

Narrabri Coal Seam Gas Project - Gas Field Development

Preliminary Environmental Assessment



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Prepared for
Eastern Star Gas

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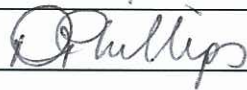
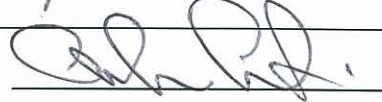
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Glossary of Terms

Abbreviation	Description
AHIMS	Aboriginal Heritage Information Management System
asl	Above Sea Level
CSG	Coal Seam Gas
DECCW	Department of Environment and Climate Change and Water NSW
DEWHA	Department of the Environment, Water, Heritage & the Arts (Commonwealth)
DoP	Department of Planning NSW
DII	Department of Industry and Investment NSW
EA	Environmental Assessment
EARs	Environmental Assessment Requirements
EEC	Endangered Ecological Community
EPL	Environment Protection Licence
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1997</i>
ESG	Eastern Star Gas
ha	Hectare
km	Kilometre
LALC	Local Aboriginal Land Council
LGA	Local Government Area
LNG	Liquefied Natural Gas
ML	Megalitre
MOU	Memorandum of Understanding
Mtpa	Million tonnes per annum
MW	Megawatt
NES	National Environmental Significance
NJV	Narrabri Coal Seam Gas Joint Venture
PAL	Petroleum Assessment Lease
PEL	Petroleum Exploration Licence
PEA	Preliminary Environmental Assessment
PJ	Petajoule

Abbreviation	Description
PPL	Petroleum Production Licence
RTA	Roads and Traffic Authority NSW
SEPP	State Environmental Planning Policy
WSP	Water Sharing Plan
1P	Proven gas reserves
2P	Proven and probable gas reserves
3P	Proven, probable and possible gas reserves

Executive Summary

Introduction

This Preliminary Environmental Assessment (PEA) has been prepared by AECOM and is submitted by Eastern Star Gas Limited (ESG), operator of the Narrabri CSG Joint Venture (NJV). The Narrabri Coal Seam Gas Project (the Project) is being developed by the NJV.

Development of the Project will involve the progressive installation of infrastructure to produce, process, compress and transport Coal Seam Gas (CSG) from CSG reservoirs within Petroleum Exploration Licence 238 (PEL 238), Petroleum Production Lease 3 (PPL 3) and Petroleum Assessment Lease 2 (PAL 2), together "the Permits", near Narrabri to various markets within NSW.

CSG exploration, gas reserves appraisal and Project development planning activities are well advanced for the Permits and, to facilitate timely development of the various Project components, it is essential that approval processes be similarly advanced. A Major Project approval is therefore being sought under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This Preliminary Environmental Assessment (PEA) describes the Gas Field Development, provides justification for the Project, sets out the risk assessment undertaken and outlines the potential environmental issues that need to be considered in more detail in the Environmental Assessment (EA) for the Project.

The Project

The Project will be developed progressively as gas reserves are proven and gas markets secured. Major Project approval is being sought for the currently expected gas demand over the first 20 years of the Project, as this complements proposed contracts for gas sales and pipelines.

The Project includes well drilling, construction of gas and water gathering and treatment infrastructure and operation of gas processing and compression facilities. Following the initial development of sufficient wells to produce gas at rates to meet market requirements, ongoing development of new production wells within the Project area would be necessary to maintain CSG production levels as the performance of existing wells progressively declines.

The main components of the Project include:

- Completion of coreholes and/or seismic surveys to the extent required for detailed design (i.e. non-exploration) purposes;
- Drilling and completion of coal seam gas production wells;
- Wellhead surface facilities;
- Installation of buried flowlines to allow gas and co-produced water to be transported to centralised processing facilities;
- Gas processing and compression facilities where CSG is processed (e.g. dehydrated and compressed) to meet downstream pipeline and/or customer requirements. It is envisaged the centralised processing and compression facilities will be expanded progressively as gas markets grow. The NJV already has in place Memoranda of Understanding (MOU) for supply of 1,700 PJ of gas for use in new gas fuelled electricity generation in NSW, comprising MOUs with Macquarie Generation (500 PJ), ERM (400 PJ) and NP Power (800 PJ);
- Dedicated water management and treatment facilities.

Buried high pressure gas transmission pipeline infrastructure (currently the subject of separate Part 3A Major Project applications) would deliver CSG from the Narrabri CSG Project into other existing pipelines and/or transport gas to new locations or markets within NSW. The feasibility of a Liquefied Natural Gas (LNG) export facility at the Port of Newcastle is currently being investigated and will be the subject of a separate Major Project application.

In 2007, the NJV embarked on a gas reserves upgrade program and, by the end of 2009, the NJV upgraded 2P (proven and probable) gas reserves to 1520 PJ and certified 3P (proven, probable and possible) gas reserves to 2797 PJ. The exploration and appraisal program also resulted in material upgrades to certified contingent resources, which now total 6,215 PJ.

Development of the Project will be a stimulus for employment and the economy of NSW, particularly northwest NSW. Development of the Narrabri CSG Project will move NSW a step closer to achieving self-sufficiency in terms of gas supply, and could in the long term contribute to the State becoming a net exporter of gas.

The Project as described meets the requirements of the NSW State Environmental Planning Policy (Major Development) 2005 as a Project of state significance. Subject to the approval of the Minister for Planning, the Project will be assessed as a Major Project under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The PEA has been undertaken to provide a background to the Project and the market context within which the Project will operate. The PEA provides a description of the components of the Project, documents the outcome of an environmental risk assessment undertaken and identifies key environmental issues associated with the Project which would be assessed as part of the detailed EA for the Project.

Key Environmental Issues

The key environmental issues that have been identified for the Project, and which will be assessed in more detail during preparation of the EA, include:

- Heritage
- Ecology
- Surface Water
- Groundwater
- Noise and Vibration
- Socio-Economic
- Waste Management (brine)
- Hazard and Risk

Other environmental issues not considered to require further detailed assessment but which will be considered in the EA include:

- Land Use
- Air Quality
- Traffic and Transport
- Landscape and Visual Amenity
- Sustainability, Climate Change and Greenhouse Gas
- Soils

As part of the preparation of the EA, further assessments will be carried out to refine the potential environmental impacts of the Project and to identify mitigation and management measures to minimise impacts to the environment during construction and operation of the Project.

1.0 Introduction

This Preliminary Environmental Assessment (PEA) has been prepared by AECOM, and is submitted by Eastern Star Gas Limited (ESG), operator of the Narrabri Coal Seam Gas Joint Venture (NJV).

The NJV holds the rights to Coal Seam Gas (CSG) produced from Petroleum Exploration Licence 238 (PEL 238), Petroleum Assessment Lease 2 (PAL 2) and Petroleum Production Lease 3 (PPL 3), together “the Permits”. Together, PEL 238, PAL 2 and PPL 3 form the basis of the Narrabri CSG Project (the Project), which the NJV is seeking to commercialise and develop.

There are no material gas markets available within or around the Project, nor is there any gas pipeline infrastructure through which CSG from the Project can be delivered to major markets. The Project would allow the development of gas production wells and infrastructure to supply gas into the NSW market and provide for ongoing expansion to support new power stations and a range of other downstream gas processing initiatives.

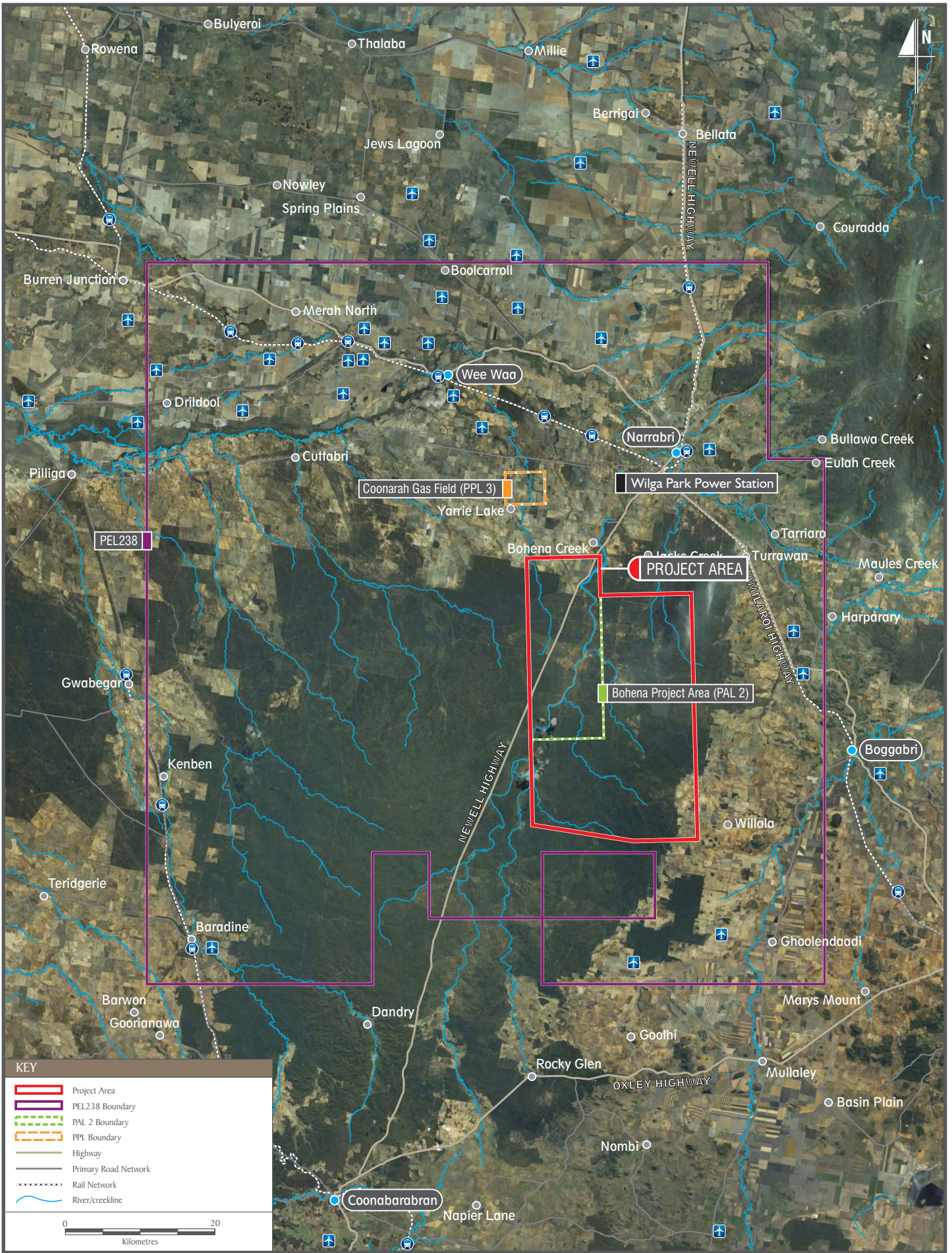
Commercialisation of the Project is dependent upon a sufficient level of proven and probable gas reserves being demonstrated to support firm gas sales commitments and, in turn, to underwrite development of requisite infrastructure to deliver CSG to these markets. It is also essential that approvals be in place to allow development and production of gas for the life of the gas sales commitments (i.e. 20 years).

