



The Narrabri Coal Seam Gas Project

Operations and Water Management Plan

PAL 2, Gunnedah Basin

New South Wales

September 2008

1 Executive Summary

Eastern Star Gas Limited is the operator of the Narrabri Coal Seam Gas Project located within Petroleum Assessment Lease No.2, Northern NSW. The main objective of this management plan is to account for the safe and effective management of gas and water produced from the CSG production wells within the existing approval and regulatory framework. The provision of adequate water management capacity is a critical, ongoing step in establishing the viability and commerciality of the gas reserves

This updated water and operations management plan is to be appended to the current approved plan which governs the operation of Bibblewindi CSG Pilot. At this stage, all water and gas produced from the CSG wells is gathered, treated, reused and stored at the dedicated water management facility located at Bibblewindi-1. The development of additional production pilots, in this case the Bibblewindi Lateral CSG Pilot, will require the revision of the water management strategy and the inclusion of plans to expand the proposed treat and dispose strategy.

The completion of a pilot water treatment project at Bibblewindi suggests that the reverse osmosis treatment process is capable of providing the project with significant reductions in saline water storage requirements. With rates of recovery having exceeded 70% over the pilot period and water quality below 250mg/l, permeates discharged from the treatment plant are able to be reused or disposed of through all available means.

The proposed disposal of up to 1ML of water per day into Bohena Creek is unlikely to create any long term detrimental effects on surface and groundwater systems associated with the creek system and accordingly unlikely to result in impacts contrary to the water quality and river flow guidelines in effect for the Namoi River catchment as defined by ANZECC and ARMCANZ.

The provision of this document fulfills the company's responsibility under Part 5, Section 111 of the *Environmental Planning and Assessment Act 1979* in which the determining authority (NSW Department of Primary Industries – Mineral Resources) is required to consider the likely and actual environmental impacts of the activity.

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Location of lands referred to by REF

The additional production activity will occur 4000m south/southeast of the Bibblewindi CSG Pilot. The water and gas will be gathered from this location and transferred back to Bibblewindi-1 for management, treatment and further transportation where described. The project area is situated approximately 40km south of Narrabri within the Bibblewindi State Forest (figure 2).

Declaration

Eastern Star Gas Ltd declares the information contained within this document an accurate representation of the existing operational environment and the extent of impacts likely to occur as a result of the proposed development. Eastern Star has endeavoured to characterise the environment within which the project is located and with the assistance of Government agencies and external contractors mitigate environmental impacts and ongoing operational risks.

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2 Introduction

Eastern Star Gas Ltd (“ESG”) is the current operator of the Narrabri Coal Seam Gas (“CSG”) Project. In partnership with Gastar Exploration Ltd, ESG continues to develop the Narrabri Coal Seam Gas Project located to the south of the Narrabri Township.

The management of formation waters associated with CSG production is a critical aspect to the successful development of this natural resource. It has become apparent that the commercialisation of alternative sources of energy, in particular CSG, is no longer simply a matter of geology and engineering capabilities. The exploration for and the conversion of these hydrocarbon sources requires equal attention to be paid to the geology, engineering and environmental requirements of the regions that contain them. ESG and its joint venture partners are committed to developing the CSG gas reserves of NSW within the bounds of ecologically sustainable development protocols and in line with current NSW legislation.

In conjunction with the environmental review completed for the Narrabri Coal Seam Gas Lateral Program, the following water and operations management plan describes the proposed installation and operation of gas and water gathering infrastructure linking the lateral pilot to the existing Bibblewindi CSG Pilot and water management facility.

The Gas Gathering System (GGS) will comprise two buried low pressure flow lines that will collect separated water and gas from the six production wells and convey them to either the expanded water treatment plant or gas compression site located adjacent to Bibblewindi-1 (figures 5 & 6).

ESG will look to revise the current approval to dispose of treated water to permit the daily discharge of an average 1ML of treated water to Bohena Creek.

The provision of this document fulfills the company’s responsibility under Part 5, Section 111 of the *Environmental Planning and Assessment Act 1979* in which the determining authority (NSW Department of Primary Industries – Mineral Resources) is required to consider the likely and actual environmental impacts of the activity.

2.1 Existing Approvals

The operation of the Bohena and Bibblewindi CSG Pilots, collectively referred to as the Narrabri Coal Seam Project, occurs under a number of approvals and consents. These include:

- The terms and conditions of Petroleum Exploration Licence 238 (renewed 31/01/08 for period of 4 years);
- The terms and conditions of Petroleum Assessment Lease 2 (granted 30/10/07 for a period of 6 years);
- The approval to construct and operate the Bibblewindi Water Management Dam and subsequently dewater Bibblewindi-1-9
- The approved water management plan in effect for the Bohena CSG Pilot
- The landholder consent provided by Forestry NSW; and
- The approval to dispose of treated water to Bohena Creek.

2.2 Current Operations

Current operations involving the production and management of water as at August 2008 include:

2.2.1 CSG production from Bohena CSG Pilot

Gas produced from these three operational wells is consumed by the generator supplying power to the PCP and telemetry with excess gas vented to atmosphere. Water extracted from each well is managed in existing impoundments located at Bohena-3, 6 and Bohena South.

2.2.2 CSG production from the Bibblewindi CSG Pilot

Gas produced from the nine wells currently on production is consumed by onsite power generation for surface equipment and the powering of the water treatment plant with any excess gas vented to atmosphere. Water extracted from the nine wells is transferred directly from the wellhead to the water treatment pilot located at Bibblewindi-1. Permeate and concentrate streams are then directed into the existing impoundments located nearby. The clean water is generally consumed by various maintenance and operational activities including the core hole drilling currently underway in PAL2 and PEL238

2.3 Proposed Operations

Operational activities for which ESG has obtained Ministerial approval include:

2.3.1 Bibblewindi CSG Lateral Pilot Drilling

An application to drill and complete a lateral production pilot adjacent to the Bibblewindi-11 corehole was been submitted to Mineral Resources in April, 2008. The pilot will involve the drilling of two parallel horizontal “in-seam” wells that will intersect up to 3 vertical production/pressure control wells each (illustrated below).

Production testing of this pilot will commence soon after drilling and completion and is described in detail throughout this operations and water management plan.

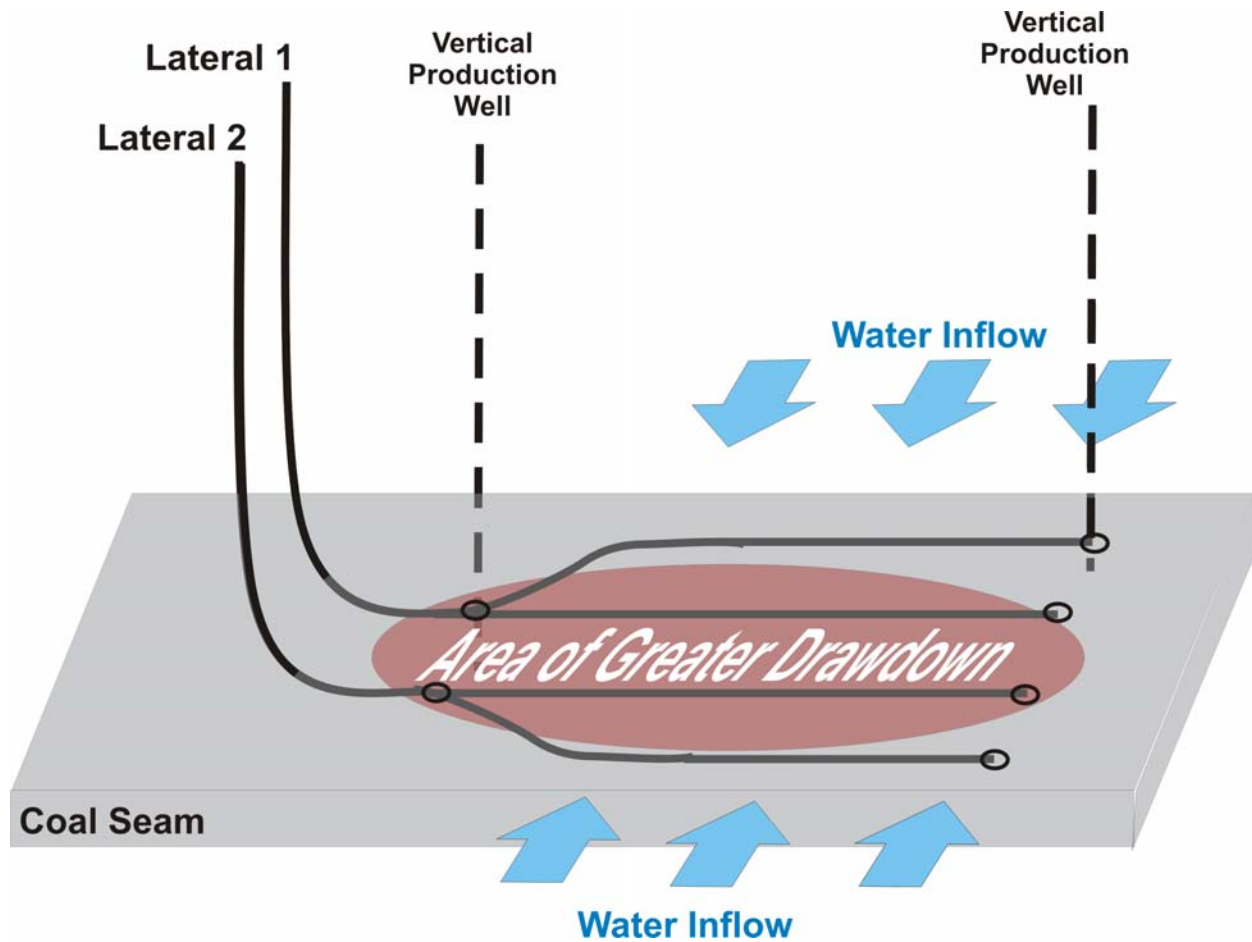


Figure 1 Conceptual design of the proposed lateral pilot southeast of the Bibblewindi CSG Pilot

2.4 Water Management Strategy

The current water management strategy for the operation of the 12 CSG production wells combines treatment and impoundment to effect zero discharge of any by-product of the activity.

2.4.1 Bohena CSG Pilot

Water produced at Bohena-3, 7 and 9 is collected from the wellheads and transferred by HDPE flow lines to the existing impoundments at Bohena-3, 6 and Bohena South-1. The network of flow lines (**figure 2**) links the available impoundment capacity with the operational wells (Note: Bohena-4L has not been in operation since 2005 although linked to Bohena-3 for water management purposes). The pipe running between Bohena 3, 7 and 6 crosses the Newell Highway via an existing culvert installed for these purposes.

The impoundments located at Bohena and Bohena South has and will continue to provide sufficient cumulative management capacity for the near and intermediate future given the current production volumes.

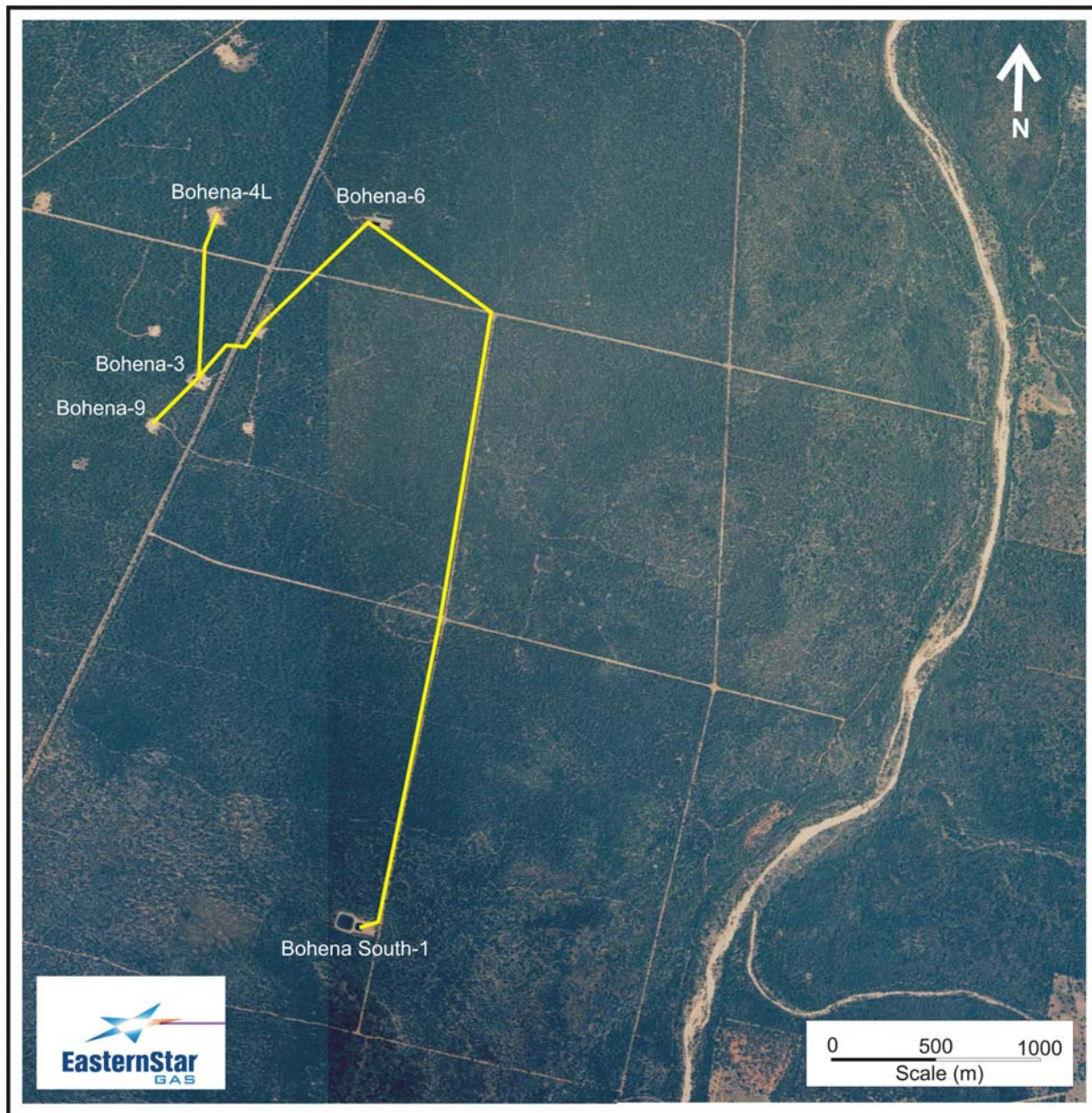


Figure 2 Existing water management infrastructure at the Bohena CSG Pilot

2.4.2 Bibblewindi CSG Pilot

Water produced from the nine wells in operation at the Bibblewindi CSG Pilot is collected at each wellhead and transferred via polypipe to the water management facility located next to Bibblewind1-1 (**Figure 3**).

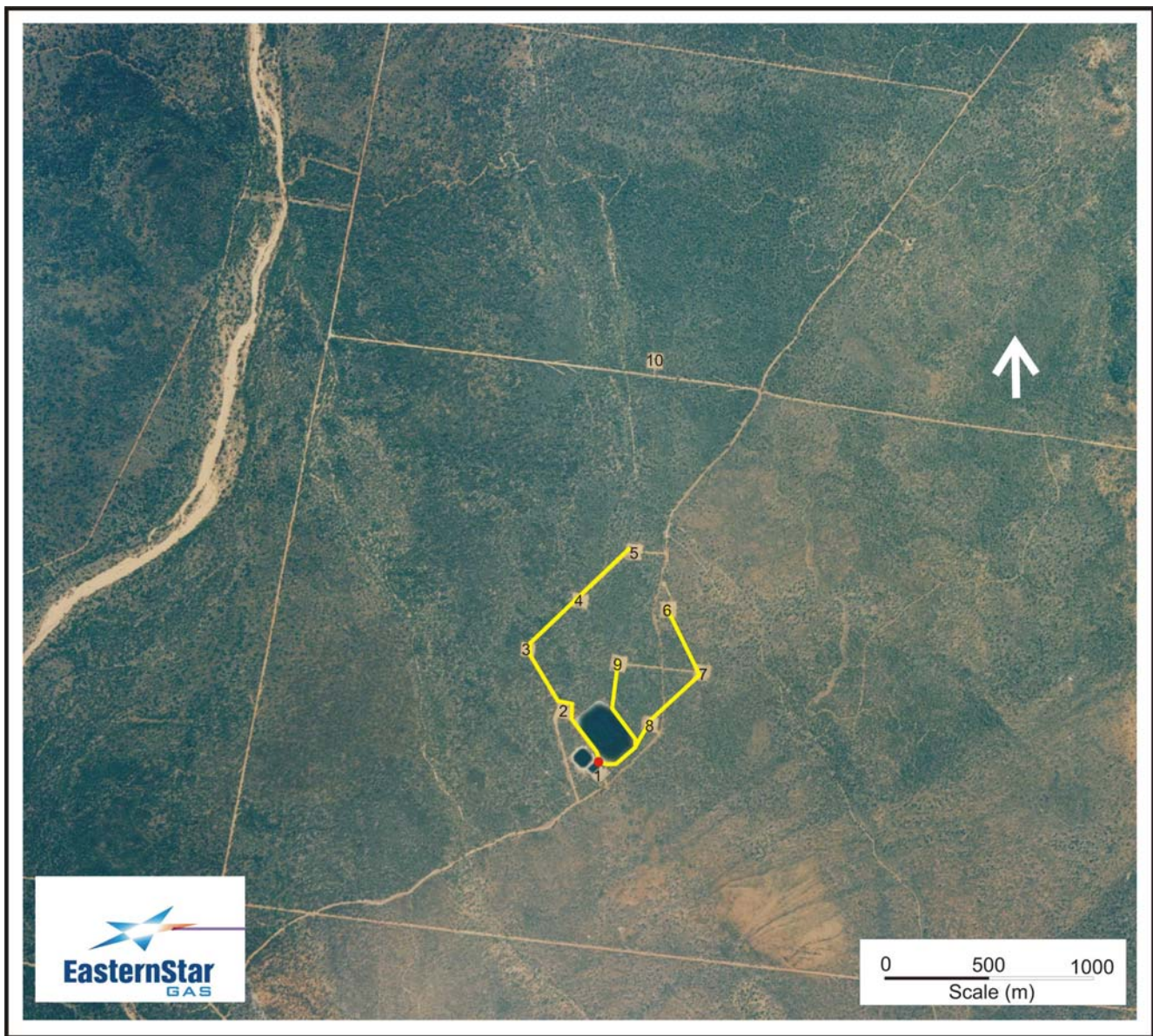


Figure 3 Existing water management infrastructure at the Bibblewindi CSG Pilot

The production water is managed in one of two ways; either discharged directly into one of two impoundments or passed into the Reverse Osmosis (RO) treatment pilot located on site.

2.5 Water Treatment Pilot

The RO pilot is currently sized to accept up to 160 000L/1000 barrels of water per day and to date has achieved sustained operating efficiencies of around 70%. The plant is contained within a footprint of approximately 12m x 5m and includes a 5000L break tank and 20ft container which houses the filters, RO membranes and control systems (**Figure 4**).

The unit is set up adjacent to the three operational impoundments and is connected directly to an inlet manifold where water from the nine production wells enters the management system. The manifold directs the water into the break tank before being injected into the RO unit for separation into permeate (clean) and concentrate (saline) streams. The permeate is discharged into the smallest of the impoundments for reuse whilst the concentrate stream is discharged into the operational impoundment (either of the 2nd largest or largest).

The indicative permeate quality has been modelled at around 250 mg/L TDS however the most recent analysis of permeate discharged from the facility resulted in a calculated TDS of 150mg/L.



