



Appendix V

Rehabilitation strategy



Narrabri Gas Project

Rehabilitation Strategy

Prepared for
Santos NSW (Eastern) Pty Ltd

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Abbreviations

Abbreviation	Description
EIS	Environmental Impact Statement
ELA	Eco Logical Australia
EPA	NSW Environment Protection Authority
LiDAR	Light Detection and Ranging
OCSG	NSW Office of Coal Seam Gas
OTI	NSW Office of Trade and Investment

Executive summary

Santos NSW (Eastern) Pty Ltd (Santos) is proposing to develop natural gas from coal seams in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri. This report presents the rehabilitation strategy for the Narrabri Gas Project. The strategy has been designed to ensure an effective rehabilitation process and provide details how rehabilitation works will proceed following disturbance by the Narrabri Gas Project.

The final land use of rehabilitated areas will be consistent with previous land uses strategies and relevant planning instruments. Rehabilitation will include the re-establishment of native forest, woodland and agricultural lands where appropriate.

Preliminary completion criteria have been developed and will be revised in discussion with stakeholders such as the NSW Office of Coal Seam Gas (OCSG), Forestry Corporation NSW and landholders. Completion criteria provide a standard against which final rehabilitation success will be measured. The satisfactory achievement of the completion criteria (as indicated by monitoring results) will demonstrate that the rehabilitated areas can be signed off in a stable and sustainable condition.

The rehabilitation strategy includes the regular monitoring of rehabilitated areas. Monitoring will evaluate the progress of vegetation establishment, assess whether the objectives of the strategy and performance criteria are being met, and if required suggest measures to increase rehabilitation success.

Details of rehabilitation methods, monitoring works, completion criteria and evidence of Santos' ability to achieve the proposed rehabilitation outcomes are discussed.

1 Introduction

1.1 Background

Eco Logical Australia (ELA) was commissioned by Santos NSW (Eastern) Pty Ltd to prepare a rehabilitation strategy for the Narrabri Gas Project. The rehabilitation strategy forms part of the Environmental Impact Statement (EIS) being prepared to support Santos' application for development consent for the construction and operation of gas wells, gas and water gathering systems, and supporting infrastructure southwest of Narrabri, NSW (GHD, 2015). A comprehensive rehabilitation plan containing detailed rehabilitation schedules will be prepared post approval and will be consistent with any relevant approval conditions.

1.2 Purpose and objectives

The purpose of this rehabilitation strategy is to ensure land disturbed by the Narrabri Gas Project is rehabilitated to a high standard and representative of surrounding vegetation communities (including pasture) and is compatible with surrounding land use objectives.

The rehabilitation strategy will provide a clear set of objectives and completion criteria for rehabilitation of each management domain (production wells, gathering systems and associated infrastructure/ auxiliary sites).

The objectives of this rehabilitation strategy include:

- To ensure topsoil and subsoil is managed to conserve the seed bank, nutrients and to encourage the establishment of vegetation.
- Disturbed areas are to be rehabilitated to their pre-production condition. Forested land will be rehabilitated to its former vegetation community and agricultural land will be rehabilitated to meet the former agricultural capability class.
- Ensuring rehabilitation works comply with relevant regulatory requirements.
- Establishment of a set of indicators and a rehabilitation monitoring program to ensure successful rehabilitation.
- Establishment of agreed criteria where rehabilitation is deemed successful by relevant authorities and stakeholders.

1.3 Structure of this report

The report is structured as follows:

- **Chapter 1 – Introduction.** This chapter introduces the rehabilitation strategy and describes the objectives of the strategy and structure of the report
- **Chapter 2 – Project description.** This chapter describes the details of the proposed project and the proposed location.
- **Chapter 3 – Secretary's Environmental Assessment Requirements.** This chapter outlines the relevant secretary's requirements for the EIS as they relate to rehabilitation. Agency comments are also provided.
- **Chapter 4 – Risk assessment.** This chapter provides a risk assessment to determine the hazards, consequences and potential control measures as they relate to rehabilitation activities

- **Chapter 5 – Rehabilitation domains.** Rehabilitation of the Narrabri Gas Project has been divided into several rehabilitation management domains. This chapter describes the proposed domains.
- **Chapter 6 – Rehabilitation management.** This chapter describes how the rehabilitation will be implemented and managed.
- **Chapter 7 – Final land use.** This chapter outlines the intended land use of disturbed areas following natural gas extraction, and decommissioning of infrastructure.
- **Chapter 8 – Conceptual rehabilitation schedule.** This chapter provides a conceptual schedule for the rehabilitation of each management domain.
- **Chapter 9 – Rehabilitation monitoring and completion criteria.** This chapter outlines the proposed rehabilitation monitoring methodology and provides preliminary completion criteria for rehabilitation.
- **Chapter 10 – Rehabilitation trials, research and ability to achieve completion criteria.** This chapter suggests possible research and provides evidence that the proposed rehabilitation methods are adequate and are likely to be successful in restoring areas to their former land use in an acceptable and sustainable condition.
- **Chapter 11 – Review of rehabilitation strategy and completion criteria.** This chapter outlines the requirements and timeframes for reviews of the rehabilitation strategy and completion criteria.

2 Project description

2.1 Overview

Santos NSW (Eastern) Pty Ltd (Santos) is proposing to develop natural gas from coal seams in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri (**Figure 1**).

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

The primary objective of the project is to commercialise natural gas from coal seams for the East Australian gas market and to support the energy security needs of NSW. Production of natural gas from coal seams under the project would deliver material economic, environmental and social benefits to the Narrabri region and the broader NSW community. The key benefits of the project can be summarised as follows:

- Development of a new source of gas supply into NSW would lead to an improvement in energy security and independence to the State. This would give NSW gas markets greater choice when entering into gas purchase arrangements. Potential would also exist for improved competition on price. Improved competition on price would have flow on benefits for NSW's economic efficiency, productivity and prosperity.
- The provision of a reduced greenhouse gas emission fuel source for power generation in NSW as compared to coal-fired power generation.
- Increased local production and regional economic development through employment and provision of services and infrastructure to the project.
- The establishment of a regional community benefit fund equivalent to five per cent of the royalty payment made to the NSW Government within the future production licence area. If matched by the NSW Government, the fund could reach \$160 million over the next two decades.

2.2 Description of project

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

Table 1: Key project components

Location	Infrastructure element
Major facilities	
Leewood	<ul style="list-style-type: none">• a central gas processing facility for the compression, dehydration and treatment of gas to commercial specifications• a central water management facility including storage and treatment of produced water and brine

Location	Infrastructure element
	<ul style="list-style-type: none"> • optional power generation for the project • a safety flare • treated water management infrastructure to facilitate the transfer of treated water for irrigation, dust suppression, construction and drilling activities • other supporting infrastructure including storage and utility buildings, staff amenities, equipment shelters, car parking, and diesel and chemical storage • continued use of existing facilities such as the brine and produced water ponds • operation of the facility
Bibblewindi	<ul style="list-style-type: none"> • in-field compression facility • a safety flare • supporting infrastructure including storage and utility areas, treated water holding tank, and a communications tower • upgrades and expansion to the staff amenities and car parking • produced water, brine and construction water storage, including recommissioning of two existing ponds • continued use of existing facilities such as the 5ML water balance tank • operation of the expanded facility
Bibblewindi to Leewood infrastructure corridor	<ul style="list-style-type: none"> • widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground (up to 132 kV) power, and buried communications transmission lines
Leewood to Wilga Park underground power line	<ul style="list-style-type: none"> • installation and operation of up to a 132kV underground power line within the existing gas pipeline easement
Gas field	
The gas field	<ul style="list-style-type: none"> • installation of up to 850 new wells on a maximum of 425 well pads <ul style="list-style-type: none"> ○ new well types would include exploration, appraisal and production wells • installation of water and gas gathering lines and supporting infrastructure • construction of new access tracks where required • water balance tanks • communications towers • conversion of existing exploration and appraisal wells to production
Ancillary	<ul style="list-style-type: none"> • upgrades to intersections on the Newell Highway • expansion of worker accommodation at Westport • a treated water pipeline and diffuser from Leewood to Bohena Creek <ul style="list-style-type: none"> ○ treated water irrigation infrastructure including: ○ pipeline(s) from Leewood to the irrigation area(s) • treated water storage dam(s) offsite from Leewood • operation of the irrigation scheme

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

Subject to obtaining the required regulatory approvals, and a financial investment decision, construction of the project is expected to commence in early 2016, with first gas scheduled for 2017/2018. Progressive construction of the gas processing and water management facilities would take around three years and would be undertaken between approximately early/mid-2016 and early/mid-2019. The gas wells would be progressively drilled during the first 20 or so years of the project. For the purpose of impact assessment, a 25 year construction and operational period has been adopted.

2.3 Project location

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

The project area covers about 950 square kilometres (95,000 hectares), and the project footprint would directly impact about one per cent of that area.