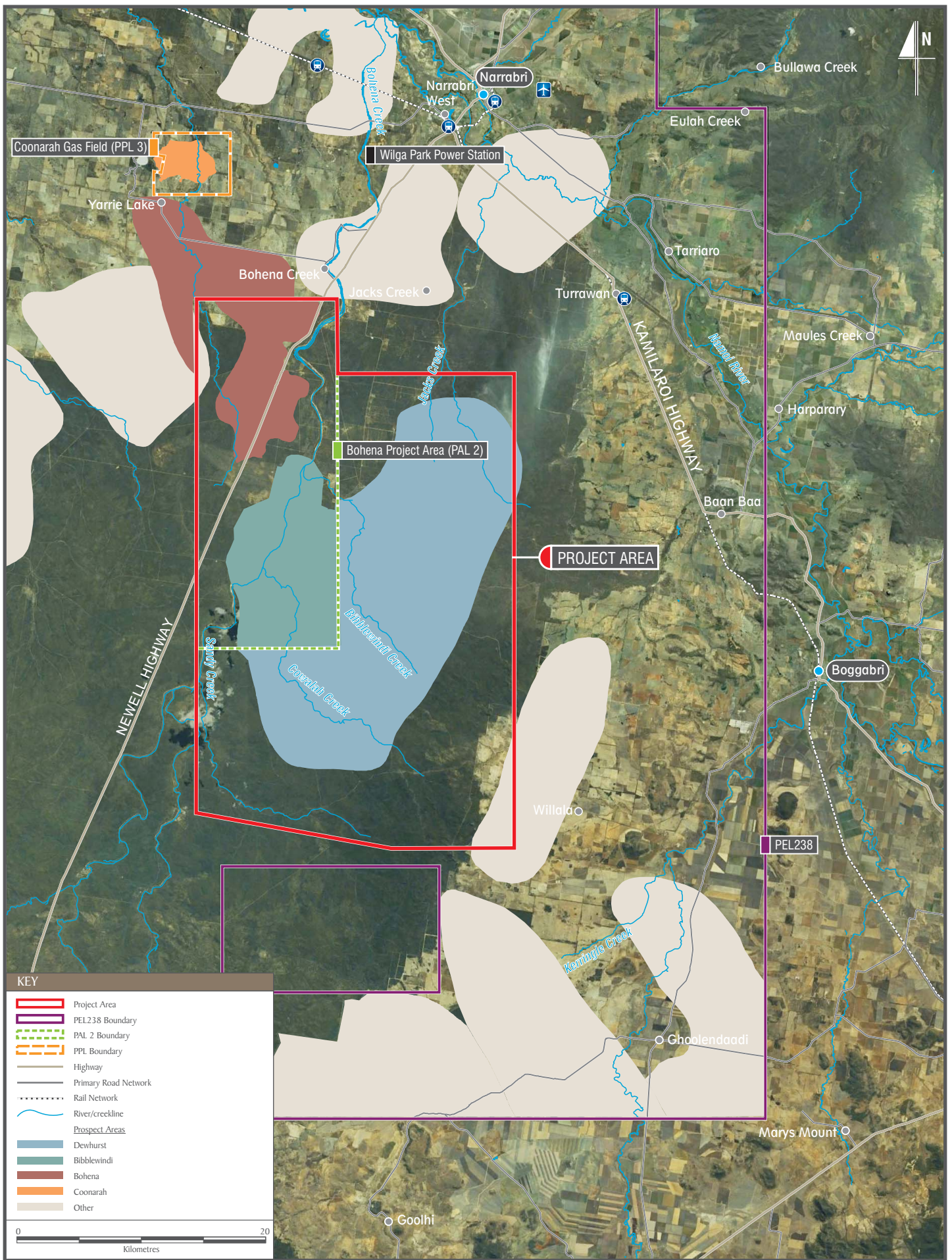
To facilitate a timely transition to commercialisation of CSG production, ESG is seeking Major Project approval for infrastructure that would be required for full-scale development of the Project.

This PEA has been prepared to assist the Director General in providing targeted, project-specific Environmental Assessment Requirements (EARs). It describes the key components of the Project, comprising core drilling, seismic survey, gas production wells, gas and water gathering infrastructure, gas processing and compression infrastructure and water management facilities. The PEA also includes an initial assessment of the key environmental issues associated with the project, which are discussed in **Section 6** and summarised in **Section 7** of this report. Assessment of these issues, in accordance with the EARs and based on the outcomes from government agency and community consultation, would form the basis for preparation of the detailed Environmental Assessment (EA) for the Project.

The proposed Project is located approximately 40 kilometres south-west of Narrabri in north-western NSW as illustrated in **Figure 1**. For the purposes of this document, the application area incorporating the gas fields, gas and water gathering infrastructure, gas processing and compression infrastructure and water management facilities, is collectively referred to as ‘the Project area’. The Project area and Permit boundaries are illustrated in **Figure 2** and prospect areas are shown in **Figure 3**.







2.0 Background

2.1 The Proponent

ESG listed on the Australian Stock Exchange in February 2001. Shortly after listing, ESG acquired 100% ownership of conventional gas interest within PEL 238, a 9,100 square kilometre licence area covering the highly prospective coal-bearing Bohena Trough area of the Permo-Triassic Gunnedah Basin. Thirty five percent (35%) of the CSG interest in PEL 238 has been strata titled to Santos.

2.2 Project Background

The NJV has been undertaking a programme of exploration within PEL 238, PAL 2 and PPL 3. Encouraging gas flows were encountered in PEL 238 during earlier exploration activity (prior to ESG's acquisition of PEL 238) on the Coonarah structure, a conventional natural gas resource located approximately 20km west of Narrabri.

The Coonarah Gas Field underwent appraisal drilling throughout 2001 culminating in the independent certification of 11.3 petajoules of 2P (proven and probable) gas reserves. As a means to commercialise what was otherwise a stranded gas resource, ESG developed the Wilga Park Power Station through its wholly owned subsidiary, Narrabri Power Limited. Following commencement of gas production, the conventional gas reserves at Coonarah were significantly downgraded to 5.8 PJ based on production and pressure performance.

Using gas from the Coonarah Gas Field, the Wilga Park Power Station commenced operation and delivery of power to Country Energy in July 2004. Producing electricity at significantly lower greenhouse intensity than coal-fired generators, the Wilga Park Power Station contributes to the NSW Government's greenhouse gas reduction strategy. NSW Greenhouse Abatement Certificates created at the power station are supplied to Country Energy.

By 2005, ESG and other parties had collectively invested in excess of \$39 million in CSG exploration activities in PEL 238. Sustained exploration efforts at Bohena and Bibblewindi confirmed the presence of extensive gas bearing coal seams in two distinct and widespread coal measures. On the basis of this work, the CSG gas-in-place potential of PEL 238 was independently estimated to significantly exceed 17 trillion cubic feet.

Project appraisal continued throughout 2006 with the development of a closely spaced nine well production pilot at Bibblewindi. As a complement to the operation of the Bohena and Bibblewindi pilots, CSG exploration and appraisal activities during 2007 involved further corehole drilling and production data collection and analysis.

The objective of the 2007 work programme was to expedite certification of gas reserves for the Project and, by the end of 2007, 1P (proven), 2P (proven and probable) and 3P (proven, probable and possible) gas reserves were independently certified by Netherland, Sewell and Associates (**Table 1**).

Table 1: Certified Gas Reserves

	Certified Gas Reserves		
	1P	2P	3P
December 2007	21 PJ	185 PJ	1,300 PJ
December 2009	115 PJ	1,520 PJ	2,797 PJ

Further reserves upgrades have since been achieved and the NJV's exploration activities supported independent certification in December 2009 of 3P gas reserves of 2,797 PJ (**Table 1**). By the end of 2009, independently certified 2P gas reserves totalled 1,520 PJ, which is considered sufficient to justify development of infrastructure that is necessary to commercialise the Project.

ESG is continuing an active CSG exploration and appraisal programme across PEL 238. The present programme of work is addressing targets with a reserve gas potential exceeding 5,000 PJ. The programme involves both corehole drilling and development of lateral well production pilots, the first two of which (brought on line during April and May 2009) are performing in accordance with expectations. Production results from these and additional lateral pilots already drilled, or to be drilled over coming months, are expected to support the targeted gas reserves upgrades.

Extended pilot production testing activities are an unavoidable component of CSG Project appraisal, providing data that is essential to the reserves certification process. ESG has installed a gas flowline to enable gas produced during pilot production testing activities to be used at the Wilga Park Power Station. The power station would also be progressively expanded as pilot production gas quantities rise, with the first of up to twelve new gas engine driven 3 MW generators commissioned in July 2009.

Approval for installation of the flowline and expansion of the Wilga Park Power Station was granted by the Minister for Planning in December 2008 (project number 07_0023). The flowline construction commenced in December 2008 and was completed by July 2009 and the partial upgrade to Wilga Park is ongoing.

While utilisation of pilot production gas is desirable for both environmental and commercial reasons, it is only an interim, albeit appropriate, measure while gas reserves are upgraded to a level to support full-scale project development. The primary objective is to develop the Project to supply gas into NSW, east coast and overseas gas markets. This, in turn, requires gas markets to be secured, gas reserves demonstrated and approvals secured to allow development of the Project and associated gas transmission infrastructure.

From a market perspective, the NJV previously had in place Memoranda of Understanding (MOUs) with the NSW Government owned electricity generator Macquarie Generation and with NP Power for the supply of a total of 1,300 PJ of gas over a 20 year period for use in the generation of electricity. In addition, the NJV has in place a MOU with ERM Power for the provision of 20 PJ of gas per annum to a new gas fired power station at Wellington over a 20 year period commencing in 2013. Further market opportunities, including liquefaction and export of gas, are being pursued.

Further reserves upgrades, to support a possible LNG export initiative at the Port of Newcastle, will be achieved through ongoing appraisal work and by confirming the broader gas reserves potential of the Permits.

2.3 Background Information on Coal Seam Gas

The principal difference between a conventional natural gas reservoir and a CSG reservoir is that conventional natural gas is formed in one location (i.e. source rock) before migrating to and being trapped in another location (i.e. reservoir rock), whereas CSG is formed and trapped in the same formation. That is, the coal in which the CSG is contained is both the source rock and the reservoir rock.

Only certain ranks of coal are suitable for the extraction of CSG. Methane generation (methanogenesis) is a function of both maceral (i.e. organic) constituents of coal and thermal maturation. Increases in the temperature and pressure to which coal has been exposed during its formation give rise to increases in the rank of the coal and its ability to generate and store methane. Early analogues of coal such as peat and lignite carry little or no potential as a CSG reservoir due to their thermal immaturity.

CSG consists primarily of methane and is stored within the coal seam by groundwater pressure, which keeps the gas adsorbed to the surface of the coal. Extracting CSG from coal requires penetration of the coal reservoir by the drilling of a well, in much the same manner as a conventional gas play. However, because CSG is adsorbed to the coal and held under pressure, CSG extraction requires this water pressure to be reduced through the process of dewatering. Dewatering permits the coincident generation and transmission of methane and water up through the CSG well to the surface. Therefore a primary by-product of CSG production is water.

Again, differing from conventional gas reservoirs which typically exhibit a decline in pressure and hence rates of production once established, the production profile of a CSG reservoir is characterised by higher initial rates of water production with little or no gas generation, followed by a decline in the rate of water production and increases in gas production. This profile will then typically stabilise for a number of years before gas production enters a period of slow but progressive decline.

In terms of achieving maximum rates of gas production, production testing carried out in PEL 238 confirms that there is a period of several months to several years (depending upon well design) from the commencement of dewatering until wells reach maximum rates of CSG production.

2.4 Current Approvals, Leases, Licences and Activities

Since ESG commenced its gas exploration activities in the Narrabri area in 2001, the following approvals, leases and licences have been sought and maintained.

2.4.1 Petroleum Exploration Licence 238

PEL 238 was acquired by ESG in 2001. This licence is issued for maximum six year periods with a review process conducted by the Department of Industries and Investment (formally the Department of Primary Industries – Mineral Resources Division) prior to each renewal. The review process takes account of factors including whether the Licensee has carried out a level of activity consistent with stated permit commitments. PEL 238 was most recently renewed for a four year period in November 2007, ending 2 August 2011. PEL 238 currently has an area of 7,920 square kilometres.

2.4.2 Petroleum Assessment Lease 2

A PAL is designed to allow retention of rights over an area in which a significant petroleum deposit has been identified, in circumstances where mining the deposit is not commercially viable in the short term but there is a reasonable prospect that it will be commercial in the longer term. The holder is allowed to continue prospecting operations and to recover petroleum in the course of assessing the viability of commercial extraction.

The application for a PAL over the 265 square kilometre Bohena CSG Project Area was submitted by ESG (on behalf of the NJV) in 2005 to facilitate the economic and technical assessment of the coal reservoir and the estimated CSG reserves. Section 33 (Rights of holders of assessment leases) of the *Petroleum (Onshore) Act 1991* states that:

'The holder of an assessment lease has the exclusive right to prospect for petroleum and to assess any petroleum deposit on the land comprised in the lease.'

PAL 2 was granted over the Bohena CSG Project Area on 20 October, 2007 for a period of six years ending 30 October 2013 and covers an area of 266.9 square kilometres.

2.4.3 Petroleum Production Lease 3 (Coonarah Gas Field)

In December 2003, the NSW Minister for Mineral Resources granted Narrabri Power Limited, a wholly owned subsidiary of ESG and ESG's nominated grantee, a Petroleum Production Lease (PPL). The Permit (PPL 3) covered the Coonarah Gas Field and incorporated an umbilical easement connecting the gasfield to the Wilga Park Power Station site. PPL 3 has a 21 year term ending 14 December 2024 and covers an area of 26.4 square kilometres.

