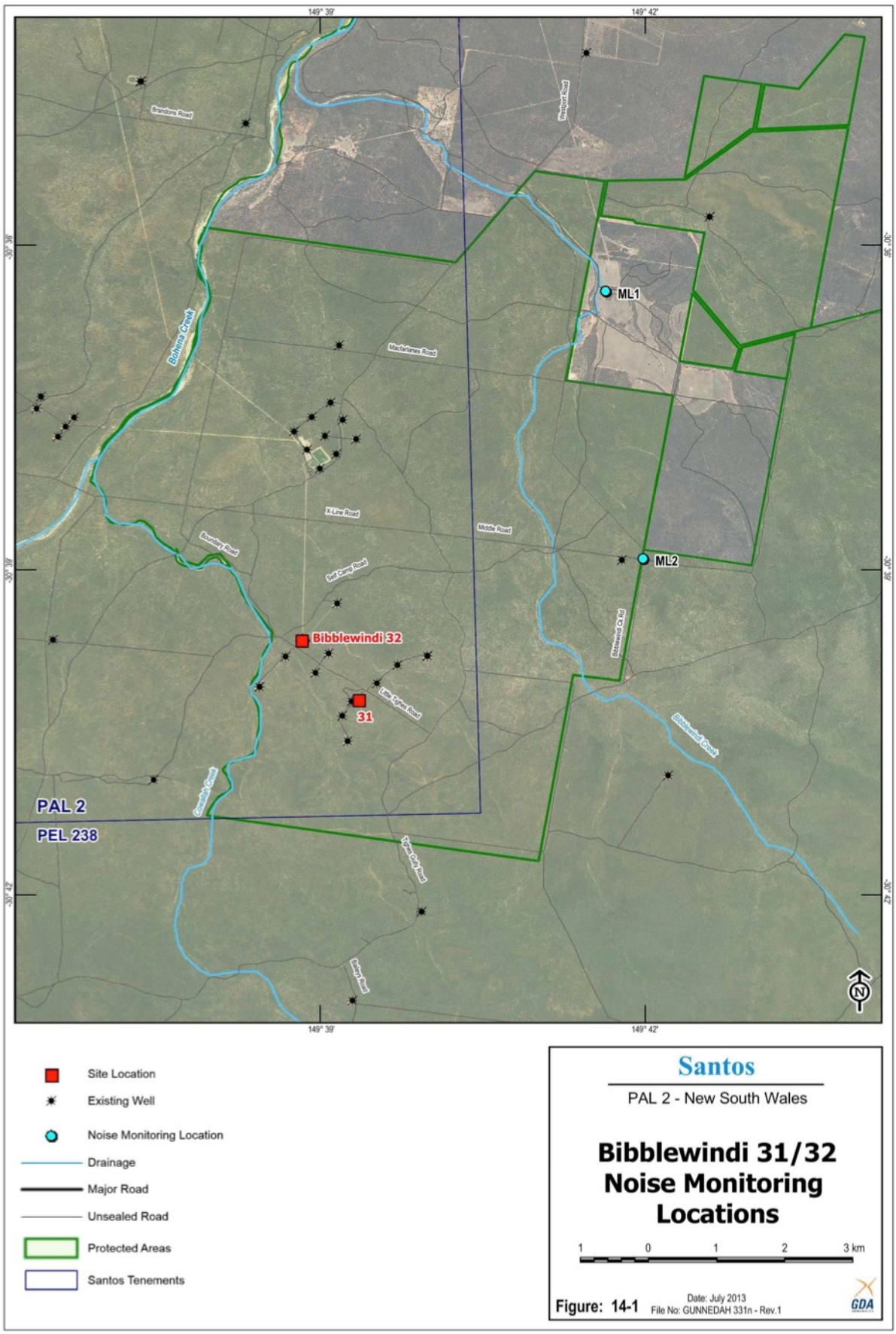

Figure 14-1 Noise monitoring locations (ML1 and ML2)

14.2.1 Noise assessment criteria

For the purpose of the Noise Assessment, the proposed activity has been considered a mining activity. In accordance with the ICNG, the construction activities for mining projects are to be assessed under the INP.

The INP assessment procedure for industrial noise sources has two components, which are:

- Controlling intrusive noise impacts in the short term for residences
- Protecting noise amenity for particular land uses and for residences

These two components are discussed below.

14.2.1.1 Intrusive noise impacts

The INP states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous level of noise from the source, measured over a 15 minute period, does not exceed the RBL, measured in the absence of the source, by more than five dB(A). This is termed the 'intrusiveness criterion'. For the proposed activity, this is LA_{eq} 35 dB(A).

14.2.1.2 Protecting noise amenity

To limit continuing increases in noise levels, the ambient noise level resulting from industrial type noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. That is, the industrial noise level contribution should not exceed the level appropriate for the particular locality and land use. This is termed the 'amenity criterion'. Table 14-2 identifies recommended amenity criteria noise levels for different land uses. Most applicable to this assessment are the amenity criteria for residential receptors in a rural area and passive recreation areas.

The recommended maximum values provide guidance on an upper limit to the level of noise from industry and industrial type facilities. In all cases, it is expected that all feasible and reasonable mitigation measures would be applied before the recommended upper limit noise levels are referenced.

Table 14-2 Recommended LA_{eq} noise levels from industrial noise sources

Type of Receptor	Indicative noise amenity area	Time of day	Recommended LA_{eq} noise level dB(A)	
			Acceptable	Recommended upper limit
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55

Although passive recreation areas are located in the surrounds of the site, public access to specific areas within the forest, where construction and operation works are proposed, would be restricted for safety reasons. Therefore State forest areas are not considered passive recreation areas for the purpose of this assessment.

14.2.1.3 Sleep disturbance criteria

The INP recommends an amenity criterion of 40 dB(A) LA_{eq} for night-time (10.00 pm to 7.00 am) at a residence in a rural area. The INP application notes recommend that the LA_1(1 minute) noise level outside a bedroom window should not exceed the LA_{90} background noise level by more than 15 dB(A) during the night-time period.

14.2.1.4 Construction noise criteria

The noise management level for works during the recommended standard hours is background plus an additional 10 dB(A). Above this noise level the proponent needs to implement all feasible and reasonable work practices, as defined in the ING, to minimise noise impacts.

14.3 Potential impacts

14.3.1 Modelling results

Noise modelling was undertaken for different weather scenarios both during construction and operation.

During construction, under all-weather scenarios, noise levels from construction will be less than 13 dB(A) beyond five kilometres from the drill rig. Given that all receptors are located beyond five kilometres construction noise would not be audible.

During operation, noise levels will also be well below guideline levels for intrusive noise (35 dB(A)), noise amenity (40-50dB(A)) and sleep disturbance (40 dB(A)) as summarised in Table 14-3.

Table 14-3 Noise modelling results during operation (LA_{eq})

Resident ID	Distance from the site (km)	Predicted noise levels dB(A)		
Scenario		Calm weather	Southerly winds	Temperature Inversion
RR1	8.3	16	24	17
RR2	9.2	15	23	16
RR3	9.5	15	23	16
RR4	8.2	17	25	18
RR5	7.5	18	26	19

14.3.2 Traffic noise

Noise levels associated with the increase in traffic due to the proposed activity would be minimal with all construction vehicles and equipment to be delivered during the beginning of the construction works and collected upon completion. Between these times, equipment will generally remain on site.

Offsite road impacts are therefore considered negligible (less than 0.1 dB(A)) and will meet the *EPA Environmental Criteria for Road Traffic Noise* (EPA, 1999).

During operation, traffic volumes would be less and would still be considered negligible.

14.4 Cumulative impacts

Noise impacts, are confined to a local area surrounding the well. Other wells within the E&A Program that will operate concurrently are all located at distances that would not create a cumulative impact.

During drilling, a maximum of two drilling rigs will be in operation. The E&A Program ensures that the two drill rigs will operate at sufficient distances to eliminate any cumulative noise impacts.

14.5 Mitigation measures

The following measures will be carried out prior to and during construction to minimise the potential noise impacts on receivers:

- Forestry Corporation of NSW to be notified prior to the proposed activity commencing. This will include details of the timing and duration of noise generating activities.
- In the event of a noise complaint, the source of the noise will be investigated. Where necessary, Santos will offer to conduct noise monitoring from the proposed activity at the affected receiver. If it is determined that noise levels are unacceptable, further feasible and reasonable work practices or mitigation measures will be implemented.

15.0 Traffic and Transport

An assessment of the potential traffic and transport impacts was prepared by GTA. This chapter provides a summary of the *Traffic and Transport Assessment*, with the report provided at Appendix 7.

15.1 Existing environment

15.1.1 Road Network

The existing road network that will service the site includes:

- Newell highway (State road)
- X-Line Road (unsealed forestry road)
- Tighes Gully Road (unsealed forestry road)
- Little Tighes Road (unsealed forestry road)
- existing unsealed access tracks located at the site.

Travel between the site, Narrabri and the drillers camp will occur during the proposed activity.

15.1.1.1 Westbourne drillers camp

Access to and from the drillers camp will be via Westport Road which intersects the Newell Highway (approximately 25 kilometres) north of X-Line Road. Alternate routes are via McFarlanes Road, Garlands Road, Boundary Road, Nickel Road, Bibblewindi Creek Road, Tighes Gully Road and X-Line Road to the south.

15.1.1.2 Narrabri Operations Centre

During the drilling of Bibblewindi 31 and 32 drilling fluid will be tankered to and from the NOC, located in Narrabri. The NOC is accessed via one driveway from Yarrie Lake Road. Yarrie Lake Road is identified as a local road and is aligned in a north southwest direction. The nearest State controlled road is the Newell Highway, located approximately 2.6 kilometres to the south east of the site.

Vehicle access between the NOC and the site will be via the Newell Highway.

15.1.2 Traffic volumes

Recent traffic volumes collected for the Newell Highway approximately 20 kilometres south of Narrabri and 20 kilometres north of X-Line Road are shown in Table 15-1. Traffic flows are relatively consistent across the day time period of 8 am to 4 pm and are in the order of 140 vehicles per hour. Full survey data is provided in Appendix 7.

Table 15-1 Traffic volumes for the Newell Highway

Detail	Volume[1]
Average daily traffic	1,860 vehicles
Proportion heavy vehicles	742 vehicles (39.9 %)
7 day average peak hour	134 vehicles
Highest average peak hour	156 vehicles
[1]Tube count data collected between September 2011 and November 2011 Source: Narrabri Shire Council	

15.2 Assessment approach

A conservative approach was adopted to identify the potential impacts of the proposed activity. Traffic generation was calculated using estimated traffic volumes and adopting a theoretical peak period thought to occur on days where there would be worker rotation at the site in combination with construction vehicle deliveries. It was noted that the frequency of such peak events would be low and typical daily volumes would be significantly lower.

Traffic volumes and types of trips are provided in Table 15-2 and traffic routes in Figure 4-3. Now new river crossings or upgrades to existing crossings (as shown in Figure 4-3) are proposed as all movements will be confined to existing Forest roads. Vehicle types would typically be heavy vehicles with the largest vehicle equivalent to a 19 metre rigid truck. During operation, vehicle types would generally by 4WD or passenger size vehicles.

