



Appendix C

Field development protocol

Narrabri Gas Project

Environmental Impact Statement

August 2016

Appendix C

Field Development Protocol

(Environmental Protocol for Constraints Planning and Field Development)

Table of Contents:

1. Introduction	1
1.1 Protocol overview	1
1.2 Description of the Project	2
2. Purpose and scope	4
2.1 Purpose	4
2.2 Scope	4
3. Compliance and audit	6
3.1 Compliance	6
3.2 Annual review and third-party audit	7
4. Landholder engagement	8
5. Field development – desktop review to final design	9
5.1 Overview of field development	9
6. Implementation management controls	17
6.1 Implement pre-clearance protocols for fauna management	17
6.2 Implementation of management and construction controls	17
6.3 Annual monitoring of performance	19
6.4 Third party audits	19
7. Ecological constraint categories	20
7.1 Ecological sensitivity and constraint categories	20
8. Ecological constraints - disturbance limits	23
8.1 Probabilistic calculation of disturbance	23
8.2 Disturbance limits	23
8.3 Ecological impact assessment	23
9. Cultural heritage constraints	29
9.1 Aboriginal cultural heritage	29
9.2 Historic heritage	32
10. Additional Constraints	34
10.1 Nature reserves, national parks and Aboriginal areas	34
10.2 State Conservation Areas	34
10.3 Occupied residences	34
10.4 Yarrie Lake	34
10.5 Constraints for noise	34
10.6 Nuisance constraints for air emissions	35

10.7	<i>Biophysical strategic agricultural land</i>	35
10.8	<i>Watercourses</i>	35
10.9	<i>Flooding and geomorphology</i>	36
10.10	<i>Production well pads spaced at least 750 m apart</i>	36
10.11	<i>Approval of the Field Development Protocol</i>	39
10.12	<i>Publication and notification</i>	39
11.	Acronyms	40
12.	Definitions	41
13.	References	42

List of Tables

Table 5-1	Avoidance hierarchy (in order of priority)	14
Table 6-1	Management plan summary	18
Table 7-1	Ecological constraints matrix	21
Table 8-1	Disturbance limits vegetation communities and habitat	25
Table 8-2	Disturbance limits Pilliga mouse habitat	27
Table 8-3	Disturbance limits threatened flora	28
Table 10-1	Project related noise constraints at occupied residence	35
Table 10-2	Riparian corridor widths	36

List of Figures

Figure 1-1	The project area	3
Figure 2-1	The Protocol within the overall project framework	4
Figure 2-2	Phases of the constraints planning process	5
Figure 5-1	Constraints planning process flow	11
Figure 5-2	Micro-siting - ecology	15
Figure 7-1	Ecological sensitivity class	22
Figure 9-1	Aboriginal cultural heritage sites	30
Figure 9-2	Historic heritage sites	31
Figure 10-1	Mapped riparian corridors	37
Figure 10-2	Maximum flood depth, 1% AEP	38

1. Introduction

1.1 Protocol overview

Santos NSW (Eastern) Pty Ltd (Santos) is proposing to develop the Narrabri Gas Project (the project) which includes the construction of up to 850 new production wells on a maximum of 425 new well pads. The planning and development of project infrastructure is an iterative or phased process, where the location of infrastructure is determined by the resource, proximity to existing infrastructure, landholder agreements and environmental constraints as described in this document.

The Field Development Protocol (the Protocol) provides a framework for the siting of gas wells and associated infrastructure to be installed within the project area. The Protocol seeks to systematically avoid, minimise and manage the environmental impacts of the project in accordance with legislation, environmental, social and cultural constraints, management plans and proposed conditions if approved. The Protocol specifies the locational criteria for the infrastructure and the procedures Santos will implement to ensure compliance with criteria.

The Protocol applies to the siting of gas wells and supporting infrastructure (gathering lines, tracks and in field water management and compression facilities) required to be located in accordance with the locational criteria. It does not apply to the water and gas treatment facilities on the Leewood Property as the location of those facilities is finalised at the time of lodgement of the EIS.

The Protocol will ensure that the development of the project, particularly the siting of in field infrastructure, minimises the impact of the project on the environment and takes place in accordance with:

- The project commitments;
- Relevant State and Commonwealth legislation;
- The environmental impacts identified in the relevant impact assessment reports that accompany the EIS;
- Environmental constraints/limits identified in the impact assessment reports;
- Environmental management plans or procedures; and
- Proposed conditions of approval.

The Protocol has been developed to ensure that the project minimises impacts on areas with specific environmental attributes within the project area and maximises avoidance of the most sensitive ecological features. The Protocol applies for the life of the project, including each stage of development, infrastructure planning and design, construction, operation, decommissioning and rehabilitation. The Protocol takes into account the following environmental, social and cultural constraints:

- Maximum ecological disturbance limits by vegetation community and for individual threatened flora;
- Cultural heritage including Aboriginal cultural heritage and non-indigenous heritage;
- Watercourses and buffer width as determined by Strahler stream order;
- Flooding and geomorphology;
- Noise; and

- Identified sites (e.g. Yarrie Lake).

If development consent and approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the NSW *Environmental Planning and Assessment Act 1979* is granted, the Protocol (currently draft) will be revised to capture conditions of approval related to the siting of infrastructure.

A Plan of Operations will fully detail site and asset specific information for planned infrastructure, as well as the direct impacts on vegetation communities. A Plan of Operations will be prepared for each stage of development and provided to the Department of Planning and Environment prior to implementation. The Government will be provided a Plan of Operations no less frequently than at two yearly intervals.

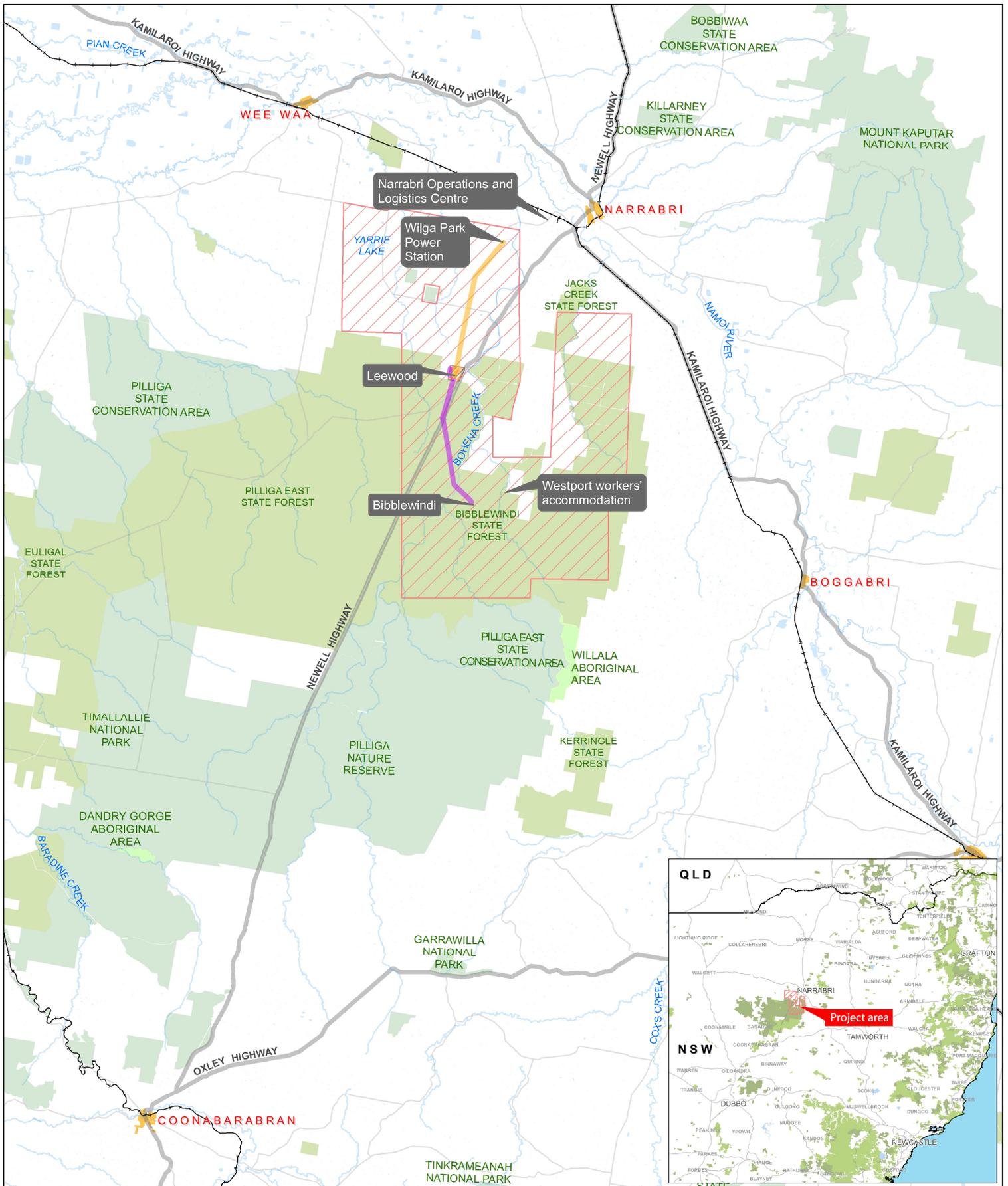
The development of the project will be subject to a combination of annual compliance review and third party audits (every three years) to assess performance relative to the requirements of the Protocol including the constraints.