Installation of a gas gathering system linking the Coonarah Gas Field with the power station occurred during early 2004 under development consent from the Narrabri Shire Council. The construction, rehabilitation and operation of the Project have been guided by a Statement of Environmental Effects prepared by R.W Corkery & Co on behalf of ESG and Narrabri Power Limited. Environmental Management Plans were implemented during construction and since operations commenced.

During 2008, ESG sold a 35% interest in PPL 3 to Gastar Exploration NSW Inc. that has since been on-sold to Santos QNT Pty Ltd. The remaining 65% interest is held by ESG's wholly owned subsidiary Eastern Energy Australia Pty Ltd so that the production licence is now held in parity with CSG interests in PEL 238 and PAL 2.

2.4.4 Wilga Park Power Station

Development consent for the construction and operation of the Wilga Park Power Station (WPPS) was issued to Narrabri Power Limited by Narrabri Shire Council on November 14, 2002.

The power station was initially developed by ESG to commercialise the stranded conventional gas reserves of the Coonarah Gas Field. When initially developed, the power station incorporated twelve 1 MW gas engine driven generators with four associated 415V to 11kV transformers, a high voltage switchyard and an 11kV to 66kV step-up transformer.

Electricity generated at the WPPS is sold to Country Energy under a ten year Power Purchase Agreement, now in its seventh year.

Following commencement of sustained gas production from the Coonarah Gas Field, poor production performance of the conventional gas field resulted in a significant downgrade of proven gas reserves of the Coonarah field, from the 11 PJ originally estimated to 5.8 PJ. The power station was operated intermittently and at part load until recently when pipeline infrastructure was installed to allow pilot production CSG to be used at the station (refer to **Section 2.4.5** below).

In 2008, ESG sold a 35% interest in WPPS to Gastar Power Pty Ltd, a wholly owned subsidiary of Gastar Exploration Ltd. Gastar Power has since on-sold to Santos Ltd. The remaining 65% interest is held by ESG's wholly owned subsidiary Narrabri Power Limited.

2.4.5 Narrabri Coal Seam Gas Utilisation Project

As a means of utilising CSG produced during extended pilot production activities within PEL 238 and PAL 2, the NJV undertook to collect and transport the gas to the WPPS, and to progressively expand the power station. This mitigates the wasteful and environmentally undesirable venting of gas.

Initially, the pilot production gas utilisation project involved installation of a 32 km fibreglass gas flowline and expansion of the WPPS from 4 MW to 7 MW. Further expansion to as much as 40 MW is planned. The budgeted cost for expansion of the power station and installation of flow line facilities to deliver gas to the power station exceeds \$46 million.

Application was made to the Minister for Planning in February 2007 to have the pilot production gas utilisation project declared a Major Project under State Environmental Planning Policy (Major Development) 2005. Consent to proceed under Part 3A of the EP&A Act was granted in April 2007.

An environmental assessment of the project was undertaken during 2007 and final EA submitted in May 2008. The Minister for Planning granted approval for the project in December 2008.

3.0 The Proposal

3.1 Summary

ESG is proposing to progressively develop the extensive CSG resources within PEL 238 for delivery into the NSW gas market. The proposal relates to the development of the gas field including drilling of production wells, installation of gas and water gathering systems, gas processing and compression and associated (e.g. workshop, offices and camps) infrastructure and water management facilities over the next 20 years.

The CSG prospects within the Permits would be progressively expanded to provide sufficient gas supply to satisfy committed gas sales contracts. Initial estimates are that over the 20 year period the Project development would cost around \$2.3 billion in present value terms including an estimated capital cost of \$1.305 billion expended in 2012 and 2013 for the gas treatment plant and transmission compression.

The Project would also provide long term employment for in excess of 200 people with a peak employment during construction exceeding 500 people.

Much of the estimated expenditure would be incurred over a period from 2012 to 2016. However, beyond this timeframe ongoing gasfield development expenditure would be incurred through drilling and connection of wells to maintain gas production levels as gas production from initial wells declines.

3.2 The Project

3.2.1 Study Area

The Project area is located approximately 40 kilometres south-west of Narrabri in north-western NSW (refer **Figure 1**). Approximately 850 square kilometres in area, the Project area is located in an area within PEL 238 comprising the existing PAL 2 title area and incorporating the Dewhurst prospect area and the Bibblewindi, Bibblewindi West and Bohena CSG pilots (refer **Figure 3**). It forms part of a larger series of prospect areas that have been the subject of exploratory drilling being undertaken by ESG within PEL 238.

3.2.2 Proposed Development

ESG proposes to develop gas production, processing and compression infrastructure within the Project area to facilitate the commercial production of CSG. The Project will be developed progressively as gas reserves are proven and gas markets secured. The proposed development includes core drilling; seismic survey; well drilling; construction of gas and water gathering infrastructure; gas compression and processing infrastructure and water management facilities; associated workshops, administration/construction offices and camps; and operation of the above facilities.

CSG wells may produce for up to 30 years economic life, but at this stage ESG seeks first stage approval for 20 years, commensurate with initial gas sales contracts. Ultimately, approval will be required for the full economic life of the gasfield.

Following the initial development of sufficient wells to produce gas at rates to meet market requirements, ongoing development of new production wells within the Project area would be necessary to maintain CSG production levels as the performance of existing wells progressively declines.

The main components of the development include:

- Drilling and completion of coal seam gas production wells. Drilling will utilise the 'in-seam' vertical and lateral well drilling techniques similar to that currently being tested in PAL 2. The lateral well drilling technique significantly reduces the number of wells required to access gas from a given area.
- Provision of wellhead surface facilities.
- Installation of buried gathering networks to transport gas and co-produced water from wells to centralised compression and processing facilities.
- Construction and operation of a centralised gas processing plant, incorporating (but not limited to) industry standard glycol dehydration equipment together with support facilities such as power generation and workshops.

- Construction and operation of gas compression facilities, to pressurise gas for direct supply into high pressure gas transmission pipelines. Compression facilities are likely to be co-located with the gas processing plant.
- Provision of a centralised water management facility, located to optimise field hydraulics and power source.
- Construction of access roads. Existing roads and tracks will be used for access purposes and as the location for connecting infrastructure wherever possible.
- Construction of administration offices, workshop and camp facilities.

Locations of the gas production wells and associated infrastructure are dependent upon geology, resource availability, environmental and land access constraints. A Well Field Development Plan is currently being prepared, which will set out the number and proposed locations of production wells. The locations would be assessed as part of the detailed Environmental Assessment to be prepared for the Project.

In the initial stage of the Project, 60 well sets (60 vertical and 60 horizontal wells) could be drilled over the first three years, which would contribute to supporting a gas production rate of 20 PJ per annum for twenty years to supply the proposed ERM power station at Wellington. Additional wells would be required to maintain the annual production over the 20 year period. ESG expects that by 2014 it may be supplying up to 150 PJ per annum for ERM and other domestic and overseas applications.

A conceptual combination of vertical and horizontal production wells would be drilled on a well pad with maximum dimensions of 150m by 80m. The gas field would initially have a well pattern with a notional 500m spacing. As the development expands, it is anticipated that well spacing would be increased to between 750m and 1,000m or greater. A conceptual well layout is provided in **Figure 4**. The location and orientation of the production wells would be refined to ensure effective gas production and optimal gas recovery, without compromise to environmental requirements or existing land-use constraints.

3.2.3 Gas Composition

The composition of produced gas may vary somewhat over the life of the Project both as gas is produced from different coal seams and different locations, and as individual coal seams are depleted. In all cases, however, produced gas will be predominantly methane with low concentrations of nitrogen, carbon dioxide and ethane.

If the composition of produced gas is not directly suitable for delivery into gas transmission pipelines, equipment will be installed to make necessary adjustments to composition. In the event it is necessary to remove small amounts of carbon dioxide from the raw gas stream, it is presently envisaged that industry standard amine based units will be used, however detailed design will confirm the optimum extraction method.

3.2.4 Water Management

Water is a primary by-product of CSG production and the appropriate management of co-produced water is critical to the gas field development and important for the long-term social and environmental interests of the Narrabri Shire. Preliminary modelling of water production has been undertaken for the Project and is estimated to peak at between 0.08 and 0.16 ML/day/well on average. Individual well production may be outside this range.

Present ESG operations in PAL 2 employ with good success a combination of storage and evaporation with tertiary treatment and discharge (environmental flows) for co-produced water management. As there are a range of potential management, treatment, reuse and disposal options being used in CSG projects in Australia, ESG has commissioned a Water Management Strategy to investigate and assess water management options for the Project and to ensure that water produced throughout the project life is managed in a sustainable and integrated manner.

The Water Management Strategy will be developed as part of the detailed Environmental Assessment being undertaken for the Narrabri CSG project. It would be regularly updated in response to economic and environmental studies, regulatory changes, outcomes of stakeholder engagement, as operations expand and as technology improves.

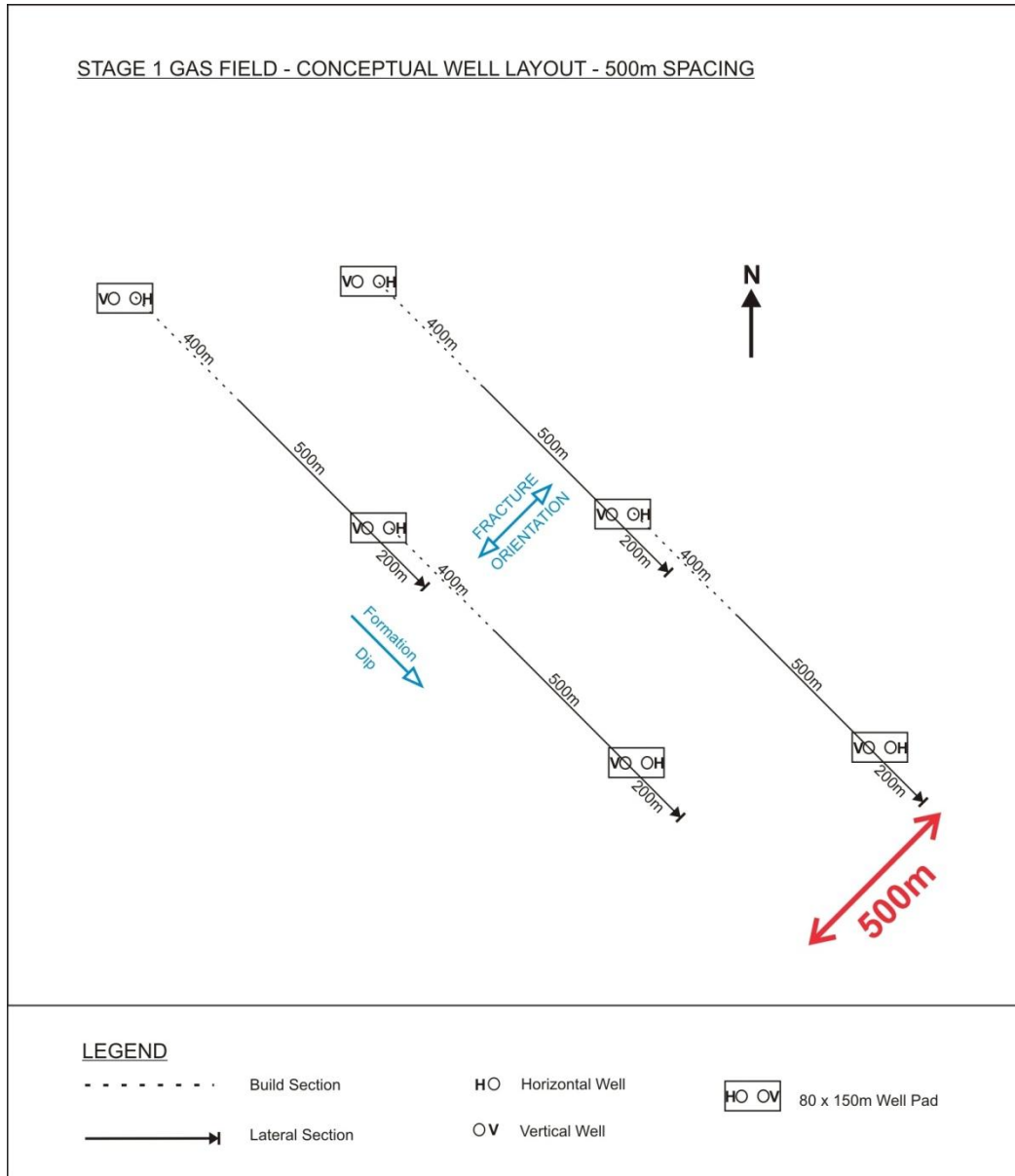


Figure 4: Conceptual Well Layout showing 500m well spacing (red)

3.2.5 Operational Activities

Operation of production wells and associated gathering pipelines, water management infrastructure and in-field compression stations will constitute the bulk of operational activities.