Table 15-2 Estimated construction traffic volumes for Bibblewindi 31 and 32

Construction Activity	Approximate duration	Maximum vehicle trips per day	Estimated vehicle trips per peak hour[1]
Site preparation	20 days	15[2]	<5
Drilling and completions	35 days	10	<5
Surface facilities[3]	50 days	5-10[3]	<5
1 Peak hour defined as the maximum number of vehicles likely to be generated in any given hour by construction related vehicles 2 Includes one trip generated by workers during the site preparation activity 3 Includes three trips generated by workers during the surface facilities activity. It is anticipated that three vehicles of 4 workers would be generated over the 50 day period.			

15.3 Potential impacts

15.3.1 Construction

All construction vehicles and equipment will be delivered during the beginning of the construction works and collected upon completion. At these times delivery and collection of equipment will have an impact on the external road network. Between these times, equipment will remain on site.

Access to the site for all construction vehicles will be from the Newell Highway and a number of unsealed forestry roads including X-Line Road, Tighes Gully Road and Little Tighes Road. This access route currently exists and services the Bibblewindi Multi-Lateral Pilot.

15.3.2 Capacity

Capacity constraints generally occur at intersections where there are opposing traffic movements. As construction vehicles will enter the Forest via X-Line Road, the intersection with Newell Highway will be impacted. However given the low volumes of traffic, and capacity of Newell Highway to accommodate

additional vehicles, it is expected that the existing road network will accommodate the increase in traffic with minimal disruption.

The *Guide to Traffic Management Part 2: Traffic Theory* (Austroads, 2009) provides further guidance when assessing the impacts associated with increased traffic volumes, which has been referenced in assessing the anticipated increase in truck volumes at the intersection of the Newell Highway and X-Line Road. During a weekday peak period, a vehicle will pass X-Line Road along the Newell Highway every 20-30 seconds. A single vehicle exiting X-Line Road would require a gap of around 7-8 seconds to enter the Newell Highway traffic stream. On this basis the intersection would be capable of safely accommodating the anticipated increase in vehicles associated with the construction works.

15.3.3 Efficiency

Efficiency is a measure of the ease of travel between an origin and destination, primarily relating to travel times, delays and vehicle kilometres travelled. No changes to the operation of the local roads used (such as detours or realignment) are proposed. Construction traffic is proposed to use the most direct route(s) capable of accommodating the proposed activity. In combination with the existing low volumes of traffic on X-Line Road and Tighes Gully Road and the low volumes of traffic generated during construction, road network efficiency will not be reduced.

15.3.4 Functionality

Functionality relates to the geometry and surface of roads and intersections to accommodate heavy vehicles.

The existing intersection configuration at the Newell Highway and X-line Road is capable of accommodating vehicle sizes up to 19m. As such, the access to the site via X-line Road would be adequate to accommodate the proposed construction activity and an intersection upgrade at this location would not be required.

In addition to the above, no changes to the existing operation of intersections (such as turning movement restrictions) are proposed.

15.3.5 Safety

Additional traffic using forest roads could increase the occurrence of crashes. Safe driving methods will be implemented in the forest including:

- traffic speeds to be below 80 kilometres per hour unless otherwise signed
- an in vehicle monitoring system (IVMS) will be installed on all Santos vehicles to monitor driver behaviour.

All site staff and delivery drivers would receive the appropriate induction (consistent with Santos policies), which would include driver protocols and identification of any local hazards.

15.3.6 Operation

The pilot is anticipated to operate for up to three years, with a similar number of staff to current operations once the drilling of Bibblewindi 31 and 32 are complete. Typically one to two staff members will visit the site daily during operation for monitoring and maintenance activities.

Operational activities would be primarily between the hours of 7 am to 5 pm 7 days a week with the workforce located in the local Narrabri area.

Given the very low volumes, the existing road network will easily accommodate the additional traffic without any additional mitigation.

15.4 Cumulative impacts

Cumulative impacts would generate additional temporary traffic volumes during construction and operation of the E&A Program. Given the existing traffic volumes on the Newell Highway and the distribution of vehicles over the day, the anticipated traffic generation (typical and maximum) will have a minimal impact on the Newell Highway and the surrounding road network. As such it is predicted that the Newell Highway will continue to operate at or near a Level of Service B, with negligible ongoing delays to highway traffic as a result of the E & A Program.

15.5 Mitigation measures

15.5.1 Construction

- Vehicles within the forest will not travel at speeds greater than 80 kilometres per hour unless otherwise signed.
- An in-vehicle monitoring system (IVMS) will be fitted to all Santos vehicles.
- Construction vehicle movements will be restricted to designated routes to/ from the site via the Newell Highway
- Construction vehicle activity will be managed and controlled in the vicinity of the site
- Any damage to roads caused by construction activities would be repaired at Santos cost in accordance with the Permit to Occupy.

15.5.2 Operation

No site-specific mitigation measures are proposed or required.

16.0 Waste

16.1 Existing environment

The *NSW Waste Avoidance and Resource Recovery Strategy 2007* (DECC, 2007a) (Waste Strategy) sets out principles promoting the adoption of measures which avoid unnecessary resource consumption and encourage resource recovery, including reuse, reprocessing, recycling and energy recovery. Four key areas are identified where outcomes must be achieved in order to avoid and manage waste. These are:

- Preventing and avoiding waste
- Increasing use of recovery and use of secondary materials
- Reducing toxicity in products and materials
- Reducing litter and illegal dumping.

Waste management measures implemented for the proposed activity will encourage efficient resource use alternatives, re-use and recycling. Waste that cannot be re-used or recycled will be disposed of in an appropriate manner.

The EPA's *Waste Classification Guidelines* (DECCW, 2009) describe a number of waste streams and provide specific direction on the classification of wastes, based on chemical composition and associated environmental impacts. Waste streams require different management, transportation and disposal depending on their classification. The six waste stream categories are:

- Special waste (e.g. clinical and related, asbestos and tyres)
- Liquid waste
- Hazardous waste (e.g. waste with pH less than two, coal tar, lead paint waste)
- Restricted solid waste
- General solid waste (putrescibles) (e.g. household wastes, manure, food wastes)
- General solid waste (non-putrescible) (e.g. glass, plastic, rubber, garden waste)

16.2 Potential impacts

The proposed activity will generate a number of waste streams. Waste will predominantly be generated during the construction phase including:

- drilling activities
- site clean up
- general waste from contractors and personnel on site.

16.2.1 Construction

The main waste types and estimated volumes generated by the proposed activity during construction are identified and classified according to the Waste Classification Guidelines in Table 16-1. Where possible, waste will be reduced or recycled with waste separated into bins on the lease area to facilitate transfer to appropriate treatment facilities. Specific reuse activities will be put in place for drilling fluids and cuttings, these are described in detail in Section 4.3.

Potential impacts associated with the generation and disposal of these wastes include:

- leaching of chemicals and other pollutants into groundwater, soils or surface water
- pollution or contamination of land or water due to illegal dumping of waste, lack of suitable containment of waste
- littering of the site, surrounding properties or surface waters due to lack of suitable containment of waste
- odours caused by improper storage or treatment of putrescible waste
- addition to landfill.

Table 16-1 Classification of potential waste generated from the proposed activity during construction

Classification	Type	Estimated Volume	Disposal Option
Liquid waste	Drilling fluid	400 m^3	Transported by a licensed contractor to a Santos operated fluids treatment facility at Narrabri or an appropriately-licensed disposal facility.
	Drilling fluid-contaminated cement slurry	45 m^3	Transported by a licensed contractor to an appropriately-licensed disposal facility.
	Produced water	300 m^3	Transported by a licensed contractor to the Leewood Produced Water Facility or an appropriately-licensed facility.
	Fuels, engine coolant and hydrocarbon residuals	< 100 L	Transported by a licensed contractor to an appropriately-licensed disposal facility.
	Human waste including pump out waste and sewage[1]	<30 m^3	Transported by a licensed contractor to an appropriately-licensed disposal facility.
General solid waste (putrescible)	General waste including food waste from personnel and non recyclables	< 20 m^3	Transported to the Narrabri Waste Management Facility.
General solid waste (non-putrescible)	Drill cuttings[2]	195 m^3	Re-use on site (under Naturally Excavated Material (NEM) exemption) or transported by a licensed contractor to an appropriately-licensed disposal facility.
	Drained oil filters, empty oil containers and oil absorbent materials that do not contain free liquids, plastics (e.g. packaging, pipe caps), concrete wastes, cured resins, paints, glues, etc.	< 40 m^3	Transported by a licensed contractor to an appropriately-licensed disposal facility.
	Recyclables including glass, PET bottles, aluminium, scrap metal (e.g. pipe cuttings), rope spacers, paper and cardboard	< 20 m^3	Transported to the Narrabri Waste Management Facility for sorting and recycling.

[1]Sewage waste from toilet facilities provided for workers during their shift. Camp facilities will not be located on site.

[2] It is expected that drill cuttings will consist of Naturally Excavated Material (NEM) and can be used in site rehabilitation under the NEM exemption issued by the EPA on 19 October 2012. If required, drill cuttings will be tested using the bulk sampling technique for NEM, and if found to exceed the limits set by the NEM exemption, will be classified and treated as general solid waste (putrescible).

16.2.2 Operation

Waste generated during operation of the Bibblewindi Multi-Lateral Pilot will consist predominantly of produced water. The estimated maximum rate of produced water from the pilot is 581 cubic metres per day, while the estimated average rate is 260 cubic metres per day.

Potential risks associated with the generation and disposal of produced water relate to the treatment of this quantity of water, and the possibility of infrastructure failure and resultant potential impact of the produced water on groundwater, soils or surface water.

Some waste will be generated through the undertaking of maintenance works, including potential workovers of the wells as per standard industry practice. It is considered that the volumes of waste generated from these activities will be minimal. As an estimate, during a workover it is likely that 75 to 125 cubic metres of water would be produced per well. This would be trucked (approximately three to five trailer loads) to the Leewood Produced Water Facility or a suitably licensed facility.

16.3 Cumulative impacts

16.3.1 Construction

The main waste types and estimated volumes generated across the drilling program during construction are identified in Table 16-2.

Potential cumulative impacts associated with the generation and disposal of these wastes mainly relate to addition to landfill and capacity of management, disposal or recycling facilities to cope with the volumes produced.

Table 16-2 Estimated cumulative waste volumes during construction

Waste Type	Estimated Volume				
	Dewhurst 13–18	Dewhurst 22–25	Dewhurst 26–31	Bibblewindi Multi-Lateral	Total
Drilling fluid (m^3)	450	450	775	400	2,075
Drilling fluid-contaminated cement slurry (m^3)	115	115	160	45	435
Produced water	300	300	+200	300	1,100
Fuels, engine coolant and hydrocarbon residuals (L)	< 100	< 100	< 100	< 100	<400
Human waste including pump out waste and sewage (m^3)[1]	<30	<30	<30	<30	<120
General waste including food waste from personnel and non recyclables (m^3)	< 20	< 20	< 20	< 20	<80
Drill cuttings (m^3)[2]	150	780	880	195	2,005
Drained oil filters, empty oil containers and oil absorbent materials that do not contain free liquids, plastics (e.g. packaging, pipe caps), concrete wastes, cured resins, paints, glues, etc. (m^3)	< 40	< 40	< 40	< 40	<160

Waste Type	Estimated Volume				
Recyclables including glass, PET bottles, aluminium, scrap metal (e.g. pipe cuttings), rope spacers, paper and cardboard (m^3)	< 20	< 20	< 20	< 20	<80

[1]Sewage waste from toilet facilities provided for workers during their shift. Camp facilities will not be located on site.

[2] It is expected that drill cuttings will consist of Naturally Excavated Material (NEM) and can be used in site rehabilitation under the NEM exemption issued by the EPA on 19 October 2012. If required drill cuttings will be tested using the bulk sampling technique for NEM, and if found to exceed the limits set by the NEM exemption, will be classified and treated as general solid waste (putrescible).

