Chapter 23

Landscape and visual

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23. Landscape and visual

The Secretary's environmental assessment requirements for the Narrabri Gas Project include a requirement to assess the likely visual impacts of the project on private landowners and key vantage points as well as lighting impacts. A detailed assessment was undertaken in response to this requirement and is provided in Appendix Q. This chapter draws on the assessment to provide a summary of the potential impacts of the project on landscape and visual receivers. Landscape receptors are those aspects of the landscape that would likely be affected by the project. Sensitive visual receivers are people or groups of people that may be affected by the project.

The key findings of the impact assessment in relation to landscape and visual were:

- The construction and operation of the gas field would have a moderate to not significant (negligible) impact on sensitive receivers. Moderate impacts would be associated with the drill rig during construction and the communication towers during operation when views are unobstructed.
- The construction and operation of the major facilities would have minor (low) to not significant (negligible) impact on nearby sensitive receivers.
- Impacts on landscape character would range from moderate to not significant (negligible) during construction and minor (low) to not significant (negligible) during operation.
- During night-time hours, light emitted from the pilot flares may be visible from sensitive receivers. Similarly, during commissioning and maintenance activities or non-routine situations (expected to occur infrequently), the safety flares at Bibblewindi and Leewood may be visible at night. Lighting would, however, be designed so it complies with applicable standards to minimise off-site light spill.

In order to undertake an assessment of visual impact, sensitive receivers were grouped into five representative zones based on the typical views experienced. The significance of impacts on receivers from each of the identified project components was determined. Occupied residences in the northern part of the project area are likely to have a higher sensitivity to change compared to recreation receivers in the forest due to less screening vegetation. It was found that the construction and operation of the gas field would have a moderate to not significant (negligible) impact on receivers, dependant on location. Impacts during construction would be associated with the height and scale of the drill rig and the proximity of the drill rig to a sensitive receptor. The assessment found that the construction and operation of the major facilities (Leewood, Bibblewindi, the infrastructure corridors and auxiliary infrastructure) would have minor (low) to not significant (negligible) impacts on nearby sensitive receivers.

Some construction activities would be undertaken outside daylight hours and require lighting. Site lighting would also be required at the major facilities during operation. Light generated during construction and operation of the project would be designed so it complies with *Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting,* and designed considering the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (NSW Department of Planning and Environment 2016). Generally, lighting would be designed to minimise off-site light spill.

During night-time hours, light emitted from the small pilot flares may be visible from sensitive receivers but the impacts would likely be reduced by the presence of intervening vegetation or the distance between potential sensitive receivers and the flares. During maintenance activities or non-routine situations (which would be rare and of limited duration), the safety flares at Bibblewindi and Leewood would likely not be visible to sensitive receivers throughout the day but may be visible at night. The pilot well flares and safety flares are unlikely to cause an impact on the long-term operation of Siding Spring observatory, near Coonabarabran.

In order to undertake an assessment of landscape impacts, landscape character units within the project area were identified. Landscape character units are common landscape types, defined by typical features and characteristics (such as vegetation or land form). The five landscape character units identified were determined to have a moderate to low landscape value. Two landscape character units were determined to have a low capacity to accommodate the project, while the remaining have a moderate or moderate to high capacity to accommodate the project. Project impacts on landscape character would range from moderate to not significant (negligible) during construction and minor (low) to not significant (negligible) during operation.

Mitigation and management measures that would be implemented to minimise landscape and visual impacts would include: consulting with landholders on the location of infrastructure on private property; using existing roads, tracks and disturbance corridors for construction, operational access and the placement of linear infrastructure (where practicable); designing lighting in accordance with applicable standards; and minimising light spill beyond construction boundaries.

23.1 Methodology

The landscape and visual impact assessment was undertaken with reference to the *Guidelines for Landscape and Visual Impact Assessment*, Third Edition (Landscape Institute and the Institute for Environmental Management and Assessment 2013). The assessment also drew upon the *Guidelines for Landscape Character and Visual Impact Assessment* (Roads and Maritime 2013). The landscape and visual impact assessment included a desktop review, a site survey and a significance assessment of landscape and visual impacts, including the production of photomontage images and zones of theoretical visibility. Lighting impacts were assessed qualitatively.

The steps in the landscape and visual impact assessment are described below.

23.1.1 Assessment of impacts

The landscape and visual impact assessment process included the identification of landscape receptors and visual receivers and an assessment of impacts based on a set of defined criteria. This process is shown in Figure 23-1 and summarised below.

The assessment process aimed to be objective and to describe landscape or visual 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.