1.2 Description of the Project

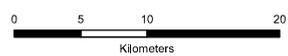
Santos is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri.

The Narrabri Gas Project seeks to develop and operate a gas production field, requiring the installation of up to 850 new gas wells on a maximum of 425 new well pads. Well types would include all new exploration, appraisal and production wells. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), to the north of the Pilliga. 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 project area covers about 950 square kilometres (95,000 hectares) in size, and the project footprint would directly impact about one per cent of that area.



- LEGEND**
- Project area
 - Leewood
 - Urban Areas
 - State forest
 - Parks and reserves
 - Aboriginal areas
 - Lakes and dams
 - Watercourses
 - Highways
 - Major Roads
 - Train line
 - Leewood to Wilga Park infrastructure corridor
 - Bibblewindi to Leewood infrastructure corridor



Narrabri Gas Project
Environmental Impact Statement

Job Number | 21-22463
Revision | A
Date | 12 Mar 2015

The project area

Figure 1-1

C:\Users\Foddy\Desktop\21_22463_KBM29.mxd [KBM: 235]
Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydney@ghd.com.au W www.ghd.com.au
© 2015. Whilst every care has been taken to prepare this map, GHD, Santos and NSW LPLMA make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: NSW Department of Lands: DTDB and DCDB - 2012-13, Santos: Operational and Base Data - 2013, Created by: afoddy

2. Purpose and scope

2.1 Purpose

The Protocol sets out the locational criteria for the infrastructure and the procedures Santos will implement to ensure that the infrastructure is sited in accordance with the criteria.

The Protocol aims to ensure that the development of the project, particularly the siting of infrastructure, minimises the impact of the project on the environment in accordance with the environmental management measures and limits outlined in the EIS. The Protocol will be revised post determination to ensure consistency with relevant approval conditions that act as a constraint for the siting of infrastructure.

The Protocol takes into account impacts to Matters of National Environmental Significance listed under the EPBC Act.

The Protocol has been designed to avoid certain attributes within the project area and maximise avoidance of the most sensitive ecological features. The Protocol applies for the life of the project, refer Figure 2-1, including each stage of infrastructure planning and design, construction and operation.

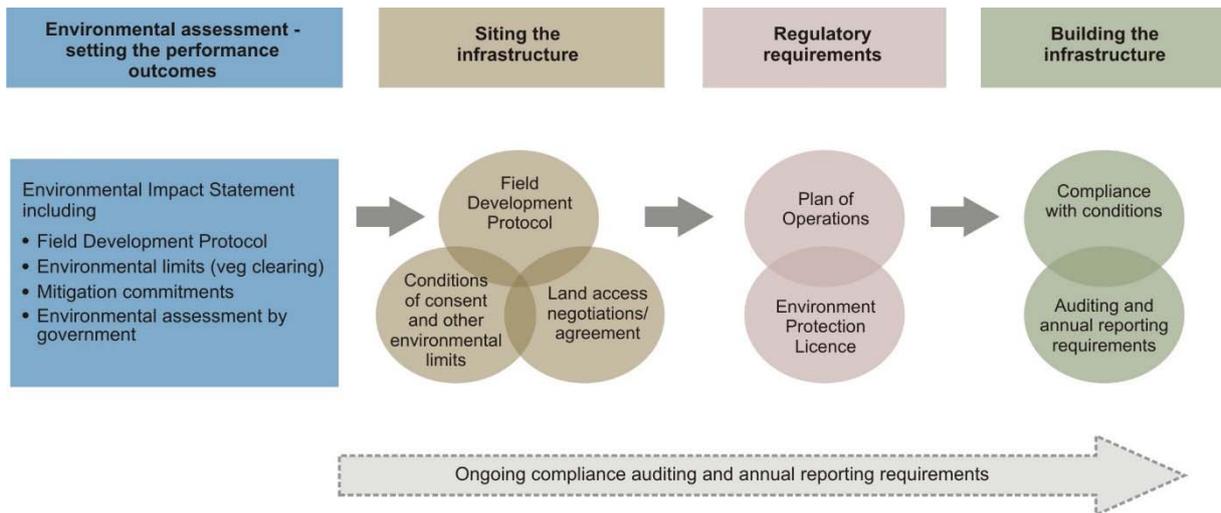


Figure 2-1 The Protocol within the overall project framework

2.2 Scope

The Protocol relates to the activities required for the commercial production of gas proposed to be undertaken under the petroleum production leases, if granted, in respect of PPLA 13, PPLA 14, PPLA15 and PPLA16. The Protocol does not apply to the major facilities at the Leewood property. These have been fully described and assessed in the EIS. The Protocol aims to manage environmental constraints relevant to the Commonwealth and State Governments under a single framework.

The Protocol is to be applied over the life of the project in four phases, as shown in Figure 2-2. Specifically, the Protocol will ensure the project is consistent with:

- All relevant State and Commonwealth legislation;
- The environmental impacts identified in the relevant impact assessment reports that accompany the EIS;
- Environmental constraints/limits identified in the impacts assessment reports;
- Environmental management plans or procedures; and
- Proposed conditions of approval.



Figure 2-2 Phases of the constraints planning process

3. Compliance and audit

3.1 Compliance

3.1.1 Legal compliance

The siting of infrastructure must comply with relevant Commonwealth and New South Wales legislation and approvals including but not limited to relevant sections of:

- Environment *Protection* and Biodiversity Conservation Act 1999 (Cth);
- Petroleum (Onshore) Act 1991 (NSW);
- Environmental Planning and Assessment Act 1979 (NSW);
- Protection of the Environment Operations Act (NSW);
- National Parks and Wildlife Act 1974 (NSW);
- Threatened Species Conservation Act 1995 (NSW)

3.1.2 Santos Environment, Health and Safety Management System

Santos will use its company-wide Environment, Health and Safety Management System (EHSMS), which provides a structured framework for effective environmental and safety practice across all Santos activities and operations. The implementation of the EHSMS will assist in compliance with the Protocol, Plan of Operations and the minimisation of environmental impacts.

The framework is consistent with Australian Standard 4801:2000 Occupational Health and Safety Management Systems – Specification with guidance for use, and AS/NZS ISO 14001:1996 Environmental Management Systems – Specification with guidance for use. The EHSMS documents are maintained in electronic form on Santos' central server that is accessible to all employees and contractors.

Management standards have been developed as part of the EHSMS and define the requirements necessary to systematically manage environmental, cultural heritage, health and safety risk.

3.1.3 Management plans and procedures

Following approval, management plans will be developed to incorporate Commonwealth and State regulatory requirements. These plans also incorporate the Santos corporate values, policies and EHSMS into project-level documents that set out measures and commitments to manage the risk of adverse impacts to environmental values.

Table 6-1 details the key management plans to be used for the project.

3.1.4 Plan of Operations

A Plan of Operations detailing the location of proposed infrastructure and other project activities will be prepared and submitted to the NSW Department of Planning and Environment and the Commonwealth Department of Environment and Energy prior to implementation. Government departments will have 28 days to review compliance with the approval conditions, and then implementation can commence.

3.2 Annual review and third-party audit

3.2.1 Annual review

On each anniversary of the approval, Santos will review implementation to ensure it is consistent with:

- the Protocol, management plans and procedures and Plan of Operations; and
- conditions of the Commonwealth and State Government approvals.

Santos will identify non-compliances, analyse the causes of these non-compliances and describe the measures that will be implemented to ensure compliance in the future.

3.2.2 Third-party audit

Within three years of the approval, and every three years thereafter, Santos will facilitate a third-party environmental audit to ensure compliance with the following:

- implementation consistent with the Protocol and Plan of Operations;
- conditions of the Commonwealth and State Government approvals and relevant licences and plans;
- relevant State and Commonwealth legislation;
- management plans; and
- the annual compliance review obligations for the period.

The third-party auditor will be suitably qualified to conduct the audit.

The auditor will provide a report to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment identifying non-compliances and recommendations to improve planning or implementation processes.

4. Landholder engagement

Landholder engagement and consultation is an important component of all stages of development. Due to the specific nature of the activities which may be proposed on each landholder's property and the localised issues that may be identified during the landholder consultation process, landholder consultation and land access agreements do not form part of this Protocol. A Farm Management Plan will be developed in liaison with landholders to document planned activities and indicative timing of these for both the landholder and Santos to enable coexistence of activities to be managed effectively.

5. Field development – desktop review to final design

The Protocol applies for the life of the project, for each stage of development throughout infrastructure planning and design, construction, operation, decommissioning and rehabilitation, and takes into account the following environmental, social and cultural constraints:

- Maximum ecological disturbance limits by vegetation community and for individual threatened flora;
- Cultural heritage including Aboriginal cultural heritage and non-indigenous heritage;
- Unless a written agreement is in place with the relevant landholder, no project infrastructure will be located within 200 m of an occupied residence on that property;
- Watercourses and buffer width as determined by Strahler stream order;
- Flooding and geomorphology;
- Noise; and
- Identified sites (e.g. Yarrie Lake, Brigalow State Conservation Area).

