gathering lines located throughout the project area. The wells will also require supporting infrastructure including access tracks, up to five water balance tanks and communications towers.
- vegetation clearance from the infrastructure corridor construction works connecting the Bibblewindi and Leewood facilities and Leewood facility to Wilga Park power station.
- the expansion of the existing Westport workers' accommodation - as part of the project, the capacity would be tripled to provide accommodation for up to 200 people.
- additional traffic activity generated during construction and operation phases of the project.

The following sections provide more detailed description of the identified potential impact generators.

When considering the type of infrastructure proposed and the activity associated with construction and operation of the infrastructure, the timing of project elements is also an important consideration for assessing landscape and visual impacts - interventions that are temporary would typically have less impact than interventions that are more permanent. In addition, impact normalisation can occur for some types of change – for example bulk earthworks would have an impact when it first occurs, but over time would be accepted as the ongoing condition of the landscape.

5.1.1 Gas Field

The gas field component of the project would be located entirely within the boundaries of the project area.

The gas field would be developed in response to variables such as geological conditions, land access agreements, and the conditions set out in the Field Development Protocol (described previously).

As the precise location of wells and associated infrastructure is not known as this time, this assessment is based on likely development scenarios and conservative estimations on the likely impacts on the landscape and visual environment.

The project involves the establishment of up to 425 well pads. There are two types of gas wells that will be established throughout the gasfield; pilot and production. The difference between pilot and production wells, from a spatial and visual perspective, is described below.

Pilot wells

Pilot wells are established during the initial phase of the gas field development, to evaluate the quantity and quality of gas in a particular location. They have a short duration only, generally operating for a period of up to three years. There are expected to be up to 25 pilot wells for the project. Pilot wells would be constructed with a spacing of a minimum of 250, with up to six wells in a set. At the end of the pilot period, pilots may be converted to production wells, monitoring bores or decommissioned. Pilot well pads will only have one well head. Pilot wells would be connected to the gas and water gathering network however in remote locations, connection to the gas gathering network may not be possible and a flare would be required. There would only be one flare per every pilot well set.

Production wells

Production wells would be constructed with a minimum spacing of 750 metres as a function of surface geography, environmental constraints, land access arrangements and subsurface characteristics. The production wells operate for varying periods, generally between five and 20 years, sometimes longer. There may be up to three well heads on the one production well pad. Production wells are connected to the gas and water gathering network.

The activities and physical infrastructure associated with the proposed gas field which have the potential to generate landscape and visual impacts at sensitive receptors include:

- establishment of gas well pads
- construction of gas wells
- gas well surface infrastructure (pilot and production wells)
- access tracks
- gas and water gathering lines
- water balance tanks
- communications towers

A detailed description of these activities is provided below. As explained previously, the establishment, construction and rehabilitation of gas wells will continue progressively throughout the life of the project.

Establishment of gas well pads

The well pads will require clearing of approximately one hectare in size during construction, reducing to approximately one quarter of a hectare size during the production phase, following partial rehabilitation. Clearing may involve removal of vegetation and topsoil.

The extent of visual impact from clearing will depend on the landscape context, the type of vegetation that may need to be cleared (e.g. trees, ground covers), the visibility of cleared areas, the form of the cleared areas (ie whether regular and in contrast with the landscape, or more irregular) and sensitivity of receptors within the vicinity.

Construction of gas wells

The construction of gas wells would require the transport and installation of temporary facilities and mobilisation of the drill rig to each well pad. Temporary facilities include pipes and casing racks, staff facilities, tanks and bins. A vent tank would be located at the well pad but there would be no flare.

The drilling rig will stand approximately 25 metres above ground level when in operation, while support facilities would generally not exceed three metres. It has been conservatively assumed

for the purposes of this assessment that up to six drilling rigs and two completion rigs will be operating concurrently throughout the project area. Drilling and installation of surface equipment on each well pad would occur for a temporary duration of up to 40 days.

An example of a drill rig and associated construction work site that may be used is shown in Photo 5-1 and Photo 5-2.

Gas field construction is expected to commence in 2016. Gas wells would progressively occur over 20 years as the gas field is developed.

Photo 5-1 Typical drill rig used on the project

Photo 5-2 Example of drill rig viewed from agricultural setting

Gas well surface infrastructure

Upon completion of construction works, there remains the possibility that landscape and visual impacts would occur from gas well surface infrastructure, and potentially, some of the pilot well flares.

The typical surface infrastructure on a well pad can include:

- a well head (up to three on a production well pad or single well head for pilot wells)
- a gas and water separator
- metering skids
- remote sensor telemetry unit
- a generator
- a water balance tank
- communications towers
- flare (remote pilot wells only).

The surface infrastructure is generally no more than 2.4 metres above ground level and as such would not be particularly prominent from vantage points more than 500 metres away.

Remote pilot well sets that cannot be easily connected to existing gas and water gathering lines will feature a flare constructed on one well pad with an average flame height of 4 metres above the stack. Flares would operate continuously for the life of the pilot well (up to three years).

An example of typical well surface infrastructure is depicted on Photo 5-3. Photo 5-4 depicts a pilot well flare and associated exclusion zone. Photo 5-5 illustrates partial rehabilitation of the larger well pad and shows that appropriate vegetation could effectively screen well surface infrastructure.

Photo 5-3 Typical well surface infrastructure

Photo 5-4 Typical pilot well flare

Photo 5-5 Partial rehabilitation of cleared well pad

Access tracks

Access to well pads would be via existing roads and access tracks wherever possible. Where this is not possible, new tracks would be constructed. New access tracks would be co-located in the same corridor as the gas and water gathering lines. A right of way up to 12 metres wide would be required for the construction of new access tracks and gathering lines. The right of way would be partially rehabilitated to a width of approximately 7 metres during operations; with the access track itself being around 5 metres wide, and slightly wider on bends as required.

Vegetation clearing and potential earthworks required during the construction of access tracks could result in some contrast with the landscape.

Gas and water gathering lines

Gas and water gathering lines (comprising underground pipelines) ultimately transfer gas and water from each well head to the central gas processing facility, gas compression facility and central water management facility.

Clearing would be required to install underground gas and water gathering lines. Where possible, the gas and water gathering lines would be co-located with existing access roads, tracks or other existing linear features such as fence lines to minimise the need for additional clearing.

Gas and water gathering lines would be constructed progressively so the impact at a location would be limited.

Low point drains would be installed on gas gathering lines to remove entrained water and high point vents would be installed on water gathering lines to release entrained gas. Whilst small in area, these vents and drains would be dotted across the project area. Photo 5-6 shows an example of a high point vent.

Photo 5-6 Example of a high point vent

Water balance tanks

In order to effectively transfer produced water from the gas field to Leewood for treatment, there may be up to five, 5 megalitre water balance tanks located throughout the gas field. These balance tanks will be located on pads of approximately one hectare in size.

Each water balance tank would typically be made from galvanised steel or alternatively, polyethylene.

A 40 kilolitre water balance tank would also exist for each pilot well set where they are not tied into existing water and gas gathering lines.

An example of a typical 40 kilolitre water balance tank is shown in Photo 5-7.

Photo 5-7 Example of a typical water balance tank (40 kilolitre)

5.1.2 Leewood Facility

The Leewood facility is centrally located within the project area, being situated west of the Newell Highway. The property is approximately 246 hectares in size and contains existing water storage ponds, underground pipeline, storage and utility areas and staff amenities and car parking. The existing infrastructure is required in order to manage water generated from the approved exploration program.

Approval is being sought for the following additional infrastructure:

- a central gas processing facility likely to feature four processing trains, each with stack heights of approximately 35 metres
- an optional power plant with a stack height of approximately 30 metres. The power plant and central gas processing plant would create a combined footprint of approximately 350 x 300 metres and setback at least 50 metres from Newell Highway

- a safety flare with a stack height of up to 50 metres with a flame height of up to 30 metres during rare unplanned events (expected to occur infrequently). The flare would also be used during commissioning and maintenance activities. The flare would be setback approximately 400 metres from Newell Highway
- a new central water management facility in order to facilitate the management of an increased volume of water. This would include replacing the water treatment facility used to manage exploration produced water, as well as the construction of one additional water or brine storage ponds with two bunded cells
- underground pipeline infrastructure to transfer water for beneficial reuse activities which would include dust suppression and managed irrigation system
- a communications tower with height up to approximately 60 metres (refer to section 5.1.5).

The configuration and siting of the proposed infrastructure at Leewood is depicted in Figure 5-1. The landscape and vegetation context of the property is mapped on Figure 5-2. It is worth noting that the proposed infrastructure is located at least 50 metres from property boundaries, while the flare is located approximately 400 metres from property boundaries. Photo 5-8 provides an example of a dehydration unit that may be installed.

The safety flare would have an average flame height of 1.5 metres to maintain the minimum flow for purge gas during operations. The safety flare would only be activated during commissioning and shut down periods of the gas compression facility, or as required for maintenance activities. Large flame events would be very infrequent.

The industrial character of the Leewood Property will intensify with the proposed development. The nature of the proposed infrastructure at the Leewood property contrasts with visual scale, shape, form, colour and line values of the surrounding landscape. However, it is noted that the perimeter of the property is well-screened by the dense forest vegetation to the south and west, together with existing vegetation located on the northern section of the site and road side vegetation along Newell Highway.

The surrounding sensitive visual receptors include residents, workers within the area inclusive of the Leewood property, road users and recreation users of state forests and local watercourses (refer also to Table 4-9). Sensitive residential receptors are located to the north, south and east of Leewood. The closest residential sensitive visual receptor is located approximately 360 metres east of the Leewood site (refer to Figure 5-3). Sensitive road user receptors along Newell Road and surrounding roads must also be considered as part of the assessment.

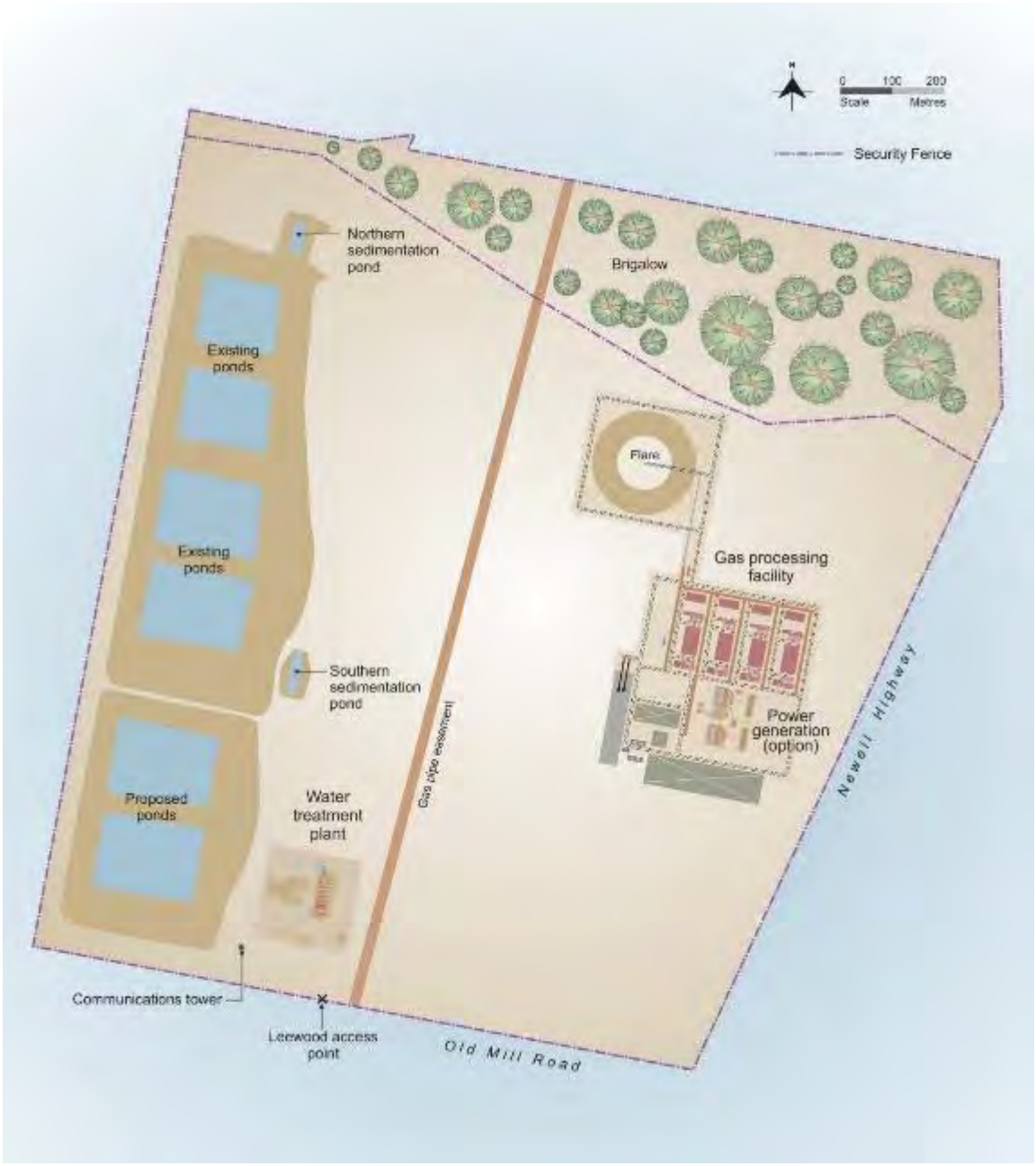
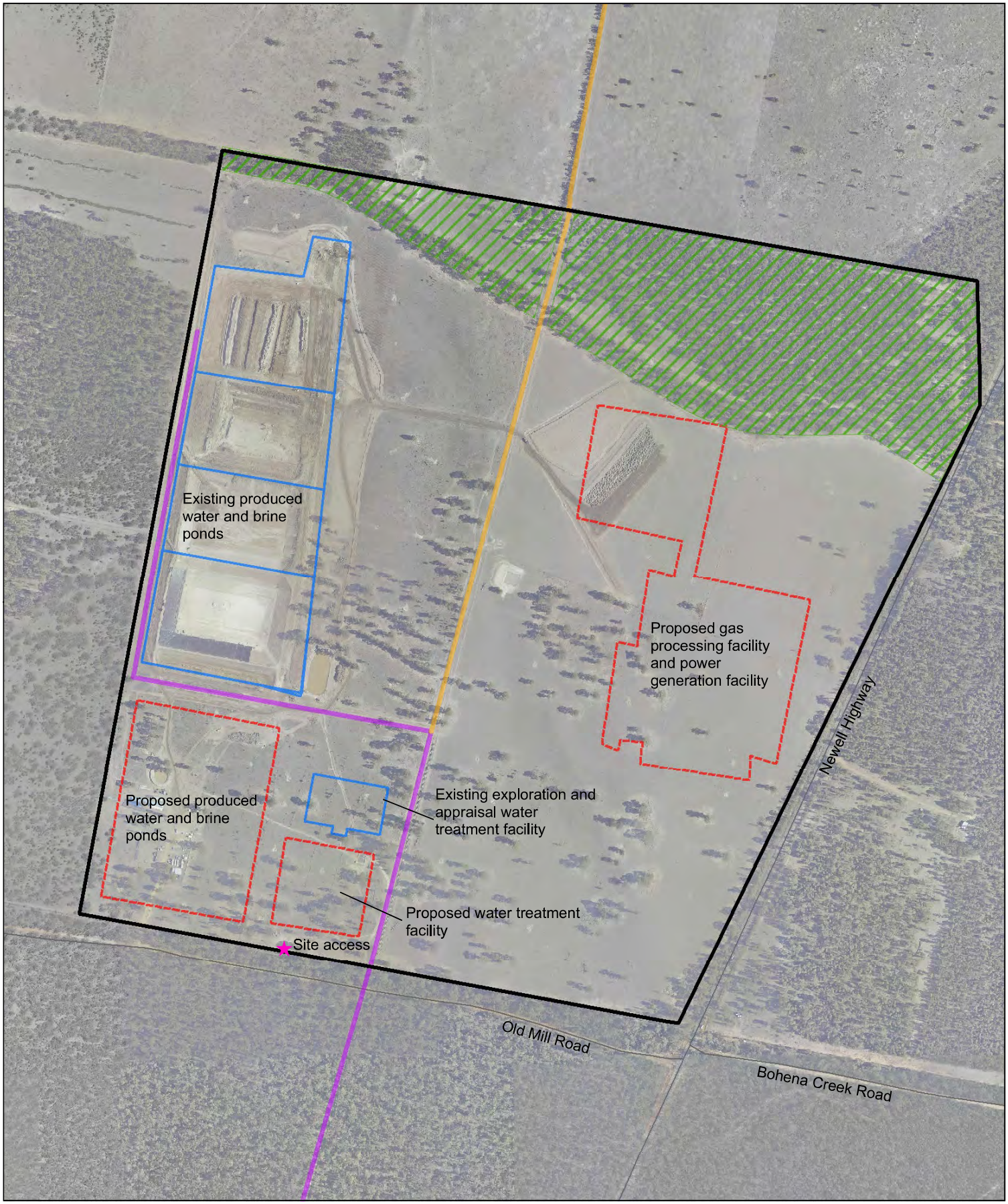


Figure 5-1 Schematic of proposed Leewood infrastructure



LEGEND

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

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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Existing and proposed infrastructure at Leewood

Figure 5-2

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

LEGEND

- Leewood
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Sensitive receivers

Representative Sensitive Receptor Zones

- RSRZ 4 – Leewood
- RSRZ 5 – Bibblewindi

0 0.35 0.7 1.4
Kilometers

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

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Sensitive Receivers surrounding Leewood

Figure 5-3

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

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5.1.3 Bibblewindi Facility

The exiting Bibblewindi facility contains existing water storage ponds, a water balance tank, a flare and a compressor station.

