

Appendix I3

Contaminated land assessment





Santos Ltd

Narrabri Gas Project - Environmental Impact Statement Contaminated Land Assessment

July 2016

Executive summary

Project overview

The Proponent is proposing to develop natural gas from the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri. The Narrabri Gas Project seeks to develop gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a rural property located (the Leewood property). The gas would then be piped via a high-pressure gas transmission pipeline to market. The gas transmission pipeline would be part of a separate approvals process and is therefore not part of this proposal.

The objective of this Contaminated Land Assessment is to document, in so far as it is possible based on available information, potential sources of contamination associated with historical and current land use operations within the project area. To achieve this objective, GHD completed a desk top review of available information and conducted a site inspection of accessible areas to evaluate potential areas of concern which may have impact on the proposed gas field development.

Environmental setting

The project area is located in the central portion of the Gunnedah Basin. The soil landscape is dominated by sandy soils associated with undifferentiated alluvium and deeper weathered sandstone. The Australian Soil Resource Information System was used to determine the risk of encountering acid sulphate soils. The Australian Soil Resource Information System categorised the project area as either 'extremely low probability' or a 'low probability' of acid sulphate soils occurring.

There are a number of river systems with associated tributaries located in the project area. Yarrie Lake is the only major water body observed within the site boundary in the north east corner of the project area. However, a number of small, agricultural dams were also observed during the field assessment.

The shallow water bearing zones of the project areas have been identified (CH₂M HILL 2013) as between 16 - 20 metres below ground level (mbgl) in sandstone, poorly cemented fine grained sand and between 29-34 mbgl in sandstone, coarse grained sand with gravelly clay.

Proposed infrastructure

The key components of the project can be broadly grouped into two categories, gas field and major facilities.

Key elements of the gas field includes the installation of up to 850 individual new wells on a maximum of 425 well pads, including new exploration, appraisals and production wells, the installation of water and gas gathering lines and supporting infrastructure, the construction of some new access tracks where required, operation of existing and new wells and development of supporting infrastructure including the use of existing infrastructure where appropriate The exact locations of the gas field infrastructure will be determined following exploration and appraisal activities.

Key elements of the major facilities include the Bibblewindi site, Bibblewindi to Leewood infrastructure corridor, a gas processing and central water management facility at the Leewood property, underground power line between Leewood and Wilga Park and supporting infrastructure including expansion of workers' accommodation at Westport. The proposed major facilities are likely to primarily consist of shallow excavation works over a number of areas (building platforms) and along corridors to develop a services network across the project area. Building foundations may also need to be established for a number of new buildings across the site. However, it is proposed that the majority of surface infrastructure will be constructed on concrete hardstands. The project will utilise or upgrade existing infrastructure where possible.

Historical land use

The project area comprises either forested areas or cleared agricultural land. Historical aerial photographs were reviewed as part of this assessment. The majority of the project area has experienced little change since 1956/1961. No significant development or major infrastructure changes were noted. The extent of natural bushland was observed to decrease from 1994 onwards. The decrease in natural bushland was accompanied by the development of small residential buildings and dams, as land clearing for agriculture was undertaken.

Previous environmental incidents

In October 2011, a complaint was lodged with the NSW Government about impacts occurring to approximately 1.2 ha of the Pilliga State Forest due to Eastern Star Gas (ESG) activities during 2011. ESG was later acquired by Santos in November 2011. The complaint concerned the release of approximately 10,000 litres of untreated coal seam gas water Bibblewindi Pond 3 in June 2011.

A soil investigation of the affected area was undertaken by Golder Associates in February 2012 to assess the extent of the impacts from the incident. The soil investigation determined that the average concentration of metals, hydrocarbons, pH, nutrients and salts in samples collected from the affected area were generally greater than (or in some cases equal to) concentrations in background samples. Soil testing results did not represent health or ecological risk, with the exception of salts.

In March 2013 Santos notified NSW EPA following receipts of results from routine groundwater sampling around Bibblewindi Pond 3. The impacts of the water release were generally found to decrease with depth. Requirements for remediation from the incident are covered under EPL 20350 held by Santos.

The Tintsfield ponds facility is located near to the Wilga Park Power Station. The power station is situated approximately ten kilometres south west of the township of Narrabri. In May 2013 Santos reported that routine water quality monitoring of the groundwater surrounding the Tintsfield Water Management Facility (the site) had shown elevated levels of dissolved metals in bores around the site.

Investigation by the NSW Environment Protection Authority (NSW EPA 2014) found that most of the elevated metals, including uranium, occurred naturally in soils at the site. The investigation did not identify factors indicating risk to private bores. A Clean Up Notice was issued on the 29 July 2014 which required Santos to empty Tintsfield pond 2 and provide a report to the EPA on the volume transferred.

Around 44.5 megalitres of produced water was removed from Pond 2 in September 2014 and inspections of the pond by a third party determined that the liner, welds and seams were intact The EPA subsequently amended the EPL in August 2015 to include a Pollution Studies and Reduction program that required further groundwater data and a summary of changes to be provided, together with a report on whether additional groundwater monitoring piezometers are required. This report was prepared and submitted in September 2015.

The EPA subsequently amended the EPL in August 2015 to include a Pollution Studies and Reduction program (PRP) that required further groundwater data and a summary of changes to be provided, together with a report on whether additional groundwater monitoring piezometers are required. This report was prepared and submitted in September 2015 and included additional data on the standing water levels at the Tintsfield site. The data provided in the report indicates the presence of groundwater mounding at the site. In response the EPA requested additional monitoring data which was provided in November 2015.

These subsequent groundwater investigations, including the additional nested monitoring bore installation, have identified that a persistent groundwater mound is centred around a recharge zone several hundred metres east (hydraulically up gradient) from the Tintsfield ponds.

The EPA has concurred with these findings and is satisfied that the requirements of the PRP have been met and the PRP has been removed from the licence.

Monitoring at the additional installed nested monitoring bore will continue to be required under the EPL.

Site inspection observations

GHD completed a visual inspection of the project area via accessible public roads, including Pilliga East State Forest, Jacks Creek State Forest and Bibblewindi State Forest. Site observations were categorised based on land use. Sources of potential contamination associated with each land use included:

- State Forest Relatively small areas of tree logging were observed. Evidence of illegal dumping, including car bodies and empty corroded 44 gallon drums was noted within the forest areas.
- Commercial areas The primary commercial site observed within the project area was the Cargill Processing facility Soapstock Disposal Site. A search of the NSW EPA contaminated land database identified a revoked notice. The notice had been issued to Cargill Processing under section 35 of the Environmentally Hazardous Chemicals Act 1985 for the burial of vegetable oil wastes (soap stock) where surface water had entered the disposal pits and displaced vegetable oil wastes off site. During the site inspection, liquid was noted to be present within the presumed disposal pits and the areas were surrounded by dry crusty matter. A relatively strong, pungent odour was noted.
- Highways Stockpiles of soil and road base gravels were observed at various locations along the Newell Highway. No control measures were in place around the stockpile areas. Empty steel drums were also observed at various locations along the highway. The former contents of the drums were not confirmed but based on localised staining and residue on the drums, it appeared some drums had previously contained oil. A large formed quarry pit was noted during the site inspection off Westport Road and excavated spoil was in the process of being taken offsite. Illegal dumping of fibre cement sheeting, possibly containing asbestos, was observed close to the north-eastern project boundary.
- Agricultural land A number of agricultural properties exist within the project area, included cropping and grazing land. Access to private agricultural properties was not obtained as part of the inspection process. However, general farming equipment and associated storage areas were observed. Based on the land uses, fuel and chemical storage are likely to be present, while there is potential for current or historic cattle dips.
- Rural residential Access to private properties was not obtained during this site inspection. In addition to the homestead buildings, farming machinery is likely to be present on those sites.

Risk ranking and conclusions

The risk ranking is based on the potential for existing, known contamination as identified in an area potentially posing constraints on the proposed development (i.e. it does not consider potential future incidents). That is, it is a contaminated land baseline.

Five risk ratings were developed as part of this process (very low, low, moderate, high or very high). Risk ratings were assigned based on the likelihood of the risk occurring (defined on a scale from remote change of occurrence to almost certain) and the consequence of that risk (defined on a scale defined by Santos of negligible to critical impact on human health and the surrounding environment). The outcomes of the risk ranking process are summarised below.