Avoidance and minimisation of impacts are prioritised throughout the field development process, in the first instance through exclusions. Field development is summarised in Figure 5-1 below and commences with a desktop review, then micro-siting in the field, finalising design and provision of the Plan of Operations to Government. The final phase is implementation including management controls, ongoing monitoring and auditing.

The Plan of Operations will be prepared for each stage of development and provided to Government prior to implementation. The Plan of Operations will further detail site specific information for planned infrastructure, compliance with various constraints including direct impacts on vegetation communities, and include management and monitoring methods that will be implemented.

5.1 Overview of field development

5.1.1 Exclusion areas and maximising avoidance

The design and location of infrastructure for the project excludes certain sensitive areas, and to minimise overall disturbance, maximises the use of areas within or adjacent to existing disturbance. This strategy includes but is not limited to:

- Exclusion of Brigalow Park Nature Reserve from the project area;
- Exclusion of surface infrastructure from the Brigalow State Conservation Area;
- Avoidance of all currently known Aboriginal sites;
- Placement of large ponds (for brine and produced water) and large dams in areas of low ecological sensitivity;
- The exclusion of non-linear infrastructure from riparian corridors;
- Disturbance to the high ecological sensitivity class is limited to 0.5% of total class area; and

- Where practicable development planning will maximise the use of existing roads, tracks and disturbance corridors for construction, operational access and the placement of linear infrastructure (for example gas and water gathering systems).

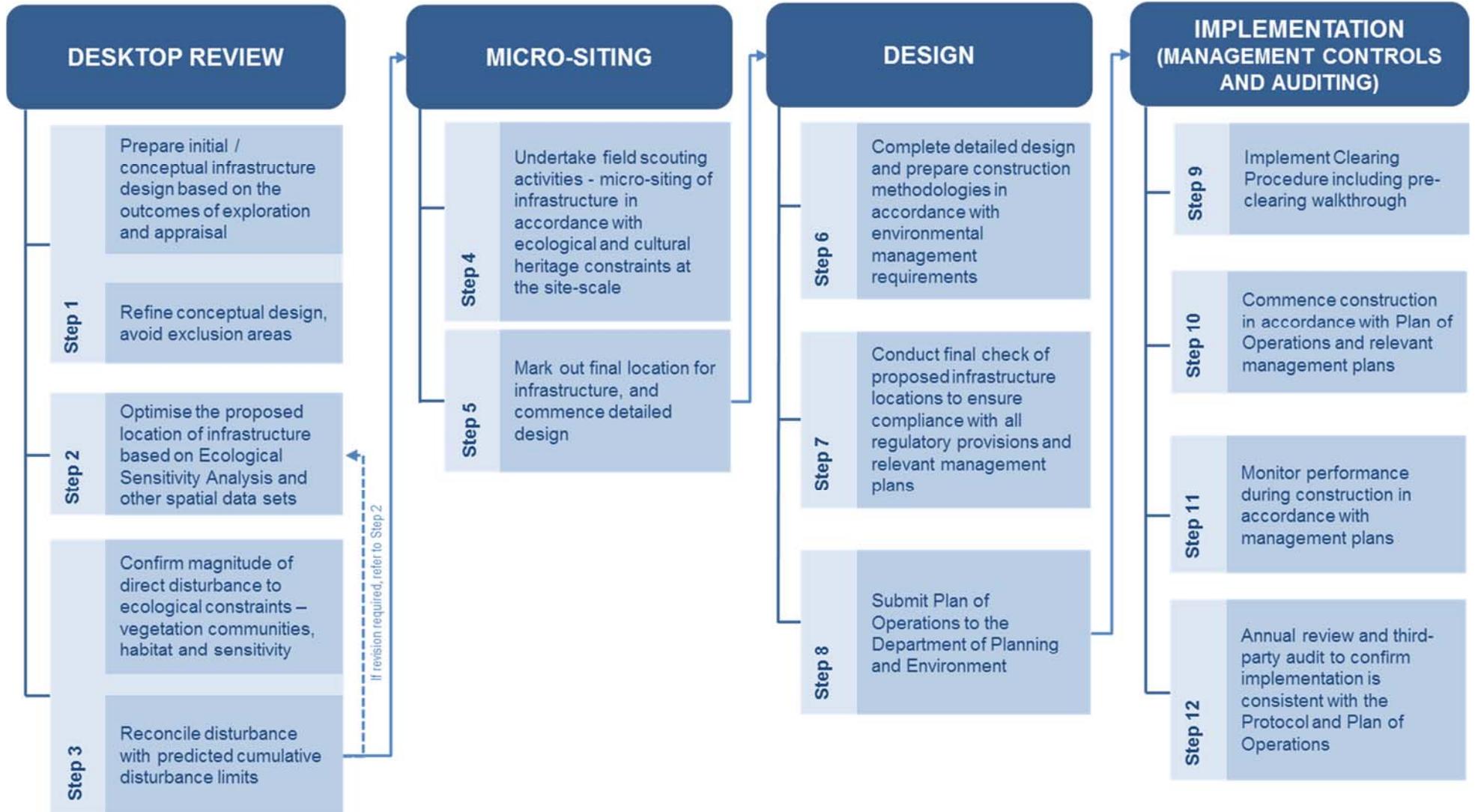


Figure 5-1 Constraints planning process flow

5.1.2 Desktop review (Steps 1 through 3)

The desktop review process optimises the location of infrastructure and environmental outcomes, and identifies likely suitable development areas. The GIS database that is utilised during desktop review includes:

- Geologic features and knowledge of gas resources;
- Ecological sensitivity mapping (see section 7.1), as well as other ecological data;
- The location of known Aboriginal cultural heritage sites as mapped in Figure 9-1 and historic heritage Figure 9-2;
- Existing access tracks and roads that can be used for the project development, minimising development scope and disturbance through co-location;
- Existing infrastructure including gas and water gathering and transmission pipelines, ponds, dams, electrical infrastructure and compression infrastructure;
- The location of surface water resources, riparian corridors and one per cent Annual Exceedance Probability flood event levels; and
- Sensitive receptors, which could potentially be impacted by noise or air emissions.

Step 1 – Define the next stage of development relative to exclusion areas (conceptual design)

This process involves the development of the initial conceptual infrastructure design and takes into account the gas resource, exclusion areas, existing infrastructure and other relevant information.

The conceptual design of infrastructure also informs the land access negotiations.

Steps 1 and 2 are not mutually exclusive and will be undertaken in parallel as an iterative process to ensure the infrastructure locations are optimised.

Step 2 – Review of the proposed infrastructure against Ecological and other spatial constraints

This step utilises the conceptual design (developed above) and seeks to optimise the placement of infrastructure using the ecological sensitivity class hierarchy described in Section 7.1 and the potential for impacts on other constraint classes. Initially this process involves reviewing the proposed infrastructure locations relative to the ecological sensitivity maps. Through this process, infrastructure locations will be directed (where practicable) to less sensitive ecological classes in accordance with the general rules and specifications provided in Section 7.1.

As detailed in the constraint matrix (Table 7-1), this will result in the majority of the well pads being located outside of high and moderate high ecological sensitivity classes (disturbance to the high ecological sensitivity class is limited to 0.5% of total class area). Linear infrastructure will be less constrained, development will be directed firstly to areas adjacent to existing linear infrastructure where practicable and/or the shortest possible routes to minimise the total clearing required.

Where the total extent of clearing is similar between two potential options, linear infrastructure will be directed to the areas with the lowest aggregate disturbance of higher order ecological sensitivity classes.

Following optimisation for ecological sensitivity, consideration is given to the remaining constraints. Where necessary, the placement of infrastructure will be modified.

Step 3 – Review of cumulative disturbance against probabilistic estimates of disturbance

Step 3 involves reconciliation of the potential disturbance of each development stage against the predicted cumulative disturbance calculations for development.

The reconciliation of potential disturbance provides a critical component of the framework for tracking of performance, as well as ensuring the conceptual design and optimisation described in Steps 1 and 2 above are maintained within the approved ecological disturbance limits over the life of the project.

5.1.3 Micro-siting

Step 4 – In-field micro-siting

Micro-siting involves, amongst other things, ensuring compliance with all of the relevant avoidance measures and constraints at the site-scale. Micro-siting in the field seeks to further direct the development away from sensitive ecological and cultural features.

The micro-siting process involves field scouting of ecological features (such as threatened flora and hollow-bearing trees) and pre clearance surveys for Aboriginal cultural heritage within the proposed area of the development. The micro-siting process will be conducted as follows:

Step 4a – Mark-out of the proposed layout of infrastructure within the development area.

Step 4b – Ecological site scouting of the marked out area and buffer areas to survey for the presence of the high value ecological features (including threatened flora and hollow-bearing trees). For the purposes of the site scouting, the survey buffers will comprise of an area approximately 50 m beyond the boundary on the 1 ha well pad site and 6 m on either side of the 12 m linear infrastructure easements.

Ecological features that will be identified during micro-siting include threatened flora species as well as hollow bearing trees. A hierarchical structure will be applied to the relocation of infrastructure to avoid or minimise impacts on key features and attributes identified during micro-siting.

Step 4c – The data collected during site scouting will be used to recommend refined infrastructure locations to maximise avoidance whilst remaining within engineering limits for construction and operation.