The project would result in an additional footprint of approximately 16 hectares at Bibblewindi. The additional footprint would largely be utilised for the infield compression and flare infrastructure. The proposed visible infrastructure at Bibblewindi includes:

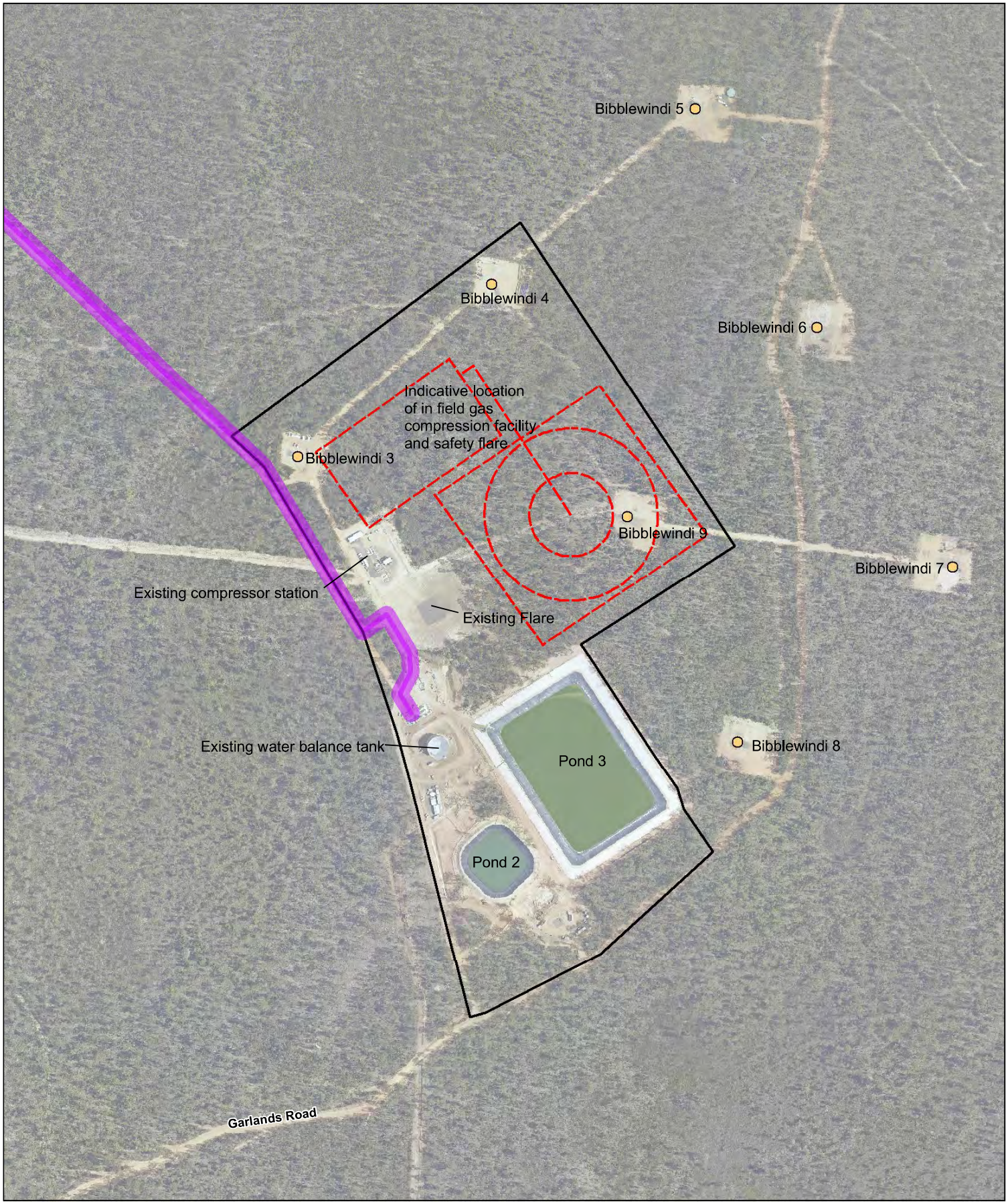
- up to 20 compressors for infield gas compression, comprising a footprint of approximately 150 x 220 metres
- Replacement of the existing safety flare with a safety flare of the same specifications and operation as that at Leewood
- an electrical substation/motor control centre.

Similar to Leewood, the safety flare would have an average flame height of 1.5 metres to maintain the minimum flow for purge gas during operations. The safety flare would only be activated during commissioning and shut down periods of the gas compression facility, such as for safety incidents or maintenance activities. Large flame events are very infrequent.

The industrial character of the Bibblewindi property will naturally intensify with the proposed infrastructure. Some impacts are likely to occur from clearing of forest vegetation required to accommodate additional infrastructure. The nature of the proposed infrastructure at the Bibblewindi property contrasts with visual scale, shape, form and colour values of the surrounding landscape. However, it is noted that the perimeter of the property is surrounded by the dense forest vegetation and does not adjoin a major road.

The location of the study area surrounding Bibblewindi is described in section 4.3.6. A diagram of the proposed upgraded facilities at Bibblewindi is provided Figure 5-4. The current layout of the Bibblewindi site is depicted on Figure 5-5. Figure 5-6 identifies that there are no sensitive receptors within a 4 kilometres of the facility.

Figure 5-4 Schematic of the Bibblewindi infield gas compression facility



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

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

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Existing and proposed infrastructure at Bibblewindi

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Figure 5-5

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

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LEGEND

Bibblewindi
State forest
Watercourses
Roads
Sensitive receivers

Representative Sensitive Receptor Zones

RSRZ 4 – Leewood
RSRZ 5 – Bibblewindi

0 0.25 0.5 1
Kilometers

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

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Sensitive Receivers surrounding Bibblewindi

Figure 5-6

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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: jrichardson

5.1.4 Infrastructure Corridors

Bibblewindi to Leewood corridor

There is currently one existing water pipeline and one approved (though yet to be constructed) water pipeline in the infrastructure corridor between Bibblewindi and Leewood. There is also an existing gas pipeline between Bibblewindi and the Leewood property which is located in the same corridor. The existing corridor crosses both the Newell Highway and Bohena Creek.

Additional infrastructure that is proposed within the corridor includes a new intermediate gas pipeline, water transfer pipeline, underground transmission line and communications cabling.

The construction and installation of the abovementioned infrastructure would require an expansion of the existing corridor from approximately 12 metres to 30 metres. The nearest residential sensitive receptors are located over two kilometres to the east and north-east of the infrastructure corridor, and would be unlikely to be affected by the cleared corridors. Some consideration must also be given to potential impacts on road users.

Leewood to Wilga Park corridor

A new underground 132kV transmission line to reticulate power from the Wilga Park power station to the Leewood site would be installed along an existing gas pipeline corridor, assumed to be 10 metres wide for this assessment. Works including grading, drilling and trenching will occur within the existing corridor and may require slashing or removal of some existing vegetation. Sensitive residential receptors along Kandool Lane are located in close proximity of the existing infrastructure corridor.

Figure 5-7 shows the location of both infrastructure corridors within the project area.

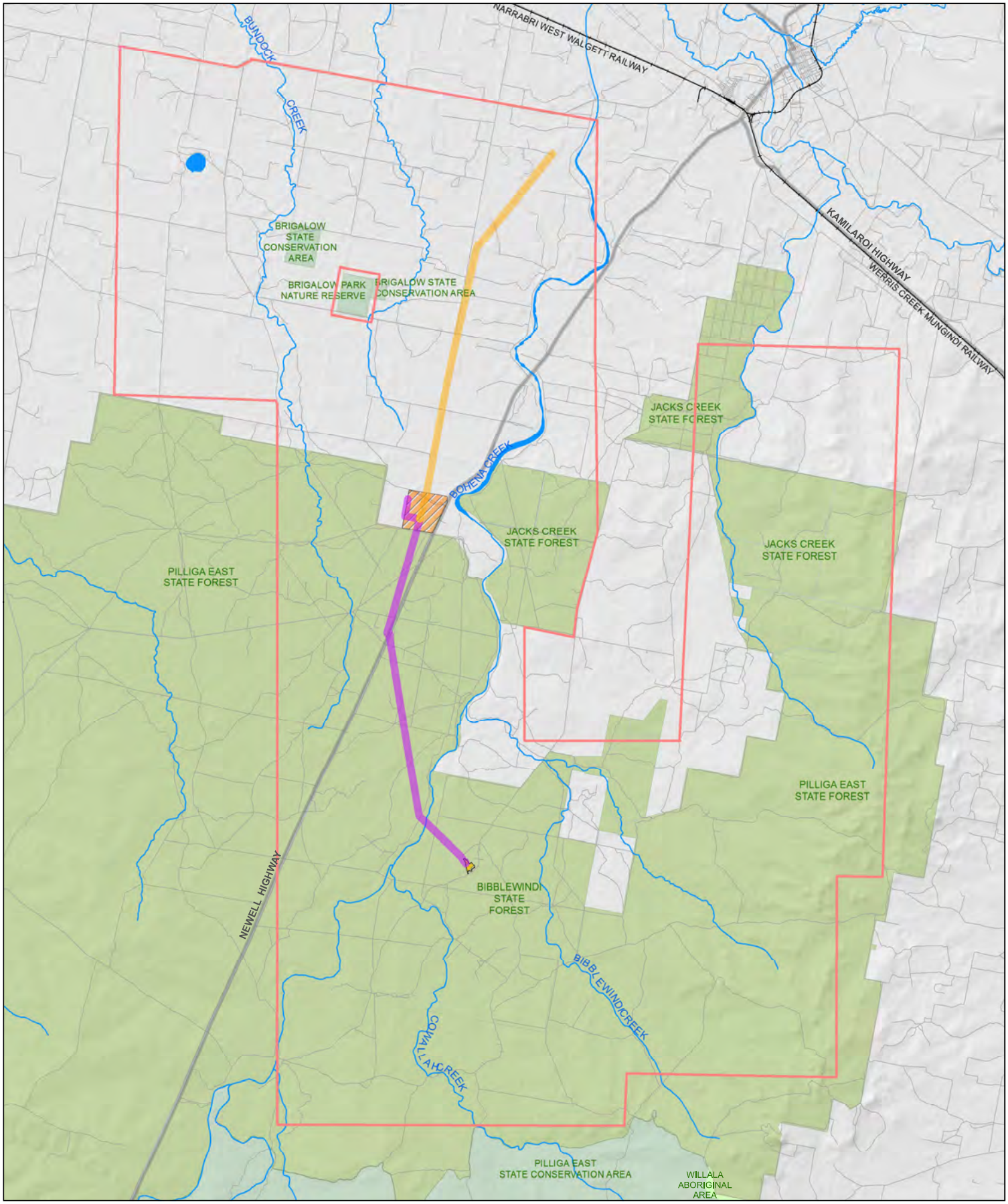
5.1.5 Telecommunication Towers

Telecommunications towers would be constructed on well pads across the project area. It is anticipated that there will be up to ten 60 metre high towers, or up to twenty 30 metre high towers, or a mix of both. It is to be noted that well pads that host a communications tower would remain at approximately one hectare in size throughout the operational phase of the gas field.

The 60 metre tower would be a lattice structure with a three legged tubular design built in modules. The tower would have a base width dimension of approximately 7.5 metres, tapering to a width of approximately 1.5 metres at the tower head.

The 30 metre tower would be a modular monopole structure. The tower would have a base width of approximately 1.25 metres, tapering to approximately 900 mm at the tower head.

The towers would accommodate a number of antennas, however the actual number and configuration for each tower is not yet known. Each tower would also incorporate a low impact concrete base shelter measuring approximately 2.7 metres in height. Perimeter fencing would also be erected to a height of 2.4 metres.



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

0 1.75 3.5 7
Kilometers

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

N

Narrabri Gas Project
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Revision A
Date 25 Jul 2016

Project area and location of infrastructure corridors

Figure 5-7

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

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Communication towers would be serviced by well pad access tracks.

A crane with a boom length of 60 metres and suitable lifting capacity would be required to lift tower modules into place. The construction of the communications towers would take place within the construction timeframe for the establishment of well pads. The construction time required for the communications towers is estimated to be between 2-3 weeks, which would allow for the installation of the foundation and tower.

Indicative designs for the communications towers are provided at Figure 5-8. The towers would be progressively constructed to meet communication requirements as the gas field expands over time.

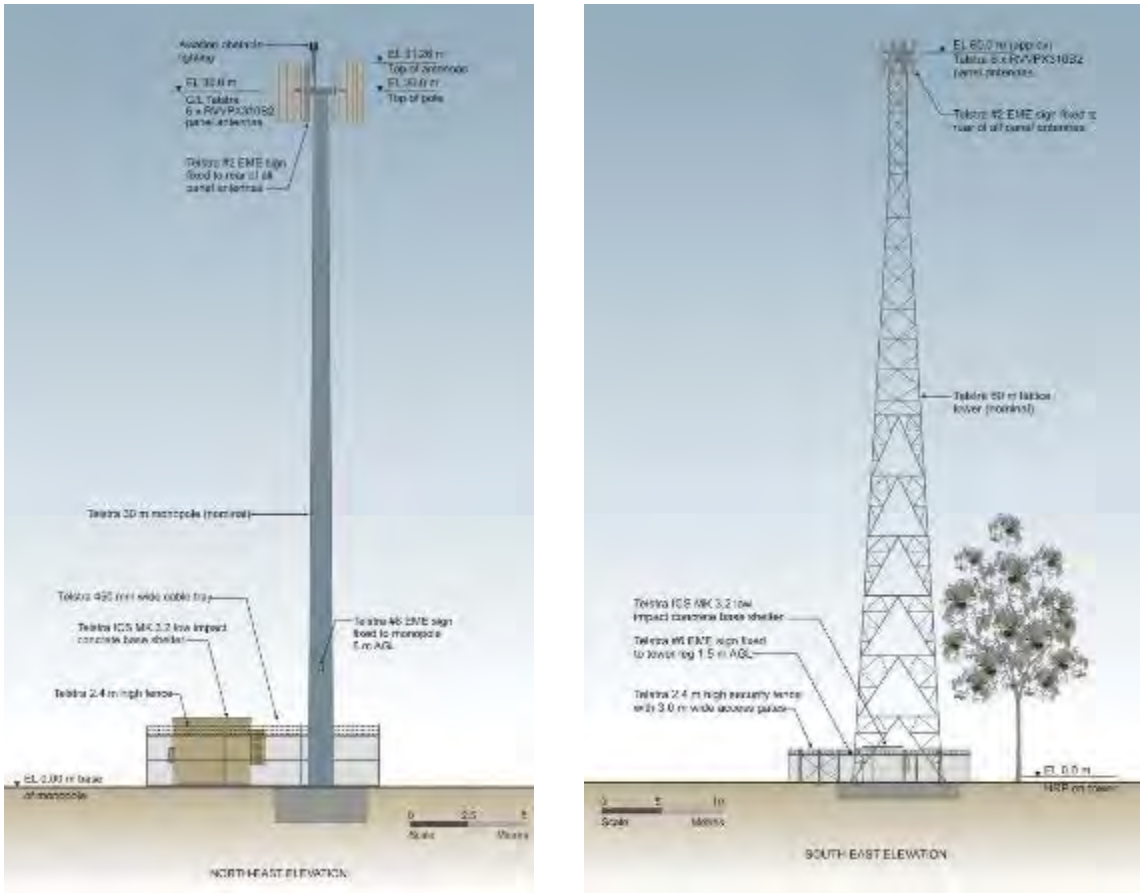


Figure 5-8 Examples of likely communication towers

5.1.6 Other Supporting Infrastructure

Irrigation lands and wet weather treated water discharge

Vegetation clearance from the construction of a wet weather discharge pipeline from the Leewood water treatment plant to Bohena Creek would be required.

Construction activities would be undertaken within daylight hours. Potentially impacted residents surrounding the site would be notified of the nature of the works, duration of works and a method of contact should it be necessary to raise a complaint.

Westport workers' accommodation

There is existing temporary accommodation for up to 64 workers at the Westport drillers' camp. As part of the project, the capacity at Westport would be tripled to provide accommodation for up to approximately 200 people. The worker's accommodation would house drilling crews only.

The location of the workers accommodation is depicted on Figure 5-9, with a photograph shown in Photo 5-8.

Construction of the workers' accommodation is expected to occur during daylight hours (nominally between 5am and 7pm, however seasonally dependent).

The expansion of the Westport workers' accommodation would involve the following construction sub-stages:

- clearing and grading of additional land
- installation of buildings. It is anticipated that the buildings would be pre-fabricated and transported to the site on trucks
- The nearest residential receptor is located approximately 1.6 kilometres from the accommodation site.

Photo 5-8 Westport workers' accommodation (existing capacity of 64 persons)

Surrounding road network

Surrounding roads on the traffic generation route which have the potential to be exposed to increases in additional traffic from the project have been considered as part of the study area and include:

- Newell Highway
- Old Gunnedah Road
- Tibbereena Street
- Maitland Street
- X-Line Road
- Yarrie Lake Road
- Goobar Street
- Mooloobar Street
- Internal forest roads.

Road and intersection upgrades

Road and intersection upgrades are proposed at the following locations:

- Newell Highway and Old Mill Road (Leewood access) intersection
- Newell Highway and X-Line Road intersection.

The road and intersection upgrade locations are shown in Figure 5-10.

