Well Completion Report

Basin: Bowen Basin
Tenure: ATP1103
Well: PD 120A
Field: Peak Downs

Operated By Arrow Energy Pty Ltd

DATE	DESCRIPTION	PREPARED	CHECKED
28/02/2017	*WELL COMPLETION REPORT FOR PD 120A*	*SHAUN WALLACE* ***24/02/2017***	*ANT WHITTLE* ***28/02/2017***

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1 WELL DATA CARD

Well Name and Number		PD 120A
Petroleum Tenure		ATP1103
Location	**Latitude**	22° 13' 06.8699" S
	Longitude	148° 15' 54.3642" E
	Easting	630391.369
	Northing	7542435.126
	Zone	55
	Datum	GDA 94
Nearest Town		MORANBAH (33 km NW)
Nearest Wells		PD130A (80.00 m S)
Elevation	**GL (m AHD)**	223.56
	KB (m AHD)	227.46 (Nitro D1) 224.76 (Nitro 14)
Total Depth (m MD GL)		1542.73 (611.98 m TVD GL)
Well Type		Appraisal
Status		Suspended
Spud Date		30-Aug-2012,(time not recorded)
Total Depth Date		7-Jan-2013, 08:30 hours
Rig Release Date		10-Jan-2013, 09:00 hours
P&A Date		Not Applicable
Drilling Contractor		Nitro Drilling Pty Ltd
Rig Number & Type		Nitro 1 (Schramm TM130XD); Nitro 14 (Sandvik DE 880)
Operator		Arrow Energy Pty Ltd
Postal Address of Well Operator		GPO Box 5262, Brisbane QLD. 4000

All depths are Measured Depth, from Ground Level (m MD GL), unless otherwise stated. Depths may differ due to corrections from KB to GL depth datums.
Due to different systems there may or may not be a space between well name and number, and leading zeroes may be excluded.

2 DRILLING/ENGINEERING DATA

2.1 DRILLING SUMMARY

PD 120A is a lateral surface to in-seam (SIS) appraisal well located 33.0 km South East of Moranbah in Queensland's Bowen Basin. The well was drilled in the Peak Downs area of Authority to Prospect 1103 (ATP 1103) to appraise the Goonyella Middle (GM) Seam of the Moranbah Coal Measures (MCM). PD 120A was designed as a single lateral SIS well targeting PD 120V (reported separately).

Nitro Drilling Pty Limited's Rig (Nitro 14) arrived on location on the 30st August 2012 and spudded the conductor section. Bit 1, an outside diameter (OD) 17" (432 mm) blade drilled on air from 1.50 m MD GL to 7.30 m MD GL. A single joint of OD 14" (356 mm) steel casing was installed from 1.50 m MD GL to 7.30 m MD GL and was cemented by the drilling contractor.

Nitro 14 commenced drilling the surface section on the 30st August 2012. Bit 2, an OD 12 ¼" (311 mm) polycrystalline diamond compact (PDC) was run in hole and tagged cement used to set the conductor casing, before mud drilling into new formation to a depth of 61.23 m MD GL. A string OD 9 ⅝" (244 mm) steel surface casing was installed from 1.03 m MD GL to 60.83 m MD GL and was cemented by the drilling contractor. A cement top-up job was conducted 24 hours later. Nitro 14 departed PD 120A on 31st August 2012.

After an extensive search of internal databases, no daily activity reports could be located for this operation.

The well head location was surveyed by RPS Australia East Pty Ltd 20th October 2012.

Nitro D1 mobilised to PD 120A on the 11th December 2012 and carried out a BOP test at a high pressure of 2000 psi and a low pressure of 750 psi, in order to test the integrity of the surface casing. Nitro D1 commenced drilling the radius bend section at 23:30 hours on the 12th December 2012. Bit 3, an OD 8 1/2" PDC was run in hole and tagged cement at 48.00 m MD GL. Bit 3 was used to mud drill through the surface casing shoe and into new formation to 69.10 m MD GL. A formation integrity test (FIT) was then conducted to a surface pressure of 86.93 psi using 8.68 ppg mud and reached an established equivalent mud weight (EMW) of 15.38 ppg. Bit 4, an OD 8 1/2" PDC with steerable directional assembly was run in hole and mud drilled from 69.10 m MD GL to 474.58 m MD GL. Following a decision to side-track, Bit 4 was pulled back to 432.10 m MD GL and drilled into new formation to a radius bend total depth of 690.97 m MD GL. The well was circulated clean.