Proposed location	Area	Potential contamination issue	Risk ranking
Gas field	Tintsfield Pond	Historical Pollution study and reduction program	Low
	Jacks Creek State Forest	Illegal dumping including potential asbestos containing materials	Low
	Private land	Pesticide residue on agricultural land	Low
		Soil stockpiles and debris / dumping	Low
		Maintenance of farm equipment, chemical and fuel storage	Low
		Cargill Processing facility Soapstock Disposal Site ponds	Low
Major facilities	Bibblewindi	Historical pollution incident	Low
(Bibblewindi)	produced water ponds	Historical Pollution study and reduction program	
Across project area	Pilliga – general	Illegal dumping	Low
	Newell Highway / Infrastructure Corridor	Illegal dumping	Low

Overall, the findings of the desk based review and site inspection indicate a low level of risk associated with potential areas of contamination or potentially contaminating activities across the project area. These risk rankings are based on the agreed consequence criteria as defined by Santos.

Potentially contaminating activities identified within the project area are considered to be low risk and can be managed as part of the infrastructure development. Flexibility in the location of gas field infrastructure in particular would enable the avoidance of existing land contamination or sources of potential land contamination.

An unexpected finds protocol should be prepared as part of the environmental management strategy (EMS) for the proposed development activities associated with the Narrabri Gas Project. The protocol should include procedures for the identification and management of contamination during the project.

Given the nature and likely extent of potential contamination risks which may be present within the project area, and the ability to manage those risks in accordance with standard protocols, the presence of potential contamination issues within the project area is not considered to pose a significant constraint to the placement of project infrastructure.

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Appendix A – Regulatory searches

1. Introduction

1.1 Overview

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri (refer Figure 1-1).

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 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 to be made available to the NSW gas market and to support the energy security needs of NSW. Production of natural gas from coal seams under the project would deliver 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 traditional 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.

1.2 Description of the 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 1-1 and are shown on Figure 1-1.

Table 1-1 Key project components

Component	Infrastructure or activity
Major facilities	
Leewood	• a central gas processing facility for the compression, dehydration and treatment of gas
	 a central water management facility including storage and treatment of produced water and brine
	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	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	 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	 installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor
Gas field	
Gas exploration,	seismic geophysical survey
appraisal and	• installation of up to 850 new wells on a maximum of 425 well pads
infrastructure	 new well types would include exploration, appraisal and production wells
	 includes well pad surface infrastructure
	 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

Component	Infrastructure or activity
Ancillary	 upgrades to intersections on the Newell Highway expansion of worker accommodation at Westport a treated water pipeline and diffuser from Leewood to Bohena Creek 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 2018, with first gas scheduled for 2019/2020. Progressive construction of the gas processing and water management facilities would take around three years and would be undertaken between approximately early/mid-2018 and early/mid-2021. 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.

1.3 **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) (see Figure 1-1).

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 project area contains a portion of the 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.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purpose of 'forestry, recreation and mineral extraction, with a strategic aim to "provide for exploration, mining, petroleum production and extractive industry" under the *Brigalow and Nandewar Community Conservation Area Act 2005.* The parts of the project area on state land are located within this section of the Pilliga.

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.

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 surface exclusion zone.



C3Users/WFoddy/Desktop/21_2248_KBM29.mvd [KBM: 235] @2015, While very care has been taken to propage this map, QHD, sands and NSW LPMA make no representations or warranties about its accuracy, reliability, completeness or waitcheff for any particular purpose and cannot accept lability of any kind (white in any were and cannot accept lability of any kind (white in any were and cannot accept lability of any kind (white in any were and cannot accept lability of any were and for any reason.) Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Sandos: Operational and Base Data - 2013, Created by: adody 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 established the absence of BSAL. This has been confirmed by the issuance of a BSAL Certificate for the project area by the NSW Government.

1.4 Planning framework and structure of this report

1.4.1 Planning Framework

The project is permissible with development consent under the *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*, and is identified as 'State significant development' under section 89C(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *State Environmental Planning Policy (State and Regional Development) 2011*.

The project is subject to the assessment and approval provisions of Division 4.1 of Part 4 of the EP&A Act. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

The project is also a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The project was declared to be a controlled action on 5 December 2014, to be assessed under the bilateral agreement between the Commonwealth and NSW Governments, and triggering the following controlling provisions:

- listed threatened species and ecological communities
- a water resource, in relation to coal seam gas development and large coal mining development
- Commonwealth land.

This Contaminated Land Assessment identifies the potential environmental issues associated with construction and operation of the project and addresses the Secretary's environmental assessment requirements for the project. The assessment will be used to support the EIS for the project.

1.4.2 Structure of report

The report is structured as follows:

- **Chapter 1 Introduction.** This chapter introduces the proposed development and the proponent and describes the project area.
- **Chapter 2 Methodology**. This chapter defines the study area assessed in this report and describes the steps undertaken in the assessment.
- **Chapter 3 Legislative context**. This chapter outlines the relevant Commonwealth and State legislation relating to the assessment.
- **Chapter 4 Existing environment**. This chapter describes the existing environmental values of the study area relevant to contaminated land assessment including results of the desktop assessment.
- **Chapter 5 Regulatory searches**. This chapter includes the result of desktop regulatory searches.

- **Chapter 6 Field assessment**. This chapter describes the observations made during the field assessment relevant to contaminated land.
- **Chapter 7 Impact assessment** This chapter examines the potential activities of environmental concern relevant contaminated lands.
- **Chapter 8 Conclusion and recommendations**. This chapter presents a conclusion to the report and presents recommendations in relation to contaminated land management.

2. Methodology

2.1 Objective of report

The objectives of this Contaminated Land Assessment are:

- to document (insofar as it is possible based on available information) the project area history and current operations to enable identification of potential contaminant sources
- prepare a constraints map indicating areas of higher potential for contamination, where management measures may be required during construction
- produce a stand-alone technical report documenting the outcomes of the assessment, including the potential for the project area to be subject to soil and / or groundwater contamination.

2.2 Scope of work

GHD undertook the following scope of work in order to meet the stated objectives:

- a review and interpretation of existing background information pertaining to the project area, including a review of the following sources of information:
 - relevant existing reports and documentation
 - historical aerial photographs
 - NSW EPA Contaminated Sites Register record of notices
 - NSW EPA Protection of the Environment Operations (POEO) Licence register
 - media releases and EPA reports
 - NSW Department of Water and Energy water information (regional bore information)
 - hydrogeological, geological and topographical maps depicting the project area
- a field assessment of readily accessible parts of the site to observe the following:
 - site activities including current land uses involving the potential for contaminating activities
 - visual and olfactory indications of contamination.
- a review of surrounding land uses adjacent to the project footprint
- preparation of this Contaminated Land Assessment report detailing the results of the assessment.

2.3 Study area

For the purpose of this study and for ease of reporting, the project area shown in Figure 1-1 was divided into sections according to the land owner (Government / Private / Santos). Table 2-1 outlines the land owner categories. These categories are closely related to land use which is shown in Figure 2-1.

Table 2-1 Land owner categories

Owner		Description
Government Pilliga East State Forest, Jacks Creek State Forest, Bibblewindi State Forest		 Land use within the gas field is dominated by State Forest. Approximately 70 per cent of the project is forest and includes the Pilliga East, Bibblewindi and Jacks Creek State Forests. Pilliga East State Forest: State forests are managed by the Forestry Corporation of NSW and are used for the harvest of timber. Currently only the Pilliga East State Forest is being harvested for timber within the gas field. The Pilliga East State Forest is also used for recreational purposes such as bush walking, bird watching and hunting. Jacks Creek State Forest: Used primarily for recreational purposes such as bush walking, bird watching, bird watching and hunting. Bibblewindi State Forest: Used primarily for recreational purposes such as bush walking, bird watching and hunting. With approval from the Forestry Corporation of NSW, it is noted that forestry land can also be potentially used for other land uses included beekeeping, commercial firewood harvesting, community firewood harvesting, harvesting of broombush and harvesting of timber fencing. Native forest and crown reserve areas occupy approximately 10 per cent of the project area. Such areas include the Brigalow State Conservation Area which is located in the north of the gas field. No
Private	Industrial \ Commercial	Commercial and/or industrial premises or land uses including mining, quarrying and other extractive industries.
	Agricultural	Land used primarily for gazing and cropping. Approximately 30 per cent of the project area is occupied by land used for grazing and cropping purposes. Agricultural land uses within the gas field consist of dryland cropping, livestock grazing (mainly beef cattle and sheep) and limited timber and honey production.
	Rural Residential	Land that contains a residential dwelling and is not less than two hectares in area and does not exceed 40 hectares in area (depicted as urban areas on Figure 2-1).
Santos		The Leewood property is owned by Santos. Leewood has been designated for infrastructure associated with the project. Major components of the project including the gas processing facility, water management facility and power plant would be situated on Leewood. The construction of the project is considered to be consistent with the existing use of the Leewood property (which is for water management under the current Santos exploration program).