16.3.2 Operation

As stated previously, produced water will form the main waste component during operation. The estimated volumes of produced water for the operation of the E&A program are provided in Table 16-3.

Potential cumulative impacts associated with this produced water relate to treatment and transportation capability, and the possibility of infrastructure failure and resultant leakages of the produced water into groundwater, soils or surface water.

Table 16-3 Estimated cumulative pilot extraction rates

Pilot	Max Extraction (m^3/day)	Average Extraction (m^3/day)
Dewhurst 13–18	397	302
Dewhurst 22–25	273	260
Dewhurst 26–31	448	378
Bibblewindi Multi-Lateral	581	260
Bibblewindi West	209	85
Tintsfield 2–7	43	23
Total	**1,951**	**1,308**

16.4 Mitigation measures

16.4.1 Construction

Prior to commencement of the proposed activity, a waste management plan will be developed based on the waste reduction hierarchy of avoid, reduce, reuse, recycle, recover, treat and dispose.

The waste management plan will identify:

- types of waste generated
- waste management processes and procedures for each waste stream
- waste transport requirements
- monitoring requirements
- audit and inspection requirements
- record keeping and reporting requirements.

The most significant waste types and volumes will be generated during drilling, and would therefore be temporary in nature. The management approach for drilling fluid and solids (cuttings) has aimed to reduce waste to landfill as much as possible.

16.4.1.1 Drilling fluid management

It is expected that the FTF will be licenced and operational by the time Bibblewindi 31 and 32 are drilled. Drilling fluids will be mixed at the FTF and then transported to site. This will reduce wastes associated with mixing chemicals on site (such as chemical containers). Drilling fluid management is discussed in Section 4.3.3.3.

During drilling, used fluids will be separated into liquids and solids (cuttings) and fluids will be continuously reused throughout the drilling process. Once the well has been drilled the drilling fluid is displaced from the well by the cementation process or by production fluids.

Where the FTF is operational the residual volume of fluid will be tested prior to being removed from the site by a contractor licensed under the POEO Act to transport trackable wastes. It will be transported to a subsequent well for re-use or back to the FTF for storage and treatment. Before drilling fluid is used on a subsequent well the chemical and physical properties are tested and the fluid amended as required.

Advice from the EPA indicates that a resource recovery exemption will not be required where drilling fluid is reused in the drilling process (i.e. at a new drill site).

There will be a residual amount of waste from the treatment facility in Narrabri which will eventually need to be disposed of at a licensed waste facility.

If the FTF is not licenced and operational, used drilling fluids will be disposed of at Transpacific Industries' liquid and hazardous waste management facility in Newcastle, NSW or another appropriately licenced facility. Approximately eight tankers will be required to transport the used drilling fluid from each well to the facility and required waste tracking requirements will be undertaken.

16.4.1.2 Drill cutting management

It is expected that drill cuttings will consist of NEM and can be used in site rehabilitation under the *Resource Recovery Exemption for Naturally Excavated Material* (NEM exemption) issued by the EPA on 19 October 2012.

Advice from the EPA indicates that where excavated material generated as part of well establishment or drilling is re-used on site from which it was generated, the activity will not trigger any waste licensing requirements. Therefore, a resource recovery exemption is not required in this case.

Drill cuttings will however be tested, if required. Typically, drill cuttings will be reused onsite for backfilling or site shaping. This will reduce the need to import additional fill and will reduce material which may otherwise go to landfill.

16.4.1.3 General waste management

In addition, the following measures will be carried out to minimise waste and potential impacts associated with waste generation and disposal:

- Management of waste, including its transport, will comply with the POEO Act and POEO (Waste) Regulation.
- The Waste Management Plan will be implemented, that will be based on the waste reduction hierarchy of avoid, reduce, reuse, recycle, recover, treat and dispose.
- General site waste will be segregated according to their classifications under the Waste Classification Guidelines and stored in bins or skips within a designated waste transfer point within the lease area prior to transportation for disposal.

- Regulated waste will be collected by licensed contractors for off-site disposal. General and recyclable waste will be transported to local council landfill and recycling facilities.
- Following completion of cementing, excess fluids and cement slurries will be segregated in steel waste tanks and removed and disposed of by a licensed waste disposal company.
- Sewage waste will be removed from the site by a licensed contractor for treatment and disposal, as required.
- Appropriate waste receptacles will be provided on site including covered rubbish bins for disposal of domestic wastes. These will remain during drilling activities.
- The type and volume of all waste removed from the site will be recorded.
- All staff and contractors will be made aware of waste management procedures during the site induction and through toolbox talks.
- Chemical, fuel and oil containers will be managed according to the MSDS or manufacturers' directions to avoid potential impacts to the environment or human health.

16.4.2 Operation

The main waste stream during operation will be associated with water produced from the wells. The produced water abstracted from the aquifer will be captured at the wellhead and transferred through the water gathering system to Bibblewindi 19H. As outlined in Section 4.4.2, the water will then be stored in a transfer tank and transferred by the existing pipeline to the Bibblewindi Water Transfer Facility, and then on to the Leewood Produced Water Facility.

Waste generated during maintenance works, including potential workovers is considered to be minimal and will be managed and disposed of using the same relevant methods as to those used during construction.

17.0 Hazards

17.1 Existing environment

Fire plays a major role in the ecology of the Pilliga scrub, with many plant species depending on fire to regenerate. However in unfavourable conditions fire can be extremely intense, destroy entire ecosystems, spread very quickly and threaten nearby properties.

The magnitude of historical Pilliga bushfires correlates with the El Nino Southern Oscillation phenomena, with El Nino (dry) years having the most severe fires (NPWS, 2006). In 1997 a major fire burned almost half of the Pilliga scrub, while an extremely dry winter and spring in 2006 saw a number of large fires develop. In January 2013, large fires threatened the Pilliga forest.

17.2 Assessment approach

The *State Environmental Planning Policy No 33 – Hazardous and Offensive Development* (SEPP 33) presents a systematic approach to planning and assessing proposals for 'potentially hazardous' and 'potentially offensive' development for the purpose of industry or storage. The Hazardous and Offensive Development Application Guidelines – Applying SEPP 33 (SEPP 33 Guideline) (DP&I, 2011) provide guidelines to assist consent authorities and proponents to establish whether an activity would fit into such definitions and hence, come under the provisions of SEPP 33.

17.2.1 Potentially hazardous industry

For an activity to be classified as 'potentially hazardous industry' the policy establishes a comprehensive test by way of a preliminary hazard analysis (PHA) to determine the risk to people, property and the environment at the proposed location and in the presence of controls. Should such risk exceed the criteria of acceptability, the development is classified as 'hazardous industry' and may not be permissible, depending on the local zoning.

In order to determine whether the proposed activity is a potentially hazardous industry, the risk screening method outlined in the SEPP 33 Guidelines was applied. The risk screening method is based on the potential for, and consequences of an explosion, fire, or release of toxic substances. It takes the following factors into account:

- the properties of the substances being handled or stored
- the conditions of storage or use
- the quantity involved
- the location with respect to the site boundary
- the surrounding land use.

The SEPP 33 Guideline provides a three-step risk screening method to assist consent authorities in determining whether a proposed development is potentially hazardous as outlined below.

(1) Identify hazardous materials and the type of hazard

(2) Group hazardous materials and total by class, activity and location

(3) Compare with screening threshold.

Step 1 has identified that a small quantity of a hazardous material (diesel) will be transported to and stored on the site (refer to Table 17-1). None of the chemicals that may be used in the drilling process or held on site during the drilling process are listed on Australian Dangerous Goods Code (ADGC) and therefore, for the purposes of the risk screening method, are not considered to be hazardous.

Step 2 of the risk screening method requires the distance of the material group to the nearest boundary. The distance is to be measured from those materials in the group located closest to the boundary. Given the proposed activity is within the State forest with no adjoining sensitive receivers or development that would be likely to be affected by potential hazards on the site, a separation distance of 50 metres has been adopted for the activity.

Table 17-1 List, volume, packaging and transport details of hazardous materials to be stored on site

Material	Australian Dangerous Goods Code (ADGC)	Packaging Group I, II or III (according to ADGC)	Volume transported to site (litres)	Mode of storage
Diesel	3	III	<0.10 tonnes	Tank

Step 3 requires the total quantity of hazardous material to be compared against the screening threshold within the SEPP 33 Guidelines which is shown at Figure 17-1. Based upon a separation distance of 50 metres, the proposal would only be within the 'potentially hazardous region' if the quantity of diesel transported to the site was around 1100 tonnes. Therefore the proposal does not comprise a potentially hazardous industry and a PHA is not considered to be necessary.

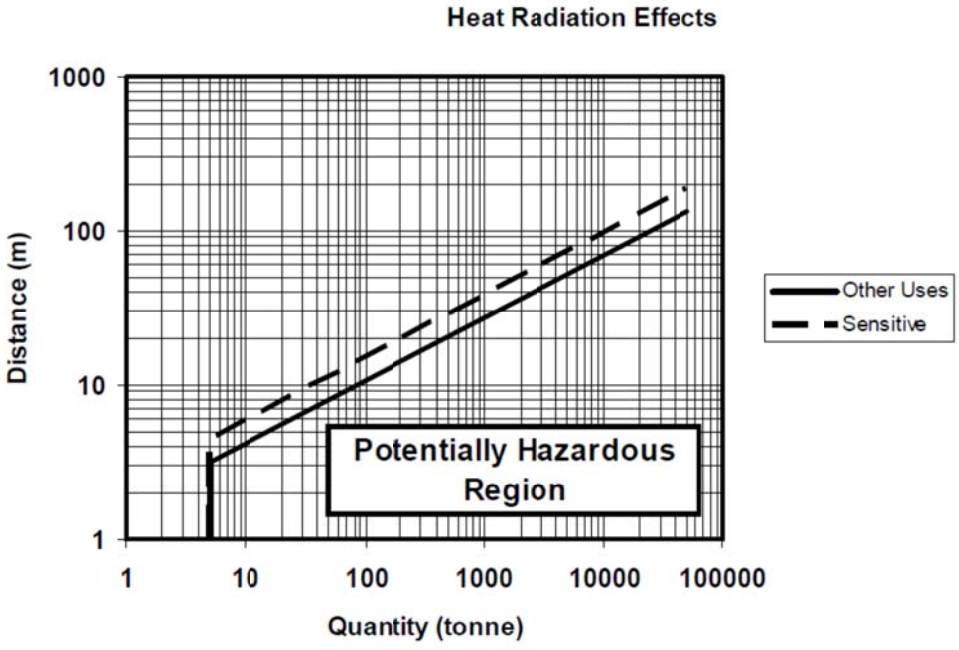

Figure 17-1 Screening threshold of the SEPP 33 Guidelines (DP&I, 2011)

17.2.2 Potentially offensive industry

The SEPP 33 Guidelines state that if a proposed activity requires a licence under any pollution control legislation the proposal should be considered to be potentially offensive. As discussed at Section 6.2.4, the proposed activity will require an EPL to be issued by EPA in accordance with the POEO Act. The key consideration in the assessment of a potentially offensive industry is that the consent authority is satisfied that there are adequate safeguards to ensure emissions can be controlled to a level at which they are not significant. If the consent authority is not satisfied, the proposal may be an offensive industry. The minimum test for such developments is meeting the requirements for licensing by EPA.