Figure 4 Reverse Osmosis pilot located at Bibblewindi-1

The current water management strategy has been effective at containing the water produced from all 12 operational CSG wells in PAL2. The expansion of the CSG project via the installation and operation of the Bibblewindi Lateral Pilot to the southeast of Bibblewindi-1 will be facilitated through the development of a revised water management strategy to provide additional water treatment capacity and furthermore develop available reuse and disposal options.

3 Project Description

3.1 Introduction

The further expansion of the production based activities in PAL2 is an integral stage in the long term objectives of the Narrabri Coal Seam Gas Project. While core hole drilling across PEL238 continues to gather important data on the distribution, thickness, quality and gas bearing capacity of the underlying coal seams, the overarching objective of the project remains the demonstration of viable drilling and completion techniques to achieve production of gas at commercial rates.

The proposed water and operations management strategy to accommodate an increase in water production will involve the following key developments:

- The installation of a water and gas gathering system linking the lateral pilot wells to infrastructure located adjacent to Bibblewindi-1 and the existing water management facility;
- The expansion of the water treatment plant at Bibblewindi-1 from 1000 bwpd to 6250 bwpd ($\approx 1\text{ML}$) to be located adjacent to the existing water management facility; and
- A revised water management plan and the amendment of the approved disposal project to permit the daily discharge of treated water Bohena Creek.

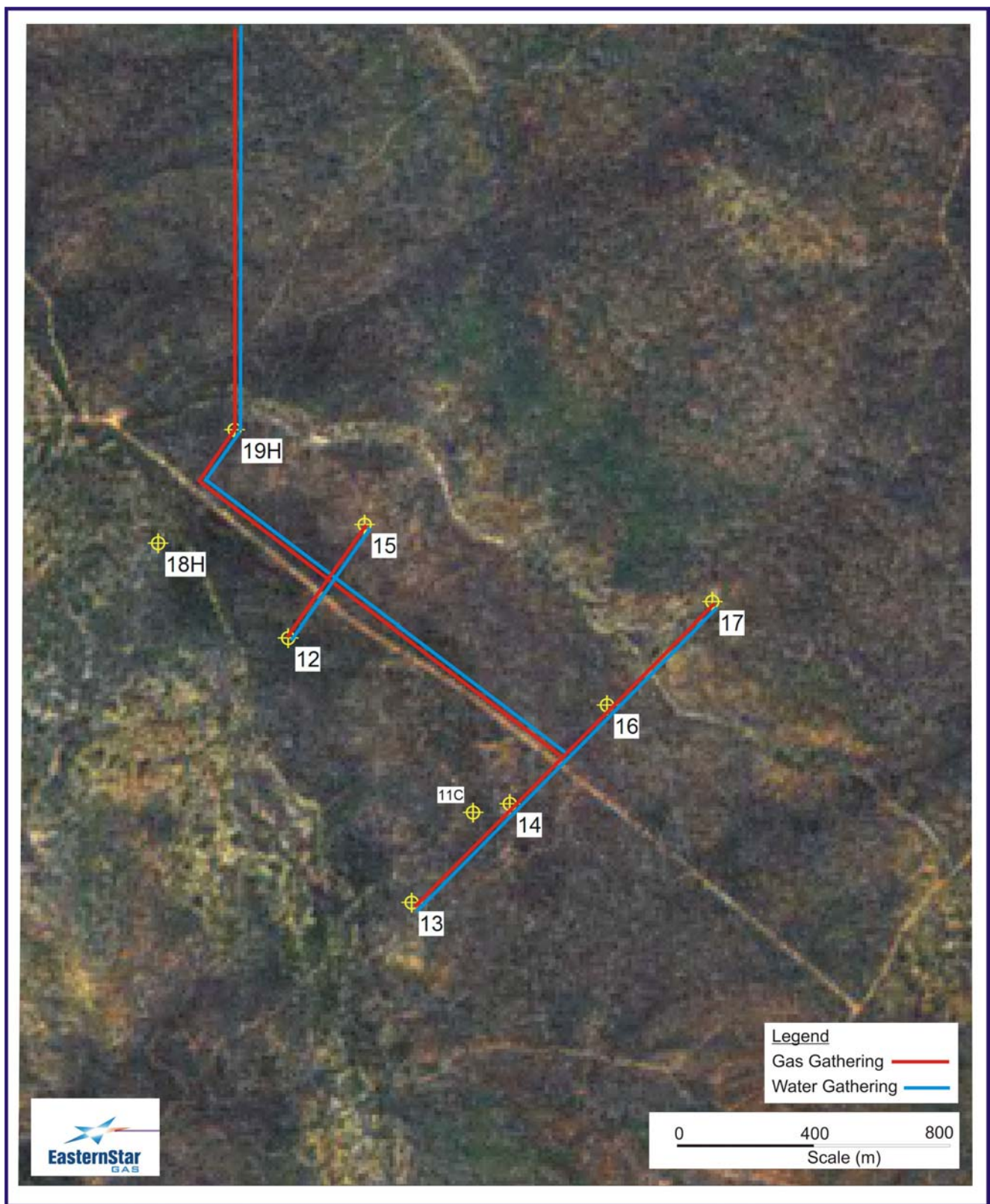


Figure 5 Conceptual layout of the proposed gathering system at the Bibblewindi Lateral Pilot

3.2 Water and Gas Gathering System

The proposed water and gas gathering system will comprise separate buried, low pressure flowlines for water and produced CSG linking the lateral pilot wellheads (Bibblewindi-12 to 17 inclusive) through to a centralised hub located on Bibblewindi-19, and then via buried flowline to the expanded water and gas management facilities located at the Bibblewindi CSG Pilot.

The gathering system shown in **Figure 5** will be located alongside access roads installed during the drilling program; by combining the working area for the roads and gathering system, the cumulative area of vegetation impacted by the proposal is reduced.

The existing gathering system at the Bibblewindi CSG Pilot will be upgraded via the installation a buried GGS similar to that linking the lateral pilot to the gas and water management facility. The location of this GGS is shown in **Figure 6** and follows existing road access except where the GGS exits the south western corner of the Bibblewindi-9 well pad and crosses approximately 350m of scrub before entering the expanded water management facility.

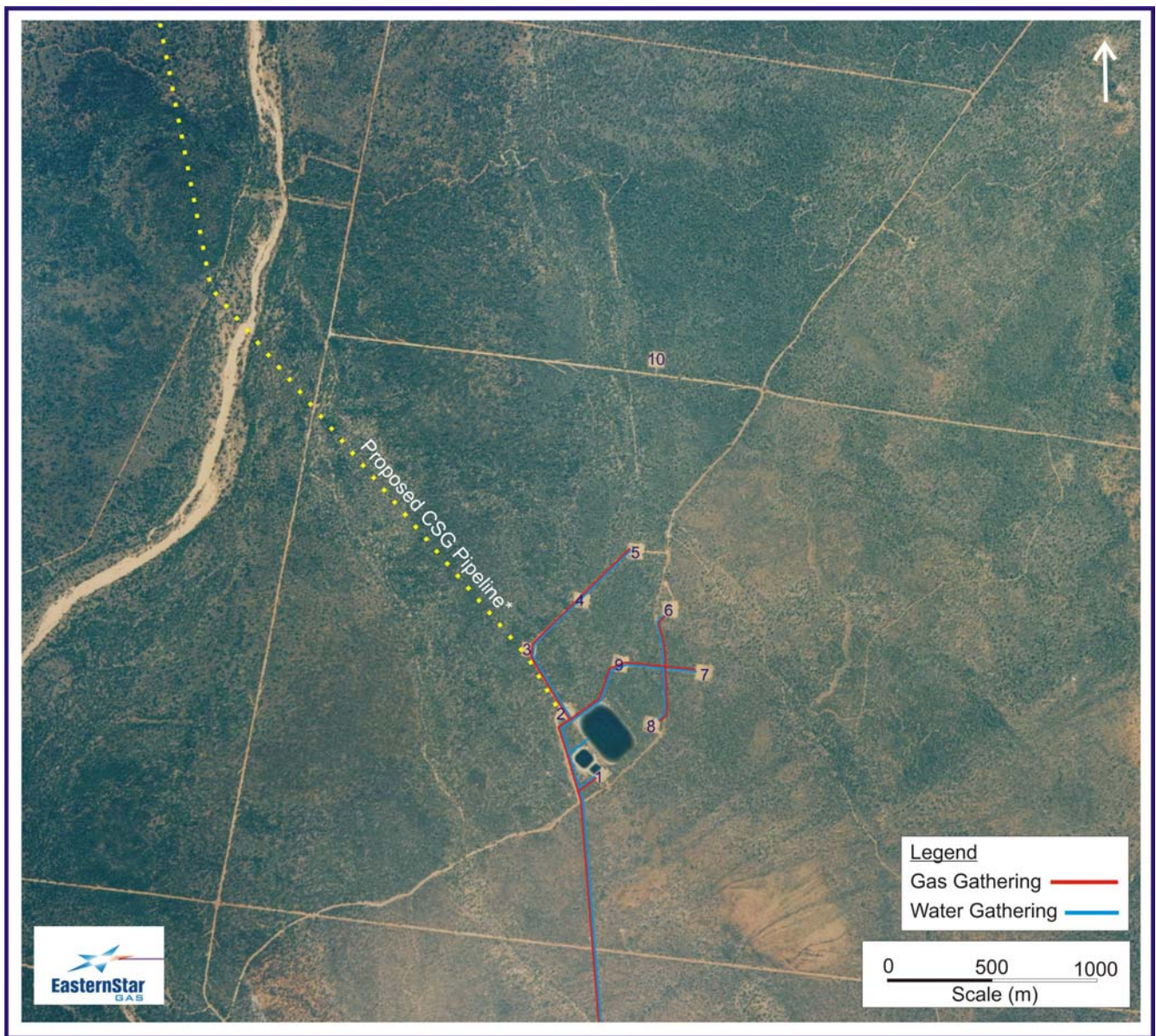


Figure 6 Proposed location and layout of gas and water gathering from the lateral pilot to Bibblewindi

3.2.1 GGS Corridor

The proposed GGS will be installed along a dedicated corridor between Bibblewindi-19 and Bibblewindi-1; the corridor will approximate 10-12 m in width to accommodate construction activities and to permit the adequate segregation of mulch, topsoil and subsoil stockpiles.

The GGS route follows the most direct pathway from the individual production wells back to Bibblewindi-19 and onto Bibblewindi-1 and makes best use of existing roads access. No other alternative routes were considered given the localised environment and likely impacts of the proposal; in terms of impacts on the biotic environment, no alternative route offers benefits in terms of a reduced area of cumulative vegetation/habitat modification.

3.2.2 GGS Specifications

GGS Component	Design Specifications
Length	5.5km
Diameter	Up to 12” O.D
Material	High Density Polyethylene (PE100)
Static Pressure Rating	To AS4130
Depth Cover	Minimum 750mm cover
Construction Right of Way	≈12m

3.2.3 Compliance with Australian Standards

The relevant Australian Standard for polyethylene pipes is AS4130; all construction materials, methods and work practices for the proposed GGS installation and operation will be designed in accordance with this and other pertinent standards (AS2885) to the satisfaction of DPI (Minerals and Petroleum).

3.2.4 Approvals Required

In order for the proposed GGS installation to proceed, ESG will seek the approval of DPI (Mineral Resources) in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* and under the terms of Petroleum Assessment Lease No 2.

Consent to construct and operate the GGS will be sought from Forestry NSW via the amendment of the occupation permit (pending) issued under the *Forestry Act 1916*.

3.2.5 Construction Activities

The installation of the GGS between the lateral pilot production wells will require the following component activities (summarised in **figure 6**):

Surveying the Gas Flow Line Corridor

The proposed gas flow line corridor will be surveyed by a registered surveyor before any preparatory activities take place. Within the forested area, the corridor will be marked clearly to avoid wherever possible any substantial trees, particularly hollow-bearing trees on or near the proposed route. In the event the alignment of either the trench or adjoining access road cannot avoid a mature tree, it will be clearly marked for later logging and collection by Forestry NSW.

Vegetation Clearance

Within either the Bibblewindi or Pilliga East State Forests, all commercial forestry products will be removed and stored in the closest staging area for later collection by Forestry NSW or its contractors. All hollow-bearing trees felled will be relocated to adjacent bushland. All remaining vegetation will be cleared from the corridor and stockpiled at the extreme edge of the corridor (see **Figure 3.9**).

Topsoil Stripping and Stockpiling

The topsoil within approximately 3m of the flow line trench will be stripped to a depth of at least 100mm and stockpiled next to the retained vegetation

Trench Surveying

The location of the trench centreline will be marked within the surveyed corridor.

Trenching

The trench will be formed by wheel or chain trencher or excavator. Subsoils will be stockpiled in a windrow adjacent to the topsoil stockpile. In the event that any hard rock or hardpan layer is encountered during trenching, a rock saw or other suitable machinery will be employed to achieve and maintain the correct trench depth.

Backfilling and Restoration

The backfilling of the trench will commence at the completion of the hydro or pneumatic testing procedures. A magnetic identification/warning tape will be installed approximately 300mm above the gas flow line itself. The compaction of the backfilled subsoil will be closely monitored to minimise the chances of subsequent settling within the trench. Additional fill may be imported from suitable local supplies (subject to landholder approval). The topsoil stockpile will only be accessed once the trench has undergone sufficient backfilling and compaction. The respreading of topsoil will be closely followed by the respreading of retained vegetative material (where available) to assist in soil stabilisation in accordance with agreed forestry protocols for site rehabilitation.

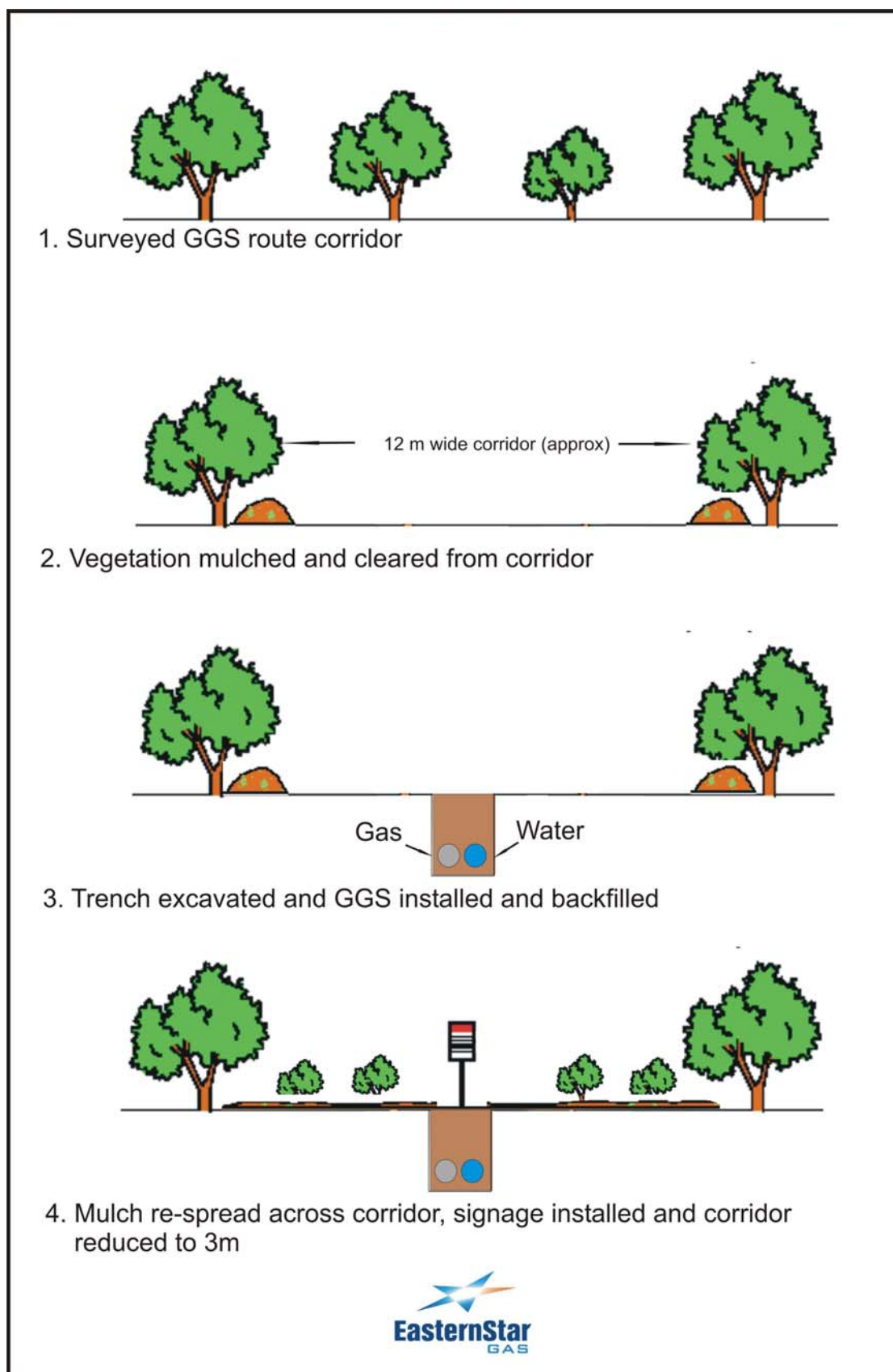


Figure 7 Indicative GGS installation sequence

3.2.6 Road Crossings

The crossing of roads intersected by the GGS will occur in accordance with RTA specifications and in line with Forests NSW policy on operations within the Pilliga East State Forests. Trenching, installation and rehabilitation on or adjacent to forestry roads will occur with minimal disruption to traffic and re-instatement of the roads surface will be carried out to Forests NSW standard.

3.2.7 Equipment

Proposed Use	Machinery / Equipment
Logging/Vegetation Removal	2-5 x Husqvarna 375 or Stihl 044 Chainsaws
	1x Bell 125 Ultra Logger
Easement Preparation	1 x Caterpillar D6N Bulldozer
	Mulcher??
	1 x Caterpillar 140G Motor Grader
	1 x Hyundai 210C Excavator
	1 x Bobcat Skid Steer Loader
Pipe / Gas Flow Line Trenching	1 x Trencor 760 HDA Chain Trencher or equiv.
Gas Flow Line Installation	1 x Flowline installer
Transport/Support	2 x Prime Movers & Low Loaders
	1 x 10 000L Water Cart
	12 x Light 4WD Vehicles (Patrol/LandCruiser or equiv)
	1 x Off-road forklift/front-end loader
	2 x Truck mounted HiAb flat-bed trucks

Table 1 Equipment required to install the GGS

The equipment utilised in the construction process will vary depending on the contractor employed, however the equipment listed in table 1 should be considered the upper limits of requirements and any variation is likely result in a considerable reduction in overall equipment requirements.

3.2.8 Waste Management

Waste materials generated during the construction period will include:

- construction materials waste such as timber, plastic and small amounts of metals.
- general domestic refuse; and
- wastes such as engine lubricants and coolant fluids.

In accordance with good field practice, work crews will be required to dispose of all waste materials in designated receptacles or collected for disposal offsite at the completion of each shift. Wherever possible, waste materials will be collected for recycling and/or reuse or otherwise be transported for disposal at the Narrabri Waste Depot.

3.3 Rehabilitation

The rehabilitation of the GGS corridor will commence as soon as practicable after the construction activities have ceased. The main objective of the rehabilitation program will be to return a maximum area of the lands disturbed by the proposed GGS installation back to previous land use as soon as practicable.