Nitro D1 installed OD 7" (178 mm) steel casing from 0.50 m MD GL to 644.77 m MD GL. Cementing was carried out by Halliburton on the 18th December 2012. The casing string was fitted with a float collar and float shoe to prevent cement slurry flow-back when pumping stopped.

Nitro D1 began drilling the in-seam section of the production phase at 08:45 on the 19th December 2012. Bit 5, an OD 6 1/8" (156 mm) PDC with steerable directional assembly was run in hole and tagged cement at 630.10 m MD GL, drilling through the shoe and into open hole at 659.00 m MD GL. Bit 6, an OD 6 1/8" (156 mm) PDC with steerable directional assembly was run in hole and mud drilled new formation from 690.97 m MD GL to 1230.80 m MD GL. Bit 6 was pulled back to 1029.00 m MD GL to commence an in-seam side-track, mud drilling new formation to 1207.88 m MD GL. Bit 6 was pulled back to 1001.10 m MD GL to side-track once again, mud drilling into new formation to 1228.62 m MD GL. Bit 7 an OD 6 1/8" (156 mm) PDC with steerable directional assembly was run in hole and drilled a side-track from 979.10 m MD GL to 1219.44 m MD GL. Bit 8 an OD 6 1/8" (156 mm) PDC with steerable directional assembly was run in hole and drilled a side-track from 979.10 m MD GL to 1459.00 m MD |GL. Bit 9, an OD 6 1/8" (156 mm) PDC with steerable directional, magnetic ranging assembly continued drilling from 1459.00 m MD GL to a production section TD of 1542.73 m MD GL where it intersected with

PD 120V at 08:30 hours on the 7th January 2013. The hole was circulated clean before 45mm poly pipe was run in hole between 630.20 m MD GL and 1542.80 m MD GL.

The well path and build section were monitored using real-time measurement whilst drilling (MWD) system data. The well path was constantly updated with geological information, through the use of a passive gamma crystal probe, allowing wellbore position and changes to geological subsurface interpretation to be made whilst drilling (e.g. seam rolls, fault negotiation). This allows corrections to be made to the well path and geological targets. Unintentional branches or side-tracks are eliminated by pulling back and cutting off as required, in an effort to maximise target exposure within the seam.

SIS well PD 120A specifically tracked a single known formation, therefore lithology was not logged in the production section of the well. The geological points of interest are provided in the Measurement While Drilling Survey Report. The MWD surveys used focused gamma to steer the well towards the target GM Seam of the MCM in the vertical PD 120V.

After the in-seam section of the production phase was completed, well head gear was installed PD 120A was suspended.

Nitro D1 was released at 09:00 hours on the 10th January 2013.

During compilation of the well completion report, some data inaccuracies were noted in the primary well site documents; where present, correct value has been marked in the appendix and the correct value used throughout the report.

2.2 HOLE SIZE

Drill Phase	Interval (from/to) (m MD GL)	Hole Size
Cellar	0.00 - 1.50	Dimensions Approximately 1.5 m x 1.5 m
Conductor	1.50 - 7.30	17" (432 mm)
Surface	7.30 - 61.23	12 1/4" (311 mm)
Radius Bend	61.23 - 690.97	8 1/2" (216 mm)
Production	690.97 – 1542.73	6 1/8" (156 mm)

Note hole size details were obtained from the daily drilling reports (APPENDIX 2) and internal databases.

2.3 DRILL BITS

Bit Number	Interval (from/to) (m MD GL)	Hole Size	Bit Type	Bit Make	Bit Model	Bit Serial Number	Bit Metres	Bit Hours	ROP m/hr
1	1.50 - 7.30	17" (432 mm)	Blade	Not recorded	Not recorded	Not recorded	5.80	Not recorded	Not recorded
2	7.30 - 61.23	12 1/4" (311 mm)	PDC	Not recorded	Not recorded	Not recorded	53.93	Not recorded	Not recorded
3	48.00 – 69.10	8 1/2" (216 mm)	PDC	NOV	SKP616M	130909	21.10	2.75	7.67
4	69.10 – 690.97	8 1/2" (216 mm)	PDC	NOV	S516	E144207	669.33	56.25	11.90
5	630.10 – 659.00	6 1/8" (156 mm)	PDC	VAREL	VM613R	4001684	28.90	1.25	23.10
6	690.97 – 1228.62	6 1/8" (156 mm)	PDC	VAREL	VM613R	4001684	930.79	130.00	7.16
7	994.07 – 1219.44	6 1/8" (156 mm)	PDC	VAREL	VM613R	4001684	225.37	41.25	5.46
8	994.07 – 1459.00	6 1/8" (156 mm)	PDC	VAREL	VM613R	4001684	464.93	52.50	8.86
9	1459.00 – 1542.73	6 1/8" (156 mm)	PDC	VAREL	VM613R	4001684	83.73	11.00	7.61

Note drill bit details were obtained from the daily drilling reports (APPENDIX 2) and internal databases.