Day to day activities anticipated to occur during the operational phase of the Project include:

- Routine inspections and maintenance of the surface facilities;
- Well workover, which may include replacing pumps and other downhole equipment; and
- Removal of surface facilities and plugging and abandonment of wells at the expiration of their economic life.

Operational activities will be supported by the installation and use of a supervisory, control and data acquisition ('SCADA') system. Development of a purpose built SCADA system is underway in preparation for full field development. This system will provide automated and remote controlled functions for all wells, gathering and compression infrastructure. Installation of initial components of the system has already been carried out for pilot production purposes, with scalable expansion of the system to be carried out as Project development proceeds.

3.3 Relationship to other Major Projects

The Project is one component of a larger concept to supply gas to NSW and international markets.

3.3.1 Gas Transmission Pipelines

Gas produced as part of the gas field development would be transported via proposed gas transmission pipelines from Narrabri to Wellington and also from Narrabri to Newcastle. The pipelines would deliver gas to future gas markets (power stations, short term gas trading market) and/or an LNG export facility at the Port of Newcastle.

A Major Project application for the gas transmission pipeline from Narrabri to Wellington, via Coolah, has been lodged with the Department of Planning (DoP). A separate Major Project application for the gas transmission pipeline from Coolah to Newcastle will also be lodged with the DoP in 2010.

3.3.2 LNG Export Facility

The feasibility of an LNG export facility located on Kooragang Island in Newcastle is currently being investigated by ESG. If feasible, CSG from the Project area would be transported from the gas field via the transmission pipeline to the LNG facility for liquefaction and export to overseas markets.

The LNG export facility will have a proposed initial plant capacity of approximately 1 Mtpa with potential future expansion to 4MTpa. Planning and design of the LNG facility will be based on port operations, technical, environmental, safety and land use factors and will be undertaken in consultation with the Department of Planning (DoP) and other relevant agencies.

A separate Major Project application will be prepared for the proposed LNG facility pending the outcome of the feasibility study.

3.4 A Development of State Significance

In addition to normal commercial incentives to provide a return to shareholders, production of CSG from the Project area will deliver material economic, environmental and social benefits to the Narrabri region and to NSW as a whole through the provision of sufficient gas to supply NSW markets and gas fired power stations. The key benefits of the Project are outlined in the following section.

3.4.1 Gas Supply Independence for NSW

NSW is presently almost entirely dependent upon gas imported from Queensland, South Australia and Victoria to meet most of the State's requirement for gas. Only modest quantities of gas are produced by ESG, from operations within the Permits, and by AGL, from CSG operations at Camden (south of Sydney). Gas produced by ESG is used at the Wilga Park Power Station, near Narrabri, and is not connected for supply to broader State markets.

While the prospect exists for increased supply of gas from NSW locations such as Camden, Gloucester or the Hunter Valley, these sources may not by themselves be sufficient to meet State needs, particularly given prospects for rapid growth in the use of gas for electricity generation if future greenhouse gas emissions targets are to be realised.

Given the sizeable potential of the Project, already equivalent to around 50 year's supply of gas at present NSW market levels, development of the Project will allow NSW to become self-sufficient in terms of gas supply.

3.4.2 Reduced Carbon Footprint for NSW-produced Energy

Primary energy production in NSW is presently dominated by coal, which is used primarily for power generation and as a major export earner. With the likely introduction of some form of carbon impost, NSW's carbon production per unit of energy consumed can be reduced through development of indigenous gas production and by creating a gas export industry.

In addition to the positive sentiment that an improved footprint may generate, diversifying domestic energy production sources away from its current coal dominance provides NSW with greater resilience to economic changes that may occur in a carbon-costed future.

3.4.3 Security of Gas Supply and Improved Competition

Development of a new source of gas supply into NSW, will lead to an obvious and immediate improvement in security of gas supply to the State.

Development of a new, indigenous gas supply will give NSW gas markets greater choice when entering into gas purchase arrangements and, since transportation distances for domestically produced gas may be shorter, potential also exists for improved competition on price.

3.4.4 Employment and Investment

The project is expected to provide long term employment for in excess of 200 people with a peak employment during construction exceeding 500 people.

The development envisaged by this Project will be one of the largest resource-based developments ever undertaken in NSW and will be the State's first large-scale hydrocarbon resource development. Indicative capital expenditure for gas field development plus gas processing and compression plant is up to \$2.3 billion initially in present value terms having regard for ongoing stay-in-business capital expenditure. This includes an estimated capital cost of \$1.305 billion expended in 2012 and 2013 for the gas treatment plant and transmission compression.

Current development expectations would see a bulk of expenditure incurred between 2012 and 2016, but with ongoing expenditure for drilling of new wells to maintain gas deliverability as the performance of existing wells declines.

In addition to the direct and indirect economic benefits to NSW that can be quantified for a Project of this scale, there is the added reputational benefit to the State associated with the successful delivery of a large-scale hydrocarbon resource development.

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4.0 Planning Considerations

4.1 Overview

This section identifies the legislative requirements and planning controls relevant to the Project and outlines the key policy and statutory considerations that will be addressed in more detail in the EA.

The Project will be undertaken in accordance with the requirements of relevant environmental and planning legislation. All associated approvals will be obtained as required for a Major Project under Part 3A of the *Environmental Planning and Assessment Act 1979*, including but not limited to:

- Commonwealth and State Government planning approvals;
- Local government development approvals;
- Operational approvals (such as an Environment Protection Licence); and
- Other potential approvals required under relevant legislation and regulations.

4.2 Commonwealth Legislation

4.2.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires the approval of the Commonwealth Minister for Environment, Heritage and the Arts for actions that will have, or are likely to have, a significant impact on matters of national environmental significance (NES). The EPBC Act lists seven matters of NES which must be addressed when assessing the impacts of a proposal, which are:

- World Heritage properties;
- National Heritage places;
- Wetlands of International Importance;
- Listed threatened species and ecological communities;
- Migratory species protected under international agreements;
- Commonwealth Marine Areas; and
- Nuclear actions (including uranium mines).

If potential significant impacts on a matter of NES are identified, then a referral to the Minister will be made in accordance with the requirements of the EPBC Act for a determination as to whether the project is a Controlled action.

There is currently no Bilateral Agreement in place between the Commonwealth and NSW Governments, which would allow the State approval process to be accredited under the EPBC Act. Therefore a Controlled action would require approval at a Commonwealth level, in addition to any approvals under NSW legislation. The EPBC Act does, however, make provision for the NSW assessment process to be accredited for the purposes of the EPBC Act.

4.2.2 National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) came into effect in September 2007 and introduced a single national reporting framework for the reporting and dissemination of information about greenhouse gas emissions, greenhouse gas projects and energy use and production by corporations. The NGER Act makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds. ESG reports emissions from the corporation, which includes those from the gas field at Narrabri.

4.3 State Legislation

4.3.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation 2007* provide the framework for environmental planning in NSW and include provisions to ensure that proposals that have the potential to impact on the environment are subject to detailed assessment and provide opportunity for public involvement.

The development assessment and approval system in NSW is set out in Parts 3A, 4 and 5 of the EP&A Act. Part 3A sets out an assessment and approval process for major infrastructure or other major projects of State or regional environmental planning significance, for which the Minister for Planning is the approval authority. Part 3A provides a single assessment process specifically designed for major projects.

Sections 75U and 75V of the EP&A Act list the legislation that must be applied consistently to projects approved under Part 3A, as well as the approvals and authorisations required under other legislation that are not required or cannot be refused for a project approved under Part 3A of the EP&A Act.

By the operation of Clause 75B(1)(a) of the EP&A Act, this project is one to which Part 3A of the EP&A Act applies. The relationship between Part 3A of the EP&A Act and State Environmental Planning Policy (Major Development) 2005 is discussed in **Section 4.4**.

4.3.2 Petroleum (Onshore) Act 1991

Section 41 of the Petroleum (Onshore) Act (PO Act) relates to the rights of holders of production leases and states:

'The holder of a production lease has the exclusive right to conduct petroleum mining operations in and on the land included in the lease together with the right to construct and maintain on the land such works, buildings, plant, waterways, roads, pipelines, dams, reservoirs, tanks, pumping stations, tramways, railways, telephone lines, electric powerlines and other structures and equipment as necessary for the full enjoyment of the lease or to fulfil the lessee's obligations under it.'

Environmental protection requirements under the petroleum production regime are specified in Part 6, Divisions 1 to 4 of the PO Act and include:

- The need to protect natural resources;
- Rehabilitation of areas damaged by operations; and
- Removal of petroleum plant at the expiration of the petroleum production lease.

The existing PEL 238 applies to the whole of the gas field area. One or more production leases granted under section 42 of the PO Act will be required over the Project area. This production lease will allow for the drilling of the wells, gas and water gathering activities and would be sought during the approvals process. If approval is granted under Part 3A of the EP&A Act, pursuant to Section 75V (1)(d) of the EP&A Act the production lease cannot be refused and must be substantially consistent with the Part 3A approval.

4.3.3 Pipelines Act 1967

This Act regulates the construction and operation of pipelines in NSW, with certain exemptions such as those operated for the supply of water or those constructed by a public authority. A pipeline that is not exempt cannot be constructed or operated without a licence. The requirement for a licence generally relates to high pressure trunk lines and would not extend to gas and water gathering lines proposed in the gas field area.

Part 5 (1) (d) states that *'nothing in this Act requires a person to hold a licence in respect of a pipeline...for the purpose of the supply of water (including irrigation), the drainage of land or the conveyance of wastewater, mine water, aqueous slurries of materials, mineral concentrates or minerals tailings'*. Therefore water distribution pipelines for managing water would be exempt from requiring a licence.

If a Pipeline Licence granted under section 14 of the Pipelines Act is required and approval is granted under Part 3A of the EP&A Act, pursuant to Section 75V (1)(g) the Pipeline Licence cannot be refused and must be substantially consistent with the Part 3A approval.

4.3.4 Water Management Act 2000

The objective of the *Water Management Act 2000* (WM Act) is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The Water Management Act was driven by the need for NSW to secure a sustainable basis for water management. As a result, the Act recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing licence holders with more secure access to water and greater opportunities to trade water in particular through the separation of water licences from land.

The main tool the Act provides for managing the State's water resources are water sharing plans (WSP). These statutory plans are used to set out the rules for the sharing of water in a particular water source between water users and the environment and rules for the trading of water in a particular water source.

The *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003* applies to all waters contained within these water sources but does not apply to water contained within aquifer water sources underlying these water sources or to waters on land adjacent to these water sources.

The *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003* sets the framework for managing groundwater in the Lower Namoi until the end of the 2015 – 2016 water year. The Project area does not fall within the jurisdiction of the WSP for the Upper and Lower Namoi groundwater sources.

Under Section 91E of the WM Act it is an offence to carry out a controlled activity on 'waterfront land' if a Section 91 activity approval has not been granted. 'Waterfront land' is defined as the bed of any river, and land lying between the river and a line drawn parallel to and 40 metres inland from the highest bank or shore in relation to non-tidal waters. The proposed Project is likely to affect waterfront land for road and infrastructure crossings, however, if approval is granted under Part 3A of the EP&A Act, pursuant to Section 75U(1)(h) an activity approval under Section 91 of the WM Act would not be required. Where possible, well pads and infrastructure crossings would be located so as to minimise impacts on waterfront land.

Under Section 91F it is an offence to carry out an aquifer interference activity if a Section 91 aquifer interference approval is not held for that activity. The WM Act outlines what constitutes an aquifer interference activity. Those relevant to the Project include:

- a) The penetration of an aquifer;
- b) Interference with water in an aquifer; and
- c) Obstruction of flow of water in an aquifer.

A Section 91 approval would not be granted unless the Minister is '*satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to the aquifer...in the course of the activity to which the approval relates*' (Section 97). However, if approval is granted under Part 3A of the EP&A Act, pursuant to Section 75U(1)(h) an activity approval under Section 91 of the Water Management Act would not be required.