Table 5-1 Avoidance hierarchy (in order of priority)

Priority	Ecological Feature or Attribute	
1	Endangered Ecological Communities by listing status	
	Ranking (highest to lowest)	Status
	1	EPBC Act Endangered
	2	TSC Act Endangered
2	Threatened flora species prioritised by listing status:	
	Ranking (highest to lowest)	Status
	1	EPBC Act Critically Endangered
	2	TSC Act Critically Endangered
	3	EPBC Act Endangered
	4	TSC Act Endangered
	5	EPBC Act Vulnerable
6	TSC Act Vulnerable	
3	Hollow-bearing trees prioritised by size class:	
	Ranking (highest to lowest)	Size Class
	1	> 300 mm
	2	>200 mm < 300 mm
	3	<200 mm
4	Significant fauna habitat (e.g. Pilliga Mouse habitat, nests, mistletoe)	

An example of the process of micro-siting and the outcomes of the process are shown below in Figure 5-2.

Step 4d – Following completion of the ecological micro-siting component, a cultural heritage pre-clearance survey will be conducted within the refined infrastructure alignment:

- This survey will be undertaken in accordance with the Cultural Heritage Management Plan (CHMP) and confirm the presence/absence of Aboriginal cultural heritage sites;
- All currently known sites will be avoided, Figure 9-1; and
- If Aboriginal cultural heritage sites are encountered in the recommended area then the procedures outlined in the CHMP will be implemented, including the avoidance commitments by Aboriginal site type. Where a re-positioning of infrastructure to avoid cultural heritage features can be conducted without causing additional impact to ecological features and attributes, the alignment will be modified immediately. Otherwise an iterative approach will be followed to ensure overall ecological impact is minimised when complying with avoidance commitments by Aboriginal site type.

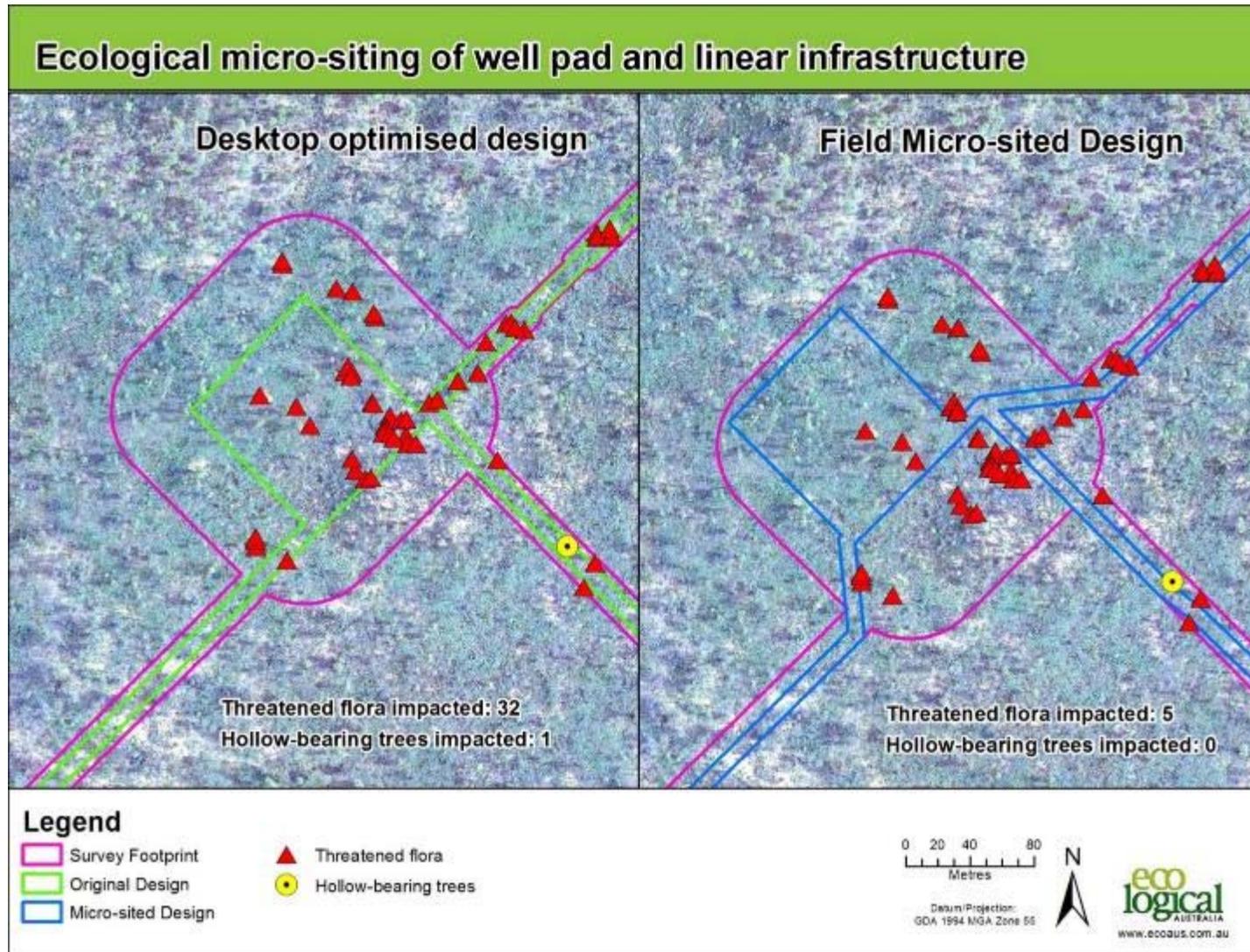


Figure 5-2 Micro-siting - ecology

Step 5 – Complete final mark-out and survey of the development area.

The final location of the infrastructure will be surveyed and marked in the field.

5.1.4 Design

Step 6 – Detailed design and management control planning

Detailed designs and management practices for the proposed development are finalised after considering:

- Constructability
- Environmental and construction hazards and risks; and Management controls (to mitigate potential impacts) and management practices (for example erosion and sediment controls).

Step 7 – Final check to verify compliance with all project conditions and management plans

A final check for the proposed infrastructure locations to ensure compliance with regulatory conditions and management plans.

Step 8 – Prepare and Submit of Plan of Operations

A Plan of Operations details the proposed infrastructure located in accordance with the constraints and processes in the Protocol. The Plan of Operations would be submitted to the NSW Department of Planning and Environment and the Commonwealth Department of Environment and Energy prior to implementation. Digital spatial data sets of existing and proposed infrastructure will also be provided. Government departments review compliance with the Protocol and approval conditions. The Plan of Operations will then be published on a web site.

6. Implementation management controls

The key strategies for management and mitigation of impacts, which will be documented within the Plan of Operations, include:

- Implementation of **pre-clearance protocols for fauna management** to minimise and mitigate disturbance to fauna within the proposed development area.
- **Construction Management** techniques that minimise the extent and nature of disturbance. A broad range of management controls have been established to manage and mitigate the impacts of construction and operational activities these are described further in Section 6.2.
- Ongoing **rehabilitation, including partial rehabilitation**, to facilitate revegetation of disturbed areas and the return of ecological functions, or resume agricultural activities in developed areas
- **Monitoring of the performance** of the management methods and key environmental indicators (for example indirect impacts on biodiversity, noise etc.)
- **Review and Auditing** to assess the performance of the Protocol and facilitate modification.

General discussion on each of these components is provided below.

6.1 Implement pre-clearance protocols for fauna management

A clearing procedure including a pre-clearing walkthrough was developed to minimise potential impacts or risk to fauna during vegetation removal (included in NGP Ecological Impact Assessment, Appendix J of the EIS). The purpose of the clearing procedure is to identify fauna occurrence in the development area, and encourage fauna to relocate outside of the development area prior to habitat clearing and move fauna during clearing.

A pre-clearing walkthrough undertaken by an appropriately qualified ecologist involves marking and recording the location of hollow-bearing trees or other significant fauna habitat features (nests, hollow-bearing logs, stags) within the proposed development area. Attributes of each hollow-bearing tree (species, diameter at breast height, hollow sizes) will be recorded.

Clearing operations are to be supervised by an appropriately qualified ecologist in accordance with the clearing procedure.

6.2 Implementation of management and construction controls

The general management and mitigation measures that will be utilised for the project are summarised in section 6.2.1.

In conjunction with the Plan of Operations, all activities will be undertaken in accordance with the Environmental Management Strategy and relevant management plans.

6.2.1 General management and mitigation measures

Relevant provisions of management plans will be implemented as appropriate throughout the constraints planning process (Figure 5-1) and construction. Relevant management plans include, but are not limited to, those listed in Table 6-1.