Santos is in the process of preparing the necessary applications for licensing under the POEO Act. The proposed activity will operate in accordance with the requirements of these EPLs. As such the proposal would not constitute an offensive industry and no further consideration of potentially offensive industry under SEPP 33 is required.

17.3 Potential impacts

17.3.1 Public safety and chemical use

The proposed activity will introduce a potential hazard to the site, such as moving vehicles, plant and machinery, and chemicals, fuels and oils. This could have safety implications for State Forest users.

The proposed activity will require the use of chemicals, fuels and oils, particularly during drilling activities. While these substances are not highly hazardous at the volumes which they are proposed to be used, potential impacts may occur due to their improper use, transport or storage, or in the event of an incident. Such impacts could include outbreak of fire, or pollution of land, water or air. Moving vehicles, plant and machinery may also introduce a potential hazard to the site, which may have safety implications due to the accidental ignition by vehicles or machinery.

Drilling fluid, containing a number of chemical additives, will be used during drilling as described in Section 4.3.3.2 of the EIS. The majority of chemicals would have no impact on the environment. Some of the chemicals to be used may have consequences to the environment if not used, stored or disposed of appropriately. However, the risk to the environment is considered to be low as chemicals will be stored on site in small quantities. Chemicals will be stored off the ground in an elevated trailer. The proposed activity will be short term and all chemicals will be used and disposed of in accordance with the relevant MSDS.

The risk to human health as a result of the chemicals is also considered to be low as site workers will wear and use the appropriate personal protective equipment and no members of the public will be able to enter the work area. Waste will be disposed of appropriately in accordance with relevant legislation.

No chemicals with added benzene, toluene, ethylbenzene, and xylenes (BTEX) will be used.

Dangerous goods will be transported according to regulatory requirements under the *Dangerous Goods (Road and Rail Transport) Act 2008.*

The impacts associated with spills and associated mitigation measures are covered in the discussion on soil quality (Section 8.4) and surface water quality (Section 10.4).

No radiation impacts are expected from the proposed activity.

As discussed at Chapter 16, a waste management plan will be prepared prior to construction to minimise potential from waste. Management of waste, including its transport, will comply with the *Protection of the Environment Operations Act 2007* (POEO Act) and *Protection of the Environment Operations (Waste) Regulation 2005* (POEO (Waste) Regulation).

17.3.2 Bushfire risk

Bushfire needs to be considered from two perspectives:

- the management activities required should a fire occur
- the risk that the proposed activity contributes to the lighting of a fire.

In the event of a bushfire a review and risk assessment will be conducted on drilling activities that have the potential to be exposed to the bushfire, with identified controls implemented to manage activity exposure. Santos has developed a bushfire management plan and an emergency response plan that details the broad responsibilities and duties of personnel during an emergency event such as a bushfire.

This bushfire management plan provides guidance on site responsibilities, actions, reporting requirements and resources required to ensure effective and timely preparedness is undertaken in the prevention of any bushfire incident or emergency at operations sites. The plan addresses the requirements of the Permit to Occupy which includes:

- Implementation of all reasonable precautions to minimize the risk of fire on the Occupation Permit Area and in particular in any facilities, building or structure on the Occupation Permit Area
- a fire tanker with capacity of not less than 400L on standby at all times together with adequate devices and appliances to prevent or retard the spread of fire
- any cleared vegetation other than merchantable logs is with the prior approval of Forestry Corporation of NSW removed from the occupation permit area and destroyed as directed by the Forestry Corporation of NSW
- no burning of timber, grass, cleared vegetation or other combustible matter is undertaken without the prior consent of the Forestry Corporation of NSW.

17.4 Cumulative impacts

Diesel will be used in plant during construction of the proposed activity and other activities as part of the E&A Program, and for maintenance activities during operation. There is potential for diesel to be spilled or leaked during transport, storage or use. However, these substances are stored and used in relatively small volumes and any spills or leaks are likely to remain localised. Therefore the potential for cumulative impacts as a result of hazardous substances is low.

There is potential for fire during the construction and operation phases of the exploration activities, particularly given the flammability of CSG, which could fuel a fire should there be any gas leaks near ignition sources. Provided bushfire prevention and mitigation measures (e.g. adequate asset protection zones) are implemented, it is unlikely that the exploration activities would alter current fire regimes across the site.

17.5 Mitigation measures

17.5.1 Construction

- Site safety protocols, incident management and emergency procedures will be implemented during the construction and drilling works.
- The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the pilot wells.
- Chemicals and potentially hazardous substances will be used and stored according to regulatory requirements including the *Work Health and Safety Act 2011*.
- Any dangerous goods will be transported according to regulatory requirements under the *Dangerous Goods (Road and Rail Transport) Act 2008*.
- Chemical, fuel and oil containers will be managed according to the MSDS or manufacturers' directions to avoid potential impacts to the environment or human health.

17.5.2 Operation

- Where feasible best practice bushfire risk management will be implemented.
- All statutory obligations for bushfire management will be met.
- An education program for staff and contractors regarding the risks from bushfires in consultation and collaboration with the NSW Rural Fire Service (RFS), Fire & Rescue NSW (FRNSW) and Forestry Corporation of NSW will be implemented.

18.0 Social and Economic

18.1 Existing environment

18.1.1 Social and Demographic overview

Social and demographic data based on the 2011 Australian Bureau of Statistics (ABS) Census was reviewed to identify any specific characteristics for the Narrabri LGA compared to NSW averages.

Based on 2012 ABS Estimated Resident Population (ERP) the population of the Narrabri Shire is approximately 13,564 people. This is an increase of approximately 89 people from the 2011 ERP figure.

The age distribution in the Narrabri LGA is indicative of a mix of young families with children as well as an ageing population. The lower proportion of residents aged 25 to 54 (which make up the majority of the working population) compared to the NSW average is reflective of the possible lack of job/career opportunities for this age bracket within the LGA.

The growth in new industries such as mining, and the local services required to support this growth, will help to not only diversify the economic base which is largely reliant on the agriculture sector of the region, but will also increase local skills in line with new employment opportunities. In order to attract younger working families to the region, provision of closer employment opportunities as well as range of opportunities is necessary. Investment in the mining industry and the resulting employment, both directly and indirectly, will provide additional job and career opportunities for the local population. The mining industry also typically results in higher wages than other industries and as such the addition of further job opportunities in this industry may help raise the current average household income levels of the Narrabri LGA.

With unemployment in the Narrabri LGA currently higher than the NSW average the addition of further employment opportunities for local residents associated with the proposed activity will have a positive impact on the current unemployment levels.

The *Narrabri Shire Economic Development Strategy* (Narrabri Shire, 2011) outlined future opportunities for the Narrabri Shire to help diversify its economy. This included the opportunity to leverage the mining sector to create further investment in the area as well as expand value adding uses such as mining services businesses locating in industrial land in the Shire.

18.1.2 Santos' role in the local community

18.1.2.1 Regional community benefit fund

As part of its commitment to the Narrabri community, Santos takes part in a local sponsorship program that benefits the local community. Approximately $300,000 is contributed annually by Santos. This money goes towards a mix of community wellbeing and health, education and youth, indigenous engagement and industry and environment. This program aims to enhance a range of local community networks and facilities. Figure 18-1 provides an indication of who the sponsorship is distributed.

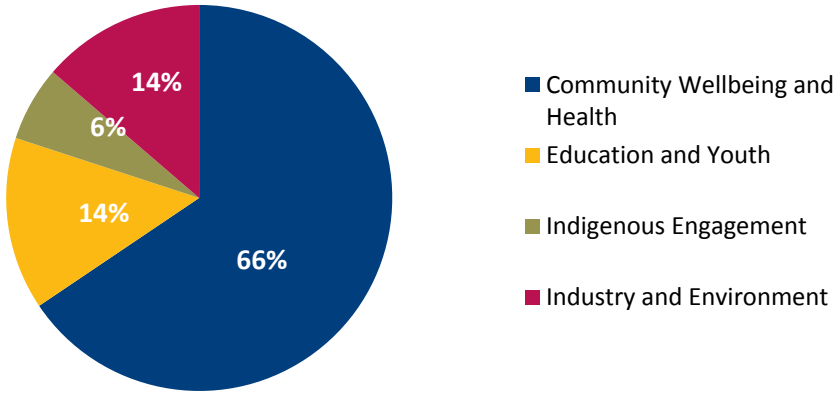

Figure 18-1 Santos sponsorship program

Moving forward, Santos has committed to contributing to the regional community benefit fund the equivalent of 5% of the royalty payment made to the NSW Government within the production licence area. This amount will then be matched by the Government. It is estimated that the fund could reach $300 million over the next two decades.

18.1.2.2 Social Infrastructure provision

Any additional population drawn to the area as a result of employment from the proposed activity is likely to be minimal, and catered for by the existing residential communities. Santos currently has 4 residences in the local area. These properties are rented to the local workforce.

The increased number of employees during drilling activities will be accommodated in the Westport Drillers Camp (refer Section 3.2.1.5). This is located approximately seven kilometres north of the proposed activity and will have capacity to accommodate 24 to 64 drillers at the camp site. The provision of this accommodation will help to mitigate any risks such as housing stress which could arise if the entry of these workers to the housing market started to limit housing supply and thus increasing rents.

18.1.2.3 Buy local program

Santos is implementing a buy local program that seeks to promote local contractors, services, equipment and products. Contractor forums have been held (refer section 5.3.5) to provide information of upcoming activities and to identify opportunities for local businesses.

Santos has estimated that approximately $0.8 million has already been spent in the last financial year on vehicle maintenance and leases, fuel and locally based contractors. This continued expenditure is likely to contribute both to the Narrabri economy and the wider northwest NSW region.

18.1.2.4 Employment

Santos employs 31 EFT people within its current operations in Narrabri and Gunnedah. All these staff are locally based. The local team are supported by employees within Sydney and Brisbane as part of Santos' Eastern Australia operations. On average an additional 12 employees visit the region per week.

18.1.2.5 Land access and compensation

Although not relevant to the proposed activity as it is located within the State forest, Santos has an established land access agreement protocol and a series of initiatives to support working with land owners.

18.2 Assessment approach

In order to determine the direct and indirect benefits of the proposed development RPS have devised an Input-Output model calculating economic and employment multipliers for different industries. The multipliers have been calculated in line with the methodology proscribed by the ABS in *Information Paper Australian National Accounts Introduction to Input-Output Multipliers* (Cat No 5246.0) (ABS, 1995) . The calculations utilise data from *Australian National Accounts: Input-Output Tables – Electronic Publication, 2007/08 Final* (Cat No. 5209.0.55.001) (ABS, 2007), namely Tables 5 and 20.

18.3 Potential impacts

18.3.1 Employment and other economic benefits

18.3.1.1 Direct employment

The proposed activity will see approximately 5.6 EFT direct jobs created during the construction and drilling phase of the project. This workforce is considered to comprise a mix of fly in fly out (FIFO) workers (4.2 EFT) as well as local residents (1.4 EFT) for the project. Once the proposed activity is operational an additional 2 EFT jobs for local residents will likely be created by the proposed activity. This workforce breakdown will see a much higher number of EFT jobs offered in the construction phases of the proposed activity compared to the operations stage of the proposed activity.

Any local based employees are anticipated to be sourced from Narrabri as well as nearby Gunnedah and Tamworth depending on the skills required for the job. Additional employment in the mining industry is in line with desired outcomes of the Narrabri Shire Economic Development Strategy and will provide employment opportunities for the growing local population.

