Narrabri Gas Project

NSW Planning Assessment Commission Field Trip to GLNG
June 2017

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About Santos

- Leading Australian natural gas company
- More than 60 years of responsible gas exploration, development and production across the nation
- Supplying gas to Adelaide since 1969
- Supplying gas to NSW since 1976
- Extracting coal seam gas for approximately 20 years in Queensland
- Employs around 3,000 workers
- Large proportion of Australian shareholders
- Drilled over 4,000 onshore wells across Australia

Santos in New South Wales

- Oil and gas exploration in the area since the mid 1960s
- Coal seam gas exploration licences cover a large area of north west NSW
- Exploration in NSW began in 2008
- Acquired Narrabri operations in November 2011 from ESG
- Field staff based at Narrabri Operations Centre, shopfronts in both Narrabri and Gunnedah
Why do the project?

- NSW imports >95% of its gas needs
- AEMO 2016
  - From 2019, as developed 2P [proved and probable] reserves decline, the delivery of new gas reserves from existing fields, and/or the development of fields that are not yet producing gas, will be critical to maintaining sufficient gas supply to meet forecast demand to 2035.
- Potential to supply up to 50% of the State’s gas needs (200TJ/day) – from certified reserves
- Natural gas delivers ~50% GHG emission saving compared with the emissions intensity of the existing NSW grid.
- Designated as a ‘Strategic Energy Project’

The stakes are high

Restricting coal seam gas development will adversely impact energy supply, affecting all Australians

- Over 5 million homes and businesses use natural gas
- 45% of manufacturing relies on natural gas as its prime energy source
- 21% of the National Electricity Market generation capacity is provided by natural gas power stations
- Insufficient gas supply will:
  - Push carbon emissions higher as electricity generation goes back to coal
  - Threaten competitiveness of manufacturing, risking ~100,000 jobs
  - Adversely impact our standard of living through higher gas prices
The Narrabri Gas Project area is located fully within the Petroleum Exploration Licence (PEL) 238 and Petroleum Assessment Lease (PAL) 2.

- Operations located on around 1,000ha or approx. 1% of 95,000ha project area
- Majority of project area is state forest
- No areas of national park or nature reserve
- No mapped Biophysical Strategic Agricultural Land (BSAL) within project area
- Central gas and water processing facility located outside the Pilliga at the Leewood site
- Up to 200TJ/day of gas would be made available to the NSW market

What is CSG?
How is it obtained?

Releasing pressure off coal releases releases natural gas – chemically CH₄.

Created when coal is forming and is buried. Is released when pressure is released.

Target CSG zones are 200-1,000 metres sub surface.

CSG does not contain ethane or longer chains (no liquid petroleum).

It can contain inert gas (N₂ and CO₂).

Production process is simply dewatering, inert removal and compression.

In Narrabri the coals produce:

- Water that is 1/3 to 1/2 seawater strength – NaCl and NaHCO₃ (≈ recreational water per guidelines)
- Gas which is produced at low pressures and which is an effective and clean-burning energy source.
In CSG development, water handling requires large early investment. Expense of upfront water handling increases the risk to the investor, with ongoing learning after development commences.

Key take aways:

- Not possible to predict precisely how a coal will give up gas until after drilling and depressurisation data is gathered.
- Successive well planning must learn from the immediate past drilling and production history.

Project Facilities

The project includes wells, an underground gathering pipeline network, gas processing and gas compression.

- Up to 850 wells on a maximum of 425 sites.
- Lateral wells with artificial lift.
- Wellhead separation.
- Separate gas and water gathering pipelines.
- Nodal Compression at Bibblewindi.
- Gas & water trunklines connecting Bibblewindi to Leewood.
- Dehydration, CO₂ removal & gas compression.
- Water storage, RO & salt crystallisation, Irrigation.
- Electricity generation.
- Pipeline tying to Moomba-Sydney pipeline will be constructed by APA Group and subject to a separate approval process.
What is the Narrabri Gas Project SSDA and EIS?

The SSDA and EIS for the Narrabri Gas Project submitted to the NSW and Commonwealth Governments for assessment.