4.3.5 Protection of the Environment Operations Act 1997

Under the POEO Act it is an offence to cause water, air or noise pollution without authorisation for such under an Environment Protection Licence (EPL). Additionally, Schedule 1 of the POEO Act identifies "scheduled activities" which are required to be licensed by the DECCW. An EPL will be required for:

- Contaminated groundwater treatment (Schedule 1:15A);
- Petroleum and fuel production (Schedule 1:31) as the activity has the capacity to produce more than 5 petajoules of natural gas or methane per year;
- Application of waste to land (Schedule 1:39) i.e. discharge of treated effluent to land;
- Waste storage (Schedule 1:42) as greater than 5T (5000 L) of liquid waste would be stored on site; and
- Discharge to waters (S.120 of the Act) if treated water is discharged to a creek.

If approval is granted under Part 3A of the EP&A Act, pursuant to Section 75V (1)(e) the EPL cannot be refused if necessary for carrying out an approved project and must be substantially consistent with the Part 3A approval.

4.3.6 Brigalow and Nandewar Community Conservation Area Act 2005

This Act designates Community Conservation Areas (CCA), with the purpose to '*reserve land for permanent conservation and protection of areas of natural and cultural heritage significance to Aboriginal people, sustainable forestry and mining and other appropriate uses*' (DECC, 2008).

The Project Area is predominantly located within State Forests, which are designated as Zone 4 land, which is managed in accordance with the Forestry Act 1916. Exploration and mining within Zone 4 are managed in accordance with the Petroleum (Onshore) Act 1991 and the Mining Act 1992 and associated regulations.

4.3.7 Forestry Act 1916

The primary objective of the Forestry Act is to provide for the dedication, reservation, control, and use of State forests, timber reserves and Crown lands for forestry and other purposes. A majority of the gas field works would be undertaken within Pilliga East and Bibblewindi State Forests, therefore, an occupation permit is likely to be required. The Act states that an occupation permit may be granted by the Forestry Commission for land within a State Forest *'for any purpose approved by the commission and specified in the permit'* (Division 5, Part 4, Clause 31 (1A)).

It is an offence under the Act to cut, strip, remove, destroy or damage any timber on any Crown-timber land or to dig for, extract, obtain, remove, destroy or damage any forest materials on any State Forest, without an appropriate licence or unless it is carried out *'in pursuance of and in accordance with the provisions of the Petroleum (Onshore) Act 1991 or any petroleum title under that Act'*, which the Project will be.

4.3.8 Native Vegetation Act 2003

The Native Vegetation (NV) Act regulates the clearing of native vegetation on land in NSW, except for land listed in Schedule 1 of the Act. The gas field development will require the clearance of native vegetation, but Schedule 1, Part 2 of the Act excludes State Forest, from the operation of the Act, therefore no approvals are required under the NV Act. Furthermore, pursuant to Section 75(U)(1)(e) of the EP&A Act, an authorisation referred to in Section 12 of the NV Act to clear native vegetation or State protected land is not required for Part 3A projects.

4.3.9 Threatened Species Conservation Act 2005

The TSC Act identifies and protects threatened native plants and animals and provides for species recovery and threat abatement programs. The objectives of the Act are to conserve biological diversity and promote sustainable development, prevent the extinction of native plants and animals, protect habitat that is critical to the survival of endangered species, eliminate or manage threats to biodiversity, properly assess the impact of development on threatened species and to encourage co-operative management in the conservation of threatened species. These objectives are achieved through:

- listing of threatened species, populations and communities;
- requiring recovery and threat abatement actions to be undertaken where threatened species are impacted; and
- providing a vehicle to improve degraded environments, and to protect areas of high conservation value to threatened species.

The NSW Government recently passed the Threatened Species Conservation Amendment (Biodiversity Banking) Regulation 2008 to address the impacts of native vegetation clearing on biodiversity values, particularly threatened species. The market-based Biodiversity Banking and Offsets Scheme (or BioBanking) is intended to provide a streamlined biodiversity assessment process for development approval.

Although vegetation clearing will be required as part of the gas field development, with potential impacts on threatened species or communities, Biobanking Agreements are not required for Part 3A projects. The Environmental Assessment will, however, investigate the purchase and retirement of Biobanking credits to provide appropriate offsets, as well as alternative or complementary offset outcomes, in consultation with DECCW and DoP.

4.3.10 Roads Act 1993

During the development of the Project, works may be required in, on, under or over public roads. Where required, consents will need to be obtained under section 138 of the *Roads Act 1993*. If approval is granted under Part 3A of the EP&A Act, pursuant to Section 75V(1)(f) of the EP&A Act, authorisations under the Roads Act cannot be refused if they are necessary for the approved project and must be substantially consistent with the Part 3A approval. Consultation would be undertaken with the Roads and Traffic Authority (RTA) and Narrabri Shire Council in relation to any potential impacts on public roads.

4.4 State Environmental Planning Policies

4.4.1 State Environmental Planning Policy (Major Development) 2005

SEPP (Major Development) defines certain developments that are major projects requiring assessment under Part 3A of the EP&A Act and determination by the Minister for Planning. Schedule 1 of the SEPP describes development that is declared to be a project to which Part 3A applies.

The Project is '*development for the purpose of drilling and operation of petroleum wells (including associated pipelines)*' (Schedule 1). Accordingly, provided that the Minister for Planning forms the opinion that the project falls within this definition, by the operation of Clause 6(1) of SEPP (Major Development) the project is a project to which Part 3A of the EP&A Act applies. The Minister for Planning is the determining authority and the Director-General will prepare Environmental Assessment Requirements (EARs) to be addressed as part of an Environmental Assessment.

4.4.2 State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

This SEPP recognises the importance of mining, petroleum production and extractive industries within NSW. Clause 7 identifies development which can be carried out with development consent and includes '*petroleum production on land on which development for the purposes of agriculture or industry may be carried out*' and '*facilities for the processing or transportation of petroleum if the petroleum was recovered from that land or adjoining land*'.

Part 3 of the SEPP sets out matters which must be considered prior to granting development consent for the purposes of petroleum production. These matters relate to natural resource and environmental management, resource recovery, transport and rehabilitation, and will be addressed in the EA to be prepared for the proposed Project.

4.4.3 State Environmental Planning Policy No. 33 – Hazardous and Offensive Industries

SEPP 33 provides definitions of hazardous and offensive industries, to ensure that in determining whether a development is a hazardous or offensive industry the consent authority has adequate information and that any measures proposed to be employed to reduce the impact of the development are taken into account.

Clause 3 describes potentially hazardous industry as:

'development for the purposes of any industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:

- 1) to human health, life or property, or
- 2) to the biophysical environment.'

Potentially offensive industry is described as:

'a development which, without employing any measures to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would emit a polluting discharge in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land.'

Should it be found during the detailed environmental assessment that the proposed gas field development has the potential to cause risk to humans or the biophysical environment, or to emit a polluting discharge, then a Preliminary Hazard Analysis (PHA) would be prepared and submitted with the development application.

4.4.4 State Environmental Planning Policy No 44 – Koala Habitat Protection

The aim of SEPP 44 is to encourage the '*proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline*'. Schedule 1 lists the local government areas (LGAs) to which SEPP 44 applies and requires an investigation to be carried out to determine if "core" or "potential" koala habitat is present and is likely to be disturbed. Narrabri LGA is listed in Schedule 1 of SEPP 44.

Section 6(b) of SEPP 44 states that the SEPP applies to '*land in relation to which a development application has been made*'. Therefore, SEPP 44 does not strictly apply to Part 3A projects as development applications are only relevant under Part 4 of the EP&A Act. However, the potential for the proposed project to impact on land identified as koala habitat will be assessed in the EA.

4.5 Local Environment Plans

The Project would be located within the Narrabri LGA and is therefore subject to the provisions of the Narrabri Local Environmental Plan 1992 (LEP). The study area is located within land zoned 1(a) General Rural. The objectives of the zone are to '*promote the proper management and utilisation of resources*' by protecting, enhancing and conserving resources including:

- agricultural land;
- soil stability;
- forests of commercial value for timber production;
- valuable deposits of minerals, coal, petroleum and extractive materials;
- vegetation in environmentally sensitive areas;
- water resources;
- areas of significance for nature conservation; and
- places and buildings of archaeological or heritage significance.

The zoning also seeks to prevent the unjustified development of agricultural land, residential development of prime crop and pasture land and the fragmented development of rural land.

The relevant provisions of the Narrabri LEP would be addressed in the EA.

5.0 Project Consultation

In order to undertake a comprehensive Environmental Assessment of the proposed Project, clear and effective consultation with the community and Government agencies is required. Consultation will be undertaken to identify relevant environmental issues and potential impacts of the Project as well as to determine the key concerns held by regulators and the community.

The key objectives of the consultation will be to:

- Initiate and maintain open communication;
- Provide an understanding of the regulatory approval process to stakeholders;
- Seek local information and input into the Project by providing a range of opportunities for stakeholders to identify key issues for consideration; and
- Proactively work with the community to propose strategies to maximise benefits and minimise any negative impacts of the Project.

Consultation with relevant government agencies and non government stakeholders has commenced, and will continue for the duration of the Project. Some of the key stakeholders consulted to date include:

- Department of Planning;
- Narrabri Shire Council; and
- Department of Industry and Investment (DII) (formerly Department of State and Regional Development).

The proponent will request that a Planning Focus Meeting be arranged by the DoP at the first opportunity to enable an open forum within which to discuss key Project matters and to assist in the formulation of the Environmental Assessment Requirements.

ESG is committed to engaging with all relevant stakeholders to ensure that the potential impacts identified for the Project are avoided or minimised. To achieve this ESG will undertake all stakeholder consultation with the aim to ensure clear, transparent, two-way communication in an open transparent manner with the aim to provide stakeholders with an opportunity to express their views and concerns, provide feedback and be involved in the EA process.

This consultation program will be ongoing throughout the EA process and will continue during Project implementation. ESG will utilise a variety of communication tools and activities to inform and receive feedback from stakeholders including meetings, newsletters and presentations. ESG will ensure all the issues identified and the resultant outcomes from consultation will be recorded and fed back into the EA process.

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6.0 Risk Assessment

6.1 Identification of Potential Environmental Issues

Potential environmental issues associated with the proposed project have been identified based on existing data and knowledge of the site held by ESG, preliminary desktop investigations and understanding of the statutory framework and general approvals requirements. The issues identified include (in no particular order):

- Surface Water;
- Geology and Groundwater;
- Traffic and Transport;
- Ecology;
- Socio-Economic;
- Noise and Vibration;
- Air Quality;
- Landscape and Visual Amenity;
- Land Use;
- Heritage;
- Soils;
- Hazard and Risk;
- Sustainability, Climate Change and Greenhouse Gas; and
- Waste Management (brine).

6.2 Methodology

Risk was allocated based on the likelihood of environmental effects and the consequence of effects in the absence of mitigation and management measures, as set out in **Table 2**.

Each issue was allocated a ranking between 1 and 3 for the likelihood of occurrence and a number between 1 and 3 for the consequence of unmanaged effects. The two numbers were added together to provide a numerical ranking for the issue, which was then used to characterise each issue into high, medium and low priority using an issues prioritisation matrix.

Table 2: Categories for likelihood and consequence of potential environmental effects

Likelihood of Effect		Consequence of Effect	
3 Probable	There is likely to be an environmental effect	3 Major	International or national implications, major adverse environmental change, serious or long term cumulative impacts, mitigation measures not available.
2 Possible	There is potential for an environmental effect	2 Moderate	Regional implications, moderate adverse environmental change, modest or medium-term cumulative impacts, non-standard mitigation measures required.
1 Improbable	There is little potential for an environmental effect	1 Minor or insignificant	Localised implications, imperceptible or short-term cumulative impacts, standard mitigation measures appropriate or none required

Issues were prioritised to reflect that a higher degree of assessment is required for issues with a greater likelihood and consequence. **Table 3** presents the issues prioritisation matrix that was used to identify priority environmental and social issues for assessment.

Table 3: Issues Prioritisation Matrix

Likelihood of Effect	Consequence of Effects		
	1 Insignificant or Minor	2 Moderate	3 Major
1 Improbable	2 Low Priority	3 Low Priority	4 Medium Priority
2 Possible	3 Low Priority	4 Medium Priority	5 High Priority
3 Probable	4 Medium Priority	5 High Priority	6 High Priority

6.3 Issues Prioritisation

The prioritisation of environmental issues related to the Narrabri Coal Seam Gas Project is shown in **Table 3**. This assessment prioritises issues for assessment in the EA and does not consider the application of mitigation measures to manage the issue. In all cases, appropriate mitigation measures, chosen based upon the experience of regulators and other similar projects, will be implemented to minimise potential impacts. These measures will be described in detail in the EA.