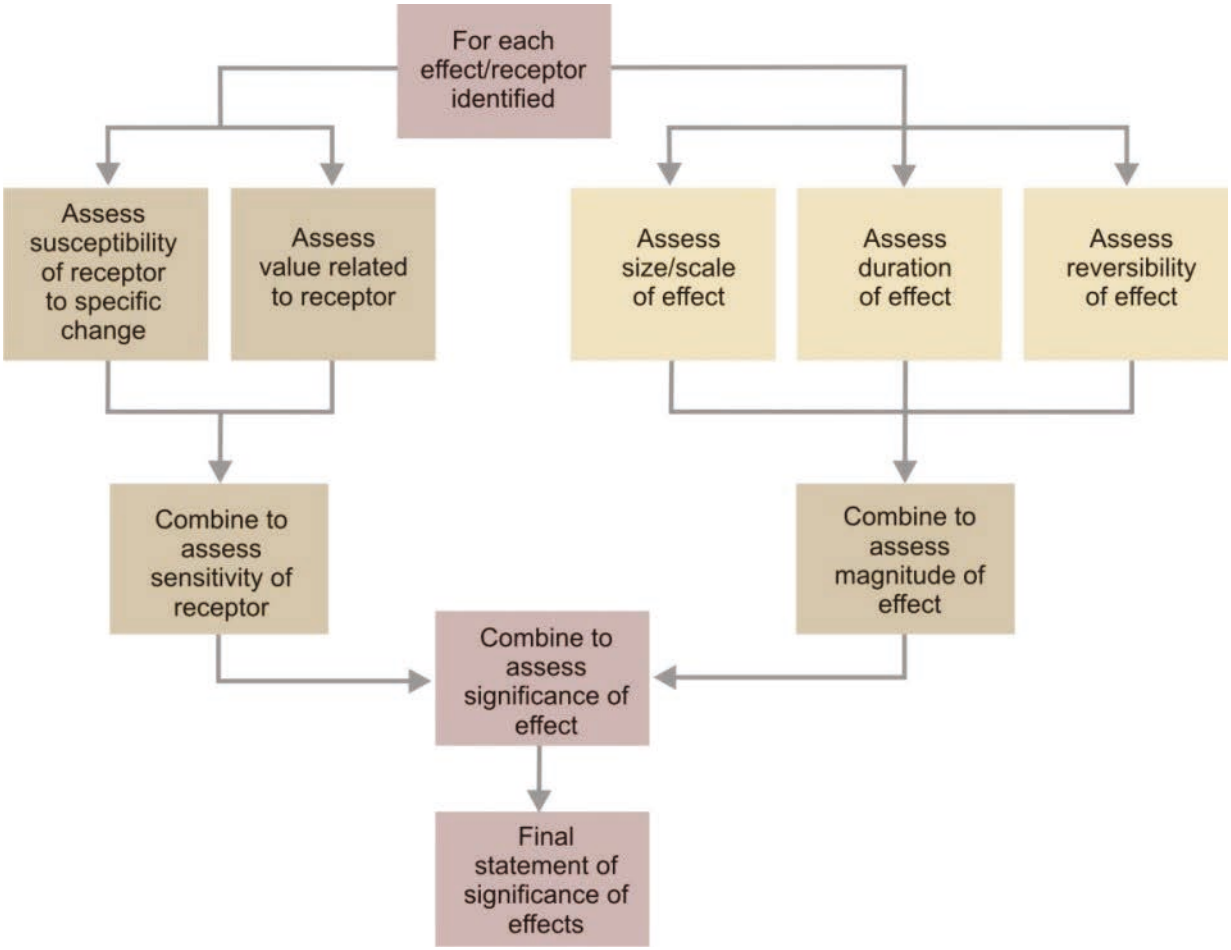


Figure 23-1 Landscape and visual impact assessment process

23.1.2 Identifying landscape receptors and sensitive receivers

Both landscape receptors and sensitive visual receivers were identified. Landscape receptors are those aspects of the landscape that would likely be affected by the project. In this case, they included overall landscape character, and a number of key landscape features (such as watercourses and ridgelines). To help classify and describe the landscape, and the landscape receptors, the project area was classified into five landscape character units. The landscape character units are described in Table 23-3 in Section 23.2.

Sensitive visual receivers are people or groups of people that may be affected by the project. A range of sensitive visual receivers was identified including residential receivers, commercial / industrial receivers in the form of agricultural businesses, recreational receivers, road users and observatory users at Siding Spring. Due to the expanse of the study area, five representative sensitive receiver zones were identified. These zones were selected as representative of the different types of viewing experiences throughout the project area (from open, unobstructed views in non-forested areas to the north, to closed, short distance views in forested areas to the south). The representative sensitive receiver zones are described in Table 23-4 in Section 23.2.

23.1.3 Photomontages and photographs

A series of 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 the 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.

In addition, a selection of photographs of existing exploration and appraisal infrastructure in the project area are included in this chapter.

23.1.4 Zones of theoretical visibility

A zone of theoretical visibility is the area around a designated point in the landscape from which that point is visible. A zone of theoretical visibility was calculated for the operation of major infrastructure (specifically for Leewood and Bibblewindi locations) using elevation data. The zone of theoretical visibility was calculated on two-metre contour intervals, with an observer eye height of 1.7 metres.

The zone of theoretical visibility did not take into account vegetation screening and, therefore, represents a worst-case representation of potential visibility. A zone of theoretical visibility for the gas field was not created; however, the visibility of a single well pad would be no greater than one kilometre within a cleared and flat landscape setting. Figure 23-2 and Figure 23-3 demonstrate the limited visibility of a well pad at 750 metres distance from two perspectives. Visibility would be substantially reduced with the presence of intervening vegetation.

Figure 23-2 Exploration and appraisal well pads 750 metres apart (arrow indicates second pad)

Figure 23-3 Exploration and appraisal well pad at a distance of 750 metres (arrow indicates second pad)

23.1.5 Assessing impacts

Landscape and visual impacts were evaluated as a product of the value of the landscape or the sensitivity of the visual receiver being affected and the magnitude of impact on that receiver, the definitions of which are provided in Appendix Q. A significance rating was assigned, based on the matrix provided in Table 23-1. The significance ratings are defined in Table 23-2.

It is important to note that the significance assessment undertaken for landscape and visual impacts is consistent with the methodology described in Chapter 10 (Approach to the impact assessment). However, the associated definitions of sensitivity, magnitude of impacts and significance of impact were further developed to focus on landscape and visual characteristics. Slightly different terminology was also adopted.

Table 23-1 Significance of impact

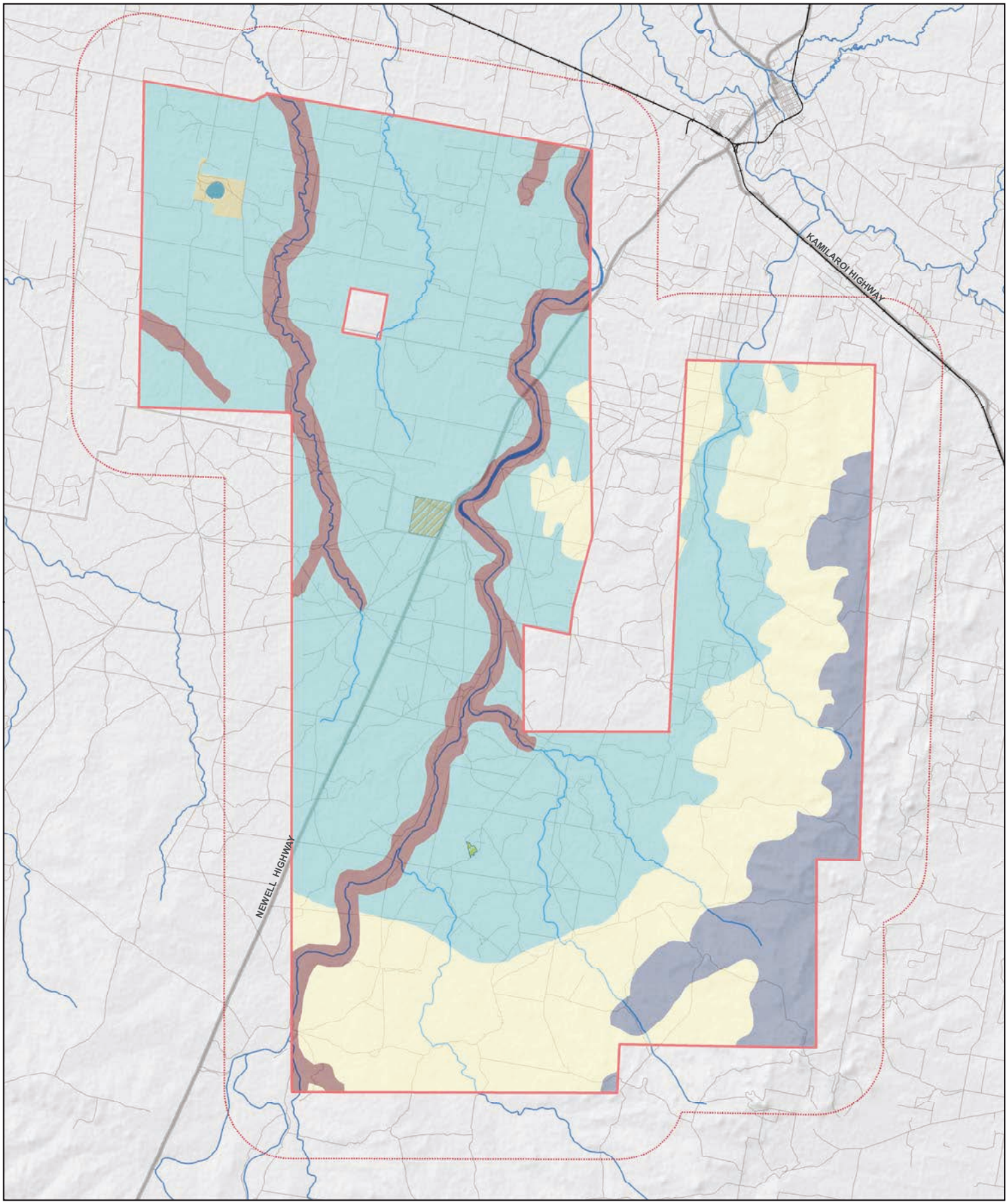
		Impact magnitude			
		High	Moderate	Low	Negligible
Landscape value / Visual receiver sensitivity	High	Major	High	Moderate	Minor (low)
	Moderate	High	Moderate	Low	Negligible
	Low	Moderate	Low	Negligible	Negligible
	Negligible	Low	Negligible	Negligible	Negligible