The majority of the project area is located within a region known as ‘the Pilliga’, which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation, managed under the NSW National Parks and Wildlife Act 1974. The Pilliga has spiritual meaning and cultural significance for the Aboriginal people of the region.

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

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and related activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of drought and wildfire.

Within the Pilliga, the project would be developed in State forests identified as suitable for ‘forestry, recreation and mineral extraction’ under the Brigalow and Nandewar Community Conservation Area Act 2005.

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

Agriculture is a major land use within the Narrabri LGA; about half of the LGA is used for agriculture, split between cropping and grazing. Although the majority of the project area would be within State forests, much of the remaining area is situated on agricultural land that supports dry-land cropping and livestock. No agricultural land in the project area is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL) and detailed soil analysis has confirmed the absence of BSAL.

Figure 1: Study area

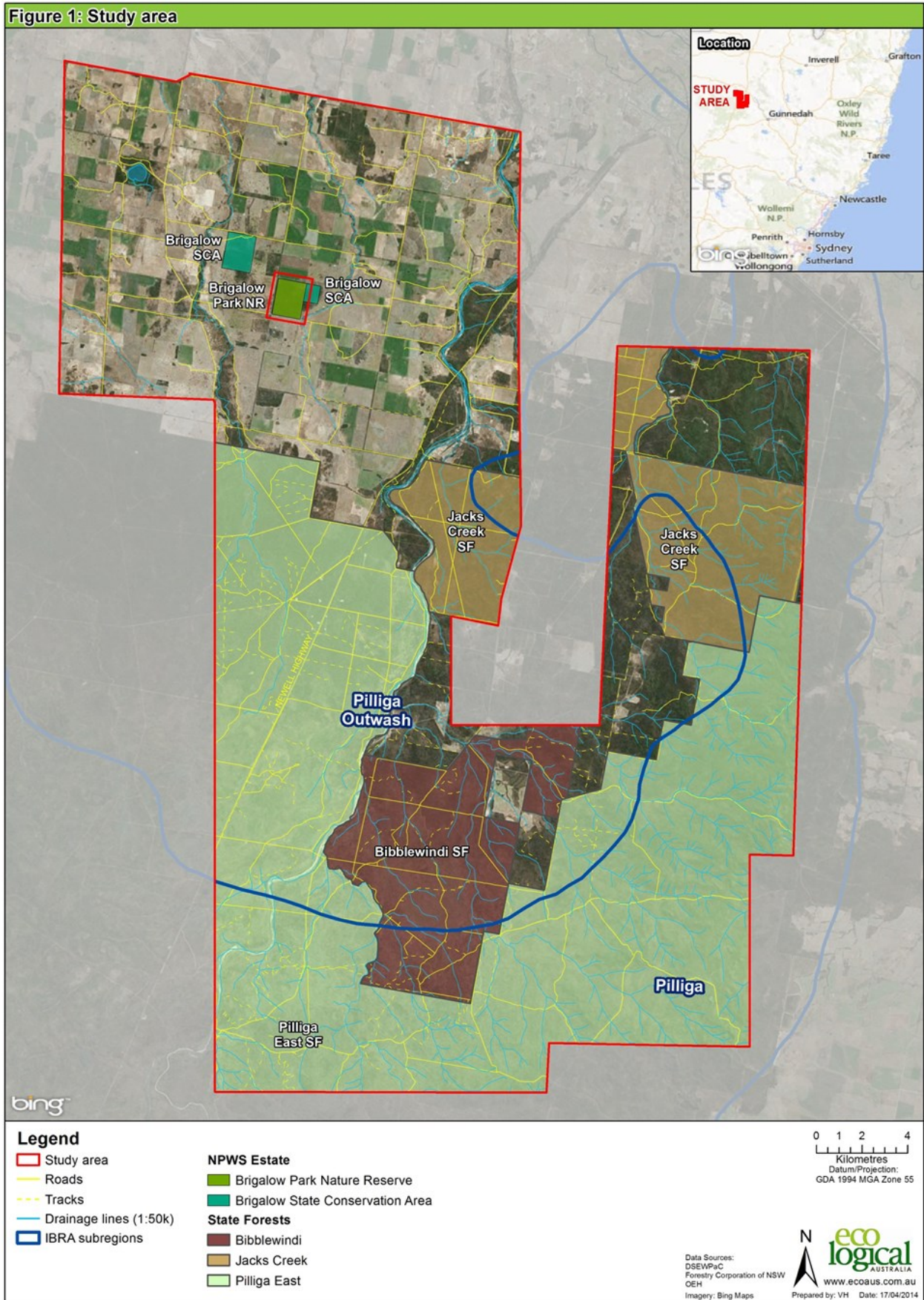


Figure 1: Project area

3 Secretary's Environmental Assessment Requirements

This rehabilitation strategy has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SSD 14_6456) issued for the Narrabri Gas Project (**Table 2**). Consideration has also been given to Agency correspondence in regards to the Secretary's Requirements. Those relevant to the rehabilitation aspect of the Project are summarised in **Table 3**, including statements from the NSW Environment Protection Authority (EPA), NSW Office of Trade and Investment, Forest Corporation NSW and Narrabri Shire Council.

Table 2: Secretary's Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements	Section where addressed in report
A rehabilitation strategy, having regard to the NSW Trade and Investment requirements	This report
Description of measures that would be implemented to monitor and report on the environmental performance of the development if it is approved	Section 8

Table 3: Summary of Agency comments to Secretary's Environmental Assessment Requirements

Agency Comment	Section where addressed in report
Environment Protection Authority	
Rehabilitation – Outline considerations of site maintenance, and proposed plans for the final condition of the site (ensuring its suitability for future uses).	Sections 4,5 and 6
Trade and Investment	
The EIS must include a section on rehabilitation which includes the following information:-	
Project description- The project description must show the proposed extent and sequence of the development by reference to plans and charts.	Section 2
Project schedule and rehabilitation- Information on the production field development strategy and scheduling, including minimising disturbance and maximising opportunities for progressive rehabilitation is required. The EIS should identify a conceptual schedule of production well and infrastructure construction, operation and decommissioning. This is required to give an indication of how many of the 850 production wells and associated infrastructure will be in operation at any one time and what will be the maximum area of disturbance (and associated rehabilitation liability) during all phases of the project	Section 7. This report addresses the rehabilitation of areas disturbed by the Narrabri Gas Project. Other measures to be addressed in relevant sections of EIS
Rehabilitation planning- Each of the following aspects of rehabilitation planning should be addressed in the rehabilitation section of the EIS:	

Agency Comment	Section where addressed in report
<p><i>Final Land Use</i> – describe the preferred final land use goal for disturbed areas including an evaluation of alternatives. This should include a discussion of how the final use(s) are aligned with relevant local and regional strategic land use objectives as well as the benefits of the post production land to the surrounding environment, a subsequent landowner, the local community and the state of NSW.</p>	Section 6
<p><i>Rehabilitation Objectives</i> – provide a clear set of rehabilitation objectives and completion criteria for rehabilitation of the production well sites and associated infrastructure/ auxiliary sites. Consideration should be given to the identification of project domains when proposing rehabilitation objectives and completion criteria. The rehabilitation objectives should make reference to capability class targets for agricultural land use and habitat/vegetation types for natural/bushland land use.</p>	Section 1.2 and 8.4
<p><i>Rehabilitation Methodology</i>- provide details regarding the rehabilitation methods to be used for disturbed areas and expected time frames for each stage of the rehabilitation process. Provide details on proposed rehabilitation monitoring and an outline of proposed rehabilitation research programs and trials.</p> <p>The EIS should also include an evaluation of current rehabilitation techniques and performance against existing rehabilitation objectives and completion criteria.</p>	Sections 5,7, 8 and 9
<p><i>Conceptual Final Landform Plan</i> – provide a final landform plan showing final contours and the target vegetation/habitat outcomes for the project. Any infrastructure associated with the project that is proposed to remain as part of the final land use must be identified in the plan or a clear statement where this is not practical (i.e. gas and water gathering lines).</p>	Sections 6 and 7
<p><i>Post-closure maintenance</i> – Describe how post closure rehabilitation areas will be actively managed and maintained in accordance with the intended land use(s) in order to demonstrate progress towards meeting the closure objectives and completion criteria in a timely manner</p>	Section 8.5
<p>Forestry Corporation NSW</p>	
<p>Decommissioning and rehabilitation-</p> <p>Forestry Corporation NSW continues to work with the NSW Office of Coal Seam Gas in the formulation of rehabilitation planning and revegetation standards specific to the Narrabri Gas Project. As part of Santos' proposed rehabilitation strategy, Forestry Corporation NSW would expect the opportunity to:</p> <ul style="list-style-type: none"> • Advise on site preparation techniques and the management of resultant regeneration to encourage vegetation communities compatible with FCNSW land use objectives for the area; and • Assess each rehabilitation project area against the agreed quantifiable measures prior to transfer back to Forestry Corporation NSW. 	Sections 5 & 8
<p>Narrabri Shire Council</p>	