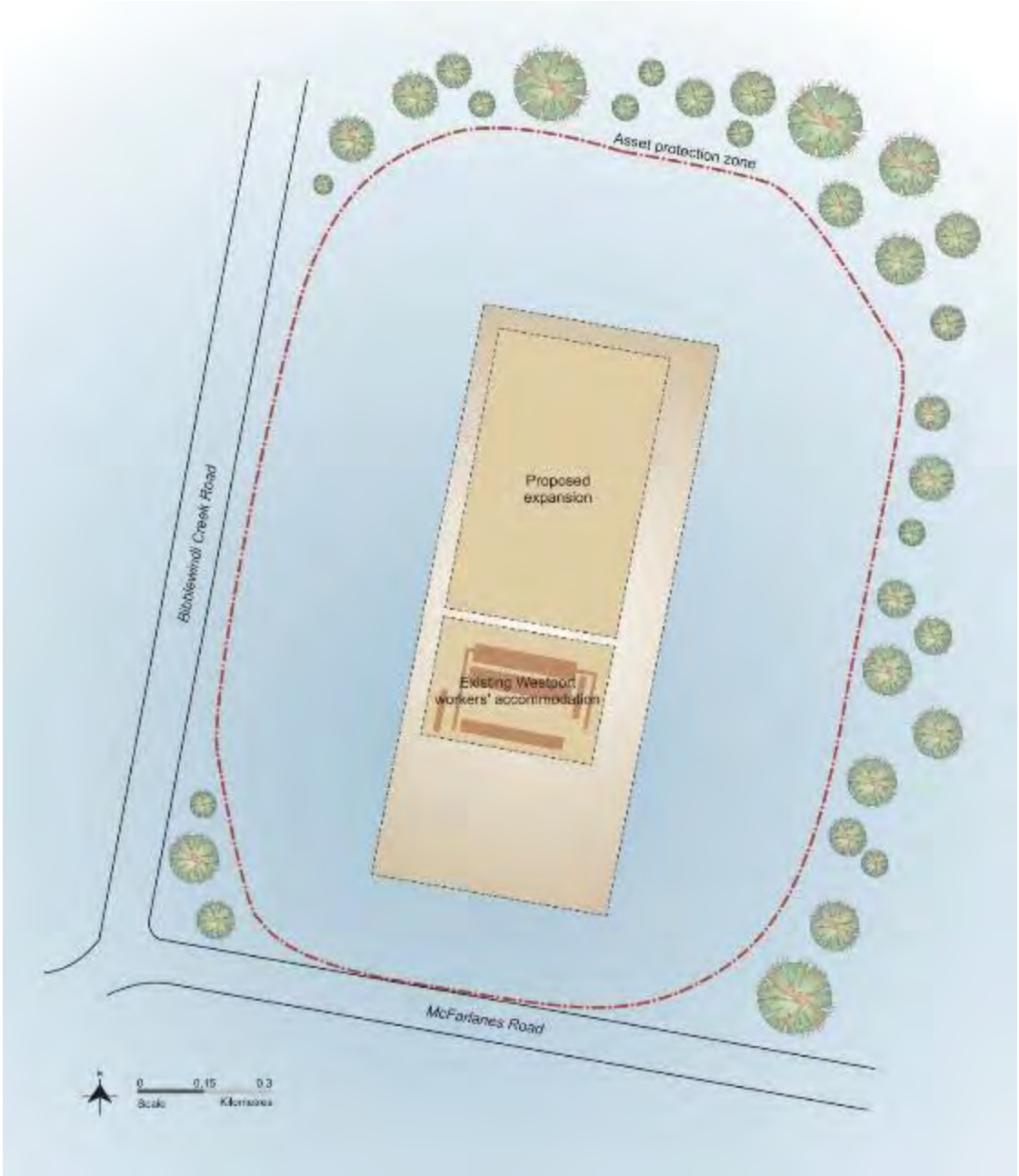
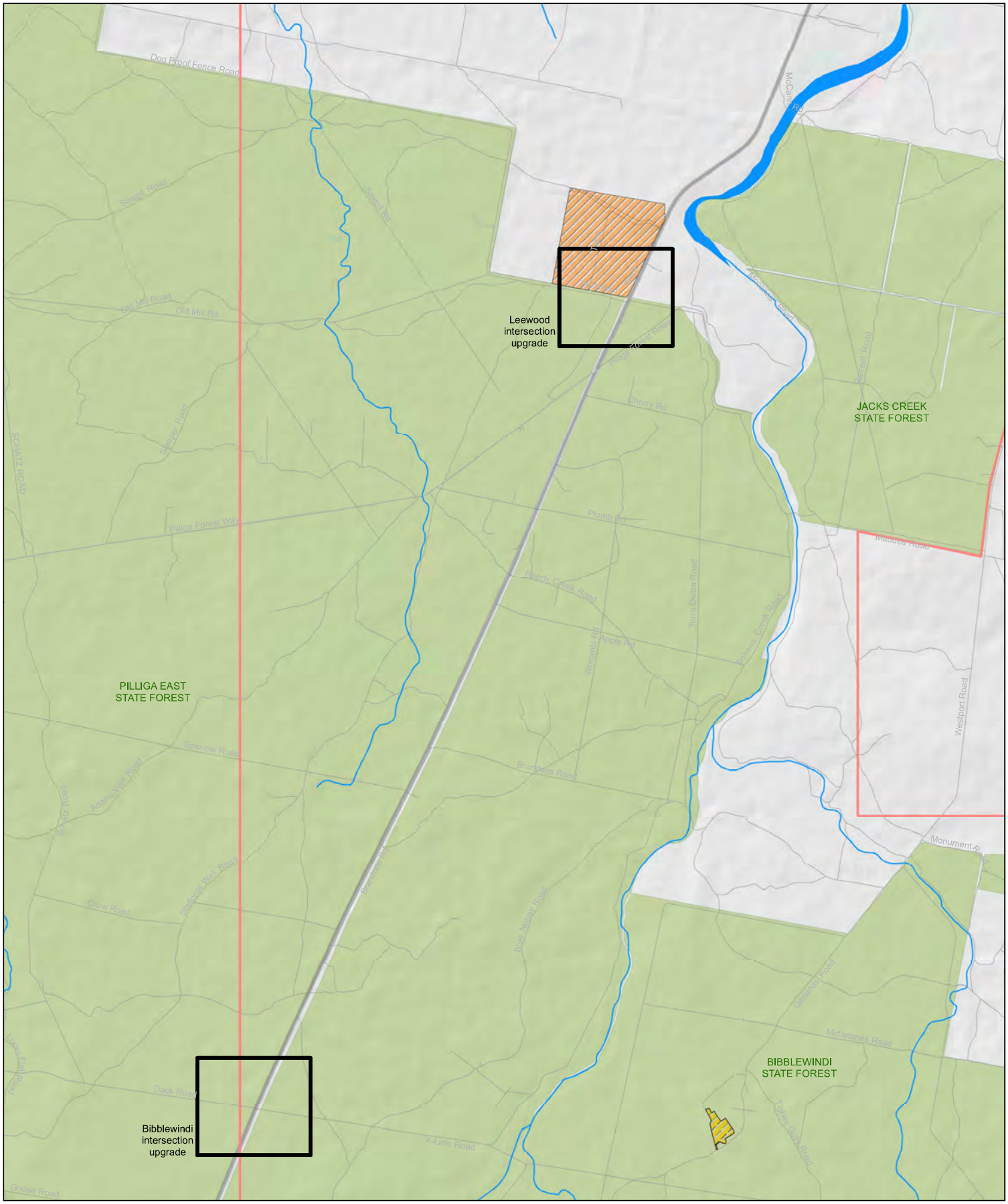


Figure 5-9 Westport workers' accommodation



LEGEND

- Project area
- Leewood
- Bibblewindi
- State forest
- Lakes and dams
- Watercourses
- Roads
- Intersection upgrades

0 0.5 1 2
Kilometers

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

N

Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Job Number 21-22463
Revision A
Date 11 Mar 2015

Road and intersection upgrade locations

Figure 5-10

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

5.2 Landscape Impact Assessment

5.2.1 Impacts on Each Landscape Character Unit

Table 5-1 identifies the sensitivity of each of the LCUs described above. The landscape value (Table 2-3) and capacity of the landscape to accommodate change (Table 2-2) for each of these landscapes has also been identified. The magnitude of impacts on each LCU (Table 2-5), and the subsequent significance of impacts on these LCU (Table 2-6) has been identified.

Table 5-1 Impacts on Each Receptor LCU

Landscape Receptor / LCU	Discussion	Value and capacity to accommodate change of LCU	Impact Magnitude	Impact Significance
LCU1 – Baradine – Coghill Channels and floodplains	The landscape elements in the area are highly valued and in particular, the creek channels are highly sensitive to change. Well pads would not be placed within the channels as the Field Development Protocol has established a minimum buffer distances. During the construction phase the linear Bibblewindi to Leewood infrastructure corridor would cross Bohena Creek. For the operational phase the corridor would be rehabilitated with little evidence of the blow ground infrastructure.	As those areas are valued locally and include protected areas, the overall value of this LCU is considered to be **medium.** It is considered that this LCU has a **low capacity to accommodate change.**	**Construction** *Moderate impact* only in the limited area where linear infrastructure crosses the LCU.	**Construction** *Moderate significance* only in the limited area where linear infrastructure crosses the LCU.
			Operation *Negligible impacts.*	**Operation** *Not significant*
LCU2 – Bugaldie Uplands	The landscape elements (particularly the continuity, form and scale of the vegetation within this area) such as mature trees and sense of serenity contribute importantly to the local character, its sense of nature and scenic values. The area is a state forest and is highly sensitive to change. There would be construction and operational impacts on this LCU. These impacts would be from the gas field infrastructure and the associated vegetation clearing as described in 5.1.1.	As it has a regional designation and is valued locally, the overall value of this LCU is considered to be **medium**. It is considered that this LCU has a **medium capacity to accommodate change.**	**Construction** *Moderate impacts* associated with the construction activities and vegetation clearing.	**Construction** *Moderate Significance* associated with the construction activities and vegetation clearing.
			Operation The impacts would reduce to a *small impact* with the implementation of the rehabilitation and mitigation measures.	**Operation** *Minor significance*

Landscape Receptor / LCU	Discussion	Value and capacity to accommodate change of LCU	Impact Magnitude	Impact Significance
LCU3 – Cubbo Uplands	The landscape elements (particularly the continuity, form and scale of the vegetation within this area) such as mature trees and sense of serenity contribute importantly to the local character, its sense of nature and scenic values. The area is a state forest and is highly sensitive to change. There would be construction and operational impacts on this LCU. These impacts would be from the gas field infrastructure and the associated vegetation clearing as described in 5.1.1	As it has a regional designation and is valued locally, the overall value of this LCU is considered to be **medium**. It is considered that this LCU has a **medium capacity to accommodate change.**	**Construction** *Moderate impacts* associated with the construction activities and vegetation clearing.	**Construction** *Moderate Significance* associated with the construction activities and vegetation clearing.
			Operation The impacts would reduce to a *small impact* with the implementation of the rehabilitation and mitigation measures.	**Operation** *Minor significance*
LCU4 – Coghill Alluvial Plains	This is a residential and agricultural landscape; elements within this area have been subjected to change. Leewood and Bibblewindi are both located within this landscape unit	It therefore has **low** value and a **medium to high capacity to accommodate change.** However, consistent with the above two landscape units the area of State Forest to the south of the LCU would have a **medium value**. As it has a regional designation and is valued locally, the State Forest portion of the LCU is considered to have **medium** value. The area is considered to have a **medium capacity to accommodate change.**	**Construction** *Moderate impacts* associated with the construction activities and vegetation clearing.	**Construction** Residential and agricultural*: minor significance* Forest: *Moderate Significance*
			Operation The impacts would reduce to a *small impact* with the implementation of the rehabilitation and mitigation measures.	**Operation** Residential and agricultural: *not significant* Forest: *Minor significance*
LCU5 – Yarrie Lake Flora and Fauna Reserve	The landscape elements of the area are highly valued to the local community as it is the only recreational reserve in a highly fragmented landscape. Given that there will be no major infrastructure near the lake and an exclusion zone around the reserve is being implemented as part of this project there would be no impacts on this LCU during operation, with negligible impacts during construction.	This landscape would have a **medium** value and a **low capacity to accommodate change.**	**Construction** *Negligible*	**Construction** *Not significant*
			Operation *Negligible*	**Operation** *Not significant*

5.2.2 Summary

The landscape throughout the study area would not experience significant adverse impacts, given the landscape character units of the study area do not exceed a *medium* landscape value.

The majority of the study area landscape has a medium capacity to accommodate change. Notwithstanding this, the implementation of mitigation measures identified in Section 6, such as considering landscape treatments where well pads may have a moderate impact, are likely to reduce the potential impacts of the project components.

5.3 Visual Impact Assessment

Assessment of visual impacts of the project on the identified RSRZs described in section 4.3 have been undertaken for both the construction and operational phases of the project. The impacts are addressed in the following sections but are not intended to be a summary of every potential visual issue associated with the construction and operation of the project. They are however, intended to provide a representation of the various issues that may arise at different locations.

5.3.1 RSRZ 1 – Northern Agricultural Plains

Table 5-2 describes the impacts to the RSRZ1 - Northern Agricultural Plains, in regards to construction and operation activities of the project.

Sensitive receptors in this zone are generally residential in nature or road users. Approximately 95 residential receptors are located within this zone. A buffer of 200 metres is to be applied to Yarrie Lake, which reduces the sensitivity of associated recreation receptors. As the proximity of residential receptors to the proposed gas field could be as close as 200 metres, residential properties with long viewing periods could experience either close or distant proximity to well infrastructure. Accordingly, the sensitive receptors within the zone are considered to range from *low* (for road users) *medium* (for locations where well infrastructure would be screened or filtered based on distance or the existing landscape, or where written agreement for access is in place with the landholder) *and high sensitivity (*for locations where wells are within the viewshed of residential dwellings).

Table 5-2 Impacts to the RSRZ 1 - Northern Agricultural Plains

Source of Impact	Description	Impact Magnitude	Impact Significance
Gas Field	**Construction**: Pilot wells will be constructed with a minimum spacing of 250 metres with up to six in a one set. These will only operate for up to three years and it is anticipated that only 25 well pads (of the total 425) would accommodate pilot wells throughout the project area. At the end of the pilot period, pilots may be converted to production wells. Production wells will be constructed with a minimum spacing of 750 metres apart. Up to 425 well pads would be constructed across the project area. Given RSRZ1 represents around 18% of the project area, a reasonable assumption would be that approximately 18% of well pads would be located within this zone. It is noted that the final location of wells would be based on geology, land access agreements and application of the Field Development Protocol. An area of approximately one hectare would be cleared to facilitate construction of the well pads on which drilling of the wells and the associated activities will take place as described in section 5.1.1. This RSRZ is characterised by a low density of tree cover with much of the RSRZ containing only ground cover vegetation due to agricultural activities and therefore clearing is expected to have a small short term visual impacts where the removal of trees is not required. There will be impacts from the drill rig and associated structures. The drill rig during construction stands approximately 25 metres above ground level. Sensitive visual receptors within a distance of 750 metres from the outer edge of the well pad would be subject to *moderate* impacts although this would only occur for a short duration (up to 40 days). The impacts would reduce with distance. Impacts would be dependent on the proximity and number of wells within a viewshed at one time. A single production well pad may be located 200 metres of a sensitive receptor with the permission of the land owner, however the view of a second production well pad within the same viewshed will be distant (greater than 550 metres) due to spacing requirements. The only exception to this scenario could be during the construction of a set of pilot wells due to reduced spacing requirements. Only a small number of pilot wells are expected to occur within the zone, due to only 25 expected throughout the entire project area. It is important to note that there is a low probability that residential receptor will be located within 750 metres of multiple well pads having regard to the size of the area, the likely number of well pads within the area and well pad spacing requirements. Access to well pads would be via existing roads and access tracks wherever possible. The construction of new access tracks would require a cleared 12 metre right of way during the construction phase for new tracks. Similarly, the construction of gas and water gathering lines would require a construction corridor of 12 metres. Vegetation clearing required during the construction of the well pads, access tracks and gathering lines would result in some colour contrast in the landscape. Remaining vegetation in the foreground could reduce visibility in some views. Elevated visual impact would likely occur within 1 kilometre of gathering line and access track construction sites but would be short in duration. Some construction activities would be undertaken outside of the daylight hours and would require lighting, such as drill rig activities occurring 24 hours a day. Such work would, however, be managed so that the required night time lighting complies with accepted standards in Appendix D. The overall impacts associated with the construction phase of the gas field infrastructure would be of a *high* to *not significant* depending on the location, number and distance of wells in view. It is noted that a land access agreement would be required with the respective land owner before a well is drilled. Impacts are most likely to be of *moderate* significance based on the temporary nature of construction works and the unlikely potential of a residential receptor being in close proximity to multiple well pads. Visual impacts from the drill rigs during the construction could be appropriately mitigated by managing the number of drill rigs in close proximity to a receptor at a time. Receptors in the study area are likely to have a sensitivity rating of medium. Given the mitigation measures intended to be implemented it is most likely that small impacts will occur. It is however possible (although unlikely) that moderate impacts occur. Combining receptor sensitivity, the probability of impacts, and the magnitude of those impacts, it is most likely that impacts on these receptors will be minor to not significant, so long as the mitigation measures are undertaken. There is however a possibility that impacts would have a greater significance if mitigation measures are not fully realised.	*Moderate to small impacts*	*High to not significant*