Environmental issues identified as high or medium priority are considered to be key issues requiring further detailed assessment in the EA. Key environmental issues are described in more detail in **Section 7** and include:

- Heritage;
- Ecology;
- Surface Water;
- Groundwater;
- Noise and Vibration;
- Socio-Economic;
- Waste Management (brine); and
- Hazard and Risk.

Other low-priority environmental issues will be considered in the EA but do not require further detailed assessment. These other issues are outlined in **Section 8** and include:

- Land Use;
- Air Quality;
- Traffic and Transport;
- Landscape and Visual Amenity;
- Sustainability, Climate Change and Greenhouse Gas; and
- Soils.

Table 4: Issues Prioritisation

Issue	Likelihood	Consequence	Priority
Surface Water			
Reduction in creek and river flows and volume due to water use	1	1	2 (Low)
Degradation of creek and river water quality	1	2	3 (Low)
Alteration of flow regime and geomorphology of ephemeral creeks	2	1	3 (Low)
Consumption of potable or regulated water supply	1	2	3 (Low)
Contamination of surface waters resulting from storage of saline coproduced water or brine	2	2	4 (Medium)
Beneficial reuse of treated co-produced water	3	1	4 (Medium)
Community perceived risk of surface water impacts	2	2	4 (Medium)
Geology and Groundwater			
Cross contamination of aquifers as a result of aquifer interference during drilling	1	2	3 (Low)
Degradation of groundwater quality resulting from well drilling process	1	2	3 (Low)
Drawdown of surface aquifers resulting from dewatering of co-produced water during gas extraction	2	2	4 (Medium)
Creation of pathways for groundwater contamination through well drilling	1	2	3 (Low)
Community perceived risk of groundwater impacts	3	2	5 (High)
Traffic and Transport			
Increased local and regional traffic during construction	2	1	3 (Low)
Increased local and regional traffic during operation	1	1	2 (Low)
Ecology			
Loss and/or fragmentation of native vegetation resulting from clearing for wells, gas plant and water infrastructure	2	2	4 (Medium)
Reduced habitat availability for State listed threatened species, populations or communities resulting from vegetation clearance	2	2	4 (Medium)

Issue	Likelihood	Consequence	Priority
Disturbance of Commonwealth listed threatened species, populations or communities (EPBC Act)	1	3	4 (Medium)
Disturbance of or changes to aquatic species and communities and their habitat resulting from discharge of co-produced water	1	2	3 (Low)
Increased risk of bushfires	2	2	4 (Medium)
Socio-economic			
Job creation during construction	3	2	5 (High)
Job creation during operation	3	1	4 (Medium)
Reduced opportunity for recreation in areas of Pilliga East State Forest	2	1	3 (Low)
Benefits to local, regional and State economies	3	3	6 (High)
Noise and Vibration			
Noise and vibration disturbance to surrounding areas during drilling and construction	3	1	4 (Medium)
Noise disturbance to surrounding areas during operation	2	1	4 (Medium)
Noise disturbance along transport routes during construction	2	1	3 (Low)
Air Quality			
Localised construction related impacts on air quality (including dust)	2	1	3 (Low)
Emissions to the atmosphere (e.g. gas flaring) during operation	2	1	3 (Low)
Landscape and Visual Amenity			
Disturbance of landscape character	2	1	3 (Low)
Visual amenity impacts resulting from vegetation clearance, construction and infrastructure	2	1	3 (Low)
Land use			
Reduced potential for timber production in areas of Pilliga East State Forest	2	1	3 (Low)
Heritage			
Damage or removal of artefacts or sites or Aboriginal heritage significance	2	2	4 (Medium)
Detrimental impact on items of non-Indigenous heritage significance	1	2	3 (Low)

Issue	Likelihood	Consequence	Priority
Sustainability, Climate Change and Greenhouse Gas			
Inefficient use of resources	1	1	2 (Low)
Increased Greenhouse Gas emissions	2	1	3 (Low)
Impact of climate change on gas field infrastructure i.e. extreme and more frequent storm events, changed rainfall patterns	1	1	2 (Low)
Waste Management			
Potential contamination of land resulting from brine storage or disposal	2	2	4 (Medium)
Hazard and Risk			
Exposure of employees to hazards and risks	1	3	4 (Medium)
Exposure of surrounding population/land use to hazards and risks	1	2	3 (Low)
Soils			
Erosion and deposition of exposed soils and release of sediment laden runoff into creeks and rivers	2	1	3 (Low)

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7.0 Key Environmental Issues

This Section describes available background information and the potential environmental impacts of the proposed Project relating to the key issues identified in the risk assessment in **Section 6**. The methods of assessment that will be used in undertaking technical studies to support the EA are also presented.

7.1 Heritage

7.1.1 Existing Environment

Aboriginal Heritage

The Project area is located within the North-Western region of Local Aboriginal Land Councils (LALC) and is covered by the Narrabri and Red Chief LALCs.

Investigations previously undertaken within the Project area and surrounding region have been summarised as part of a preliminary desktop assessment undertaken for the Project. A search of the Aboriginal Heritage and Information Management System (AHIMS) administered by DECCW was also undertaken as part of the desktop assessment. The results provided by the AHIMS search and background heritage assessments have shown that the Project area consists of a rich variety of Aboriginal sites, generally occurring in association with creek lines and water bodies, with increased potential in elevated areas.

The registered sites consisted predominantly of stone artefact scatters and isolated finds, but also included open sites, burials, a rock shelter, a grinding groove and a scarred tree. Sites such as aboriginal grinding groove sites and burials are considered of particular high cultural significance to Aboriginal people, although the frequency of these sites is likely to be lower by comparison to stone artefact scatters and isolated finds.

Historic Heritage

The Project area and surrounding region was visited by early explorers, including John Oxley, Thomas Mitchell and Charles Sturt during their searches for the mythical inland sea. From the 1830s, settlers moved into the area, bringing with them sheep and cattle. There is also significant history associated with the forests of the area as exploitation of the forests was a major part of the local economy. With the introduction of rail and trams to NSW there came a market for sleepers and the forests of the region supported many sleeper-cutters and their families. Ironbark was the favoured timber due to its strength and durability and Cypress Pine was also targeted for use in the construction industry (Curby and Humphreys, 2002).

The Pilliga State Forests were dedicated in 1917, which formalised activities in the forests. Families lived in the forests, establishing semi-permanent residences. The location of these activities is not well recorded and there is the possibility that unidentified camps exist in the forests. In the 1920s and 1930s, several timber mills were established in the areas to the west of the Project area. Small timber cutters still continued to operate in the forests, under licence, but numbers reduced following WWII.

Prior to 1935, the purpose of State Forests was the production of timber. After this time the concept of 'multi-use forests' was introduced, which allowed for wildlife preservation and recreational activities. Tension often exists between these competing uses today.

Preliminary historic register searches conducted for the Project area found no listed sites of heritage significance within the Project area. There is the possibility that isolated sites of historic importance exist within the Project area, such as evidence of wood and sleeper cutter camps. The discovery of these sites would demonstrate historical uses of the forests and provide an insight into the development of forest management practises.

7.1.2 Issues for Consideration

Gas field development activities including well drilling, installation of gas/water gathering systems, earthworks, construction of access roads and water management infrastructure, will result in surface and sub-surface impacts. Therefore there is potential for heritage values to be impacted, particularly in areas associated with creeklines and water bodies.

The identification and protection of Aboriginal and historic heritage in the existing CSG exploration area will be addressed in the EA. Due to the potential risks of the proposed Project impacting on Aboriginal heritage, a cultural heritage assessment will be undertaken as part of the EA.

7.1.3 Method of Assessment

A heritage assessment would be undertaken in accordance with relevant guidelines prepared specifically for development applications assessed under Part 3A of the EP&A Act.

Consultation with DECCW and Aboriginal groups will be required to establish the scope of surveys and assessment to be undertaken as part of the EA. The statutory Aboriginal stakeholder consultation process is already underway for the Project.

The heritage assessment would include:

- Background research, including:
 - Identify statutory requirements relevant to the proposed Project;
 - Consultation with the Aboriginal community and other interested stakeholders in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010);
 - Literature review of previous archaeological studies relevant to the Project area; and
 - Search of the AHIMS database and historic heritage registers.
- Field survey, targeted in higher risk areas determined through background research and in consultation with the Aboriginal community.
- Impact assessment including:
 - Assessment of Aboriginal archaeological and cultural heritage items identified within the Project area;
 - Baseline inventory of all heritage sites inside the Project area; and
 - Evaluate known, potential and cumulative impacts of the proposed Project on heritage.
- Prepare mitigation and management strategies and identify measures to avoid and/or minimise identified impacts on heritage.
- Identify residual environmental risk.

7.2 Ecology

7.2.1 Existing Environment

The Project area is located predominantly within the Pilliga East, Bibblewindi and Jack's Creek State Forests, with some isolated areas of freehold land occurring within the Project area. The State Forests are managed for timber production as well as recreation and conservation values. Freehold land in the north and east of the Project area, consists primarily of agricultural land used for cropping and pastoral (livestock) activities. Land to the south and west of the Project area is predominantly Crown lands consisting of State Forest, National Park or Conservation Areas. Land to the north and east of the study area is predominantly freehold agricultural land.

The Project area falls within the Brigalow Belt South Bioregion, which extends from the mid-Queensland coast and continues south of Dubbo in the central-west of NSW. The bioregion is characterised by *Acacia harpophylla* (brigalow), however vegetation in the State Forests within and surrounding the Project area, commonly consist of Narrowleaved ironbark *Eucalyptus crebra* community, comprising varying amounts of White cypress pine *Callitris glaucophylla* and Bull oak *Allocasuarina luehmannii*. Pilliga box *Eucalyptus pilligaensis*, Brown bloodwood *Corymbia trachyphloia*, Roughbarked apple *Angophora* spp, Brigalow *Acacia harpophylla* and Red gum *Eucalyptus* spp, are less common communities and also have varying amounts of White cypress pine and Bull oak.

Threatened Communities Database Search

An EPBC Act Protected Matters Report generated for the study area in June 2010 identified five Threatened Ecological Communities (TECs) listed under the EPBC Act with the potential to occur within a 10 km radius of the study area. These communities are also listed under the TSC Act.

These include:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) – Endangered.
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia - Endangered.

- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland – Critically Endangered.
- Weeping Myall Woodlands - Endangered.
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – Critically Endangered.

The presence or absence of these threatened communities within the Project area will be investigated during the preparation of the EA.

Threatened Flora Database Searches

Searches of the NPWS Atlas of NSW Wildlife and EPBC Act Protected Matters Search Tool were conducted to determine if any threatened flora species listed under the TSC Act or EPBC Act are likely to occur in the Project area.

A total of 12 endangered or vulnerable flora species under the TSC Act and/or the EPBC Act were identified as known or potentially occurring within 10 km of the study area (**Table 5**). Of these, all 12 are EPBC Act listed species (two endangered, nine vulnerable, one critically endangered) and four are listed under the TSC Act (all vulnerable). The presence or absence of threatened flora species within the Project area will be investigated during the preparation of the EA.

Table 5: Threatened flora species with potential to occur in the study area

Scientific Name	Common Name	TSC Act Status*	EPBC Act Status*	NPWS Atlas of NSW Wildlife Record within 10km of study area
<i>Bertya opposens</i>	-	V	V	Yes
<i>Cadellia pentastylis</i>	Ooline	-	V	No
<i>Digitaria porrecta</i>	Finger Panic Grass	-	E	No
<i>Diuris sheaffiana</i>	Tricolour Diuris	-	V	No
<i>Lepidium aschersonii</i>	Spiny Peppergrass	V	V	No
<i>Philothea ericifolia</i>	-	-	V	No
<i>Prasophyllum</i> sp. <i>Wybong</i> (C.Phelps ORG 5269)	a leek-orchid	-	CE	No
<i>Pterostylis cobarensis</i>	Greenhood Orchid	V	V	No
<i>Rulingia procumbens</i>	-	V	V	Yes
<i>Swainsona murrayana</i>	Slender Darling-pea	-	V	No
<i>Thesium australe</i>	Austral Toadflax	-	V	No
<i>Tylophora linearis</i>	-	-	E	No
* V = Vulnerable, E = Endangered, CE = Critically Endangered, - = Species not listed				

Information obtained from the NPWS Atlas of NSW Wildlife (DECCW), shows that there are records of two threatened flora species occurring within 10km of the study area: *Bertya opposens* and *Rulingia procumben*.