Agency Comment	Section where addressed in report
<p>Decommissioning and Remediation-</p> <p>There is a need to address such matters as:</p> <ul style="list-style-type: none"> • Methods proposed to be utilised to remediate the wells and maintenance of the Gas Field as sectors are decommissioned. Regrowth after decommissioning needs to be supported. 	<p>Sections 5 & 8</p>
<p>Biodiversity-</p> <p>The EIS should also cover:</p> <ul style="list-style-type: none"> • Measures to be taken to avoid, reduce or mitigate impacts on biodiversity; these to include but not limited to, biodiversity offset areas of similar fauna and flora as those areas disturbed, connecting wildlife corridors, relocation of fauna, and rehabilitation of the region. 	<p>This report addresses the rehabilitation of areas disturbed by the Narrabri Gas Project. Other measures to be addressed in relevant sections of EIS.</p>

4 Risk assessment

A risk assessment has been undertaken to determine the hazards, consequences and potential control measures required to address each risk in relation to achieving the rehabilitation objectives (**Section 1.2**). For the purposes of this assessment, risk is defined as the chance of an adverse action occurring that is likely to have a negative impact on the objectives of the rehabilitation strategy. The risk assessment examines site-specific issues and constraints which may require specific management actions to ensure the objectives of the rehabilitation strategy can be realised. The risk assessment also identifies and guides the development of management and mitigation measures.

A risk assessment matrix has been developed based on the likelihood or probability of each scenario occurring and the potential consequences for successful rehabilitation (**Table 4**). Criteria for assigning the level of consequence to each scenario has been provided in **Table 5**. A risk assessment was then prepared for rehabilitation activities based on the assessment matrix and level of consequence for each scenario (**Table 6**). Each scenario has been assigned a risk for both pre and post mitigation measures.

Where the final risk assessment is red (H1-6), this represents the highest risk to rehabilitation activities and management activities or mitigation measures should be prioritised accordingly. Orange cells represent a moderate risk (M7-13) and green cells a lower risk (L14-16).

Table 4: Risk Assessment Matrix

Consequences	Likelihood			
	Very likely (could happen at any time)	Likely (could happen infrequently)	Unlikely (could happen very rarely)	Very unlikely (could happen but generally never will)
Major	H1	H2	H3	M7
Moderate	H4	H5	M8	M9
Minor	H6	M10	M11	L14
Insignificant	M12	M13	L15	L16

Table 5: Criteria for assigning the degree of consequence

Risk to successful rehabilitation	Description
Major	<ul style="list-style-type: none"> • Very low to low chance of successful rehabilitation without intensive management/intervention • Large area affected • Major remediation cost • Long-term to permanent impact
Moderate	<ul style="list-style-type: none"> • Moderate chance of success without intensive management/intervention • Moderately sized area affected

Risk to successful rehabilitation	Description
	<ul style="list-style-type: none"> • Moderate remediation cost • Medium-term impact
Minor	<ul style="list-style-type: none"> • Intensive management/intervention not required • Small area affected • Low remediation cost • Short-term impact
Insignificant	<ul style="list-style-type: none"> • Little to no management required • Very small area affected • Insignificant remediation cost • Impact can be remedied almost immediately

Table 6 : Risk Assessment

Scenario	Possible Consequences	Risk Rating	Control Measure	New Risk Rating
Weeds	Weeds dominate rehabilitation areas and prevent successful rehabilitation	H2	<p>Rehabilitation monitoring will report on weeds observed, any control undertaken and recommend control measures. Best practice control techniques to be utilised.</p> <p>Six monthly inspections for new weed infestations will be implemented across the project area. All new infestations are to be controlled using best practice techniques.</p> <p>Trucks, machinery and materials from outside the project area will be inspected, washed down as necessary, prior to site mobilisation.</p>	M7
	Weeds spread to surrounding areas of forest			
	Species of weeds not previously recorded introduced into forest or agricultural lands			
Feral animals	Feral animals prevent successful rehabilitation through over-grazing or soil disturbance	H5	A feral animal control strategy will be developed as part of the Narrabri Gas Project which will address feral animal control at a landscape scale.	M8
Inappropriate seed material or plantings	Species from different vegetation type seeded or planted	M10	Where required, seed will preferentially be collected from within the project area. Advice from an appropriate seed collection authority or experienced botanist will inform a list of appropriate species for seed collection. Detailed rehabilitation schedules including species lists and seed requirements will be prepared post approval	L14
	Non-indigenous species from outside of the Narrabri area seeded or planted	M8		M9
Inappropriate topsoil management	Topsoil not available	H5	Topsoil will be stripped to appropriate depths and stored separately to subsoil. Reliable documentation is to be kept to ensure that the location of stockpiles is known, enough soil remains for all stages of rehabilitation and soil from an appropriate vegetation community is used.	M9
	Topsoil from different vegetation community used during rehabilitation	M10		L14

Scenario	Possible Consequences	Risk Rating	Control Measure	New Risk Rating
			<p>If topsoil is unavailable then additional options will be investigated to re-create topsoil such as turning mulch through the soil profile to improve soil organic matter and improve infiltration supplemented with direct seeding using locally native species from the respective vegetation community. If after two years of monitoring, little evidence of germination is observed then planting of locally native species will be undertaken.</p> <p>If seasonal conditions during this two year period are poor, e.g. drought, there may be an additional 12 months before planting.</p>	
	Lack of soil seedbank - regeneration unsuccessful (poor species diversity or cover of native species) – rehabilitation fails to meet completion criteria	H5	The area will then be seeded with species appropriate to the surrounding vegetation community. If after two years of monitoring, little evidence of germination is observed then planting of acceptable species will be undertaken unless it is decided to wait an additional 12 months due to poor seasonal conditions.	M9
Erosion	Heavy rainfall/ strong winds or flooding removes topsoil and soil seedbank - rehabilitation fails to meet completion criteria	M10	<p>Spreading of topsoil before predicted extreme weather events is to be avoided wherever possible.</p> <p>If topsoil is unavailable then additional options will be investigated to re-create topsoil such as turning mulch through the soil profile to improve soil organic matter and improve infiltration supplemented with direct seeding using locally native species from the respective vegetation community. If after two years of monitoring, little evidence of germination is observed then planting of locally native species will be undertaken unless it is decided to wait an additional 12 months due to poor seasonal conditions.</p>	L14
Disturbance to native vegetation outside of nominated areas	Unplanned rehabilitation of additional areas required	M10	Areas to be cleared or disturbed are to be clearly demarcated. Staff will be made aware of work zones and work plans before commencing clearing or ground disturbance.	L14

Scenario	Possible Consequences	Risk Rating	Control Measure	New Risk Rating
			The rehabilitation bond should include a consideration for unplanned events and additional rehabilitation.	
Spills	Contamination of topsoil	H5	<p>Equipment and machinery is to be maintained to avoid spills. Environmental procedures and safety equipment are to be in place to prevent and minimise the impact of any spills.</p> <p>If a spill occurs, this is to be clearly documented and soil remediation undertaken using best practice methods. Rehabilitation methods will vary according to the severity and area covered by the spill. This may require the recreation of topsoil through incorporation of mulch and reseeded with suitable native species.</p>	M8
Bushfire	Rehabilitation area burnt – reduced native plant diversity and cover - progress towards completion criteria set back	H2	<p>A bushfire management plan will be developed as part of the Narrabri Gas Project which will assess bushfire impacts and mitigation strategies at a landscape scale.</p> <p>Annual monitoring will be undertaken which assesses the condition of rehabilitation areas (including fire). If native species fail to regenerate after two years or rehabilitation appears to be set back significantly, reseeded with suitable native species should be considered.</p> <p>Contingencies are required to ensure resources are available for intensive management/intervention for rehabilitation sites affected by fire before they have successfully re-established.</p>	H3
Drought/lack of rainfall	Natural regeneration or direct seeding fails due to dry conditions	H5	<p>Ensure rehabilitation activities occur during favourable conditions. Avoid respraying topsoil or undertaking direct seeding in periods of low rainfall wherever possible.</p> <p>Prioritise seeding activities to occur during wetter periods of the year and ideally before forecast rainfall.</p>	M8

5 Rehabilitation domains

Rehabilitation domains are land management units which share similar rehabilitation requirements and final land uses. Four distinct rehabilitation domains are recognised for the Narrabri Gas Project and are described below.

Domain 1 – Non-linear infrastructure

Domain 1 includes (but is not limited to) exploration and production wells, small nodal compressor stations, water transfer tanks, small laydown areas and temporary drilling camps (if required) across the project area.