Source of Impact	Description	Impact Magnitude	Impact Significance
	Operation: Pilot well sets (up to six wells) that cannot be easily connected to existing gas gathering lines will feature a flare constructed on one well pad with an average flame height of 4 metres above the stack. A (40 kilolitre) water balance tank would also exist for each pilot. Pilot wells would operate for up to three years before being converted to production wells, monitoring bores or decommissioned. The typical surface infrastructure of a well pad is considered to be low-scale. It includes a well head (up to three on the one well pad), a separator, telemetry and a generator. The infrastructure is generally no more than 2.4 m tall. Up to five, five-megalitre water balance tanks are to be located throughout the gas field. Applying a similar assumption that RSRZ 1 is approximately 18% of the project area, it could be expected that no more than one of these tanks could be located within this zone. Water balance tanks could be mitigated through muted colour selection, diligent micro siting and landscape screening. It would not be unusual for tanks to occur in this landscape setting. The production well pad would be partially rehabilitated to approximately one quarter of a hectare with the exception of pads that accommodate supporting infrastructure (telecommunication towers or water balance tanks) which will remain at approximately one hectare. It is important to note that the visual impact of surface infrastructure reduces significantly beyond 300 metres, due to the infrastructure being of a scale that integrates well within the landscape which is further enhanced through partial rehabilitation. The visual impact will further reduce when vegetation filters or screen views. The spacing requirement for production well pads would result in only one well pad located as close as 200 to 300 metres from a sensitive receptor. The view of a second production well pad within a viewing experience of a sensitive receptor would be distant (greater than 550 metres) due to spacing requirements. Greater visual impact may be experienced by sensitive receptors where multiple views of pilot well pads could be experienced within a 200 to 300 metre range. Only a small number of pilot wells are expected to occur within the zone, due to only 25 expected throughout the entire project area. Road users may also have the potential to see multiple wells at one time, however, much like sensitive receptors, the likelihood is low given the spacing requirements and low scale nature of infrastructure. Photomontage views 01,02, 03 and 05 included in Appendix B as Figures B1, B2, B3 and B5 respectively, show potential close and distant views of typical well surface infrastructure and rehabilitated well pad in four views throughout the zone. The photomontages demonstrate that the surface infrastructure would integrate with the agricultural landscape to a point where impacts would be small to negligible depending on location, number and distance of wells in view. New and existing access tracks would be rehabilitated back to a corridor width of approximately five metres for the operations phase; seven metres when co-located with a gathering line. Dedicated gathering lines would also be rehabilitated to 5 metres in width. Access tracks and gas and water gathering lines have limited surface activities with the exception of safety signs placed above lines and as such will not create a strong visual effect in the agricultural landscape. The overall significance of the impacts to the proposed well infrastructure would range from *moderate to not significant* depending on the location, number and distance of wells in view. The impacts significance may reduce with the implementation of the Field Development Protocol and in consultation with the landowner. It is expected that well pads would be located at fence lines or in areas screened through existing vegetation in agreement with the landowner.	*Small to negligible impacts*	*Moderate to not significant*
Leewood property	**Construction and operation:** The Leewood property is located three (3) kilometres south of RSRZ 1. The construction and operation of the facility is anticipated to have *negligible* visual impact on sensitive receptors within this RSRZ. There may be some long distance views of the taller infrastructure, such as the communication tower and the safety flare. A level of night lighting glow may be visible. As those components would be viewed at a distance, with many views filtered by intervening vegetation, it is assessed as having *minor* significance based on the distance between potential sensitive receptors and the Leewood property.	*Negligible impacts*	*Minor to not significant*
Bibblewindi facility	**Construction and operation:** The Bibblewindi facility is located approximately 13 kilometres south of RSRZ 1. The construction and operation of the facility is anticipated to have a *negligible* visual impact on sensitive receptors within this RSRZ due to the significant separation distance.	*Negligible impacts*	*Not significant*
Infrastructure corridors – Leewood to Wilga Park **Leewood to Bibblewindi**	**Construction and operation:** The Leewood to Wilga Park infrastructure corridor is largely contained within this RSRZ whilst the Leewood to Bibblewindi Corridor would not be visible due to a separation distance of approximately 3 kilometres. The construction of the power line between Leewood and Wilga Park would occur within the existing corridor. Some vegetation slashing within the existing corridor is likely, although this is expected to have a *negligible impact*. Negligible impacts on this zone are anticipated from the operation of the infrastructure corridors, as the infrastructure will be located underground while surface areas will be subject to rehabilitation. It is therefore anticipated that there will be *negligible* impacts on the RSRZ from the construction works and operation phase associated with the Leewood to Wilga Park Infrastructure corridor.	*Negligible impacts*	*Not significant*
Communication Towers	**Construction:** Communication towers would be required through the project area to enable the remote telemetry on wells to operate and to facilitate effective communications across the gas field. There may be up to ten 60 metre high towers; or up to twenty 30 metre high towers, or a combination of both across the project area. It is expected that more of these towers and most likely the taller towers would be located within the forest where existing vegetation poses greater signal constraints. Given there is little impedance to communication signals within RSRZ1, the towers would be fewer and more likely to take the form of a 30 metre monopole tower. Consistent with the assumptions in relation to well pads and water balance tanks, it is conservatively assumed that approximately 30% of the towers (three 60 metre towers or six 30 metre towers) would be located within the cleared agricultural landscape which is generally represented by RSRZ1. A crane with a boom length of 60 metres with a suitable lifting capacity (height above ground) would be required to lift tower modules into place. The impacts experienced by sensitive visual receptors during the construction phase of the towers would likely be *moderate to small*. The impacts would reduce with distance. The construction of towers is expected to take approximately 2-3 weeks and therefore construction impacts would be short in duration. Communication towers would be accessed via well pad access tracks and therefore no additional clearance would be required for access.	*Moderate to small impacts*	*High to minor significance*

Source of Impact	Description	Impact Magnitude	Impact Significance
	Operation: The visual impact of a communication tower would be from the vertical tower structure and antenna attached to the tower head. It is expected that the 30 metre high tower structure would be deployed in RSRZ 1 due to the cleared nature of agricultural land posing less signal constraints. Visual contrast would be created by the vertical nature of the tower creating a silhouette effect against the skyline and an open and flat landscape. The maximum visual impact of the tower would be experienced where a sensitive visual receptor is located as close as 500 metres from a well pad hosting a tower. Such an impact would likely have a *moderate to small* magnitude. Beyond 500 metres the visual impact of the tower would reduce and the potential to integrate with the surrounding landscape would increase. *Small* impacts would be experienced from ancillary perimeter fencing and the low impact concrete shelter due to the height being no greater than 2.7 metres above ground. Vegetation screening could be strategically planted to further minimise visual impact from ancillary elements. Depending on the final location and proximity of towers, the significance of these impacts would range from high to *not significant* depending on the sensitivity of receptors. Mitigation measures including appropriate site selection, diligent micro-siting, land owner consultation and screening of ancillary structures would assist in minimising visual impacts.	*Moderate to small impacts*	*High to minor significance*
Other Impacts	**Construction and operation:** There would be visual impacts associated with the additional construction vehicles and operational vehicles present within the area. These would be viewed from residential properties and by road users which have a sensitivity of high/medium and low, respectively. They are considered to be of a *small to negligible impact*, based on vehicles being a common characteristic within the existing landscape. Construction traffic will be present for a significantly shorter period. The impact of the construction and operation vehicles would therefore be *moderate to not significant.*	*Small to negligible impacts*	*Moderate to not significant*

5.3.2 RSRZ 2 – Channels and Floodplains

Table 5-3 describes the impacts to the RSRZ 2 - Channels and Floodplains in regards to construction and operation activities. Sensitive receptors in this zone are generally residential or recreational in nature. Approximately 59 residential receptors are located within this zone. The Field Development Protocol specifies buffer distances ranging from 20-80 metres depending on the watercourse classification. Residential receptors could be as close as 200 metres to the proposed gas field. Residential properties with long viewing periods could experience either close or distant proximities to well infrastructure. Accordingly, the overall sensitivity of receptors within the zone is considered to range from *low* (for road users) *medium* (for locations where well infrastructure will be screened or filtered based on distance or the existing landscape, or where written agreement for access is in place with the landholder) to *high sensitivity (*for locations where wells are within the viewshed of residential dwellings).

Table 5-3 Impacts to the RSRZ 2 – Channels and Floodplains

Source of Impact	Description	Impact Magnitude	Impact Significance
Gas Field	**Construction**: No wells will be constructed within the drainage lines as there would be a minimum 20 – 80 metre buffer from the top of the watercourse bank; depending on the watercourse classification. There are 59 residential sensitive receptors scattered within this RSRZ. Pilot wells will be constructed with a minimum spacing of 250 metres with up to six in a one set. These will only operate for up to three years and it is anticipated that only 25 well pads (of the total 425) would accommodate pilot wells throughout the project area. At the end of the pilot period, pilots may be converted to production wells. Production wells pad would be constructed with a minimum spacing of 750 metres apart. Up to 425 well pads would be constructed across the project area. Given RSRZ2 represents around 12% of the project area, for the purposes of this assessment it is assumed that approximately 12% of well pads would be located within this zone. It is noted that the final location of wells would be based on geology, land access agreements and application of the Field Development Protocol. An area of approximately one hectare would be cleared to facilitate construction of the well pads on which drilling of the wells and the associated activities will take place as described in section 5.1.1. This RSRZ is characterised by tall woodland vegetation within the flood plain and riparian areas. Clearing would have a visual impact where the removal of trees is required. There would be visual impacts from the drill rig and associated structures. The drill rig during construction stands approximately 25 metres above ground level. Sensitive visual receptors within a distance of 750 metres from the outer edge of the well pad would be subject to *moderate* impacts although this would only occur for a short duration (up to 40 days). The impacts would reduce with distance. Impacts would be dependent on the proximity and number of wells within a view at one time. A single production well pad may be located 200 metres of a residential sensitive receptor, however the view of a second production well pad within the same view would be at a distance (greater than 500 metres) due to project spacing requirements. The only exception to this scenario could potentially be during the construction of a set of pilot wells where the requirements for spacing between pads is reduced. Only a small (if any) number of pilot well pads are expected to occur within the zone. This is because only 25 pilot well pads are expected throughout the entire project area. It is important to note that there is a moderate probability that residential receptor will be located within 750 metres of multiple well pads having regard to the size of the zone, the likely number of well pads within the area and well pad spacing requirements. Access to well pads would be via existing roads and access tracks wherever possible. The construction of new access tracks would not be sealed or gravelled and would require a cleared 12 metre right of way during the construction phase. Similarly, the construction of gas and water gathering lines would require a construction corridor of 12 metres. Vegetation clearing required during the construction of the well pads, access tracks and gathering lines would result in some colour contrast in the landscape. Remaining vegetation in the foreground could reduce visibility in some views. Increased short term visual impact would likely occur within one kilometre of gathering line and access track during construction. Some construction activities would be undertaken outside of the daylight hours and would require lighting, including drill rig activities occurring 24 hours a day. Such work would, however, be managed so that the required night time lighting complies with accepted standards in Appendix D. The overall impacts associated with the construction phase of the gas field infrastructure would be of a *high to minor significance* or *not significant* depending on the location, number and distance of wells in view. It is noted that a land access agreement would be required with the respective land owner before a well is drilled. Impacts are most likely to be of *moderate* significance based on the nature of construction works and the reduced probability of a residential receptor being in close proximity to multiple well pads. Visual impacts from the drill rigs during the construction could be appropriately mitigated by managing the number of drill rigs in close proximity to a receptor at one time. Receptors in the study area are likely to have a sensitivity rating of medium. Given the mitigation measures intended to be implemented it is most likely that small impacts will occur. It is however possible (although unlikely) that moderate impacts occur. Combining receptor sensitivity, the probability of impacts, and the magnitude of those impacts, it is most likely that impacts on these receptors will be minor to not significant, so long as the mitigation measures are undertaken. There is however a possibility that impacts would have a greater significance if mitigation measures are not fully realised.	*Moderate to negligible impacts*	*High to not significant*

Source of Impact	Description	Impact Magnitude	Impact Significance
	Operation: Pilot well sets (up to six wells) that cannot be easily connected to existing gas gathering lines will feature a flare constructed on one well pad with an average flame height of 4 metres above the stack. A 40 kilolitre water balance tank would also exist for each pilot. Pilot wells would operate for up to three years before being converted to production wells, monitoring bores or decommissioned. The typical surface infrastructure of a well pad is considered to be low-scale. It includes a well head (up to three on the one well pad), a separator, telemetry and a generator. The infrastructure is generally no more than 2.4 m tall. Up to five, 5-megalitre water balance tanks are to be located throughout the gas field. Applying a similar assumption that RSRZ 2 is approximately 12% of the project area, it could be expected that one of these tanks could be located within this zone. Water balance tanks could be mitigated through muted colour selection, diligent micro siting and landscape screening. It would not be unusual for tanks to occur in this landscape setting. The production well pad would be partially rehabilitated to approximately one quarter of a hectare with the exception of pads that accommodate supporting infrastructure (telecommunication towers or water balance tanks) which will remain at approximately one hectare. It is important to note that the visual impact of surface infrastructure would start to reduce beyond 300 metres. The visual impact will further reduce when vegetation filters or screen views. The spacing requirement for production well pads would result in only one well pad located as close as 200 to 300 metres from a sensitive receptor. The view of a second production well pad within a viewing experience of a sensitive receptor would be distant (greater than 550 metres) due to spacing requirements. Greater visual impact may be experienced by sensitive receptors where multiple views of pilot well pads could be experienced within a 200 to 300 metre range. Only a small number of pilot wells are expected to occur within this zone, due to relatively limited spatial extents of this zone and only 25 pilot wells proposed throughout the project area. Road users may also have the potential to see multiple wells at one time, however, much like sensitive receptors; the likelihood is low given the spacing requirements and low scale nature of infrastructure. Depending on the proximity, final arrangement and the agreed mitigation measures (refer to Section 6 of this report) put in place, the potential impacts from typical surface infrastructure on sensitive receptors would be up to *small,* depending on location, number and distance of wells in view. New and existing access tracks would be rehabilitated back to a corridor width of approximately five metres for the operations phase; seven metres when co-located with a gathering line. Some linear infrastructure would be constructed across watercourses. Dedicated gathering lines would also be rehabilitated to 5 metres in width. Access tracks and gas and water gathering lines have limited surface activities with the exception of safety signs placed above lines and as such will not create a strong visual effect within the zone. The overall significance of the impacts to the proposed well infrastructure would range from *minor to not significant* depending on the location, number and distance of wells in view. The impacts significance may reduce with the implementation of the Field Development Protocol and in consultation with the landowner. It is expected that well pads would be located at fence lines or in areas screened through existing vegetation in agreement with the landowner.	*Small to negligible impacts*	*Minor to not significant*
Leewood property	**Construction and operation:** The Leewood property is located three (3) kilometres from the southern boundaries of the zone. The construction and operation of the facility is anticipated to have negligible visual impact on sensitive receptors within this RSRZ. There may be some long distance views of the taller infrastructure, such as the communication tower and the safety flare. A level of night lighting glow may be visible. As those components would be viewed at a distance, with some views filtered by intervening vegetation, it is assessed as having *negligible* impacts based on the distance between potential sensitive receptors and the Leewood property.	*Negligible impacts*	*Minor to not significant*
Bibblewindi facility	**Construction and operation:** The Bibblewindi facility is located approximately 13 kilometres from the southern boundaries of RSRZ 2. The construction and operation of the facility is anticipated to have a *negligible* visual impact on sensitive receptors within this RSRZ due to the significant separation distance.	*Negligible impacts*	*Not significant*
Infrastructure corridors – Leewood to Wilga Park **Leewood to Bibblewindi**	**Construction and operation:** The Leewood to Wilga Park infrastructure corridor traverses a small section of the zone whilst the Leewood to Bibblewindi Corridor would not be visible. The construction of the power line between Leewood and Wilga Park would occur within the existing corridor. Some additional vegetation removal within the existing corridor is likely although this is *not expected to be significant*. No impacts are expected during operation with the exception of infrequent maintenance activities. This is due to the infrastructure being located under-ground while surface areas will be subject to rehabilitation. It is therefore anticipated that there will be *no significant impacts* on the RSRZ from the construction works and operation phase associated with the Leewood to Wilga Park Infrastructure corridor.	*Negligible impacts*	*Not significant*
Communication Towers	**Construction:** Communication towers would be required through the project area to enable the remote telemetry on wells to operate and to facilitate effective communications across the gas field. There may be up to ten 60 metre high towers; or up to twenty 30 metre high towers, or a combination of both across the project area. RSRZ 2 is characterised by a combination of woodland vegetation adjacent channels and floodplains and open agricultural land. Therefore, some impedance to signal strength may occur. Consistent with the assumptions in relation to well pads and water balance tanks, it is conservatively assumed that approximately 12% of the towers (one 60 metre tower or two 30 metre towers) would be located within RSRZ 2. A crane with a boom length of 60 metres with a suitable lifting capacity (height above ground) would be required to lift tower modules into place. The impacts experienced by sensitive visual receptors during the construction phase of the towers would likely be *moderate to small*. The impacts would reduce with distance. The construction of towers is expected to take approximately 2-3 weeks and therefore construction impacts would be short in duration. Communication towers would be accessed via well pad access tracks and therefore no additional clearance would be required for access.	*Moderate to small impacts*	*High to minor significance*

Source of Impact	Description	Impact Magnitude	Impact Significance
	Operation: The visual impact of a communication tower would be from the vertical tower structure and antenna attached to the tower head. Visual contrast would be created by the vertical nature of the tower creating a silhouette effect against the skyline. Intervening woodland vegetation would assist in minimising visual impacts. The maximum visual impact of the tower would be experienced where a sensitive visual receptor is located as close as 500 metres from a well pad hosting a tower. Such an impact would likely have a *moderate* magnitude. Beyond 500 metres the visual impact of the tower would reduce and the potential to integrate with the surrounding landscape would increase. *Small* impacts would be experienced from ancillary perimeter fencing and the low impact concrete shelter due to the height being no greater than 2.7 metres above ground. Vegetation screening could be strategically planted to further minimise visual impact from ancillary elements. Depending on the final location and proximity of towers, the significance of these impacts would range from *minor to high* depending on the sensitivity of receptors. The likelihood of high impact significance is considered low based on the limited number of towers throughout the project area. Mitigation measures including appropriate site selection, diligent micro-siting, land owner consultation and screening of ancillary structures would assist in minimising visual impacts.	*Moderate to small impacts*	*High to minor significance*
Other Impacts	**Construction and operation:** There would be visual impacts associated with the additional construction vehicles and operational vehicles present within the area. These would be viewed from residential properties and by road users which have a sensitivity of medium and low, respectively. They are considered to be of a *negligible impact*, based on vehicles being a common characteristic within the existing landscape. It is important to note that construction traffic will be present for a significantly shorter duration. The impact of the construction and operation vehicles would therefore be *not significant*.	*Negligible impacts*	*Not significant*

5.3.3 RSRZ 3 – Forest

Table 5-4 describes the impacts to the RSRZ 3 - State Forest in regards to construction and operation activities.

