



MORANBAH GAS PROJECT

PL191

DME Drilling Initiative

FINAL REPORT

**Exploring the Fort Cooper Coal Measures for Coal Seam
Gas Potential**

Bowen Basin, Queensland

As per agreement dated 01.04.2009 CD10147 (Tracking Number: ME000284)

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Aim

The aim of this report is to summarise the outcomes of the drilling, fracture stimulation, completion and production testing of wells GR070, GR071 and GR072 of the Fort Cooper Coal Measures in the Bowen Basin in Central Queensland as proposed in the report *Collaborative Drilling Initiative – Exploring the Fort Cooper Coal Measures for Coal Seam Gas Potential (Dec 2008)*.

This report is a key Arrow deliverable required by the **FUNDING DEED – COLLABORATIVE DRILLING INITIATIVE** between *The State of Queensland Acting through the Department of Mines and Energy* AND *Arrow Energy Ltd*. Under the deed the Department of Mines and Energy will meet up to half of the direct drilling costs for GR070, GR071 and GR072, to a maximum of \$150,000 for an approved project.

Background

Coal seam gas (CSG) extraction using fracture stimulation (fracking) technology is widely used overseas and to a lesser extent within Australia. Indeed most CSG world wide is extracted using various forms of fracking technology.

The Bowen Basin contains three main coal measures (oldest to youngest), the Moranbah Coal Measures (MCM), Fort Cooper Coal Measures (FCCM) and Rangal Coal Measures (RCM). The MCM and RCM are currently mined commercially for coal. The FCCM has previously proved unsuitable to mine using conventional methods due to being composed of many thin seams (some less than 1 cm), its high ash content and its friable nature. It is however very thick, in some areas with gross thickness up to 350 meters including 100 meters of coal packages. The FCCM however represents a potentially massive reservoir of coal seam gas and is estimated to contain in excess of 20 TCF (21,050 petajoules). 20 TCF is about half of the gas available from the Gorgon Gas Project in Western Australia, according to publically available figures.

The Moranbah Gas Project (MGP) in the Bowen Basin has utilised surface-to-inseam (SIS) technology to target the MCM since 2001. In the early 1990's, frac type wells had been trialled at the Broadmeadow Field in the northern portion of the MGP targeting the MCM. At that time, the technology did not produce economic production gas flow rates and the project was abandoned.

The structure of the FCCM renders it unsuitable for the SIS extraction technology which relies on the coal seams being thick and continuous and requires a different completion technology.

Arrow Energy proposed to drill, fracture (frac), complete and equip a series of three vertical pilot wells (GR070, GR071 and GR072) targeting the Fairhill Seam of the FCCM in order to see if this technology could be utilised in this formation thereby unlocking the large resource potential.

The details of the background and planning for this project are contained in the proposal Appendix A.

Geological Overview

The primary exploration target is the lowermost Fairhill Seam (FS) part of the Fairhill Formation (FHF) of the Late Permian FCCM. Due to the nature of the coal seams of the FCCM all pilot wells were of a stand-alone vertical design.

Rather than target an individual seam, the wells target multiple seams or coaly bands within the formation. At present the target depth 'window' for economic coal seam gas production lies

between approximately 100 meters and 600 meters depth. Seams shallower than 100 meters are often found to be degassed due to low confinement pressure and seams greater than 600m, although often rich in gas sorption quantity, have very low permeability.

Up to 65 meters thick and rich in coal, carbonaceous mudstones and stony bands the FHF marks the base of the FCCM (see Figure 1). This highly banded seam with numerous stone partings is laterally continuous across the MGP area and has a gross thickness of between 40 meters and 65 meters with an estimated net coal thickness of approximately 15 meters. The formation is interspersed with isolated sandstone intervals, possibly lensoid channel deposits. Gas content and permeability of the seam is variable with net coal content estimated at approximately 30% of gross seam thickness with gas contents in the range 8 – 22 m³/tonne at 15% ash. Permeability is generally low (0.07 to 6.46 mD).

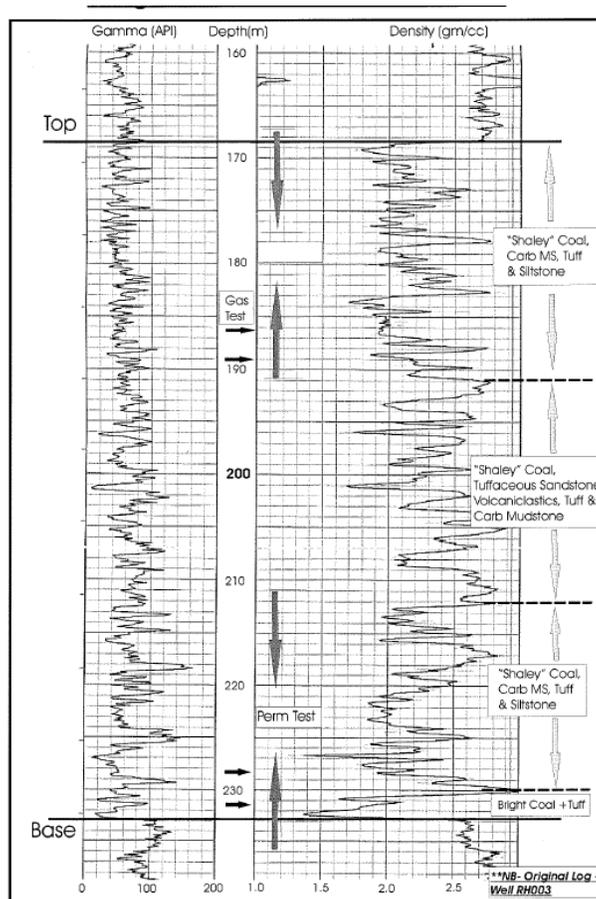


Figure 1 - Fairhill Formation Profile

Drilling

Three vertical 'frac' wells were used to production test the FHF, GR070, GR071 and GR072.