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2.4 Risk ranking

Given the size of the project area, a method of prioritising specific areas was required to assist in identifying areas where contamination may potentially pose a potential constraint to the proposed development.

The risk ranking is based on the potential for existing contamination to pose constraints on the proposed development during construction. It does not consider the risk of future incidents occurring. That is, it is a contaminated land baseline report.

Potential contamination sources were assessed using a variety of factors, which included the following:

- potential source of the contamination
- the nature of the potential or known contamination (for example. hydrocarbon contamination from fuel storage)
- the toxicity of the potential contaminants, (high, moderate and low)
- the magnitude of the contamination. For example, one site may have a very high potential to have caused contamination, the extent of which is likely to be limited. As such, it may be less likely to impact a proposed development. The media in which the contamination potentially may occur (i.e. soil, groundwater, gas and sediment) is also considered in this section. The potential magnitude is assessed as: localised, moderate or widespread.
- does the identified risk represent potential constraints to the proposed development?

Risk ratings (Table 2-4) were assigned based on the likelihood of the risk occurring and the consequence of that risk:

- Likelihood is categorised on a scale from almost certain (once per year or greater) to remote (once per one thousand years).
- Consequence criteria range on a scale from 'negligible' to 'critical'; defined as a function of the size of the impact, the spatial area affected, the expected recovery time of the environment, and community and financial factors.

Likelihood criteria are defined in Table 2-2. Consequence criteria are defined in Table 2-3.

Likelihood level	Description
Almost certain Common	Will occur, or is of a continuous nature, or the likelihood is unknown. There is likely to be an event at least once a year or greater (up to ten times per year). It often occurs in similar environments. The event is expected to occur in most circumstances or is known to have occurred.
Likely Has occurred in recent history	There is likely to be an event on average every one to five years. Likely to have been a similar incident occurring in similar environments. The event will probably occur in most circumstances.
Possible Could happen, has occurred in the past, but not common	The event could occur. There is likely to be an event on average every five to twenty years.
Unlikely Not likely or uncommon	The event could occur but is not expected. A rare occurrence (once per one hundred years.
Remote Rare or practically impossible	The event may occur only in exceptional circumstances. Very rare occurrence (once per one thousand years). Unlikely that it has occurred elsewhere; if it has occurred, it is regarded as extremely unique.

Table 2-2 Likelihood criteria

Table 2-3 Consequence criteria

Consequence category	Description
Critical Severe, widespread long-term effect	Destruction of sensitive environmental features or immediate risk to human health. Severe impact on ecosystem. Environmental impacts are irreversible and /or widespread. Regulatory and high-level government intervention/action. Community outrage expected. Prosecution likely. Financial loss in excess of \$100 million.
Major Wider spread, moderate to long- term effect	Long-term impact of regional significance on sensitive environmental features (e.g. wetlands) or longer term risk to human health. Likely to result in regulatory intervention/action. Environmental harm either temporary or permanent, requiring immediate attention / remediation. Community outrage possible. Prosecution possible. Financial loss from \$50 million to \$100 million.
Moderate Localised, short-term to moderate effect	Short-term impact on sensitive environmental features or longer term human health. Triggers regulatory investigation. Significant changes that require remediation. Repeated public concern. Financial loss from \$5 million to \$50 million.
Minor Localised short-term effect	Impact of fauna, flora and /or habitat but no negative effects on ecosystem. Easily rehabilitated. Requires immediate regulator notification. Financial loss from \$500,000 to \$5 million.
Negligible Minimal impact or no lasting effect	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Negligible impact to human health. Impacts are local, temporary and reversible with management. Incident reporting according to routine protocols. Financial losses up to \$500,000.

Table 2-4 Risk matrix

Consequence	Likelihood				
	Almost certain	Likely	Possible	Unlikely	Remote
Critical	Very High	Very High	High	High	Medium
Major	Very High	High	High	Medium	Medium
Moderate	High	Medium	Medium	Medium	Low
Minor	Medium	Medium	Low	Low	Very Low
Negligible	Medium	Low	Low	Very Low	Very Low

It should be noted that if an area scores low or very low, this does not necessarily infer that no contamination issues exist in this area. A risk ranking of low or very low is intended to reflect that no significant contamination sources have been identified during the Contamination Land Assessment which has the potential to pose major constraints to the proposed development. The outcomes of the risk ranking process are presented in Section 2.4.

3. Legislative context

3.1 Relevant guidelines

The framework for this assessment has been developed in accordance with guidelines made or approved by the NSW EPA under *Section 105* of the *Contaminated Land Management Act, 1997*. The guidelines include:

- National Environment Protection Council (NEPC) 1999 (amended 2013), National Environment Protection (Assessment of Site Contamination) Measure (NEPM).
- NSW Office of Environment & Heritage (OEH) 2011, Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites.
- NSW EPA (2015), Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997.
- NSW DEC 2006, Contaminated Sites: Guidelines for NSW Site Auditor Scheme (2nd Edition).
- NSW EPA 2014 Waste Classification Guidelines Part 1: Classifying Waste 1.

3.2 Secretary' requirements

In addition to the framework outlined in Section 3.1, this report has been prepared with reference to the Secretary's Environmental Assessment Requirements (SEARs) for the project and the supporting letters. It is noted that the assessment of contaminated land is not listed as a general requirement under the SEARs however it is noted in the NSW EPA supporting letter.

In their letter dated 17 April 2014, the EPA stated that the EIS should provide baseline conditions and assessment of potential impacts with respect to contamination. Table 3-1 provides a summary of the specific details requested by the EPA, and how this report addresses those requirements.

Table 3-1 EPA requirements

EPA requirement	GHD comment
Provide details on site history – if earthworks are proposed, this needs to be considered with regards to possible soil contamination, for example if the site was previously a landfill site or if irrigation of effluent has occurred.	A summary of historical land use across the project area based on aerial photograph review is presented in Section 6.2 of this report
Provide details that are needed to describe the existing situation in terms of soil types and properties and soil contamination	Environmental setting of the project area is described in Section 5 of this report
 Identify the likely impacts resulting from the construction or operation of the proposal, including the likelihood of: Disturbing any existing contaminated soil Contamination of soil by operation of the activity Subsidence or instability Soil erosion Disturbing acid sulphate or potential acid sulphate soils 	A more detailed description of soil types and properties, including assessment of likely impacts associated with soil erosion and acid sulphate soils during the construction or operational phase of the project, is addressed in the geology, soil and contamination chapter within the EIS.
Reference should be made to relevant guidelines	As outlined in Section 3.1 of this report

¹ The Waste Classification Guidelines provide threshold levels for the assessment and appropriate waste classification and subsequent disposal of waste materials. This process is addressed in the Waste Chapter within the EIS.

4. Existing environment

4.1 Environmental setting

The project area is located within the Narrabri LGA. Land use in the Narrabri LGA is dominated by agriculture (54.7 per cent). Other land uses comprise rural residential development (18.7 per cent), native vegetation (14.6 per cent), irrigated plants consisting predominantly of cotton (11.1 per cent), intensive animal husbandry (0.2 per cent) and extractive industries (0.1 per cent) (Edge Land Planning, 2009).

4.2 Geology

The project area is located in the central portion of the Gunnedah Basin where Jurassic and Cretaceous Surat Basin sediments overlie Permo-Triassic Gunnedah Basin sediments.

The surface geology of the project can be generally described as unconsolidated or poorly consolidated regolith material covering bedrock, with outcropping bedrock in some areas (Raymond *et al.* 2012).

The underlying geology in the northern half of the project area is made up of aged alluvial sediment deposited by rivers and streams in the Quaternary period. This geology is common in the region of the project area, given the presence of expansive floodplains. Deposits of clay, laterite, calcrete and magnesite are known to intersperse the sediment deposits.

The underlying geology in the southern half of the project area is made up of Quaternary period sediments, like the northern half, with the addition of Jurassic period quartz, pebbly sandstone, claystone and a minor conglomerate known as the Pilliga Sandstone. The Pilliga Sandstone was formed from the deposition of rivers and streams in the Jurassic period.