18.3.1.2 Indirect employment

Based on capital investment of approximately $8.1 to $8.3 million the proposed activity is estimated to generate $5.3 to $5.5 million in output multiplier effect (ie. additional demand). This effect will lead to the creation of up to an additional indirect 16 jobs in the local and wider economy as part of this multiplier effect. It should be noted that these are preliminary projections and provide an indication of the potential additional economic and employment benefits the proposed development may have based on current inputs.

The proposed activity relies on a number of FIFO workers during drilling however this will still benefit the local and regional economy in a number of ways. The Westport Drillers camp will be serviced by local people and provisions, including food and fresh produce which are sourced locally. FIFO workers are also estimated to generate a local expenditure of approximately $25 per person per day on local businesses such as restaurants, cafes, cinema, hotels etc. This expenditure on local goods and services ensures that the benefits of the FIFO workforce of the proposed activity are passed along to local businesses and are not confined to the mining services sector.

18.3.1.3 Other impacts

The potential effects of the proposed on the economic and social fabric of Narrabri and its surrounding communities are summarised in Table 4 below. A '+' indicates a positive effect, a '0' a neutral or uncertain and a '-' a negative effect.

18.4 Cumulative impacts

The E&A Program will further increase local expenditure and employment opportunities. This would stimulate the local and regional economies through employment and investment in the region and contribute to diversifying the local economy. Santos is committed to working with local governments to ensure that these benefits are realised.

The proposed activity as part of the E&A program will lead to a net benefit for the local and regional community and possibly NSW as part of a growing CSG industry.

18.5 Mitigation measures

- Consultation activities will occur in accordance with Section 5 of the EIS.

Table 18-1 Proposed activity impact on economic and social indicators

Criteria			Impact	Comment
1	Economic Impacts	Increases or decreases retail and other services within the local area	0	No change to current situation
		Increases or decreases facilities within the local area	0	No change to current situation
		Better uses or makes redundant existing infrastructure	+	Makes use of existing infrastructure and is contained within existing development footprint
		Increases or decreases demand for local goods and services	+	Additional local jobs as part of the construction phase will increase household expenditure levels creating flow on economic benefits for local businesses and services
		Impact on existing economic land uses (commercial, tourism, etc)	0	No change to current situation
		Impact on existing energy supply	+	Proposed activity will contribute contribution to future domestic gas supply
2	Employment	Improves or reduces access to employment	+	Provision of more local employment during each phase of project
		Increases or decreases long term jobs (temporary or permanent)	+	Predominately short term employment opportunities during proposed activity however E&A Program may result in an increase in long term employment opportunities during production
		Impact on skills / education	+	Provision of local employment will assist in up-skilling, where education and qualifications are provided on-the-job.
		Safeguards or threatens existing jobs	+	Additional jobs will ensure existing mining related and supply services in Narrabri as well as the wider region have the opportunity to continue to employ people
4	Community Networks	Provides or reduces facilities or opportunities for social interaction	0	No change to current situation
		Improves or reduces community identity and cohesion	0	No change to current situation
		Improves or reduces existing residential amenity	0	No change to current situation
		Creates or removes physical barriers between homes and community facilities	0	No change to current situation.
		Impacts on disadvantaged social groups	+	Santos sponsorship program includes education and youth, and indigenous engagement
		Benefits or displaces disadvantaged groups	+	Sponsorship program benefits local youth and indigenous population through engagement and education

Criteria			Impact	Comment
		Consolidates or dislocates existing social or cultural networks	+	The sponsorship program will aim to engage and consolidate community and cultural networks through funding a variety of different categories
5	Public Realm	Safeguards or threatens heritage sites or buildings, or archaeological sites	0	No change to current situation
		Makes available / enhances or detrimental to public places / open space	0	No change to current situation
		Provides or displaces public facilities	0	No change to current situation
		Avoids or exhibits overdevelopment / large scale buildings	+	The proposed activity makes use of existing infrastructure and is entirely within the footprint of existing lease areas
6	Infrastructure	Increases or decreases housing stock	0	Drillers will be accommodated within the Westport drillers camp. Other FIFO workers will stay at local hotel/motel accommodation. As such no effect on local housing stock
		Increases or decreases stock of low income housing, or its affordability	0	No change to current situation
		Increases or decreases housing rental averages	0	No change to current situation
		Increases or decreases choice in housing	0	No change to current situation
		Increases or decreases provision of special needs housing	0	No change to current situation
		Increases or decreases the social mix of residents in the area	0	No change to current situation
7	Access	Decreases or increases distance from homes to local community facilities and services	0	No change to current situation
		Improves or reduces public transport services or access to such services	0	No change to current situation
		Improves or reduces access to local facilities for pedestrians, cyclists or the disabled	0	No change to current situation

19.0 Other issues

Whilst not identified as a key risk for the proposed activity, Cultural heritage was considered as part of the impact assessment.

19.1 Aboriginal cultural heritage

19.1.1 Existing environment

The REF prepared for the existing Bibblewindi Multi Lateral (ESG, 2008) included an assessment of risks to Aboriginal cultural heritage during establishment of the Bibblewindi 14 and 19H lease areas. The assessment included desktop searches of the Aboriginal Heritage Information Management System (AHIMS) maintained by OEH and the Aboriginal site register maintained by the Pilliga Forest Aboriginal Management Committee (PFAMC) and NSW Forestry, and the results of previous surveys of the broader PAL 2 area by PFAMC cultural heritage advisors. The assessment indicated that there was little risk of direct impacts to Aboriginal sites of significance as a result of the Bibblewindi Multi-lateral Pilot. To further minimise risks, ESG proposed that PFAMC heritage advisors survey each lease area prior to commencing works.

19.1.2 Assessment approach

An additional search of the AHIMS register and an archaeological inspection of the well leases and surrounding area were undertaken by RPS for due diligence purposes. The AHIMS search was undertaken on 15 October 2012. The archaeological survey was carried out by one archaeologist walking 5.0-10 metre wide transects on 27 November 2012.

The archaeological survey found that the Bibblewindi 14 and 19H well leases have been completely cleared of vegetation and topsoil. No Aboriginal objects, sites, places of significance or culturally modified trees were identified within the site or immediate surrounds. No evidence of Aboriginal objects or sites were identified along the tributary of Cowallah Creek. No Aboriginal objects or places recorded on the AHIMS were identified within 10 kilometres of the site. The potential for any previously unidentified Aboriginal objects or sites to be located within the site or immediate surrounds is considered to be nil to low.

19.1.3 Potential impacts

The proposed wells and ancillary infrastructure would be located entirely within the existing established Bibblewindi 14 and 19H well leases and would not impact on any previously identified Aboriginal cultural heritage sites or objects. There is very low potential for any previously unidentified Aboriginal sites or objects to be impacted.

19.1.4 Cumulative impacts

As cultural heritage impacts are site specific, there is no cumulative impact. The sites of proposed activities within the E&A Program will be/have been assessed for potential to impact Aboriginal cultural heritage.

19.1.5 Mitigation measures

The following measures will be implemented to reduce potential impacts on Aboriginal heritage:

- Project staff and contractors will be made aware of their statutory obligations to protect Aboriginal cultural heritage objects under the NPW Act, through the site induction and toolbox talks.
- All works will be undertaken to comply with Part 6 of the NPW Act.
- If any previously unidentified Aboriginal cultural heritage objects are identified during works, then such in

the immediate area will cease, the area will be cordoned off and the OEH Enviroline 131 555 will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed managed in accordance with relevant legislative and policy requirements.

- In the event that skeletal remains are uncovered, then works in the immediate area will cease, the area will be cordoned off and the NSW Police will be contacted. Should the NSW Police determine that the material is not recent, the OEH Enviroline 131 555 and relevant Aboriginal stakeholders will be contacted to determine an action plan for the management of the skeletal remains prior to works re-commencing.

19.2 Non-Indigenous cultural heritage

19.2.1 Assessment approach

Database searches of the World Heritage List register, Australian Heritage Database and the NSW State Heritage Inventory indicated that there are no listed items of National, State or Local heritage significance within the site or surrounding area. No heritage sites, relics or places of non-Indigenous cultural heritage value, or vegetation with natural heritage values, were recorded on the site during the archaeological survey undertaken by RPS on 27 November 2012.

19.2.2 Potential impacts

The project would not impact on any listed non-Indigenous cultural or natural heritage. There is limited potential for previously unidentified non-Indigenous cultural heritage items or relics to be impacted during the works.

19.2.3 Cumulative impacts

As cultural heritage impacts are site specific, there is no cumulative impact. All proposed activities within the E&A Program will be/have been assessed for cultural heritage impacts.

19.2.4 Mitigation measures

If any previously unidentified potential non-Indigenous cultural heritage material is identified during construction or drilling, then works in the immediate area will cease, the area will be cordoned off and the OEH Heritage Branch will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed and managed.

PART C

20.0 Statement of Commitments

Table 20-1 provides a statement of commitments for the proposed activity.

Table 20-1 Statement of commitments

Item	Commitment
Activity type	The Bibblewindi Gas Exploration Pilot Expansion (proposed activity) includes the construction and drilling of Bibblewindi 31 and 32 on the existing Bibblewindi 14 and Bibblewindi 19H well leases respectively, installation of surface infrastructure to connect the two wells to the existing Bibblewindi Multi-Lateral Pilot and operation of the Bibblewindi 31 and 32 wells as part of the Bibblewindi Multi-Lateral Pilot.
Location	The proposed activity is within PAL2, within the Bibblewindi State Forest.
Hours of operation	Hours of operation will be up to 24 hours a day, seven days a week.
Activity duration	Approximately 15 weeks construction and up to 3 years for operation of the wells.
Proposed commencement date	Works are scheduled to commence in Q2 2014
Maximum area of disturbance	Nil. The activity includes the construction and drilling of Bibblewindi 31 and 32 on the existing Bibblewindi 14 and Bibblewindi 19H well leases and access tracks.
Rehabilitation commitments and timeframes	Pilot well decommissioning and rehabilitation of the well lease areas and access tracks will occur within 6 months of abandonment. Pilot wells and ancillary infrastructure would be decommissioned and lease areas rehabilitated as outlined in Section 4.5.1 of the EIS.
Community consultation	▪ Community consultation will be undertaken in accordance with Chapter 5 of the EIS ▪ Advice to landholder will be provided 14 days prior to the proposed activity commencing ▪ Advice will be provided to relevant landholders that may be impacted by the activity 14 days prior to the proposed activity commencing ▪ Narrabri Shire Council will be consulted on a monthly basis where appropriate ▪ Updates on the proposed activity will be provided to the Narrabri Community Consultation Committee. ▪ Advertisements will be placed in the local media of the up-coming exploration and drilling activities. ▪ The local police will be notified of the proposed drilling activities and provided with a road traffic plan specifying the route, time and location of the drilling rig14 days prior to the drilling rig mobilising to site.
Land resources	Construction ▪ Excess topsoil and subsoil generated during site preparation activities will be stockpiled on site and used as backfill following completion of drilling. ▪ Erosion and sediment controls will be implemented where necessary during site preparation activities, in accordance with best management practices (such as the Blue Book or IECA Guidelines). These controls will be maintained until disturbed areas of the site are stabilised. ▪ The quantity of chemicals, fuels and oils stored on site will be minimised, where practicable. ▪ All additives, chemicals, fuels and oils stored on site will be kept in an appropriately secured, bunded storage shed in accordance with the relevant MSDS. ▪ Where there is a risk of contamination pits will be lined or material will be stored in surface tanks or metal bins. ▪ An MSDS register of all chemicals used or stored on site will be maintained.