The three pilot wells are positioned equidistant, 100 meters apart in order to stimulate them into early production once completed. Each pilot well has a total depth (TD) between 470 meters and 475 meters which includes a 100 meters sump. The well positions were chosen as the local area is geologically well understood and is close to seismic survey lines.

Each hole represents a standalone vertical, drilled to 100 meters below the base of the FS, cased with steel casing to TD and then cemented into position. The steel casing was then perforated adjacent to the target areas and high-pressure fluids pumped into the formation causing it to fracture.

The spud dates for GR070, GR071 and GR072 were 10 October 2008, 24 October 2008 and 28 October 2008 respectively.

The details of the drilling programs for GR070, GR071 and GR072 are contained in Appendix B.

Cement Bond Log & Perforation

The details of the Cement Bond Log (CBL) and Perforation programs for GR070, GR071 and GR072 are contained in Appendix C.

Fracture Stimulation

The FHF in GR070, GR071 and GR072 was stimulated as per the design in the fracture stimulation program.

The details of the fracture stimulation program for GR070, GR071 and GR072 are contained in Appendix D.

Well Completion

The pilot wells were fitted with down-hole pumps, tubing and well head assemblies to test the production capabilities as per the plan.

The details of the completion program for GR070, GR071 and GR072 are contained in Appendix E.

Production Testing

Production testing started 1 March 2009 when dewatering commenced on the three wells. GR072 produced first gas the same day with GR070 and GR071 producing gas some 10 days later.

Production testing is still underway with the aim of optimising the well production to both maximise the production rate and improve consistence of production. Though good production rates were achieved, continuity of production over time could not be maintained, probably due to the dynamic changes of formation permeability during production testing.

Full commercialisation will require a more comprehensive understanding of fracture stimulation on the FCCM.

Photo 1 shows the flare on GR071 and GR072 burning coal seam gas produced during production testing.



Photo 1 - GR071 and GR072 Flares during Production Testing

Direct Drilling Costs

The Direct Drilling Costs for GR070, GR071 and GR072 are shown in Table 2.

GR070, GR071 & GR072 Detailed Cost Analysis

	GR070	GR071	GR072
Drilling - Field expenses	\$3,122		
Drilling - Metreage/time based	\$126,062	\$122,527	\$126,292
Drilling - Contractor standby	\$7,360	\$5,440	\$7,040
Drilling - Other Expenses	\$2,244		
Drilling - Water Carting	\$8,416	\$9,670	\$11,676
Site Access & Preparation	\$1,330		
Direct Project Materials	\$3,241	\$3,522	\$1,260
Pipe, Valve, Fittings	\$1,074		
Contract Svcs-Other	\$2,205		
Drilling - Rig Time	\$46,380	\$36,001	\$38,513
Salary Recharge	\$8,136	\$2,908	\$512
DME Direct Actual Drilling Costs	\$209,569	\$180,068	\$185,293

Table 2 – Detailed Direct Drilling Cost Analysis

Results

The project was executed as per Section 5 the DME Drilling Initiative, Exploration the Fort Cooper Coal Measures for Coal Seam Gas Potential, Dec 2008.

The permeability of the FCCM typically ranges from 0.1 – 6 mD; Diagnostic Fracture Injection Testing (DFIT) was performed on one well and due to limited monitoring definite results were not obtained.

The pilot production testing was a technical success having produced the coal seam gas from the FCCM for the first time using fracture stimulation techniques (see Photo 1).

The pilot was a limited commercial success in that Arrow booked 1.3 PJ of 1P, 15.6 PJ of 2P and 41 PJ of 3P reserves in the Fairhill formation on PL191 as a result of the successful testing of the pilots. Coal seam gas flows were however not sustained from all three wells.

Further development work needs to be performed to optimise and improve the robustness of the FCCM coal seam gas production from the wells and then develop a suitable business case to fully commercialise this resource.

A summary of the Direct Drilling Costs is shown in Table 1 below.

	GR070	GR071	GR072	Total Cost
Estimated Cost	\$236,600	\$236,600	\$236,600	\$709,800
Actual Direct Drilling Cost	\$209,569	\$180,068	\$185,293	\$574,930

Table 1 – Direct Drilling Cost Summary

Appendices

Appendix A - DME Drilling Initiative Proposal

- Exploration the Fort Cooper Coal Measures for Coal Seam Gas Potential, Dec 2008;

Appendix B - Drilling

- GR070 - Lithology Log;
- GR070 - Density Caliper Gamma Deviation (electronic only);
- GR070 - Well Deviation (electronic only);
- GR071 - Lithology Log;
- GR071 - Density Caliper Gamma Deviation (electronic only);
- GR071 - Well Deviation (electronic only);
- GR072 - Density Caliper Gamma Deviation (electronic only);
- GR072 - Well Deviation (electronic only);

Appendix C - CBL and Perforation Program

- GR070 - CBL & Perf Program;
- GR071 - CBL & Perf Program;
- GR072 - CBL & Perf Program;

Appendix D - Fracture Stimulation Program

- GR070 - Frac Stimulation Program;
- GR071 - Frac Stimulation Program;
- GR072 - Frac Stimulation Program;
- GR070 - DFIT Program;
- GR071 - DFIT Program;
- GR072 - DFIT Program;
- GR070 - Main Treatment Post Job Report;
- GR071 - Main Treatment Post Job Report;
- GR072 - Main Treatment Post Job Report;

Appendix E - Completion Reports

- GR070 - Well Completion Report;
- GR071 - Well Completion Report;
- GR072 - Well Completion Report;