- The EIS is required to:
  - Identify all potential impacts of the Narrabri Gas Project
  - Assess those potential impacts
  - Detail plans and procedures to mitigate and manage potential impacts

- The EIS is a comprehensive document which:
  - Contains almost 7,000 pages and 45 technical studies
  - Draws on data from over 13,000 hours of on-ground ecological surveys, water monitoring activities dating back to 2010, over 1400 hours of background noise monitoring and three months of baseline air quality data collection
  - Contains reports, studies and modelling by scientific and environmental experts on areas including water, flora, fauna, soil, noise, air quality, cultural heritage and social impacts
  - Details around 100 commitments which will assist to minimise the impact of the project

- The EIS concluded the risks to the environment are minimal and manageable

Key findings of the EIS

The EIS concluded the Project can proceed safely with minimal and manageable risk to the environment.

- Water available to farmers and the community will be unaffected
- Drilling can be carried out safely adhering to the *NSW Well Integrity Code of Practice*, which was reviewed by the NSW Chief Scientist and Engineer
- Significant impacts on threatened and endangered flora and fauna will be avoided
- Known Aboriginal cultural heritage sites will be protected
- The Project can coexist with current land uses including agriculture and forestry
- Social impacts can be managed
- Substantial economic benefits will be generated including:
  - 1,300 jobs during construction and 200 ongoing positions during operations
  - Around $1.2 billion in royalties to NSW
  - A regional benefit fund of up to $120 million to support local community projects, programs and initiatives
Risks must be managed (and understood)

There are environmental, safety, social and economic risks to be managed in a way which enables investment.

The EIS quantifies objective criteria for max impact project will have on the whole of the environment. For example, despite uncertainty of well locations, EIS states objective criteria that defines the environmental outcomes.

Investors and Treasury (Tax) need objective criteria to assess investment risk. Project approval (if granted) must have conditionality that is objective, quantitative & clear.

To successfully deliver gas to NSW all elements must work together:
- Environmental footprint and economic benefit
- Government, Local Community and investors (ca. $3bn needed!)

EIS – Chapters

The EIS is a comprehensive assessment of the potential impacts of the Project.

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<th>Part C - continued</th>
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<td>14 Soils and land contamination</td>
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<td>16 Aquatic ecology</td>
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<td>17 Property and land use</td>
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The EIS contains detailed reports on a number of key issues prepared by subject matter experts.

A. Environmental Assessment Requirements
B. Referral of proposed action
C. Field Development Protocol
D. Stakeholder & community consultation
E. Drilling waste letter from the EPA
F. Groundwater Impact Assessment
G1. Managed release study (Bohena Creek)
G2. Concept Irrigation Design
G3. Water Monitoring Plan
H. Hydrology and Geomorphology
I1. Interpretive Soils Report
I2. Biophysical Strategic Agricultural Land Site Verification Certificate
I3. Contaminated Land Assessment
J1. Ecological Impact Assessment
J2. Biodiversity Assessment Report
K. Agricultural Impact Assessment
L. Air Quality Impact Assessment
M. Noise and Vibration Assessment
N1. Aboriginal Cultural Heritage Assessment
N2. Cultural Heritage Management Plan
N3. Historic Heritage Impact Assessment
O. Hazard and Risk Assessment
P. Social Impact Assessment
Q. Landscape and Visual Impact Assessment
R. Chemical Risk Assessment
S. Economic Assessment (Cost Benefit analysis)
T1. Economic Assessment (Macroeconomics analysis)
T2. Rehabilitation Strategy
T3. Decommissioning Report

A pipeline will link the project to the Moomba - Sydney pipeline.

- APA is Australia’s largest gas infrastructure business
  - Owns and/or operates 15,000km+ of pipeline infrastructure
  - Transports around half of Australia’s natural gas across all mainland states and territories
- APA will soon submit a preliminary Environmental Assessment to the State, commencing the assessment process under Part 5.1 of the Environmental Planning and Assessment Act 1979
- Following construction, land is returned as close as possible to its previous productivity, with topsoil and natural drainage patterns re-established
- As the pipeline is well (generally 900mm) underground, shallow-rooted vegetation can be re-established across the entire pipeline right of way (e.g. cropping)
- No long term impacts would be expected to land uses that rely on cropping and grazing

The proposed 450km Western Slopes Pipeline will undergo a separate approval process and be constructed and owned by APA Group.
**Project timeline**

