BOWEN GAS PROJECT
ENVIRONMENTAL IMPACT STATEMENT
COMMUNITY INFORMATION SESSIONS
MARCH 2013
I acknowledge the Traditional Owners of the land where we gather today and pay my respect to Elders past and present and to emerging community leaders.
ARROW ENERGY
AGENDA

• Arrow Energy overview

• Bowen Gas Project (BGP)
  Environmental Impact Statement (EIS)

• Bowen EIS groundwater study findings

• Questions and answers
WHO IS ARROW?

Arrow Energy

- owned 50/50 by a joint venture partnership of Shell and PetroChina
- Arrow’s head office is in Brisbane, with field operations in Moranbah and Dalby, and an office in Gladstone
- 41,500km² exploration acreage
- approximately 300 exploration wells
- approximately 900 production wells
- gas reserves of 9,500 petajoules
- 1200 staff, 2000+ contractors
- more than 200,000 external stakeholders

Power operations

- owns and operates Braemar 2 power station – 450MW
- supplies about 20% of Queensland’s gas
ARROW ENERGY
WHAT IS CSG AND LNG?

- CSG is naturally occurring gas trapped in underground coal seams, most commonly methane.
- CSG is extracted by drilling into the coal seam and pumping out water, which lowers the pressure and releases the gas.
- It has been commercially produced in Queensland for more than 12 years.
- CSG is cooled to -161°C, which reduces it to LNG for transport (1/600th of the original volume, not under pressure)
- Arrow is planning an LNG plant in Gladstone that will convert CSG to LNG in preparation for international shipping.

*Artist's impression of Arrow LNG Plant*
ARROW ENERGY
THE FASTEST GROWING SOURCE OF ENERGY IN EASTERN AUSTRALIA

Graph 1: CSG reserves by basin

Graph 1 Source: DEEDI 2012, Geoscience Australia
ARROW ENERGY
THE FASTEST GROWING SOURCE OF ENERGY IN EASTERN AUSTRALIA

<table>
<thead>
<tr>
<th>CSG resources</th>
<th>Petajoules</th>
<th>Trillion cubic feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic demonstrated resources</td>
<td>35,905</td>
<td>33</td>
</tr>
<tr>
<td>Sub-economic demonstrated resources</td>
<td>65,529</td>
<td>60</td>
</tr>
<tr>
<td>Inferred resources</td>
<td>120,020</td>
<td>111</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>223,454</strong></td>
<td><strong>203</strong></td>
</tr>
</tbody>
</table>

Table 1 Source: DEEDI (2011, 2012), AEMO (2012), Geoscience Australia
Graph 2 Source: DEEDI 2012, AEMO 2011, Geoscience Australia
Graph 3 Source: ABARES 2011, BREE 2012b, Geoscience Australia
ARROW ENERGY

ARROW LNG PROJECT

Upstream | Surat Gas Project
| Bowen Gas Project

- Production infrastructure – gathering lines, compression stations, water treatment facilities, power assets
- Production wells

Midstream | Arrow Surat Pipeline
| Arrow Bowen Pipeline

- 2 x 500km pipelines from Surat and Bowen basins to Arrow Energy Gas Hub near Gladstone

Downstream | Arrow LNG Plant

- Ancillary infrastructure construction, e.g. jetty, 6km tunnel
- Located on Curtis Island off Gladstone
Five gas producing fields:

- Moranbah Gas Field (Bowen - largest gas operating field in Australia)
  - supplies power to Townsville Power Station and industry
- Kogan North (Surat)
- Stratheden (Surat)
- Tipton West (Surat)
- Daandine (Surat)
  - supplies power to Dalby and south-east Queensland
ARROW ENERGY
SAFETY - LIFE SAVING RULES