4.3 Soils

The project area is dominated by sandy soils associated with undifferentiated alluvium and deeper weathered sandstone. The project area is situated within outcropping Pilliga Sandstone recharge zones of the Great Artesian Basin. Due to the sandy soils and subsequent high infiltration rates, precipitation would infiltrate the soil and then into the underlying sediments. Most stream sediment within the landscape is derived from Pilliga Sandstone plateaus, or as a result of reworking of the broad outwash plain.

Australian Soils Classification mapping identify much of the area as being dominated by Sodosols, with some occurrence of Rudosols/Tenosols. Sodosols are typical of those derived from the Pilliga Sandstone and are described as being highly siliceous with poor soil nutrient status and low Plant Available Water Capacity (NSW OEH 2012a). Additional soils information is available in Appendices I1 and K of this EIS.

The Australian Soil Resource Information System was used to determine the risk of encountering acid sulphate soils. Australian Soil Resource Information System indicated that the site area exhibits either 'extremely low probability' or a 'low probability' of acid sulphate soils occurring.

4.4 Hydrology

There are a number of river systems with associated tributaries located in the project area. Some of the more significant systems are:

- Bohena Creek (tributaries: Bibblewindi Creek, Sandy creek, Killen Creek, Sawpit Creek, Mount Pleasant Creek, Cowallah Creek, Box Flat Creek, Duck Creek, Yellow Spring Creek, Borah Creek, and Yaminba Creek)
- Jacks Creek, Pine Creek and Tuppiari Creek
- Cowallah Creek
- Bundock Creek
- Mollee Creek.

Yarrie Lake is the only major water body observed within the site boundary, being in the northwest corner of the project area. However, a number of small, agricultural dams were also observed during the field assessment.

4.5 Hydrogeology

Groundwater resources in the study area are highly developed within the areas occupied by the alluvial sediments of the Narrabri, Gunnedah and Cubbaroo formations. Extraction occurs primarily from the alluvial aquifers associated with the main rivers and their major tributaries, although a large number of smaller scale extractions also occur from the consolidated (porous) and fractured rock aquifers.

The 1:2,000,000 Groundwater in New South Wales, Assessment of Pollution Risk Map indicates that the site is likely to comprise of three groundwater classifications in terms of pollution risk. The classifications are as follows:

- South and west regions of project area: Sandstone in the Great Artesian Basin. The map notes that the area has high potential for groundwater movement and is likely to have a groundwater salinity of 0-1 000 mg/L. Accordingly, it is suitable for all stock, domestic and some irrigation purposes.
- North and west region of project area: Alluvial and other unconsolidated deposits. The map indicates the area has medium potential for groundwater movement and groundwater salinity is likely to be between 3 000 to 7 000 mg/L. The area is suitable for stock water and is suitable for dairy cattle, beef cattle, horses and sheep.
- East region of project area Sandstone in the other sedimentary basins with a low potential for groundwater movement. The map indicates that groundwater salinity is likely to be salinity of 1 000 to 3 000 mg/L. It is therefore suitable for all stock.

The water bearing zones of the project areas have been identified (CH₂M Hill 2013) as being between 16 and 20 metres below ground level (mbgl) in sandstone, poorly cemented fine grained sand and between 29-34 mbgl in sandstone, coarse grained sand with gravelly clay.

5. Regulatory searches

5.1 Local Council LEP

The majority of the project area is located in areas zoned as either RU1 (Primary Production) or RU3 (Forestry) under the Narrabri Local Environment Plan (LEP), 2012. Land use across the project area is identified on

Figure 2-1. As discussed in Table 2-1 (Section 2), land use within the project area is dominated by forest, which accounts for approximately 70 per cent of land.

Land designated as RU3 (Forestry) includes the Pilliga East State Forest, Bibblewindi State Forest and Jacks Creek State Forest. The state forests are designated Crown Lands under the *Forestry Act 1916*.

The Narrabri LEP does not refer to contaminated sites or requirements for development of contaminated sites.

5.2 Aerial photographic review

A selection of current and historical aerial photographs was examined in order to ascertain past land uses in and immediately surrounding the site. The area crossed an aerial survey boundary, resulting in a lack of consistent photography throughout a year. Subsequently, the years examined were 1956-1961, 1980-1983, 1994, 2009 and 2014 (current).

A summary of the information gained from the review of historical aerial photography is provided in Table 5-1. The site was divided into the following three approximate areas for ease of discussion:

- Northern portion comprised of the top third of the site up to Dog Proof Fence Road (Narrabri Aerial Photographs)
- Mid region comprised the middle third between the above and McFarlanes Road
- Southern portion the most southern third of the site (Baan Baa photographs).

Years	Observations
1956-1961	North: The northern section of the project area appeared to be predominantly cleared land with minor roads. Bundock Creek and Bohena Creek appeared to be the main surface water features.
	Mid: The area appeared to be predominantly undeveloped and densely vegetated land with some minor roads. Bundock Creek and Bohena Creek appeared to be the main surface water features.
	South: The southern portion of the project area appeared to be undeveloped and densely vegetated land with minor roads. Bundock Creek and Bohena Creek were found to be the main surface water features.

Table 5-1 Aerial Photography

Years	Observations
1980-1983	North: The northern section of the project area appeared to have undergone minor changes since 1956.
	The project area appeared to consist of agricultural farm land, intersected by a series of minor dirt roads. There were very few structures in the area. However, a number of dams were observed as small surface water bodies.
	Vegetation was observed to be extremely sparse, except around surface water such as Mollee Creek. Bohena Creek was found to have a large area of vegetation between it and the Newell Highway (west of creek). East of Jacks Creek State Forest (including Jacks Creek and Oakdale Lane) appeared to be vegetated on both sides, leading to a dense vegetation band, east of the Newell highway up to the Mitchel Highway.
	North of Dog Proof Fence Road appeared to be cleared, agricultural land, up until the intersection with the Newell Highway. The Leewood property contains some vegetation; however, no structures were observed.
	Beyond the project boundary, approximately 600 m north of Yarrie Lake Road, the Narrabri Observatory was clearly observed. The town of Narrabri was clearly seen with the Namoi River flowing through its centre. To the east of the eastern site boundary (i.e. between Oakdale Lane and Davis Road, up to Kamilaroi Highway), intensive land use involving land clearing and grading was observed on the boundary of the forested band.
	Mid: The mid portion of the project area appeared to have undergone little change since the 1956 aerial photographs were taken.
	Dense vegetation with small, minor dirt roads was observed south of Jacks Creek State Forrest and up to the eastern site boundary. The same characteristics were also observed south of Dog Proof Fence Road.
	Both the western and eastern portion of the mid-region was found to comprise of dense vegetation. Roads were observed to intersect the vegetation on the western portion. Agricultural land with a small buffer of dense vegetation was evident beyond the eastern site boundary, as noted in the northern section.
	South: The southern portion of the project area appeared to have undergone little change since the 1956 aerial photographs were taken.
	The area now known as Bibblewindi State forest was observed to consist of dense vegetation, as were areas to the east, west and south. A small patch of cleared land was observed on the northern border of the site. The dense vegetation continued to the southern border of the project area and extended further south, on the eastern side of the site. On the western side, south of the Warrumbungle trail, the vegetated area rapidly changed to cleared agricultural land.
1994	North: The north-west and northern portion of the project area appeared to remain predominantly cleared agricultural farm land. In addition, there were some isolated developments of agricultural infrastructure, including unsealed roads.
	The north-eastern section of the project area appeared to remain predominantly heavily vegetated land and part of the Jacks Creek State Forest. Developments in agricultural infrastructure and land usage were seen on and nearby the outskirts of the nature reserve. Such infrastructure included buildings, sheds, small surface water bodies (including dams) and unsealed roads.
	To the north-east of the site, the Narrabri town centre has expanded. A moderate increase in residential and commercial buildings is evident, as well as more intensified agricultural use of the surrounding area.
	Mid: The mid region of the project area appeared to have undergone little change since the 1983 aerial photographs were taken. The project area appeared to be predominantly dense vegetation with unsealed roads and more localised areas of cleared land.
	South: The southern portion of the project area appeared to have undergone little change since the 1983 aerial photography was flown. The southern portion of the project area appeared to be predominantly dense vegetation with unsealed roads and more localised areas of cleared land.