Table 6-1 Management plan summary

Management Plan	Management Strategies and Approaches
Erosion and Sediment Control Plan (ESCP)	The purpose of the erosion and sediment control plan is to minimise sedimentation to surface watercourse as a result of construction activities.
Cultural Heritage Management Plan (CHMP)	Provides the framework for the management of Aboriginal cultural heritage during the implementation of the project.
Biodiversity Management Plan	Applies in all project stages and would include a significant species management plan and management measures to minimise impacts on terrestrial flora and fauna. Also includes the pre-clearing and clearing procedure to minimise potential impacts or risk to fauna during vegetation removal.
Noise and Vibration Management Plan	Methods used to minimise construction noise and vibration such that noise constraints are met during construction, operation and rehabilitation.
Pest, Plant and Animal Control Plan	An inventory of weeds, diseases present, and management measures to be implemented in design, construction and post construction to control weeds. The plan would address feral animal control at a landscape scale.
Historic Heritage Management Plan (HHMP)	Measures to guide the management and protection of identified heritage items within the project area across the construction phase of the project
Rehabilitation Strategy	Ensure an overarching and consistent approach to rehabilitation management, with specific rehabilitation requirements to populate other plans as required (such as farm management plans, and sediment and erosion control plans).
Decommissioning Management Plan	The decommissioning of wells in accordance with the <i>NSW Code of Practice for Coal Seam Gas Well Integrity</i> , in addition to the decommissioning of major infrastructure and other field infrastructure.
Bushfire Management Plan	Description of the bushfire risks, formal preparedness procedures, procedures during bushfire and maintenance requirements for emergency access and egress routes. To be prepared in consultation with landholders and the NSW Rural Fire Service.

6.2.2 Management strategies for mitigation of impacts on terrestrial ecology

Actions to mitigate the potential impacts of each development stage on ecological values have been detailed in the EIS (included in NGP Ecological Impact Assessment, Appendix J of the EIS). Management strategies include: site inductions, clear demarcation of work areas, restricting access to designated access roads and corridors, inspection of trenches, observations of illegal hunting or collection, installation of fauna friendly fencing, speed limitations, minimising driving during high fauna activity periods (i.e. from dusk through to dawn), dust suppression, prohibition of domestic pets, minimising light spill, progressive rehabilitation, adequate storage and bunding of liquids, spill management procedures and rubbish collection.

6.2.3 Rehabilitation strategy

A Rehabilitation Strategy has been prepared for the project, Appendix V of the EIS. Partial rehabilitation of the disturbed areas will occur as soon as practicable. Partial rehabilitation of well pads can commence after an assessment of the operational performance of the well. Following the decommissioning of infrastructure rehabilitation of sites will be completed.

6.3 Annual monitoring of performance

On each anniversary of the approval, Santos will conduct an annual compliance review to ensure it is compliant with:

- the Protocol, management plans and procedures and Plan of Operations; and
- conditions of the Commonwealth and State Government approvals.

Santos will identify non-compliances and analyse the causes of these non-compliances and describe the measures that will be implemented to ensure compliance in the future.

6.4 Third party audits

Within three years of the approval, and every three years thereafter, Santos will facilitate a third-party environmental audit to ensure compliance with the following:

- implementation consistent with the Protocol and Plan of Operations;
- conditions of the Commonwealth and State Government approvals and relevant licences and plans;
- relevant State and Commonwealth legislation;
- management plans; and
- the annual compliance review obligations for the period.

The third-party auditor will be suitably qualified to conduct the audit.

The auditor will provide a report to the NSW Department of Planning and Environment and the Commonwealth Department of the Environment and Energy identifying non-compliances and recommendations to improve planning or implementation processes.

7. Ecological constraint categories

The potential constraints of the project area from an ecological perspective are complex including threatened flora, threatened fauna habitat, Endangered Ecological Communities, high quality vegetation, regionally significant vegetation and large patch size. To present these constraints in a meaningful manner, an Ecological Sensitivity Analysis (ESA) was developed to identify the degree of ecological sensitivity and hence constraint to development.

The primary purpose of the ESA is to inform the selection of locations for well pads and associated infrastructure (such as access tracks, gas and water gathering systems, water balance tanks and telecommunications equipment) to maximise avoidance of areas of higher ecological sensitivity.

- The ecological sensitivity analysis used available spatial data as well as new spatial data collected through field investigations and developed specifically for the project to identify areas of sensitivity. Ecological criteria were identified and assigned rankings and weightings. The sensitivity analysis then combined scores for the data, applied weightings, and modelled sensitivity indices. The following five relative sensitivity classes based on identified trends (clustering) in the sensitivity index were modelled:
- **Low** – Areas that include a high degree of previous disturbance which impact on long term viability. Disturbance should be directed to these areas wherever possible.
- **Low - Moderate** – Areas that exhibit effects of previous disturbance, or habitat values which are of lower sensitivity in the regional context. Disturbance of these areas should be minimised at the site scale.
- **Moderate** – Areas that exhibit some effects of previous disturbance, or habitat values which are of moderate sensitivity in the regional context. Disturbance of these areas should be minimised at the site scale.
- **Moderate - High** – Areas that include a range of ecological values, including those listed under State or Federal legislation. Maximise avoidance on these areas whenever practicable.
- **High** – Areas which contain a combination of significant ecological values, including those listed under State or Federal legislation. Maximise avoidance on these areas whenever practicable. (Note: disturbance limited to 0.5% of area).

7.1 Ecological sensitivity and constraint categories

The key ecological sensitivity constraints for the project are summarised below in Table 7-1.

- **Support for planning** - Monitoring including air quality, noise, ecological surveys, pests and weeds and cultural heritage surveys.
- **Non-linear infrastructure** - Infrastructure including (but not limited to) exploration and production wells, field compressor stations, dams, ponds, communications towers, water tanks/balance tanks, flares, irrigation areas (and associated infrastructure) and maintenance facilities.
- **Linear infrastructure** - Infrastructure including (but not limited to) gas and water gathering lines, low and medium pressure gas and water pipelines/water trunk lines, access tracks, power lines, communication lines and other service lines.
- **Large ponds and dams** – Ponds and dams greater than 100 megalitres capacity.

Table 7-1 Ecological constraints matrix

Constraint category	Prohibited activities	Permitted activities	Ecological Sensitivity Class
No-go area	Petroleum activities are prohibited in this area.	NIL	Nature Reserves, National Parks, Aboriginal Areas
Surface development exclusion area	Linear infrastructure Non-linear infrastructure Large ponds and dams	Support for planning	State Conservation Areas
High constraint area	Large ponds and dams	Support for planning Linear infrastructure Non-Linear Infrastructure	High Moderate-High Note: ecological disturbance limits and siting of infrastructure process apply. Disturbance to high ecological sensitivity class limited to 0.5% of total class area.
Moderate constraint area	Large ponds and dams	Support for planning Linear infrastructure Non-linear infrastructure	Low-moderate Moderate Note: ecological disturbance limits and 'siting of infrastructure' process apply
Low constraint area	No prohibited activities.	Support for planning Linear infrastructure Non-linear infrastructure Large ponds and dams	Low ecological sensitivity Note: ecological disturbance limits apply where relevant

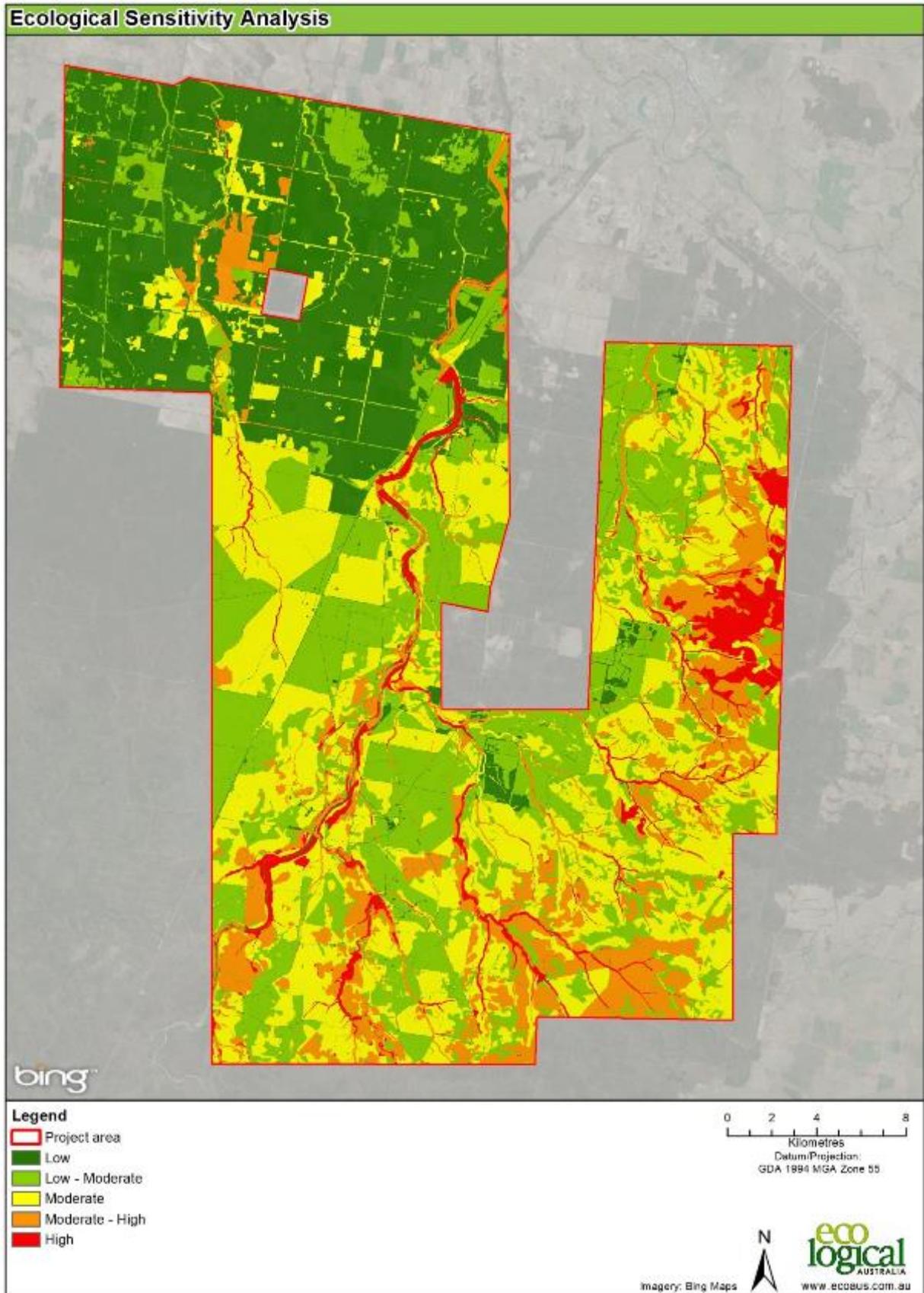


Figure 7-1 Ecological sensitivity class

8. Ecological constraints - disturbance limits

The project application seeks approval for the estimated total maximum disturbance on vegetation communities and habitat. The development planning and execution, in accordance with the Protocol, maintains the project under these defined limits.