Table 23-2 Definition of impacts

Significance of impact	Definition
Major	Large reduction (modification) in the amenity for receivers of high visual sensitivity
High	Large reduction (modification) in the amenity of a view for receivers of moderate visual sensitivity
Moderate	Moderate reduction (modification) in the amenity of a view for receivers of a moderate level visual sensitivity; or Large reduction (modification) in the amenity of a view for receivers of low visual sensitivity
Low	Moderate reduction (modification) in the amenity of a view for receivers of low sensitivity; or Small reduction (modification) in the amenity of a view for receivers of moderate sensitivity
Negligible	Small reduction (modification) in the amenity of a view for receivers of low sensitivity

23.2 Existing environment

The project area was classified into five landscape character units and five representative sensitive receiver zones. The landscape character units are shown in Figure 23-4 and are described in Table 23-3. The representative sensitive receiver zones are shown in Figure 23-5 and are described in Table 23-4.



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

Narrabri Gas Project
Environmental Impact Statement

Job Number 21-22463
Revision A
Date 21 Oct 2015

Landscape Character Units

Figure 23-4

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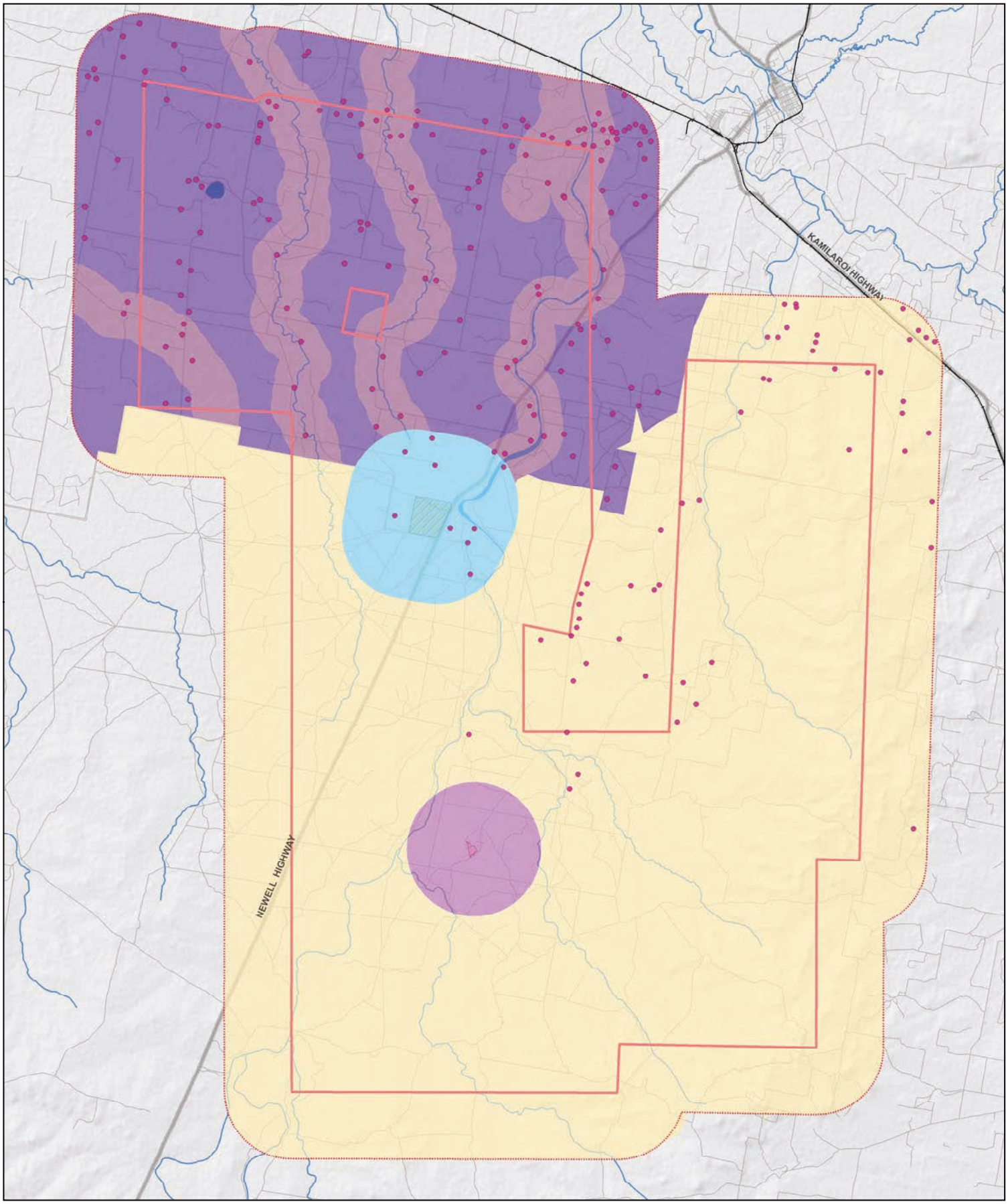
Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

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



LEGEND

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

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

Narrabri Gas Project
Environmental Impact Statement

Representative Sensitive Receiver Zones

Job Number 21-22463
Revision A
Date 21 Oct 2015

Figure 23-5

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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

Table 23-3 Landscape character units in the study area

Landscape character unit		Image	Location	Description
1	Baradine – Coghill channels and floodplains		Located along the main drainage lines within the study area and is predominately comprised of channels and floodplains.	• Valley • Woodland dominated by river red gum • Roads and tracks cross the channels • Limited number of buildings • Limited recreational characteristics
2	Bugaldie uplands		Located in the south-eastern part of the study area, which is defined by Jurassic quartz sandstone with some conglomerate, shale and inter-bedded basaltic volcanic rocks formed to create a stepped stony ridge landscape.	• Steeply sloping • Thick canopy and understorey • Roads and tracks • State forests provide recreational values to the local community
3	Cubbo uplands		Located in the central and south-eastern portion of the study area and is dominated by rocky outcrops.	• Rocky outcrop • Supports various forests and woodlands • State forest provides recreational value to the local community • Roads and tracks
4	Coghill alluvial plains		Located in the northern and central sections of the study area and is defined by a Quaternary alluvial fan.	• Alluvial plains • Grass trees dominate the sandy stream channels and river red gum line the creek lines, whereas the remaining landscape is open forest • Single dwellings with associated farm buildings as well as agricultural infrastructure • Roads, access tracks and powerlines • Nature reserve provides an important natural recreational value to local community
5	Yarrie Lake flora and fauna reserve		Three-kilometre saucer shaped lake located centrally within the agricultural part of the study area.	• High biodiversity • Recreational facilities • Roads, access tracks and powerlines • Reserve provides an important natural recreational value to local community