Approximately 70% of the flow line corridor will be encouraged to regenerate naturally from seed stock contained within the topsoils and mulched material retained from the clearance process. The remaining 30% will be retained as foot based access. The retention of this area will permit access for future monitoring and maintenance (if required) and to reduce the potential for the regrowth of vegetation to impact on pipe integrity.

The retention and use of the mulch is expected to provide a means of encouraging vegetation regrowth across this area where soils are less fertile and are likely to contain seed stocks of slower growing native species. The primary goal will be the stabilisation of topsoils and therefore the minimisation of incidental erosion by surface flows during and after rainfall and wind. The method is quick, provides a physical barrier to incidental erosion, and does not introduce any new materials that may harbour weeds and diseases. This method, also used on the main gas flowline from Bibblewindi to Wilga Park, together with retention and replacement of topsoil, will also facilitate germination and establishment of seed from the soil seed bank.

No additional over sowing of the disturbance corridor is planned.

No additional tree or shrub planting scheme is planned within the Forestry lands. Previous experience with the introduction of seedlings in a rehabilitation effort at Bohena-2 suggests natural regeneration is more successful as it generally initiated and supported by natural rainfall patterns. The rehabilitation of the Jacks Creek North-1 well site utilised a technique similar to that described above. This example provides the basis for the rehabilitation of the disturbance corridor within the East Pilliga and Bibblewindi State Forests.

3.3.1 Monitoring and Maintenance

Aspects of the rehabilitation program that will be monitored for the duration of the operational period will include:

- Any evidence of slumping within the area of the GGS trench;

- Any suggestion of excessive erosion or topsoil instability; and
- Any issues with the adequate drainage of the corridor.

Remedial action will be taken where issues such as described or otherwise are evident. No time limits will be placed upon the duration of the monitoring and maintenance program.

4 The Existing Environment

The information contained in this section characterises the existing environment around the GGS project, describes the likely and potential environmental impacts of the proposed development and accordingly discusses the scope for impact mitigation where such opportunity exists.

4.1 Topography

The project is located in the Bibblewindi State Forest, to the east of Bohena Creek and is surrounded on its east, west and south by the Pilliga East State Forest. Indicative elevations of this area approximate 280m AHD and generally fall away to the west and northwest.

4.2 Drainage

The project lies within the Namoi River Basin Catchment, one of the main tributaries of the Barwon Darling River System. The Namoi River Basin covers an area of 43 000 km² and incorporates the regions major centres of Tamworth, Gunnedah, Narrabri and Walgett (Corkery and Assoc., 2004).

The Bohena Creek sub-catchment covers an area of 1500km², and is the major drainage feature in the area. It is ephemeral in nature and flows only with significant rainfall in the catchment further south of PAL 2 towards the north western margins of the Warrumbungle Ranges.

4.3 Land Use

The GGS will be wholly located upon lands designated Crown Lands State Forest under the *Forestry Act 1916*.

The *Brigalow and Nandewar Community Conservation Area Act 2005* redefined the land use classification for the Pilliga State Forests system. The objects of this Act are to reserve forested land in the Brigalow and Nandewar sub regions for the maintenance of Community Conservation Areas (CCA) which in turn provide a mechanism for the permanent conservation of land, protection of areas of natural and cultural heritage significance to Aboriginal people and sustainable forestry, mining and other appropriate uses. The project is located within a zone four CCA which wholly permits the continued exploration for and assessment of petroleum resources.

The vegetation surrounding the project site is predominantly native woodland vegetation within the Bibblewindi State Forest. This area is made up of forest types 190 (White Cypress Pine-Brown Bloodwood) and type 189 (White Cypress Pine-Narrow leaved Ironbark) and in terms of commercial forestry operations is considered of low quality/low productive capacity.

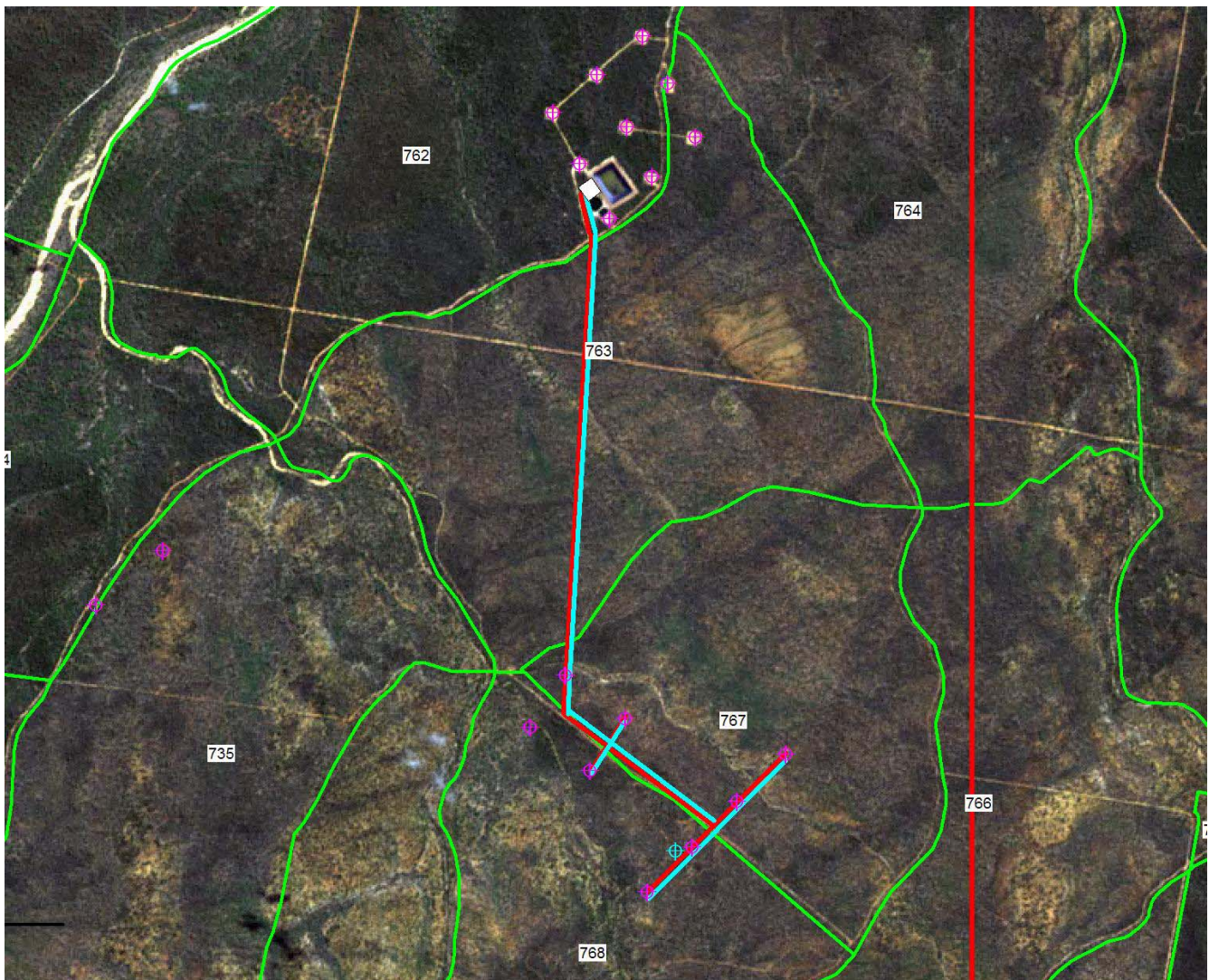


Figure 8 The project location within Bibblewindi State Forest compartments 763, 767 and 768.

The occupation of Forestry Lands for the purposes of petroleum exploration and assessment is subject to an occupation permit (pending as at 01/02/08) under the *Forestry Act* 1916. ESG will engage the assistance of Forests NSW in assessing the commercial value of forestry resources located on or adjacent to operational areas including the proposed GGS. Consultation with Forestry NSW indicates the current and future operations in the area include:

- Compartments 528, 529, 704, 705, 713, 714, 770, 708 and 709 have current or future harvest plans;
- Non commercial thinning operations are occurring in compartments 707, 709, 709, 528, 529: and
- Hazard reduction burning is planned for compartments 781, 782 and 784

Wild fire has impacted heavily on a large area to the south of the Bibblewindi CSG Pilot. The areas of high albedo (reflection) in the various satellite and aerial photographs shown through the document are a direct result of wild fires in late 2005 and late 2006 that burnt large areas of the Pilliga East SF and Nature Reserve; where

dense tree canopies reflect little electromagnetic radiation, the areas heavily impacted by fire reflect greater amounts of sunlight from bare soils and show up as white and light brown in colour. Whilst natural regrowth of these areas has and will continue to occur, the commercial forestry value of these areas is significantly reduced.

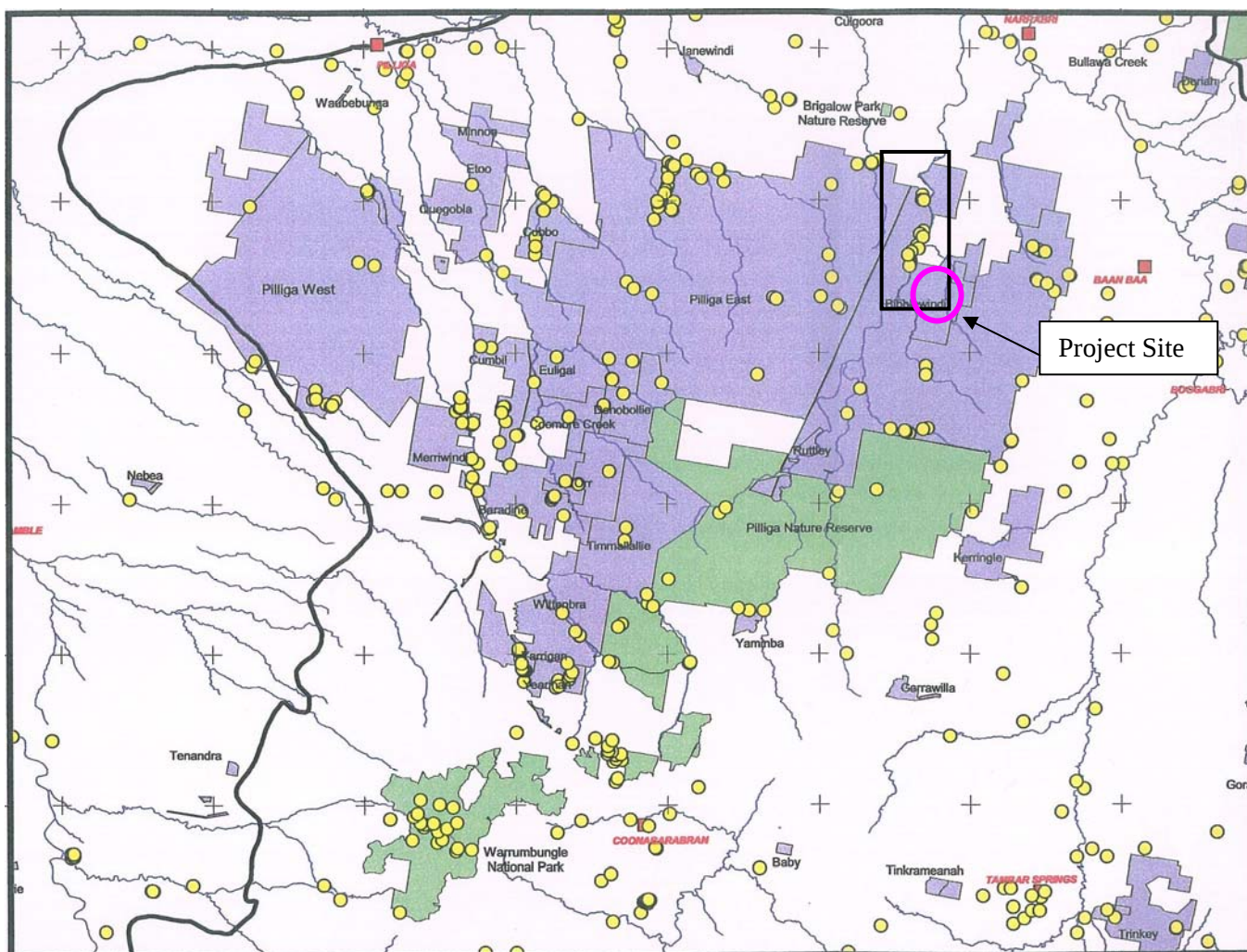
4.4 Cultural Heritage

Throughout the development of the Narrabri CSG Project, the existing knowledge base on the extent of Aboriginal inhabitation across the region has steadily grown. Cultural heritage surveying has occurred frequently since Eastern Star commenced the active development of PEL238's CSG reserves in 2004.

Survey efforts carried out to date have included numerous site specific cultural heritage investigations for the installation of production and core hole well pads across PAL2, the surveying of the area impacted by the installation of the Bibblewindi CSG Pilot and water management facility and the proposed flowline linking the Bibblewindi and Bohena CSG Pilots with the Wilga Park Power Station. The surveys have been directed by Mr Eddie Trindall, cultural heritage advisor and representative of the Pilliga Forest Aboriginal Management Committee and Narrabri Local Aboriginal Land Council.

The existing archaeological record for the region consists of various sources of cultural heritage information including the NPWS AHIMS database, the Forestry NSW/PFAMC site register and published reports on the extent of Aboriginal inhabitation of the Pilliga Forests. These sources corroborate on the understanding that Pilliga Forests were frequently utilised by Aboriginal communities for a range of uses and that a number of significant sites have been identified during subsequent survey efforts.

The information contained within the various published reports provides the basis for the cultural heritage investigations for the proposed GGS project.



Preliminary desktop data analysis has been based upon GIS data provide by Forests NSW (Baradine) on dominant canopy species in the area surrounding the proposed GGS project. **Figure 9** indicates that the GGS will be located in and amongst vegetation communities dominated by Narrow leaf Ironbark/Bull Oak/White Cypress (COP) and White Cypress/Narrow leaf Ironbark/Bull Oak (PCO), although field verification of these communities cannot identify a consistent difference between the stated dominance of any one species.

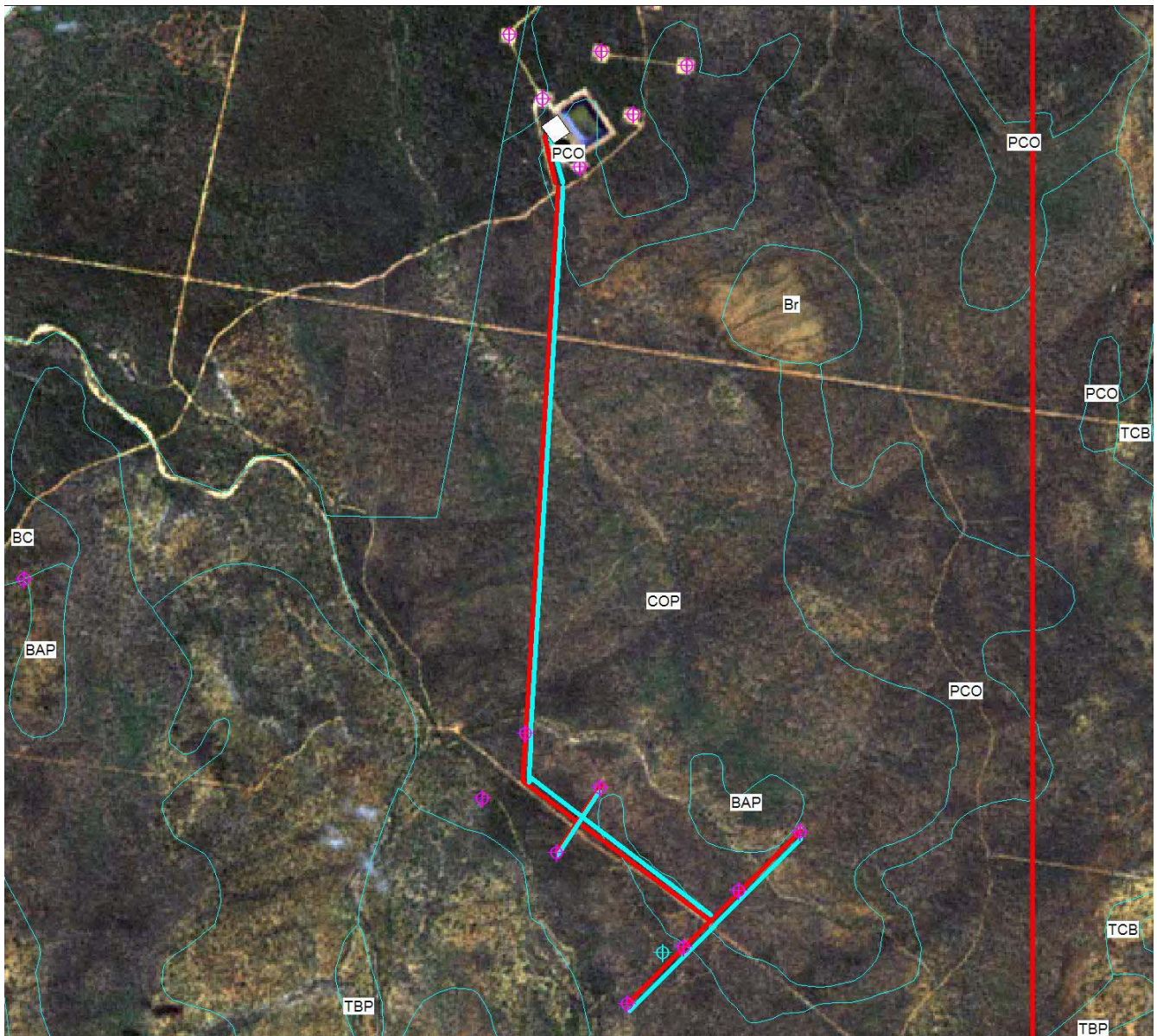


Figure 10 Dominant canopy species mapping of the area surrounding the GGS

Existing records from DECC databases indicate that threatened species and endangered ecological communities and threatened flora species have been observed within the Pilliga East State Forests and Nature Reserve and

surrounding region. However no species of significance have been observed within the localised area (<5km) surrounding the project site. Records of these observations are shown in **Figure 10**.