Discussion of the calculation methodologies employed, calculated disturbances and accounting for these limits are described in the sections below. This calculation has been achieved through two key methodologies:

1. a probabilistic methodology for defined ecological communities using a range of development scenarios; and
2. association modelling for specific flora and fauna species.

8.1 Probabilistic calculation of disturbance

A probabilistic calculation of disturbance was completed. The methodology involved the use of a theoretical framework and probabilistic methodology to estimate the maximum vegetation community and habitat disturbance associated with the project. The calculations provided a robust, clear and repeatable methodology for the assessment carried out in the EIS. Maximising avoidance of the high ecological class was incorporated in the calculations.

A detailed discussion of the probabilistic calculation methodology is provided in the document Probabilistic Estimation Methodology for Calculation of Land Disturbance (EHS Support, 2015).

8.2 Disturbance limits

The disturbance limits, direct impacts, are the maximum amount of each native vegetation community or threatened flora that is proposed to be cleared for the project. Direct impacts considered for this assessment are vegetation removal, habitat removal and removal of threatened flora individuals.

The impact assessment took a conservative approach and assumes the disturbance limit for each vegetation community will be reached, representing a 'worst case' impact.

Approval is being sought for a maximum of 988.8 ha of new disturbance of native vegetation including derived native grassland.

The maximum disturbance of each vegetation community has been assessed by plant community types (Table 8-1). The maximum disturbance is displayed as both hectares removed, and also a percentage of the plant community type to be removed in the study area.

8.3 Ecological impact assessment

A comprehensive impact assessment which considered the terrestrial ecological values of the project area was undertaken as part of the EIS.

The impact assessment used multiple data sources including existing mapping layers and Light Detection and Ranging datasets which were supported by extensive targeted field surveys and mapping to develop a robust baseline dataset.

A series of technical reports were produced as part of the terrestrial ecological assessment which provide a detailed description of the assessment methodologies and findings, including:

- NGP - Vegetation Mapping. Eco Logical Australia, 2015
- NGP - Pilliga Mouse Survey. Eco Logical Australia, 2015
- NGP - Pilliga Mouse Habitat Assessment. Eco Logical Australia 2015
- Koala Refuges in the Pilliga Forests. Niche Environment and Heritage, 2014
- NGP - Ecological Sensitivity Analysis. Eco Logical Australia, 2015
- NGP - Ecological Impact Assessment. Eco Logical Australia, 2015
- North-east Pilliga Forest - Threatened Flora Modelling. Eco Logical Australia, 2015
- Probabilistic Estimation Methodology for Calculation of Land Disturbance. EHS Support, 2015.

Table 8-1 Disturbance limits vegetation communities and habitat

Plant Community Type	Fauna habitat type	Condition class	Total in project area (ha)	Estimated disturbance (ha)	Percent impact
27 - Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions	Grassy woodland	Native Vegetation	36.0	0.1	0.28%
27 - Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions	Grassland	DNG	173.3	0.5	0.29%
35 - Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	Grassland	DNG	4,228.5	37.2	0.88%
35 - Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	Closed forest	Native Vegetation	2,468.0	19.3	0.78%
55 - Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Grassland	DNG	322.9	1.7	0.53%
55 - Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Closed forest	Native Vegetation	362.5	3.9	1.08%
78 - River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions	Riparian woodland	Native Vegetation	10.5	0.0	0.00%
88 - Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	Grassland	DNG	1,526.9	8.8	0.58%
88 - Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	Shrub grass woodland	Native Vegetation	4,456.4	40.8	0.92%
141 - Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	Heath	Native Vegetation	1,035.6	19.5	1.88%
202 - Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South-western Slopes Bioregion	Grassland	DNG	1.4	0.0	0.00%
202 - Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South-western Slopes Bioregion	Grassy woodland	Native Vegetation	588.9	5.9	1.00%
256 - Green Mallee tall mallee woodland rises in the Pilliga - Goonoo regions, southern BBS Bioregion	Shrubby woodland	Native Vegetation	20.3	0.3	1.48%
379 - Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the BBS Bioregion	Heathy woodland	Native Vegetation	103.6	2.7	2.61%
397 - Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, BBS Bioregion	Grassland	DNG	446.3	1.3	0.29%

Plant Community Type	Fauna habitat type	Condition class	Total in project area (ha)	Estimated disturbance (ha)	Percent impact
397 - Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, BBS Bioregion	Shrub grass woodland	Native Vegetation	326.7	1.0	0.31%
398 - Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion	Grassland	DNG	494.9	3.9	0.79%
398 - Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion	Shrub grass woodland	Native Vegetation	23,492.0	323.4	1.38%
399 - Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, BBS Bioregion	Grassland	DNG	47.1	0.2	0.42%
399 - Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, BBS Bioregion	Riparian woodland	Native Vegetation	1,048.0	3.4	0.32%
401 - Rough-barked Apple - red gum - cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region	Grassland	DNG	1,641.2	18.1	1.10%
401 - Rough-barked Apple - red gum - cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region	Riparian woodland	Native Vegetation	5,954.9	46.4	0.78%
402 - Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, BBS Bioregion	Grassy woodland	Native Vegetation	177.7	1.6	0.90%
402 - Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, BBS Bioregion	Grassland	DNG	189.7	1.6	0.84%
404 - Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	Shrubby woodland	Native Vegetation	9,993.9	86.6	0.87%
405 - White Bloodwood - Red Ironbark - cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	Heathy woodland	Native Vegetation	6,652.1	108.7	1.63%
406 - White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland/open forest mainly in east Pilliga forests	Heathy woodland	Native Vegetation	3,239.2	69.0	2.13%
408 - Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland of the Pilliga forests and surrounding region	Grassland	DNG	103.5	0.4	0.39%
408 - Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland of the Pilliga forests and surrounding region	Heathy woodland	Native Vegetation	3,084.8	33.3	1.08%
418 - White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion	Shrub grass woodland	Native Vegetation	66.2	0.2	0.30%

Plant Community Type	Fauna habitat type	Condition class	Total in project area (ha)	Estimated disturbance (ha)	Percent impact
418 - White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion	Grassland	DNG	69.6	0.3	0.43%
425 - Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion	Heath	Native Vegetation	366.7	8.4	2.29%
428 - Carbeen - White Cypress Pine - Curracabah - White Box tall woodland on sand in the Narrabri - Warialda region of the Brigalow Belt South Bioregion	Riparian woodland	Native Vegetation	15.0	0.0	0.00%
40X - White Bloodwood – Dirty Gum – Rough Barked Apple heathy open woodland on deep sand in the Pilliga forests	Grassland	DNG	239.5	1.9	0.79%
40X - White Bloodwood – Dirty Gum – Rough Barked Apple heathy open woodland on deep sand in the Pilliga forests	Heathy woodland	Native Vegetation	7,534.9	138.4	1.84%
			80,518.6	988.8	1.23%

Table 8-2 Disturbance limits Pilliga mouse habitat

Pilliga Mouse Habitat Type	Total in project area (ha)	Estimated direct impact (ha)	Percent impact
Primary	9,082	135	1.49%
Secondary	15,172	182	1.20%
Dispersal	68,147	889	1.30%

Table 8-3 Disturbance limits threatened flora

Species	Study area			Direct and indirect impact			Proportion		
	Estimated mean abundance	Lower 95% CI	Upper 95% CI	Impact (number of individuals)	Lower 95% CI	Upper 95% CI	Impact (%)	Lower 95% CI	Upper 95% CI
<i>Bertya opposens</i>	964,321	868,123	1,060,519	10,309	N/A	N/A	1.07%	N/A	N/A
<i>Diuris tricolor</i>	3,357	1,746	6,453	52	27	100	1.55%	1.55%	1.55%
<i>Lepidium aschersonii</i> #	208	N/A	N/A	3	N/A	N/A	1.55%	N/A	N/A
<i>Lepidium monoplocoides</i> #	258	N/A	N/A	4	N/A	N/A	1.55%	N/A	N/A
<i>Myriophyllum implicatum</i>	1	N/A	N/A	0	N/A	N/A	0	N/A	N/A
<i>Polygala linariifolia</i>	16,340	8,198	28,134	252	127	435	1.54%	1.55%	1.55%
<i>Pomaderris queenslandica</i>	45,528	44,212	46,843	467	N/A	N/A	1.03%	N/A	N/A
<i>Pterostylis cobarensis</i>	432,465	339,437	550,802	6,658	5,220	8,477	1.54%	1.54%	1.54%
<i>Rulingia procumbens</i>	240,605	90,924	858,781	3,716	1,404	13,265	1.54%	1.54%	1.54%
<i>Tylophora linearis</i>	33,200	25,775	43,772	513	398	676	1.55%	1.54%	1.54%

Impacts to these species will be proportional to the total population identified in the study area. Impacts will be capped at 1.55% of the total population in the study area. Should surveys increase the known abundance of these species during the project, then the number of impacted individuals can increase but must stay below 1.55% of the total population.