Years	Observations
2009 to 2014	North: The north-western and northern sections of the project area appeared to have undergone little change since the 1994 aerial photographs were taken. It appeared that Narrabri had undergone some expansion with the construction of new residential buildings. Some minor developments in commercial and agricultural industries were seen in Narrabri west.
	Mid: The mid portion of the project area appeared to have undergone little change since the 1994 aerial photographs were taken.
	South: The southern portion of the project area appeared to have undergone little change since the 1994 aerial photographs.
2014 (current)	North: The north-western sections of the project area appeared to have undergone little change since the 2009 aerial photographs were taken. The area remained predominantly cleared agricultural farm land. Close to Wee-Waa-Yarrie Lake Road, a number of small dams were observed, as well as a larger body of water. This was assumed to be the Bibblewindi Pond.
	No substantial changes were observed in the north eastern portion of the project area. It remained as heavily vegetated land and part of the Jacks Creek State Forest. Dirt tracks were observed throughout this area with two areas of cleared land close to the northern boundary of the project area.
	Mid: The mid portion of the project area appeared to have undergone little change since the 2009 aerial photographs were taken. The area remained heavily vegetated with scattered dirt roads. A large dam associated with an area of partially cleared land was observed on the western boundary of the eastern portion. Additional areas of cleared land were observed beyond the project area boundary.
	South: The southern portion of the project area appeared to have undergone little change since the 2009 aerial photograph, except four groups of well pads were observed in the middle section of this area.

Key findings of the historical aerial photograph review are summarised as follows:

- the majority of the project area appears to consist of either heavily vegetated areas or cleared agricultural land
- based on the review of historical aerial photographs, the majority of the project area has experienced little change since 1956 / 1961. No significant development or infrastructure development has been noted within the project area footprint
- the extent of natural bushland was observed to decrease from 1994 onwards as land clearing for agriculture was undertaken. The agricultural development was accompanied by the development of small residential buildings and associated dams
- agriculture extended to the areas surrounding the project boundary, with only a small buffer zone of vegetation immediately adjacent to the boundary in the southern section. Some development was observed to occur in the town of Narrabri, beyond the project boundary.

With the exception of localised areas of minor development, infrastructure upgrades and increased agricultural land use practices, the findings of the historical aerial photograph review did not identify significant sources of potential contamination associated with historical land use within the project footprint.

5.3 NSW EPA registers

5.3.1 Contaminated Sites Register

A site will be included on the 'Contaminated Land: Record of Notices' only if the EPA has issued a regulatory notice in relation to the site pursuant to the *Contaminated Land Management Act* 1997 (CLM Act). A search of the register was undertaken on 25 July 2016 by local government area. A copy of the search results is presented in Appendix A.

The search identified one result for Cargill Processing Limited for an incident at the Soapstock Disposal Site located off Westport Road, Narrabri. The notice was revoked in 2008. Whilst the processing facility is located approximately 500 metres outside of the project footprint, the disposal ponds are located within the project boundary.

Details of the former notice are summarised in Table 5-2.

Notice Recipient	Site Description	Details	Status
Cargill Processing Limited Lot 181 in DP 628398, Westport Road, Narrabri, 2390	Soapstock Disposal Site Soapstock often contain high levels of fatty acids which produce high biological oxygen demand and chemical oxygen demand levels. They may also contain heavy metals.	The site was deemed to be contaminated and environmentally degraded due to the disposal of vegetable oil wastes (soapstock) by burial at the site.	Notice revoked in 2008. Remediation works and validation sampling were conducted at site, including excavation of liquid waste, contaminated soil and sediment for land farming. The EPA determined (Oct 2008) there was no reasonable grounds to believe soil contamination presented a significant risk of harm to human health or the environment and no longer required regulation under the CLM Act.

Table 5-2 Summary of CLM Act register information

It is important to note that the abovementioned database is not a comprehensive list of all contaminated sites that may be present in a project area. Other contaminated sites may exist that have not been reported to the EPA.

5.3.2 Protection of the Environment Operations Act 1997 register

Under the provisions of the *Protection of the Environment Operations Act 1997* (the POEO Act), a register of current and surrendered licences is maintained by the NSW EPA. A search of the register was undertaken on 25 July 2016 for environmental incidents under licences issued pursuant to the POEO Act applicable to Santos NSW (Eastern) Pty Ltd. A copy of the search results are presented in Appendix A. Table 5-3 provides a summary of the licences recorded.

Licence Number	Name	Location	Activity Type	Licence Status	Details
20350	Santos NSW (Eastern) Pty Ltd	Narrabri Gas Field, Narrabri (project area)	Petroleum exploration and production	Current – issued 1 May 2014	Two Pollution Studies and Reduction Programs have been required under this licence (further details provided in Table 5-6 of this report)

Table 5-3 Summary of POEO register

Licence Number	Name	Location	Activity Type	Licence Status	Details
20378	Santos NSW (Eastern) Pty Ltd	Santos Narrabri Operations Centre, 300 Yarrie Lake Road, Narrabri	Waste storage - hazardous, restricted solid, liquid, clinical and related waste and asbestos waste Non-thermal treatment of hazardous and other waste	Current - issued 18 September 2014	The premise is located in Lot 24 in DP 1120041

In addition, a search of the POEO register on 25 July 2016 was undertaken for listed sites located within the Narrabri LGA. In addition to the sites listed in Table 5-3, (within the project area), 12 sites were located in the Narrabri LGA with one premise identified within one kilometre of the project site.. The details for the licence are presented in Table 5-4. A copy of the search results are presented in Appendix A.

Licence Number	Applicant	Site Address	Activity Type	Licence Status	Proximity to the site
902	Cargill Processing Limited	Baranbar street, Narrabri West	Agricultural processing and chemical storage facility	Current	Processing facility located 500 metres outside site boundary, disposal ponds located within the project boundary

Table 5-4 Summary of POEO register – Narrabri LGA

5.3.3 Pollution incident and reporting failures, and Pollution Studies and Reduction Programs under POEO Act (EPL 20350)

This section provides an overview of relevant information relating to known pollution incidents Pollution Studies and Reduction Programs within the project footprint. These are:

- Pollution incidents and reporting failures in relation to operations previously owned and operated by Eastern Star Gas (ESG) Bibblewindi Water Treatment Plant (Table 5-5).
- A Pollution Study and Reduction Program in relation to the Bibblewindi Water Treatment Plant (Table 5-6) which has been satisfactorily completed.
- A Pollution Study and Reduction Program in relation to the Tintsfield Water Management Facility (Table 5-7).

Table 5-5 Pollution incidents and reporting failures in relation to operations previously owned and operated by Eastern Star Gas

	Bibblewindi Water Treatment Plant – Eastern Star Gas/Santos, 2011 to 2013
Event	In June 2011 approximately 10,000 L of untreated coal seam gas water was released from the Bibblewindi water treatment plant that was not reported to the regulator. The spill resulted in an area of around 3.4 ha of vegetation die back adjacent to the water treatment plant. After acquiring ESG in November 2011 Santos discovered evidence of the release from the Bibblewindi facility and other reporting failures and notified the regulator.

	Bibblewindi Water Treatment Plant – Eastern Star Gas/Santos, 2011 to 2013
	Santos publicly released a report on incidents at the Bibblewindi Water Treatment Facility in February 2012. The report included the results of soil testing undertaken around the Bibblewindi Water treatment plant. The results did not represent a health or ecological risk with the exception of salts. The salts were responsible for the area of vegetation die back adjacent to the Bibblewindi plant and were present in the soil due to the spill.
Response	In February 2012, Golder Associates (Golder 2012) undertook a soil investigation of the affected area to assess the extent of the impacts from the incident.
	The investigation determined that the average concentration of metals, TPH/TRH, pH, nutrients and salts in soil samples collected from the affected area were generally greater than (or in some cases equal to) concentrations in background samples.
	A detailed report from a review of ESG's operations and facilities was submitted in February 2012. The report included the results of soil testing (carried out by an external analyst) conducted around the Bibblewindi water treatment plant. The report findings were:
	 ESG had released approximately 10,000 L of untreated coal seam gas water from test wells in June 2011. The release was not reported to the regulator at the time. In general, it was found that a number of ESG incidents had not been recorded or had been lost Soil testing results did not represent health or ecological risk, with the exception of salts. The salts were responsible for the area of vegetation die back (i.e. adjacent to the Bibblewindi plant) and were present in the soil due to the spill. The impacted area will be
	In December 2011, after acquiring Eastern Star Gas, Santos temporarily shut down all operations in permits PEL 238 and PAL 2 near Narrabri, including the Bibblewindi water treatment plant BWTP and treated produced water discharge to Bohena Creek. The BWTP was subsequently decommissioned and removed.
	The water stored at the Bibblewindi Water Management Facility was transferred to the Leewood facility in October 2014 and the area affected by the spill is being progressively rehabilitated.
	In July 2012 Eastern Star Gas was issued two penalty infringement notices (PINs) under section 120 of the <i>Protection of Environment Operations Act</i> 1997 for pollution incidents which occurred in the months of March and November 2010 at the Bibblewindi Water Treatment Facility for discharging water containing high levels of salt into Bohena Creek. The EPA also issued a Formal Warning to Santos Limited for a discharge event in December 2011 that contained elevated levels of ammonia. The EPA stated that it did not believe that any environmental harm resulted from this event.
	In June 2013 Santos NSW Pty Ltd was prosecuted under the <i>Petroleum (Onshore) Act 1991</i> for the previous reporting failures during Eastern Star Gas' operations. Santos NSW Pty Ltd entered guilty pleas for Eastern Star Gas' failure to report the spill in June 2011 and for lodging three reports by Eastern Star Gas that contained inaccuracies about the quality of treated water being discharged from the treatment plant. Santos NSW was fined \$52,500.