Threatened Fauna Database Searches

Searches of the NPWS Atlas of NSW Wildlife and EPBC Act Protected Matters Search Tool were conducted to determine if any threatened fauna species listed under the TSC Act or EPBC Act are likely to occur in the vicinity of the Project area.

A total of 36 endangered or vulnerable fauna species known or potentially occurring within 10 km of the study area were identified in the searches (refer **Table 6**). Of these, 11 are EPBC Act listed species (three endangered and eight vulnerable) and 30 are listed under the TSC Act (five endangered and 25 vulnerable). The presence or absence of threatened flora species within the Project area will be investigated during the preparation of the EA.

Table 6: Threatened fauna species with potential to occur in the study area

Scientific Name	Common Name	TSC Act Status*	EPBC Act Status*	NPWS Atlas of NSW Wildlife Record within 10km of study area
Birds				
<i>Burhinus grallarius</i>	Bush Stone-curlew	E	-	Yes
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	-	Yes
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	-	Yes
<i>Climacteris picumnus</i>	Brown Treecreeper	V	-	Yes
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	Yes
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	Yes
<i>Grantiella picta</i>	Painted Honeyeater	V	-	No
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	V	-	No
<i>Hieraetus morphnoides</i>	Little Eagle	V	-	No
<i>Lathamus discolor</i>	Swift Parrot	-	E	No
<i>Leipoa ocellata</i>	Malleefowl	-	V	Yes
<i>Lophoictinia isura</i>	Square-tailed Kite	V	-	No
<i>Melanodryas cucullata</i>	Hooded Robin	V	-	Yes
<i>Neophema pulchella</i>	Turquoise Parrot	V	-	Yes
<i>Ninox connivens</i>	Barking Owl	V	-	Yes
<i>Polytelis swainsonii</i>	Superb Parrot	-	V	Yes
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	-	Yes

Scientific Name	Common Name	TSC Act Status*	EPBC Act Status*	NPWS Atlas of NSW Wildlife Record within 10km of study area
<i>Pyrrholaemus saggitatus</i>	Speckled Warbler	V	-	Yes
<i>Rostratula australis</i>	Australian Painted Snipe	-	V	No
<i>Stagonopleura guttata</i>	Diamond Firetail	V	-	Yes
<i>Tyto novaehollandiae</i>	Masked Owl	V	--	Yes
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	E	No
Mammals				
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Yes
<i>Chalinolobus picatus</i>	Little Pied Bat	V	-	Yes
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	-	No
<i>Leporillus conditor</i>	Greater Stick-nest Rat	E	-	Yes
<i>Macropus dorsalis</i>	Black-striped Wallaby	E	-	Yes
<i>Nyctophilus timoriensis</i> (South-eastern form)	Greater Long-eared Bat	V	V	Yes
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-	Yes
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V	Yes
<i>Phascolarctos cinereus</i>	Koala	V	-	Yes
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	V	Yes
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	-	Yes
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	-	Yes
Frogs				
<i>Litoria booroolongensis</i>	Booroolong Frog	-	E	No
Reptiles				
<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	-	V	No
* V = Vulnerable, E = Endangered, - = Species not listed. Fish are not included as they are not considered likely to occur within the study area.				

Information obtained from the NPWS Atlas of NSW Wildlife (DECCW), shows that there are records of twenty six threatened fauna species occurring within 10km of the study area (refer **Table 6**). In addition to species records listed in **Table 6** there are records of two additional threatened species, pale headed snake (*Hoplocephalus bitorquatus*) and spotted harrier (*Circus assimilis*), both of which are listed as vulnerable under the TSC Act.

Migratory Species

A search of the EPBC Act Protected Matters Search Tool identified five migratory terrestrial bird species protected under the Act that are likely to occur in the Project area. Migratory terrestrial species listed below have the potential to occur in the study area:

- *Haliaeetus leucogaster* (White-bellied Sea-Eagle).
- *Hirundapus caudacutus* (White-throated Needletail).
- *Leipoa ocellata* (Malleefowl).
- *Merops ornatus* (Rainbow Bee-eater).
- *Xanthomyza phrygia* (Regent Honeyeater).

Migratory wetland birds, birds that fly over marine areas and migratory marine species have not been listed above as their habitat is not considered likely to occur in the study area.

Fire

The study area is part of the large semi-arid forest, woodland and shrub complex known as the Pilliga Scrub. The Scrub has an extensive fire history, with about 400 fires recorded in the last fifty years. The eastern Pilliga Scrub has been described as 'big fire country', where periodically, a single large fire will affect a major proportion of the scrub. Major fires that affected the Pilliga East State Forest occurred in 1951/52, 1957/58, 1974/75, 1982/82, 1997/98 with the most recent large fires occurring in 2006. Major fire seasons in the Pilliga have occurred at least once every decade and have been associated with drought periods and when the Southern Oscillation Indices were either very low, or declining (NPWS, 2006).

7.2.2 Issues for Consideration

The proposed works, including preparation of well sites, access and surface gas and water gathering infrastructure, will involve the removal of discreet areas of native vegetation (**Plate 1**). There is the potential for endangered ecological communities, threatened species, populations and communities to exist in several locations within the Project area and could therefore pose a constraint to locating wells and gas/water gathering infrastructure.

Detailed ecological surveys of the footprint of the gas fields works would be undertaken as part of the EA to assess the extent that the construction works would impact on listed endangered ecological communities and threatened species and to determine suitable mitigation measures to offset disturbance to flora and fauna. Constraints posed by threatened species are likely to be able to be overcome through appropriate site/route selection for wells and gas/water gathering infrastructure that is sensitive to areas of high ecological value.

The Project would be located in an area of high bushfire activity. Fire hazard would be addressed during the preparation of the EA.



Plate 1: Example of vegetation clearing required for a typical well

7.3 Surface Water

7.3.1 Existing Environment

The Project area is located in the Namoi River catchment and within tributary catchments of Bohena, Bibblewindi and Jacks Creeks. The Namoi River catchment covers an area of approximately 42,000 square kilometres and has been used extensively for agricultural activities for over 100 years. It is one of Australia's most developed irrigation areas, supporting significant cotton and broadacre cropping (mainly sorghum, sunflower and wheat) as well as other crops, and some sheep and cattle grazing. The catchment provides vital water resources to local agriculture as well as local townships that rely on surface and groundwater for both domestic use and drinking water. The Namoi River in the vicinity of the Project areas flows in a north-westerly direction and ranges approximately 15 to 45 km to the north-east of the Project area.

Bohena Creek, Bibblewindi Creek and Jacks Creek are a series of low sinuosity, fine grained, ephemeral rivers which remain dry for extended periods between runoff events, sometimes for periods in excess of 12 months. Baseflows are insignificant and the creeks generally flow for short periods after significant rainfall events or protracted wet periods.

7.3.2 Issues for Consideration

In the absence of management measures, erosion and sedimentation resulting from construction activities for the gas field development have the potential to impact on surface water quality.

Management of co-produced water from the dewatering and production process is a key issue for the Project. Co-produced water will be treated in dedicated water treatment facilities. Treated water would be managed according to the preferred strategic reuse or disposal option identified in a Water Management Strategy (WMS) being prepared for the Project. Options being considered include reuse in gas field operational activities, agricultural supply and recharge of surface aquifers via discharge to ephemeral creeks or rivers.

7.3.3 Method of Assessment

Water management would be further investigated as part of the EA. The WMS currently under preparation will provide a strategic management framework for the long term adaptive and sustainable management of co-produced water from wells in the Project area.

The scope of the WMS includes:

- Describe the existing surface and groundwater environment.
- Provide a water balance for the Project.
- Provide a detailed assessment of groundwater conditions and connectivity.
- Develop and assess water management options.
- Recommend a preferred water management option for further detailed assessment.

Outcomes and recommendations of the WMS will be described and assessed as part of the EA.

A hydroecological assessment would be undertaken to investigate constraints and opportunities associated with beneficial discharge of treated co-produced water to ephemeral creeks or rivers in and around the Project area. The results of the assessment would inform the WMS and be presented in the EA.

7.4 Geology and Groundwater

7.4.1 Existing Environment

Geology

The Project area is located predominantly within the northern portion of the Gunnedah Basin. The Gunnedah Basin is part of the larger Sydney-Gunnedah-Bowen Basin system and consists of Early Permian to Late Triassic aged consolidated sediments (including ESG's target coal seams) of shallow marine and fluvial origin. These sediments are underlain by basement rocks of the Lachlan Fold Belt (Barnes *et al*, 2002). Basement rocks of the New England Fold Belt abut the eastern boundary of the Gunnedah Basin.

The most important structure of the Gunnedah Basin within the Project area is the Bohena Trough. The Bohena Trough contains two well developed coal measures:

- The Late Permian Black Jack coal measure, which contains the Hoskissons coal seam (a 6m to 10m thick, laterally extensive seam, at a depth of less than 700m).
- The Early Permian Maules Creek coal measure, which contains ESG's primary coal seam gas target, the Bohena coal seam (a 22m thick, laterally extensive seam, at depths of between 600m and 1,200m).

Younger sediments of the Surat Basin (a sub-basin of the Great Artesian Basin) overlie the Gunnedah Basin sediments, except in the north-west of the study area, where the sediments of the Surat Basin directly overlie basement rocks of the Lachlan Fold Belt. The Pilliga Sandstone is the most regionally extensive unit of the Surat Basin sequence. It comprises medium to coarse-grained quartz sandstone of fluvial origin (Barnes *et al*, 2002) and either outcrops or occurs at relatively shallow depths beneath the study area.

Quaternary sediments associated with remnant and present-day drainage systems overlie the Surat Basin sediments.

Hydrogeology

There are three main hydrogeological features beneath the Project area:

- Alluvial aquifers associated with remnant and present-day drainage systems such as the Namoi River and its tributaries including Bohena Creek;
- Pilliga Sandstone aquifers in which water is most likely transmitted via bedding planes, fractures and joints within the consolidated sediments; and
- Water bearing Hoskissons and Bohena coal seams, within which water is transmitted via joint patterns. The Napperby formation and/or Purlawaugh formation act as confining layers.

Groundwater Use

Groundwater in the Namoi catchment supports an irrigation industry worth in excess of \$380 million as well as supplying water for many towns and intensive industries such as feedlots (Namoi CMA, 2010). Local drinking water for Narrabri and Boggabri is sourced from groundwater bores close to the townships.

Groundwater irrigation in the vicinity of the Project area utilises water from the Lower Namoi Alluvium and Great Artesian Basin intake beds. The closest large scale groundwater irrigation in proximity to the Project area occurs along the Namoi River generally between Narrabri and Boggabri to the north and north-east of the Project area. Between this area and the Project area are several agricultural properties used for dryland cotton, non irrigated cropping and pasture. These properties use predominately groundwater for domestic and stock use.

7.4.2 Issues for Consideration

The potential impacts to groundwater within the Project area are primarily related to the potential for drawdown of deep groundwater as a result of the dewatering required during the gas production process. Groundwater studies completed for the Project to date have suggested that the confining layers of the Napperby shale restricts the hydraulic communication between the water bearing Great Artesian Basin units and coal measures such that these groundwater aquifers are not likely to be impacted by the dewatering process. The potential impacts associated with aquifer drawdown will be investigated in the EA.

The volume of co-produced water that would arise during CSG extraction will vary depending on geology (coal thickness, aquifer recharge, etc) as well as the stage of the CSG production cycle. Water production volumes from CSG wells are generally characterised by higher production rates immediately following well establishment, followed by a decline in volume over the life of the well. Water production rates, however, can be highly variable even amongst individual wells within the same gas field.

The quality of the associated water is variable by location, but in general remains relatively consistent over time for a given location. Co-produced water frequently contains elevated total dissolved solid concentrations, including sodium, bicarbonate and chloride. Other parameters such as, but not limited to, heavy metals, dissolved oxygen, suspended solids, calcium and magnesium can also be present at levels which result in poor water quality. Inappropriate management of CSG co-produced water can potentially result in detrimental impacts on the environment. Treatment, use and disposal of co-produced water present a challenge for the Narrabri CSG project, but ESG is currently investigating a number of options for beneficial use of co-produced water and sustainable management of this important natural resource.

7.4.3 Method of Assessment

A WMS being prepared for the gas field will provide a strategic framework for managing co-produced water and it will ensure that water produced throughout the project life is managed in a sustainable and integrated manner. An integral component of the WMS is a detailed groundwater assessment for the Project area, which is currently underway.