9. Cultural heritage constraints

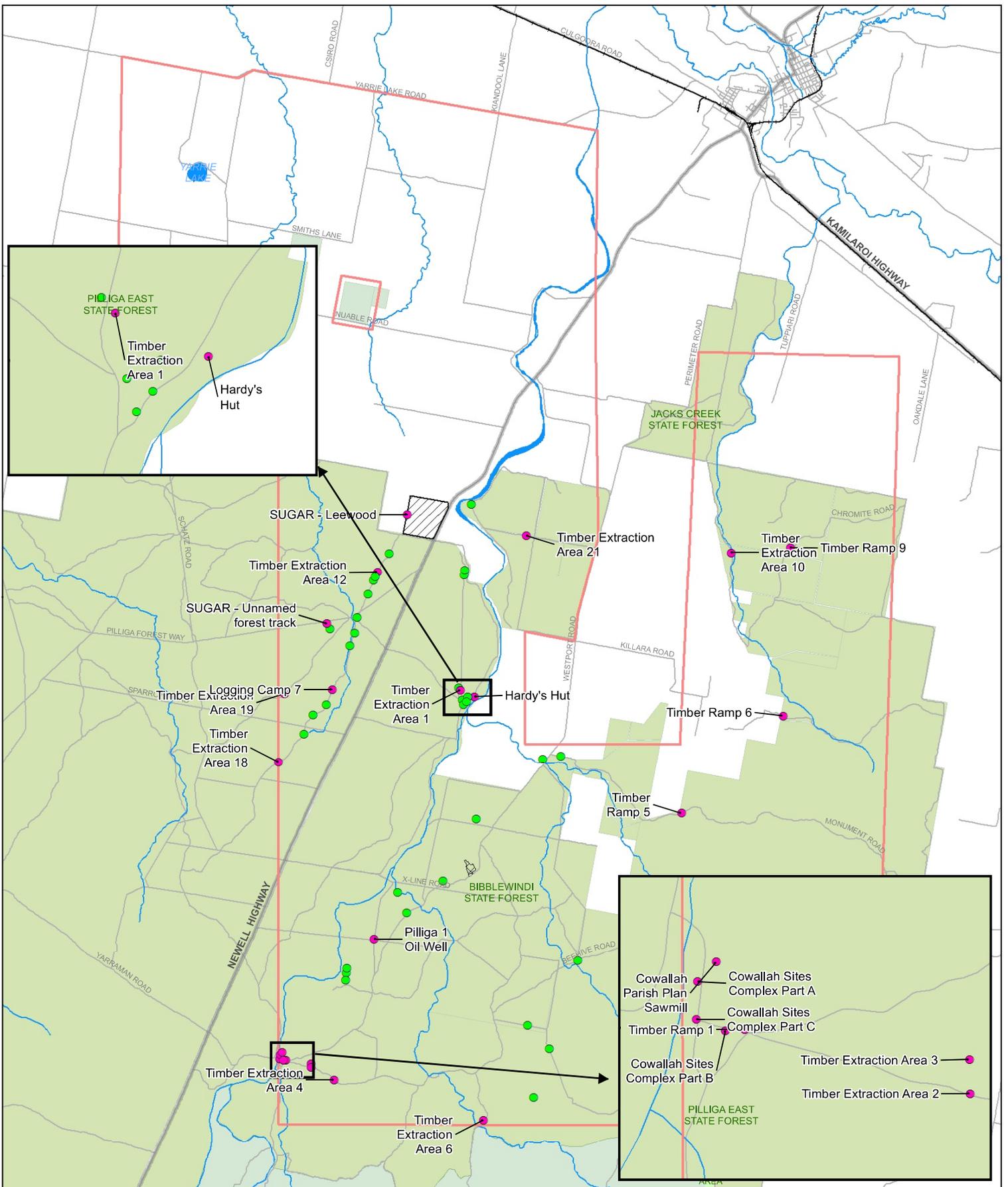
9.1 Aboriginal cultural heritage

In accordance with the Aboriginal Cultural Heritage Assessment Report, Narrabri Gas Project (CQCHM 2015) Appendix N1 of the EIS, and the CHMP Appendix N2, Santos has committed to avoiding all currently known Aboriginal sites and objects, as detailed in Figure 9-1. Sites known at the time of EIS submission will be a surface development exclusion zone. Santos has also committed to avoidance strategies by site type as detailed in the CHMP.

In advance of petroleum activities as part of the field micro-siting process, cultural heritage pre-clearance surveys will be undertaken with representatives of the Aboriginal community accordance with the CHMP.

REMOVED FOLLOWING REQUEST MADE
DURING CONSULTATION PROCESS WITH
REGISTERED ABORIGINAL PARTIES

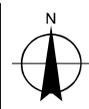
Figure 9-1 Aboriginal cultural heritage sites



- LEGEND**
- Project area
 - Lakes and dams
 - Leewood
 - Watercourses
 - Bibblewindi
 - Roads
 - Parks and reserves
 - Train line
 - State forest
 - Historic heritage site
 - Historic heritage site (surface development exclusion zone)
 - Aboriginal areas

0 1 2 4 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55



Narrabri Gas Project
Environmental Impact Statement

Job Number 21-22463
Revision A
Date 27 Jul 2016

Historic heritage constraints

Figure 9-2

9.2 Historic heritage

Within the project area 53 potential historic heritage sites have been identified, primarily associated with past logging activities. The sites can be characterised into seven types:

- Sawmill sites
- Habitation sites
- Timber extraction areas
- Timber loading ramps
- Logging tracks
- Sydney University Giant Air-shower Recorder (SUGAR) pits
- Other sundry sites.

Further information on each of the sites can be found in Historic Heritage Impact Assessment Appendix O of the EIS.

The majority of sites were found to be of local significance as part of a collection, referred to as the Pilliga East Logging Cultural Landscape, that can demonstrate the pattern and course of the development of logging in the forests. In order to preserve the Pilliga East Logging Cultural Landscape, the following sites are surface development exclusion areas:

- Cowallah Parish Plan Sawmill;
- Logging Camp 7;
- Cowallah Sites Complex; and
- Hardy's Hut.

Due to the similarities of the timber extraction areas and logging ramps across the project area, if impacts are unavoidable at a site listed below, another site of the same type may be substituted as a surface development exclusion area without impacting the heritage significance:

- Timber extraction areas 1, 2, 3, 4, 6, 10, 12, 18, 19 and 21; and
- Timber loading ramp 1, 5, 6, 9 and ramp associated with timber extraction area 19.

The following sites are also identified as surface development exclusion areas based on their heritage significance:

- Pilliga 1 Oil Well; and
- SUGAR pits - located at the Leewood site and the intersection of Plumb Road and No Name Road.

The locations of the historic heritage surface development exclusion areas are shown in Figure 9-2.

Impacts to other identified sites would be effectively mitigated through implementation of the measures outlined in the HHMP, including the establishment of a GIS layer showing the location of identified heritage items and photographic archival recording where required.

Support for planning activities (e.g. monitoring air, noise, water, ecology etc.) that do not result in disturbance to the surface of the site may be undertaken without impacting the heritage significance.

Potential historic heritage sites that are identified during site surveying or micro-siting will be managed in accordance with an unexpected finds procedure provided in the HHMP. This will include adding the location of the site to the GIS layers, creation of an inventory sheet recording the features and components of the site and protocols and criteria for determining mitigation measures required.

10. Additional Constraints

10.1 Nature reserves, national parks and Aboriginal areas

Petroleum activities are not permissible within the following National Parks and Wildlife Act reserve categories, Nature Reserves, National Parks and Aboriginal Areas.

Brigalow Park Nature Reserve has been excluded from the project area and no petroleum activities will occur in this area.

10.2 State Conservation Areas

The Brigalow State Conservation Area is located within the project area. The Brigalow State Conservation Area is gazetted to a depth of 100 m.

It is a designated surface development exclusion zone (including a buffer of at least 50 m) for the project. No surface infrastructure will be located within the State Conservation Area. Wells drilled under Brigalow State Conservation Area from outside of the buffer must be at least 110 m deep under the State Conservation Area.

10.3 Occupied residences

Unless a written agreement is in place with the relevant landholder, no project infrastructure will be located within 200 m of an occupied residence on that property.

10.4 Yarrie Lake

Surface infrastructure will be excluded from Yarrie Lake and a buffer of at least 200 m around Yarrie Lake.

10.5 Constraints for noise

Noise impacts during construction and operation are considered a constraint for the project.