Table 5-6Pollution study and reduction program – Bibblewindi WaterTreatment Plant 2013

	Bibblewindi Water Treatment Plant – Santos, March 2013		
Event	On 26 March 2013, Santos notified NSW EPA after results from routine groundwater sampling around the Bibblewindi produced water ponds (depicted on Figure 6-1) indicated elevated levels of total dissolved solids and slightly elevated levels of other elements, including heavy metals such as arsenic, barium, strontium and uranium. At the time, Bibblewindi hosted three ponds (Ponds 1 to 3) which were adjoined by the Pilliga East State Forest.		
Response	A number of investigations were undertaken in the vicinity of the ponds, the findings of which are summarised in the <i>Rehabilitation Plan for Pond 3 Groundwater – Bibblewindi NSW</i> (EHS 2014). A conceptual site model was prepared for the site by CH ₂ M Hill (2013) which indicated that a leak from Pond 3 had occurred and the lateral extent of impacts in groundwater was confined to a discreet area immediately adjacent to Pond 3 (EHS 2014). The impacts of the water release were generally found to decrease with depth. The report also found that current site conditions posed no risk to human health and the environment.		
	On 18 February 2014, the NSW EPA released a media statement on the incident which included:		
	 The NSW EPA has issued a \$1,500 fine to Santos following a pollution incident at their Narrabri Gas Field operations in the Pilliga Pond 3 had historically been used to contain the water and brine generated from the gas field. Water quality testing by Santos of the surrounding aquifers showed elevated levels of total dissolved solids, heavy metal and cations and anions outside the average readings for the aquifers in the area Further investigation showed the pond had been installed in 2007 by the site's previous owner, Eastern Star Gas. A report Santos provided to the EPA showed there was no evidence that contractors, engaged by Eastern Star Gas, had carried out the necessary field testing, quality control or quality assurance during 		
	On the 1 May 2014, the EPA issued an Environment Protection License (EPL) for the coal seam gas operations. The EPL included a Pollution Studies and Reduction Program for the Bibblewindi Water Management Facility including the following conditions:		
	 By 30 May 2014 the licensee must provide a report to the EPA that includes the clarification of localised extent, direction and flow rate of the plume of water that has leaked from Pond 3; Identify if any additional groundwater quality monitoring peizometres around the Bibblewindi WMF are required for the purposes of monitoring the quality of the affected groundwater as well as the groundwaters down gradient. Details of contingencies and response plan, including notification procedures, to be implemented if monitoring demonstrates changes to contamination or migration of the plume. 		
	 By 20 July 2014 the licensee must have installed any groundwater monitoring piezometers to enable ongoing quality monitoring of the affected groundwaters. By the 30th of each month until liquids are removed from Pond 3, the licensee must have provided to the EPA a progress report on the works being undertaken to construct 'Leewood' and to decommission Pond 3 		

Bibblewindi Water Treatment Plant – Santos, March 2013
 The following works are required to be undertaken at Pond 3 by the nominated date: By 31 December 2014 all liquid and sludge material is to have been removed from Pond 3 and managed in accordance with the DEC Waste Classification Guidelines as in force from time to time. By 30 April 2015 a report is to be provided to the EPA detailing the future works proposed to be conducted at Pond 3.
Pond 3 was emptied in October 2014 with the water transferred to the Leewood Water Management Facility.
The EPA subsequently advised that the conditions of the PRP for the Bibblewindi Water Management Facility had been satisfactorily completed.

Table 5-7 Pollution study and reduction program- Tintsfield Ponds 2013

	Tintsfield Ponds Integrity – Santos, May 2013			
Event	The Tintsfield ponds facility (location depicted on Figure 6-1) is located adjacent to the Wilga Park Power Station. It comprises of two produced water/brine holding ponds with a capacity of 23 ML (Pond 1) and 92 ML (pond 2), respectively.			
	Water monitoring bores identified elevated salinity and some heavy metals under the two water storage ponds. Slightly elevated concentrations of metals (including uranium) were also detected. Santos reported the findings to the EPA in May 2013 and subsequently minor repairs were made to the lining of Pond 1 in late 2013.			
Response	Investigation by the NSW Environment Protection Authority (NSW EPA 2014) found that most of the elevated metals, including uranium, occurred naturally in soils at the site. The investigation did not identify factors indicating risk to private bores.			
	A Clean Up Notice was issued on 29 July 2014 which required Santos to empty Tintsfield pond 2 and provide a report to the EPA on the volume transferred.			
	44.5ML of produced water was removed from Pond 2 in September 2014 and inspections of the pond by a third party determined that the liner, welds and seams were intact.			
	The EPA subsequently amended the EPL in August 2015 to include a Pollution Studies and Reduction program (PRP) that required further groundwater data and a summary of changes to be provided, together with a report on whether additional groundwater monitoring piezometers are required. This report was prepared and submitted in September 2015 and included additional data on the standing water levels at the Tintsfield site. The data provided in the report indicates the presence of groundwater mounding at the site. In response the EPA requested additional monitoring data which was provided in November 2015.			
	Following the review of the reports and data the EPA included further requirements on the PRP, being: By 29 May 2016 the licensee must have installed an additional nested groundwater monitoring piezometer between MW1 and MW17 and provide the EPA with the geological report and water bearing information collected during bore installation.			
	The nested installation must include shallow and deep bores in formations corresponding to those monitored by existing monitoring bores immediately adjacent to the Tintsfield Ponds. This monitoring piezometer is required to provide background representative water levels and water quality in the shallow and deep aquifers upgradient of the Tintsfield ponds.			
	By 30 June 2016 the licensee must provide a report to the EPA that includes the following:			
	 Updated data collected after June 2015 on standing water levels at the site. 			
	 A summary and discussion of changes (if any) to standing water levels, groundwater quality and inferred groundwater flow at the site. 			

Tintsfield Ponds Integrity – Santos, May 2013

- Any proposed actions that will be taken to address any changes outlined in (b) above.
- An evaluation and explanation on any indicative groundwater mounding occurring at the site.

These subsequent groundwater investigations, including the additional nested monitoring bore installation, have identified that a persistent groundwater mound is centred around a recharge zone several hundred metres east (hydraulically up gradient) from the Tintsfield ponds.

The EPA has concurred with these findings and is satisfied that the requirements of the PRP have been met and the PRP has been removed from the licence.

Monitoring at the additional installed nested monitoring bore will continue to be required under the EPL.

In addition, the EPL was amended to require the implementation of a Liner Integrity Monitoring Program for the Tintsfield Water Management Facility. This involves operating the two Tintsfield ponds in a duty and standby mode, whereby once a pond has been emptied, an annual inspection of the liner is undertaken and a report is to be provided to the EPA regarding the liner's integrity.

6. Field assessment

On 4, 5 and 6 February 2014 a visual inspection of the project area (via accessible public roads) was undertaken. The site inspection included the Pilliga State Forest, Jacks Creek State Forest and Bibblewindi State Forest. As noted in Section 2.1, the project area has been divided into different categories based upon the primary land use and land owner, being:

- state forest
- industrial / commercial areas
- agricultural land use
- rural residential.

An additional area termed "earthworks" has been incorporated as a land use category as a result of the observations made during the site inspection. The key findings for each 'land use type' are presented in the following sections. The approximate locations of photographs taken during the site inspection are denoted on Figure 6-1.

6.1 Pilliga State Forest and Bibblewindi State Forest

A drive by inspection was undertaken for accessible areas of the Pilliga State Forest and Bibblewindi State Forest.

The topography was generally flat with some undulations with also some generally steep and relatively low embankments. Areas of both sparse and dense vegetation were encountered.