<table>
<thead>
<tr>
<th>Exploration</th>
<th>Appraisal and Approvals</th>
<th>Construction</th>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>20+ years</td>
<td>20+ years</td>
<td>2 years</td>
<td>~ 2 years</td>
</tr>
</tbody>
</table>

Where we are now

- Appraisal of resource underway and EIS submitted for assessment

- Approximately 4 years
  - Core holes
  - Seismic
  - Baseline scientific data

- Government assessment
- Appraisal pilots
- Engineering & design
- Final Investment Decision

- Build facilities
- Gas pipeline
- Work camps
- Drilling production wells

- Natural gas production
- Ongoing field development
- Rehabilitation

**Narrabri Gas Project**

The EIS concluded the Project can proceed safely. Risk must be managed and criteria must be objectively quantified in order to be clearly understood.

- Project could supply up to half of NSW’s natural gas needs
- Pilliga - an areas designated for natural gas development.
- 1,300 jobs during construction with and estimated $1.2 billion in royalties to NSW

**OBJECTIVE & CLEAR CRITERIA NEEDED TO MANAGE EITHER OF THESE ASPECTS**
Interest Group Issue:
Queensland operations vs. Narrabri Proposal

What’s in a question?
It depends

For example: How safe is road transport?
### Overview of QLD operations and proposed NSW project

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Queensland operations</th>
<th>Proposed NGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of wells</td>
<td>Surat Cumulative Management Area (CMA) 6,500 currently, 17,900 total proposed.</td>
<td>850 new wells</td>
</tr>
<tr>
<td>Number of wells per pad</td>
<td>Up to 4 on 1.5 hectare pad.</td>
<td>Up to 3 on max. 1 hectare pad</td>
</tr>
<tr>
<td>Production well spacing</td>
<td>Minimum ~780m</td>
<td>Minimum 750m</td>
</tr>
<tr>
<td>Well designs</td>
<td>Vertical and deviated</td>
<td>Vertical, lateral and deviated</td>
</tr>
<tr>
<td>Depth to target coal seams</td>
<td>500-1200m (in some cases ~150m)</td>
<td>500-1200m</td>
</tr>
<tr>
<td>Need for hydraulic fracturing</td>
<td>Yes (historically~10%, future 50-100%)</td>
<td>No</td>
</tr>
<tr>
<td>Landholder water sources</td>
<td>Over 2000 landholder bores access water from same Walloon target coal seams in Surat CMA (75% of affected bores above triggers are in Walloon coals)</td>
<td>Most landholders bores &lt;150m deep, none within target coal seams</td>
</tr>
<tr>
<td>Right to extract groundwater</td>
<td>Statutory right under the petroleum tenure</td>
<td>WAL required from sustainable allocation within LTAAE limit.</td>
</tr>
<tr>
<td>Annual water volumes extracted (GL/year)</td>
<td>Surat Basin CMA total:(OGIA, 2016)</td>
<td>Average 1.5GL</td>
</tr>
<tr>
<td></td>
<td>• Current CSG: 65GL</td>
<td>Peak expected 3.65GL (years 2-4)</td>
</tr>
<tr>
<td></td>
<td>• Current non-CSG: 203GL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Peak expected CSG: 110GL</td>
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</tbody>
</table>

**NOTE:** Information in table is indicative and generalised for purpose of comparison.

### Overview of QLD operations and proposed NSW project

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<th>Aspect</th>
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<th>Proposed NGP</th>
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</thead>
<tbody>
<tr>
<td>Water Management Framework</td>
<td>Baseline assessment, monitoring, recording and‘Make Good’ provision. OGIA has statutory role in CMA’s to coordinate and assigns Make Good requirements to tenure holders.</td>
<td>Baseline assessment, monitoring, recording and ‘Make Good’ provisions in accordance with the Aquifer Interference Policy.</td>
</tr>
<tr>
<td>Water reuse activities undertaken</td>
<td>Irrigation, stock watering, construction, dust suppression, managed release &amp; reinjection.</td>
<td>Irrigation, stock watering, construction, dust suppression and managed release (when existing flows in creek &gt;100ML)</td>
</tr>
<tr>
<td>Underground gas storage</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Field design and infrastructure placement</td>
<td>Surat Basin CMA managed by OGIA. Its 2016 Report found: • Less water extraction than expected • CSG takes &lt;2% of volume extracted for irrigation from Condamine Alluvium • No change from background trends in water pressure of non-target formations</td>
<td>Assessed. 17 other existing and proposed projects considered. Cumulative groundwater effects with Narrabri North Coal Mine dominated by impacts of mine, NGP’s contribution indiscernible</td>
</tr>
</tbody>
</table>