Life-Saving Rules

01. Work with a valid work permit when required
02. Conduct gas tests when required
03. Verify isolation before work begins and use the specified life-protecting equipment
04. Obtain authorisation before entering a confined space
05. Obtain authorisation before overriding or disabling safety critical equipment
06. Protect yourself against a fall when working at height
07. Do not walk under a suspended load
08. Do not smoke outside designated areas
09. No alcohol or drugs while working or driving
10. While driving, do not use your phone and do not exceed speed limits
11. Wear your seat belt
12. Follow prescribed Journey Management Plan
ARROW ENERGY
ARROW LAND ACCESS RULES

1. Only enter a property with the approval of your supervisor.
2. Only conduct activities that are approved within the access conditions.
3. Follow the directions of landholders.
4. Report landholder discussions to Land Liaison Officer/s.
5. Carry personal and vehicle identification.

7. Do not interfere with landholders’ property.
8. No alcohol, illicit drugs, firearms, animals, weapons.
9. No fires. Smoke only in permitted areas.
10. Don’t enter during or after wet weather without consent.
11. Do not negotiate with landholders. Only LLOs to negotiate.
12. Don’t threaten or pressure landholders or others.
ARROW ENERGY
MORANBAH COMMUNITY INFORMATION CENTRE

• Access information about our operations and long-term plans
• CIC features maps, fact sheets and information on:
  1. Arrow LNG Project
     • Bowen Gas Project
     • Surat Gas Project
     • Arrow Bowen Pipeline
     • Arrow Surat Pipeline
     • LNG Plant.
  2. Domestic operations
     • Moranbah Gas Project
     • Surat Basin (domestic projects).
• Information on managing potential environmental impacts such as groundwater, salt, drilling, land access and exploration.
• There are also opportunities to provide feedback.

Moranbah Community Information Centre
15 Town Square Avenue, Moranbah
Open Monday to Friday, 9am – 5pm
ARROW ENERGY
ENVIRONMENTAL IMPACT ASSESSMENT

All projects have impacts. The EIS considers:

• how, where and when will they occur
• if the impacts are significant
• if the impacts can be managed
• the residual impacts (if any).
ARROW ENERGY
ENVIRONMENTAL IMPACT ASSESSMENT METHODS

Compliance
- Do predicted impacts meet or exceed guidelines/limits, e.g. air quality.

Risk management
- Likelihood and consequence, e.g. hazard and risk.

Significance
- Sensitivity and magnitude, e.g. terrestrial and aquatic ecology.
# ARROW ENERGY

## ENVIRONMENTAL FRAMEWORK

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Infrastructure</th>
<th>Applicable framework</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wells</td>
<td>Flowlines and pipelines</td>
</tr>
<tr>
<td>No Go</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>High</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Moderate</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Low</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
ARROW ENERGY
ENVIRONMENTAL FRAMEWORK CONSTRAINTS MAP

No go zone
High constraint area
Moderate constraint area
Low constraint area
# ARROW ENERGY

## ENVIRONMENTAL STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Terms of Reference</strong></td>
<td>Public notice and comment on Draft Terms of Reference (EHP)</td>
</tr>
<tr>
<td><strong>Assessment of significant impacts</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental Impact Statement</strong></td>
<td>Public notice and comment on Environmental Impact Statement (EHP)</td>
</tr>
<tr>
<td><strong>Detailed assessment of impacts (EM plan)</strong></td>
<td><em>Detailed assessment of impacts (EM plan) such as the location of major infrastructure i.e. integrated processing facilities and central gas processing facilities</em></td>
</tr>
<tr>
<td><strong>Environmental Authority</strong></td>
<td>Public notice and comment on Environmental Authority (EHP)</td>
</tr>
<tr>
<td><strong>Initial development plan</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Petroleum Lease (or PPL)</strong></td>
<td>Public notice and comment on Petroleum Lease or Petroleum Pipeline License (DNRM)</td>
</tr>
<tr>
<td><strong>Property specific information</strong></td>
<td><em>Property specific information such as property level detail on location of wells, gathering system and access arrangements</em></td>
</tr>
<tr>
<td><strong>Conduct and Compensation Agreement</strong></td>
<td>Negotiation and agreement with landholder (proponent)</td>
</tr>
</tbody>
</table>
ARROW ENERGY
KEY IMPACTS