Table 23-4 Representative sensitive receiver zones

Representative sensitive receptor zones		Image	Location	Description
1	Northern agricultural plains		Located in the northern and central areas of the study area and is characterised by flat agricultural plains, mostly cleared and farm properties.	• Generally flat within an increase in elevation further south • 95 identified residences • Includes recreational areas, particularly around Yarrie Lake • Open with medium distance views • The Newell Highway passes through the zone
2	Channels and floodplains		Located in the northern and central areas of the study area characterised by linear watercourses and woodland floodplains.	• Predominately native riparian vegetation and open woodland • 59 identified residences • Screening provided by vegetation • Predominately short distance views
3	Forest		Located in the southern half of the study area and is characterised by woodland forest.	• Flat to undulating, with some sloping areas and ridges • 53 identified residences (16 within the project area) • Predominately utilised for forestry activities and recreational purposes • Closed with short to medium distance views
4	Old Mill Road		Located in the central west part of the project area. It includes the Leewood property and an area within a 3 km radius around the property. Characterised by a mixture of State forest and agricultural land.	• Flat to gently undulating • Predominantly cleared outside of State forest • Eight identified residences • Views in the northern section are open while views within the State forest are screened • Includes closest sensitive receivers to Leewood
5	Forest (Bibblewindi)		Located within State forest in the southern part of the project area. It includes the Bibblewindi site and an area within a 3 km radius around the site.	• Flat to gently undulating • Vegetation includes State forest and mixed woodland • No identified residences • Predominantly used for forestry purposes • Infrastructure currently exists at the Bibblewindi site for gas exploration and appraisal • Views are generally short and screened

23.3 Potential impacts

The potential landscape and visual impacts of the project are summarised below. Mitigation measures to avoid or reduce these impacts are discussed in Section 23.4.

23.3.1 Visual impact assessment (construction)

During construction, potential impacts on sensitive receivers would result from the establishment of work areas (including clearing of vegetation and grading) and the presence of construction equipment (for example, drilling rigs) and construction vehicles. Some construction activities would occur at night, and would require lighting. Lighting impacts are discussed in further detail in Section 23.3.4. Impacts during construction would be short-term and temporary at a given location.

Major facilities

Leewood

Construction activities at Leewood would involve clearing vegetation, grading and installing infrastructure. The significance of impacts associated with these activities would range from minor (low) to not significant (negligible) for sensitive receivers within the northern agricultural plains, channels and floodplains or the forest as sensitive receivers within these zones would be located more than three kilometres from Leewood and activities would likely not be visible.

For sensitive receivers closer to Leewood, construction activities would also have minor (low) to not significant (negligible) impact as existing vegetation along the boundaries of the site would likely filter views.

Bibblewindi

Construction activities at Bibblewindi would involve clearing vegetation, grading and installing infrastructure. The significance of these impacts would be minor (low) for recreational and road users and not significant (negligible) for residential receivers. Vegetation around the boundary of the site would likely filter views from sensitive receivers such as bushwalkers. There are no sensitive residential receivers within four kilometres of Bibblewindi.

Infrastructure corridors

Construction of the infrastructure corridors would involve clearing vegetation, grading, trenching and drilling at the Newell Highway. Linear construction activities of this type typically proceed in a sequential fashion (that is, from one section of trench to the next). Therefore, construction impacts would be taking place at different locations along the corridor at a given time. As a consequence, the visual impacts at a given point would be short-term. Average construction rates are typically 400 to 600 metres per day for trenching. Based on such rates, sensitive receivers would be impacted for less than five days during trenching operations.

Construction of the Leewood to Wilga Park underground power line would occur within an existing corridor. Some vegetation slashing would be likely although this is expected to have a minor (low) to not significant (negligible) impact on sensitive receivers within the northern agricultural plains, channels and floodplains. Construction of the Bibblewindi to Leewood infrastructure corridor would involve corridor preparation (for example, clearing vegetation and trenching/plough-in) which would create some minor

(low) to not significant (negligible) visual impacts on those visual receivers using local roads (there are no sensitive receivers within two kilometres of the proposed infrastructure corridor).

Construction of infrastructure in both corridors would be not significant (negligible) on those receivers travelling through the area on the Newell Highway and local roads. There are no sensitive residential receivers close to Leewood that would be impacted during construction of the infrastructure corridors.

Auxiliary infrastructure

Construction activities would involve clearing vegetation, grading and installing auxiliary infrastructure (water pipelines and irrigation infrastructure) or buildings (workers' accommodation at Westport). There would be visual impacts on sensitive receivers where residential receivers are located in close proximity to the irrigation infrastructure construction activity and when this activity is not screened by existing vegetation. In this scenario, the significance of these impacts has the potential to be moderate. The impact would be associated with the presence of construction vehicles. More generally, the presence of construction vehicles would be not significant (negligible) (from road users).

Construction of the workers' accommodation at Westport would have negligible impact as the closest sensitive residential receivers would be located approximately 1.6 kilometres from the site. The presence of tall and dense intervening vegetation would also filter views.

Road intersection upgrades would generally have a not significant (negligible) impact on those receivers travelling along local roads and the Newell Highway.

Gas field

Establishing the well pads would require clearing an area of vegetation and topsoil approximately one hectare in size. Constructing the gas wells would involve transporting and installing temporary facilities and mobilising a drill rig to each well pad. The drill rig would stand approximately 25 metres above ground level when in operation, while support facilities would generally not exceed three metres. Drilling would occur for up to around 30 days. An example of a drill rig that may be used during construction of the project is shown in Figure 23-6.

Sensitive receivers within 750 metres of the outer edge of the well pad may potentially be subject to moderate impacts in locations where intervening vegetation or other screening is not present and consequently the drill rig is visible for a short duration whilst the activity takes place. This is not expected to occur frequently as the location of wells would be agreed with the landowner hosting the infrastructure and it is expected that a landowner would take into consideration their visual impacts during their decision making process. For adjacent landowners, where a drill rig may be within 750 metres of the occupied residence, the trigger for negotiation with that landowner would be the commitment to meet the *Interim Construction Noise Guideline* (DECC 2009). More generally the visual impacts associated with drilling would be not significant (negligible).

A crane with a boom approximately 60 metres long and with suitable lifting capacity would be required to lift the telecommunication tower modules into place. The construction of the telecommunications towers would take place within the construction timeframe for the establishment of the well pads. Similar to the drill rig, there is the potential for visual impacts associated with the crane however with the mitigation measures in place the impacts would more likely be not significant (negligible).

A right-of-way up to 12 metres wide (on average 10 metres wide) would be required to construct new access tracks and gas and water gathering lines. Visual impacts associated with this construction would be limited to vegetation clearing and earthworks. Visual impacts would likely occur within one kilometre of gathering line and access track construction sites but would be short in duration and not significant (negligible).

Within the forest, views to construction areas would generally be filtered or completely screened by tall vegetation and impacts would be not significant (negligible).

Figure 23-6 Typical drill rig used on the project (photo taken in forested area)

Construction of the gas field would result in visual impacts from the air. The gas field infrastructure would be more visually prominent in forested areas (in the south of the project area) compared to infrastructure located in agricultural areas (in the north of the project area) from the air. This is because forested areas would have a lower visual absorption capacity than agricultural areas. Visual absorption capacity is the capacity of the landscape to absorb development without creating significant visual change and reduction in scenic quality.

Agricultural areas would have a higher visual absorption capacity than forested areas. Gas field infrastructure located in agricultural areas that are already altered would tend to make gas field infrastructure less visually intrusive. Partial rehabilitation of the well pads post construction would improve the absorption capacity; particularly in the forested areas of the project.

Currently, there are no commercial flights into or out of Narrabri. Flights in the vicinity of the project area are restricted to charter flights. Views from flights would therefore be transient and experienced by a relatively small number of people at a time. Partial rehabilitation of linear infrastructure post-construction would also reduce visual impacts from the air due to revegetation regrowth (refer to Figure 23-7 and Figure 23-8).