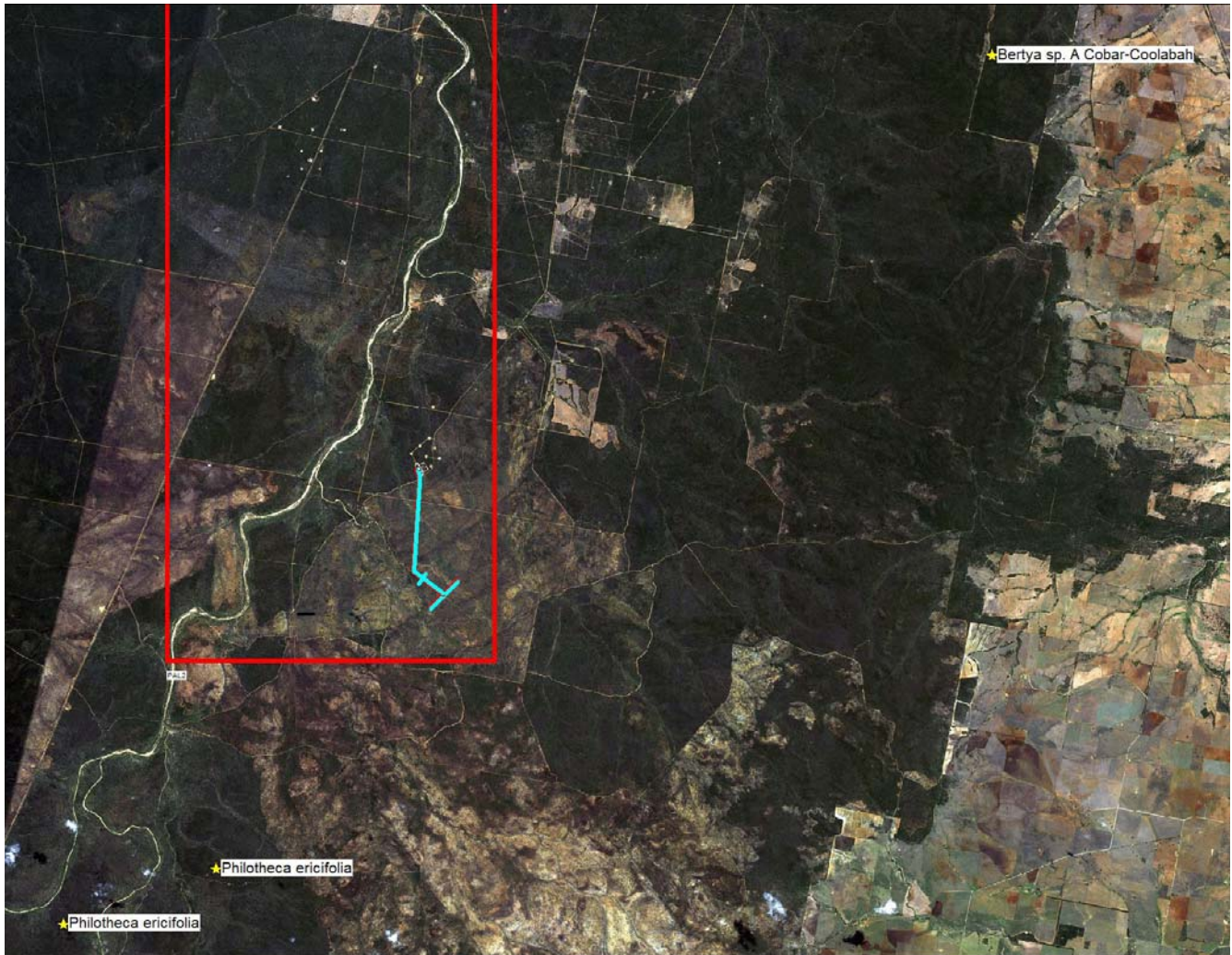


Figure 11 NSW DECC threatened flora records in the vicinity of the GGS project

4.6 Fauna

Prior to the development of the Narrabri CSG Project, the Pilliga East and Bibblewindi State Forest received little detailed attention in terms of systematic fauna surveying to assess the presence of threatened faunal species, populations or ecological communities and potential/actual habitat. Fauna studies completed for Eastern Star's Pilliga Seismic Survey by Smith (2002) suggest that the Pilliga State Forests and Nature Reserve, including Bibblewindi State Forest, form one of the largest forest remnants on the north-west slopes and plains of NSW. The remnant has national, state and regional conservation significance for the protection of biodiversity and threatened species due to its large size (>500 000 ha), high threatened species diversity and high quality habitat.

Since the initial fauna assessment in 2002, a number of fauna survey efforts have been carried out across PAL 2 during the development of the Narrabri CSG Project. The methodology for this impact assessment has focused on the compilation of existing data sources including the DECC threatened species records, significant fauna and fauna species habitat records held by Natural Resources and additional consultation with State and Federal schedules for the protection of threatened species and threat abatement plans.

Field surveys have generally been carried out on the basis of determining the relationships between habitat types and fauna distribution across the Pilliga and so have utilised the findings of Greg Elks in the various flora survey reports completed to date. ESG has employed Mr Keith Kendall of Kendall & Kendall Ecological Consultants to complete detailed fauna assessments on a number of project related developments.

The impact assessments carried out to date and recent database searches indicate that various threatened and endangered species have been observed within the Pilliga East State Forest. Many of the observations shown in **Figure 12** were registered by Kendall at the completion of the survey efforts carried out for ESG in the past 4 years (Kendall, 2005 and Kendall, 2006).

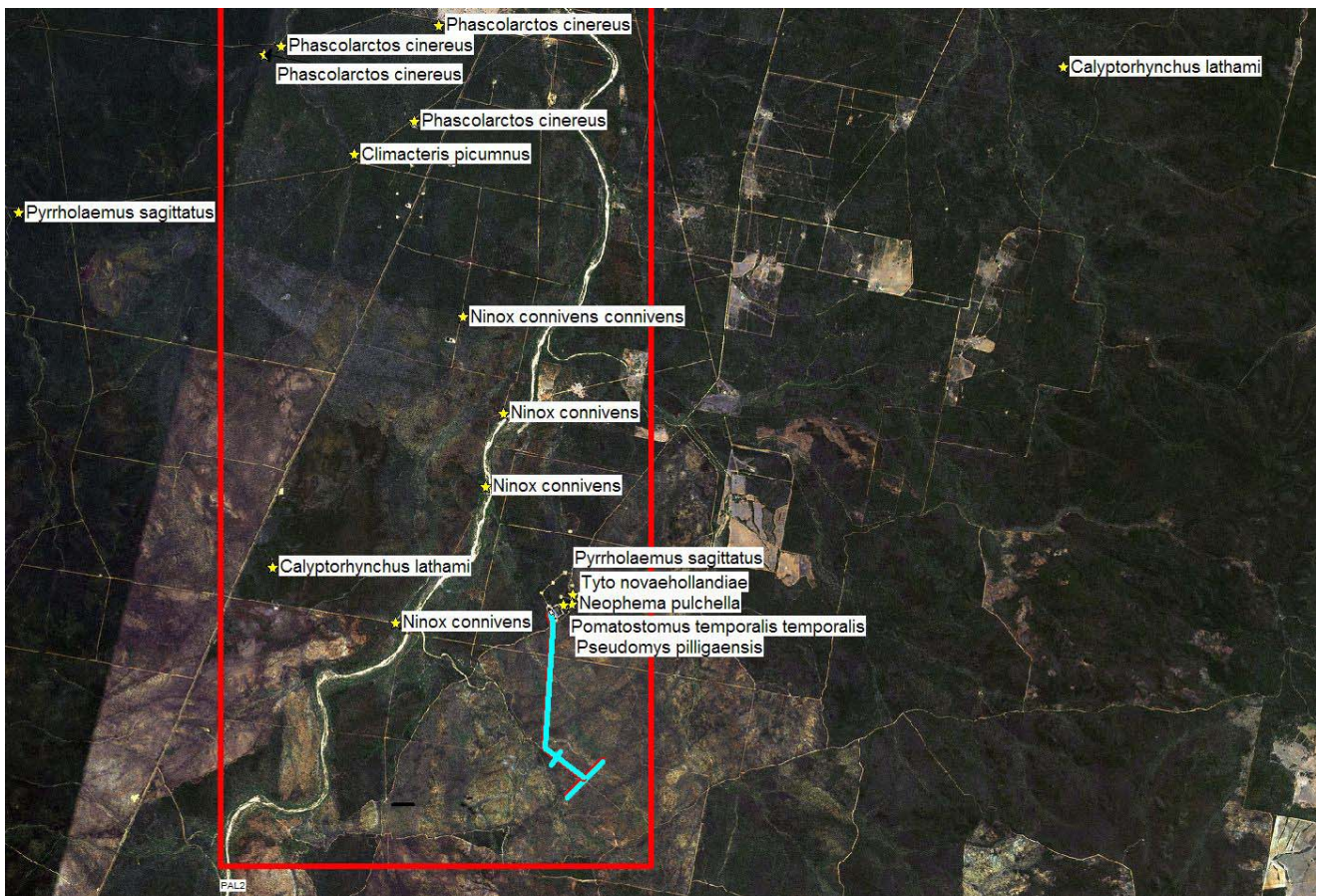


Figure 12 DECC database records for threatened species of fauna nearby the project site

5 Environmental Impact Assessment and Mitigation

The assessment and prediction of the likely environmental impacts associated with the proposed activity is provided by ESG in response to Section 111 of the *Environmental Planning and Assessment Act 1979*. The level of detail contained in this REF document was determined by factoring together the intensity of the activity, the relative sensitivity of the environment and the likelihood of remediation at the projects completion.

5.1 Land

The confidence levels in predicting the impact of the GGS installation and operation at this location are high. The process of preparing the GGS corridor, the construction activity and the operation of the GGS to during the extended period of production testing is relatively small in scale and limited to a finite area. The GGS flow line corridor will approximate 5.5 km in total length and approximate 12m in width. The cumulative area of land impacted by the proposed activity will therefore approximate 6.6 ha in a worst case scenario.

The *E. crebra* dry open forest community within which the proposed activity is to occur is the dominant vegetation community in the Pilliga East and Bibblewindi State Forests and is the most widespread of the White cypress forestry types occupying around 40% of the total area of managed cypress forests (Forestry Commission in Elks, 2007). The modification of a further 6.6 ha of this regionally common vegetation type is unlikely to result in any measurable reduction in the value of the area as habitat or a commercial resource.

The sensitivity of the operational environment is well understood in terms of its resilience to disturbance; whilst the project is likely to occur over an extended period, the likelihood of a full reversion to the pre-existing condition is very high given the actions taken to preserve the natural regeneration potential of the site.

ESG considers the cumulative impacts as a result of this activity are relatively small and will occur over a short timeframe. The rehabilitation potential of the site is protected by the mulching technique which will be effective in protecting both soil structure and existing seed stock required for natural regeneration.

5.2 Access

A major objective of Eastern Star's operations within Forests NSW Lands is to use existing roads and tracks as far as practicable. The extensive system of roads and tracks crossing the Pilliga East and Bibblewindi State Forests permits safe and efficient access to much of PAL2.

Access to the lateral pilot and GGS will be via the Newell Highway, X-Line Rd, Middle Rd, Tighes Gully Rd and Little Tighes Road. To prevent overuse and damage to the smaller access tracks, it will be ESG's policy that this designated route is used by all contractors and employees for the duration of the activity.

ESG envisages that some improvements to the access will be required in the near future to account for the slight increases in traffic during operations (i.e. morning and afternoon field rounds). This action will occur in consultation with Forestry NSW.

Any damage to existing roads/access caused by the operations activity remains the responsibility of ESG and will be rectified as soon as practicable at the direction of Forestry NSW.

5.3 Drainage:

Topographic maps indicate that various ephemeral tributaries and drainage lines leading to Bohena Creek are located nearby and field verification confirms that the main access road bisecting the lateral pilot is located upon slightly higher and well drained ground between two natural drainage features.

The engineering design and construction methods employed for this project will include due consideration of the issues aligned with both the drainage of water from the corridor itself during operations and the installation of the GGS across existing creek beds.

ESG's general erosion and sediment management strategies plan will be incorporated into the construction management plans at the completion of route surveying; site specific management strategies will be devised during surveying to minimise the likelihood of issues occurring in this regard. The current general erosion and sediment management plan is contained within Appendix 1.

5.4 Subsurface Impacts:

The extent of subsurface impacts likely to occur as a result of the GGS project is relatively minor given the proposed methods of construction. The GGS trench will be excavated to a maximum depth of 1m with topsoils and subsoils separated along the working area.

Further management actions to account for subsurface impacts, specifically soil management, are contained within the soils and land capability management plan (Appendix 1).

5.5 Air

5.5.1 Fugitive Dust Generation:

The dust generated by the mobilisation of the construction equipment to and from the location is generally no greater than localised traffic movements. In the event that the roads are excessively dry and soft and where mobilisation may be expected to generate excessive amounts of dust, a water truck will be deployed to suppress road based dusts before and during the more intense periods of activity.

No dust suppression is expected to occur along the GGS corridor while under construction; specific directives in regard to the protection of soil structure have been made by Cunningham (2007) for the main gas flowline to Wilga Park. It is expected that these management actions will also apply for this project as the soil and vegetation types are very similar and the rehabilitation objectives are accordingly the same (see soils and land capability management plan).

ESG considers these impacts to be small in scale, localised and short in length. No long term effects will be introduced where the management actions are adhered to.

5.5.2 Noise Impacts:

All of the equipment employed to complete the proposed GGS installation are modern, well maintained and have noise silencing apparatus fitted as standard. Times of peak noise emissions from the operational site will be generally between the hours of 7am and 6pm or daylight hours, whichever provides the required time to complete the planned 12 hour shifts.

The distances from any given point along the proposed GGS corridor to the nearest inhabitation will range from in excess of 8km to no less than 5km and a negligible likelihood of impacting on such residences at any time during construction. ESG is confident that the mobilisation of equipment and personnel and its operation in constructing the GGS is unlikely to result in any measurable noise related impacts on existing point source receptors such as homes and businesses.

5.6 Water

5.6.1 Impacts on localised water courses

The intersection of an unnamed tributary of Cowallah Creek during the installation of the GGS will require a specific management plan to minimise the impact of construction on the water course. As shown in **Figure 15**, the water course is an ephemeral sand creek bed of less than 3m average width and is not expected to bear water at the proposed depths of burial.

The installation of the pipe across this creek will use the same open trenching method, however a number of management actions are to be observed in the 20m either side of the creek zone so as to maintain objectives of Forestry NSW's policy on operations within the vicinity of creeks and water courses. The specific actions to be taken to minimise impacts include:

- Minimising the removal or modification of existing vegetation to the greatest extent as a means to preserve the structure of the creek zone;



Figure 13 The unnamed tributary of Cowallah Creek intersected by the GGS

A management plan to govern the installation of the GGS across this creek will be devised in conjunction with the GGS contractor and submitted to DPI as part of the construction management plans.

5.6.2 Water Source

Any water required during the construction period will be sourced from the water treatment plant located at Bibblewindi-1 and transported via tanker to location.

5.7 Flora

The basis for the assessment of impacts on the native flora species and vegetation communities posed by the installation of the GGS is the existing knowledge base on flora impact assessments carried out across PAL2 to date. Survey reports from the following surveys have been consulted and are considered sufficient to provide an understanding of the actual, likely and potential impacts associated with the proposed activity:

- **Clements, A & Moore, R. (2002).** *Survey Report and Review of Existing Flora Data: PEL238 Pilliga East Seismic Survey, Anne Clements & Associates Pty Ltd, North Sydney, NSW*
- **Elks, G.N. (2005).** *PEL238 Coal Seam Gas Flora Survey – Bibblewindi Nine Spot, Idyll Spaces Environmental Consultants, Bonville NSW*
- **Elks, G.N. (2006).** *PEL238 Coal Seam Gas Flora Survey – Water Management Facility, Idyll Spaces Environmental Consultants, Bonville NSW*
- **Elks, G.N. (2007).** *PEL238 Narrabri Coal Seam Gas Project Flowline Flora Survey, Idyll Spaces Environmental Consultants, Bonville NSW*

5.7.1 Background Information

The various databases available suggest that a number of threatened communities and species have been identified within the Narrabri region and the Pilliga State Forests and Nature Reserve.

Elks (2005, 2006, 2007) provides a comprehensive review of existing threatened species records across various State and Commonwealth registers (**Table 2**).

Database Search	Threatened Community/Species/Habitat
EPBC (2000) Act threatened communities	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant). Endangered community known to occur with the study area Grassy White Box Woodlands endangered community may occur within area locality
EPBC (2000) Act threatened species	<i>Bertya</i> sp. Cobar Coolabah (v) <i>Cadellia pentastylis</i> (v) <i>Digitaria porrecta</i> (e) <i>Diuris sheaffiana</i> (v) <i>Goodenia macbarronii</i> (v) <i>Lepidium aschersonii</i> (v) <i>Philothea ericifolia</i> (v) <i>Pterostylis cobarensis</i> (v) <i>Rulingia procumbens</i> (v)

NSW TSC Act Endangered Ecological Communities	- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Penepplain, Murray-Darling Depression, Riverina and NSW South western Slopes - Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions - Coolibah - Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions - Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions - <i>Cadellia pentastylis</i> (Ooline) community in the Nandewar and Brigalow Belt South IBRA regions - McKies Stringybark/Blackbutt Open Forest in the Nandewar and New England Tableland Bioregions - Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions - White Box Yellow Box Blakely's Red Gum Woodland
Threatened species records within 30km (centroid)	<i>Bertya</i> sp. Cobar-Coolabah Vulnerable <i>Lepidium aschersonii</i> Vulnerable <i>Philotheca ericifolia</i> Vulnerable <i>Rulingia procumbens</i> Vulnerable
Bionet search (TSC Act listed species) for Pilliga East and Bibblewindi SF	<i>Goodenia macbarronii</i> Vulnerable <i>Philotheca ericifolia</i> Vulnerable <i>Rulingia procumbens</i> Vulnerable
Threatened species known or predicted in the Pilliga Outwash CMA Subregion	<i>Cyperus conicus</i> (e) <i>Dichanthium setosum</i> (v) <i>Swainsona murrayana</i> (v) <i>Tylophora linearis</i> (e)

Table 2 Threatened communities, species and habitats occurring in the Pilliga State Forests

In summary, communities listed as threatened under the relevant state and federal jurisdictions are known to occur on the relevant 1:100,000 mapsheets or likely to occur within the locality.

The dominant canopy species mapping sourced from Forestry NSW references two communities, Narrow leaf Ironbark/Bull Oak/White Cypress (COP) and White Cypress/Narrow leaf Ironbark/Bull Oak (PCO) as occurring at or around the proposed location, although field verification of these communities indicates no consistent difference between the stated dominance of any one species. **Table 3** summarises the community assemblage which has undergone field verification at various locations across PAL2.

Vegetation Community	Summary
<i>Eucalyptus crebra</i> Dry Open Forest	Narrow leaved Ironbark is always present and usually dominant. Other common species include White pine <i>Callitris glaucophylla</i> and bull oak <i>Allocasuarina luehmannii</i> . Midstratum of hophushes <i>Dodonea spp</i> , <i>Calytrix tetragona</i> , wattles <i>Acacia spp</i> , broom and bitter pea <i>Daviesia genistifolia</i> . Ground layer most diverse, with mat-rushes <i>Lomandra spp</i> , sawsedge <i>Gahnia aspera</i> , flax lily <i>Dianella longifolia</i> , wild onion <i>Bulbine semibarbata</i> , <i>Laxmannia gracilis</i> , <i>Calandrinia spp</i> , <i>Goodenia spp</i> , bluebells <i>Wahlenbergia spp</i> , cutleaf daisy <i>Brachycome multifida</i> and the fern <i>Cheilanthes austrotenuifolia</i> very common. Open stands of narrow

	leaved ironbark at around 20m tall with or without white cypress and bull oak over the midstratum with scattered stands or sparse individual sclerophyllous shrub. Sparse to mid-dense ground layer of forbs, grasses and graminoids. Community occurs on silty sand with adequate drainage.
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Table 3 Summary of the *E. crebra* Dry Open Forest community

5.7.2 Assessment of Significant Effects

The assessment of significant effect on threatened species, populations or ecological communities or their habitats as per S5A (2) of the *Environmental Planning and Assessment Act 1979*, as applied to the GGS are such that:

- a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,**

Flora surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat associate with the Narrow leafed Ironbark Dry Open Forest described by Elks (2007). Given the limited impact of the activity and likelihood of full rehabilitation, it is unlikely that this proposal will have any adverse effects on the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

- b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,**

Flora surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat associate with the Narrow leafed Ironbark Dry Open Forest described by Elks (2007). Given the limited impact of the activity and likelihood of full rehabilitation, it is unlikely that this proposal will have any adverse effects on the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

- c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

No evidence of any endangered ecological community or critically endangered ecological community located in the localised or surrounding area has been identified during the flora surveys, hence

- (i) the proposed activity is not likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
- (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

d) In relation to the habitat of a threatened species, population or ecological community:

- (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

The area impacted by the proposed activity represents a very small percentage of the dominant vegetation community mapped within PAL2, and will impact on less than 0.002% of habitat of similar quality in the locality.