Domain 2 – Linear infrastructure

Domain 2 includes (but is not limited to) gas and water gathering lines, low and high pressure gas and water pipelines, roads and tracks, power lines and other service lines.

Domain 3 – Major facilities

Domain 3 includes areas of longer-term ground disturbance such as major gas treatment and compression facilities, water treatment facilities, power stations, major camps and construction/maintenance yards (if required), large ponds >150 mega litres for brine and produced water and brine management facilities. Domain 3 may also include smaller scale infrastructure that involves long-term ground disturbance.

Domain 4 – Agricultural land

Domain 5 consists of areas designated for post-production agriculture. Where required, subsoil and topsoil will be excavated and stored. Following the reinstating of topsoil, areas designated for post-production agriculture will be sown with a mixture of pasture species

6 Rehabilitation management

Santos is committed to the progressive rehabilitation of production areas for forestry and agricultural purposes and to return land to former land uses.

A Plan of Operations will be prepared for each stage of project development and it is envisaged this will occur no less frequently than two yearly intervals (but may occur more frequently depending on the progress of development). This Plan of Operations will be used by the Office of Coal Seam Gas to calculate the required rehabilitation bond for each stage of the project.

Management of rehabilitation will require the collection, storage and management of accurate records from initial clearing or ground disturbance to rehabilitation. Santos is committed to the collection, storage and management of accurate records to ensure effective management of rehabilitation.

6.1 Rehabilitation methods

The following methods will generally be used when rehabilitating disturbed areas:

- Installing and maintaining sediment and erosion control devices appropriate to the site
- Temporary retention of perimeter fencing to exclude grazing animals during the early rehabilitation will be considered on a case by case basis
- Ultimately removal of perimeter fencing and all other infrastructure.
- Replacement of subsoil, contouring to the landscape and partially compacting.
- Placing topsoil uniformly across the well pads, and grading to natural levels.
- Regeneration with native species contained within the seed bank.
- Surface contouring, through ploughing and the creation of 'hummock' and low relief features similar to the surrounding area.
- Spreading of retained woody material to provide sites for seed germination and habitat for fauna.
- Blocking access tracks to minimise disturbance of the site by vehicles and to maximise natural regeneration.
- Controlling weeds and feral animals.
- On-going monitoring of success through comparison to identified reference sites and regional datasets.

Any assisted revegetation will utilise species that:

- are locally available to eliminate the introduction and establishment of foreign species from other areas of the Pilliga and/or exotic weeds
- will reduce erosion of sediment by wind or water by through the development of root mass in rehabilitated soils
- enhance the speed of plant colonisation of rehabilitated soils beyond that expected from surrounding areas alone
- provide microsites for further natural species ingress into the rehabilitated areas, especially tree species which require some immediate low-level shelter, soil moisture and organic content
- provide wildlife habitat in the rehabilitated areas.

Within areas of State Forest, the Forestry Corporation NSW will be consulted to provide advice on preparation techniques and the management of resultant regeneration to encourage vegetation

communities compatible with Forestry Corporation NSW land use objectives for the area. As such these methods may be refined over time.

More specific methods prescribed for each rehabilitation domain are detailed in **Sections 6.2, 6.3, 5.4 and 6.5.**

6.2 Domain 1 - non-linear infrastructure

Rehabilitation of the well pads will occur in two stages. The first stage will involve reducing the well lease area width through progressive rehabilitation following construction activities, whilst enabling ongoing access and maintenance. Just over half of each cleared one hectare well pad would be partially rehabilitated at this stage, following an assessment of the operational performance of the well. This assessment would typically be undertaken less than 6 months after installation. Well pads that contain other infrastructure such as water balance tanks or telecommunication towers will not be partially rehabilitated at this stage and will remain at approximately 1 ha in area.

The second stage is final rehabilitation and this will occur following decommissioning of infrastructure and removal of equipment and materials from well pads, water storage facilities, temporary camp facilities and laydown areas. Stockpiled topsoil will be replaced and Santos will undertake works in a manner which facilitates natural regeneration. Natural regeneration is considered appropriate for this environment and this approach is supported by Forestry Corporation NSW.

Facilitation of natural regeneration will include minor re-shaping of landforms to mimic natural ground surface, the spreading of woody material, weed management and be supplemented by direct seeding (if required as determined by monitoring). Assisted regeneration through seeding or planting will be considered in the event that natural regeneration is unsuccessful, in accordance with the completion criteria detailed in **Section 9.4.**

6.3 Domain 2 – linear infrastructure

Gas and water gathering systems will be co-located with existing roads and tracks wherever possible. Where this is not possible new tracks and gas and water gathering systems will be constructed. A right of way approximately 10 metres wide on average would be required for the construction of new access tracks and gas and water gathering systems.

A network of underground gas and water gathering systems will connect the well pads to the gas and water processing facility. This will be undertaken wherever practicable using the 'ploughing' method. Ploughing is the preferred option for the installation of underground gathering systems, as equipment is able to 'plough in' the underground pipes which requires minimises topsoil disturbance and allows for immediate natural regeneration.

Underground gas and water gathering systems that require a trench to be dug before pipelines are installed require subsoil and topsoil to be excavated and stored during construction. The trench will be backfilled as the pipes are installed and the area will be left to partially regenerate.

Approximately 50% of the right of way would be rehabilitated following construction, allowing continual access along the access track and to buried gas and water gathering systems and siting of pipeline signage (at line of sight intervals).

Natural regeneration of shrubs, grasses and herbs will be encouraged through the spreading of woody material and management of weeds. Partial rehabilitation would comprise shrubs and grasses only, with

any overstorey trees that germinate being selectively removed in order to allow access over roadside pipelines and to prevent damage to pipes or infrastructure.

During decommissioning of infrastructure, all gas and water gathering systems will be left *in situ* and natural regeneration will proceed without disturbance.

Final rehabilitation of access tracks and gas and water gathering systems will include minor re-shaping of tracks to mimic natural ground surface and reduce areas of compacted soil, the spreading of woody material and weed management. The overstorey (if present in surrounding lands) will be allowed to regenerate over time to mimic surrounding landscape and vegetation communities. Assisted regeneration through seeding or planting will be considered in the event that natural regeneration is unsuccessful, in accordance with the completion criteria detailed in **Section 9.4**.

6.4 Domain 3 – major facilities

As soil has been stockpiled for an extended period and land disturbed more severely than Domains 1, 2 & 4, complete reliance on natural regeneration is likely to be inappropriate for this domain.

Stockpiled topsoil and subsoil will be replaced and rehabilitation will be supported by direct seeding.

The spreading of woody material and weed management will be used to facilitate the regeneration of native plant communities.

Species indigenous to the project area and surrounding vegetation will be targeted for direct seeding. Seed would preferentially be collected from within the project area to maintain genetic integrity of the project area. If seed for principal species is not available in suitable densities, or if they fail to germinate after two years of monitoring, contingency species should be targeted for planting. Mechanised direct seeding of suitable species, such as *Acacia* species, should be supplemented with hand direct seeding of other target species. Ripping of areas to be direct seeded should be undertaken during dry soil conditions, following control of all weeds.

6.5 Domain 4 – agricultural land

Domain 4 consists of former agricultural land that has been disturbed by the Narrabri Gas Project. Rehabilitation methodology for Domain 4 will be developed in consultation with landholders with the aim of returning land to its former agricultural capability class and being suitable for long-term agricultural activities. Rehabilitation methods will depend on the type of disturbance (e.g. gathering system, well pads or more permanent infrastructure) and include:

- Temporary stock exclusion fencing (if appropriate).
- Reinstatement of subsoil and topsoil.
- Sowing with a mixture of pasture species appropriate for surrounding environment, season and aims of the landowner.
- Weed management.

Following establishment of these areas it is anticipated agricultural activities will continue as per the pre-production land use.

6.6 Topsoil management

For the purposes of this rehabilitation strategy, 'topsoil' is considered to be the 'O' and 'A' horizons of the soil profile. Reference is also made in the sections below to 'subsoil', which for the purposes of this document is considered to be all soil horizons below the A horizon. Subsoil will be stockpiled separately to topsoil. Whilst both topsoil and subsoil will need to be managed appropriately, greater emphasis is placed on the management of topsoil as this soil layer is of particular importance to achieving rehabilitation objectives.

Topsoil and subsoil stripping will be undertaken using a grader, or similar equipment, and a front-end loader, backhoe or similar equipment to place the soil into stockpiles. Topsoil will be progressively stripped to the observed depth of the topsoil. Subsoil will be stripped to the minimum depth required for construction.

Topsoils and subsoils will be stockpiled separately to prevent cross contamination, and to enable easy recognition and retrieval for rehabilitation. Stockpile management measures will be adhered to until soil is redeployed after well/infrastructure decommissioning at the end of production life or after the installation of gathering systems.

Topsoils will be stored according to vegetation community, allowing the rehabilitation of correct species in the designated vegetation type.