Item	Commitment
	▪ Maintenance of vehicles, plant and equipment will occur off site at an appropriately licensed facility unless deemed necessary and appropriate to conduct such maintenance on site. ▪ Refuelling of plant and equipment will occur in a designated, bunded area, at least 40 metres from the nearest waterway. ▪ Any spills or leaks will be contained and cleaned up immediately using the spill kit. Contaminated material (such as contaminated soil or absorbent materials) will be placed in a bag and removed from the site for disposal at a licensed waste facility. ▪ Plant and equipment will be inspected daily to ensure these are properly maintained. Operation ▪ Ongoing management and maintenance of remaining infrastructure on site will occur, including water transfer area and well heads ▪ The gathering system water pressure will be monitored. Should line failure occur between the wells to the transfer tank at Bibblewindi Water Transfer Facility, operation of the well will be suspended until the problem is rectified. ▪ The site will be rehabilitated in accordance with Section 4.5.1 of the EIS
Groundwater	Construction ▪ The wells will be designed and constructed in accordance with the NSW Coal Seam Gas Code of Practice Well Integrity (DTIRIS, 2012b). ▪ Drilling and installation operations, well control, waste management and abandonment procedures for the pilot wells will be in accordance with accepted industry practices and in accordance with the processes outlined in the EIS. ▪ A driller that holds the relevant qualifications as defined by the NSW Office of Water will be on site during drilling of the top hole until the surface casing is set, cemented, and pressure tested. During this time, there will be 24 hour coverage by one person working the day shift and on call at site during the night. This will ensure that the appropriate knowledge of water legislation and regulation in NSW and technical skills are employed to avoid impacts to surface and groundwater sources. ▪ Excessive drilling fluid losses will be cured by loss circulation material (cellulose material such as sawdust or other benign naturally occurring substances, as required) to ensure most fluids return to the surface. ▪ Santos will make reasonable endeavours to seek permission (from landowners) to access registered groundwater bores within two kilometres of the site to undertake groundwater monitoring prior to drilling, to establish baseline conditions, and on completion of drilling, to determine if there are any impacts. Where access to bores is granted (and the bore is functioning), monitoring will include water level measurements and water quality observations in the field, and sampling for analysis by an accredited laboratory. Operation ▪ The volume of water extracted from the pilot wells will be monitored. ▪ Pressure gauges will be fitted to the pilot wells and monitored remotely through a Supervisory Control and Data Acquisition (SCADA) system. Should pressure change due to a leak, the pilot wells will be shut down immediately and the affected area investigated. ▪ The groundwater monitoring program will be implemented ▪ In line with monitoring during drilling, Santos will make reasonable endeavours to seek permission (from landowners) to continue monitoring of registered groundwater bores within two kilometres of the site to determine if there are any impacts to aquifers. ▪ The wells will be decommissioned as soon as they are no longer required.

Item	Commitment
Surface water	Construction ▪ Water will not be extracted from nearby watercourses, including Cowallah Creek or Mount Pleasant Creek. ▪ The existing diversion bund will be maintained on the up-slope side of the lease areas to divert clean water around the work area. ▪ Drilling fluids will be contained in surface tanks which will be regularly inspected and maintained. ▪ Water that drains to the cellar pit will be circulated with the drilling fluid throughout the drilling process. ▪ Should any formation fluid rise through the well, it will be captured in the waste fluid tank and will be removed to a licensed waste facility that is able to accept liquid waste for disposal or treatment. ▪ Drilling fluids will be transported to and from the site by an appropriately licensed contractor. ▪ Fuel and lubricants will be stored on site only when necessary and maintained off site whenever possible. ▪ Wastewater generated through general site activities will be removed by an appropriately licensed contractor for disposal at a licensed facility or treated to an appropriate quality prior to discharging. ▪ All areas storing or handling fuel, fuel using equipment, and chemicals will be bunded in accordance with Australian Standard 1940-2004; The Storage and Handling of Flammable and Combustible Liquids or other relevant guidelines. ▪ Weather forecast will be monitored and in the event that prolonged, severe wet weather of flooding is predicted, works will cease and plant, machinery and any chemicals will be secured and bunded. ▪ A minimum freeboard of 300 millimetres will be maintained for any tanks or pits containing liquid waste. Operation ▪ The surface infrastructure at the lease areas will be regularly inspected. ▪ The surface water monitoring program will be implemented.
Biodiversity	▪ The site boundary will be clearly demarcated to ensure that plant and vehicles keep within the approved area of disturbance ▪ The site will be rehabilitated in accordance with Section 4.5 of the EIS ▪ Construction and operational vehicles/plant will only travel on the designated access tracks. Site speed limits will be imposed to reduce the potential of fauna strike and to reduce dust generation. ▪ Weed management measures will be undertaken. ▪ Weed monitoring will occur throughout all phases of the proposed activity. Weed removal will be carried out as necessary.
Air quality	▪ Dust will be suppressed as required by spraying water along the access tracks and lease areas ▪ Site speed limits will be imposed to minimise dust generated by vehicle movements ▪ Vehicles, plant and equipment will be regularly maintained to ensure they are in good operating condition ▪ Vehicles, plant and machinery will be turned off when not in use rather than left idling ▪ Rehabilitation works, including landform establishment, will occur within 6 months of abandonment.

Item	Commitment
Greenhouse Gases	Construction ▪ Energy efficient equipment and processes will be used where possible. ▪ Water based drilling fluid will be used. ▪ Appropriate monitoring of emissions and consumables will be undertaken for legislative reporting requirements (such as to inform NGERS calculations). Operation ▪ Regular monitoring and maintenance of equipment and pipes to minimise fugitive emissions. ▪ A fugitive emissions monitoring program will be implemented in the E&A Program area. ▪ Appropriate monitoring of emissions and consumables will be undertaken for legislative reporting requirements (such as to inform NGERS calculations).
Noise	▪ Forestry Corporation of NSW to be notified prior to the proposed activity commencing. This will include details of the timing and duration of noise generating activities. ▪ In the event of a noise complaint, the source of the noise will be investigated. Where necessary, Santos will offer to conduct noise monitoring from the proposed activity at the affected receiver. If it is determined that noise levels are unacceptable, further feasible and reasonable work practices or mitigation measures will be implemented.
Traffic and Transport	▪ Vehicles within the forest will not travel at speeds greater than 80 kilometres per hour unless otherwise signed. ▪ An in-vehicle monitoring system (IVMS) will be fitted to all Santos vehicles. ▪ Construction vehicle movements will be restricted to designated routes to/ from the site via the Newell Highway ▪ Construction vehicle activity will be managed and controlled in the vicinity of the site ▪ Any damage to roads caused by construction activities would be repaired at Santos cost in accordance with the Permit to Occupy.
Waste	▪ Management of waste, including its transport, will comply with the POEO Act and POEO (Waste) Regulation. ▪ The Waste Management Plan will be implemented, that will be based on the waste reduction hierarchy of avoid, reduce, reuse, recycle, recover, treat and dispose. ▪ General site waste will be segregated according to their classifications under the Waste Classification Guidelines and stored in bins or skips within a designated waste transfer point within the lease area prior to transportation for disposal. ▪ Drill cuttings will be used for backfilling or site shaping during rehabilitation of the site, to reduce material which may otherwise go to landfill ▪ Regulated waste will be collected by licensed contractors for off-site disposal. General and recyclable waste will be transported to local council landfill and recycling facilities. ▪ Following completion of cementing, excess fluids and cement slurries will be segregated in steel waste tanks and removed and disposed of by a licensed waste disposal company. ▪ Sewage waste will be removed from the site by a licensed contractor for treatment and disposal, as required. ▪ Appropriate waste receptacles will be provided on site including covered rubbish bins for disposal of domestic wastes. These will remain during drilling activities. ▪ The type and volume of all waste removed from the site will be recorded.

Item	Commitment
	▪ All staff and contractors will be made aware of waste management procedures during the site induction and through toolbox talks. ▪ Chemical, fuel and oil containers will be managed according to the MSDS or manufacturers' directions to avoid potential impacts to the environment or human health.
Hazards	Construction ▪ Site safety protocols, incident management and emergency procedures will be implemented during the construction and drilling works. ▪ The site will be kept in a clean and tidy manner during site preparation, drilling activities and operation of the pilot wells. ▪ Chemicals and potentially hazardous substances will be used and stored according to regulatory requirements including the Work Health and Safety Act 2011. ▪ Any dangerous goods will be transported according to regulatory requirements under the Dangerous Goods (Road and Rail Transport) Act 2008. ▪ Chemical, fuel and oil containers will be managed according to the MSDS or manufacturers' directions to avoid potential impacts to the environment or human health. Operation ▪ Where feasible best practice bushfire risk management will be implemented. ▪ All statutory obligations for bushfire management will be met. ▪ An education program for staff and contractors regarding the risks from bushfires in consultation and collaboration with the NSW Rural Fire Service (RFS), Fire & Rescue NSW (FRNSW) and Forestry Corporation of NSW will be implemented.
Social and Economic	▪ Consultation activities will occur in accordance with Section 5 of the EIS.
Other	▪ Project staff and contractors will be made aware of their statutory obligations to protect Aboriginal cultural heritage objects under the NPW Act, through the site induction and toolbox talks. ▪ All works will be undertaken to comply with Part 6 of the NPW Act. ▪ If any previously unidentified Aboriginal cultural heritage objects are identified during works, then such in the immediate area will cease, the area will be cordoned off and the OEH Enviroline 131 555 will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed managed in accordance with relevant legislative and policy requirements. ▪ In the event that skeletal remains are uncovered, then works in the immediate area will cease, the area will be cordoned off and the NSW Police will be contacted. Should the NSW Police determine that the material is not recent, the OEH Enviroline 131 555 and relevant Aboriginal stakeholders will be contacted to determine an action plan for the management of the skeletal remains prior to works re-commencing. ▪ If any previously unidentified potential non-Indigenous cultural heritage material is identified during construction or drilling, then works in the immediate area will cease, the area will be cordoned off and the OEH Heritage Branch will be contacted. A suitably qualified archaeologist will be contacted so that the site can be assessed and managed.

21.0 Summary and Conclusion

This EIS has assessed the environmental impacts of the proposed activity to construct and drill two new wells (Bibblewindi 31 and 32) on the existing Bibblewindi 14 and Bibblewindi 19H well leases respectively, install new surface infrastructure to connect the two wells to the existing Bibblewindi Multi-Lateral Pilot and operation of Bibblewindi Multi-Lateral Pilot including Bibblewindi 31 and 32 wells, and the management of the water and gas produced during operation of the 14 wells for up to three years.

21.1 Environmental considerations

Table 21-1 summaries the environmental impacts of the proposed activity.