Indicators of potential contamination noted within the state forests are summarised as follows:

- relatively small areas of tree clearing was evidenced (refer to Plate 1). The clearing area was potentially associated with flowline installation. Possible minor fuel spills associated with former logging activities were also observed in this area
- soil stockpiles adjacent to well pads were observed (refer to Plate 2). Relatively well established vegetation was noted on the stockpiles, indicating that the stockpiles has not been recently generated
- examples of isolated illegal dumping within the forest area were sighted, including corroded car bodies (refer to Plate 3) and empty and corroded 44 gallon drums (refer to Plate 4).

Photographs of the observations are presented in Table 6-1.



NAU/Sydney/Projects/21/22463/GISMaps/21/

Table 6-1 Photographs - Pilliga State Forest and Bibblewindi State Forest

Photograph Summary – Pilliga State Forest and Bibblewindi State Forest



Plate 1: Minor tree clearance



Plate 2: Sand stockpile



Plate 3: corroded car body

Plate 4: Corroded 44 gallon drums

6.2 Industrial / Commercial area

With the exception of the Soapstock Disposal Site associated with the Cargill Processing facility, no major commercial facilities or industrial sites were inspected within the investigation area.

6.3 Agriculture land use

The main agricultural activity in the project area is livestock grazing (mainly beef cattle and sheep), which occurs on approximately 22 per cent of the project area. Dryland cropping is less extensive and occurs on approximately seven per cent of the project area. There is also a small amount of timber and honey production on agricultural land.

The majority of the project area is classified as Class 4, Class 5 or Class 7, (OEH 2014) meaning it is generally incapable of sustaining cropping without specialist management practices and resources. A relatively small proportion of the project area is classified Class 3 and is therefore capable of sustaining higher productivity land uses, such as cropping.

The relatively low utilisation of land for cropping in the project area is reflected in an analysis by the NSW Office of Environment and Heritage (OEH 2009), which found that 93 per cent of the cleared properties were not cropped between 2000 and 2009.

The project area does not contain biophysical strategic agricultural land under the *State Environmental Planning Policy* (Mining, Petroleum Production and Extractive Industries) 2007 as confirmed through a detailed assessment and soil survey. A Site Verification Certificate acknowledging this was issued by the NSW Office of Environment and Heritage on 1 December 2015.

6.4 Rural residential land use

Around 18.7 per cent of the Narrabri LGA is zoned rural residential. Within the project area, rural residential land use comprises around 2,580 hectares, or around 2.7 per cent.

The rural residential land use areas typically include a residential dwelling and associated buildings, general farming equipment and water tanks. Within the project area, rural residential is defined as small to medium blocks with isolated residential buildings often with pockets of remnant vegetation.

6.5 Earthworks and illegal dumping

In addition to the general land uses described in the previous sections, evidence of earthworks and illegal dumping was observed at various locations from the main highway. Key observations are summarised as follows:

- during the site inspection, a large formed quarry pit was observed (approximately 100 metres long, 50 metres wide and 10 metres deep) being excavated, with spoil being taken offsite (refer to Plate 5)
- fibre cement sheets, possibly containing asbestos, were observed close the north eastern boundary of the project area (refer to Plate 6)
- stockpiles of soil and gravel were observed in a cleared area adjacent to the Newell Highway. The stockpiles comprised of soils and blue metal / road base gravels. The stockpile area was not fenced and no environmental controls were present. No signage was present to indicate the origin of the material (refer to Plate 7)
- stockpiled materials, including clay soil with traces of asphalt/bitumen, were noted adjacent to the Newell Highway. The origin of the material was not confirmed (refer to Plate 8)
- abandoned rubber tyres were noted adjacent to the road (Plate 9).
- empty 20 litre and 205 litre steel drums were noted adjacent to the Newell Highway. At least one 20 litre drum formerly contained what appeared to be engine oil. The former contents of the 205 litre drums are unknown (refer to Plate 10).

Table 6-2 Photographs – Earthworks and illegal dumping

Photograph Summary – Earthworks and illegal dumping



Plate 5: Excavation pit



Plate 6: Fibre cement sheeting



Plate 7: Stockpiled materials



Plate 9: Rubber tyres



Plate 8: Stockpiled material



Plate 10: Abandoned drums

6.6 Summary of field assessment

Based on the site inspection of accessible areas, the primary potential sources of contamination are summarised as follows:

- Pilliga State Forest and Bibblewindi State Forest
 - isolated areas of potential surficial contamination, including illegal dumping of car bodies, fibre cement sheeting and empty drums
- Commercial land use
 - isolated areas of potential surficial contamination, including soil stockpiles
 - localised areas of potential contamination associated with leakage from former chemical / oil storage containers
 - areas of potential large scale surficial (and potentially subsurface) contamination associated with the former Cargill Soapstock Disposal Site (outside the project area)
- Agricultural Area/rural residential land use
 - potential for pesticide residue associated with agricultural use
 - potential for isolated surficial contamination associated with areas of illegal dumping and maintenance and usage of typical farming equipment
 - potential for surficial contamination within associated with storage sheds, silos and maintenance of farm equipment
 - potential for surficial contamination associated with current or historic cattle dips.

7. Impact assessment

7.1 Activities/areas of potential contamination

The findings of the desktop study and field assessment were used to identify the primary areas of potential contamination associated with each of the major land use types within the project area. A summary of activities and areas of potential contamination associated with the gas field and major facilities is provided in Sections 7.1.1 and 7.1.2 respectively.

7.1.1 Gas field

A summary of the activities / areas of potential contamination which may be encountered during development of gas field infrastructure within the project area is provided in Table 7-1.

Land owner	Land use	Potential source of contamination
Government	State Forest areas (Pilliga East, Jacks Creek and Bibblewindi)	- Illegal dumping including observations of potential asbestos cement sheeting (Jacks Creek State Forest)
	Newell Highway	- Illegal dumping (drums, stockpiles, car types)
Private	Industrial / commercial	Soil stockpilesCargill processing facility Soapstock Disposal Site
	Agricultural	 Soil stockpiles Illegal dumping Potential for pesticide residues associated with agricultural use Storage and maintenance of farming equipment Minor chemical and fuel storage Localised historical landfilling activities
	Rural residential	 Storage and home maintenance of farming equipment Minor chemical and fuel storage Domestic waste (septic tanks)
Santos	Commercial	 Tintsfield ponds – Pollution Study and Reduction Program as outlined in Section 5.3 of this report

 Table 7-1 Activities or areas of potential contamination

7.1.2 Major facilities

Potential sources of contamination identified at proposed or existing major facilities within the project area include:

- Bibblewindi produced water ponds a Pollution Study and Reduction Program (as addressed at Section 5.3)
- infrastruture corridor Newell Highway illegal dumping (drums, stockpiles, car tyres)
- infrastructure corridors Pilliga potential for illegal dumping.

7.1.3 Waste

Waste associated with other activities in the vicinity of the project area may also include:

- general domestic waste (including sewage)
- commercial and hazardous wastes (including illegal dumping)
- agricultural waste (including pesticides and herbicides)
- industrial waste (including mineral waste from mining activities).

7.2 Risk ranking

Information gathered during the field assessment and the desktop study was used to assess potential contamination sources.

The risk ranking was undertaken using a matrix approach as outlined in Section 2.4. In completing the risk assessment, the following points were considered:

- the first phase considers the likelihood for contamination (potential or actual) to have occurred at each site (ranked between remote to almost certain)
- the second phase considers the consequences negligible to critical)
- the third phase multiplies the likelihood and consequence to determine the risk ranking.

The results of the risk ranking are summarised in Table 7-2 and depicted on Figure 7-1.

Table 7-2 Risk ranking summary

Proposed location	Area	Potential contamination issue	Risk ranking
Gas field	Tintsfield Pond	Historic Pollution Study and Reduction Program	Low
	Jacks Creek State Forest	Illegal dumping including potential asbestos containing materials	Low
	Private land	Pesticide residue on agricultural land	Low
		Soil stockpiles and debris/dumping	Low
		Maintenance of farm equipment, chemical and fuel storage and landfilling	Low
		Cargill Processing facility Soapstock Disposal Site	Low
Major facilities (Bibblewindi)	Bibblewindi produced water ponds	Historic pollution incident and reporting failure Historic Pollution Study and Reduction Program	Low
Across project area	Pilliga – general	Illegal dumping	Low
	Newell Highway / Infrastructure Corridors	Illegal dumping	Low

7.3 Implications of risk rankings

Overall, the findings of the desk based review and site inspection indicate a low level of risk associated with potential areas of contamination or potentially contaminating activities across the project area. It should be noted that these risk rankings are based on the agreed consequence criteria and indicate that the potentially contaminating activities identified within the project area would not pose a major risk and can be managed as part of the infrastructure development. Flexibility in the location of gas field infrastructure in particular would enable the avoidance of existing land contamination or sources of potential land contamination.