**NOTE:** Information in table is indicative and generalised for purpose of comparison.
Queensland groundwater system

Figure 5-1 Representation of the main groundwater systems in the Surat CMA

SOURCE: HYDROGEOLOGICAL CONCEPTUALISATION REPORT FOR THE SURAT CUMULATIVE MANAGEMENT AREA, OGIA, AUGUST 2016

Narrabri Gas Project groundwater system

Geological cross-section

NOT TO SCALE
<table>
<thead>
<tr>
<th>Narrabri Gas Project</th>
<th>The EIS found water available to farmers and the community will be unaffected</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>› As part of the EIS, a Groundwater Impact Assessment (GIA) was developed to determine what impact the Project would have on local water</td>
</tr>
<tr>
<td></td>
<td>› The GIA incorporated the findings of a regional groundwater model developed by specialist groundwater scientists</td>
</tr>
<tr>
<td></td>
<td>› The model simulated water pressure and included data from more than 100 locations in the Narrabri region</td>
</tr>
<tr>
<td></td>
<td>› The model was peer-reviewed by the CSIRO and described as &quot;state of the art&quot; and suited to assess the potential impacts</td>
</tr>
<tr>
<td></td>
<td>› The GIA found that impacts to the good quality shallow groundwater sources would be negligible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Narrabri Gas Project</th>
<th>Water extraction in context</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>› The water extracted is not the same water source accessed by farmers and the community</td>
</tr>
<tr>
<td></td>
<td>› It is not from the Great Artesian Basin, but from coal seams much deeper, generally 500 - 1,200m underground.</td>
</tr>
<tr>
<td></td>
<td>› Underground rock formations isolate coal seams from the water used by farmers and the community</td>
</tr>
<tr>
<td></td>
<td>› The maximum drawdown from the Project would be less than 0.5m in the Namoi Alluvium and Pilliga Sandstone. Predicted to occur in Pilliga Sst around 350 years after project commencement.</td>
</tr>
<tr>
<td></td>
<td>› Indiscernible from existing variations in groundwater pressures and storage volumes caused by existing uses and replenishment with seasonal fluctuations</td>
</tr>
</tbody>
</table>
Water extraction in context: Long Term Assigned Groundwater rights in Groundwater Resources in the Project Area

- The Government assesses water sources and then sets sustainable extraction limits for them:
  - The Project is predicted to extract an average of 1.5 gigalitres (GL) of water per year
  - 1.5GL per year equates to less than 1% of the sustainable extraction limit of the water source targeted
  - 1.5GL per year is equivalent to the amount of water needed annually to irrigate about 250ha of cotton
  - All of the water extracted will be licensed by the Government, as is the case for any other user

Interest Group Issue: Hydraulic Fracturing
Hydraulic fracturing

Tensile fractures in the rock that open in the direction of least resistance.

Improves hydrocarbon flow by creating fractures in the formation that connect the reservoir and the wellbore.

Used around world since 1949.

Used consistently since early 1980s to enhance oil and gas recovery.

Over 4,400 intervals in ~1,400 (mostly conventional) wells have been hydraulically fractured in SA, Qld and NT by Santos.

Hydraulic fracturing (HF)

Utilised extensively over a long period of oil and gas production

HF are designed and monitored by engineers: In situ stresses control the pressure and direction of fracture initiation and growth, consistent with the laws of physics.

Fluid is pumped into the formation containing oil or gas at high pressure. The pressure of the fluid fractures the layer to produce tiny cracks.

Underground target formations are geologically separated from other underground layers and all wells are surrounded by steel and concrete. This ensures no movement of fluid into aquifers.