Figure 23-7 Early stage partial rehabilitation of co-located gathering lines and an access track in the forest (less than one year of regrowth)

Figure 23-8 Partial rehabilitation of access track in the forest (around two to three years regrowth)

Once the gas wells are no longer commercially viable they would be decommissioned in accordance with the *NSW Code of Practice for Coal Seam Gas – Well Integrity* (DTIRIS 2012) and final rehabilitation would take place.

23.3.2 Visual impact assessment (operation)

During operation of the project, potential impacts on visual receivers would result from the presence of vehicles, new infrastructure and lighting. Lighting impacts are discussed in further detail in Section 23.3.4.

Major facilities

Leewood

The visible infrastructure at Leewood would include:

- the central gas processing facility, which would likely feature four processing trains (described in detail in Chapter 6), or identical gas beneficiation units, each with a stack of approximately 35 metres
- the water management facility
- if included, the power generation facility which would have a potential stack height of approximately 30 metres
- a safety flare with a stack up to 50 metres high, with an average flame height of approximately 1.5 metres and up to 30 metres during rare, unplanned events. The flare would also be used during commissioning and maintenance activities
- tanks and pipes associated with the treated water management infrastructure
- a telecommunications tower up to approximately 60 metres high
- supporting infrastructure including buildings, equipment shelters and vehicles.

The proposed infrastructure would be located at least 50 metres from the property boundary, while the flare would be located approximately 400 metres from the boundary.

It is anticipated there would be limited to no visibility of the proposed infrastructure from surrounding sensitive receivers, based on the zone of theoretical visibility provided in Appendix C of Appendix Q. The proposed infrastructure may be visible from an occupied residence east of the site, but views would likely be screened by intervening vegetation (refer to Figure 23-9).

Figure 23-9 Vegetation screening at Leewood as viewed from the Newell Highway

A photomontage showing the indicative infrastructure layout at Leewood from the Newell Highway is provided as Figure 23-10. The photomontage shows that the existing roadside vegetation would significantly screen views to the proposed infrastructure from the Newell Highway. The impacts would the therefore be not significant (negligible).

There may be some long distance views of the taller infrastructure (the telecommunication tower and the safety flare). However, as the infrastructure would be viewed at a distance of more than three kilometres, the views would be filtered by intervening vegetation. The significance of these impacts would be minor (low) to not significant (negligible).

Figure 23-10 Photomontage view from the Newell Highway looking south-west toward Leewood

Bibblewindi

The visible infrastructure at Bibblewindi would include:

- compressors
- a safety flare of the same specifications and operation as at Leewood
- buildings, equipment shelters and vehicles.

The perimeter of Bibblewindi is surrounded by dense vegetation and does not adjoin a major road. In addition, there are no residential receivers within four kilometres of the facility. It is therefore anticipated that there would be a negligible visual impact for residential receivers.

As with Leewood, there may be some long distance views of the taller infrastructure. However, the infrastructure would be viewed at a distance with views filtered by intervening vegetation. The zone of theoretical visibility provided in Appendix C of Appendix Q indicates that the flare (excluding glow) is unlikely to be visible at identified sensitive residential receivers.

There would be minor (low) to not significant (negligible) impacts on sensitive receivers passing through the forest.

Infrastructure corridors

The infrastructure corridors would be rehabilitated and restored to a vegetation corridor consisting of grasses and low shrubs. Impacts during operation would be limited to routine vegetation maintenance (mowing and slashing) and, as such, would be not significant (negligible) on sensitive receivers.

Auxiliary infrastructure

Impacts associated with the operation of the auxiliary infrastructure would be limited to the presence of occasional operational vehicles. These impacts would be not significant (negligible).

Gas field

The visible infrastructure on a well pad would typically include a well head (potentially up to three) and associated infrastructure including a gas and water separator, metering skid, remote sensor telemetry unit and a generator. Some well pads would also have a water balance tank (there would be up to five water balance tanks across the project area) or a telecommunication tower (there would be up to 10 telecommunication towers 60 metres high, or up to 20 towers 30 metres high, or a mix of both within the project area). For remote pilot wells, there may also be a small flare with an average flame height of approximately four metres.

With the exception of the telecommunications towers, the bulk of the surface infrastructure would generally be no more than two to three metres above ground level and, as such, is unlikely to be particularly prominent from vantage points more than 500 metres away. An example of typical well surface infrastructure is shown in Figure 23-11.

The well pads 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. Figure 23-12, Figure 23-13, and Figure 23-14 show partial rehabilitation of a well pad at various stages of vegetation maturity.