7.5 Noise and Vibration

7.5.1 Existing Environment

The CSG field is predominantly located within the Pilliga East State Forest and surrounded by rural environment with low residential density. Existing noise sources are typical of the State Forest/rural environment and include localised vehicular traffic, commercial logging and farming activities.

7.5.2 Issues for Consideration

CSG field development will require significant construction effort. The generation of construction noise will occur from a variety of sources including vegetation clearing activities; drilling activities; earthworks associated with site preparation works; and construction of gas processing and compression infrastructure and water management facilities. There are also likely to be localised impacts on noise relating to construction traffic movements. Given the distances to sensitive receptors, the rural based setting of low population density and relatively short term nature of these activities, the impact of construction noise is expected to be low.

During operation, the Project will generate noise from such sources as on-going drilling activities and operation of the gas compression and processing plant and water management plant.

7.5.3 Method of Assessment

An assessment of noise and vibration for the proposed Project will be undertaken and the methodology proposed for the assessment would include:

- Determine existing background noise levels;
- Determine sound power levels of all acoustically significant plant and equipment to be operated during construction and operation;
- Analyse noise data with reference to local weather conditions and cumulative impacts;
- Impact assessment of construction and operational noise and vibration, including considerations of cumulative impacts, sleep disturbance impacts and traffic noise at identified nearest potential receivers, for day, evening and night time periods under calm and prevailing meteorological conditions;
- Identify noise management strategies and mitigation measures, as required; and
- Identify any residual environmental risk.

The assessment would be undertaken in accordance with government policy and guidance, including: The *Interim Construction Noise Guidelines* (DECC, 2009), the *NSW Industrial Noise Policy* (EPA, 2000) and the *Environmental Criteria for Road Traffic Noise* (EPA, 1999). Consultation with potentially affected landholders would be undertaken to identify any potential impacts before they occur and management controls would be adopted to minimise such impacts.

7.6 Socio-Economic

The proposed development has the potential to result in a beneficial social impact for the regional economy through local business investment and employment generation. In the short term, construction activities associated with the well drilling and construction of the gas processing, gas compression and water management facilities are expected to generate a large number of jobs and contribute directly to the local economy. The Project would also have indirect benefits to the local economy by drawing on local goods and service providers (e.g. contractors, caterers, transport services).

The Project would also generate direct employment at the gas processing and water treatment facilities, as well as supporting ancillary activities in the local economy. Specific details on workforce numbers and accommodation requirements are not known at this point and will be influenced by the timing and intensity of field development activities. However, it is estimated that the Project will generate employment for 200 people in the long term and for over 500 people during construction.

Potential adverse social impacts from the Project may include alterations to property access, increased or altered traffic movements, landscape and visual impacts and reduced recreational access to the Pilliga East State Forest. The operations are not anticipated to have significant negative social impacts in the long term.

As part of the EA a socio-economic assessment of the Project would be conducted and measures identified to minimise any potential negative impacts.

7.7 Waste Management

7.7.1 Existing Environment

The primary waste product currently produced within the Project area is brine that results from the treatment of co-produced water from the gas wells within the ESG gas production areas. The highly-saline effluent is currently stored in a purpose-built evaporation pond that has been appropriately engineered, constructed and lined with a 2mm thick liner to mitigate any risk of land or groundwater contamination.

ESG has developed a Waste Management Plan for its operations in Narrabri. The plan would be amended to incorporate the proposed gas field development. The primary objectives of the plan are to ensure operations are carried out in accordance with legislative requirements and accepted industry practices to protect identified environmental values relevant to the area including:

- Use and management of resources;
- Surface water and groundwater contamination; and
- Soil contamination.

The Waste Management Plan provides a framework for addressing relevant aspects of waste management and to ensure that waste management practices are sustainable and comply with ESG policies, industry standards, legislative obligations and licence conditions.

7.7.2 Issues for Consideration

Construction waste is likely to be generated during the development of the gas fields, construction of gas processing and compression infrastructure and water management facilities. The primary waste produced during operation of the gas field will be highly concentrated brine resulting from water treatment. Options for brine disposal would be assessed as part of the EA.

7.7.3 Method of Assessment

Measures to minimise the production of waste and to appropriately dispose of waste would be investigated as part of the EA. Brine management is being investigated as part of the WMS that is in preparation for the Project.

Controls would be identified in the EA and the existing Waste Management Plan would be amended if required.

7.8 Hazards and Risks

7.8.1 Issues for Consideration

SEPP 33 Hazardous and Offensive Developments is aimed at ensuring hazard and risk for potential hazardous and offensive industries is assessed.

The construction and operation of the gas production wells, compression and processing infrastructure and water management facilities may result in the potential for isolated risks and hazards to the health and safety of the workforce and the local community. The Project is also located in an area prone to bushfires, which could present a hazard to employees and gas infrastructure. The EA would therefore incorporate an assessment of potential hazards and risks.

7.8.2 Method of Assessment

Hazard identification and screening would be undertaken and a preliminary hazard analysis (PHA) would be undertaken as part of the EA, in accordance with the provisions of SEPP 33.

The assessment would assist in identifying the scope and nature of control measures including emergency and fire response plans, fire and rescue training and natural disaster contingency plans. Specific attention would be given to mitigation of risks on the health and safety of the workforce and local community.

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8.0 Other Environmental Issues

8.1 Land Use

The Project area is located within the Shire of Narrabri and is therefore subject to the provisions of the Narrabri Local Environmental Plan 1992 (LEP). The study area is located within land zoned 1(a) General Rural. The objectives of the zone are to '*promote the proper management and utilisation of resources*' by:

- a) protecting, enhancing and conserving: agricultural land; soil stability; forests of commercial value; trees and vegetation; valuable mineral, coal and petroleum deposits; water resources; areas of conservation significance; and places of heritage or archaeological significance.
- b) preventing unjustified development of agricultural land.
- c) preventing residential development of prime crop and pasture land.
- d) facilitating farm adjustments.
- e) ensuring that any allotment created for an intensive agricultural pursuit is potentially capable of sustaining a range of such purposes or other agricultural purposes.
- f) minimising the cost to the community of fragmented and isolated development of rural land, and of providing, extending and maintaining public amenities and services.

The Project area is located predominantly within the Pilliga East, Bibblewindi and Jack's Creek State Forests, which are managed for timber production, recreation and conservation. The State Forests are within a Community Conservation Area (CCA), designated by the *Brigalow and Nandewar Community Conservation Area Act 2005*. The State Forests are designated as Zone 4 land, which is managed in accordance with the Forestry Act 1916.

There are hundreds of kilometres of roads and management tracks within the State Forests that are publically accessible for recreational activities such as bird watching, bushwalking and shooting e.g. of wild pigs.

Areas to the south and west of the Project area are predominantly Crown lands consisting of State Forest, National Park or Conservation Areas. Land tenure is predominantly freehold to the north and east of the Project area, consisting primarily of agricultural land use including irrigation, dry-land cropping and pastoral (livestock) activities.

The Project area is located in the Namoi River catchment. Creeks within the Project area are generally ephemeral drainage lines, depressions and chains of ponds, characterised by a range of geomorphic features. Vegetation within the riparian zone generally includes sedges and native grasses.

Being predominantly State Forest, there are few electricity transmission lines within the Project area. To the north east of the Project area there are two TransGrid 133 KV transmission lines which link Narrabri and Tamworth, passing through Gunnedah. As part of their CSG Utilisation Project, ESG constructed a 32km underground gas transmission pipeline from the Bibblewindi Pilot area to the Wilga Park gas-fired power station, located approximately 10km south-west of Narrabri and to the north-west of the Project area.

There are three existing open cut coal mines in the Narrabri Shire: Whitehaven, Tallawonga and Boggabri. These mines extract premium coal for export markets and are located to the east of the Project area.

Land use issues resulting from the Project would be considered in the EA, including permissibility, compatibility with existing land use and impacts on surrounding rural land use.

8.2 Air Quality

Sources of emissions to the atmosphere resulting from the Project could include flaring, venting, vehicle exhaust, generators associated with operation of the gas compressor and water treatment stations and dust associated with construction, drilling activities and transport movements. Atmospheric emissions associated with Project could include:

- Carbon dioxide (CO₂);
- Carbon monoxide (CO);
- Nitrogen oxides (NO_x);
- Sulphur dioxide (SO₂);
- Volatile organic compounds (VOCs); and
- Particulates and dust.

Air quality impacts, including Greenhouse Gas emissions, associated with field development activities would be considered as part of the EA and management controls to minimise potential impacts would be identified.

8.3 Traffic and Transport

With the predominantly forestry and rural based land use of the gas field development area, transport infrastructure is minimal with a number of rural secondary roads linking the major regional road network. Most of the roads within the Project area are unsealed forest roads and management tracks. There are very few roads or tracks in the south-eastern part of the Project area.

To the west of the Project area is the Newell Highway, extending more than 1000 km from Goondiwindi (QLD) to Tocumwal (VIC), via Narrabri. To the east of the site is the Kamilaroi Highway, which extends from Willow Creek (south of Tamworth) to Bourke, passing through Narrabri.

The North-Western Branch Railway (Narrabri to Werris Creek) is located to the north-east of the Project area, roughly following the alignment of the Kamilaroi Highway. The line is used for passenger services as well as transporting freight (wheat, coal) from the Northern Tablelands to Sydney.

Existing gas field developments within the Permits have resulted in the construction of a number of gas field access roads (predominantly unsealed roads).

The Project is not expected to have a significant impact on traffic movements and transport. The construction stage of the Project has the greatest potential for the generation of additional traffic movements such as construction machinery, private vehicles and delivery vehicles. Development of the gas field and associated infrastructure is likely to require the construction of new access roads and tracks. Wherever possible, the Project will utilise existing access and tracks.

The potential impacts on traffic and transport during construction and operation would be considered as part of the EA.

8.4 Landscape Character and Visual Amenity

The Project would be developed within a landscape of continuously forested areas with a rural landscape character. The Project is located within the Brigalow Belt South Bioregion, more specifically within the Pilliga Outwash, Pilliga (Part A) and the Liverpool Plains subregions (NPWS, 2003). The elevation of the Project area is approximately 250 metres above sea level (asl) in the west rising to approximately 350 to 400 metres asl to the east. To the south and east of the study area, the topography rises more steeply with some areas greater than 600 metres asl, whilst to the north the topography is generally more flat and below 250 metres asl.

Landscape and visual amenity impacts are likely to be localised within the remote setting of the State Forest and could result from a variety of activities associated with the gas field development including vegetation clearing, earthworks, site preparation works, drilling activities and construction of gas processing and compression facilities and water management infrastructure. Most impacts will be confined to within the forested areas and generally not in proximity to sensitive receptors such as tourist facilities, residential development and public roads.

Freehold agricultural land in the north-west and south-east of the Project area has a rural landscape character and is generally cleared of vegetation with isolated houses and farm buildings.

The existing landscape character of the Project area and surrounds would be described in the EA. An assessment of potential impacts on landscape and visual amenity would be undertaken and measures to avoid or minimise impacts to the landscape and visual amenity would be proposed where required.

8.5 Soils

The Project proposes to drill and complete development wells in prospect areas within the Project area, as well as installing the related operational infrastructure such as access roads, gas gathering, compression and water gathering networks. Construction activities and vegetation clearing would disturb soils and expose large areas of cleared ground. This in turn would have the potential to result in soil erosion and deposition. If these impacts are carefully managed, the Project is unlikely to have significant environmental impacts on soils and geology.

The EA would consider potential risks to soils during construction and operation. The assessment would also identify appropriate controls (such as sediment and erosion controls, and a rehabilitation strategy) to minimise impacts on soils.

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9.0 Conclusion

The Narrabri Coal Seam Gas project includes well drilling, construction of gas and water gathering and treatment infrastructure and operation of gas processing and compression facilities. Major Project approval under Part 3A of the *Environmental Planning and Assessment Act 1979* is being sought to facilitate the development and production of gas to meet gas demand and sale commitments over the next 20 years.

This PEA has described the key components of the project and includes an initial assessment of the key environmental issues associated with the Project. It has been prepared to assist the Director General in providing targeted Environmental Assessment Requirements, which would form the basis for preparation of the detailed EA for the Project.

The key environmental issues identified for the Project include:

- Heritage
- Ecology
- Surface Water
- Groundwater
- Noise and Vibration
- Socio-Economic
- Waste Management (brine)
- Hazard and Risk

These issues would be considered in detail in the EA. Other environmental issues would be addressed as part of the EA, although such issues are not expected to have significant environmental impacts and would be managed through the implementation of appropriate mitigation measures.

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