It is noted that the majority of the potentially contaminating activities are associated with land use types and not a specific location (e.g. the potential for asbestos containing materials to be illegally dumped or minor chemical or fuel spills associated with maintenance of farming machinery). As such, an unexpected finds protocol should be prepared to manage the risks associated with potential sources of contamination which may be encountered during the development of infrastructure.

The unexpected finds protocol should be included in the environmental management plan for the proposed development activities associated with the Narrabri Gas Project. The unexpected finds protocol should include procedures for the identification and management of contamination during further activities. The protocol should include, but not necessarily be limited to:

- notification procedures in the event that unexpected areas of contamination are encountered
- procedures for identification of the extent of the contamination
- sampling and analytical requirements, including reference to relevant guidelines and procedures
- training requirements for site personnel.



NAU/Sydney/Projects/21/22463/GIS/WareV21/22463/KBM2_mxd [KBM:14] (© 2016). White very case has been taken to propose this map, CHD. Samos and NSVL PMA make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and response/libry of any kind (whether in contrast, int or contentine) for any expresse factors and/control including infinite or consequential damage) which are or may be incurred by any party as a result of the map being necurate, necomplete or unsuitable in any way and for any reason. Data sources: NSW Department of Lands: DTDB and CODB - 2012-13. Senior: Operational and Base Data - 2013. Created by ritchardson The unexpected finds protocol should be included in the environmental management plan for the proposed development activities associated with the Narrabri Gas Project. The unexpected finds protocol should include procedures for the identification and management of contamination during further activities. The protocol should include, but not necessarily be limited to:

- notification procedures in the event that unexpected areas of contamination are encountered
- procedures for identification of the extent of the contamination
- sampling and analytical requirements, including reference to relevant guidelines and procedures
- training requirements for site personnel.

8. Conclusion and recommendations

Santos is proposing to develop natural gas from coal seams in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri. The primary objective of the Narrabri Gas Project is to commercialise natural gas from coal seams for the East Australian gas market and to support the energy security needs of NSW. As part of the EIS, a Contaminated Land Assessment was completed for the project area.

8.1 Conclusions

Based on the findings of the Contaminated Land Assessment the following conclusions are made:

Gas field

- the historical aerial photographs do not indicate that the project area has been subject to widespread contaminating activities
- the site inspection identified that there is evidence of sporadic illegal dumping within the Pilliga and along the Newell Highway. Of note, was the illegal dumping of fibre cement sheeting (which has the potential to contain asbestos cement sheeting) in Jacks Creek State Forest. There is the potential for small areas of localised contamination associated with illegal dumping events. In the event that illegal dumping or potential asbestos containing materials are identified in an area selected for well construction, the procedures outlined in the Environmental Management Plan should be implemented and the area assessed and managed or remediated as required
- maintenance of farm equipment, and chemical and fuel storage was observed during the site inspection. If evidence of contamination, including staining, odours or fill material is encountered during well construction, the unexpected finds procedures outlined in the Environmental Management Plan should be adopted and the area assessed and managed or remediated as required.

Leewood, Bibblewindi and the infrastructure corridors

- the historical aerial photographs do not indicate that the locations have been subject to widespread contaminating activities
- with the exception of the recorded pollution incident and reporting failures and pollution study and reduction programs that have now been completed the regulatory information did not identify contamination issues that may impact the site
- the site inspection identified sporadic illegal dumping within the Pilliga (where the proposed widening of the infrastructure corridor would occur) and along the Newell Highway.

Overall, the findings of the desk based review and site inspection indicate a low level of risk associated with potential areas of contamination or potentially contaminating activities across the project area. Potentially contaminating activities identified within the project area can be readily avoided and/or managed as part of the infrastructure development. Flexibility in the location of gas field infrastructure in particular would enable the avoidance of existing land contamination or sources of potential land contamination.

8.2 **Recommendations**

Based on the findings of the assessment, an unexpected finds protocol should be prepared as part of the Environmental Management Plan for the Narrabri Gas Project. The protocol should include procedures for the identification and management of contamination during development.

Project Commitment:

If previously unidentified land contamination or sources of potential land contamination are encountered the landholder would be notified and the contamination would be avoided as far as practicable.

9. References

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Appendices

Appendix A – Regulatory searches



Healthy Environment, Healthy Community, Healthy Business

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	relating to 1 site. Search Again Refine Search			
Suburb	Address	Site Name	Notices related to this site	
NARRABRI	Westport ROAD	Cargill Soapstock Disposal Site	2 former	
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Search results

Your search for: POEO Licences with the following criteria

Suburb - narrabri

returned 14 results

Export to	excel 1 c	of 1 Pages			Search Again	
Numbe	rName	Location	Туре	<u>Status</u>	Issued date	
<u>6957</u>	AUSCOTT MARKETING PTY	21154 Kamilaroi Highway, NARRABRI, NSW 2390	POEO licence	Issued	03 Jan 2002	
<u>3778</u>	BORAL RESOURCES (COUNTRY) PTY. LIMITED	WAVE HILL ROAD, NARRABRI, NSW 2390	POEO licence	Issued	22 Oct 1999	
<u>902</u>	CARGILL PROCESSING LIMITED	BARANBAR STREET, NARRABRI WEST, NSW 2390	POEO licence	Issued	25 Aug 2000	
<u>1477</u>	CSR LIMITED	COLGOORA ROAD, NARRABRI, NSW	POEO licence	Surrendere	ed18 Feb 2000	
<u>20236</u>	G & S Lein Earthmoving Pty Ltd	Sandy Creek Lane, NARRABRI, NSW	POEO licence	Issued	15 Jul 2013	
<u>7196</u>	HUNTER AND NEW ENGLAND AREA HEALTH SERVICE	11 CAMERON STREET, NARRABRI, NSW 2390	POEO licence	No longer i force	in 21 Mar 2000	
<u>20139</u>	Johnstone Concrete and Landscape Supplies Pty Ltd	Wavehill Road, NARRABRI, NSW 2390	POEO licence	Issued	22 Aug 2012	Connect
<u>11572</u>	MALCOLM FRANCIS GETT	CULGOORA ROAD, NARRABRI WEST, NSW 2390	POEO licence	Surrendere	ed21 May 2002	
<u>200</u>	NARRABRI SHIRE COUNCIL	NEWELL HIGHWAY, NARRABRI, NSW 2390	POEO licence	Issued	18 Dec 2000	
<u>10697</u>	NARRABRI SHIRE COUNCIL	NAMOI STREET, NARRABRI, NSW 2390	POEO licence	Issued	01 Nov 2001	
<u>11760</u>	NARRABRI SHIRE COUNCIL	Wave Hill Road, NARRABRI, NSW 2390	POEO licence	Surrendere	ed01 Jun 2004	
<u>12193</u>	NARRABRI SHIRE COUNCIL	Yarrie Lake Road, NARRABRI, NSW 2390	POEO licence	Issued	13 Dec 2004	
<u>20350</u>	SANTOS NSW (EASTERN) PTY LTD	X Line Road, NARRABRI, NSW	POEO licence	Issued	01 May 2014	
<u>20378</u>	SANTOS NSW (EASTERN) PTY LTD	300 Yarrie Lake Road, NARRABRI, NSW 2390	POEO licence	Issued	18 Sep 2014	
					25 July 2016	

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Search results

Your search for: General Search with the following criteria

Suburb - NARRABRI Name - Santos

returned 4 results

Export to excel	1 of 1	Pages		Search Again
<u>NumberName</u>		<u>Location</u>	Type Status	Issued date
20350 SANTOS NSW PTY LTD	(EASTERN)	X Line Road, NARRABRI, NSW 2390	POEO licence Issued	01 May 2014
1523754 SANTOS NSW PTY LTD	(EASTERN)	X Line Road, NARRABRI, NSW 2390	s.91 Clean UpIssued Notice	29 Jul 2014
20378 SANTOS NSW PTY LTD	(EASTERN)	300 Yarrie Lake Road, NARRABRI, NSW 2390	POEO licence Issued	18 Sep 2014
1537959 SANTOS NSW PTY LTD	(EASTERN)	X Line Road, NARRABRI, NSW 2390	s.58 Licence Issued Variation	30 Mar 2016
				25 July 2016

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