Table 21-1 Environmental considerations

Aspect	Potential impacts	Potential impact category (with mitigation measures)
Land resources	▪ The site is not located on Biophysical Strategic Agricultural Land and/or a Critical Industry Cluster.	negligible impact
Surface water	▪ Sedimentation of surface waters due to increased erosion. ▪ Contamination of surface waters in event of a leak or spill. ▪ Pollution/contamination of surface waters in event of flooding and inundation of the site.	minimal impact
Groundwater	▪ Groundwater contamination due to mixing of aquifers, loss of drilling mud into the formation or inappropriate management of spills. ▪ Total water abstracted over 3 years, approximately 285,110 cubic metres. ▪ Negligible change in flux or drawdown in the upper layers, no impact to registered bore users or groundwater dependant ecosystems.	minimal impact
Flooding	▪ Area not within flood prone land.	negligible impact
Biological	▪ No additional vegetation clearing or disturbance will be undertaken as part of the proposed activity. ▪ No threatened flora, fauna or migratory species listed under the TSC Act and/or EPBC Act were recorded at the site and no threatened flora, fauna or migratory species assessed as having potential to occur at the site is considered likely to be directly or indirectly impacted upon as a result of the proposed activity.	negligible impact
Dust, odours and radiation	▪ Generation of dust and other particulates. ▪ Generation of noise, particularly during drilling activities which may occur up to 24 hours per day.	negligible to minimal impact
Greenhouse gases	▪ Total greenhouse gas emissions resulting from operation of the activity are estimated to be approximately 254,602 t CO_2^e per year. This represents approximately 0.2 per cent of the total greenhouse gas emissions from NSW in 2011 (158,991,280 t CO_2^{-e}). ▪ The beneficial aspects of the proposed activity provides significant GHG mitigation potential through the supply of CSG for power generation, which represents a 58 per cent emissions saving (per GJ) over more traditional large-scale energy sources such as coal. ▪ Likely greenhouse gas emissions from the proposed activity are not considered to have significant impact on increasing greenhouse gas emissions.	minimal impact

Aspect	Potential impacts	Potential impact category (with mitigation measures)
Noise and vibration	▪ Noise levels will be below the NSW Industrial Noise Policy (EPA, 1999b). ▪ Operational noise impacts related to the activity are unlikely to be result in any audible impacts at nearby residences.	negligible impact
Traffic and transport	▪ Based on existing traffic volumes on the Newell Highway and the distribution of vehicles over the day, the anticipated traffic generation for the proposed activity (typical and maximum) both during construction and operation will have a minimal impact on the Newell Highway and the surrounding road network.	minimal impact
Waste	▪ The proposed activity is likely to result in the generation of wastes, in particular during the construction phase. Waste management procedures would be developed as part of the waste management plan for the activity which would ensure waste is handled and stored appropriately and ultimately reused, recycled or disposed of in accordance with legislative requirements and best practice. ▪ Reusable other materials would be managed and reused onsite or recycled where appropriate, including treated water. Waste requiring offsite disposal would consequently be minimised and residual waste would be disposed of in an appropriate manner. As such significant, residual impacts in relation to waste are not anticipated.	minimal impact
Hazards	▪ Land, water or air pollution, or fire, from improper use of hazardous substances or chemicals.	minimal impact
Social and economic	▪ The proposed activity will result in a number of positive economic impacts for the local, regional and State economies. This includes a mix of both local and fly in fly out jobs over the course of the proposed activity (5.6 Equivalent Full Time jobs at peak), a $5.3-5.5 million economic multiplier effect from capital expenditure, increase in local expenditure on goods and services as well as the potential to increase the NSW domestic gas supply. The development of the proposed activity is in line with the goals and outcomes of both the *Narrabri Economic Development Strategy* (DTIRIS, 2011) and the Strategic Regional Land Use Plan (SRLUP) for New England and the North West.	minimal impact
Cumulative impact	▪ The proposed activity has been assessed in conjunction with other activities proposed as part of the E&A Program. All impacts have been assessed from a cumulative aspect with a particular focus on biodiversity and groundwater. ▪ The E&A Program is expected to have a negligible to minimal impact on the environment.	minimal impact

21.2 Conclusion

Santos has a long term commitment to the development of new gas supplies to the growing NSW market. The proposed activity and the E&A Program have been developed taking into account environmental, economic and social considerations. The EIS has identified the potential environmental impacts together with measures mitigate those potential impacts.

The proposed activity is "State Significant Development" to which Division 4.1 of Part 4 of the *EP&A Act* applies in accordance with the *State Environmental Planning Policy (State and Regional Development) 2011*.

The EIS assesses the potential environmental impacts of the activity in accordance with clauses 6 and 7 in Schedule 2 of the *NSW Environmental Planning and Assessment Regulation 2000* and the DGRs which were issued on 20 May 2013.

The proposed activity is temporary and minor in scale. The site of the proposed activity has been selected to avoid significant environmental and heritage constraints, and reduce impacts to the surrounding community.

In considering the likely environmental significance of the impacts from the proposed activity it has been predicted that:

- potential impacts are considered to be localised and temporary in nature
- the proposed activity is unlikely to have a significant effect on highly productive groundwater sources, registered groundwater users or groundwater dependent ecosystems
- the proposed activity is unlikely to have a significant effect on the environment or the community
- the proposed activity is unlikely to have a significant effect on threatened species, populations, ecological communities or their habitats
- the proposed activity is not on land that is, or part of, critical habitat

Based on the assessments undertaken within the EIS the impact of the activity would be kept to a minimum provided that the mitigation measures identified in the EIS are employed.

22.0 References

Australian Bureau of Statistics (ABS), 1995, *Information Paper Australian National Accounts Introduction to Input-Output Multipliers* (Cat No 5246.0).

Australian Bureau of Statistics (ABS), 2007, *Australian National Accounts: Input-Output Tables – Electronic Publication, 2007/08 Final* (Cat No. 5209.0.55.001),

Australian Energy Market Operator (AEMO), 2011, Gas Statement of Opportunities, www.aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities/Previous-GSOO-reports/2011-Gas-Statement-of-Opportunities

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE), 2006, *Gunnedah Basin Coal Seam Project – Impact Assessment of Groundwater Disposal*. Report prepared for Eastern Star Gas Limited.

Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand. (ARMCANZ), 2000, *National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1 The Guidelines*.

Australian Standard AS IEC 61672.1-2004 *Electroacoustics – Sound level meters – Specifications*

Austroads, 2009, *Guide to Traffic Management Part 2: Traffic Theory*

Bureau of Meteorology (BoM), 2012, *Monthly climate statistics: Narrabri West Post Office and Narrabri Airport AWS*, accessed on 9 July 2012: http://www.bom.gov.au/climate/data/

Commonwealth Department of Climate Change and Energy Efficiency (DCCEE), 2012 *Australian National Greenhouse Accounts – National Greenhouse Accounts Factors*. Published by the Department of Climate Change and Energy Efficiency.

Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC), 2009, *Air Quality Standards*, http://www.environment.gov.au/atmosphere/airquality/standards.html#emission

Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), 2012, *Key threatening processes under the EPBC Act*, accessed on 8 July 2012: http://www.environment.gov.au/biodiversity/threatened/ktp.html

Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2007, *Water availability in the Namoi. A report to the Australian Government from the CSIRO. Murray-Darling Basin Sustainable Yields Project, CSIRO*, Australia, December 2007

Eastern Star Gas (ESG), 2008, *Review of Environmental Factors (REF) 2008 Narrabri Coal Seam Gas Lateral Program – Lateral Pilot A.*

Eastern Star Gas (ESG), 2009, *Review of Environmental Factors (REF) 2009 Narrabri Coal Seam Gas Program – Dewhurst-8 Lateral Production Pilot*.

Eco Logical Australia, 2009, *Riverine Vegetation in the Namoi Catchment – An Assessment of Type and Condition*. Report prepared for the Cotton Catchment Communities CRC and Namoi Catchment Management Authority.

Eco Logical Australia,2013 *PEL 238 TSC Act Cumulative Impact Assessment*. Prepared for Santos Limited.

Fairfull, S., Witheridge, G. (2003) *Why Do Fish Need to Cross the Road? – Fish Passage Requirements for Waterway Crossings*. NSW Fisheries, Cronulla.

Golder, 2011, *Groundwater impact assessment for the Narrabri Gas Project, Eastern Star Gas*, Golder Associates, report number 117626002-002-R-RevG.

Golder, 2012. *Santos Gunnedah CSG Project Bore Inventory Summary Report No. 2.*

Great Artesian Basin Consultative Council, 1998, *Great Artesian Basin Resource Study*, Canberra, ACT.

GTA Consultants, 2013, *Bibblewindi Gas Exploration Pilot Expansion, Narrabri Traffic and Transport Assessment*

International Erosion Control Association (IECA), 2008, *Best Practice Erosion and Sediment Control. Picton, Australia.*

Janssen, L. H. J. M., van Wakeren, J. H. A., van Duuren, H. and Elshout, A. J. (1988) *A Classification of NO oxidation rates in power plant plumes based on atmospheric conditions*. Atmospheric Environment, Volume 22, Number 1, 43-53.

Lampert, G and Short, A, 2004, *Namoi River Styles Report. River Styles, Indicative Geomorphic Condition and Geomorphic Priorities for River Conservation and Rehabilitation in the Namoi Catchment, North-West NSW*. Namoi Catchment Management Authority and Department of Infrastructure, Planning and Natural Resources (National Action Plan for Salinity and Water Quality).

Landcom, 2004, *Managing Urban Stormwater: Soils and Construction, 4th Edition*

Mawhinney, W, 2011, *Namoi Water Quality Project 2002-2007 – Final report*, NSW Office of Water, Sydney.

Namoi Catchment Management Authority (NCMA),2010 *Extant vegetation mapping in the Namoi CMA*. This dataset was compiled by Eco Logical Australia for the Namoi Catchment Management Authority.

Naomi Catchment Management Authority (NCMA), 2013, Naomi Catchment Management Area, accessed on 9 July 2012: http://www.namoi.cma.nsw.gov.au/

Narrabri Shire, 2011, *Narrabri Shire Economic Development Strategy*

NHMRC and NRMMC, 2011, *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Norris, E, 1996, *A Study of the Soil and Vegetation Patterns Within Part of the Pilliga Forests and an Evaluation of the Impact of European Settlement on the Vegetation*, MSC Submission, Macquarie University, Ryde.

NSW Department of Environment and Conservation (DEC),2005 *Approved methods for the modelling and assessment of air pollutants in New South Wales*. Prepared by the NSW Environment Protection Authority (EPA), as part of the Department of Environment and Conservation NSW.

NSW Department of Environment & Climate Change (DECC), 2002, *Descriptions for NSW (Mitchell) Landscapes – Version 2 (2002)*

NSW Department of Environment and Climate Change (DECC) (2007) *Threatened species assessment guidelines. The assessment of Significance*. DECC, Sydney.

NSW Department of Environment and Climate Change (DECC) (2007a) *NSW Waste Avoidance and Resource Recovery Strategy*.

NSW Department of Environment and Climate Change (DECC), 2009, *Interim Construction Noise Guideline*, Sydney.

NSW Department of Environment, Climate Change and Water (DECCW), 2006, *NSW Water Quality and River Flow Objectives – Namoi River*.

NSW Department of Environment, Climate Change and Water (DECCW), 2009, *Waste Classification Guidelines Part 1: Classifying Waste*

NSW Department of Environment, Climate Change and Water (DECCW), 2010, *2010 Due Diligence Code of Practice for the protection of Aboriginal Objects in NSW*

NSW Department of Land and Water Conservation, (DLWC), 1997 – *NSW State Groundwater Policy Framework Document*.

NSW Department of Planning and Infrastructure (DP&I), 2011, *Applying SEPP33 – Hazardous and Offensive Development Guidelines*, Sydney.

NSW Department of Planning and Infrastructure (DP&I), 2012, *Strategic Regional Land Use Plan New England North West*

NSW Department of Primary Industries (DPI), 2007, *Key Fish Habitat in the Narrabri LGA*. Accessed June 2013. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/341247/Narrabri.pdf

NSW Department of Resources, Energy and Tourism (DRET), 2012 – *Energy White Paper 2012*.