There is no discernible difference in ecological integrity between habitat to be affected and habitat to remain. Furthermore, the small scale and spatial arrangement of the proposed impact is such that habitat is not likely to become fragmented or isolated from other areas of habitat.

The apparent absence of threatened flora species from the study area and the large areas of similar habitat in the region and locality suggest that the habitat to be removed is unlikely to be of importance for the long-term survival of the threatened species *Diuris tricolor*; *Goodenia macbarronii*; *Philotheca ericifolia*; *Rulingia procumbens* or *Tylophora linearis* in the locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Critical habitat as listed in the Register of Critical Habitat kept by the Director-General of DECC does not occur in the study area. The proposed activity is unlikely to have any adverse effect on critical habitat, either directly or indirectly.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No recovery plans or threat abatement plans are currently listed for *Diuris tricolor*; *Goodenia macbarronii*; *Philothea ericifolia*; *Rulingia procumbens* or *Tylophora linearis*.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed action will involve the key threatening process 'Clearing of native vegetation'. It has the potential to contribute to the impact of 'Invasion of native plant communities by exotic perennial grasses'. However this potential is likely to be low as most invasive exotic perennial grasses have been selected for their productive capacity in managed pasture and are likely to be poorly adapted for the relatively infertile sandy soils characteristic of forest in the study area. Clearing and weed competition are threats listed for *Philothea ericifolia* and *Diuris tricolor*. Weed invasion is listed as a threat for *Goodenia macbarronii*, and soil disturbances are listed as a threat for *Rulingia procumbens*.

The importation of weed and pest species onto site via seed and vegetative material is mitigated through the wash down of vehicles in Narrabri prior to entry to Forestry Lands (see section 5.5.4).

5.7.3 Conclusions

Given consideration of the above assessment, and in particular the small area of vegetation to be removed, both in absolute terms and in terms of the habitat for threatened species in the locality and region, and the apparent absence of threatened flora species from the subject site and study area, it is concluded that a Species Impact Statement would not be required.

Approximately 40,000ha of area mapped as the vegetation class 'Pilliga Outwash Dry Sclerophyll Forest' and a further 20,000ha of the floristically similar 'Western Slopes Dry Sclerophyll Forest' occurs in the locality but the habitat has been modified by grazing, modified fire regimes, and forestry activities (Elks, 2006).

The *E. crebra* dry open forest community within which the proposed activity is to occur is the dominant vegetation community in the Pilliga East and Bibblewindi State Forests and is the most widespread of the White cypress forestry types occupying around 40% of the total area of managed cypress forests (Forestry Commission in Elks, 2007).

Endangered communities listed in the NSW Threatened Species Conservation Act and Environmental Protection and Biodiversity Conservation Act (Cwth) have yet to be detected in the area and are assessed as unlikely to occur there.

Habitat requirements for five threatened flora species may be met in the study area, but as threatened flora species have not been previously recorded in the study area and have not been were not detected in surveying carried out to date, the possibility that they do occur there is considered to be low.

Given that the clearing of vegetation has been reduced to the smallest area possible and is spread across the landscape at known locations, it is considered that:

- the proposed activities would not be likely to have an adverse effect on the life cycle of a threatened flora species such that a viable local population is likely to be placed at risk of extinction;
- the extent to which habitat is likely to be removed or modified as a result of the action proposed is not likely to be significant;
- habitat is not likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;
- the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of Threatened flora species in the locality is not likely to be significant, and
- the action proposed is not inconsistent with the objectives or actions of a recovery plan or threat abatement plan.

5.7.4 Weed Species

The risk of introduction of weeds and pests species to the site via the entry of vehicles and plant will be mitigated by the wash down of all vehicles, plant and ancillary equipment new to the region at the ESG maintenance yard in Narrabri. This will entail the complete removal of soils and organic matter from wheels, wheels arches, chassis and other sites capable of holding any material considered able to germinate or provide a means for the proliferation of any species of plant.

A weeds management plan is discussed in further detail in Appendix 1.

5.8 Fauna

The assessment of impacts on the native fauna posed by the installation of the GGS relies on the existing knowledge base on fauna impacts carried out to date. Survey reports from the following field surveys have been consulted and are considered sufficient to provide an understanding of the actual, likely and potential impacts associated with the proposed activity:

- **Kendall, K. (2005).** *Fauna Study PEL238 Coal Seam Gas Project - Bibblewindi Nine Spot*, Kendall & Kendall Ecological Consultants, West Kempsey NSW
- **Kendall, K. (2006).** *Fauna Study PEL238 Coal Seam Gas Project - Water Management Facility*, Kendall & Kendall Ecological Consultants, West Kempsey NSW
- **Kendall, K. (2007).** *Fauna Study PEL238 Narrabri Coal Seam Gas Project Flowline*, Kendall & Kendall Ecological Consultants, West Kempsey NSW
- **Smith, A. 2002.** *PEL238 Pilliga East Seismic Survey: Fauna Review*, AUSTECO Environmental Consultants, Armidale, NSW

5.8.1 Background Information

Records of threatened species, populations or communities as listed under the *Threatened Species Conservation Act 1995* (TSC Act) known to occur within 25 km of the study area were extracted from the New South Wales Wildlife Atlas database for the Baan Baa, Baradine, Narrabri and Wee Waa 1:100,000 map sheets. Under these search parameters, eight TSC Act threatened species recorded within 25 km of the study area on the DEC wildlife atlas; they include:

- Glossy Black-Cockatoo *Calyptorhynchus lathami*
- Barking Owl *Ninox connivens*
- Brown Treecreeper *Climacteris picumnus*
- Speckled Warbler *Pyrrholaemus sagittatus*
- Painted Honeyeater *Grantiella picta*
- Hooded Robin *Melanodryas cucullata*
- Koala *Phascolarctos cinereus*
- Black-striped Wallaby *Macropus dorsalis*
- Pilliga Mouse *Pseudomys pilligaensis*

TSC Act threatened fauna species not recorded within 25 km of the Study Area but known or predicted to occur in the Pilliga Outwash sub regions of the Namoi CMA and based on habitat requirements considered as possible or likely to occur on the study area

- *Ninox connivens* Barking Owl
- *Hamirostra melanosternon* Black-breasted Buzzard
- *Melithreptus gularis gularis* Black-chinned Honeyeater (eastern subspecies)
- *Macropus dorsalis* Black-striped Wallaby
- *Burhinus grallarius* Bush Stone-curlew

- *Stagonopleura guttata* Diamond Firetail
- *Cercartetus nanus* Eastern Pygmy-possum
- *Anomalopus mackayi* Five-clawed Worm-skink
- *Pachycephala inornata* Gilbert's Whistler
- *Calyptorhynchus lathamii* Glossy Black-cockatoo
- *Nyctophilus timoriensis* Greater Long-eared Bat (south eastern form)
- *Falco hypoleucos* Grey Falcon
- *Pomatostomus temporalis temporalis* Grey-crowned Babbler (eastern subspecies)
- *Melanodryas cucullata cucullata* Hooded Robin (south-eastern form)
- *Phascolarctos cinereus* Koala
- *Chalinolobus picatus* Little Pied Bat
- *Tyto novaehollandiae* Masked Owl
- *Grantiella picta* Painted Honeyeater
- *Hoplocephalus bitorquatus* Pale-headed Snake
- *Pseudomys pilligaensis* Pilliga Mouse
- *Aepyprymnus rufescens* Rufous Bettong
- *Dasyurus maculatus* Spotted-tailed Quoll
- *Lophoictinia isura* Square-tailed Kite
- *Petaurus norfolcensis* Squirrel Glider
- *Neophema pulchella* Turquoise Parrot

EPBC Act significant species whose mapped habitat may occur within 25 km of the study area and have been subsequently assessed as possibly occurring within the study area:

Birds

- Swift Parrot *Lathamus discolor*
- Superb Parrot *Polytelis swainsonii*
- Regent Honeyeater *Xanthomyza phrygia*
- White-throated Needletail *Hirundapus caudacutus*
- Rainbow Bee-eater *Merops ornatus*
- Regent Honeyeater *Xanthomyza phrygia*

Mammals

- Large Pied Bat *Chalinolobus dwyeri*
- Eastern Long-eared Bat *Nyctophilus timoriensis*
- Pilliga Mouse *Pseudomys pilligaensis*

Reptiles

- Five-clawed Worm-skink *Anomalopus mackayi*

5.8.2 Field Surveying and Assessment Reporting

Field surveys carried out to date in PAL2 have occurred on four separate occasions, the full results of which are contained within the aforementioned impact assessment reports. In summary, the impact assessments conducted to date conclude that:

- Critical habitat as listed in the Register of Critical Habitat kept by the Director General of Department of Environment and Conservation does not occur in the study area;
- No threatened ecological fauna communities or fauna populations listed on the schedules of the TSC Act occur in the study area;
- The cumulative study area is not potential habitat as defined in SEPP44 (Koala Habitat Protection);
- Many of the species identified during surveying are avian species with sufficiently large home ranges that, when combined with the extent of the regionally common *E. crebra* dry open forest habitat identified by Elks, is unlikely to result in any long term, significant impacts any species or community in the Pilliga East State Forests;
- Activities on this scale are such that habitat is not likely to become fragmented or isolated from other areas of habitat within the Pilliga Scrub;
- Sufficient mitigative action can be taken to limit the impact of the proposal on the hollow dependant species identified by Kendall;
- The proposed activity will not impact on habitat favoured by the Pilliga Mouse *Pseudomys pilligaensis* which includes recently burnt gullies, areas dominated by broombush and areas containing an understorey of kurricabah (*Acacia burrowii*) with a bloodwood (*Corymbia trachyphloia*) overstorey; and
- Habitat for the listed microbats is widespread and common in the study area, locality, and region.

5.8.3 Assessment of Significance

The assessment of significant effect on threatened species, populations or ecological communities or their habitats as per S5A (2) of the *Environmental Planning and Assessment Act 1979*, as applied to the GGS project are such that

- a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,**

Fauna surveys conducted across the project area suggest that no threatened species, populations, communities or critical habitat are at risk from the proposed activity. Given the limited impact of the activity, it is unlikely that this proposal will have any adverse effects on

the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

- b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,**

Flora and fauna surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat or species/partial remnants that constitute a threatened, population, community or critical habitat. Given the limited impact of the activity, it is unlikely that this proposal will have any adverse effects on the life cycle of any threatened species such that a viable local population is likely to be placed at risk of extinction.

- (c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

As all endangered ecological communities are vegetation communities see section 5.5.2 (c) for consideration of this factor.

- (d) In relation to the habitat of a threatened species, population or ecological community:**

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Approximately 40,000ha of area mapped as the vegetation class ‘Pilliga Outwash Dry Sclerophyll Forest’ and a further 20,000ha of the floristically similar ‘Western Slopes Dry Sclerophyll Forest’ occurs in the locality but the habitat has been modified by grazing, modified fire regimes, and forestry activities (Elks, 2006).

The area impacted by the proposed activity represents a very small percentage of the dominant vegetation community mapped within PAL2, and will impact on less than 0.002% of habitat of similar quality in the locality.

There is no discernible difference in ecological integrity between habitat to be affected and habitat to remain.

The small scale and spatial arrangement of the proposal is such that habitat is not likely to become fragmented or isolated from other areas of habitat.

The apparent absence of threatened flora species from the study area and the large areas of similar habitat in the region and locality suggest that the habitat to be removed is unlikely to be of importance for the long-term survival of the threatened species *Diuris tricolor*; *Goodenia macbarronii*; *Philotheca ericifolia*; *Rulingia procumbens* or *Tylophora linearis* in the locality.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

Critical habitat as listed in the Register of Critical Habitat kept by the Director-General of DECC does not occur in the study area. The proposed activity is unlikely to have any adverse effect on critical habitat, either directly or indirectly.

f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

Fauna surveys conducted across the project area have found no evidence of any threatened species, populations, communities or critical habitat in terms of the action being inconsistent with the objectives or actions of recovery and threat abatement plans.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

With respect to fauna, the removal of vegetation would not be likely significantly impact on the habitat of TSC Act threatened fauna species known to occur within the Study Area or considered as possible occurrences within the Study Area.

5.8.4 Conclusions

Based upon the assessment reports from the various fauna surveying and the available data from State and Commonwealth databases, the likelihood that the proposed activity will impact on a species of

significance is negligible. Furthermore, the extent of removal, modification and fragmentation of vegetation associated with this activity is not considered significant.

Various strategies for the mitigation of threats to these species are discussed in the survey reports many of which are feasible for incorporation into the operational plans for the proposed GGS. They include:

- Finalising the GGS route that avoid any environmentally sensitive areas and habitat elements,
- Large (>40cm a.b.h.) living or standing dead trees should be left undisturbed unless no practical alternative exists. Pre-felling surveys of habitat trees to occur should this be required.

ESG is confident that the planned activity will not introduce any long term impacts on threatened species or the habitat favoured by them. All attempts to minimise the overall footprint of the activity have been made to date and will continue to be an integral part of the planning process.

5.8.5 Vegetation Offsets

The scope for an offsets program to account for the cumulative impacts of ESG's development activities in the Pilliga East has advanced considerably over the past 12 months.

The environmental assessment carried out for the Narrabri Gas Utilisation Project and the subsequent evaluation of the project by DECC has raised a requirement to initiate proceedings to achieve a stated offset against the cumulative impacts of the proposed gas flowline. Further to this requirement, ESG proposes to commit to an inclusive offsets program via negotiations with both DECC and the Namoi CMA that will account for the cumulative impacts (≈40-50ha) of all exploration activities carried out to date (2002-2008).

No further detail of this proposal can be provided at this stage, however full disclosure of the program will be forthcoming in the near future and documentation provided to all stakeholders including DPI (Minerals and Petroleum).

5.9 Cultural Heritage

Throughout the development of the Narrabri CSG Project, the existing knowledge base on the extent of Aboriginal inhabitation across the region has steadily grown. Cultural heritage surveying has occurred prior to all exploration activities within the Pilliga East State Forest since Eastern Star commenced the active development of the Narrabri CSG Project in 2004.

Eastern Star Gas has on all occasions the Pilliga Forest Aboriginal Management Committee (PFAMC) to assist in the conduct of Aboriginal heritage investigations across the PAL2. The objectives of the

surveys are to quantify the likely impacts an activity will have on known and previously undiscovered heritage places.

The existing archaeological record for the region consists of various sources of cultural heritage information including the NPWS AHIMS database, the Forestry NSW/PFAMC site register and a number of published reports on the Aboriginal inhabitation of the Pilliga Forests. These sources corroborate on the understanding that Pilliga Forests were frequently utilised by Aboriginal communities for a range of uses and that a number of significant sites have been identified during subsequent survey efforts.

To date, the project specific survey efforts have located one site of Aboriginal heritage significance in the Pilliga East State Forest; a possible scarred tree was located during surveying for the proposed CSG flowline linking the Bibblewindi and Bohena CSG pilot with the Wilga Park Power Station. No other places or items of significance have been identified during the survey efforts.

The low number of sites identified during this survey is generally thought to be related to a range of environmental factors, primarily:

- a lack of permanent or semi-permanent water around which places (e.g. campsites) of cultural significance may have been based;
- the lack of landforms such as rocky outcrop or exposed rocks that would have provided shelter and a potential materials resources;
- the lack of sufficiently mature old growth trees from which definite or possible scars could be located; and
- the frequency of bushfire across much of the Project Site and there impact on indigenous vegetation.

Assessing the proposed activity for likely and actual impacts on Aboriginal heritage, sufficient evidence on the distribution and frequency of sites across PAL2 exists that indicates that the proposal carries no potential for direct impacts on the cultural heritage values of the project area or the wider Pilliga State Forests System.

A search of the DEC (NPWS) AHIMS database indicates that no sites of cultural heritage significance are located within the vicinity of the proposed sites.

A search of the Pilliga Forest Aboriginal Management Committee/Forestry NSW Aboriginal Site Register indicates that no sites of significance are likely to be impacted by the proposed activities.

To further reduce the risks of impact on the Aboriginal heritage values of the region, ESG will undertake site specific surveys of the proposed GGS route with the assistance of the PFAMC heritage advisors.

Based upon the information collated from previous heritage assessments and field surveying efforts, the following recommendations have been made by the PFAMC to account for any residual risks:

- The PFAMC are consulted when any changes are made to the proposed locations or where the project scope is altered in any significant way;
- Where changes are made to the project plans in regard to the proposed disturbance zones, further field based surveying is carried out; and
- If any potential places, sites or items of cultural significance are identified, all activities are to cease until such time as the appropriate representatives of the PFAMC have assessed the site and adequate site management plans have been devised.

5.10 Waste Disposal

Waste materials generated during the construction period will include (but are not limited to:

- Construction materials waste such as timber, plastic and small amounts of metals.
- General domestic refuse; and
- Wastes such as engine lubricants and coolant fluids.

In accordance with good field practice, work crews will be required to contain waste materials within rubbish cages located at regular points along the active construction zone. Wherever possible, waste materials will be collected for recycling and/or reuse or otherwise be transported for disposal at the Narrabri Waste Depot.

5.11 Visual Amenity

The proposal requires the creation of a corridor of approximately 12m in width and the longer term maintenance of a 3m wide corridor linking the Bibblewindi Lateral Pilot and the Bibblewindi CSG Pilot. In terms of visual impact, this will require the removal of vegetation within the corridor for the entire length of the GGS.

The retention of approximately 3m corridor in a mostly vegetation free state is required for the operational life of the GGS. This cleared area will provide ongoing access for maintenance in addition to reducing the potential impact of vegetation growth and bushfire in the close vicinity of the buried pipes.

Given the relative isolation of the project site the visual impact of the proposed activity is not considered significant and will not be the subject of a specific mitigation strategy.

The marking of the GGS with adequate locational and safety signage is a key requirement that cannot be avoided. Australian Standard 2885 is the overarching standard that applies to the operation of flow lines operating in excess of 1050kPa. However, the erection of signs indicating the location of the low pressure GGS will mitigate any residual risk of interference by forestry operations or the like. ESG will install and maintain signage at regular intervals the route such that a sign is visible at any given point. Additional signage will be installed at points where the GGS crosses existing roads and tracks.

6 Cumulative Impact Assessment

This review has identified and assessed the relevant environmental impacts associated with the proposed implementation and operation of GGS linking the Bibblewindi Lateral Pilot with the existing Bibblewindi CSG Pilot (**Figure 5**). ESG remains confident that the project will not create any long term, detrimental environmental impacts likely to alter the localised or regional environment.

In preparing this review, the existing knowledge base on the PAL 2 environment has been consulted to accurately characterise the biophysical environment around the project site and the potential and likely impacts of the proposal. In consultation with stakeholders and external contractors, significant efforts to reduce the cumulative impact of all project components have been made and safeguards, controls and mitigation measures incorporated where at all possible.

6.1 Biophysical Considerations

6.2 Flora and Fauna

The modification and alteration of native vegetation/habitat has been reduced to the smallest area possible in light of the project design and construction specifications. No threatened species or communities listed as such under State and Commonwealth legislative instruments have been identified as likely to be impacted by the Project.

The GGS project as described will require the modification of a maximum 5.5 ha of native vegetation although significant reductions in this area will be achieved by utilising existing roads & access tracks as part of the construction/working area. This strategy has the potential to reduce the impacts of native vegetation by 30% or 1.7ha.

To date, the total area of operational lands within PAL2 approximates 30ha which is just over 0.001% of the 26 500 ha of lands under the PAL2 title. The addition of up to 5.5 ha to accommodate the GGS will not result in a significant increase in this figure nor the likelihood of longer term impacts on the biotic environment as discussed in section 4.7 and 4.8.