2.4 DRILL FLUIDS

Drill Phase	Interval (from/to) (m MD GL)	Hole Size	Drill Fluid Type	Drill Fluid Parameters	Drill Fluid Additives
Conductor	1.50 - 7.30	17" (432 mm)	Air		Not recorded
Surface	7.30 - 61.23	12 1/4" (311 mm)	Mud		Not recorded
Radius Bend	61.23 - 690.97	8 1/2" (216 mm)	Mud		25 kg (Aus Dex) 250 kg (KCl) 25 kg (Soda Ash) 20 kg (Xan-Bore)
Production	690.97 – 1542.73	6 1/8" (156 mm)	Mud		525 kg (Aus Dex) 2075 kg (KCl) 120 kg (Ezee Pac R) 11.34 kg (Frac-seal Coarse) 342 kg (Residrill) 200 kg (Xan-Bore) 125 kg (Soda Ash) 100 kg (Defoamer) 60 kg (Biocide) 200 litres (EP Bit Lube)

Note drill fluid details were obtained from the daily drilling reports (APPENDIX 2) and internal databases.

2.5 BRANCH SUMMARY

Branch	Interval (from/to) (m MD GL)	Total (m)	END TVD (m)	End GDA Easting (mE)	End GDA Northing (mN)	Parent
B01	1.50 - 474.58	473.08	465.70	630427.302	7542410.342	Surface
B02	449.47 - 1230.80	781.33	593.50	631054.459	7542084.544	B01
B03	1032.37 - 1207.88	175.51	617.07	631035.20	7542100.36	B02
B04	1013.17 - 1228.62	215.45	615.77	631053.19	7542090.04	B02
B05	994.07 - 1219.44	225.37	602.17	631048.28	7542097.96	B02
B06	994.07 – 1542.73	548.66	611.98	631340.84	7541961.32	B02

Note branch summary details were obtained from the Measurement While Drilling (MWD) Survey Report (APPENDIX 5).
Note depths provided are bit depths. In APPENDIX 5, 'MD' depths are survey tool depths and 'HD' depths are bit depths – except the final depth recorded in the 'MD' column.
Note the Easting and Northings detailed in this table and APPENDIX 5 are referenced to the wellhead coordinates as surveyed during drilling. Subsequent surveys may have established slightly different wellhead coordinates

2.6 CASING

Casing Phase	Interval (from/to) (m MD GL)	Outside Diameter OD	API Grade	Thread	Weight (lb/ft)
Conductor	1.50 - 7.30	14" (356 mm)	Not recorded	Not recorded	Not recorded
Surface	1.03 - 60.83	9 5/8" (244 mm)	API 5CT K55	BTC	36.00
Radius Bend	0.50 – 644.77	7" (178 mm)	API 5CT K55	BTC	23.00
Production	630.20 – 1542.80	(45 mm)	Not Applicable	Not Applicable	None Recorded

Note casing details were obtained from the daily drilling reports (APPENDIX 2) and internal databases.

2.7 CEMENT CASING ANNULUS

Casing Phase	Interval (from/to) (m MD GL)	Cement Type	Slurry Volume (Barrels)	Slurry Weight (ppg)	Displacement Volume (Barrels)	Returns To Surface	Additives
Conductor	1.50 - 7.30	Not recorded					
Surface	1.50 - 61.23	Class A	23.02	13.68	12.38	Not recorded	68 kg (CaCl2)
Surface (Top-up)	1.50 – 61.23	Class A	0.50	Not recorded			
Radius Bend (Lead)	1.03 - 690.97	Class A	56.50	12.50	70.0	13.5	128 gal (Econolite) 2 gal (NF-6 Defoamer)
Radius Bend (Tail)	1.03 - 690.97	Class A	22.50	14.80			106 lbs (Halad -322) 1 gal (NF-6 Defoamer)

Note cement casing annuli for conductor and surface sections were cemented by the drilling contractor. Cement casing for the radius bend section was completed by Halliburton.
Please note, where cementing has been completed by the drilling contractor, no specific cement job reports were generated. Cementing details were obtained from the daily drilling reports (APPENDIX 2) and internal databases.