6.7 Weed management

Weed species have the potential to have a major impact on revegetation and regeneration outcomes. Weed management is a critical component of rehabilitation activities. The Project has the potential to result in an increase in environmental weeds, such as *Eragrostis curvula* (African Love Grass) *E. trichophora* and *Hyparrhenia hirta* (Coolatai Grass), particularly adjacent to well pads, proposed roads and within soil stockpiles.

Weeds will be managed in the project area by:

- Trucks, machinery and materials from outside the project area will be inspected and washed down prior to site mobilisation.
- Utilising best practice weed control methods.
- Six monthly inspections for new weed infestations will be implemented across the project area, including major access routes to the project area, soil stockpiles and regeneration areas. All new infestations are to be controlled using best practice techniques.
- Any work areas with significant infestations of noxious or environmental weeds are to be clearly marked on site until the weeds have been controlled, and all machinery and vehicles operating in these areas are to be washed down after leaving the site to minimise the risk of establishing new weed infestations.
- Rehabilitation monitoring will report on weeds observed, any control undertaken and recommend control measures.

6.8 Feral animal control

A feral animal control strategy will be developed as part of the Narrabri Gas Project which will address feral animal control at a landscape scale. Given the connectivity of habitat in the project area and Pilliga, it is considered most beneficial to approach feral animal control at this scale. The landscape approach will target feral animals across tenures and will incorporate a team of land managers including the NSW

Forestry Corporation, the NSW National Parks and Wildlife Service and in cooperation with private landholders.

The strategy will be designed to target feral fauna identified as high risk to the survival of native flora and fauna in the Pilliga. Control measures used will be specific for the target fauna species, with a range of control techniques to be applied. The poisoning of non-target species will be addressed through the design of the control techniques. The strategy will include monitoring to detect any changes to targeted feral fauna abundance from control measures applied at the landscape scale. Monitoring will also detect any poisoning of non-target species to ensure the program is not having adverse effects on native wildlife.

6.9 Annual compliance review

An annual review of all rehabilitation activities will be completed. This will document the status of proposed rehabilitation and management activities and focus rehabilitation priorities for the coming year. A summary report will be provided to relevant landholders and the regulator.

7 Final land use

The final land use of disturbed areas will depend on their location, tenure and previous land use. The primary objective of the rehabilitation strategy is to return land to its original vegetation community or former agricultural activity (grazing or cropping) and be suitable for transfer back to Forestry Corporation NSW or private ownership.

The final land use of rehabilitated areas will be consistent with land use strategies, vegetation communities and (where relevant) agricultural capability and be consistent with relevant planning instruments.

As the Narrabri Gas Project is predominantly located in a production timber forest which contributes to the sustainable timber yield of Forestry Corporation NSW in the Brigalow-Nandewar Bioregion, this strategy has been designed to maintain both the timber productivity and biodiversity of the forests in the long term. As production wells and other infrastructure are decommissioned, they will be progressively rehabilitated to pre-production vegetation condition.

7.1 Projected landform

The potential impacts of the Narrabri Gas Project on landform are expected to be relatively minor and limited to small scale surface disturbances only (e.g. grading of roads and well pads, excavation of trenches and excavation of pits at production wells).

Due to the relatively flat to gently undulating nature of the project area, only relatively minor grading is likely to be necessary to rehabilitate disturbed areas. High quality datasets derived from such as contours and digital elevation models (derived from LiDAR) will be utilised to ensure rehabilitation areas conform with the surrounding landscape.

Once subsoil and topsoil have been replaced and re-shaped, natural regeneration will be facilitated to minimise erosion and stabilise the landform. The replacement of retained woody material will assist this process by catching overland flow.

The conceptual rehabilitated landform design for a typical gas well pad and associated gathering system within a forested area is shown in **Figure 2**.

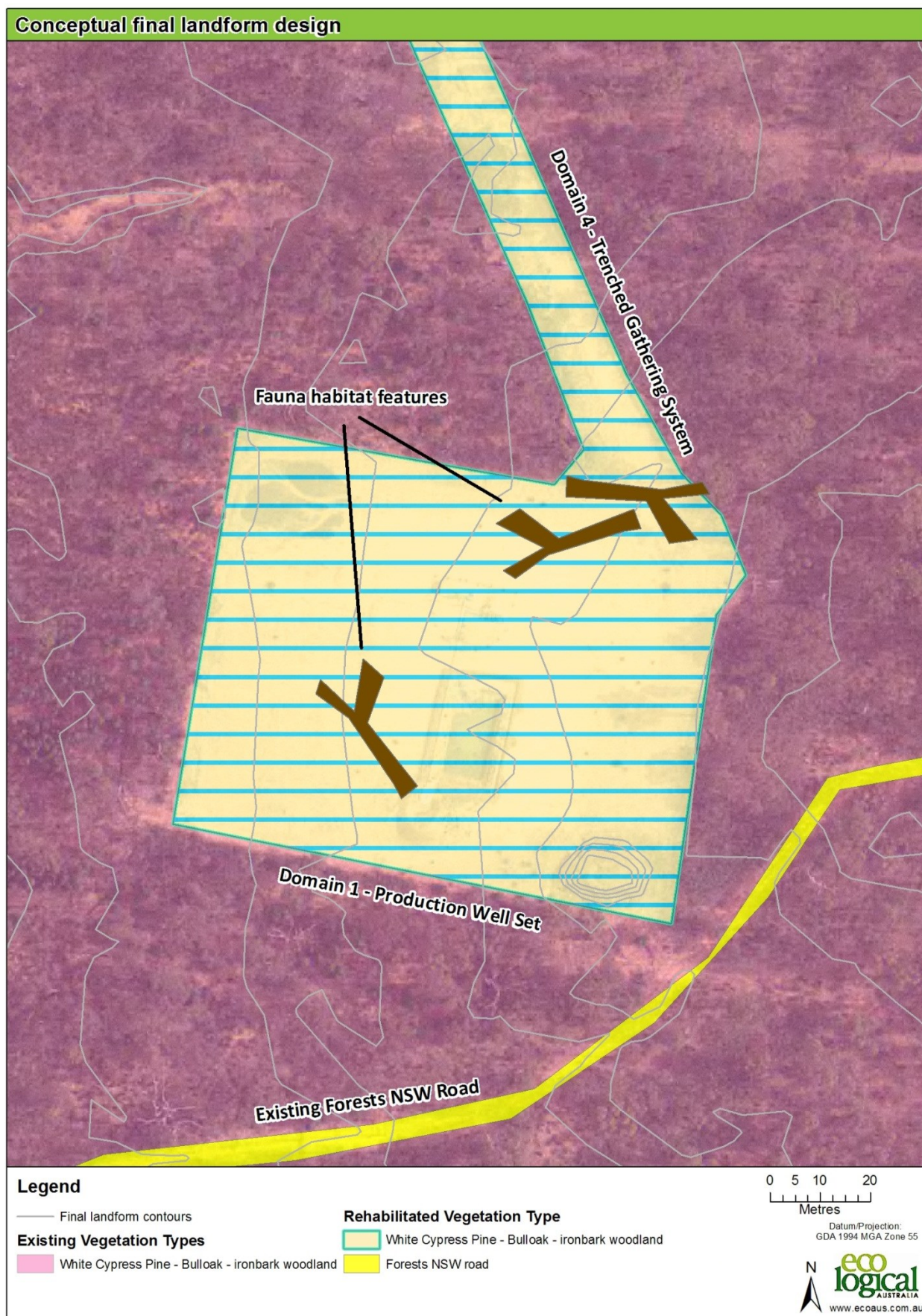


Figure 2: Conceptual final landform design

7.2 Benefits of post-production land

The Narrabri Gas Project is wholly located within the Narrabri LGA and is subject to the Narrabri Local Environmental Plan 2012. The project area is located within the RU1 Primary Production and RU3 Forestry zones. The proposed final use of disturbed land is consistent with relevant local and regional strategic land use objectives. The rehabilitation of post-production land will have several benefits for the surrounding environment, subsequent landowners and the State of NSW as outlined below.

7.2.1 Benefits to the surrounding environment

The biodiversity values of rehabilitated areas are expected to meet that of surrounding lands over time and be compatible with conservation and recreational objectives within the Pilliga East, Bibblewindi and Jacks Creek State Forests.

7.2.2 Benefits to subsequent land owners

Post production land will be rehabilitated to meet its former land use objectives. The Narrabri Gas Project is primarily located in a production forest which contributes to the sustainable timber yield of the Forestry Corporation NSW in the Brigalow-Nandewar Bioregion. As such, much of the rehabilitated land will be returned to its former use as a native production forest.

Agricultural land will be rehabilitated to meet the sites former agricultural capability class and be suitable for its former agricultural land use.

7.2.3 Benefits to the local community and the State of NSW

The rehabilitation of post-production land will assist in the conservation of biodiversity within NSW, and enable continuity of land uses such as production forest, recreational areas and agriculture while delivering material, economic and social benefits to the Narrabri region and the State of NSW.