Further cumulative reductions in the impact of the ongoing exploration activities will be achieved through the creation of or participation in a suitable green offsets program. Details of the program will be forwarded to all Government stakeholders upon the completion of discussions with the Namoi CMA for the proposed Part 3A project.

6.3 Aboriginal Heritage

The GGS project will not impact on any known places or items of Aboriginal heritage significance. The conduct of further heritage clearance of the site will furthermore reduce the risk of impacts on previously undiscovered places and items of significance.

6.4 Noise Impacts

Whilst the installation of the GGS will generate localised noise in excess of current background levels, the activities are not dissimilar to normal forestry operations in terms of noise impacts. Furthermore, the remote location and short construction time frames are unlikely to result in any specific noise related impacts that require mitigative action.

6.5 Socio-economic Considerations

The impact of the Project on the local and regional socio-economic environment has been determined as positive, with measurable increases in direct and indirect employment opportunities and the utilisation of the region's extensive network of retail and industrial service providers.

The Project, as an integral part of the development of CSG resources in PEL238 would also have significant economic benefits to NSW through the generation of royalty revenue and the establishment of additional, gas fired electricity generation capacity.

6.6 Greenhouse Gas Impacts

The operation of the CSG lateral pilot and the methane generated as a by product presents an ongoing concern in terms of its environmental impact as a greenhouse gas. ESG, in preparation for the submission of a major project application to Planning NSW, commissioned Heggies Pty Ltd to conduct a greenhouse gas assessment of the Bibblewindi and Bohena CSG Pilots and the relative benefits of gas capture and consumption at the Wilga Park Powerstation in preference to atmospheric venting and/or flaring.

The operation of the CSG project and currently includes 12 production wells across the Bibblewindi and Bohena CSG pilots, impacts considerably on the environment in terms of greenhouse gases. Heggies (2007) conducted a comprehensive review of the potential impacts of the current situation should no action be taken to consume methane being vented to atmosphere from the Bibblewindi and Bohena CSG Pilots. CSG gas vented directly to the atmosphere has a greater global warming potential than combusted CSG due to the high (~88%) methane content of the gas, coupled with the GWP of methane (21 times the GWP of CO₂). Calculations of greenhouse gases from venting, in terms of CO₂-e were calculated by Heggies from modeled throughput values and thence compared in terms of State and National totals

Comparison Emissions Figures on the Project, Venting Option, State and National Figures

Source	Emissions (t CO ₂ -e)	% of National
Project	204 193 (predicted)	0.0365%
Atmospheric venting option	1 431 624 (predicted)	0.256%
NSW annual total	158 200 000	28.29%
National annual total	559 100 000	

Table 4 Comparison emission figures from the gas utilisation project (Heggies 2007)

The comparison of predicted emissions with the 2005 State and National emissions figures suggests that that the proposed combustion of the produced CSG at the Wilga Park Power Station would represent an increase of approximately 0.0365% the total baseline Australian emissions for 2005 or 0.265% from the venting of the CSG to atmosphere. A comparison of the two options demonstrates that equivalent emissions would be in the order of 7.2 times greater if the gas was vented to atmosphere preferentially over its collecting and combustion at the Wilga Park Power Station.

The conclusions of this report and the findings of ESG as the proponent of the major project that would gather and transport all gas produced at these two pilots suggest that considerable environmental and economic benefits can be gained from the proposal. Similarly, it is ESG's intention, as described in the water and operations management plan to collect all gas produced at the lateral pilot for consumption *in situ* (surface and subsurface equipment) or transportation via the gathering system back to Bibblewindi and into the main flowline to Wilga Park. Therefore in terms of the potential greenhouse impacts of the gases produced at the lateral pilot, it is planned to capture and consume as close to 100% of production as practicable for the life of the project.

6.7 Conclusions

The project presents a feasible option for the collection and transport of gas and water produced at the Bibblewindi lateral pilot consumption of gas produced from within PAL2. The Project has been designed to address the key issues raised by all levels of Government, landholders affected by the Project and the wider community.

The Project provides a pathway for the management of produced gases and water during the extended testing of CSG wells and (subject to consent modification and approvals) consumption in electricity generation in preference to the venting of gases to atmosphere. In addition to the environmental benefits offered by the Project, the construction and operation of the project will continue to result in a significant economic boost to the Narrabri Region.

7 Water Treatment Plant

7.1 Water Treatment

The revised water treatment process implemented as part of this project expansion will be different to that currently in operation. **Figure 14** outlines in general terms the flow of water and its products through the treatment system.

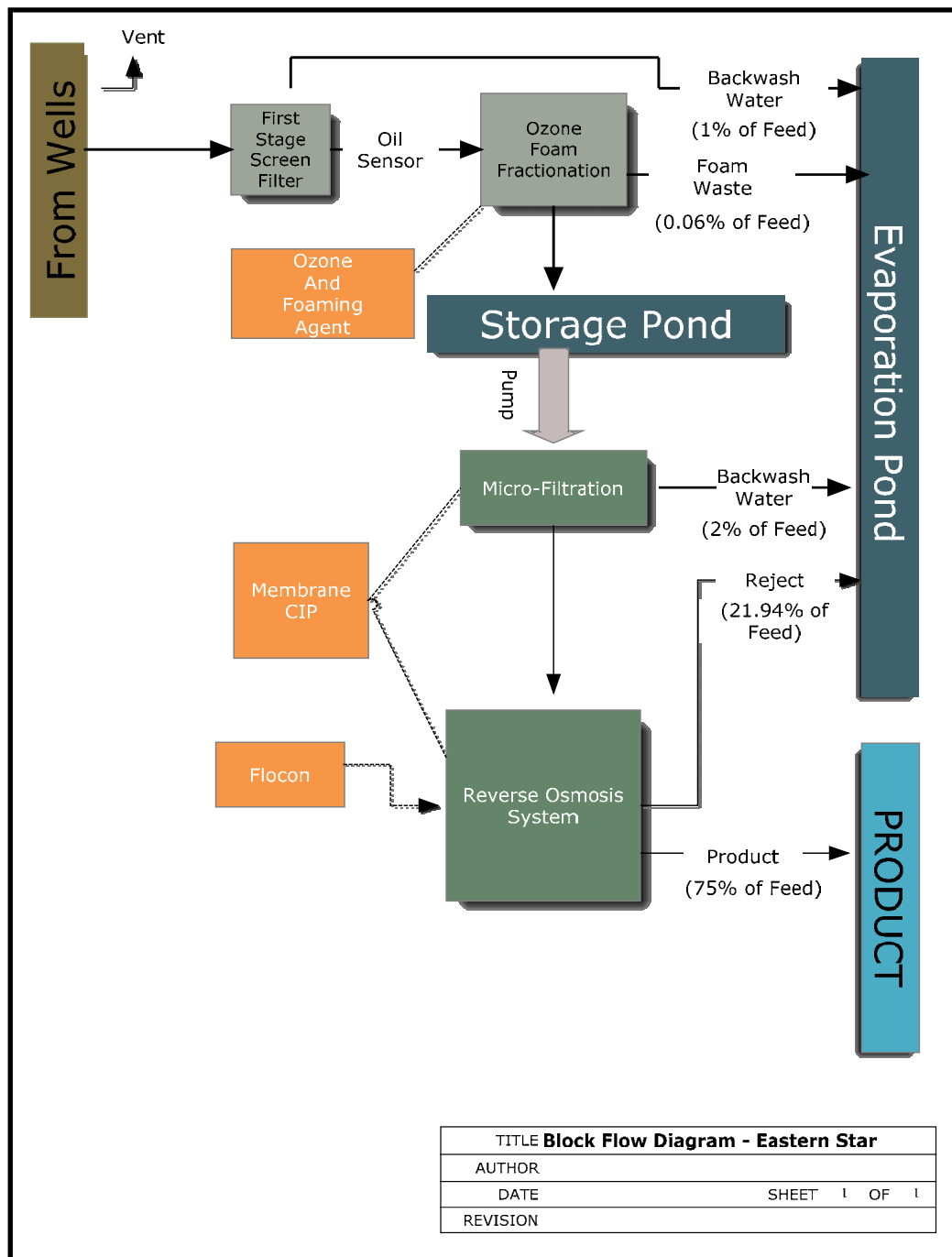


Figure 14 Flow diagram for the expanded water treatment facility

7.2 Permeate water quality

The rates of recovery from the expanded treatment plant are expected to range between 70 and 90% when running at full capacity. As the expanded plant has a maximum capacity of 1ML, this will result in daily permeate volumes of between 700 and 900 kL.

Estimated permeate qualities of less than 250mg/L TDS are expected however higher qualities are currently being achieved from the pilot plant. The most recent analysis of permeates indicates permeate water quality of around 150mg/L.

7.3 Concentrate water quality

The quality of concentrates discharged from the treatment units has been estimated by the manufacturer and is expected to approximate 42 154mg/l TDS.

7.4 Water Transport

Permeates discharged from the treatment unit will be collected and placed into the smaller of the two lined evaporation structures at Bibblewindi-1.

The water in this impoundment will then be pumped from site via surface flowline to the discharge point on Bohena Creek although various other reuse options will also utilise this supply (drilling, roads maintenance, fire fighting). The flowline will be laid in a location that makes efficient use of the approximately 20m of topographic relief between Bibblewindi and Bohena Creek. No excavation, dredging or other type of ground disturbance will be necessary for the placement of this transfer flowline.

7.5 Water Discharge

Permeates discharged from the treatment unit will flow along the transfer flowline and be discharged at the outlet manifold located on the sand bed of Bohena Creek. It is proposed that a device to minimise the velocity of discharge waters is employed to mitigate any potential for direct impacts caused by the flow of water from the transfer flowline.

The water will be allowed to flow under gravity from the outlet manifold and into the permeable sand beds of Bohena Creek as permitted under the current approval to do so (see section 7 for further discussion).

7.6 Concentrate Management

The concentrates discharged from the treatment unit will flow directly into the lined water management facility adjacent to Bibblewindi-1.

This facility will contain a mixture of periodic inflows of raw formation waters, concentrates from the treatment plant and incidental rain fall during the production testing phases.

Currently there is no specific long term concentrate management plan, however various potential options to manage concentrates are being considered and

7.7 Reuse Options

The reuse of permeates obtained from the treatment unit during both the pilot study and full scale treatment project will remain the preferred objective of this strategy.

There remains a need for water of suitable quality in the immediate area; roads maintenance and improvement, dust suppression, well maintenance and other minor operational requirements will consume a proportion of the permeates produced and stored in the existing impoundments.

ESG has discussed the provision of water to Forestry NSW for various purposes including road maintenance and fire fighting. There are a number of dams located in the vicinity of the project that will accept significant volumes of water given that natural inflows have been small for the past summer and winter period.

8 Water Treatment & Disposal Strategy

ESG has obtained approval to discharge treated water from the Bibblewindi CSG pilot into the localised creek system after a considerable period of discussion and negotiation with DPI (Minerals and Petroleum) in conjunction with a range of Government agency stakeholders.

The application and assessment process included the completion of comprehensive surface and groundwater modelling to characterise the likely impact of discharging up to 1ML per day of treated water into the creek system. The existing approval (**DPI ref: 06-6386-03**, 11 April 2007) can be found in its entirety in Appendix 2.

A limited revision of the project application and impact assessment is required to demonstrate to agency stakeholders the extent of variation to the original proposal and how this variation can be accounted for in the project impact assessment carried out to date. Furthermore, specific issues raised by agency stakeholders during the scoping and screening process that may now require resolution are discussed.

8.1 Disposal Project Review

In preparation for the expansion of the treat/dispose strategy, ESG provides the following review of the current approval and specifically identifies the areas where the expansion plan differs from that originally proposed.

Conditions attached to the approval that provide the basis for this review include:

- The approval is valid only for the duration of the production test for Bibblewindi 1 to 9 (**8.1.1**);
- Water may only be discharged from the treatment plant into Bohena Creek after all options to reuse and/or evaporate the water have been exhausted (**8.1.2**); and
- Water discharged to Bohena Creek must be of a quality equal to or better than the receiving water unless an Environmental Protection Licence is first obtained from DECC (**8.1.3**);

8.1.1 Addition of the Bibblewindi Lateral Pilot wells to the Approval

ESG has received approval to implement the Bibblewindi CSG lateral pilot project approximately 4000m south east of the Bibblewindi Bibblewindi-1. This project will develop the concept of lateral, ‘in seam’ drilling intersecting vertical production (**Figure 1**) wells. This technique has been successful in providing commercial success in similar CSG projects in Australia and worldwide.

Six of the eight wells in the lateral pilot are to be equipped with pumping facilities and surface equipment required to produce water and gas from the target CSG reservoir. The construction of a gas and water gathering system (GGS) will provide the means of transfer from the lateral production wells

back to the existing water treatment and management facility at the Bibblewindi CSG pilot (**Figures 5 & 6**).

The request to review and amend the condition restricting the approval is based upon the observed rates of water production from the Bibblewindi CSG Pilot and the production model for the lateral pilot. In general terms, the cumulative rates of water produced from both pilots is not expected to exceed the rates on which the original application to treat/dispose was based and does not represent a significant departure from the scope of the proposal and subsequent approval. ESG remains confident that the existing approval to treat all production water and discharge up to 1 ML into Bohena Creek accounts for the cumulative rates of production expected from both pilots over the next 12-18 month period.

In summary, ESG requests that the approval to treat and discharge CSG production water incorporates all 15 production wells located at Bibblewindi.

8.1.2 Limitations on discharge conditions

The limitation of discharge only after all options to reuse and/or evaporate the water have been exhausted does not recognise the longer term importance of conserving the operational capacities of impoundments at the CSG pilot. The long term sustainability of the project and the ability to continue the longer term testing of drilling, completion techniques and above all production relies on reducing the volumes of production water where possible and through all means available.

Evaporative systems that exploit the high rates of natural, solar evaporation in the Narrabri region have been evaluated as a method of reducing storage requirements. Testing of a basic system that atomises production water within the lined impoundment suggests that similar systems can achieve >50% increase in evaporation over natural rates. However where higher rates of water production are encountered and over longer periods, this method impacts only superficially on the cumulative volumes requiring longer term storage within the project site and is impacted significantly by climatic variation (temperature) and high wind speeds which limit its operation.

The pilot treatment plant (capacity 160 kL/day) has been successful in reducing the volumes of production water requiring storage by between 70 and 75% through the removal of dissolved salts. Various reuse options including supply of drilling rigs, roads maintenance and similar operational requirements have made use of permeates and sustain the treat and store strategy. Water qualities of between 150 and 250mg/L have been consistently achieved.

The modification of the consent from emergency discharge after all other reuse option have been exhausted to permit the daily discharge of up to 1 ML of treated water into Bohena Creek is required to sustain the CSG project and conserve the long term storage capacities at Bibblewindi. While the reuse

of permeates remains the primary objective, the expected rates of water production across the next 12-18 months will exceed all current daily operational requirements, available storage capacity and any potential reuse option.

The disposal project impact assessment submitted to DPI requests consent to discharge daily, utilises the 1ML discharge rate in all ground water and surface water modeling and characterizes the likely impacts of this strategy. A review of the key points found in the assessment can be found in section 8.3 below.

In summary, ESG requests that the approval to treat and discharge CSG production water is amended to permit the daily discharge of up to 1ML.

8.1.3 Water Quality Limitations

The requirement that the quality of treated water discharged to the creek system as proposed must be of quality equal to or better than the receiving water unless licensed by DECC (EPA) is discussed in some detail within the project impact assessment. The issue of environmental protection licensing under existing regulatory frameworks has been stated as unnecessary by DECC in preference of ensuring that the disposal of treated water of known quality does not exceed published water quality objective (WQO) thresholds for the Namoi catchment and furthermore providing offsets for all salt loads above those found in the receiving waters.

In these terms, the pertinent WQO's for this project given the potential downstream uses are:

- Aquatic ecosystems - Lowland rivers: 125–2200 $\mu\text{S}/\text{cm}$ (equiv. 80-1400mg/L)
- Homestead water supply - < 500 mg/L is regarded as good quality drinking water based on taste.
- Drinking water (groundwater) - > 800 $\mu\text{S}/\text{cm}$ causes a deterioration in taste (equiv. 512mg/L)

The proposed discharge of up to 1ML of water per day of a known quality ($\leq 250\text{mg/L}$) will not exceed the WQO for the Namoi River at any time.

Green offsets to balance the impact of increased salt loading will be accounted for through a program of vegetation offsets currently being discussed with the Namoi Catchment Management Authority for the Narrabri Coal Seam Gas Utilisation Project being assessed by Planning NSW. ESG commits to the inclusion of additional offset requirements for salt load and furthermore will consult with DECC on the objectives, content and projected outcomes of such a program.

8.2 Impact Assessment Review

Key findings of the impact assessment carried out for the disposal project are reviewed in the following section and clearly define the scope of the proposal to discharge up to 1ML/day to Bohena Creek and the likely and potential impacts of this activity.

8.2.1 Surface Water Impact Assessment

The following summary and conclusions were provided by WRM (2006);

AGE (2006) found that the overall impact of disposing treated water up to 1 ML/d will be to raise the groundwater table beneath the creek to surface (creek bed) level, or near surface level. This will create a wetting front and zone of saturation progressing downstream of the disposal site along Bohena Creek for approximately 11 km. Therefore, the 11 km reach immediately downstream of the disposal site, all of which is within the Pilliga State Forest boundary, is potentially the only reach of the creek that will experience some impact due to the proposed disposal of water.

A sensitivity analysis undertaken by AGE (2006) showed that the saturation length of the creek is not dependent on the specific yield of the alluvial sands. The saturation length will however increase if the creek width and/or the evapotranspiration rate are less than the assumed values. If the assumed values are halved the saturation length of the creek would be doubled to 22 km. On the basis of the above findings by AGE (2006), the proposed disposal of treated ESG water will have insignificant impact on the overall flow characteristics in Bohena Creek.

During dry periods the impact will not extend as far downstream as the Newell Highway crossing, even after taking into account uncertainties in assumed creek width and evapotranspiration rates. During runoff events however, the disposed water will mix with stream flow and travel further downstream. Based on the overall stream flow characteristics of Bohena Creek, the magnitude and duration of this impact will be insignificant. It is noted that the average volume of runoff at Newell Highway during a runoff event is in the order of 30,000 ML and the volume of treated ESG water discharged into the creek during such an event will be less than 100 ML.

A rainfall-runoff model was developed to establish the long-term baseline stream flow characteristics in the Bohena Creek. The model was calibrated against 10 years of Bohena Creek flow data recorded at a stream gauging station located at the Newell Highway crossing. A 106 year (1900-2006) daily simulation of the Bohena Creek flow behaviour shows the following baseline characteristics:

- Runoff events are infrequent (less than 1 per year on average) but when they occur they produce large volumes of runoff and last a significant period (several months);*
- Over the long term, the creek flows only for about 12% of days (i.e. it is dry for 88% of days);*
- On average, the creek is dry for extended period of time generally in excess of 12 months.*

The proposed disposal of treated CSG water will have an insignificant impact on the overall flow characteristics in Bohena Creek. During dry periods the impact will not even extend as far downstream as the Newell Highway crossing. During runoff events however, the disposed water will mix with stream flow and travel further downstream. Based on the overall stream flow characteristics of Bohena Creek, the magnitude and duration of this impact will be insignificant.

8.2.2 Groundwater Impact Assessment

The following conclusions on the groundwater hydrology of the project area and the likelihood of actual impacts being realised in any significant way have been provided by AGE (2006).