There are approximately 17 residential properties throughout RSRZ 3, due to forest occupying much of the zone. Sensitive receptors also include a low number of recreation users of the state parks and road users of the highway passing through the area. Recreation users are more likely to frequent forest areas on the western side of Newell Highway. The visual amenity of the recreational receptors would be directly and adversely affected by the presence of construction vehicles and activities if they are in close proximity to them. It is likely that the existing tall trees within the forest will screen most of the visual impacts of the activities from the recreational receptors, if they are located at a distance. Therefore, the receptors in this RSRZ would have an overall sensitivity of *medium to low.*

Table 5-4 Impacts to the RSRZ 3 – Forest

Source of Impact	Description	Impact Magnitude	Impact Significance
Gas Field	**Construction**: Pilot wells will be constructed with a minimum spacing of 250 metres with up to six in a set. These will only operate for up to three years and it is anticipated that only 25 well pads (of the total 425) would accommodate pilot wells throughout the project area. At the end of the pilot period, pilots may be converted to production wells. Production wells will be constructed with a minimum spacing of 750 metres apart. Up to 425 well pads would be constructed across the project area. Given RSRZ3 represents around 60% of the project area, a reasonable assumption would be that approximately 60% of well pads could be located within this zone. It is noted that the final location of wells would be based on geology, land access agreements and application of the Field Development Protocol. An area of approximately one hectare would be cleared to facilitate construction of the well pads on which drilling of the wells and the associated activities will take place as described in section 5.1.1. This RSRZ is characterised by tall forest vegetation of state forests and includes mixed woodland with mostly canopy, shrub and ground cover layers. Available sensitive receptor views are short to medium in distance and closed with the exception of linear road areas. Vegetation clearing would have *moderate* localised visual impacts that significantly reduce with distance, given the density of woodland vegetation of the zone. The drill rig during construction stands approximately 25 metres above ground level and would typically stand higher than forest vegetation. Accordingly, there would be potential *moderate* visual impacts from the drill rig and associated structures. However, potential views would be significantly screened from forest vegetation with distance due to the lack of open views and would only occur for a short duration (up to 40 days). The dense forest vegetation is unlikely to allow for views of multiple wells by receptors. Access to well pads would be via existing roads and access tracks wherever possible. The construction of new access tracks would not be sealed or gravelled and would require a cleared 12 metre right of way during the construction phase. Similarly, the construction of gas and water gathering lines would require a construction corridor of 12 metres. Vegetation clearing required during the construction of the well pads, access tracks and gathering lines would result in some localised contrast in the landscape. The forest vegetation in the foreground would significantly reduce visibility in many views. Some construction activities would be undertaken outside of the daylight hours and would require lighting, such as drill rig activities occurring 24 hours a day. Such work would, however, be managed so that the required night time lighting complies with accepted standards in Appendix D. The overall impacts associated with the construction phase of the gas field infrastructure would be of a *moderate significance to not significant* depending on the location, number and distance of wells in view. It should be noted that it is anticipated that many of the potential views from within the Forest RSRZ towards infrastructure would be completely screened by existing tall vegetation within the area. There would only be a limited number of locations where potential views would be available. Receptors in the study area are likely to have a sensitivity rating of medium to low. Given the mitigation measures intended to be implemented it is most likely that small impacts will occur. It is however possible (although unlikely) that moderate impacts occur. Combining receptor sensitivity, the probability of impacts, and the magnitude of those impacts, it is most likely that impacts on these receptors will be minor to not significant, so long as the mitigation measures are undertaken. There is however a possibility that impacts would have a greater significance if mitigation measures are not fully realised.	*Moderate to negligible impacts*	*Moderate to not significant*

Source of Impact	Description	Impact Magnitude	Impact Significance
	Operation: Pilot well sets (up to six wells) that cannot be easily connected to existing gas gathering lines will feature a flare constructed on one well pad with an average flame height of 4 metres above the stack. A 40 kilolitre water balance tank would also exist for each pilot. Pilot wells would operate for up to three years before being converted to production wells, monitoring bores or decommissioned. The typical surface infrastructure of a production or pilot well pad is considered to be low-scale. It includes a well head (up to three on the one production well pad), a separator, telemetry and a generator. The infrastructure is generally no more than 2.4 m tall. Up to five, five-megalitre water balance tanks are to be located throughout the gas field. Applying a similar assumption that RSRZ 3 is approximately 60% of the project area, it could be expected that three of these tanks could be located within this zone. Water balance tanks could be mitigated through muted colour selection, diligent micro siting and landscape screening. It would not be unusual for tanks to occur in this landscape setting. The production well pad would be partially rehabilitated to approximately one quarter of a hectare with the exception of pads that accommodate supporting infrastructure (telecommunication towers or water balance tanks) which will remain at approximately one hectare. The impact of cleared vegetation from construction would be reduced through a carefully considered rehabilitation planting consistent with surrounding vegetation. The visual impact of surface infrastructure within this zone would be no greater than *small* and generally limited to a localised area due to the density and height of forest vegetation. Furthermore, it would generally not be possible for sensitive recreation receptors to view multiple well pads in a single view or viewing experience due to the density of forest vegetation and spacing requirements of well pads. New and existing access tracks would be rehabilitated back to a corridor width of approximately five metres for the operations phase; seven metres when co-located with a gathering line. Dedicated gathering lines would also be rehabilitated to 5 metres in width. Access tracks and gas and water gathering lines have limited surface activities with the exception of safety signs placed above lines and as such will create *negligible* visual impacts in the Forest RSRZ, given access tracks are a common element in the landscape. The overall significance of the impacts to the proposed well infrastructure would range from *minor to not significant*. The majority of impacts would be *not significant* given views of multiple wells are not possible in this RSRZ. The impacts may reduce with the implementation and establishment of mitigation measures through the consultation and construction management plan phase.	*Small to negligible impacts*	*Minor to not significant*
Leewood property	**Construction and operation:** The Leewood property is located three (3) kilometres from the boundaries of the zone. The construction and operation of the facility is anticipated to have *a negligible* visual impact on sensitive receptors within this RSRZ. There may be some long distance views of the taller infrastructure, such as the communication tower and the safety flare. A level of night lighting glow may be visible. As those components would be viewed at a distance, with some views filtered by intervening vegetation, impacts are assessed as being not significant based on the distance between potential sensitive receptors and the Leewood property.	*Negligible impact*	*Not significant*
Bibblewindi facility	**Construction and operation:** There is an active facility already present at Bibblewindi. Construction activities would increase the size of the Bibblewindi facility. This may include clearing of additional vegetation. Whilst the facility is surrounded by State Forest, it is already an active site. The scale and nature of forest vegetation surrounding the facility site would ensure that potential impacts would be *small to negligible* and of *minor significance to not significant* when viewed from RSRZ 3.	*Small to negligible impacts*	*Minor to not significant*
Infrastructure corridors – Leewood to Wilga Park **Leewood to Bibblewindi**	**Construction:** The Leewood to Bibblewindi infrastructure corridor would largely be contained within the zone whilst the Leewood to Wilga Park Corridor would not be visible due to a separation distance of 3km. The sensitive receptors within the RSRZ may be impacted during trenching. Corridor preparation stages are all expected to create some visual impacts along forest roads. The corridor would have a construction corridor width of 30 metres. No sensitive residential receptors are located within two kilometres of the proposed infrastructure corridor alignment. Other receptors within a one kilometre distance of the pipeline route would potentially be subject to construction impacts. Average construction rates are typically 400 to 600 metres per day for trenching. Based on such rates, sensitive receptors would be impacted for less than five days during trenching operations. Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D. Linear construction activities of this type typically proceed in a sequential fashion (i.e. from one section of trench to the next). Therefore, construction impacts would take place at different locations along the trench / plough-in at given time. As a consequence, the impacts at one point are short-term. Impacts typically last less than five days during trenching or plough-in. The construction activities would therefore have *small to* negligible *impacts* and would be minor to *not significant.*	*Small to negligible impacts*	*Minor to not significant*
	Operation: Negligible impacts are expected during operation with the exception of infrequent maintenance activities. This is due to the infrastructure being located underground while surface areas will be subject to rehabilitation. It is therefore anticipated that impacts will *not be significant* during the operation phase of the Leewood to Bibblewindi Infrastructure corridor.	*Negligible impacts*	*Not significant*
Communication Towers	**Construction:** RSRZ 3 is largely characterised by state forest and woodland vegetation with canopy, shrub and ground cover layers. It is likely that the extent of vegetation will create signal constraints. It is therefore expected that communication towers in RSRZ 3 would likely be the taller 60 metre design. Consistent with the assumptions in relation to well pads and water balance tanks, it is assumed that at least 60% of the towers (six 60 metre towers or a combination of 60 metre and 30 metre towers) would be located within RSRZ 3. A crane with a boom length of 60 metres with a suitable lifting capacity (height above ground) would be required to lift tower modules into place. The impacts experienced by sensitive visual receptors during the construction phase of the towers would likely be *moderate (when in the viewshed of residential receptors) to small*. The impacts would reduce with distance. The construction of towers is expected to take approximately 2-3 weeks. Therefore, construction impacts would be short in duration and would occur progressively throughout the project area. Communication towers would be accessed via well pad access tracks and therefore no additional clearance would be required for access purposes.	*Moderate to small impacts*	*Moderate to not significant*

Source of Impact	Description	Impact Magnitude	Impact Significance
	Operation: The visual impact of a communication tower would be from the vertical tower structure and antenna attached to the tower head. Visual contrast would be created by the vertical nature of the tower creating a silhouette effect against the skyline. Intervening forest woodland vegetation throughout the RSRZ would significantly screen views to towers. The maximum visual impact of the tower would be experienced where a sensitive visual receptor is located as close as 500 metres from a well pad hosting a tower. Such an impact would likely have a *moderate* magnitude. Beyond 500 metres the visual impact of the tower would significantly reduce due to the density and height of vegetation throughout the zone. *Negligible* impacts would be experienced from ancillary perimeter fencing and the low impact concrete shelter due to the height being no greater than 2.7 metres above ground. Vegetation screening could be strategically planted to further minimise visual impact from ancillary elements. Depending on the final location and proximity of towers, the significance of these impacts would range from *moderate (when in the viewshed of residential receptors) to not significant* depending on the sensitivity of receptors. The likelihood of moderate impact significance is considered low based on the limited number of towers throughout the project area. Mitigation measures including appropriate site selection, diligent micro-siting, land owner consultation and screening of ancillary structures would assist in minimising visual impacts.	*Moderate to negligible impacts*	*Moderate to not significant*
Other Impacts	**Construction and operation:** ***Westport workers' accommodation*** The impacts from the construction of Westport workers' accommodation are likely to be *negligible* and should not adversely affect surrounding sensitive residential receptors. This is due to distance of approximately 1.6 kilometres from the closest residential receptor and the presence of tall and dense intervening vegetation. There may be some additional night site lighting associated with the operational phase of the workers camp however this would be managed so that it complies with the night time lighting standards in Appendix D. ***Road traffic impact*** There would be visual impacts associated with the additional construction vehicles and operational vehicles present within the area. These are considered to be of a *negligible impact and not significant.*	*Negligible impacts*	*Not significant*

5.3.4 RSRZ 4 – Old Mill Road

Table 5-5 describes the impacts to the RSRZ 4 – Old Mill Road in regards to construction and operation activities.

There are 8 sensitive visual receptors scattered within the zone that may be impacted by the construction and operation activities. Receptors in this zone include a combination of residents of farming properties, road users and recreation users of surrounding state forests. The overall sensitivity of receptors is considered to be *high to medium,* depending on distance of views available from sensitive receptors or where written agreement for access is in place with the landholder. Road users would have a *low* sensitivity (this is because their viewing period is typically short or limited).

Table 5-5 Impacts to the RSRZ 4 – Old Mill Road

Source of Impact	Description	Impact Magnitude	Impact Significance
Gas Field	**Construction**: Pilot wells would be constructed with a minimum spacing of 250 metres with up to six in a set. These would only operate for up to three years and it is anticipated that only 25 well pads (of the total 425) would accommodate pilot wells throughout the project area. At the end of the pilot period, pilots may be converted to production wells. Production wells would be constructed with a minimum spacing of 750 metres apart. Up to 425 well pads would be constructed across the project area. Given RSRZ4 represents around 5% of the project area, a reasonable assumption would be that approximately 5% of well pads (approximately 20) would be located within this zone. It is noted that the final location of wells would be based on geology, land access agreements and application of the Field Development Protocol. An area of approximately one hectare would be cleared to facilitate construction of the well pads on which drilling of the wells and the associated activities would take place as described in section 5.1.3. This RSRZ is characterised by a visual landscape that is open to the north and surrounded by tall and dense forest vegetation to the south, east and west Vegetation clearing could have *moderate* localised visual impacts that significantly reduce with distance, given the density of woodland vegetation areas of the zone. There would be some impacts from the drill rig and associated structures. The drill rig during construction stands approximately 25 metres above ground level and would stand above forest vegetation. Sensitive visual receptors within a distance of 750 metres from the outer edge of the well pad would be subject to *moderate* impacts although this would only occur for a short duration (up to 40 days). The impacts would reduce with distance. Impacts would be dependent on the proximity and number of wells within a viewshed at one time. A single production well pad may be located 200 metres of a sensitive receptor, however the view of a second production well pad within the same viewshed would be distant (greater than 500 metres) due to spacing requirements. Given the size of this zone, a set of pilot wells is unlikely to be established within RSRZ4. Portions of a pilot well set may be located within the RSRZ, however these may be well-separated from sensitive receptors. Access to well pads would be via existing roads and access tracks wherever possible. The construction of new access tracks would require a cleared 12 metre right of way during the construction phase for new tracks. Similarly, the construction of gas and water gathering lines would require a construction corridor of 12 metres. Vegetation clearing required during the construction of the well pads, access tracks and gathering lines would result in some contrast in the landscape. Vegetation in the foreground could significantly reduce visibility in some views. Some construction activities would be undertaken outside of the daylight hours and would require lighting, such as drill rig activities occurring 24 hours a day. Such work would, however, be managed so that the required night time lighting complies with accepted standards in Appendix D. The overall impacts associated with the construction phase of the gas filed infrastructure would be of a *high* to *not significant* depending on the location, number and distance of wells in view. It is anticipated that many of the potential views from within the forest areas towards infrastructure would be completely screened by existing tall vegetation within the area. There would only be a limited number of locations where potential views would be available in these areas. It is noted that a land access agreement would be required with the respective land owner before a well is drilled. Visual impacts from the drill rigs during the construction could be appropriately mitigated by managing the number of drill rigs in close proximity to a receptor at one time.	*Moderate to small impacts*	*High to minor significance*
	Operation: The typical surface infrastructure of a production well pad is considered to be low-scale. It includes a well head (up to three on the one well pad), a separator, telemetry and a generator. The infrastructure is generally no more than 2.4 m tall. It is unlikely this RSRZ would accommodate a water balance tank for production wells. The production well pad would be partially rehabilitated to approximately one quarter of a hectare with the exception of pads that accommodate supporting infrastructure (telecommunication towers or water balance tanks) which would remain at approximately one hectare. It is important to note that the visual impact of surface infrastructure reduces significantly beyond 300 metres, due to the infrastructure being of a scale that integrates well within the landscape which is further enhanced through partial rehabilitation. The visual impact would further reduce when vegetation filters or screen views. The spacing requirement for production well pads would result in only one well pad located as close as 200 to 300 metres from a sensitive receptor. The view of a second production well pad within a viewing experience of a sensitive receptor would be distant (greater than 550 metres) due to spacing requirements. Depending on the proximity, final arrangement and the agreed mitigation measures (refer to Section 6 of this report) put in place, the potential impacts from typical surface infrastructure on sensitive receptors would be *small to negligible,* depending on the location, number, and distance of wells in view. New and existing access tracks would be rehabilitated back to a corridor width of approximately five metres for the operations phase; seven metres when co-located with a gathering line. Some linear infrastructure would be constructed across watercourses. Dedicated gathering lines would also be rehabilitated to 5 metres in width. Access tracks and gas and water gathering lines have limited surface activities with the exception of safety signs placed above lines and as such would not create a strong visual effect in the landscape. The overall significance of the impacts to the proposed well infrastructure would range from *moderate significance to not significant* depending on the location, number and distance of wells in view. The impacts significance may reduce with the implementation of the Field Development Protocol and in consultation with the landowner. It is expected that well pads would be located at fence lines or in areas screened through existing vegetation in agreement with the landowner. It should be noted that it is anticipated that many of the potential views from within the forest areas towards infrastructure would be completely screened by existing tall vegetation within the area. There would only be a limited number of locations where potential views would be available in these areas. The impacts significance may reduce with the implementation of the Field Development Protocol and in consultation with the landowner. It is expected that well pads would be located at fence lines or in areas screened through existing vegetation in agreement with the landowner.	*Small to negligible impacts*	*Minor to not significant*

Source of Impact	Description	Impact Magnitude	Impact Significance
Leewood property	**Construction:** A central gas processing facility with four processing trains (each with a stack height of approximately 35 metres) would be constructed. Two options to power infrastructure at Leewood are proposed. An optional power plant may be constructed as part of the gas processing plant which will comprise an engine hall approximately 10 metres high with a stack height of approximately 30 metres. A safety flare with a stack height of approximately 50 metres and an average flame height of up to 30 metres would also be required. The second option would involve the connection to the power grid to draw power from Wilga Park Power Station via the proposed power distribution line, in which case, no optional power plant would be constructed or operated. A water treatment facility, communications tower up to 60 metres and upgrade to staff amenities and car parking would also be constructed. There is vegetation around the boundary of the site which would filter some views. A photomontage of a view point 200 metres from the proposed Leewood infrastructure, along the Newell Highway, has been included in Appendix B as Figure B4. The photomontage demonstrates that existing roadside vegetation would significantly screen infrastructure from this distance. A series of zones of theoretical visibility (ZTV) based on the ultimate height for the selected tall infrastructure at Leewood have been calculated and are illustrated in Appendix C (100 megawatt power plant Figure C1, Central Gas Processing Facility Figure C2 and Safety Flare Figure C3). Based on the assessment, it is anticipated that there would be limited to no visibility of the proposed infrastructure by surrounding sensitive receptors. Sensitive receptors are therefore assessed as being subject to *small to negligible impacts*. The significance of the impacts would be *minor to not significant*. Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D.	*Small to negligible impacts*	*Minor to not significant*
	Operation: A series of ZTVs based on the ultimate height for the selected tall infrastructure at Leewood have been calculated and are illustrated in Appendix C (100 megawatt power plant Figure C1, Central Gas Processing Facility Figure C2 and Safety Flare Figure C3). Consequently, it is anticipated that there would be limited to no visibility of the proposed infrastructure by surrounding sensitive receptors. Sensitive receptors are therefore assessed as being subject to *small to negligible impacts* of *minor significance to not significant*. There may be some infrequent night time lighting impacts associated with the safety flare when in operation. There may also be some visible night time lighting glow associated with lighting of the site, however such lighting would adhere to the guideline limits set out in Appendix D.	*Small to negligible impacts*	*Minor to not significant*
Bibblewindi facility	**Construction and operation:** The Bibblewindi property is located eight kilometres from the boundary of the zone. The construction and operation of the facility is anticipated to have *negligible* visual impact on sensitive receptors within this RSRZ. There may be some long distance views of the taller infrastructure such as the safety flare. A level of night lighting glow may be visible. As those components would be viewed at a distance, with some views filtered by intervening vegetation, the associated impacts are assessed as not significant based on the distance between potential sensitive receptors and the Leewood property.	*Negligible impacts*	*Not significant*
Infrastructure corridors	**Construction:** There are no residential sensitive receptors within the RSRZ that would be impacted during the construction works. Impacts would be restricted to those sensitive receptors traveling through the area along the Newell Highway and local roads. Trenching / plough in, clearing and corridor preparation stages are all expected to cause some impacts. Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D. In general terms, linear construction activities of this type proceed in a sequential fashion from one section of trench to the next. Therefore, construction impacts would be taking place at different locations along the trench at a given time. Thus, the impacts at one point are short-term, typically lasting less than five days during trenching. On this basis, the activities would have a small *impact* which would be *not significant.*	*Small impact*	*Not significant*
	Operation: The infrastructure corridors would be rehabilitated and restored back to a revegetated corridor of 30 and 10 metres. It is considered that the impact during the operational phase would be *negligible*. The significance of impacts would be *not significant*.	*Negligible impacts*	*Not significant*
Communication towers	A 60 metre communication tower is prosed at the Leewood facility and assessed under ‘Leewood Property’. No additional communication towers are expected within the zone.	*N/A*	*N/A*
Other impacts	**Construction:** ***Road intersection Upgrades*** There are no residential sensitive receptors within the RSRZ that would be impacted during the construction works. Impacts would be restricted to sensitive receptors traveling through the area along the Newell Highway and local roads. Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D. The activities would therefore have a *small impact* which would be *minor to not significant*. There would be visual impacts associated with the additional operational vehicles present within the area. This would be view from residential properties and by road users which have a sensitivity of high and low, respectively. The activities would have a *small to negligible impact* and would be *moderate to not significant.*	*Small to negligible impacts*	Moderate to *not significant*
	Operation: ***Road traffic impact*** There would be visual impacts associated with the additional operational vehicles present within the area. This would be view from residential properties and by road users which have a sensitivity of high and low, respectively. The activities would have a *negligible impact* and would be *not significant.*	*Negligible impact*	*Not significant*

5.3.5 RSRZ 5 –Forest (Bibblewindi)

Table 5-6 describes the impacts to the RSRZ 5 - forest area surrounding Bibblewindi, in regards to construction and operation activities. Sensitive receptors of this RSRZ include recreation users of the state forest and road users. Due to the restriction of views and absence of residential sensitive receptors within the RSRZ, the overall sensitivity of receptors would be *medium to low* visual sensitivity.