NSW Department of Trade, Investment, Regional Infrastructure and Services (DTIRIS), 2011, *Draft Additional Part 5 assessment requirements: A supplement to ESG2 Environmental Impact Assessment Guidelines*

NSW Department of Trade, Investment, Regional Infrastructure and Services (DTIRIS), 2012a, *ESG2: Environmental Impact Assessment Guidelines for Exploration, Mining and Petroleum Production Activities Subject to Part 5 of the Environmental Planning and Assessment Act 1979*

NSW Department of Trade, Investment, Regional Infrastructure and Services (DTIRIS), 2012b, *NSW Code of Practice for Coal Seam Gas Well Integrity*

NSW Department of Water and Energy (DWE), 2009, *Water Sharing Plan: NSW Great Artesian Basin Groundwater Sources – Background document.*

NSW Environment Protection Authority (EPA), 1999a, *Criteria for Road Traffic Noise*, Sydney.

NSW Environment Protection Authority (EPA), 1999b, *Industrial Noise Policy*, Sydney.

NSW Environment Protection Authority (EPA), 2009 *Brigalow and Nandewar Community Conservation Area Agreement, made between the Minister for Environment and Climate Change and the Minister for Primary Industries for the period 11 June 2009- 10 June 2016,* http://www.epa.nsw.gov.au/resources/forestagreements/ccaAgreement.pdf

NSW Environment Protection Authority (EPA), 2012 – *NSW State of the Environment 2012*: http://www.environment.nsw.gov.au/soe/soe2012/index.htm

NSW Government, 2012, NSW Natural Resource Atlas website, accessed on 9 November 2012: http://www.nratlas.nsw.gov.au

NSW National Parks and Wildlife Service, Northern Plains Region (NPWS), 2006, *Pilliga Nature Reserve – Fire Management Strategy*.

NSW Office of Environment and Heritage (OEH), 2006, NSW Wetland Mapping. Accessed June 2013. http://mapdata.environment.nsw.gov.au/geonetwork/srv/en/main.home?any=wetland&northBL=&westBL=&eastBL=&southBL=&relation=overlaps&sortBy=relevance&sortOrder=&hitsPerPage=10&output=full

NSW Office of Environment and Heritage (OEH), 2012, *Draft Inherent Soil Fertility Mapping, Upper Hunter and New England North West Strategic Regional Landuse Areas*. State of New South Wales

NSW Office of Water (NOW), 2011, *Water resources and management overview: Namoi catchment.*

NSW Office of Water (NOW), 2012a, *NSW Aquifer Interference Policy*

NSW Office of Water (NOW), 2012b, *Water Sharing Plan for the Murray-Darling Basin Fractured Rock Groundwater Sources – Background document.*

NSW Office of Water (NOW), 2012c, *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources*

Schlumberger Water Services (Australia) Pty Ltd, 2012, *Namoi Catchment Water Study Independent Expert Final Study Report*, Perth

Serov P, Kuginis L, Williams J.P., 2012, *Risk assessment guidelines for groundwater dependent ecosystems*, Volume 1 – The conceptual framework, NSW Department of Primary Industries, Office of Water, Sydney."

Standards Australia, 2008, *AS1141–2008 Methods of Sampling and testing Aggregate*

URS,2009 *American Petroleum Institute Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry*. Prepared by URS for the American Petroleum Institute.

Welsh, W.D.,2000, *GABFLOW: A steady state groundwater flow model of the Great Artesian Basin*. Bureau of Rural Sciences, Canberra.

World Business Council for Sustainable Development. (WBCSD) and the World Resources Institute(WRI),2004 *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard – Revised Edition.*

WRM water and environment, 2006. *Gunnedah Coal Seam Gas Project – Impact of Surface Water Disposal on Bohena Creek Flows*. Report prepared by S. Markar and R. Walton for Eastern Star Gas.

23.0 Glossary

Term/abbreviation	Meaning
Abandonment	Decommissioning the well. A process which involves shutting down the well and rehabilitating the site.
ABS	Australian Bureau of Statistics
ADGC	Australian Dangerous Goods Code
AEMO	Australian Energy Market Operator
AGE	Australasian Groundwater and Environmental Consultants
AHD	Australian Height Datum
AHIMS	Aboriginal heritage Information Management System
AIP	Aquifer Interference Policy
AIS	Agricultural Impact Statement
Annulus	The space between the wellbore and surrounding pipe.
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute
Aquiclude	Compacted geological formations through which no groundwater flows.
ASC	Australian Soils Classification
Aquitard	Low permeability formation which restricts the flow of groundwater.
BOP	Blow out preventer - one of several valves installed in a wellhead to prevent the escape of pressure either in the annular space between the casing and the drill pipe or in the open hole during drilling, completion and work over operations.
BoM	Bureau of Meteorology
BOP	Blow out preventer
BSAL	Biophysical Strategic Agricultural Land
BTEX	*A* group of chemicals comprising Benzene, toluene, ethylbenzene, and xylenes.
BNCCA Act	*Brigalow and Nadewar Community Conservation Area Act 2005*
Casing	A pipe placed in a well to prevent the wall of the hole from caving in and to prevent movement of fluids from one formation to another.
Casing collar	Coupling between two joints.
Casing coupling	Tubular section of pipe that is threaded inside and used to connect two joints of casing.
Casing head	A heavy flanged steel fitting connected to the first string of casing. It provides a housing for slips and packing assemblies.
CCC	Community Consultative Committee
Cementing	The application of a liquid slurry of cement and water to various points inside and outside the casing.
Cementing head	Component fitted to the bore for the use of cementing.
Cement plug	Portion of cement placed at some point in the wellbore.
CIC	Critical Industry Cluster
CO	Carbon monoxide
Coring	Process of cutting a vertical, cylindrical sample of the formations.
CSG	Coal Seam Gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAMB	Deep aquifer monitoring bore
DCCEE	Department of Climate Change and Energy Efficiency

Term/abbreviation	Meaning
DD	Deposited dust
DGRs	Director-General's Requirements
DO	Dissolved Oxygen
DP&I	NSW Department of Planning and Infrastructure
DPI	NSW Department of Primary Industries
DRET	Department of Resources, Energy and Tourism
Drill fluid/mud	Circulating fluid that can lift cuttings from the wellbore to the surface and to cool down the drill bit.
DST	Drill Stem Test
DTIRIS	Department of Trade, Investment, Regional Infrastructure and Services
E&A Program	Santos's NSW Exploration and Appraisal Program for PEL 238 and PAL 2.
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EEC	Endangered Ecological Communities
EFT	Equivalent Full Time
EHSMS	Environmental, Health and Safety Management System
EIS	Environmental Impact Statement
EPA	NSW Environmental Protection Authority
EPL	Environment Protection Licences
ESD	Ecologically Sustainable Development
ESG	Eastern Star Gas
FIFO	Fly in/fly out
flux	rate of volume flow across a unit area ($m^3/s /m^2$)
FTF	Fluids treatment facility
HDPE	High density polyethylene
K_2S0_4	Potassium sulphate
kPag	Kilopascal gauge
KTPs	Key threatening processes
GAB	Great Artesian Basin
GDE	Groundwater dependent ecosystems
GHG	Greenhouse gases
GJ	Gigajoule
GWP	Global Warming Potential
ICNG	Interim Construction Noise Guideline
IECA	International Erosion Control Association
INP	Industrial Noise Policy
ISCA	Infrastructure Sustainability Council of Australia
IVMS	In vehicle monitoring system
killing the well	Flushing the well with a higher density liquid
LA_{eq}	Logarithmic average noise level from all sources
LA_{90}	Also called L90 or background. An indicator of the quietest time of day and is calculated as the noise level equalled or exceeded for 90% of the measurement time.

Term/abbreviation	Meaning
LCM	Lost circulation material
LGA	Local government area
LSC	Land and soil capability class
m^3	Cubic metres
MDB	Murray-Darling Basin
ML	Mega litres
MNES	Matter of National Environmental Significance
MMscf	Million standard cubic feet
MSDS	Materials Safety Data Sheets
MW	Mega watt
$NaHC0_3$	Sodium Hydrogen Carbonate
NATA	National Association of Testing Authorities
NEM	Naturally Excavated Material
NV Act	Native Vegetation Act 2003
NGA	National Greenhouse Accounts
NGER Act	National Greenhouse Energy Reporting Act
NGERS	National Greenhouse Energy Reporting Scheme
NOC	Narrabri Operations Centre
NOW	NSW Office of Water
NO_2	Nitrogen dioxide
NPW	National Parks and Wildlife
NSW	New South Wales
NSW State Plan 2021	*NSW 2021: A Plan to Make NSW Number One*
NTSCORP Ltd	the Native Title Service Provider for Aboriginal Traditional Owners in NSW
NV	Native vegetation
OCSG	Office of Coal Seam Gas
OEH	Office of Environment and Heritage
Packer	Piece of down hole equipment that consists of a sealing device. Used to block the flow of fluids through the annular space between the pipe and the wall of the wellbore.
PAL	Petroleum Assessment Lease
PAWC	Plant Available Water Capacity
PEL	Petroleum Exploration Licence
PET	Polyethylene terephthalate
PFAMC	Pilliga Forest Aboriginal Management Committee
PFC	Projected foliage cover
PHA	Preliminary hazard analysis
PHPA	Partially Hydrolised Poly Acrylamide
Plug	Any object or device that blocks a hole or passageway.
PM_{10}	Measure of particles in the atmosphere with a diameter of less than 10 or equal to a nominal 10 micrometres
POEO	*Protection of the Environment Operations Act 1997*
POEO (Waste) Regulation	*Protection of the Environment Operations (Waste) Regulation 2005*

Term/abbreviation	Meaning
POP	Petroleum Operations Plan
RAMSAR	RAMSAR convention is an intergovernmental treaty to conserve wetlands of international importance
RBL	Rating background noise levels
REF	Review of Environmental Factors
RMS	NSW Roads and Maritime Services
RPS	RPS Australia East Pty Ltd
RTU	Remote Telemetry Unit
SAL	Strategic Agricultural Land
Santos	Santos NSW (Eastern) Pty Ltd
SEIA	Social and Economic Impact Assessment
SEPP	State Environmental Planning Policy
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SCADA	Supervisory Control and Data Acquisition
SIS	Species Impact Statement
SRD SEPP	State and regional development State Environmental Planning Policy
SRLUP	State and Regional Land Use Policy
SSD	State Significant Development
Surface casing	A drilled and cemented pipe used to provide blow-out protection, to seal off water/hydrocarbon sands and prevent the loss of circulation. Also used to seal off water sands, weak formations and/or lost circulation zones. In some cases surface and intermediate casing requirements are provided by the same string.
TAPM	Air population model developed by CSIRO
TCP	Traffic control plan
TEC	Threatened Ecological Communities
TDS	Total dissolved solids
THPS	Tetrakis Hydroxymethyl Phosponium Sulphate
TSC Act	*Threatened Species Conservation Act 1995*
TSR	Travelling stock routes
TSP	Total suspended particulates
Surface casing	A drilled and cemented pipe used to provide blow-out protection, to seal off water/hydrocarbon sands and prevent the loss of circulation. Also used to seal off water sands, weak formations and/or lost circulation zones. In some cases surface and intermediate casing requirements are provided by the same string.
WAL	Water access licence
Wall cake	Low permeability ‘skin’ around the wall of the hole.
Wellhead	The system of spools, valves and associated adapters that provide pressure control for production.
WMA	Water Management Act 2000
WPPS	Wilga Park Power Station
WSP	Water Sharing Plan
WTF	Water Transfer Facility