Even in the highly unlikely event that there was some connection between fracturing fluid and an aquifer, the CSIRO concludes that the risk of contamination would be minimised because during production water would flow away from the aquifer and towards the well.

CSIRO found potential for groundwater contamination from HF fluids is considered low risk.
Hydraulic fracturing (HF)

The fluid is around 99% water and sand. The sand remains underground to hold open the cracks, whilst the rest of the fluid is pumped back to surface and recovered.

A small amount of chemicals are also used to reduce friction, remove bacteria, dissolve some minerals and improve the transportation of sand. These chemicals are found in many household products such as toothpaste, baked goods, ice cream, food additives, detergents and soap.

Fracture height growth has been extensively measured using micoseismic monitoring in the US and Cooper Basin (SA)
• Average growth of 100m with maximum typically around 300-350m
• NO evidence of fracture growth into shallow aquifers has been recorded

Numerous reputable independent reports and inquiries have found the HF process to be safe and sustainable when accompanied by operational capability, good management processes and a robust regulatory framework.
### Queensland operations: Economic and Community Opportunity

Investment by the Santos-led GLNG project since January 2011:

- $15.4 billion in materials and services Australia wide
- $8 billion in Queensland alone ($1 billion in regional areas)
- 10,000+ people have worked on GLNG, and many more suppliers and businesses have benefitted
- Roma unemployment of 1.9% compared to Queensland’s 6.1%
- $63 million in landowner compensation
- $65 million in regional community projects: aeromedical services, airports, hospitals, schools, housing, training, infrastructure, pest and weed management, community events and organisations
- $140 million in road upgrades and maintenance

### Queensland operations: Landowners and Communities

**Landholder relationships**

- Respect and openness at all times
- Engage early and regularly
- Results to date: ~1450 agreements with ~410 landholders for long-term gas production infrastructure
- Opportunity for landowners to improve their own business

**Community considerations**

- All parties must commit to open and regular communication
- Invest time to educate, answer questions, listen to each other and respond to concerns
- Recognise and prepare for the distinct phases of high-activity construction and long term operation
Queensland operations: Landowners and Communities

Clear and transparent processes to ensure respectful relationships with landholders

- **Landholder engagement process**
  - Rights ownership and management
  - Communication and advice
  - Compensation payments
  - Landholders' rights to continue farming
  - Access arrangements
  - Site access planning
  - Reclaiming and restoral
  - Monitoring
  - Resolving claims
  - Restoring land

**Master Conduct and Compensation Agreement Property, Mine, Rules of Conduct**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>Site will be restored after mining.</td>
</tr>
<tr>
<td>Water</td>
<td>Water management will be undertaken.</td>
</tr>
<tr>
<td>Air</td>
<td>Air emissions will be minimized.</td>
</tr>
<tr>
<td>Noise</td>
<td>Noise levels will be controlled.</td>
</tr>
</tbody>
</table>

Example of our commitment to open and thorough communication: Ready Reckoner guide for landholders

The guide illustrates and explains every possible activity that may take place through exploration, development, production and rehabilitation.
**Narrabri Gas Project:**

**Landholder benefits**

Santos has no shortage of landholders for access

Santos was a primary signatory to the 'NSW Principles of Land Access'.

Currently have sufficient agreements with landholders in the Narrabri area

Land Access Agreements and Farm Management Plans are agreed with landholders covering infrastructure location, conduct and timing of activities, communication, compensation and any property specific requirements.

**Compensation Framework in NSW for production**

Year 1: $30,000 annual service fee + 120% of land value of the area utilised

Year 2 onwards: $30,000 annual service fee + share of Landholder Incentive Fund.

Landholder Incentive Fund = 5% of Santos' annual royalty payment. Each landholder receives a share proportionate to the amount of their land being utilised.

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**Coexistence with other land uses**

Harvest at Tintsfield property, near Narrabri, December 2016
Interest Group Issue: Rehabilitation activities Narrabri

Rehabilitation activities: Narrabri

Rehabilitation of sites impacted by previous operator’s activities is progressing well

Bibblewindi facility:

May 2013

May 2017
Rehabilitation activities: Narrabri

Rehabilitation of sites impacted by previous operator’s activities is progressing well

May 2013

May 2017

In closing.....

Consider any approvals conditions carefully

Risk

Reward
Questions?