Table 5-6 Impacts to the RSRZ 5 – Forest (Bibblewindi)

Source of Impact	Description	Impact Magnitude	Impact Significance
Gas Field	**Construction**: Production wells would be constructed with a minimum spacing of 750 metres apart. Up to 425 well pads would be constructed across the project area. Given RSRZ3 represents around 3% of the project area, a reasonable assumption would be that approximately 3% of production well pads (12) could be located within this zone. It is noted that the final location of wells would be based on geology, land access agreements and application of the Field Development Protocol. An area of approximately one hectare would be cleared to facilitate construction of the well pads on which drilling of the wells and the associated activities would take place as described in section 5.1.3. This RSRZ is characterised by tall forest vegetation of state forests and includes mixed woodland with mostly canopy, shrub and ground cover layers. Available sensitive receptor views are therefore short to medium and screened, with the exception of linear road areas. Vegetation clearing could have up to *moderate* localised visual impacts that significantly reduce with distance, given the density of woodland vegetation of the zone. The drill rig during construction stands approximately 25 metres above ground level and would typically stand higher than typical forest vegetation. Accordingly, there would be potential *moderate* visual impacts from the drill rig and associated structures. However, potential views would be significantly screened from forest vegetation with distance due to the lack of open views and would only occur for a short duration (up to 40 days). It should be noted that it is anticipated that many of the potential views from within the Bibblewindi forest RSRZ towards infrastructure would be completely screened by existing tall vegetation within the area. There would only be a limited number of locations where potential views would be available. The construction of pilot wells is not anticipated within this zone based on the zone being only 3% of the project area. Access to well pads would be via existing roads and access tracks wherever possible. The construction of new access tracks would not be sealed or gravelled and would require a cleared 12 metre right of way during the construction phase. Similarly, the construction of gas and water gathering lines would require a construction corridor of 12 metres. Vegetation clearing required during the construction of the well pads, access tracks and gathering lines would result in some localised contrast in the landscape. The forest vegetation in the foreground would significantly reduce visibility in many views. Some construction activities would be undertaken outside of the daylight hours and would require lighting, such as drill rig activities occurring 24 hours a day. Such work would, however, be managed so that the required night time lighting complies with accepted standards in Appendix D. The overall impacts associated with the construction phase of the gas field infrastructure would be of a *moderate* to *not significant* depending on location, number and distance of wells in view. It should be noted that it is anticipated that many of the potential views from within the Forest RSRZ towards infrastructure would be completely screened by existing tall vegetation within the area. There would only be a limited number of locations where potential views would be available. Receptors in the study area are likely to have a sensitivity rating of medium to low. Given the mitigation measures intended to be implemented it is most likely that small impacts will occur. It is however possible (although unlikely) that moderate impacts occur. Combining receptor sensitivity, the probability of impacts, and the magnitude of those impacts, it is most likely that impacts on these receptors will be minor to not significant, so long as the mitigation measures are undertaken. There is however a possibility that impacts would have a greater significance if mitigation measures are not fully realised.	*Moderate to negligible impacts*	*Moderate to not significant*
	Operation: The typical surface infrastructure of a production or pilot well pad is considered to be low-scale. It includes a well head (up to three on the one production well pad), a separator, telemetry and a generator. The infrastructure is generally no more than 2.4 m tall. It is unlikely this RSRZ would accommodate a water balance tank for production wells. The production well pad would be partially rehabilitated to approximately one quarter of a hectare with the exception of pads that accommodate supporting infrastructure (telecommunication towers or water balance tanks) which would remain at approximately one hectare. The visual impact of surface infrastructure within this zone would be no greater than *small* and generally limited to a localised area due to the density and height of forest vegetation. Furthermore, it would not be possible for sensitive recreation receptors to view multiple well pads in a single viewshed or viewing experience due to the density of forest vegetation. Given the size of this zone, a set of pilot wells is unlikely to be established within RSRZ5. Portions of a pilot well set may be located within the RSRZ, however these would not impact on any sensitive residential receptors. New and existing access tracks would be rehabilitated back to a corridor width of approximately five metres for the operations phase; seven metres when co-located with a gathering line. Dedicated gathering lines would also be rehabilitated to 5 metres in width. Access tracks and gas and water gathering lines have limited surface activities with the exception of safety signs placed above lines and as such would create negligible visual impacts in the Forest RSRZ, given access tracks are a common element in the landscape. The overall significance of the impacts to the proposed well infrastructure would range from *minor to not significant.* The significance is dependent upon the location, number and distance of wells in view. The impacts may reduce with the implementation and establishment of mitigation measures through the consultation and construction management plan phase.	*Small to negligible impacts*	*Minor to not significant*
Leewood property	**Construction and operation:** It is anticipated that there would be negligible impacts on the RSRZ from the Leewood property during the construction or operation phase due to a separation of approximately 8 kilometres and absence of sensitive residential receptors in the zone	*Negligible impacts*	*Not significant*

Source of Impact	Description	Impact Magnitude	Impact Significance
Bibblewindi facility	**Construction:** The existing vegetation situated around the boundary of the site would filter many views into the site. A ZTV for the safety flare at Bibblewindi has been calculated and is illustrated in Appendix C (Figure C4). No sensitive residential receptors are located within the RSRZ. Further, it is anticipated that the proposed infrastructure would not be visible to the nearest residential sensitive receptor outside of the RSRZ. Sensitive receptors are therefore assessed as being subject to *negligible impacts* that would not be significant. Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D.	*Negligible impacts*	*Not significant*
	Operation: The existing vegetation located around the boundary of the site would filter many views into the site. A ZTV for the safety flare at Bibblewindi have been calculated and is illustrated in Appendix C (Figure C4). On this basis, it is anticipated that the proposed infrastructure would not be visible from the surrounding residential sensitive receptors. Sensitive receptors are therefore assessed as being subject to *negligible impacts*. The flare stack would typically have a small flame with the exception of shut down periods associated with maintenance, commissioning or emergencies. It is expected that the safety flare activation would occur approximately seven days per year and therefore would generally result in negligible night glow impacts. Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D. New access tracks would be rehabilitated back to a corridor width of approximately seven metres wide for the operational phase, when co-located with gas and water gathering lines; five metres when not.	*Negligible impacts*	*Not significant*
Infrastructure corridors	**Construction:** The Leewood to Wilga Park infrastructure corridor will not be visible in the zone, due to a separation distance of approximately 8 kilometres. There are no residential sensitive receptors within the RSRZ that would be impacted during the construction works of the Leewood to Bibblewindi corridor. Impacts would be restricted to sensitive receptors travelling through the area along local roads and recreation users of the state forest parks. Trenching / plough in, clearing and corridor preparation stages are all expected to cause *small* impacts. Sensitive visual receptors within a distance of 250 metres of the pipeline route would be potentially subject to construction impacts. Average construction rates are typically 400 to 600 metres per day for trenching. Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D. Generally, linear construction activities of this type proceed in a sequential fashion from one section of trench to the next. Therefore, construction impacts would be taking place at different locations along the trench at a given time. As a result, the impacts at one point are short-term, typically lasting less than five days during trenching. The impacts of the corridor construction are therefore considered to be *small to* negligible *impacts* and would be minor to *not significant.*	*Small to negligible impacts*	*Minor to not significant*
	Operation: Negligible impacts are expected during operation with the exception of infrequent maintenance activities. This is due to the infrastructure being located underground while surface areas will be subject to rehabilitation. It is therefore anticipated that impacts will be *not significant* during the operation phase of the Leewood to Bibblewindi Infrastructure corridor.	*Negligible impacts*	*Not significant*
Communication towers	A communication tower is unlikely to be required within RSRZ 5 on the basis that the zone represents approximately 3% of the project area.	*N/A*	*N/A*
Other impacts	**Construction and operation:** There would be visual impacts associated with the additional construction vehicles and operational vehicles present within the area. These are considered to be of a *negligible impact and* would be *not significant.*	*Negligible impacts*	*Not significant*

5.4 Lighting Impacts

Light generated during construction and operation of the project would result from:

- construction lighting from drill rigs during installation of well pads. Construction of the well pads would occur 24 hours per day, seven days per week but would generally be limited in duration (up to 40 days) at a single location
- construction lighting at Leewood, Bibblewindi, Westport workers' accommodation and along the two infrastructure corridors. As construction work at these locations would generally be limited to daylight hours, this is expected to be minimal
- operational site lighting at Leewood, Bibblewindi and Westport workers' accommodation
- pilot well flares. There would be a maximum of six pilot flares across the entire project area. Each flare would operate for up to three years. The pilot flares would have a blue flame with an average height of approximately four metres
- safety flares at Leewood and Bibblewindi. The safety flares would have a blue flame with an average height of approximately 1.5 metres during normal operations. During commissioning, maintenance activities or non-routine situations where the gas is required to be safely managed through the flare, the flame height may be up to 30 metres. However, use of the flare to this extent would be rare and of limited duration.

Light generated during construction and operation would be managed in accordance with the requirements in *Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting*. This standard sets out guidelines for the control of the effects of outdoor lighting on nearby residents, road users and transport signalling systems and gives recommended limits for the relevant lighting parameters to contain these effects within tolerable levels. Generally, lighting would be designed to minimise off-site light spill.

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.*

During the night, light would be emitted from the small pilot flares. If a pilot flare was located in proximity to a sensitive receptor there is the possibility that it may be visible at the sensitive receptor. However due to the small number of pilot flares proposed the vegetated nature of much of the project area and the temporary nature of the pilot flare's operation it is unlikely that sensitive receptors would be affected. In addition, the potential for visual impacts from the flare's operation would be considered during siting of pilot flares. During maintenance activities or non-routine situations where the safety flare at Leewood is required to operate at a higher than standard purge gas flow rate, the Leewood safety flare may be visible at night to nearby sensitive receptors. The operation of the flare at Bibblewindi at higher than standard flow rate is not likely to be visible to sensitive receptors (refer to Appendix C).

The safety flare at Leewood would be approximately 100 kilometres from the observatory at Siding Spring while the safety flare at Bibblewindi would be approximately 90 kilometres from Siding Spring. Discussions have been held with representatives of the Siding Spring Observatory in relation to the potential for light impacts from the project affecting observatory activities. It is understood that due to the small number of flares, the dispersed nature of lit locations and the limited magnitude of the flare height and minimal lighting requirements of operational sites, that the potential for impacts is considered to be negligible. If the safety flare is required to be operated at its full capacity at night, it may be visible at the Observatory but is considered unlikely to significantly affect observation activities. The use of the safety flare to this extent is likely to be rare and of short duration.

5.5 Cumulative Impacts

The risk of cumulative impacts within the project has been considered in the preceding assessment. This section considered risks of cumulative impacts in relation to this project and other projects occurring or likely to occur in the area.

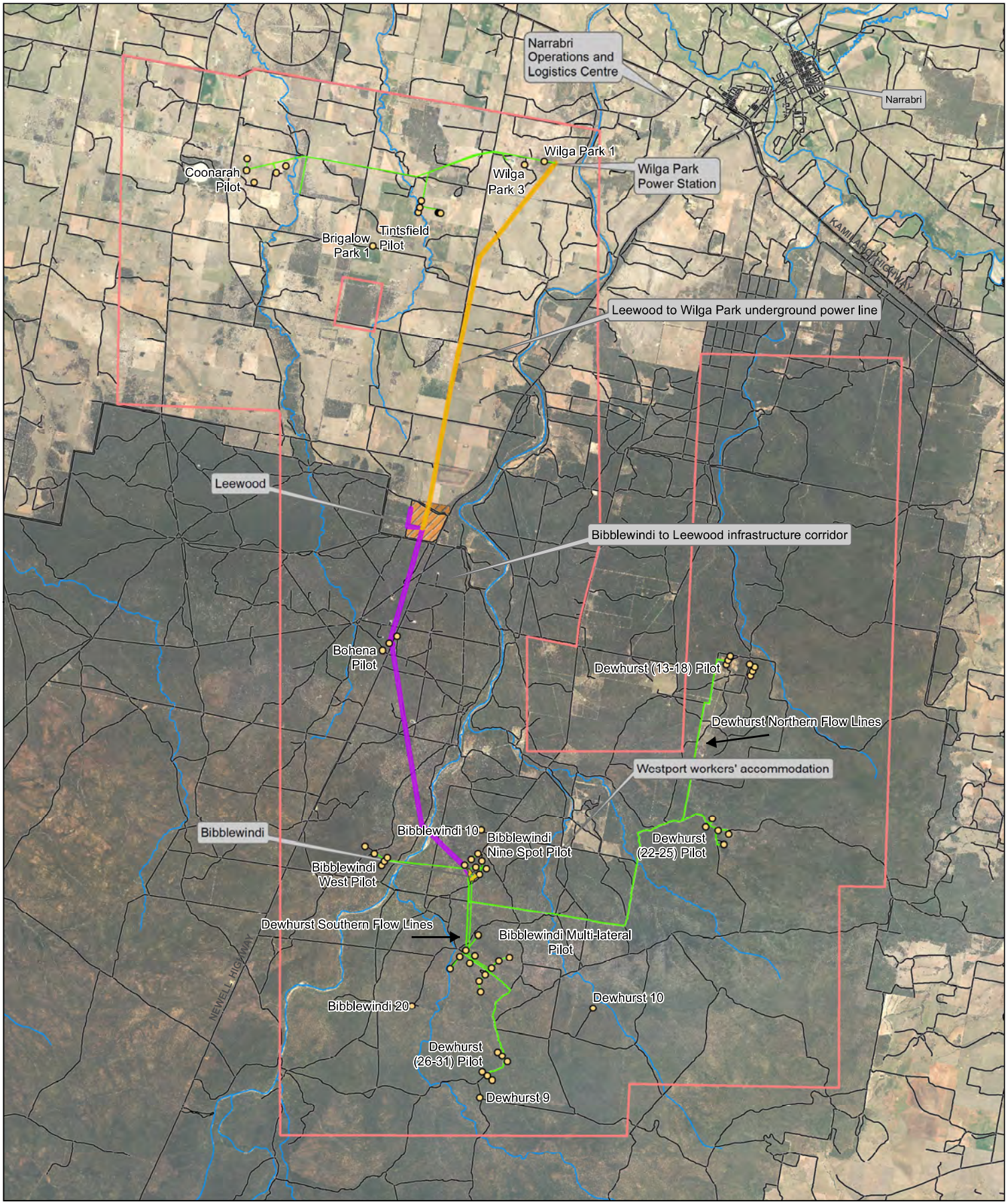
A summary of other development projects, including their location and development status is provided in Table 5-7. There will be no cumulative impacts in relation to the projects listed in Table 5-7, due to the distance between these projects and the project area.

However, there will be potential cumulative landscape and visual impacts associated with the existing Narrabri Gas Exploration project by Santos occurring within the subject project area. The Narrabri Gas Exploration project is the result of a number of existing approvals allowing the establishment of 10 exploration wells. The location of existing exploration wells is depicted in Figure 5-11. The proposed pilot and productions wells will be spaced, as per the distances stated in section 5.1.3, taking into consideration the location of existing exploration wells. As a result, the cumulative impact will be no different to the impacts identified and discussed in sections 5.2 and 5.3 associated with the gas field. Accordingly, the mitigation measures outlined in section 6 will also apply to such impacts.