2.8 CEMENT PLUG DETAILS

Cement plug not emplaced.

2.9 PERFORATIONS / SLOTTING

No casing was perforated and no slotted casing was installed in this well.

2.10 HOLE DESIGN DIAGRAM

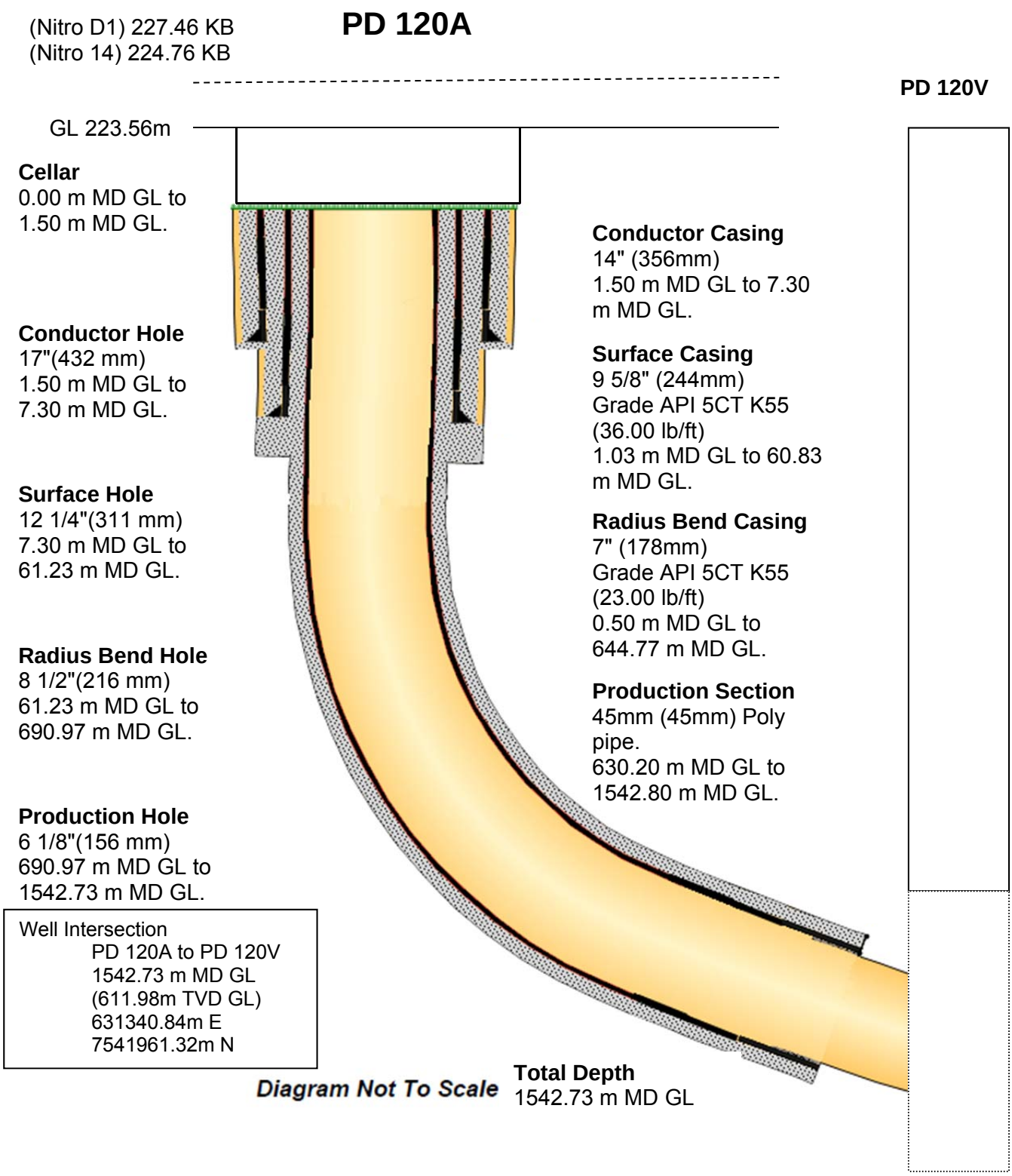
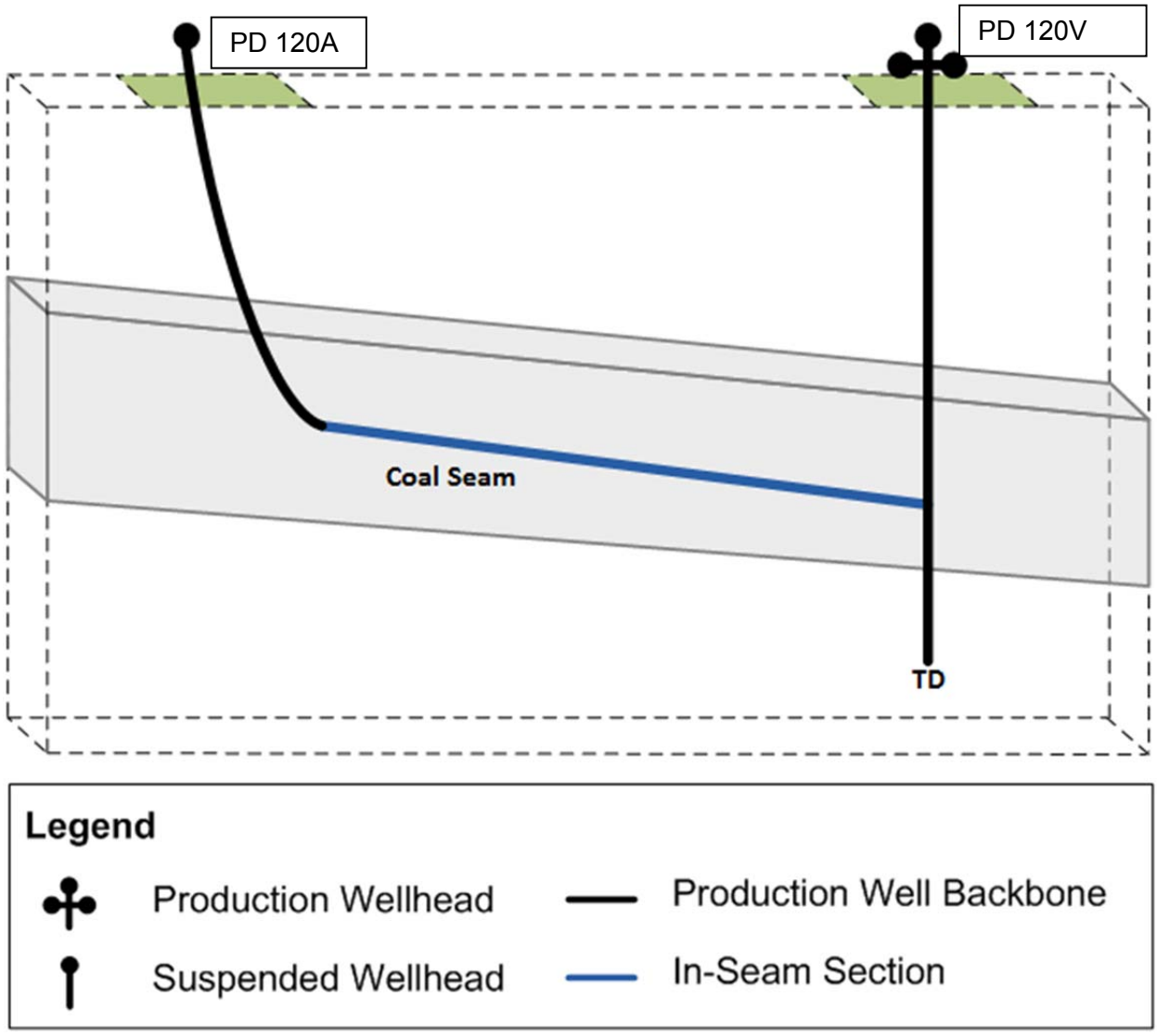