7.3 Alternative final land uses

Alternative land uses for rehabilitated areas are likely to be limited to those currently proposed. The low agricultural value of much of the Pilliga has historically resulted in the retention of forested areas and facilitated the development of timber harvesting industries and lands designated for biodiversity conservation.

After the completion of the Narrabri Gas Project, the potential future use of the land could also include the following:

- Water storage ponds and dams retained for farmers or for bushfire management.
- Access tracks maintained as fire breaks or for forestry purposes.
- Major infrastructure areas converted for alternative uses.

8 Conceptual rehabilitation schedule

Gas exploration and appraisal activities within the project area are ongoing and the precise location of infrastructure will be determined through the field development protocol. A more comprehensive rehabilitation plan containing detailed rehabilitation schedules will be prepared post approval and will be consistent with any relevant approval conditions.

Rehabilitation activities will be undertaken progressively and as early as practicable to ensure the total disturbance from the project at any one time is minimised. The ability to progressively rehabilitate sections of the Narrabri Gas Project, initially following construction and then as they are decommissioned (at the end of their economic life) is an important component of the rehabilitation strategy.

Benefits of progressive rehabilitation include:

- An ability to learn from early rehabilitation actions, and if required, to adapt and improve the procedures used as the project progresses.
- An ability to trial various options and demonstrate rehabilitation outcomes to the wider community.
- Demonstrating a commitment to stakeholders and employees that Santos is effectively managing their environmental impact.
- Reduction of the final closure cost.
- Reduction of the risk of failure and ultimate liability.
- Progressive reduction of the any security bonds.

Planning for closure and rehabilitation will commence at least 2 years ahead of planned decommissioning of wells and other infrastructure. This is to allow sufficient native seed to be collected and will ensure progressive rehabilitation over the life of the project such that the total overall impact of the project is not operating at any one time.

8.1 Life cycle of the gas field

A typical gas field involves progressively developing infrastructure over the life of the project. The decommissioning and rehabilitation of the gas field will be undertaken progressively in accordance with regulatory requirements and industry standards.

A summary of the life cycle of a typical gas field is as follows:

- Exploration. This broadly involves undertaking seismic surveys, drilling core holes and collecting baseline scientific data.
- Appraisal. The drilling of pilot wells to gain knowledge of the gas content and composition to inform gas field design.
- Construction. Building components of the gas field, including drilling wells and major infrastructure such as gas and water processing facilities.
- Operations. Extracting water and gas, compressing gas to commercial quality and treatment and beneficial reuse of the water.
- Well decommissioning and rehabilitation. Once wells are no longer economically producing gas, they are plugged and abandoned and the well pads rehabilitated.
- Gas Project decommissioning and rehabilitation. Once the gas field is no longer commercial, all remaining equipment is decommissioned and the site is rehabilitated.

8.2 Rehabilitation schedule for each domain

The proposed timeline for the rehabilitation for a single disturbance area within each domain is outlined in **Table 7** to **Table 10**.

Table 7: Rehabilitation schedules for non-linear infrastructure (Domain 1)

Process	Estimated Timing
Each well pad (approximately 1 ha) and construction area cleared of vegetation, topsoil and subsoil stripped to minimum depth required for construction and stored separately. Vegetation slashed and mulched with larger trees retained for fauna habitat reconstruction. Commercially viable timber may be removed and stored for collection by Forestry Corporation NSW or its contractors and remaining logs salvaged for reuse.	~1 month
Topsoil either: <ul style="list-style-type: none"> Protected with temporary soil protection matting Topsoil and subsoil stripped and stored separately. 	~1 month Soil stockpiled until decommissioning of infrastructure
Construction activities.	~3 months
Restoration of subsoil and topsoil and rehabilitation just over 50% of each well pad.	Where practical within 6 months from completion of construction
Weed management and rehabilitation monitoring.	Until site reaches agreed completion criteria
Gas and water extraction.	Over life of project until well becomes uneconomical
Decommissioning - wells plugged and abandoned. All above-ground infrastructure, fill and other imported material removed and disposed of appropriately.	Within 6 months of abandonment.
Restoration of subsoil and topsoil, spreading of retained woody material and final rehabilitation (including direct seeding where required), weed management and monitoring.	Within 6 months of abandonment Monitoring and management continued until site reaches agreed completion criteria (Section 8).

Table 8: Rehabilitation schedule for linear infrastructure (Domain 2)

Process	Estimated Timing
Vegetation slashed and mulched with larger trees retained for fauna habitat reconstruction. Commercially viable timber may be removed and stored for collection by Forestry Corporation NSW or its contractors and remaining logs salvaged for reuse.	<1 month
Ploughing in of pipelines and back filling of topsoil within a construction right of way up to 12 m	~1 month
Excavation for gathering systems within a construction right of way of up to 12 m.	~1 month

Process	Estimated Timing
Partial rehabilitation of up to 7 m, but on average approximately 50% of the right of way, weed management and monitoring. (ploughed in gathering system).	Immediately following gathering system installation. Monitoring and management continued until site reaches agreed completion criteria (Section 8).
Blocking tracks and ripping soils to reduce compaction and encourage regeneration (access tracks)	~6months of abandonment
Weed management and monitoring	Monitoring and management continued until site reaches agreed completion criteria (Section 8)

Table 9: Rehabilitation schedule for major facilities (Domain 3)

Process	Estimated Timing
Complete removal of vegetation across the proposed construction footprint. Vegetation mulched with larger trees retained for fauna habitat reconstruction. Commercially viable timber may be removed and stored for collection by Forestry Corporation NSW or its contractors and remaining logs salvaged for reuse.	~1 month
Topsoil and subsoil stripped and stored separately.	~1 month Soil stockpiled until decommissioning of infrastructure
Construction of infrastructure.	~up to 2 years+
Decommissioning and removal of infrastructure.	Within 6 months of abandonment.
Rehabilitation - replacement of subsoil and topsoil, spreading of retained woody material and final rehabilitation (including direct seeding where required), weed management and monitoring.	Within 6 months of abandonment and continued until site reaches agreed completion criteria (Section 8)

Table 10: Rehabilitation schedules for agricultural land (Domain 4)

Process	Estimated Timing
Topsoil either: <ul style="list-style-type: none"> Protected with temporary soil protection matting Topsoil and subsoil stripped and stored separately. 	~1 month Soil stockpiled until decommissioning of infrastructure
Construction activities.	~3 months
Restoration of subsoil and topsoil and rehabilitation just over 50% of each well pad.	Where practical within 6 months from completion of construction
Direct seeding of disturbed areas using preferred pasture species for the region/season or as requested by the landholder	Immediately following restoration of subsoil and topsoil.
Weed management and rehabilitation monitoring.	Until site reaches agreed completion criteria

Process	Estimated Timing
Decommissioning - wells plugged and abandoned. All above-ground infrastructure, fill and other imported material removed and disposed of appropriately.	Within 6 months of abandonment.
Restoration of subsoil and topsoil and final rehabilitation (including direct seeding using preferred pasture species), weed management and monitoring.	Within 6 months of abandonment Monitoring and management continued until site reaches agreed completion criteria (Section 8).

9 Rehabilitation monitoring and completion criteria

Monitoring is an essential part of any rehabilitation strategy as it allows for adaptive management to achieve positive outcomes for the environment. Without monitoring, the success (or failure) of rehabilitation cannot be quantified. While the methods described in this rehabilitation strategy are considered current best-practice, the science of restoration and rehabilitation is still in its infancy, hence it cannot be assumed that they will be successful in all cases.

When rehabilitation is undertaken successfully, monitoring is documented evidence which allows for the successful methods of restoration to become the standard, and allows for the methods to be used in other projects within the region.

Completion criteria provide a measureable goal for rehabilitation works to achieve. Satisfaction and of the completion criteria will demonstrate that the rehabilitated area can be relinquished from Santos' responsibility and returned to former land use objectives in a productive and sustainable condition.

9.1 Rehabilitation monitoring

To facilitate monitoring across such a large project area and to minimise the risk that areas not subject to on-ground monitoring are meeting the performance objectives, an integrated two tiered remote sensing (passive) and targeted ground survey monitoring (active) design has been developed.

Remote sensing data capture will provide information of vegetation condition and extent across the entire impact area (both direct and indirect impact regions) with repeat capture providing quantitative information on changes in vegetation condition (Hick, Caccetta, & Corner, 1999). Anomalies identified through remote sensing will be targeted for ground survey to provide detailed condition information. In addition to anomaly directed field survey, a set of permanent control and impact field monitoring sites is proposed for baseline data and ongoing monitoring.

It is proposed to establish a minimum of two control and two impact sites per representative plant community type stratified across all domains. Existing plot locations from previous flora surveys (ELA, 2015) will be used where possible.