The noise constraints associated with the construction and operational periods of the project are summarised in Table 10-1 and will apply at occupied residences unless a written agreement is in place with the landholder. These levels will be measured in accordance with the Industrial Noise Policy (2000). Santos will manage noise through a range of avoidance, mitigation and management methods as outlined in the EIS.

Table 10-1 Project related noise constraints at occupied residence

Time period		Construction noise (where written agreement is not in place)	Operational noise (where written agreement is not in place)
Day	7 a.m. to 6 p.m. Monday to Friday and 8 a.m. to 1 p.m. Saturday	see Note 1	35 dB(A) LAeq(15min)
	7 a.m. to 8 a.m. and 1 p.m. to 6 p.m. Saturday, 8 a.m. to 6 p.m. Sunday and public holidays	35 dB(A) LAeq(15min)	35 dB(A) LAeq(15min)
Evening	6 p.m. to 10 p.m.	35 dB(A) LAeq(15min)	35 dB(A) LAeq(15min)
Night	10 p.m. to 7 a.m. Monday to Saturday and 10 p.m. to 8 a.m. Sunday and public holidays	35 dB(A) LAeq(15min) 45 dB(A) LAmax	35 dB(A) LAeq(15min) 45 dB(A) LAmax

Note 1: For construction between the hours of 7 a.m. and 6 p.m. Monday to Friday and 8 am to 1 pm Saturday, 40 dB(A) (or background plus 10 dB(A)) is the noise management level where feasible and reasonable work practices would be implemented. Potentially impacted occupied residences will be informed of the nature of the works, duration of works and a method of contact to raise any complaints.

10.6 Nuisance constraints for air emissions

Based on the size and specifications for construction and operational infrastructure (including but not limited to generators at well pads), the potential air emissions from these sources are insufficient to exceed applicable air emission limits. Details of potential air emission sources are described in Appendix L of the EIS. On this basis, no constraints are proposed for air emissions.

10.7 Biophysical strategic agricultural land

No biophysical strategic agricultural land is located within the project area. A site verification certificate acknowledging the absence of biophysical strategic agricultural land in the project area was issued by the NSW Department of Planning and the Environment on 1 December 2015 (refer to Appendix I2). On this basis, no constraints are proposed.

10.8 Watercourses

Watercourses in the project area have been mapped at a scale of 1:15,000. Stream order was assigned to each watercourse in accordance with the Strahler (1952) system. To account for the need to include channel widths as part of the total riparian corridor width, top of bank was digitized for watercourses with larger channels that could be identified at a scale of 1:15 000 (including all 5th and 6th order watercourses). For all other watercourses, an average channel width was applied based on their stream order. Average channel widths for 1st to 4th order streams were determined by identifying the average channel width for 10% of the watercourses within each of these classes. The average channel width was identified by measuring (in the GIS) the width of the top of bank (where visible in the high-resolution contour data) at a few locations along each reach. The average widths for 10% of each stream order class were then combined and a mean determined for each class.

Riparian corridors were determined in accordance with the riparian corridor widths detailed in Table 10-2, and shown in Figure 10-1, consistent with the NSW Guidelines for riparian corridors on waterfront land (NSW Office of Water 2012). Non-linear infrastructure and large ponds and dams will be excluded from these buffers.

Table 10-2 Riparian corridor widths

Strahler Order	Riparian corridor width
1st order	20 m plus channel width
2nd order	40 m plus channel width
3rd order	60 m plus channel width
4th order and greater	80 m plus channel width

10.9 Flooding and geomorphology

Flood analysis over the project area has been carried out for a one per cent Annual Exceedance Probability (AEP), Figure 10-2 shows the maximum flood levels for a one percent AEP flood event in the project area. A detailed discussion of the hydrology and flood assessments is contained within Appendix H of the EIS.

Large ponds and dams will be located outside of the one percent AEP to ensure long term protection of these assets and to minimise impact from the project on surface flow during large flood events.

All other infrastructure and activities located in accordance with the Protocol will be designed and installed to ensure that where they occur within the one percent AEP, there will be negligible modification of flows and necessary sediment and erosion controls will be implemented, and no ongoing impacts to geomorphology. Activities within the one percent AEP will be planned and constructed in accordance with the commitments and mitigations in Appendix H of the EIS, and the ESCP.

10.10 Production well pads spaced at least 750 m apart

Production well pads would be spaced at least 750 metres apart, depending on surface geography, coal physical and chemical properties, environmental constraints, land access arrangements and subsurface characteristics.



Figure 10-1 Mapped riparian corridors

10.11 Approval of the Field Development Protocol

The Protocol will be submitted for the approval of the Minister Planning and Environment, as part of the approval framework under State Significant Development application SSD 14-6456.

During the 25 years of the project the Protocol will be reviewed following completion of third party audits. If changes to the Protocol are proposed, it will be submitted to the Secretary of the NSW Department of Planning and Environment for approval.

10.12 Publication and notification

The Protocol and associated plans approved by the Commonwealth and State Government will be published on a website within 30 days of approval.

11. Acronyms

Acronym	Definition
AEP	Annual Exceedance Probability
CHMP	Cultural Heritage Management Plan
dB(A)	decibel
EHSMS	Environment, Health and Safety Management System
EIS	Narrabri Gas Project Environmental Impact Statement (GHD 2016a)
EPBC Act	<i>Environmental Protection and Biodiversity Conservation Act 1999</i>
ESA	Ecological Sensitivity Analysis
ESCP	Erosion and Sediment Control Plan
ha	Hectares
HHMP	Historic Heritage Management Plan
NGP	Narrabri Gas Project
NSW	New South Wales
SSD	State Significant Development
The Protocol	The Narrabri Gas Project Field Development Protocol

12. Definitions

Associated infrastructure	Including but not limited to access roads, waste management areas, laydown and storage areas, etc.
Conditions	These conditions attached to the approval of the project
Dam	Used to store treated water or bore water
Disturbance of native vegetation	The area directly impacted by the clearing, cutting down or felling of native vegetation, not including areas that have been partially rehabilitated by the project.
Environmental Impact Statement (EIS)	The process used to assess the predicted benefits and impacts of the project, and identify appropriate management and mitigation measures.
Environmental Management Plan (EMP)	Site or project specific plan that sets out a management framework for environmental issue management, monitoring programs and preparing statutory reports.
Irrigation area	Where produced water is applied for beneficial reuse, including but not limited to the use of centre pivots.
Linear infrastructure	Infrastructure including (but not limited to) gas and water gathering lines, low and medium pressure gas and water pipelines/water trunk lines, access tracks, power lines, communication lines and other service lines
Listed	Those species, ecological communities or other identified matters of environmental significance listed for protection under Part 3 of the EPBC Act or relevant State legislation
Large ponds and dams	Ponds and large dams greater than 100 megalitres capacity
MNES	Matters of national environmental significance, being the relevant matters protected under Part 3 of the EPBC Act
Non-linear infrastructure	Infrastructure including (but not limited to) exploration and production wells, field compressor stations, dams, ponds, communications towers, water tanks/balance tanks, flares, camps and construction/maintenance yards (if needed), irrigation areas (and associated infrastructure) and maintenance facilities
Petroleum Activities	All activities in the project other than support for planning (monitoring)
Ponds/balance tanks	Designed for produced water and brine, as well as treated water. Ponds will include double liners and leak detection and leak return systems.
Stakeholders	Individuals and organisations with an interest in or adversely effected by proposed projects and activities including relevant governments (local, state and national), NGOs (conservation, catchment management groups) Aboriginal peoples and representative groups, landholders and other interested parties.
Support for planning	Monitoring including air quality, noise, water including groundwater, ecological surveys, pests and weeds and cultural heritage surveys
Gathering lines	Pipelines used to transfer gas and water from well sites.
Water trunklines	Pipelines used to transfer water between any or all of the following: storage ponds, balance tanks and water treatment plants or to transfer water to a discharge point or an irrigation area.

13. References

- CQCHM (2015). *Aboriginal Cultural Heritage Assessment Report, Narrabri Gas Project.*
- Niche Environment and Heritage (2014). *Koala Refuges in the Pilliga Forest.*
- Eco Logical Australia (2015). *Narrabri Gas Project Targeted Pilliga Mouse Habitat Assessment.*
- Eco Logical Australia (2015). *Santos Ltd NGP EIS Appendix J - Ecological Impact Assessment.*
- Eco Logical Australia (2015). *NGP Ecological Sensitivity Analysis.*
- Eco Logical Australia (2015). Santos Ltd NGP EIS Appendix V - Rehabilitation Strategy*
- Eco Logical Australia (2015). *NGP Targeted Pilliga Mouse Survey.*
- Eco Logical Australia (2015). *NGP Vegetation Mapping.*
- EHS Support. (2015). *Probabilistic Estimation Methodology for Calculation of Land Disturbance.*
- GHD (2016a) - *Santos Ltd NGP - Environmental Impact Statement.*
- GHD (2016b). *Santos Ltd NGP EIS Appendix H - Hydrology and Geomorphology.*
- NSW Office of Water (NoW) 2012. *Guidelines for riparian corridors on waterfront land.* NSW Government.
- Strahler, A. N. (1952). Dynamic basis of geomorphology. *Geological Society of America Bulletin*, 63, 923-938.