Figure 1: PD 120A Hole Design Diagram

2.11 STYLISED WELL DESIGN DIAGRAM

PD 120A was designed as a Surface to In-Seam lateral with a toe intersect on vertical well (PD 120V).



3 LOGGING AND TESTING

3.1 CORED INTERVALS

Coring not conducted.

3.2 WIRELINE LOGS

Wireline logging not conducted.

3.3 WELL TESTS

Well tests not conducted.

3.4 FLOW TESTS

Flow tests not conducted.

3.5 FORMATION INTEGRITY AND LEAK OFF TEST

A formation integrity test (FIT) was conducted at 69.10 m MD GL to a surface pressure of 86.93 psi using 8.68 ppg mud and reached an established equivalent mud weight (EMW) of 15.38 ppg.

3.6 DESORPTION SAMPLES

Desorption sampling and analysis not conducted.

3.7 LANGMUIR ADSORPTION ISOTHERMS

Langmuir Adsorption Isotherm analysis not conducted.

3.8 VITRINITE REFLECTANCE

Vitrinite Reflectance not conducted.

3.9 COAL MACERAL ANALYSIS

Coal Maceral analysis not conducted.

3.10 GEOTECHNICAL ANALYSIS

Geotechnical analysis not conducted.

3.11 CORE PHOTOS

Core photos not conducted.

4 GEOLOGY

4.1 REASONS FOR DRILLING

PD 120A was part of appraisal wells targeting Goonyella Middle (GM) seam of Moranbah Coal Measures (MCM) in the Peak Downs area of ATP 1103. The well was drilled as a single lateral surface to In-seam appraisal well to assess the target seam, resource maturation plan, and test the local variability of reservoir to compare with the model.

4.2 LITHOSTRATIGRAPHIC UNITS

The SIS well PD 120A specifically tracked a single known formation, therefore lithology was not logged in this well. It is known from other proximal wells that PD 120A spudded in alluvium before passing through the Rangal and Fort Cooper Coal Measures and into the Moranbah Coal Measures, where the target GM Seam was intersected and drilled in-seam, intersecting PD 120V at TD.

4.3 REGIONAL GEOLOGY

4.3.1 *Introduction*

The Bowen Basin extends from Central to Southern Queensland, Australia and covers an area of roughly 60,000km^2 (Figure 3). At its southern extent, the basin is overlain by the Mesozoic Surat Basin. The Bowen Basin is contemporaneous with the Gunnedah and Sydney Basins to the South (Esterle et al 2002).

The Late Permian deposits of the Blackwater Group are the primary CSG targets within the Bowen Basin. The Blackwater Group is divided into three terrestrial units – the Rangal Coal Measures (RCM), Fort Cooper Coal Measures (FCCM) and Moranbah Coal Measures (MCM). Figure 4illustrates the chronostratigraphic relationship between the main units of the Bowen Basin.

Coal seams in the Bowen Basin exhibit major variations in rank and quality, reflecting both the depositional and tectonic history of the basin. A broad trend of increasing rank from west to east has long been recognised, and was used as a guide for coal exploration targets during the late 1950s and early 1960s (*Queensland Department of Natural Resources and Mines 2003*). Igneous intrusions present as dykes and sills are rarely found intruded through coal seams, causing coking and heat-affected coal which can potentially impact the economic potential of CSG.

The evolution of the Bowen Basin can be broken into four broad phases; a crustalextension phase, a thermal subsidence phase, a foreland loading phase and a basin closure phase (Fielding et al 1997).

4.3.2 *Crustal Extension*

Development of the Bowen Basin initiated during the early-Permian as East-West extension generated a series of half graben sub-basins. Subsequent partial filling of the sub-basins occurred in the form of volcanic and sedimentary (lacustrine and fluvial) deposits (i.e. the Reid's Dome Beds (Esterle et al 2002)).

4.3.3 *Thermal Subsidence*

Rapid subsidence due to continued thermal sag and continental erosion led to a marine transgression. From this point onwards, deposition within the basin became dominated by coastal and shallow marine sedimentation (e.g. The Back Creek Group).

4.3.4 *Foreland Loading*

Evolution of the Bowen Basin continued into the Late Permian, as further basin opening occurred with uplift and renewed volcanism in the east of the basin. During this period the half graben sub-basins became interconnected with continuing burial by a series of transgressive and regressive events.

4.3.5 *Basin Closure*

A period of tectonic compression in the Middle to Late-Triassic terminated any further sedimentation within the basin resulting in gentle folding and regional faulting (e.g. The Jellinbah Thrust). The regional area is mantled by an irregular cover of poorly consolidated Tertiary sedimentary strata and basalt (fresh and weathered). The Tertiary cover unconformably overlies the sediments and main coal-bearing units of the Late Permian Blackwater Group.