• Groundwater

• Amenities (noise, air quality)

• Socio-economic

• Co-development with mining
ARROW ENERGY
NOISE CRITERIA FINDINGS

<table>
<thead>
<tr>
<th>Time period</th>
<th>Short-term noise event</th>
<th>Medium-term noise event</th>
<th>Long-term noise event</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.00am to 6.00pm</td>
<td>Day 45dB(A)</td>
<td>43dB(A)</td>
<td>40dB(A)</td>
</tr>
<tr>
<td>6.00pm to 10.00pm</td>
<td>Evening 40dB(A)</td>
<td>38dB(A)</td>
<td>35dB(A)</td>
</tr>
<tr>
<td>10.00pm to 6.00am</td>
<td>Night 28dB(A)</td>
<td>28dB(A)</td>
<td>28dB(A)</td>
</tr>
<tr>
<td>6.00am to 7.00am</td>
<td>Morning 40dB(A)</td>
<td>38dB(A)</td>
<td>35dB(A)</td>
</tr>
</tbody>
</table>

- Background noise levels typically 19dB(A) to 34dB(A)
- Production wells unmitigated are 300m and mitigated 80m
- Integrated processing facility unmitigated 3-5km and mitigated 1-1.5km
- Vibration below threshold for human detection/no structural damage
ARROW ENERGY
NOISE PROPAGATION CONTOURS (TYPICAL LARGE FACILITY)

Unmitigated

Mitigated
Pollutants:

• key indicators are oxides of nitrogen (NO$_x$) and ozone (O$_3$).

Impact assessment:

• peak development year modelled (production facilities and wells)
• worst-case meteorological conditions assumed
• single exceedence at regional level for nitrogen dioxide (NO$_2$) levels from major facilities at 1400m. Hence a distance constraint on locating facilities.
ARROW ENERGY
SOCIO-ECONOMIC IMPACT

Social Impact Assessment (SIA)
• Reports on the project’s social impacts, including benefits
• Identifies, assesses and proposes mitigation measures for social impacts.

Social Impact Management Plan (SIMP)
• Establishes the roles and responsibilities of proponents, government, stakeholders and communities throughout the life of a project
• Mitigates and manages social impacts and opportunities.

Economic Impact Assessment
• Involves analysing the existing economic environment in the Bowen region and the broader economic context for Queensland and Australia.
ARROW ENERGY
SOCIO-ECONOMIC IMPACT

Bowen Gas Project’s social and economic impacts and objectives:

- population and demographics
- housing and accommodation
- employment, skills and business
- land use and property
- community values and lifestyles
- community infrastructure and services
- health, safety and environment.

The above are reflected and addressed in the SIMP as part of the EIS.
ARROW ENERGY
CO-DEVELOPMENT WITH MINING

• Arrow has a history of working with mining companies.
• Arrow has 19 agreements with coal companies in the Bowen Basin.
• To avoid impacts, strategies have been implemented to exist, develop and maintain flexibility with both open cut and longwall mining.
• Benefits to miners include:
  • improved health and safety
  • reduced costs.

“Coal and gas sectors have defined a path to work together that will ensure commercial certainty and viable co-development.”
ARROW ENERGY
ARROW’S CSG WATER AND BRINE MANAGEMENT STRATEGY

- Arrow’s options for management of CSG water include:
  - beneficial new uses e.g. agriculture, industry and urban
  - discharge to watercourses
  - injection into deep aquifers
  - ocean outfall.

- Arrow’s options for management of CSG brine include:
  - production of salt products for industrial use
  - injection into deep aquifers
  - ocean outfall
  - disposal at a suitably licensed facility.
Content of submission:

- scope of assessment (Terms of Reference)
- adequacy of assessment
- management measures.