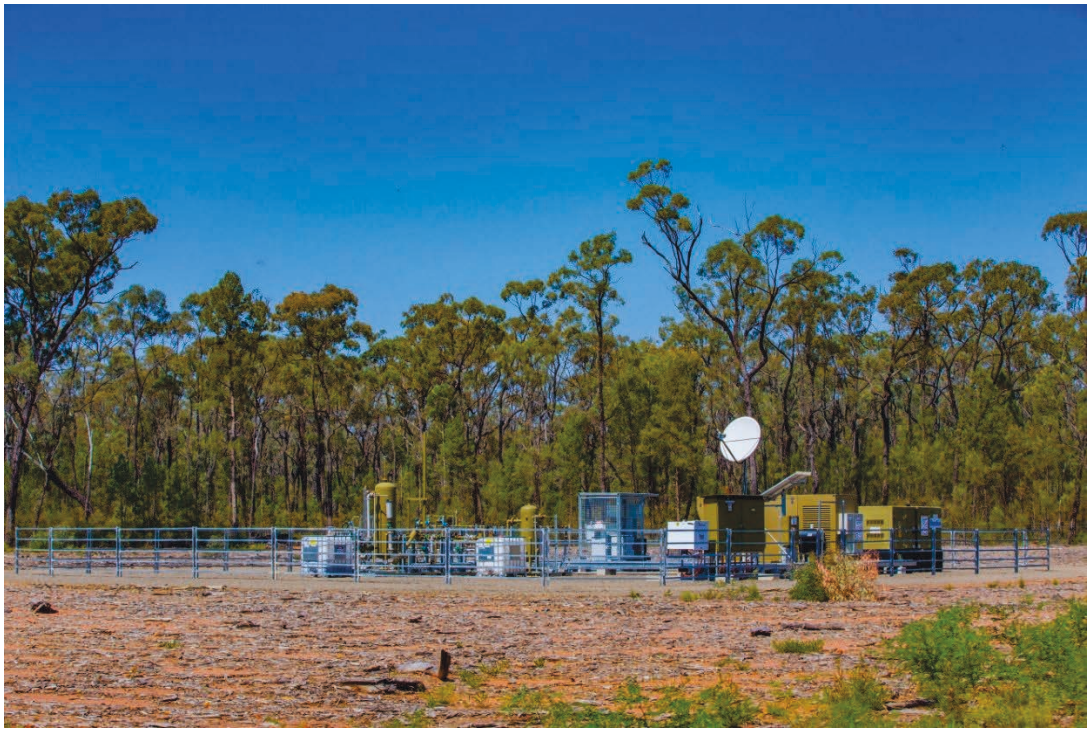

Figure 23-11 Well pad infrastructure showing early stage partial rehabilitation

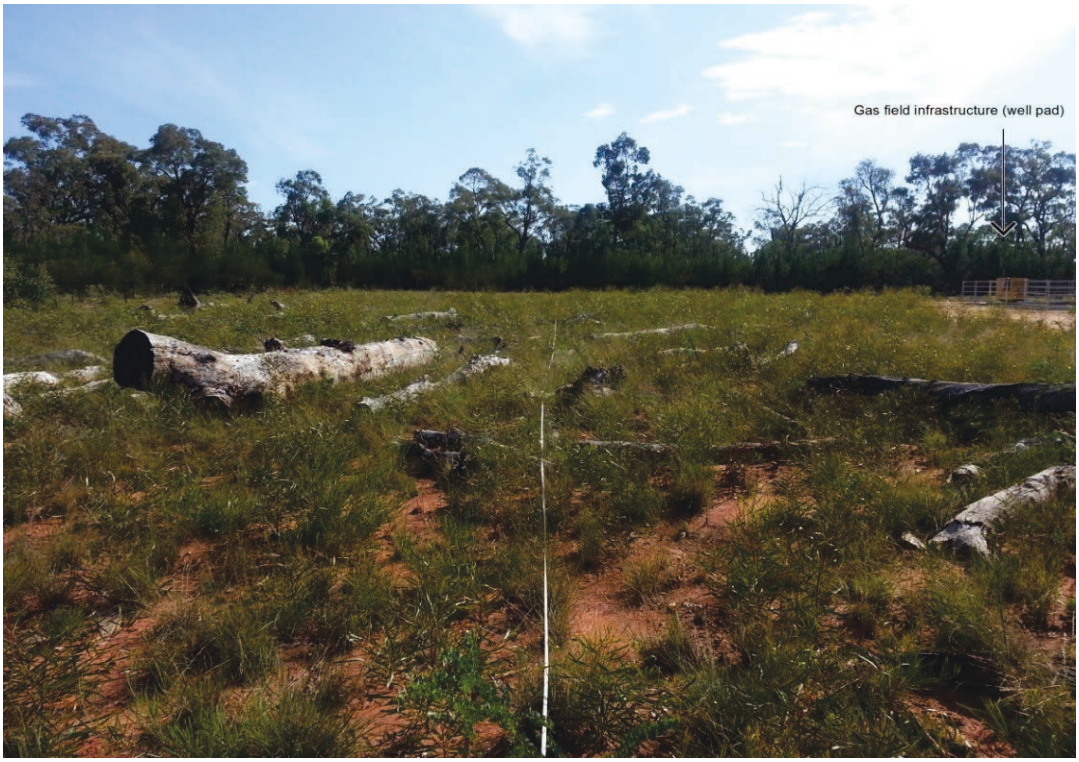

Figure 23-12 Partial rehabilitation of a well pad - well pad within 50 metres and with between one and two years' regrowth

Figure 23-13 Partial rehabilitation of a well pad - well pad within 50 metres and with between two and three years' regrowth

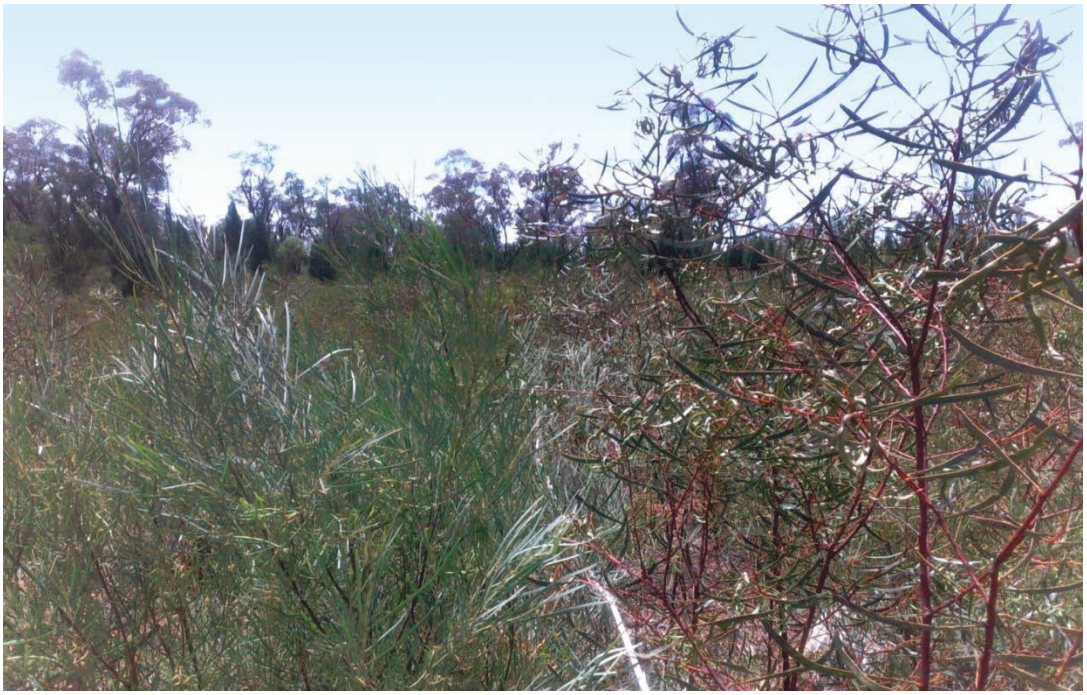

Figure 23-14 Partial rehabilitation of a well pad - well pad within 50 metres and over three years' regrowth

The potential impacts from typical surface infrastructure on sensitive receivers would vary from minor (low) to not significant (negligible) depending on the location, number and distance of wells in view. In agricultural areas, the surface infrastructure would integrate with the agricultural landscape, which is demonstrated in the indicative photomontages provided as Figure 23-15 through Figure 23-18.

Note that Figure 23-15 through Figure 23-18 inclusive are for illustrative purposes and do not necessarily represent the actual locations of well pads or well pad configurations within the project area.

Within the forest, the views to the surface infrastructure would generally be filtered or completely screened by tall vegetation. Furthermore, it would generally not be possible for sensitive receivers to view multiple well pads in a single view due to the density of vegetation and the spacing requirements of the well pads (well pads would be at least 750 metres apart).

The right-of-way for the access tracks and gas and water gathering lines would be partially rehabilitated to a width of approximately seven metres during operation, and as such, is unlikely to create a strong visual effect within the project area (refer to Figure 23-7 and Figure 23-8).