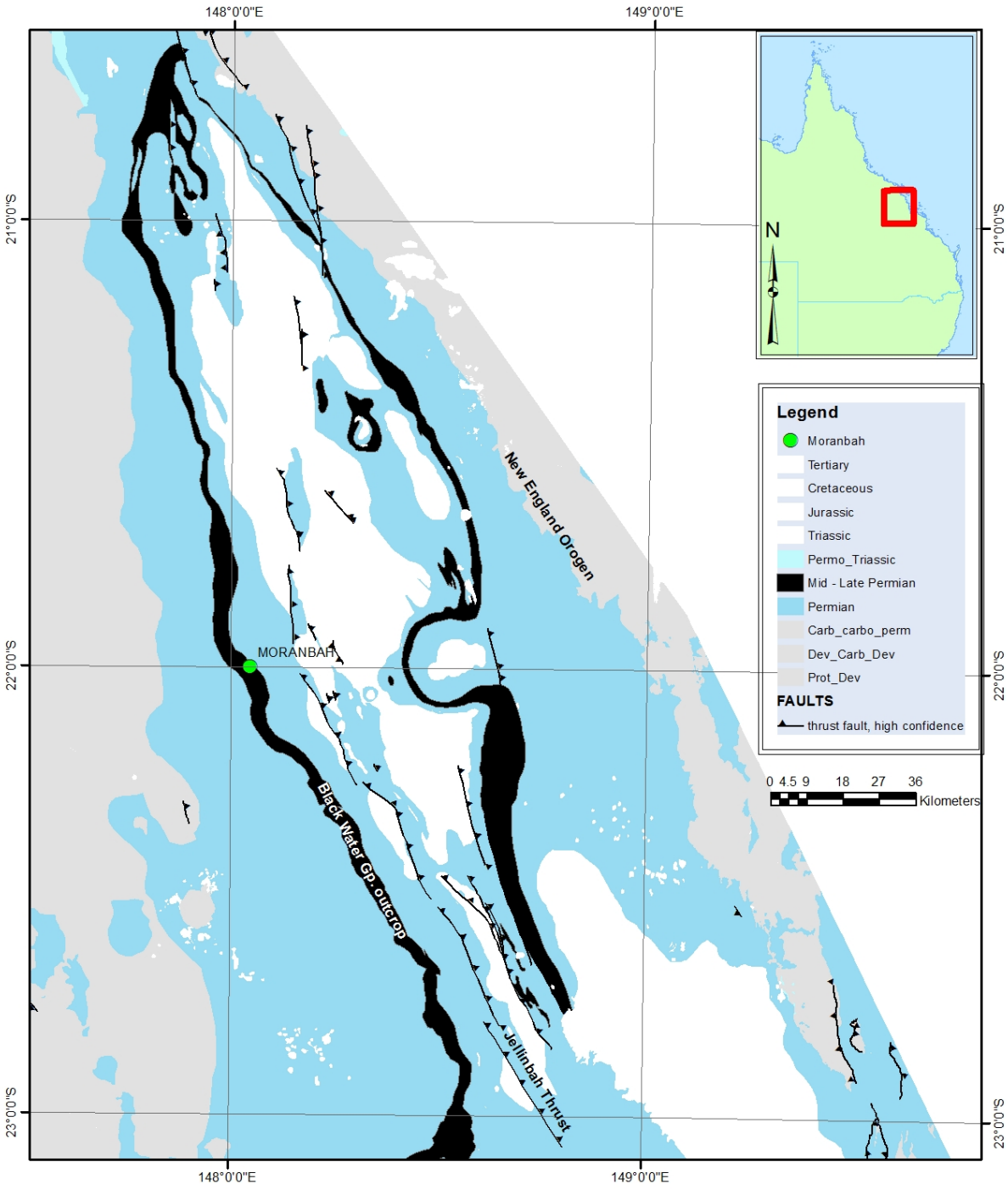


Figure 3: Bowen Basin map, illustrating basic geology of the area

Group	Formation	Member	Northern Bowen Basin					Blackwater	Baralaba	Formation
			N						S	
Moolayember Formation	Undifferentiated									
Clematis Group	Undifferentiated									
Rewan Group	Undifferentiated									
Blackwater Group	Rangal Coal Measures	Leichhardt Member	LU					Aries1	Moody	Baralaba Coal Measures
								Aries2	Boyd	
								Aries	Cameron	
								Castor	Reid	
									Doubtful	
			LL					Pollux	Dawson	
									Dunstan	
									Wright	
								Orion	Double	
									Coolum	
		Vermont Member	VU					Pisces	Dirty	
			YT					YT		
			VL						Sub Dirty	
	Fort Cooper Coal Measures	Girrah Member	No Defined Seams					Virgo	Kaloola 1	Burngrove Formation
		FCCM5 Member	No Defined Seams					Leo Upper	Kaloola 2	
		FCCM4 Member	No Defined Seams					Leo	Kaloola 3	
		FCCM3 Member	No Defined Seams					Aquarius	Kaloola 4	
		FCCM2 Member	No Defined Seams					Hercules Upper	Kaloola 5	Fairhill Formation
								Hercules		
		FCCM1 Member	No Defined Seams					Canis	Kaloola 6	
								Lepus		
		Fairhill Member	No Defined Seams					Fairhill	?	
	Moranbah Coal Measures	GU-Q Member				S		Macmillan Formation		
							R			
			GU5		QA1					
			GU3	QA21	QA2					
				QA22						
			GU0		QB					
		P Member		GR1				Pleiades		German Creek Coal Measures
			GP3							
				GR0						
			GP2 (PL1)							
			GP1 (PL2)							
			PT							
			GP0 (PL3)							
		GM-HC Member	GM		HC			Aquila		
				GMS						
		GL-HCL Member	GL5	GML1	HCL1			Tieri		
				GML2						
			GL3	GML3	HCL2					
				GML4						
		GL-DY Member	GL2		DYU1			Corvus		
					DYU2					
					DYU3					
					DYU4					
			GL7		DYR1			German Creek		
					DYR2					
					DYR3					
					DYR4					
		DL Member			DL1					
			GLL0		DL0					
Back Greek Group	Exmoor Formation	Undifferentiated								Exmoor Formation

Figure 4: Table of Regional Stratigraphic units and seam nomenclature of the Bowen Basin

4.4 COAL GEOLOGY OF THE PEAK DOWNS AREA

4.4.1 *Introduction*

The Peak Downs area is located on the Collinsville Shelf in the west of the Bowen Basin, and hosts a continuation of the proven reservoirs of the Moranbah Gas Field(MGP).The structure of the Peak Downs area is relatively benign. The Peak Downs area is underlain by three Permian coals at depths appropriate for CSG extraction, in descending stratigraphic order:

- Rangal Coal Measures (RCM) (secondary target)
- Fort Cooper Coal Measures (FCCM) (prospective formation)
- Moranbah Coal Measures (MCM) (primary target).