Submissions must be:

- in writing and signed with name and address provided
- made to the Chief Executive of the Department of Environment and Heritage Protection (EHP)
  - note that factsheets contain mail/email addresses
- received by EHP no later than 5pm Tuesday 23 April 2013.

Enquiries to Arrow

- Freecall: 1800 038 856
- Email address: bowengas@arrowenergy.com.au
- Website: www.arrowenergy.com.au
ARROW ENERGY
BOWEN EIS GROUNDWATER STUDY FINDINGS

- Groundwater overview
- Environmental impacts
- Predicting impacts
- Mitigation and management measures
- Groundwater monitoring
ARROW ENERGY
WHAT IS GROUNDWATER?

Groundwater is stored below the land surface in:

- pores within sediments
- fractures and micropores within rock.

An **aquifer** is a unit capable of transmitting water and can be:

- unconfined
- semi-confined
- confined.

An **aquitard** is a unit that impedes the flow of groundwater.
Groundwater is required for a number of reasons, including:

- consumptive or productive uses (irrigation/town water/mining)
- maintaining biological integrity of groundwater dependent ecosystems (springs)
- support to areas of cultural and spiritual importance (springs/wetlands).

Potential impacts to groundwater systems may arise from:

- other mining and resource activity
- coal seam depressurisation
- coal seam gas field development
- storage management and handling of associated water.
The significance of the potential groundwater impacts for the EIS were assessed using a Significance Assessment Approach (as shown below).

- Identify environmental values (section 4 and 5) and potential impacts (section 8)
- Classify the sensitivity of groundwater environmental values (section 9)
- Determine magnitude of potential impacts on environmental values (section 9 and 10)
- Assess significance of potential impacts on environmental values (section 9)
- Develop design responses/mitigation measures (section 9 and 10)
- Assess significance of residual impacts on environmental values (section 9 and 10)
Environmental values are defined by the *Environmental Protection (Water) Policy 2009* and aim to enhance or protect Queensland waters.

These values include:

- biological integrity of aquatic ecosystems
- suitability for recreational use (not applicable in the study area)
- suitability for minimal treatment before supply as drinking water
- suitability for use in primary industries
- cultural and spiritual values.
ARROW ENERGY
ENVIRONMENTAL IMPACTS

Shallow groundwater system

- Alluvium (15 - 35m thick) – low sensitivity
- Basalt (0 - 80m thick) – moderate sensitivity

Intermediate groundwater system

- Clematis Sandstone (0 to 300m thick)
  – moderate sensitivity

Deep groundwater system

- Coal Seam targets (25 to 700m thick) – low sensitivity
To inform the BGP EIS, numerical groundwater modelling of the study area was undertaken by Ausenco – Norwest and peer reviewed by CDM Smith.

The following two scenarios were modelled:

1. Bowen Gas Project only (scenario one)
2. Cumulative Impact Representation (scenario two).

The models assumed a 55 year project life and 50 year recovery period. Modelling was calibrated using existing data.
Based on the groundwater modelling, the following potential impacts were identified.

Direct impacts:

- depressurisation of the coal seam gas target formations.

Indirect impacts:

- depressurisation due to induced flow and changes to groundwater quality
- depressurisation causes inter-aquifer flow and reduces groundwater levels and flow to streams, wetlands, riparian zones or sites of cultural/spiritual values.

Other impacts:

- deterioration in groundwater quality (contamination) due to well installation and sub-surface activities
- deterioration in groundwater quality from associated water and waste storage, processing and distribution infrastructure activities.
ARROW ENERGY
CONCEPTUAL HYDROGEOLOGICAL MODEL

[Diagram showing hydrogeological model with various geological formations and hydrological processes, including rainfall, evapotranspiration (ET), springs, and groundwater flow paths.]
ARROW ENERGY
MITIGATION AND MANAGEMENT MEASURES

• Arrow has statutory obligations to ‘make good’ and to complete baseline assessments.