Remote sensing and field surveys in the permanent plots will occur every two years. Monitoring is to be undertaken for a period of approximately 5 years after the practical completion of the project (i.e. decommissioning of all infrastructure) and will be subject to the successful rehabilitation of the remainder of the Narrabri Gas Project. Once rehabilitation sites have met the completion criteria (**Section 9.4**), monitoring will no longer be required at those sites.

9.2 Monitoring methods

Reference sites located in remnant vegetation will be utilised to compare data collected from rehabilitation plots within the same plant community type. Generally reference sites will be located 100-200 m from corresponding rehabilitation site to ensure vegetation of a similar disturbance history and condition is monitored.

At each rehabilitation and reference site, survey data will be collected from a 20 x 20 m plot (0.04 ha) and a 50 m line transect as shown in **Figure 3**. The geographic location of each plot will be recorded with a hand-held GPS unit at the start of each transect.

Data to be collected will include a list of plant species present and an estimate of the cover/abundance of each species (including weeds), vegetation structure, the number of hollow bearing trees (reference sites only); resilience factors such as over-storey regeneration and fruiting/seeding; and length of fallen logs in accordance with BioBanking Assessment Methodology. Native canopy and mid-storey cover will be visually estimated at 10 points along the 50 m line transect and divided by 10 to provide an estimated projected foliage cover for the plot. The projected foliage cover (%) of ground covers (native grasses, shrubs, other and exotic species), will be calculated by recording their presence/absence at 50 points along the 50 m line transect and dividing the total number of hits by 50.

Additional data recorded will include the presence of leaf litter, evidence of erosion, reproductive status (i.e. presence of flower and/or fruits), climatic trends (drought phase etc.) and evidence of feral animals. Several photographs will be taken at each site at selected locations to visually record rehabilitation progress (or decline).

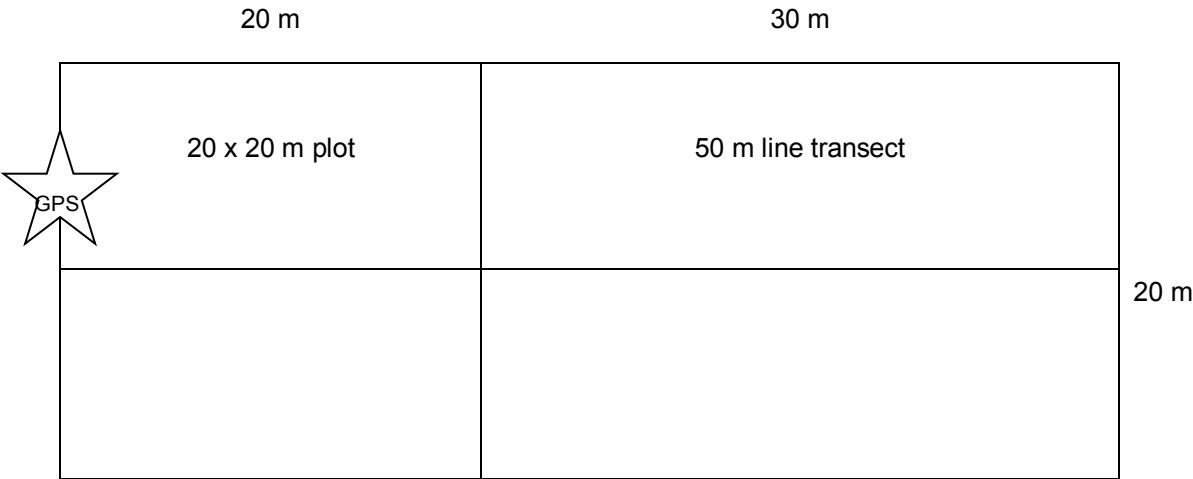


Figure 3: Rehabilitation monitoring plot configuration

9.3 Data analysis and reporting

The results of rehabilitation monitoring will be presented in an annual report. The report will contain an analysis of field data, report on any issues observed and provide recommendations for adaptive management.

Data collected from rehabilitation sites will be compared to data collected in reference sites in the same plant community type. The use of paired sites enables comparison with pre-production vegetation rather than vegetation in ‘benchmark’ condition.

Rehabilitation site data will be categorised into BioMetric vegetation types according to the Vegetation Types Database (OEH, 2012) and then compared against the corresponding benchmarks to develop an accurate and repeatable condition score for each site.

Rehabilitation site data will also be compared to completion criteria to assess how rehabilitation is progressing and determine if additional management actions area required (**Section 9.4**).

9.4 Preliminary completion criteria

The success of rehabilitation will be appraised by comparing rehabilitation monitoring data against agreed completion criteria. Preliminary completion criteria are listed in **Table 11**. These criteria will be further refined in consultation with relevant approval authorities, land owners and the Forestry Corporation of NSW and will be subject to further review. This adaptive process is illustrated in **Figure 4**.

Preliminary completion criteria for areas disturbed by the Narrabri Gas Project have been developed based on previous rehabilitation commitments and an extensive understanding of the ecology of the Pilliga. Preliminary completion criteria have been developed for each phase and activity of rehabilitation in **Table 11**.

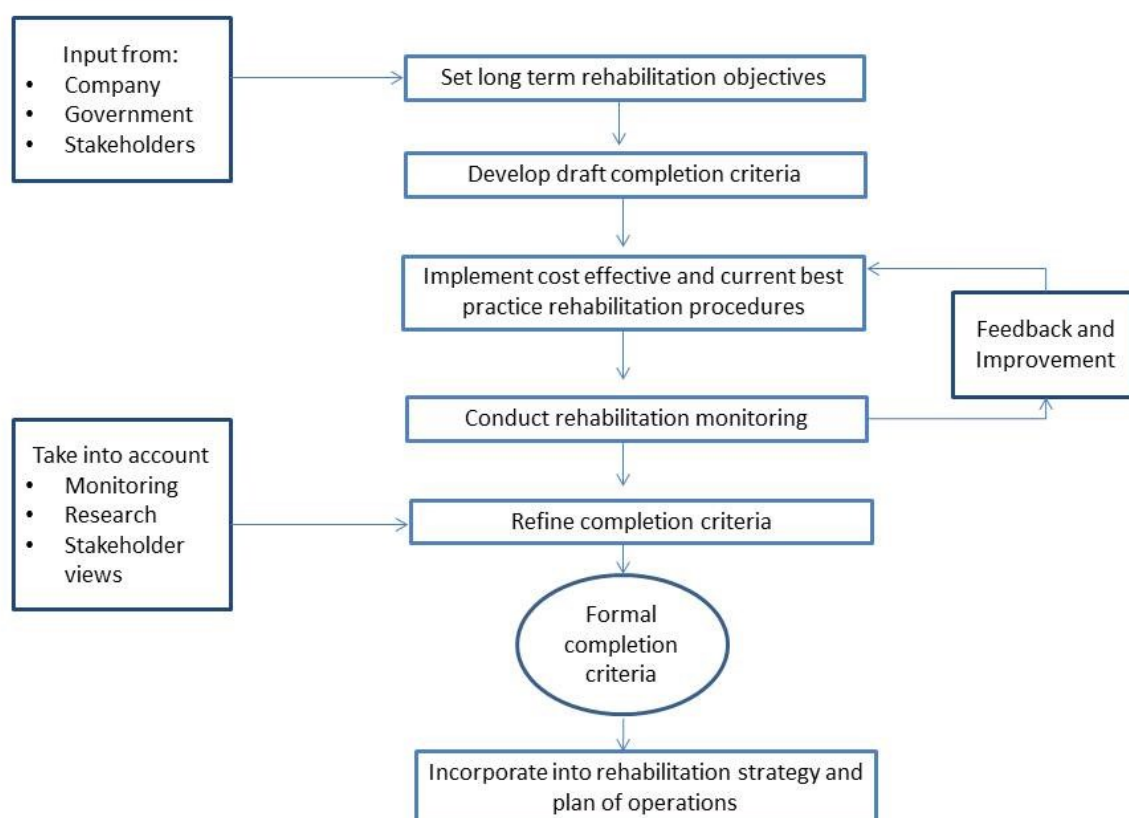


Figure 4: Process of continuous improvement of rehabilitation and refining of completion criteria (NSW Trade and Investment, 2013).

Table 11: Preliminary rehabilitation completion criteria

Phase	Description	Activity	Timing	Preliminary completion criteria
Decommissioning of site infrastructure.	Lease areas.	All plant, equipment, containers, waste materials and temporary buildings removed from the site. Fencing removed. Note temporary retention of perimeter fencing to exclude grazing animals during the early rehabilitation stages will be considered on a case by case basis.	Within 6 months of abandonment.	Site cleared. Decommissioning of the wells in accordance with the <i>NSW Code of Practice for Coal Seam Gas Well Integrity</i> (DTIRIS, 2012).
	Gathering system.	Pipes flushed and capped each end, remain <i>in situ</i> .	Within 6 months of abandonment.	Decommissioning in accordance with <i>Code of Practice, Upstream PE Gathering Networks</i> (APIA, 2014).
Landform establishment.	Topography to mimic the micro topographical undulations of the surrounding area.	Site graded and reshaped to reinstate, as far as practicable, the original contour and drainage. Erosion and sediment control implemented to minimise runoff channeling/erosion.	Within 6 months of abandonment.	No areas of instability or slumping. No areas of active erosion. Site landform established that is suitable for final land use and compatible with surrounding landscape.