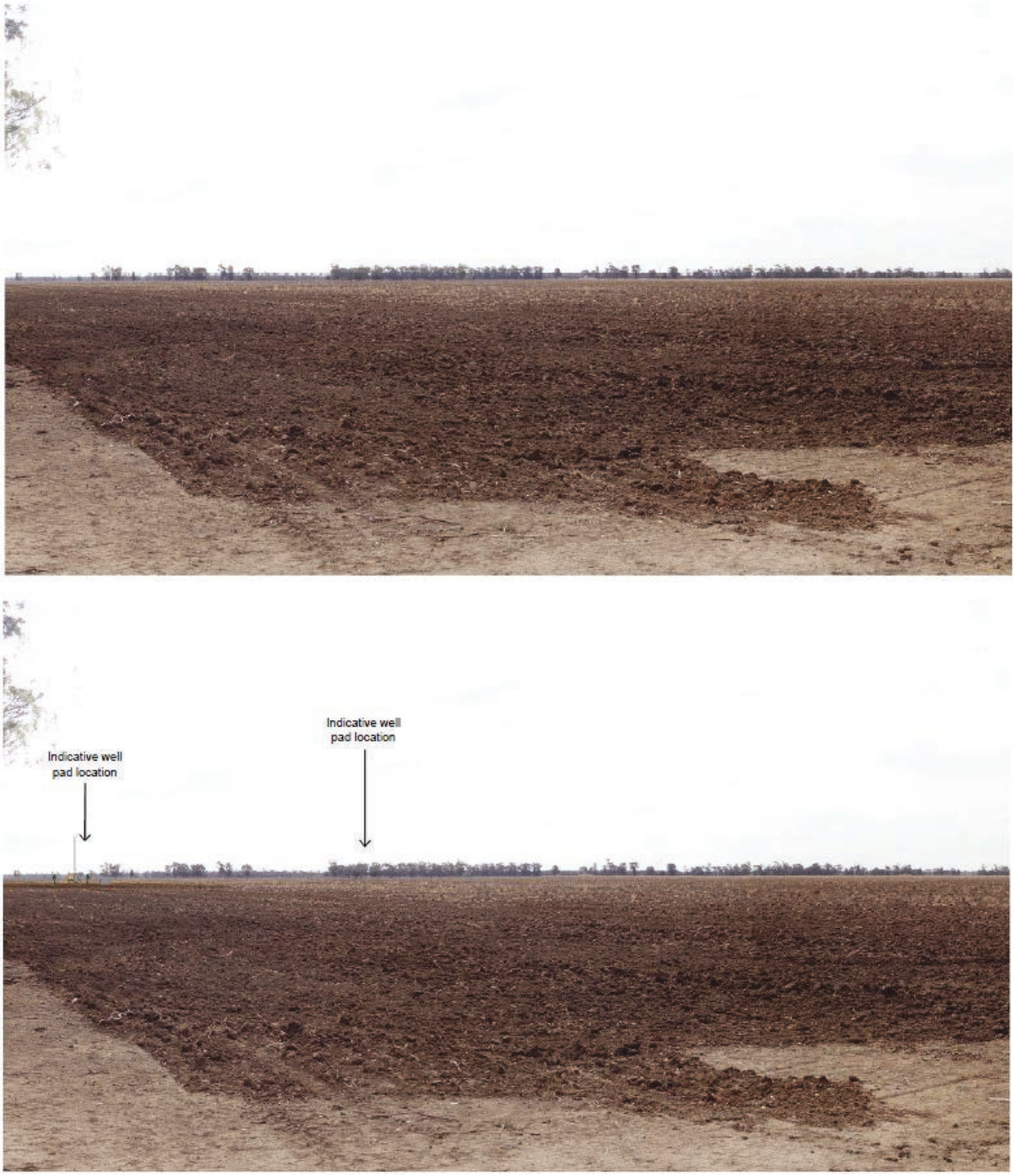

Figure 23-15 Photomontage view of gas field infrastructure on ploughed agricultural land

Figure 23-16 Photomontage view of gas field infrastructure on cropped agricultural land

Figure 23-17 Photomontage view of gas field infrastructure on agricultural land with sparse vegetation

Figure 23-18 Photo\montage view of gas field infrastructure on agricultural land with medium vegetation density

It is anticipated that there would be up to 10 telecommunication towers at a height of 60 metres, or up to 20 towers at a height of 30 metres, or a mix of both within the project area. Typically, taller towers have a lattice structure with a three-legged tubular design, while smaller towers have more of a modular monopole structure. Examples of typical telecommunications towers are provided in Chapter 6 (Project description).

There would generally be not significant (negligible) impacts from the telecommunication towers in the northern agricultural plains, channels and floodplains, and forest. The exception may be where a sensitive visual receiver is located within 500 metres from a well pad hosting a tower and the view is unobstructed, as shown indicatively in Figure 23-19 to Figure 23-22. Figure 23-19 to Figure 23-22 inclusive are for illustrative purposes and do not necessarily represent the actual locations of telecommunication towers within the project area. Beyond 500 metres, the visual impact of the tower would reduce and the potential to integrate with the surrounding landscape would increase.

Operation of the gas field would result in visual impacts from the air. The gas field infrastructure would be more visually prominent in forested areas (in the south of the project area) compared to infrastructure located in agricultural areas (in the north of the project area) from the air. As noted earlier in this chapter, that is because forested areas would have a lower visual absorption capacity than agricultural areas. The visual absorption capacity is the capacity of the landscape to absorb development without creating significant visual change and reduction in scenic quality.

The visual absorption capacity of the forest would improve following partial rehabilitation of a well pad.

Agricultural areas would have a higher visual absorption capacity than forested areas. Gas field infrastructure located in agricultural areas that are already altered would tend to make gas field infrastructure less visually intrusive. An aerial perspective of cleared well pads within an agricultural area is shown in Figure 23-2.

Currently, there are no commercial flights into or out of Narrabri. Flights in the vicinity of the project area are restricted to charter flights. Views from flights would therefore be transient and experienced by a relatively small number of people at a time. Partial rehabilitation of well pads and linear infrastructure post-construction would reduce visual impacts from the air due to revegetation regrowth.

Figure 23-19 Photomontage view of gas field infrastructure with 30 metre telecommunication tower on ploughed agricultural land

Figure 23-20 Photomontage view of gas field infrastructure with 60 metre telecommunication tower on ploughed agricultural land

Figure 23-21 Photomontage view of gas field infrastructure with 30 metre telecommunication tower on agricultural land with medium vegetation density

Figure 23-22 Photomontage view of gas field infrastructure with 60 metre telecommunication tower on agricultural land with medium vegetation density

23.3.3 Landscape impacts (construction and operation)

Construction and operation of the project would result in the following landscape impacts:

- Baradine – Coghill channels and floodplains – The landscape elements in the area are highly valued. The creek channels in particular are highly sensitive to change. During construction, the Bibblewindi to Leewood infrastructure corridor would cross Bohena Creek. During operation, the corridor would be rehabilitated and restored back to a vegetation corridor consisting of grasses and low shrubs. Impacts would be of moderate significance during construction and not significant (negligible) during operation.
- Bugaldie uplands – The landscape elements, particularly the continuity, form and scale of the vegetation within the area, provide important value to the local character, its sense of nature and scenic values. The area is afforded some protection as a State forest and is highly sensitive to change. Construction and operation of the gas field would result in landscape impacts that would be of moderate significance during construction and of minor (low) significance during operation.
- Cubbo uplands – The landscape elements, particularly the continuity, form and scale of the vegetation within this area, contribute to the local character, its sense of nature and scenic values. The area is a State forest and is highly sensitive to change. Construction and operation of the gas field would result in landscape impacts that would be of moderate significance during construction and of minor (low) significance during operation.
- Coghill alluvial plains – The residential and agricultural landscape elements within this area have been subjected to change. The construction and operation of Leewood and Bibblewindi would result in impacts that would be of minor significance during construction and not significant (negligible) during operation. State forest to the south has a regional designation and is valued locally. The construction and operation of Leewood and Bibblewindi would result in impacts that would be of moderate significance during construction and minor (low) significance during operation.
- Yarrie Lake flora and fauna reserve – The landscape elements of the reserve are highly valued to the local community. As there would be no major infrastructure near the lake and an exclusion zone established around the reserve, there would be no landscape impacts.

23.3.4 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 at a given 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, light generation is expected to be minimal
- operational site lighting at Leewood, Bibblewindi and Westport workers' accommodation
- night time truck movements are not scheduled during operation of the project and would be largely limited to drilling rigs

- 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 yellow flame with an average height of approximately four metres
- safety flares at Leewood and Bibblewindi. The safety flares would have a yellow flame with an average height of approximately 1.5 metres during normal operations. During commissioning, maintenance activities or non-routine situations (expected to occur infrequently) 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.