Table 5-7 Projects in the vicinity of Narrabri

Project	Proponent	Project Type	Status	Local government area	Location
Maules Creek Coal Mine	Whitehaven Coal	Mining	Construction	Narrabri Shire Council	Off Therribri Road, Maules Creek
Vickery Coal Mine	Whitehaven Coal	Mining	Proposed (DA recently determined)	Gunnedah Shire Council Narrabri Shire Council	22 kilometres north of Gunnedah, 18 kilometres south-east of Boggabri
Boggabri Mine	Idemitsu Australia	Mining	Existing	Narrabri Shire Council	386 Leard Forest Road, Boggabri
Narrabri North Mine	Narrabri Coal Operations	Mining	Existing	Narrabri Shire Council	25 km, south-east of Narrabri
Watermark Coal Mine	Shenhua Watermark Coal Pty Limited	Mining	Proposed (under PAC review)	Gunnedah Shire Council	Kamilaroi Highway, Breeza
Tarrawonga Mine	Whitehaven Coal	Mining	Existing	Narrabri Shire Council	15 km north-east of Boggabri, East Boggabri
Inglegreen	Power Partners Generation	Electricity generation from piggery biogas	Proposed (DGR issued)	Narrabri Shire Council	Inglegreen, 10 km west of Narrabri Lot 7 DP757806

Project	Proponent	Project Type	Status	Local government area	Location
Queensland Hunter Gas Pipeline	Hunter Gas Pipeline	Pipeline	Proposed (approved)	Gunnedah Shire Council Liverpool Plains Shire Council Maitland City Council Moree Plains Shire Council Muswellbrook Shire Council Narrabri Shire Council Newcastle City Council Port Stephens Council Singleton Shire Council Upper Hunter Shire Council	Wallumbilla to Newcastle via Moree, Narrabri and Gunnedah
Rocglen Mine	Whitehaven Coal	Mining	Existing	Gunnedah Shire Council	Wean Road, Gunnedah
Watermark Coal Mine	Shenhua Watermark Coal Pty Limited	Mining	Proposed (under PAC review)	Gunnedah Shire Council	Kamilaroi Highway, Breeza
Caroona Coal Mine	BHP Billiton	Mining	Proposed (DGR issued)	Gunnedah Shire Council Liverpool Plains Shire Council	Coonabarabran Road, Caroona, NSW
Werris Creek Mine	Whitehaven Coal	Mining	Existing	Liverpool Plains Shire Council	4 km south of Werris Creek on the Quirindi Road
Melbourne to Brisbane Inland Rail	Melbourne to Brisbane Inland Rail Alliance	Railway	Proposed	Multiple	Melbourne to Brisbane



LEGEND

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

0 1.75 3.5 7
Kilometers

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

N

GHD

Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Job Number 21-22463
Revision A
Date 16 Aug 2016

Existing infrastructure

Figure 5-11

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6. Mitigation measures

6.1 Introduction

Appropriate mitigation measures are an integral part of the scheme design to achieve a best fit within the landscape. Preliminary evaluation of the layout should be guided by the need to avoid or reduce potential adverse effects on landscape character and visual receptors.

Environmental constraints and opportunities have been / will be taken into consideration during project development. This iterative approach assists in avoiding or minimising potential negative effects of the project, while also helping to identify opportunities for enhancement.

6.2 Overview of mitigation measures

The following mitigation measures would be implemented to minimise landscape and visual impacts of the project:

- infrastructure on private property would be sited in consultation with the landholder.
- existing roads, tracks and disturbance corridors for construction, operational access and the placement of linear infrastructure, would be utilised where practicable.
- lighting would be designed to meet Australian Standard AS 4282-1997 Control of the obtrusive effects of outdoor lighting and the Australian/New Zealand Standard AS/NZS 1158-2010 Lighting for roads and public spaces for roadways and plant, applicable.
- lighting would be focused on work sites during construction and on project infrastructure during operation to minimise light spill into adjoining areas.
- reasonable and feasible measures would be adopted to minimise light impacts from flaring.
- the decommissioning and rehabilitation plan would be implemented.

These mitigation measures are discussed in further detail below.

6.3 Landscape and visual impact mitigation measures

A number of measures are inherent in the design of the gas field that aid in the reduction of the surface infrastructure footprint. This has the benefit of designing out some of the potential visual impacts of the project. These design considerations include elements such as up to three well heads on a single pad and horizontal drilling in multiple seams. Further, infrastructure has been co-located at Leewood and Bibblewindi where existing facilities are already located.

A number of additional measures would be considered through the design phase, where possible in order to further reduce potential impacts including:

- negotiation with landholders on the location of wells to minimise localised viewing impacts
- use of existing roads, tracks and disturbance corridors for construction, operational access and the placement of linear infrastructure, where practicable to minimise ground disturbance
- following existing forest tracks or fence lines in the agricultural area
- minimising the extent of vegetation clearing to allow for well pad earthworks
- minimising construction times for wells in close proximity to sensitive receptors

- limiting the number of well pads under construction or drill rigs in operation in close proximity to a sensitive receptor through careful site selection, planning and construction staging
- potential landscape treatments at sensitive receptor viewer locations negotiated as part of the land access agreement with the landowner
- implementation of the decommissioning and rehabilitation plan.

The majority of impacts expected to be experienced within study area will be moderate or less and therefore specific mitigation measures are not critical. However, the mitigation measures will further reduce impacts and achieve a better community outcome.

6.4 Construction Management Plan

A Construction Management Plan would be prepared during the post approval stage of the project. The Construction Management Plan would detail the methods used for the project to minimise construction impacts and would be updated as additional information on construction becomes available. The Construction Management Plan would include:

- a Construction Method Statement for each site and activity which would include:
  - details of the construction methods for each site and activity once detailed contractor information relating to construction becomes available
  - details of specific license or consent conditions
  - validation of the impact at surrounding sensitive visual receptors for the site (including sites unknown at this stage of the project). The validation should include the number of sensitive visual receptors impacted, the duration of impact, the time period and anticipated significant negative visual impacts to occur as a result of the activities
  - detailed examination of feasible and reasonable work that would be implemented at the site
  - details of work undertaken outside of the standard recommended construction hours and additional mitigation measures for managing night time lighting impacts
  - details of negotiated agreements with land holders including agreed mitigations measures for reducing landscape and or visual impacts.
- a Community Consultation Plan that would include:
  - a notification procedure for surrounding sensitive receptors that have the potential to be impacted by the site construction works. The notification procedure would include details of the construction work that would be undertaken including timing, likely visual impacts and remediation measures and site contact details should it be necessary to lodge a complaint
  - a compliance monitoring procedure to deal with complaints arising from the construction works.

6.4.1 Construction Mitigation Measures

Some construction activities may be undertaken outside of the daylight hours and may require lighting. Such work would, however, be managed so that if night time lighting is required, it complies with accepted standards in Appendix D. Other mitigation strategies may include:

- reducing the number of plant used during the out of hours' periods in order to reduce lighting impacts
- undertaking work at a suitable distance from the sensitive receiver so that lighting levels do not cause disturbance.

6.5 Lighting

In terms of mitigation measures for night time lighting impacts, there are a number measures that can be applied.

6.5.1 Flares

There is limited opportunity to mitigate the impact of flares however in locating flares, the proximity of sensitive receivers would be a key consideration. The Leewood and Bibblewindi flares are small during normal operational activities; however, there is the potential for a large flare event. This would occur very infrequently and therefore mitigation is not warranted.

6.5.2 Site Lighting

Australian standard AS/NZS 4282 – 1997 *Control of the obtrusive effects of outdoor lighting* provides general guidance on the issue of obtrusive 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 should be designed to meet AS/NZS 4282 generally and AS/NZS 1158 for roadways and plant. This is likely to result in 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 sky glow, 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*.

7. Conclusion

The Landscape and Visual Impact Assessment (LVIA) report forms part of a broader Environmental Impact Statement that has been prepared for the project. The assessment identifies and describes impacts on the landscape and visual environment that would potentially arise from the construction or operation of the project. This assessment addresses the Secretary's environmental assessment requirements for the project, being:

> ***Visual*** *– including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, and minimising the lighting impacts of the development;*

Although the Secretary's requirements only seek assessment of visual impacts, it is usual for visual impacts to be assessed in combination with assessment of landscape impacts. The two issues are integrally related. As such, this assessment includes both:

- an assessment of development impacts upon the landscape as a resource, in terms of character, features and values, and
- an assessment of development impacts on the visual environment, in terms of impacts on views and visual amenity

The central purpose of the LVIA is to identify potentially significant adverse impacts at the project planning stage and to propose measures to mitigate or ameliorate such impacts.

The landscape of the identified study area was classified into five different Landscape Character Units (LCU) which were predominately based on the NSW Mitchell Landscapes (DECC 2008).

The overall landscape and visual impacts of the project are assessed as being of varying significance throughout the study area ranging from *moderate* to *not significant*. Due to the nature of the project there would be an overall long term impact on the visual landscape and amenity from some viewing locations. However, as the gas wells are proposed to be decommissioned and rehabilitated when they come to the end of their production life span, the impact duration from gas wells will be reduced in all areas.

The focus of mitigation measures should be on enhancing the quality of the landscape within the study area and when mitigation measures include planting that it is of native species that are suitable to the site in accordance with the Project Ecological Assessment (Appendix J1). A stated aim of the project is that a detailed decommissioning and rehabilitation strategy would be developed for the project. Conceptual strategies have been provided at Appendices V and W respectively. One of the main objectives of this would be to returning disturbed areas to a stable condition similar to that of the surrounding area within an acceptable time frame consistent with stakeholder requirements and expectations.

The landscape and visual impacts of the project would occur both during the construction and operational phases, and measures to minimise these impact need to be undertaken for both stages. The mitigation would be negotiated and agreed during the construction management planning process with land holders and stakeholders in order to reducing landscape and or visual impacts. The landscape within the study area was assessed as generally having a *medium potential capacity to accommodate change* of the type that would occur as part of this project.

To assist with description of the landscape and understanding of potential impacts, five landscape character units (LCUs) were identified and described. Table 7-1 summarises the sensitivity of each LCU and their capacity to accommodate change of the type expected of the project.

Table 7-1 Summary of LCUs

LCU	Summary of landscape values and qualities	Capacity to Accommodate Change	Value of LCU	Impact Magnitude	Impact Significance
LCU 1 Baradine - Coghill Channels and Floodplains.	The landscape elements in this area are highly valued and particularly the creek channels are highly sensitive to change.	Low	Medium	**Construction** *Moderate* impact only in the limited area where linear infrastructure crosses the LCU.	**Construction** *Moderate Significance*
				Operation *Negligible impacts.*	**Operation** *Not significant*
LCU 2 Bugaldie Uplands.	The landscape elements, particularly the continuity, form and scale of the vegetation within this area provide important value to the local character, its sense of nature and scenic values.	Medium	Medium	**Construction** *Moderate impacts* associated with the construction activities and vegetation clearing.	**Construction** *Moderate significance*
				Operation The impacts would reduce to a *Small Impact* with the implementation of the rehabilitation and mitigation measures.	**Operation** *Minor significance*
LCU 3 Cubbo Uplands.	The landscape elements, particularly the continuity, form and scale of the vegetation within this area with mature trees and sense of serenity contribute importantly to the local character, its sense of nature and scenic values. This area is a state forest and is highly sensitive to change.	Medium	Medium	**Construction** *Moderate impacts* associated with the construction activities and vegetation clearing.	**Construction** *Moderate significance*
				Operation The impacts would reduce to a *small impact* with the implementation of the rehabilitation and mitigation measures.	**Operation** *Minor significance*

LCU	Summary of landscape values and qualities	Capacity to Accommodate Change	Value of LCU	Impact Magnitude	Impact Significance
LCU 4 Coghill Alluvial Plains.	The residential and agricultural landscape elements within this area have been subjected to change.	Medium	Medium to low	**Construction** *Moderate impacts* associated with the construction activities and vegetation clearing.	**Construction** Residential and agricultural*: minor significance* Forest: *Moderate significance*
				Operation The impacts would reduce to a *small impact* with the implementation of the rehabilitation and mitigation measures.	**Operation** Residential and agricultural: *Not significant* *Forest: Minor significance*
LCU 5 Yarrie Lake Flora and Fauna Reserve.	The landscape elements of this area are highly valued to the local community as it is the only recreational reserve in a highly fragmented landscape.	Low	Medium	**Construction** *Negligible*	**Construction** *Not significant*
				Operation *Negligible*	**Operation** *Not significant*

In order to undertake an assessment of visual impacts sensitive receptors were grouped into representative zones based on typical types of views experience. The representative sensitive receptor zones (RSRZ) consist of areas where full or screened views of the project may be possible and human activity would be undertaken. The activity may include residential, business, or recreation. In addition, sensitivity receptors may also use the zones for transient purposes such as cycling, driving, and walking (including bush walking). As impacts can be seen outside the defined project area, sensitive receivers within three kilometres of the project area was included in this assessment. Table 7-2 summarises the sensitivity to change of the type expected of the project for each of the five selected RSRZ.

Table 7-2 Summary of RSRZ

RSRZ	Summary of visual context	Collective Sensitivity of Visual Receptors
RSRZ 1 – Northern Agricultural Plains	The visual landscape when viewed from the agricultural and residential properties is open with medium distance views depending on constraints by localised vegetation. Views in this area are primarily composed of large areas of cleared agricultural, exposed land with low vegetation. Views to the foreground consist of small groups of trees, residential properties, farm buildings, roads and fences. Some views are obstructed in the foreground by the tree corridors along the creek line. Views from this zone are experienced by: • Residents of the rural farms and agricultural properties. • Road users. • Recreational users of Yarrie Lake, Brigalow Park Nature Reserve and the local creeks.	Low - High

RSRZ	Summary of visual context	Collective Sensitivity of Visual Receptors
RSRZ 2 – Channels and Floodplains	The visual landscape when viewed from this zone is predominately short based on the screening by the woodland vegetation. Views from this zone are dictated by the location of the receptor within the zone. On the channel edge or in the channel the views are open and linearly continuous. However, the views from the floodplain are short due to the tall vegetation. Views from this zone are experienced by: • Recreational users of the creeks. • Residents of the properties.	Low - High
RSRZ 3 – Forest	The visual landscape when viewed from this zone is mostly short to medium distance and closed with the exception of the openness of the linear roads. In some elevated areas to the south-east on the top of slopes or ridges the landscape is visible in a 360 degree view of 'natural' landscape. Views from this zones are experienced by: • Recreational users of the state parks.	Low - Medium
RSRZ 4 – Old Mill Road	The visual landscape in this zone is varied dependent on the location of the receptor. The visual landscape when viewed from the northern part of the project area is open and extends to the distance towards the mountainous landscape in the southern part of the area. The view within the state forest is short to medium and screened dependent on the vegetation and vantage point of the receptor. The background of the state forest provides a 'natural' vista of the steep slopes whereas the flat area in the north provides a vast open vista. Views from this zone are experienced by: • Residents of the rural farms and agricultural properties. • Road users. • Recreational users of the state forests and local creeks.	Low - High
RSRZ 5 – Bibblewindi forest	The views within this zone are generally short and are screened, dependent on the vegetation and vantage point of the receptor. Views from this zone are experienced by: • Recreational users of the state forest. • Road users	Low to Medium

Based on the observations on receptor sensitivity and potential impacts, the significance of impacts on receptors from each of the identified project components was determined. Table 7-3 summarises the rating of impact significance for each of the receptors and project components.

Table 7-3 Summary of rating of impact significance

Source of Impact	Impact Significance				
	RSRZ 1 – Northern Agricultural Plains	**RSRZ 2 – Channels and Floodplains**	**RSRZ 3 – Forest**	**RSRZ 4 – Old Mill Road**	**RSRZ 5 – Forest (Bibblewindi)**
Gas Field	*Construction:* High to not significant	*Construction:* Minor to not significant	*Construction:* Moderate to not significant	*Construction:* Minor to not significant	*Construction:* Moderate to not significant
	Operation: Moderate to not significant	*Operation:* Minor to not significant	*Operation:* Minor to not significant	*Operation:* Minor to not significant	*Operation:* Minor to not significant
Leewood property	*Construction:* Minor to not significant	*Construction:* Minor to not significant	*Construction:* Not significant	*Construction:* Minor to not significant	*Construction:* Not significant
	Operation: Minor to not significant	*Operation:* Minor to not significant	*Operation:* Not significant	*Operation*: Minor to not significant	*Operation:* Not significant
Bibblewindi	*Construction:* Not significant	*Construction:* Not significant	*Construction:* Minor to not significant	*Construction:* Not significant	*Construction:* Not significant
	Operation: Not significant	*Operation:* Not significant	*Operation:* Minor to not significant	*Operation:* Not significant	*Operation:* Not significant
Infrastructure corridors	*Construction:* Not significant	*Construction:* Not significant	*Construction*: Minor to not significant	*Construction:* Not significant	*Construction:* Minor to not significant
	Operation: Not significant	*Operation:* Not significant	*Operation:* Not significant	*Operation:* Not significant	*Operation:* Not significant
Communication towers	*Construction:* High to minor significance	*Construction:* High to minor significance	*Construction:* Moderate to not significance	*Construction:* Assessed as part of facility	*Construction:* N/A
	Operation: High to minor significance	*Operation:* High to minor significance	*Operation:* Moderate to not significant	*Operation:* Assessed as part of facility	*Operation:* N/A
Other	*Construction:* Moderate to not significant	*Construction:* Not significant	*Construction:* Not significant	*Construction:* Moderate to not significant	*Construction:* Not significant
	Operation: Moderate to not significant	*Operation:* Not significant	*Operation:* Not significant	*Operation:* Not significant	*Operation:* Not significant

8. References

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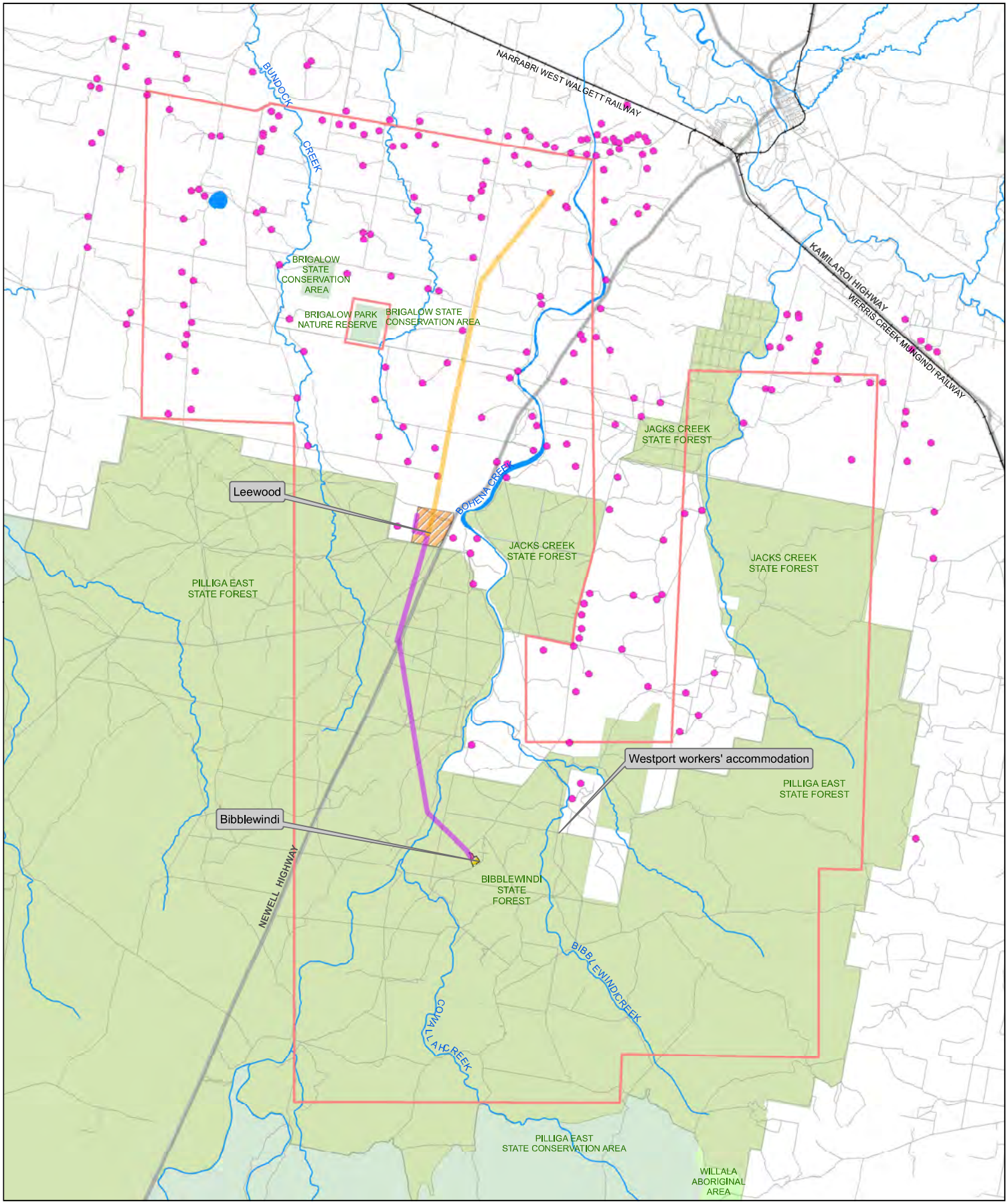
Appendices