Phase	Description	Activity	Timing	Preliminary completion criteria
Restoration activities by natural rehabilitation (Domains 1 & 2).	Restored native plant diversity.	Restore native plant species richness, and native canopy, midstory and ground cover.	Canopy: 15 years Midstory: 10 years Groundcover: 5 years	Native plant species richness approximates 75% of reference sites. Canopy, midstory and groundcover on a clear trajectory to meet that of reference sites.
Assisted restoration by direct seeding and/or planting or where natural rehabilitation does not meet requirements within stated period.	Restored native plant diversity.	Restore native plant species richness, and native canopy, midstory and ground cover.	Ground cover: where natural regeneration has produced less than 25% of reference condition after 12 months of rehabilitation. Canopy: where canopy species do not regenerate within 3 years of rehabilitation.	Native plant species richness approximates 75% of reference sites. Canopy, midstory and groundcover on a clear trajectory to meet that of reference sites with little management required.
Fauna habitat components reinstated (fallen logs and bush rock)	Increased fauna habitat complexity.	Restore lengths of fallen logs and woody debris in accordance with advice from a suitably qualified ecologist.	Within 6 months of abandonment.	Fauna habitat complexity increased.
Restoration of agricultural areas (Domain 4).	Restoration of agricultural land to former capability class.	Establish suitable pasture/crop species in consultation with landowner.	Within 6 months of abandonment.	Land meets former agricultural capability class and vegetative cover equals that of surrounding land.

Phase	Description	Activity	Timing	Preliminary completion criteria
Weed management.	Management of weed cover.	Infestations of environmental and noxious weeds at well pads, gathering systems, infrastructure areas or stockpile. Weeds managed in accordance with requirements of <i>Noxious Weeds Act 1993</i> .	Until ground cover achieves completion criteria, as above.	Weed cover does not exceed values of reference sites by more than 10%.
Monitoring and reporting.	Compliance check and reporting to regulator	Ensure all required rehabilitation activities have been completed Review report prepared every two years.	Every two years and at completion of rehabilitation.	Report provided to relevant landholders and the regulator.
	Review of rehabilitation strategy and completion criteria	Ensure rehabilitation strategy remains current and completion criteria are updated if necessary after appropriate consultation	After 5 years.	Rehabilitation plan updated and remains current. Rehabilitation reflects any modifications to project
	Review and finalisation of completion criteria and rehabilitation sites	Review completion criteria and update rehabilitation strategy	5 years following review of rehabilitation strategy	If completion criteria reached rehabilitation areas can be signed off and monitoring and maintenance relinquished.

9.5 Post closure maintenance

The closure of the Narrabri Gas Project is contingent on achieving the rehabilitation objectives and completion criteria outlined in **Section 1.2** and **9.4** of this Strategy. Due to the extensive time periods required for vegetation to achieve a natural structure, monitoring of rehabilitation undertaken for the project should be able to show the rehabilitation is on a clear trajectory that will eventually result in the rehabilitation approaching the condition of surrounding lands not directly impacted by the project. It is expected this should be able to be demonstrated within 5 years of rehabilitation being undertaken.

It is proposed that rehabilitation works, maintenance and monitoring will be required to continue for approximately 5 years after the practical completion of the project (i.e. decommissioning of all infrastructure) and closure will be subject to the successful rehabilitation of the remainder of the areas impacted by the Narrabri Gas Project.

10 Rehabilitation trials, research and ability to achieve completion criteria

The natural regeneration approach used by Santos is advocated by Forestry Corporation NSW, who utilise natural regeneration following forestry operations in the Pilliga.

Successful rehabilitation is reliant on the regular review of rehabilitation performance and identifying areas and methods that require improvement. Rehabilitation of selected well pads and gathering systems is currently occurring as part of the progressive rehabilitation of exploration and appraisal activities within the project area. Monitoring of rehabilitation has been undertaken in the project area since 2012.

Paired sites (rehabilitated and largely undisturbed) in the same vegetation type were utilised for monitoring. The use of paired sites enables comparison with pre-production vegetation rather than comparing vegetation in 'benchmark' condition. This is important as the vegetation in the project area has seen varying levels of disturbance due to logging history, bushfire and other disturbance.

While floristic composition varies between rehabilitated areas and reference sites (as expected after removal of vegetation), rehabilitation monitoring has provided encouraging results for such a short time period since disturbance. Partial regeneration of well pads and gathering systems has occurred to date, with the overall site value of rehabilitation sites approximating 74% of the site value at reference sites (**Figure 5**). An example of rehabilitation at a well pad is shown in **Plate 1**.

Many of the rehabilitation areas have similar numbers of native species to reference sites, a dense shrub layer, relatively low weed cover and regeneration of overstorey species through coppice regrowth. It is expected that as midstorey and canopy species continue to grow, with continued weed monitoring and management, rehabilitated areas will attain similar composition and structure to adjacent remnant woodland and are on a trajectory to attaining completion criteria.

The results to date demonstrate that the methods proposed in this rehabilitation strategy are achievable and will result in the establishment of pre-production natural vegetation communities in the Pilliga. These results are also considered to exceed those achievable on rehabilitation sites in traditional open cut mining projects (which require complete ecosystem reconstruction) in terms of timeframes, species diversity and habitat structure.

Santos will contribute to and actively participate in rehabilitation trials and research to continually improve rehabilitation techniques and performance throughout the life of the Narrabri Gas Project.

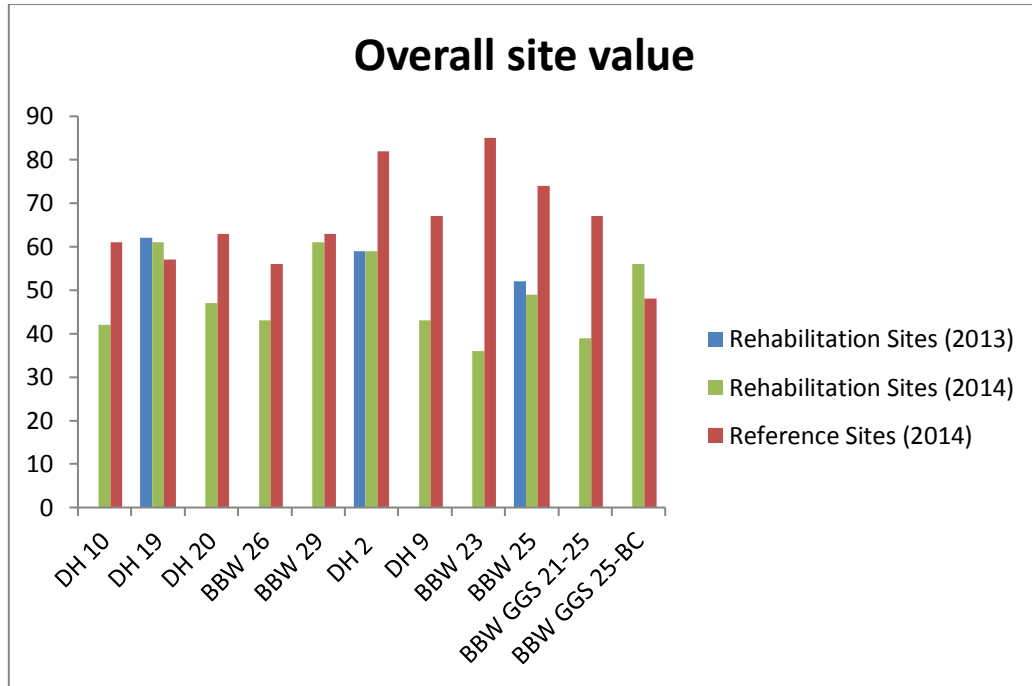


Figure 5: Overall site value in rehabilitation areas compared to nearby reference sites not disturbed by the project (2013-14)



Plate 1: Natural regeneration two years since disturbance in well pad BBW25

11 Review of rehabilitation strategy and completion criteria

This rehabilitation strategy is to be reviewed at five year intervals to ensure the document remains current and is adapted to any advances in best practice rehabilitation methods and the results of monitoring works. A quantitative review of the completion criteria should be undertaken including any justification for amendments. At this time a review of rehabilitation works will be conducted. If completion criteria have been reached for any rehabilitation areas then these can be signed off and monitoring and maintenance at these areas relinquished.

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