The design and operation of the project would give due consideration to the good lighting design principles in the *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (NSW Department of Planning and Environment 2016) and 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*, as applicable. These documents set 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.

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 receivers would be affected. In addition, the potential for visual impacts from the flare's operation would be considered during siting of pilot flares.

During commissioning, maintenance activities and non-routine situations where the safety flare at Leewood is required to operate at a higher than standard purge gas flow rate, it may be visible at night to nearby sensitive receivers. The operation of the flare at Bibblewindi at higher than standard flow rate is not likely to be visible to sensitive receivers as there are no sensitive receivers in close proximity to the flare.

The pilot well flares and safety flares are unlikely to cause an impact on the long-term operation of the observatory at Siding Spring. 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.

Consultation with relevant representatives from Siding Spring Observatory has indicated the potential for impacts to observing conditions at the observatory as result of the project is negligible given the limited flame height of safety flares, the small number and dispersed location of potential pilot flares, and the minimal operational night lighting requirements.

If the safety flare is required to be operated at its full capacity at night, it may be visible at the observatory. However, the use of the safety flare to this extent is limited to during commissioning and maintenance activities and in non-routine situations, which are expected to occur infrequently. Accordingly, the landscape and visual impact assessment found that the pilot well flares and safety flares is unlikely to cause an impact on the long-term operation of Siding Spring Observatory.

The project would generate air emissions such as particulate matter (including dust) and nitrogen dioxide. These emissions have the potential to affect the clarity of the night sky and therefore the observing conditions at Siding Spring Observatory. The concentration of these and other emissions were assessed to comply with the relevant air quality standards and would generally decrease with distance from source to become indistinguishable from surrounding air quality. Impacts to observing conditions at Siding Spring Observatory are therefore not predicted. Air emissions are discussed further in Chapter 18.

23.4 Significance assessment

Table 23-5 summarises the significance assessment undertaken for the potential impacts of the project on landscape and visual values. For each identified potential impact, the assessment considered:

- the potential significance of the impact
- the mitigation measures that would be used to manage the potential impact on landscape and visual values
- the residual significance of the potential impact after the implementation of mitigation measures (the residual significance takes into account the potential for impact that remains after the mitigation measures are applied).

Lighting impacts were incorporated into the significance assessment of adverse visual effects on sensitive receivers, as shown in Table 23-5. This is consistent with the assessment method used in Appendix Q.

Table 23-5 Environmental significance assessment

Potential impact	Infrastructure	Phase	Pre-mitigated significance			Mitigation and management measures	Residual significance		
			Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
Adverse visual effects on sensitive receivers (including lighting impacts)	Leewood	Construction	Moderate–low	Low–negligible	Low–negligible	Land Access Agreements and Farm Management Plans will be developed in consultation with affected landholders. Existing roads, tracks and disturbance corridors for construction and operational access and the placement of linear infrastructure, will be utilised where practicable. Lighting will 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*, as applicable.	Moderate–low	Low–negligible	Low–negligible
		Operation	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
		Decommissioning	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
	Bibblewindi	Construction	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
		Operation	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
		Decommissioning	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
	Infrastructure corridors	Construction	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
		Operation	Moderate–low	Negligible	Negligible		Moderate–low	Negligible	Negligible
		Decommissioning	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
	Westport camp	Construction	Moderate–low	Negligible	Negligible		Moderate–low	Negligible	Negligible
		Operation	Moderate–low	Negligible	Negligible		Moderate–low	Negligible	Negligible
		Decommissioning	Moderate–low	Negligible	Negligible		Moderate–low	Negligible	Negligible

Potential impact	Infrastructure	Phase	Pre-mitigated significance			Mitigation and management measures	Residual significance		
			Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
	Gas field (wells and gathering system)	Construction	Moderate–low	Moderate–negligible	Moderate–negligible	The design and operation of night lighting will consider the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (NSW Department of Planning and Environment 2016) Lighting will be focused on work sites during construction and on project infrastructure during operation to minimise light spill into adjoining areas. Reasonable and feasible measures will be adopted to minimise light impacts from flaring.	Moderate–low[a]	Negligible[b]	Negligible
		Operation	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
		Decommissioning	Moderate–low	Moderate–negligible	Moderate–negligible		Moderate–low	Negligible[b]	Negligible
	Gas field (telecommunication towers)	Construction	Moderate–low	Moderate–low	Moderate–negligible		Moderate–low	Low[b]	Negligible
		Operation	Moderate–low	Moderate–negligible	Moderate–negligible		Moderate–low	Negligible[b]	Negligible
		Decommissioning	Moderate–low	Moderate–low	Moderate–negligible		Moderate–low	Low[b]	Negligible
Adverse impacts to landscape character generally		Construction	Moderate–low	Moderate–negligible	Moderate–negligible		Moderate–low	Moderate–negligible	Moderate–negligible
		Operation	Moderate–low	Low–negligible	Low–negligible		Moderate–low	Low–negligible	Low–negligible
		Decommissioning	Moderate–low	Moderate–negligible	Moderate–negligible		Moderate–low	Moderate–negligible	Moderate–negligible

Potential impact	Infrastructure	Phase	Pre-mitigated significance			Mitigation and management measures	Residual significance		
			Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
						A Rehabilitation Plan and a Decommissioning Plan which build on the Rehabilitation Strategy (Appendix V) and Decommissioning Strategy (Appendix W) will be developed and implemented over the life of the project.			

[a] The majority of sensitive receivers in the project area are considered as having a moderate to low sensitivity as generally views would be screened or short term. It is anticipated that given the flexibility in locating well pads and associated infrastructure and the involvement of the landholder locating infrastructure on their property, the locations selected would minimise visual impacts. It is possible that a landholder may choose to locate infrastructure in a visible location and in that scenario the visual sensitivity would consequently be higher than identified in this table.

[b] No well would be located without agreement of a landholder. It is possible however that a landholder chooses to accept a reduced level of amenity and consequently visual impacts could be higher than identified within this table.

23.5 Conclusion

Mitigation and management measures that would be implemented to minimise landscape and visual impacts would include: consulting with landholders on the location of infrastructure on private property; using existing roads, tracks and disturbance corridors for construction, operational access and the placement of linear infrastructure (where practicable); designing outdoor lighting in accordance with applicable standards; minimising light spill beyond construction boundaries; and implementing reasonable and feasible measures to minimise light impacts from flaring.

The implementation of mitigation and management measures would be appropriate to control and minimise the potential impacts of the project. The significance of the residual impacts for each infrastructure component for the construction, operation and decommissioning phases of the project are summarised in Table 23-6.

Table 23-6 Landscape and visual significance of residual impacts

Potential impact	Infrastructure	Residual significance		
		Construction	Operation	Decommissioning
Adverse visual effects on sensitive receivers (including lighting impacts)	Leewood	Low–negligible	Low–negligible	Low–negligible
	Bibblewindi	Low–negligible	Low–negligible	Low–negligible
	Infrastructure corridors	Low–negligible	Negligible	Low–negligible
	Westport camp	Negligible	Negligible	Negligible
	Gas field (wells and gathering system)	Negligible	Low–negligible	Negligible
	Gas field (telecommunication towers)	Negligible	Negligible	Negligible
Adverse impacts to landscape character generally		Moderate–negligible	Low–negligible	Moderate–negligible