Appendix A – Sensitive receivers in the project area



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line
- Sensitive receivers
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

0 1.75 3.5 7
Kilometers

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

N

Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Sensitive receivers in the vicinity of the project area

Job Number 21-22463
Revision A
Date 27 Jul 2016

Appendix A

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

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

Appendix B – Photomontages

Narrabri Gas Project
Environmental Impact Statement

Photomontage view of gas field infrastructure on ploughed agricultural land

Job Number 21-22463
Revision A
Date 24 Feb 2015

Figure B1

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Narrabri Gas Project
Environmental Impact Statement

Job Number 21-22463
Revision A
Date 24 Feb 2015

Photomontage view of gas field infrastructure on agricultural land with medium vegetation density

Figure B2

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Narrabri Gas Project
Environmental Impact Statement

Job Number 21-22463
Revision A
Date 24 Feb 2015

Photomontage view of gas field infrastructure on cropped agricultural land

Figure B3

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Narrabri Gas Project
Environmental Impact Statement

Photomontage view from the Newell Highway looking south-west toward Leewood

Job Number	21-22463
Revision	A
Date	24 Feb 2015

Figure B4

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Narrabri Gas Project
Environmental Impact Statement

Job Number 21-22463
Revision A
Date 24 Feb 2015

Photomontage view of gas field infrastructure on agricultural land with sparse vegetation

Figure B5

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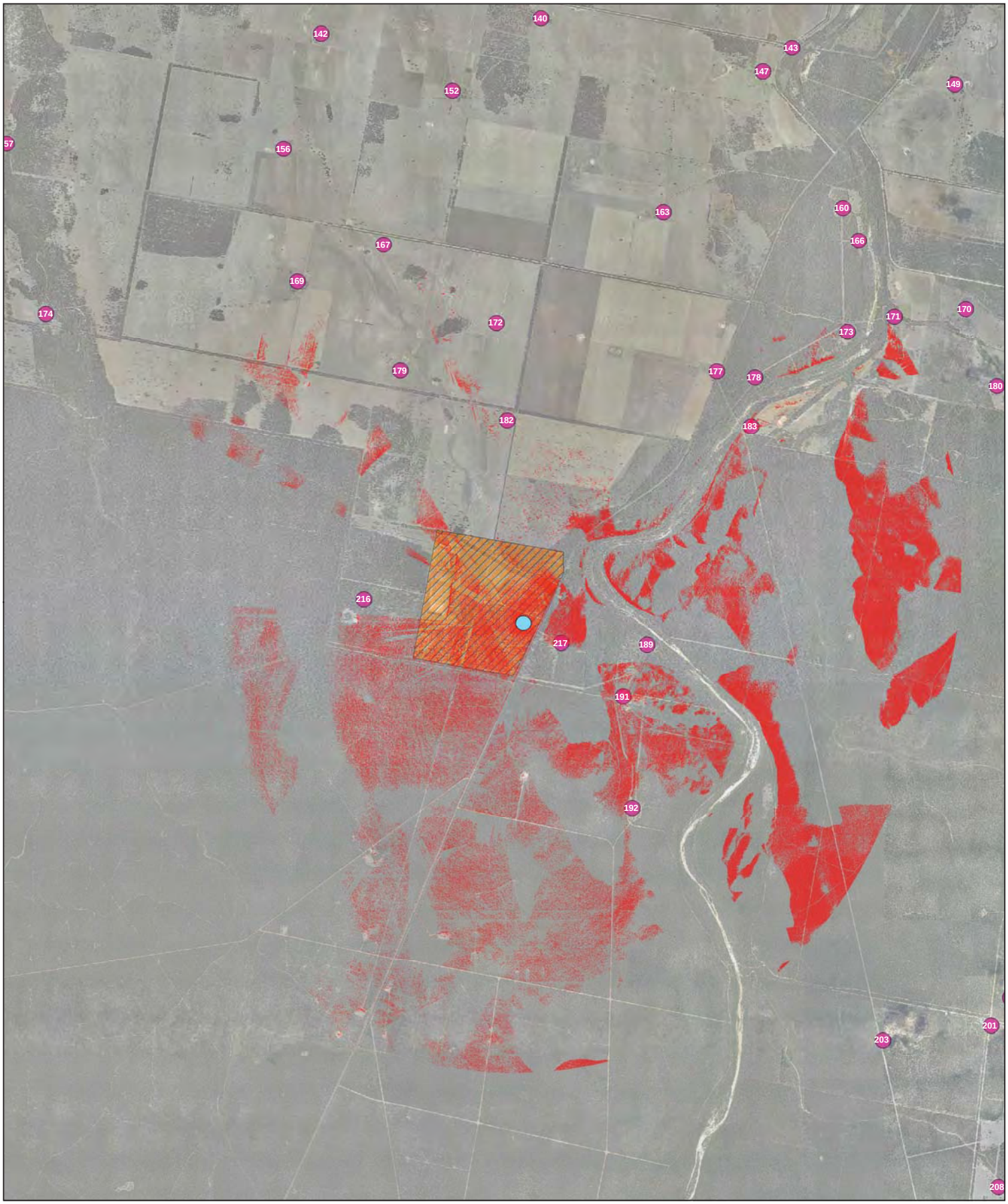
Appendix C – Zones of Theoretical Visibility



LEGEND

- Leewood
- Sensitive receivers
- Area where proposed infrastructure is visible from eye height
- Location of proposed 100 megawatt power plant (27.5m RL)

This Zone of Theoretical Visibility illustrates the potential visibilty of selected infrastructure from any point in the surrounding area. This visibility is based on 2 m contour intervals, an observer eye height of 1.7 m. This analysis does not take into account vegetation or existing built form and is representative only.

0 0.5 1 2
Kilometers

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

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Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Job Number 21-22463
Revision A
Date 11 Mar 2015

Zone of theoretical visibility - Leewood 100 megawatt power plant

Figure C1

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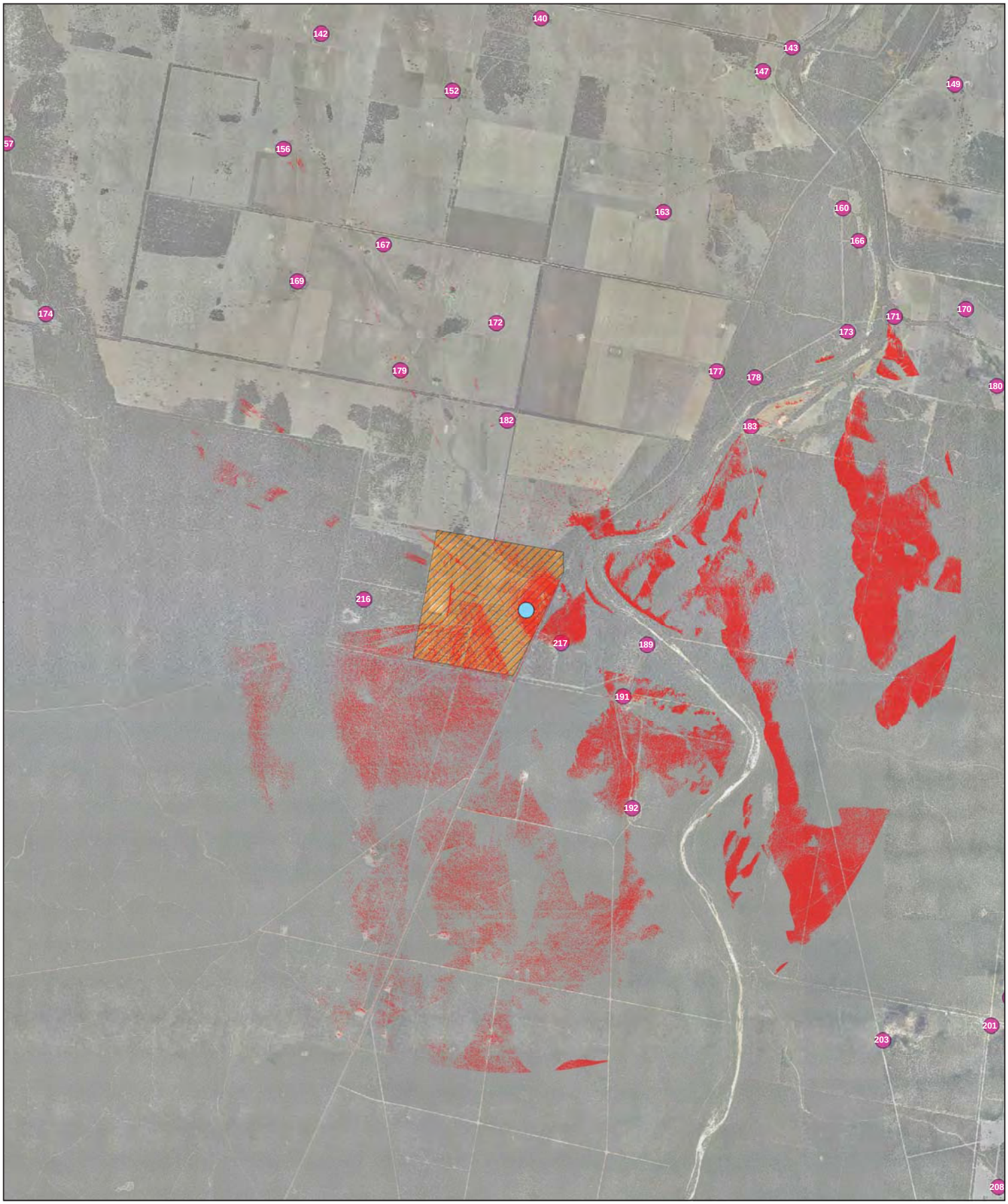
Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

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



LEGEND

- Leewood
- Sensitive receivers
- Area where proposed infrastructure is visible from eye height
- Location of proposed central gas processing facility (35m RL)

This Zone of Theoretical Visibility illustrates the potential visibilty of selected infrastructure from any point in the surrounding area. This visibility is based on 2 m contour intervals, an observer eye height of 1.7 m. This analysis does not take into account vegetation or existing built form and is representative only.

0 0.5 1 2
Kilometers

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

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Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Job Number 21-22463
Revision A
Date 11 Mar 2015

Zone of theoretical visibility - Leewood Central gas processing facility

Figure C2

C:\Users\AFoddy\Desktop\21_22463_KBM29.mxd [KBM: 133]

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

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LEGEND

- Leewood
- Sensitive receivers
- Area where proposed infrastructure is visible from eye height
- Location of proposed safety flare (59m RL)

This Zone of Theoretical Visibility illustrates the potential visibilty of selected infrastructure from any point in the surrounding area. This visibility is based on 2 m contour intervals, an observer eye height of 1.7 m. This analysis does not take into account vegetation or existing built form and is representative only.

0 0.5 1 2
Kilometers

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

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Job Number 21-22463
Revision A
Date 11 Mar 2015

Zone of theoretical visibility - Leewood Safety flare

Figure C3

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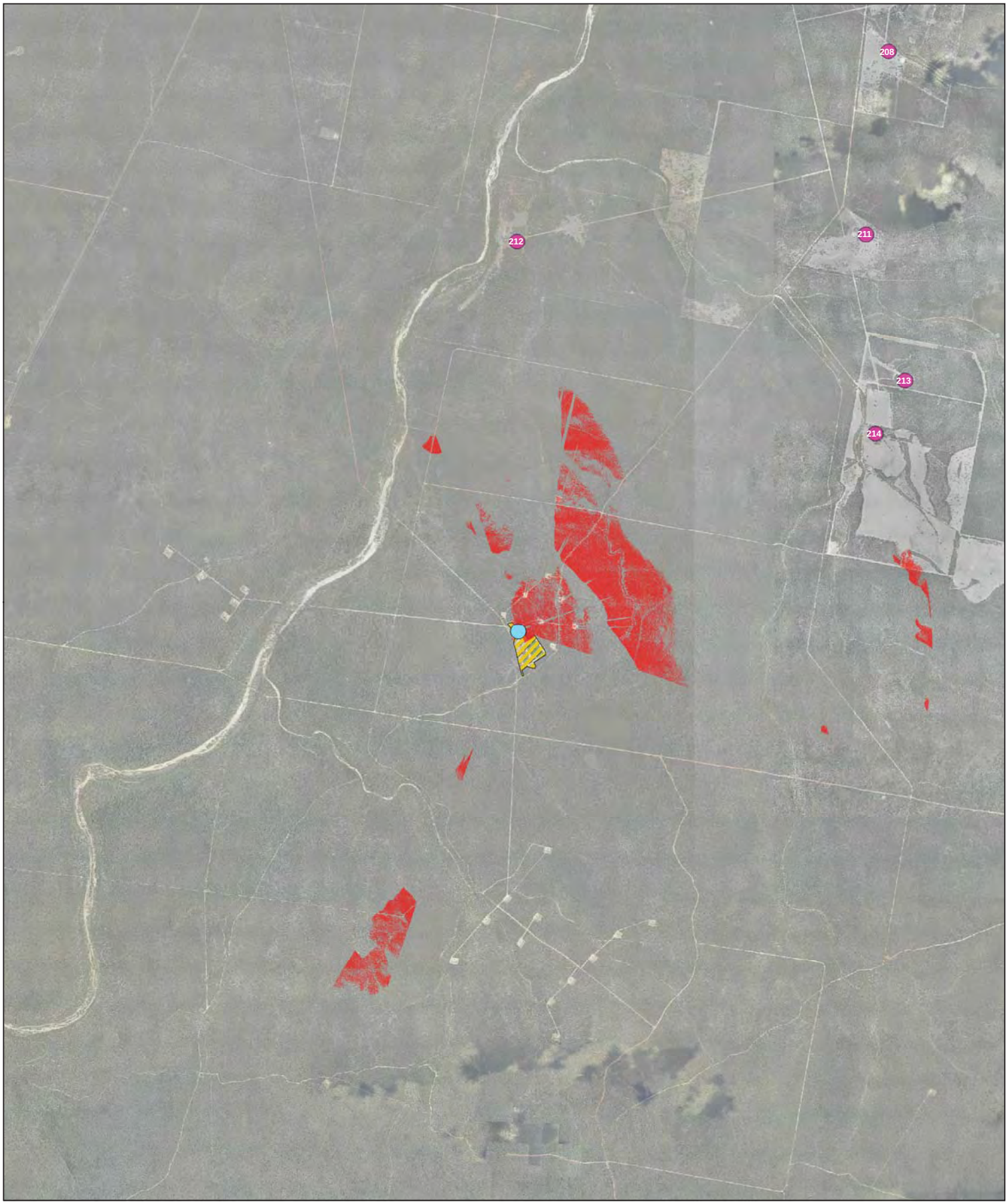
Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: afoddy

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



LEGEND

- Bibblewindi
- Sensitive receivers
- Area where proposed infrastructure is visible from eye height
- Location of proposed safety flare (59m RL)

This Zone of Theoretical Visibility illustrates the potential visibilty of selected infrastructure from any point in the surrounding area. This visibility is based on 2 m contour intervals, an observer eye height of 1.7 m. This analysis does not take into account vegetation or existing built form and is representative only.

0 0.5 1 2
Kilometers

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

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Job Number 21-22463
Revision A
Date 11 Mar 2015

Zone of theoretical visibility - Bibblewindi Safety flare

Figure C4

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

Appendix D – Lighting Impact Guidelines

Facility Lighting

Avoid glare problems from poorly aimed and unsuitable light fittings by:

- limiting illuminance and glare levels to those recommended in AS/NZS 1158
- maintaining spill lighting at receptors to levels recommended in AS/NZS 4282
- careful selection of luminaire and light source types. Luminaires should be carefully selected to be appropriate for the application, should be aimed correctly, and should limit light output only to the areas where it is required.
- 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.
- ensuring no light output is directed above the horizontal plane – light output is to be directed downwards to minimise sky glow.
- working platforms should be lit with full cut off luminaires rather than floodlights.
- ensuring light sources are directed away from sensitive receptors and possible sources of reflectance such as ponds.
- using the lowest practical luminaire mounting heights and poles.
- where safe to do so, make use of lighting control systems that ensure plant lighting is only switched on when required through the use of local presence detectors. Switch lights on instantly when required and off until required.
- roadway and yard area lights can be set up to only illuminate when actually required.

Flares

Minimise glare problems from flares by:

- locating flare stacks in valleys and depressions rather than on slopes and on ridge lines
- reducing the duration of time that the flare is active
- providing visual screening by vegetation where possible
- in the event of a particular sensitive receptor raising concerns, localised screening in the form of tree planting or the installation of physical barrier screening could be offered as mitigation
- when possible, provide advance warning of flare events so that observatory users can plan work around strategies.

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