A review of the hydrogeological regime of the Bibblewindi CSG Pilot Area and surrounds, indicates that there are three aquifer systems of significance in the project area, viz:

- Alluvial creek sands to confined to the bed of Bohena Creek and its major tributaries;*
- The Pilliga Sandstone aquifer; and*
- The Permian Coal Seams.*

The aquifers are hydraulically isolated from each other by intervening impermeable shale, mudstone or siltstone beds. The groundwater table of the alluvial sands of Bohena Creek is perched about 20m above the water table of the Pilliga Sandstone, which is the major aquifer exploited by farms in the area, for stock and domestic use. Although of very high quality there is little use made of groundwater from Bohena Creek, probably because the [Pilliga sandstone] aquifer is laterally extensive, [the creek alluvium] being confined to the creek bed and storage and yield is relatively low.

The Permian coal seam contains very poor quality water which will be produced as a by-product of coal seam gas. This water will be treated by reverse osmosis and it is proposed to discharge the water into Bohena Creek. An assessment of the potential impacts of this proposal was undertaken and it is concluded that:

- The creek is likely to be impacted over an 11km reach downstream of the discharge site;*
- The impact will be to raise groundwater levels by 1.5-2m in the alluvial sands to surface level and this is likely to result in surface flow over most of the 11km reach;*
- Groundwater levels will be maintained relatively constant at higher than natural levels for the proposed 18-24 month period over which discharge will occur; whereas under normal conditions groundwater levels are likely to have fluctuated by 1.5-2m in response to dry periods, rainfall and creek flow;*
- Pool levels will be maintained in the reach of the creek impacted, however natural drying conditions will not be mimicked over the 18-24 month period;*

- *Groundwater dependant ecosystems will be maintained although there will not be the variability in groundwater levels that occur under natural conditions. A water level rise of 1.5-2m is within the natural water table fluctuation range, and is considered that an 18-24 month period is too short a time to establish an impact; and*
- *The quality of groundwater should not change significantly as a result of discharge of the treated water and hence there should be no impact on aquatic ecosystems, visual amenity, livestock, irrigation or homestead supply.*

The Namoi Water Quality and River flow Objective (RFO's) state that the streams in mainly forested areas are often valued for their conservation and recreational values. They usually have relatively natural flows and water quality. It also states that parts of Baradine and Bohena Creeks start is largely cleared land, and that water quality and flow patterns through vegetated areas such as the Pilliga State Forest generally reflect upstream effects. It is considered that the RFO's will be impacts marginally over an 11km reach for an 18-24 month period and that water quality should essentially remain unchanged.

With respect to State Legislation and Policy, the Water Management Act 2000 requires for “controlled activities” and “aquifer interference activity” that impact on the water resource and land degradation must be avoided or managed. It is considered that this report demonstrates that there will be minimal impact on the groundwater regime; however a licence to discharge will be required.

Similarly, with respect to State Groundwater Policy, it is concluded that the proposal meets the objectives of the Groundwater Quality and Groundwater Protection Policies and that Groundwater Ecosystems will not be adversely impacted.

The Pilliga Sandstone aquifer has been classified as a “high risk aquifer”, however the aquifer will not be impacted by the proposal as the alluvial aquifer system of Bohena Creek is perched on impermeable sediments that hydraulically separate the aquifers.

In summary, it is concluded that there should be minimal impact on the groundwater regime of the creek as a result of the proposal. As described by AGE (2006), the Bohena Creek alluvium is recharged primarily from infiltration of surface water during creek flow events and to a lesser degree by direct infiltration of rainfall on the sand deposits. The overall impact of this activity will be the recharge of the near surface alluvial system and to a lesser extent any laterally contiguous groundwater systems that may be in hydraulic communication with the alluvium along the impacted reach. Overall this can be considered a positive impact for the mid to long term health of the creek system.

8.2.3 Mobilisation of sediments

The disposal of treated CSG water into Bohena Creek and the extent to which this activity increases sediment/nutrient loads can be reasonably assessed from current knowledge base. In summary, the following information suggests that the activity is unlikely to result in any significant alteration to the current condition of the creek system and furthermore result in any long term environmental impacts.

Field based observations and further laboratory analysis confirmed high concentrations of suspended solids and turbidity in the alluvial waters of Bohena Creek. Whilst the catchment is almost entirely vegetated, the short term and intense surface flow events that occur in the region are effective at mobilising the fine surface sediments and depositing them in the sand alluvium of the representative creek systems.

The impact of the proposed activity on the mobilisation of sediments downstream is likely to involve some dilution of the suspended solids nearby the discharge point but no overall net increase in the concentration of or transport of the sediments downstream. The infiltration of water into the sand bed is gravity based and the inclusion of an outlet manifold device furthermore reduces outflow velocity hence the mobilisation and transportation of sediments and nutrients downstream is less likely to occur to any significant degree. The more gentle formation of a groundwater mound forming below and downstream of the discharge point is much less likely to result in such a reaction than would theoretically occur during a surface flow event where a large ‘slug’ of surface and subsurface flow containing significant sediment load would enter the creek system and move rapidly downstream.

8.2.4 Mobilisation of nutrients

The water within the creek system is generally of high quality with very low concentrations of dissolved solids (table 6). This suggests that the upstream catchment does not contribute any significant nutrient loads during surface flow events or that the creek alluvium and the sand bed provide a poor matrix for the capture and storage of nutrients mobilised during such events. The proposed disposal of high quality water with low to very low concentrations of dissolved solids is unlikely to significantly alter the overall quality of neither the receiving waters nor its already nutrient devoid composition. Additionally, the ionic composition of the treated water is dominated by elements that are generally not considered important to environmental nutrient cycles (e.g. sodium, bicarbonates and to a lesser extent chloride which is considered a micronutrient). With no measurable concentrations of either macro or micro nutrients and an alluvial system that readily transports dissolved solids, the likelihood that the proposed activity will result in nutrification of the downstream lentic/lotic systems remains inconsequential.

8.2.5 Accumulation of salts with the alluvial creek bed

The disposal of treated CSG water into Bohena Creek is likely to result in an increase of dissolved solids or salts within the alluvial groundwater system and the transportation of these salts downstream. Based upon the worst case water quality of the permeate stream and the maximum potential rates of discharge, the accumulation of salts in the alluvium has been estimated as:

Indicative permeate water quality	= 250mg/L TDS
Maximum rate of discharge	= 1 000 000 L/day
Cumulative daily salt loading	= 1 000 000L x 250mg/L
	= 250 000 000 mg/day
	= 250kg/day

AGE (2006) discuss the proposed activity with respect to the Namoi River Water Quality Objectives (WQO's) and suggest that the discharge of water not dissimilar to the water within the natural systems of the region will have minimal, if any, impacts with respect to the WQO's.

8.2.6 Namoi Catchment Water Quality and River Flow Objectives

The impacts associated with the proposed activity with respect to the Namoi Catchments Water Quality (WQO) and River Flow Objectives (RFO) have been considered. Based upon the maximum rate of discharge and the indicative water quality the following objectives apply to the project and must be taken into account in characterising the potential and likely impacts of the activity.

(RFO) Protect Pools in Dry Times – the protection of natural water levels in pools of creeks and rivers and wetlands during periods of no flow

AGE (2006) suggests that the presence of natural pools within the 11km downstream reach is unknown; a physical inspection of the 11km downstream reach cannot identify any natural pools in the impacted reach. The first permanent pool is located approximately 25km downstream of the discharge point and was formed incidentally in the excavation of sand for industrial purposes. The lack of natural pools in the impacted reach, and the location of the first permanent water 25km downstream of the discharge point suggest that this RFO does not apply to the proposed activity.

(RFO) Protect Natural Low Flow – very low natural flows should be fully protected for the environment

The introduction of up to 1ML of water per day into the creek system will impact a downstream reach 11km from the discharge point, at times causing shallow surface flow and/or visibly wet sands where evaporation rates are sufficiently low. The lack of any recorded flows in the creek except where a sufficient surface flow event occurs suggest that the activity is not likely to impact on the RFO.

(RFO) Mimic Natural Drying in Temporary Waterways – mimic the natural frequency, duration and seasonal nature of drying periods in natural temporary waterways

The disposal of water continuously at a rate of 1ML/day for an 18-24 month period would not permit the maintenance of this RFO. The model suggests that at this rate, 11km of the downstream reach will remain wetted and at times result in visible, shallow surface flows. The strategy for the management of water from the CSG project included the treatment, reuse where possible and the disposal of volumes above and beyond what can be stored in the existing pond for reuse and consumption. The likelihood of continuous discharge at the maximum rate is quite small and is more likely to involve the periodic discharge of significantly smaller volumes that would permit the observation of this particular RFO.

(RFO) Maintain Groundwater for Ecosystems – maintain groundwater within natural levels and variability, critical to surface flows and ecosystems

The AGE (2006) states that the shallow groundwater in the Bohena Creek alluvium provides base flow during dry periods and is probably the primary source of water to riparian vegetation and aquatic flora and fauna associated with pools in the creek. The periodic discharge of up to 1ML/day is unlikely to result in a significant departure from what is considered a natural level of groundwater flow considering that the natural levels vary considerably, from the observed levels some 1.5-2.0m below the sand surface to short term depths of many metres during runoff events e.g. the runoff events recorded at the Newell Highway gauging station in mid 1998 and late 2004).

(WQO) Visual Amenity – Aesthetic qualities of waters

The application of the key indicators and their numerical criteria used to assess and monitor the aesthetic qualities of waters generally do not apply in this particular case. The visual amenity WQO relates specifically to the visual clarity and colour, presence of surface films and debris and nuisance organisms; the proposed activity is unlikely to result in any visual impact that detracts from the stated objectives.

(WQO) Livestock Water Supply, Irrigation Water Supply and Homestead Water Supply – protecting water quality to maximise production of healthy livestock, protecting the quality of water applied to crops and pasture and for domestic use in homesteads including drinking, cooking and bathing

The proposed discharge of waters of the indicative quality exceed all key indicators and numerical criteria for these closely related WQO's as discussed in the ANZECC guidelines. The recorded stream flow data collected from the Newell Highway gauging station indicates that Bohena Creek has contained measurable flows for less than 12% of the time period. Additionally, the creek is not utilised to any significant extent for livestock, irrigation and homestead supplies due to these negligible flows and potential yields. The extent to which the water discharged into the creek flows downstream has been modelled by AGE (2006) and WRM (2006), who agree that at a maximum discharge rate of 1ML

the wetted front will extend 11km downstream. This is well short of the Newell Highway gauging station and some 12km upstream of the first semipermanent water hole that may be employed at various times for a water supply. There is no discernible risk that the project will not meet the indicator objectives for these WQO's and smaller chance that the water will be off sufficient volume to reach the areas with any potential for consumption under the WQO's for livestock, irrigation and homestead water supply.

8.2.7 Namoi Catchment River Salinity Targets

The proposed discharge activity is likely to impact on the Namoi Catchment River Salinity Targets and the main objective of minimising the quantities of salt reaching surface water systems. Whilst Bohena Creek is not considered a targeted zone, that is an area with *high levels of stream salinity or areas of salinity hazard with potentially significant social, economic and environmental impact*, Eastern Star acknowledges the role this activity plays in the overall catchment scale objectives of improving water quality and controlling point source contributions of salt.

As discussed in section 5.11, the scope for green/salinity offsets to account for the net increase in salts discharge remains relatively small for the duration of the production testing phase. As part of the ongoing project development, Eastern Star is committed to maintaining records on all salt loads discharged into the environment with a commitment to retrospectively accounting for these is an appropriately scaled green offsets programme once the project is considered a scheduled activity under the *Protection of the Environment Operations Act 1997*.

8.2.8 Conclusions

The impacts on the environment likely to be introduced by the operation of a treat/dispose water management strategy have been characterised and described in this review; Eastern Star remain confident that the proposed activity will not create any long term, detrimental environmental impacts likely to alter the operational environment or the surrounding region.

The proposed activity will not result in any impacts on the biophysical environment including flora, terrestrial and aquatic flora or sites of cultural heritage significance.

Bohena Creek and its tributaries are ephemeral, generally flowing for short periods following significant rainfall events or protracted wet periods. Base flows in these creeks are insignificant. The creek remains dry for extended periods between runoff events, sometimes for periods in excess of 12 months.

The water table in the alluvium of Bohena Creek varies from surface level following periods of creek flow, to an estimated 2.0m below surface level during dryer periods. Natural water holes occur within

the creek bed downstream of the discharge site, in areas of deep scour and where sand extraction has occurred. It is considered that groundwater in the alluvium is perched on the finer grained sedimentary deposits of the Blythesdale Group, as the water level in the deeper Pilliga Sandstone aquifer is 20- 30m below ground level.

Recharge of the alluvium occurs primarily from infiltration of surface water during creek flow events and to a lesser degree by direct infiltration of rainfall on the sand deposits. Groundwater flow is to the north along the creek channel, with discharge eventually to the Namoi River and/or the major alluvial aquifers associated with the river.

The proposed activity is unlikely to create any long term detrimental effects on surface and groundwater systems associated with Bohena Creek and accordingly unlikely to result in impacts contrary to the water quality and river flow guidelines in effect for the Namoi River catchment as defined by ANZECC and ARMCANZ.

The cumulative environmental impacts associated with the treat and discharge strategy is not likely to result in any detrimental alteration to the natural and man made environment of the area nor otherwise initiate a significant departure from what is considered natural for the creek system and its hydrology.

9 GGS Hazard and Risk Assessment

A desktop based hazard screening was conducted to assess the potential for any significant hazard or risk impacts associated with operating a buried GGS. Further hazard and risk assessment is carried out during design and engineering stages (per AS4130/2885) however this internal assessment takes into account the potential land use conflicts associated with the project.

9.1 Description

The proposed GGS infrastructure linking the Bibblewindi lateral pilot to the Bibblewindi CSG Pilot will incorporate two buried, 12 inch (max) diameter low pressure HDPE pipes for the conveyance of gas and water.

The GGS will be buried for their entire length with a cover not less than **750mm** and will be located within a disturbance corridor typically 12m wide but reduced to 3m in width after construction has been completed.

9.2 Construction Activities

The construction activities required to install the GGS will be confined to the GGS corridor itself and the existing CSG well pads located across the project site. Access to the construction zone will be via existing forestry tracks and shire roads intersected along the length of the disturbance corridor.

The GGS construction activity will comprise the following key steps:

- Each section of the GGS will be pegged and field verified by certified surveyor;
- A representative of the PFAMC will inspect the GGS corridor for places or items of Aboriginal heritage significance;
- Forests NSW will inspect the corridor and assess harvestable forestry products for felling and removal;
- All remaining vegetation is to be mulched *in situ* and graded from the immediate working area for replacement across the corridor during site rehabilitation;
- The flowline trench will be excavated and water and gas lines placed installed to a minimum depth 750mm along the surveyed corridor;
- The trench is backfilled, magnetic marker tape installed and the working area rehabilitated
- Safety signage installed; and
- The mulch stockpile will be respread across the corridor

9.3 Hazard Screening

The screening of potential hazards associated with the proposed activity is designed to determine whether further hazard analysis is required via the completion of a PHA.

The screening of hazards is carried out using a method consistent with Australian Standard for gas and water flowlined including AS4130 (HDPE Piping) and 2885.1-1997 (Gas and Liquid Petroleum) and involves:

- Identification of general and location specific threats to the integrity of the proposed GGS; and
- Assessment of these threats through a general risk management process involving likelihood of occurrence and the consequences of such occurrences.

The consequences associated with each threat were considered from public, employee, environmental and economic perspectives and take into account the mitigation strategies incorporated into project design, construction and operations planning.

9.4 Overview of Flowline Route

The 5.5 km GGS will be located within a cleared corridor of approximately 3m in width (post construction) and traverse lands zoned Crown Lands State Forest. The occupation of this land will be administered under an occupation permit (pending) issued under S31 of the *Forestry Act 1916*.

9.5 Risk Mitigation Measures

The following measures have been incorporated into the project design as part of the risk mitigation strategy.

- The GGS will be buried for its entire length ensuring a minimum cover of **750mm** or greater where land use and infrastructure requirements (e.g. road crossings) dictate. AS 2885 will be applied in determining the appropriate depth of burial.
- The erection of clear signage along the flowline route as per AS 2885.
- The installation of magnetic marker tape for post rehabilitation flowline locating.

9.6 Frequency of Occurrence

The predicted frequency of each identified threat has been assessed according to the descriptions presented in the **Table 4**.

Frequency	Description
Frequent	Expected to occur typically once per year or more
Occasional	Expected to occur several times in the life of a flowline
Unlikely	Not likely to occur within the life of a flowline, but possible
Remote	Very unlikely to occur within the life of the flowline
Improbable	Have been known to occur, but not anticipated
Hypothetical	Theoretically possible, but not known to have occurred

Table 5 Frequency Categories for Hazard Screening

9.7 Consequences

The possible consequences of each identified threat, should it occur, have been assessed taking into account the potential for:

- Human injury or fatality;
- Environmental damage; and
- Economic impact resulting from loss of gas supply.

The severity of each identified threat has then been estimated according to categories set out in the following table

Severity	Description
Catastrophic	Only applicable where many fatalities would result
Major	Few fatalities, loss of supply, major environmental damage
Severe	Injuries, supply restriction, minor environmental damage
Minor	No injuries or supply problems

Table 6 Severity Categories for Hazard Screening

9.8 Risk Ranking

According to estimated frequencies of occurrence and consequences, the risk ranking of each identified threat has been determined and is included in the following table. Risk rankings have been formulated on the basis of the basis of the following risk matrix.

Frequency	Risk Rankings (Severity Class)			
	Catastrophic	Major	Severe	Minor
Frequent	High	High	High	Intermediate
Occasional	High	High	Intermediate	Low
Unlikely	High	High	Low	Low
Remote	High	Intermediate	Low	Low

Improbable	High	Intermediate	Low	Low
Hypothetical	Intermediate	Low	Negligible	Low

9.9 General and Specific Threats

The key threats to the structural and operational integrity of the proposed GGS are discussed and assigned a risk ranking.

9.9.1 Third party interference

Whether accidental or intentional, interference with the buried flow lines is a key threat. Examples of inference include construction activities (fences, dwellings), service or infrastructure development (water, telephone, electricity and roads maintenance) and forestry activities that may disturb the soils such that the GGS is unearthed.

Frequency: Unlikely to occur given the land use type, registration with Forestry NSW via occupation permit and high visibility safety signage installed

Consequence: Severe

Risk Ranking: Low

9.9.2 Failure of flowline

The materials utilised in the flowline manufacture and construction processes comply with the relevant codes and standards for gaseous and liquid petroleum transmission including the following:

- Materials and components comply with API 15 LR.
- Flowline shall be manufactured to comply with ASTM D2996.
- Flowline designed in accordance with ISO 14692 Part 3.

Frequency: Remote

Consequence: Severe

Risk Ranking: Low

9.9.3 Over pressure of flowline

The potential for transmission pipes to become over pressured leading to rupture and gas leaks is negligible. The flow lines will operate at low to very pressures and inlet control systems (installed where gas enters the flowlines) will incorporate duplicate (active and standby) overpressure control systems.

Frequency: Improbable

Consequence: Minor

Risk Ranking: Low

9.9.4 Escape of flammable contents

The risk of spontaneous explosions or an ignition of leaking gas is dependant upon three main factors which include a source of gas (i.e. leak, failure or third party interference), the introduction of oxygen in critical quantities and the presence of a source of ignition itself. When considered with quickly dispersive physical properties of methane, the risk of explosion is very small if not negligible.

Frequency: Remote

Consequence: Severe

Risk Ranking: Low

9.9.5 Road crossings

The flowlines will intersect low traffic forestry tracks and public roads.