4.4.2 Rangal Coal Measures (RCM)

The RCM sub-crop along the central spine of the Peak Downs area. The RCM dip to a maximum depth of 100m, to the top of the formation. Here the formation contacts the Burton-Jellinbah Fault Zone. To the east of the Peak Downs area, the RCM are shallowed across a series of thrust blocks due to thrust faulting. The RCM locally are approximately 200m thick, with total formation coal thickness up to 11m. The thickest seam, the Leichhardt, is up to 7m thick.

4.4.3 *Fort Cooper Coal Measures (FCCM)*

The FCCM lie directly below the RCM and are contiguous across the Peak Downs area. Maximum depth of cover to the top of the formation is approximately 400m with the Fairhill seam showing most potential with at least 60m gross coal thickness. The FCCM is a secondary CSG target for exploitation in the Peak Downs area.

The FCCM are comprised of interspersed sandstones, mudstones, tuff-bands and high-ash coaly packages. They comprise at least seven main seam intervals of variable resource potential. These packages c consist of a series of thin, high-ash coal bands, stone bands and carbonaceous units with a low net-to-gross coal ratio.

4.4.4 *Moranbah Coal Measures (MCM)*

The MCM sub-crop to the west of the area and are continuous eastwards. The maximum depth to the top of the formation is approximately 600m. Seams dip to the east between 4 to 6 degrees with steeper dips associated with local faulting (Esterle et al 2000). The thickest seam, the GM seam (locally known as the Harrow Creek seam), is up to 12m thick in the Peak Downs area.

The MCM form a 250m to 350m thick formation underlying the FCCM. CSG exploitation in the Peak Downs area is targeting the resource from within the three main, regionally continuous, GU, GL (locally known as the Dysart seam) and GM (Harrow Creek) seams. Locally these three seams total a net coal thickness of up to 22m.

The stratigraphic units of the Collinsville Shelf dip ENE at approximately 5°-7° until they truncate against the Jellinbah Fault Zone. The upper seams of the MCM subcrop to Tertiary overburden in the western parts of the Peak Downs area, with the deepest seams of the formation approaching 900m at the fault zone. Through the fault zone, repeated, shallowing sequences occur as discrete compartmentalised areas.

5 REFERENCES

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APPENDIX 1. LOCATION MAP

APPENDIX 2. DAILY DRILLING REPORTS

APPENDIX 3. CEMENTING REPORTS

APPENDIX 4. WELL HEAD LOCATION SURVEY REPORT

APPENDIX 5. MEASUREMENT WHILST DRILLING SURVEY REPORT