• Arrow’s proposed management measures include:
  • groundwater monitoring program (connectivity/drawdown/water quality)
  • bore and baseline assessment for third party bores (impaired capacity)
  • well integrity management system identified (Code of Practice for Constructing and Abandoning Coal Seam Gas Wells in Queensland, DEEDI, 2011).

• Refinement of groundwater models.
<table>
<thead>
<tr>
<th>Impacts</th>
<th>Unmitigated Impact Significance</th>
<th>Residual (Mitigated) Impact Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depressurisation of CSG formations reduces groundwater supply in the same formation</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Depressurisation causes possible indirect impacts due to induced flow and changes to groundwater quality</td>
<td>Low to very low</td>
<td>Low to very low</td>
</tr>
<tr>
<td>Depressurisation causes inter-aquifer flow and reduces groundwater levels and flow to streams, wetlands, riparian zones or sites of cultural/spiritual values</td>
<td>Moderate to low</td>
<td>Low</td>
</tr>
<tr>
<td>Impacts</td>
<td>Unmitigated Impact Significance</td>
<td>Residual (Mitigated) Impact Significance</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>Deterioration in groundwater quality from associated water and waste storage, processing and distribution infrastructure activities</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Impacts to shallow, intermediate and coal seam groundwater systems from infrastructure footprints</td>
<td>Moderate to very low</td>
<td>Low to very low</td>
</tr>
<tr>
<td>Impacts caused by CSG water activities to shallow groundwater systems (alluvium and basalt)</td>
<td>Moderate</td>
<td>Low</td>
</tr>
</tbody>
</table>
GROUNDWATER MONITORING

Groundwater monitoring network and program will:

- establish background trends
- identify changes in aquifer conditions within and near areas of development
- identify changes in aquifer conditions near environmental values
- reduce model uncertainty in future groundwater flow modelling
- improve understanding of connectivity between aquifers
- develop an ‘early warning system’ that identifies potential impacts and allows early intervention.
Arrow’s existing groundwater monitoring program includes:

- Environmental Authority groundwater monitoring bores at the Moranbah Gas Project (MGP):
  - approximately 42 groundwater bores monitoring shallow aquifers have been installed.
- Underground Water Impact Report Groundwater Monitoring Strategy groundwater monitoring bores:
  - four groundwater bores monitoring deep aquifers will be installed in 2013
  - nine groundwater monitoring bores will be installed in 2014.
ARROW ENERGY
LOCAL CONTENT POLICY

Arrow Energy is committed to creating sustainable employment and economic development for local industry.

Arrow Energy will provide *full, fair and reasonable* opportunity for capable and competitive local industry to participate in the procurement of goods, equipment and services.

Arrow has committed to:

- actively seeking local industry participation
- local, i.e. Australia and New Zealand
- regional, i.e. 50km within operating footprint.
You must be able to demonstrate:

- commitment to regulatory compliance
- safety and environmental track record
- capability to supply on time
- competitive pricing and robust cost management
- customer focus
- robust supply chain with local content.

These requirements are no different to any major project or government agency.
ARROW ENERGY
SUPPLIER REGISTRATION

Work for us ➔ suppliers ➔ register your interest

www.arrowenergy.com.au
In 2012, Arrow invested more than $3.7 million across the Surat and Bowen Basins, Gladstone, Brisbane and several other communities.

- Local employee committees assess applications for donations, sponsorships and partnerships, based on:
  - health and safety
  - education
  - environment.
- Successful applicants in the Bowen Basin include:
  - Moranbah District & Support Services
  - Mackay Community Visitors Association
  - Moranbah State High School
  - Dysart State School P&C Committee
  - Moranbah Athletics Club
  - Middlemount Community Sports Association
  - Wiri Community Limited
Questions and Answers

Freecall: 1800 038 856

Email address: bowengas@arrowenergy.com.au

Website: www.arrowenergy.com.au
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