The GGS will be installed across access tracks and public roads by open-trenching and occur as per published RTA guidelines and Forestry approved management plans for partial road closures. The crossing design will be engineered to avoid road subsidence and pipe stress.

The key threat to the installed flowline at or near road crossings will be exposure of the pipe to accidental interference. In these terms, the stated requirements for the construction of a flowline across a shire road is that the depth to the top of the flowline must be a minimum for 1.5m below the existing table drain.

Frequency: Improbable

Consequence: Minor

Risk Ranking: Low

9.9.6 Creek crossing

The proposed gas flowline will intersect a small, unnamed creek at two locations. As the creek is ephemeral in nature and subsurface water flow is quite minimal, the crossing will be constructed using either a plough in or open cut technique. The flow lines will be installed at reasonable depth to ensure the pipe is bedded into firm substrate and additionally anchored with pre-cast concrete ballast.

Frequency: Improbable

Consequence: Minor

Risk Ranking: Low

9.10 GGS Hazard Conclusions

For each of the general and specific threats, Industry standard practices are available for mitigation of hazards associated with the proposed gas flowline system.

Sufficient design and operational safeguards have been incorporated into the Project to account for potential risks.

Risks arising from development and operation of the Project have been assessed as low and in these terms it is not necessary to undertake a Preliminary Hazard Assessment.

10 Conclusions

This updated water and operations management plan is to be appended to the current approved plan which governs the operation of Bibblewindi CSG Pilot. At this stage, all water and gas produced from the CSG wells is gathered, treated, reused and stored at the dedicated water management facility located at Bibblewindi-1. The development of additional production pilots, in this case the Bibblewindi lateral CSG Pilot, will require the revision of the water management strategy and the inclusion of plans to expand the proposed treat and dispose strategy.

The completion of a pilot water treatment project at Bibblewindi suggests that the reverse osmosis treatment process is capable of providing the project with significant reductions in saline water storage requirements. With rates of recovery having exceeded 70% over the pilot period and water quality below 250mg/l, permeates discharged from the treatment plant are able to be reused or disposed of through all available means.

The proposed disposal of up to 1ML of water per day into Bohena Creek is unlikely to create any long term detrimental effects on surface and groundwater systems associated with the creek system and accordingly unlikely to result in impacts contrary to the water quality and river flow guidelines in effect for the Namoi River catchment as defined by ANZECC and ARMCANZ.

The proposed activity will not result in any impacts on the biophysical environment including flora, terrestrial and aquatic flora or sites of cultural heritage significance.

The provision of this document fulfills the company's responsibility under Part 5, Section 111 of the *Environmental Planning and Assessment Act 1979* in which the determining authority (NSW Department of Primary Industries – Mineral Resources) is required to consider the likely and actual environmental impacts of the activity.

11 References and Bibliography

- Binns, D & Beckers, D., 2001. *Floristic Patterns of the Pilliga in*
Dargavel, J., Hart, D & Libbis, Brenda (Eds), 2001. Perfumed Pineries: Environmental History of Australia's
Callitris Forests
Centre for Resource and Environmental Studies, Australian National University, Canberra
- Clements, A & Moore, R. 2002. *Review of Existing Flora Data: PEL238 Pilliga East Seismic Survey*
Anne Clements & Associates Pty Ltd, North Sydney, NSW
- Smith, A. 2002. *PEL238 Pilliga East Seismic Survey: Fauna Review*
AUSTECO Environmental Consultants, Armidale, NSW
- Lindsay, A.D, (1974) *Forest Types of the NSW Cypress Zone*
Technical Paper 8, Forestry Commission of New South Wales
- Corkery, R.W & Company (2004). *Petroleum Production Environmental Operations Plan: Coonarah Gas Project*
R.W Corkery & Company Pty Ltd, Orange, NSW
- Elks, G.N. (2005). *PEL238 Coal Seam Gas Flora Survey – Bibblewindi Nine Spot*
Idyll Spaces Environmental Consultants, Bonville NSW
- Elks, G.N. (2006). *PEL238 Coal Seam Gas Flora Survey – Water Management Facility*
Idyll Spaces Environmental Consultants, Bonville NSW
- Kendall, K. (2005) *Fauna Study PEL238 Coal Seam Gas Project - Bibblewindi Nine Spot*
Kendall & Kendall Ecological Consultants, West Kempsey NSW
- Kendall, K. (2006) *Fauna Study PEL238 Coal Seam Gas Project - Water Management Facility*
Kendall & Kendall Ecological Consultants, West Kempsey NSW
- Trindall, E. (2005) *Aboriginal Heritage Investigations For Review of Environmental Factors (REF)“Biblewindi*
Nine Spot Project”
Trindall Cultural Advisory Services, Narrabri NSW
- Trindall, E. (2006) *Aboriginal Heritage Investigations For Review of Environmental Factors (REF)“Biblewindi*
Nine Spot Project” Water Management Facility
Trindall Cultural Advisory Services, Narrabri NSW

12 Appendix 1 - Environmental Management Plans

12.1 Access EMP

The nature and frequency of access to the flowline disturbance corridor will vary considerably according to the two main land use types encountered, the specific flowline disturbance corridor rehabilitation objectives and the extent of proposed maintenance.

Management Measures
• Access to the flowline disturbance corridor during construction and operation should be limited to essential traffic and personnel to the greatest extent. The disturbance corridor is not to be used as general thoroughfare. • Access to the working and staging areas should utilise existing roads, tracks and access as far as practicable to ensure minimal disturbance of flowline disturbance corridor. Sufficient existing access is available throughout the Bibblewindi and Pilliga East State Forests. • Public access to the flowline disturbance corridor during construction and operation should not be permitted unless the access already exists. • The safeguards, controls and mitigation measures discussed in the flora and soils impact assessment reports shall be strictly adhered to, most specifically: 1. The clearance envelope is to be marked before commencement of clearing, and movement of plant, machinery or materials beyond the clearance boundary is to be rigorously avoided; 2. the period when the trench is open should be limited to minimise the potential for soil erosion; and 3. excessive driving of vehicles on the area adjacent to the trench should be avoided to preserve soil structure • The safeguards, controls and mitigation measures discussed in the weed management plan shall be strictly observed at all times; • Speed limits shall be strictly observed by all contractors and their employees • Vehicular parking shall be limited to designated staging areas

12.2 Soils and Land Capability EMP

Management Measures
• The safeguards, controls and mitigation measures discussed in the soils impact assessment reports within the Part 3A project Statement of Commitments shall be strictly adhered to, most specifically: 1. The clearance envelope is to be marked before commencement of clearing, and movement of plant, machinery or materials beyond the clearance boundary is to be rigorously avoided; 2. The period when the trench is open should be limited to minimise the potential for soil erosion; and 3. Excessive driving of vehicles on the area adjacent to the trench should be avoided to preserve soil structure 4. No stockpiling of soils should be undertaken. Instead, the soil materials from topsoil stripping should be windrowed on one side of the excavated trench and the excavated subsoil material on the other side. The period when the trench is open should be limited to minimise the potential for soil erosion 5. Profile inversion should be avoided completely as the subsoil dispersibility will cause major erosion problems should subsoil material be placed on the surface of the rehabilitated trench line; 6. Soils shall not be worked if excessively moist in order to avoid structural degradation. 7. Topsoil should only be removed from the immediate vicinity of the trench where subsoil excavation is to occur. • The rehabilitation of the disturbance corridor within the State Forests is to occur as soon as practicable post construction. The re-instatement of the subsoil and topsoil profiles is to immediately precede the replacement of vegetation or 'brush' retained from the clearing activity.

12.3 Vegetation and Weed Management EMP

Management Measures
• The clearance of vegetation along the disturbance corridor should be minimised as far as practicable • The retention of non-harvestable vegetation ('brush') shall be maximised to permit the rehabilitation of the disturbance corridor as described in the flora impact assessment report • The movement of plant, machinery or materials beyond the disturbance corridor boundary is to be rigorously avoided; • Habitat trees or those with significant natural, heritage or amenity value may be retained on or adjacent to the disturbance corridor. An assessment of these trees will be made on a case by case basis in consultation with Forestry NSW and the safety guidelines for operations within Forestry Lands • Clearing shall aim to maximise the retention of understorey and groundcover root stock within the disturbance corridor • Slashing of understorey and groundcover shall be preferred to the use of bull dozers or graders as means to retain root stock material on areas away from the trenching zone • The regrowth of trees within 3m and shrubs within 1.5m of the trench centreline shall be removed at seedling or sapling stage so as to mitigate the risk of damage to the flowline • Key features of the weed management plan include: 1. Plant and vehicle hygiene standards are to be maintained throughout the construction period to minimise the risk of weed and pathogen transfer. 2. Plant and vehicle wash down to occur at ESG maintenance depot on arrival in region or, for local contractors, prior to commencement of works. Wash down will focus on the removal of all soils, mud and vegetative matter. 3. Plant and vehicle wash down to occur after exit from Forest and prior to entry onto pasture/cropping lands in a specified wash down bay with appropriate seed, vegetative material and sediment collection devices. 4. Soils disturbed during stripping/stockpiling and trench spoil must remain at the point source as far as practicable. Any materials imported to the disturbance corridor must be from landholder approved sources. 5. As per the rehabilitation and monitoring plan, weed monitoring and control of weeds will occur during the construction period and on a quarterly basis or as specified in individual land holder access agreements.

12.4 Dust Management EMP

Management Measures
• Access to the flowline disturbance corridor during construction and operation should be limited to essential traffic and personnel to the greatest extent. The disturbance corridor is not to be used as general thoroughfare. • Access to the working and staging areas should utilise existing roads, tracks and access as far as practicable to ensure minimal disturbance of flowline disturbance corridor. Sufficient existing access is available throughout State Forests and Agricultural lands • Slashing of understorey and groundcover shall be preferred to the use of bull dozers or graders as means to retain root stock material on areas away from the trenching zone • Vehicle speed limit restrictions on all unsealed roads and access tracks must be observed to minimise fugitive dust generation • Existing unsealed road surfaces will be subject to dust control up to twice daily depending on projected vehicular movements and weather conditions. The deployment of a water cart to suppress dusts will be at the discretion of the site foreman and Eastern Star's field representative • Any physical construction activities such as vegetation clearance, topsoils/subsoil stripping or trenching shall cease during periods of high winds and high temperatures • The suppression of dusts generated along the disturbance corridor during construction is to occur as per recommended soils management guidelines taking specific notice that all soils will be subject to structural degradation if worked when too moist. • Topsoils and subsoils stockpiled in windrows should be replaced as soon as practicable; the time the trench is open should be limited to minimise the potential for soil erosion • Where the trench is required to be open for longer periods, suitable physical protection of windrows should be afforded to limit the potential for dust generation caused by high winds

12.5 Waste Management EMP

Management Measures
• In accordance with good field practice, work crews will be required to contain waste materials within rubbish cages or recycling stockpiles located at each staging area along the disturbance corridor • Where possible, materials capable of being recycled and/or reused will be stockpiled and transported to the recycling centre at the Narrabri Waste Depot • General domestic refuse will be collected regularly from rubbish cages located at staging areas and collected for disposal at the Narrabri Waste Depot • Material wastes such as engine lubricants and coolant fluids will be stored and disposed of according to manufacturers and government guidelines. • Portable ablution/portaloos will be placed at the staging areas for the duration of the construction period and serviced regularly by local service providers

12.6 Erosion and Sediment Control EMP

Management Measures
• The main objectives of the erosion and sediment control plan is to minimise to the greatest extent the incidental mobilisation and hence loss of soil resources by wind and water; • Topsoils from SMU1 are to be rapidly protected by mulches or retained vegetation at the completion of construction activities; • Strict limitations on the timeframes that subsoils through all SMU's are exposed on the surface; • No long term stockpiling of soils is to occur; • Limiting the time the trench is open; • Ensuring that profile inversion is avoided; • Excessive driving of vehicles on the area adjacent to the trench should be avoided • The separate retention of topsoil and subsoil stockpiles on opposite sides of the cleared corridor is designed to retain of a majority of potentially sediment laden water within the cleared corridor where it can infiltrate naturally; • The installation of sediment controls including straw bales, silt top fencing and protective surface mulches will occur where minor changes of slope occur and where a need to do so is identified by the site supervisor; • The rehabilitation of the disturbance corridor within the State Forests is to occur as soon as practicable post construction. The re-instatement of the subsoil and topsoil profiles is to immediately precede the replacement of vegetation or 'brush' retained from the clearing activity.

12.7 Fauna Management (Open Trench) EMP

Management Measures
The excavation and retention of an open trench presents some risk to the native fauna which inhabit the operational environment. The objective of the fauna management (open trench) EMP is to mitigate the risks that the open trench poses to the normal movements of fauna across and around the working zone where the trench remains open during the overnight period. The following actions will be taken to achieve this objective • The operational zone and hence length of open trench shall be minimised to the smallest length possible; • The period over which any part of the trench remains open should be limited to the smallest timeframe practicable; • Fauna ramps will be placed in the trench (max 250m intervals) at the completion of each day shift where the trench will remain open overnight; • At the commencement of each days shift, a visual inspection of the open trench by qualified person/s will occur to locate any fauna that has fallen into the trench and assist in its relocation off the working area; • Where the trench will remain open for extended periods throughout the day time, additional inspections will be scheduled and fauna refuge devices placed within the open trench to provide shelter.

12.8 Monitoring EMP

Management Measures
• The main objectives of the monitoring program are to maintain the standards of environmental management incorporated into the project construction and operations plans for the life of the project • The structured monitoring of the disturbance corridor will ensure that the objectives of the vegetation/weed management, soils/land capability and access management plans are met and that the rehabilitation of the disturbance corridor is completed/maintained to an adequate standard • Monitoring of the disturbance corridor will occur on a weekly schedule from the completion of the construction phase for a period of 3 months, and then monthly until the rehabilitation has been signed off by each landholder • The disturbance corridor will be visually inspected once per week for evidence of: 1. Unauthorised access to the disturbance corridor; 2. Soils instability, trench zone slumping and incidental erosion of topsoils whilst groundcover vegetation is reinstated; 3. Post rehabilitation weed emergence As a result of scheduled monitoring, the remediation of specific issues is to occur as soon as practicable. No action is to be taken without the direct consent of each landholder affected, specifically where any action will impact on current farming activities or where the application of herbicides is required.

13 Appendix 2 - Existing Approval to Dispose of Treated Water



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Now incorporating Department of Mineral Resources
ABN 51 734 124 190-003

06/6386-03

Tim Donnan
Environmental Officer
Eastern Star Gas Limited
GPO Box 4526
Sydney 2001

Dear Tim,

**PEL238: Approval to treat and dispose of produced formation water from BW1-9
CBM exploration well(s)**

In accordance with Condition 1 of PEL238 granted under the provisions of the *Petroleum (Onshore) Act 1991*, the titleholder is hereby granted approval to treat produced formation water from BW1-9 by reverse osmosis and dispose of the treated water to Bohena Creek, subject to the conditions set out below. These conditions relate specifically to this approval. The conditions are in addition to those previously attached to PEL238 and prevail to the extent of any inconsistency. A breach of these conditions is an offence under the *Petroleum (Onshore) Act 1991*.

CONDITIONS

General conditions

1. The works must be carried out at the location(s) and in accordance with the methods contained in:
 - The Bohena Coal Seam Gas Project Review of Environmental Factors Water Treatment and Disposal Project PEL238, Gunnedah Basin New South Wales (including all appendices), submitted by Eastern Star Gas Limited and dated December 2006

Except as amended by the following conditions.

2. This approval is valid for the duration of the production test for BW1-9 only.
3. Water may only be discharged from the treatment plant into Bohena Creek after all options to reuse and/or evaporate the water have been exhausted.
4. Water discharged to Bohena Creek must be of a quality equal to or better than the receiving water unless an Environment Protection Licence is first obtained from the Department of Environment and Climate Change.
5. The condition of Bohena Creek must be documented by taking representative photographs of the creekbed and banks from fixed photographic stations. These stations must be established at the proposed discharge point and downstream for at least 11km at approximately 500m intervals. Photographs must be taken at each of the stations:
 - prior to the commencement of any discharge to Bohena Creek; and thereafter,
 - at six-monthly intervals for the duration of the production test.

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These photographs must be included as part of the biannual reports described in Condition 9.

6. The Department may impose additional monitoring and/or reporting requirements relating to any aspect of the environmental impacts of the activity. The titleholder must comply with any written instructions in this regard.

Management plan

7. Prior to the commencement of the activities subject to this approval, a Water Treatment and Disposal Management Plan must be developed and submitted to the Director, Environmental Sustainability for approval. The plan must be implemented as approved. This Plan must include:
 - A plan describing the layout of the water treatment plant and associated infrastructure.
 - A concentrate management and disposal plan.
 - A monitoring plan to evaluate the integrity of the concentrate pond liner during the life of the pond.
 - A contingency plan to define actions to be taken in the event of any leakage from the concentrate pond. The plan must include thresholds for the implementation of the plan in the event of any leakage from the concentrate pond.
 - Procedures for handling and management of chemicals used during the scaling process.

Record-keeping requirements

8. The following information must be recorded and maintained by the titleholder and made available for inspection by the Department on request:

WATER TREATMENT PROCESS STAGE	PARAMETER	INTERVAL
Input water	• Source • Volume • TDS • EC • pH • Cations • Anions	Daily (minimum) for all parameters except cations & anions (weekly)
Permeate	• Volume • TDS • EC • pH • Cations • Anions • Fate*	Daily (minimum) for all parameters except cations & anions (weekly)
Concentrate	• Volume • TDS • EC • pH • Cations • Anions • Fate*	Daily (minimum) for all parameters except cations & anions (weekly)

*Fate includes both the method of disposal and location of any discharge from the treatment process

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Reporting requirements

9. Biannual reports relating to water management within PEL238 must be prepared and submitted to the Department. For each calendar year, these reports are to cover the periods:

- i) 1 January to 30 June
- ii) 1 July to 31 December

Copies of each biannual report must be submitted to the Department of Primary Industries – Mineral Resources and the Department of Environment and Conservation (Armidale office) within one calendar month of the end of the reporting period identified above (i.e. 31 July and 31 January respectively).

The reports must include the following information:

- a) For each well:
 - Water production (volume) during the reporting period
 - Produced water quality (TDS, EC, pH, cations, anions etc.) during the reporting period
 - Produced water fate (storage facility)
- b) For each water storage facility:
 - Total storage capacity
 - Water inputs (volumes and sources) during the reporting period
 - Produced water quality (TDS, EC, pH, cations, anions etc.) during the reporting period
 - Evaporative and other losses (volume lost)
 - Remaining storage capacity
 - Freeboard
 - Liner condition
- c) For the reverse osmosis treatment and disposal facility:
 - A summary of the information specified in Condition 8.
- d) Bohena Creek
 - Representative photographs documenting the "before and after" condition of the bed and banks of Bohena Creek as described in Condition 5.
- e) Incidents
 - Any environmental incidents during the reporting period.

10. A Rehabilitation Report must be provided to the Department following the completion and rehabilitation of any land-disturbing activities subject to this approval.

NOTES

Process water and concentrate from the treatment plant must be disposed of in a manner that does not pollute the environment and complies with the provisions of the Protection of the Environment Act 1997 (POEO Act).

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*Any pollution incident must be notified to the Appropriate Regulatory Authority
as defined by the POEO Act, being Narrabri Shire Council.*

Should you wish to discuss any details of this approval, please contact Stephen Barry
directly on (02) 4931 6608.

Yours Sincerely,



Elise Newberry
Assistant Director – Environment

DATE 11 Apr 07

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