

### **3.0 WELL EVALUATION**

#### **3.1 Wellsite Geology:**

Geological sample descriptions and supervision during the drilling, testing, coring and logging phases, from the commencement of drilling below the 9.625" casing shoe to total depth, was provided by Les Burgess and Paul Elliott of Westminster Geological Pty Ltd.

The composite log, Enclosure A, was constructed by Les Burgess.

#### **3.2 Mud Logging:**

Mud logging services were provided by Baker Hughes Inteq. Equipment available included sensors for recording and monitoring depth, total and chromatographic gas, fluorescence, mud-pit levels, weight on bit (WOB), RPM and torque.

Refer to Enclosure B for the 1:200 metric mudlog.

#### **3.3 Cuttings Sampling:**

The following cutting samples were taken at the wellsite:

Cuttings, Washed and Dried – one set each for Falcon oil and Gas (Australia) Pty Ltd and for the Northern Territory Department of Regional Development, Primary Industry, Fisheries and Resources (DRDPIFR, now DOR).

Samples were collected at the nominal 3m intervals from 1555m to total depth at 1745m, driller. SAMPLEX tray and geochemistry samples were also collected for Falcon. The sample manifest, including a list of samples from the Shenandoah-1 section, is included as Appendix 6.

#### **3.4 Coring:**

Two full-hole 100mm (4") cores were cut by Baker Hughes with a 216mm (8.5") diameter core bit. Core-1 was cut in the lower Kyalla Formation from 1585-1595.5m and recovered 100% of predominantly dark grey siltstone and minor sandstones.

Core-2 was cut in the lower Velkerri Formation from 2511-2517.4m. A total of 6.37m was recovered (99.8%).

No fluorescence shows were seen in the cores but of interest were occasional open fractures visible to the naked eye.

A Weatherford mobile gas-desorption laboratory was on-site and processed core samples for gas content. Good results were obtained as seen in the preliminary report in Appendix 2.

Core descriptions and photographs are also included in Appendix 2.

### 3.5 Drill-Stem Testing:

One on-penetration drill-stem test was run to evaluate the high gas shows in the lower Kyalla Formation and upper Moroak Sandstone from 1580-1745m. Unfortunately the packer-seat was lost after 5 minutes of flow and the test was aborted. There were no indications of hydrocarbons during the short flow-period or from reversed out fluid (mud).

The DST Australia and Falcon drill-stem reports are included in Appendix 3.

### 3.6 Logging While Drilling (LWD):

Baker Hughes INTEQ OnTrak LWD tools were run from 1918m to define the target high TOC zones within the Velkerri Formation that were to be cored. These zones had characteristically high resistivity values in Atree-2, as well as elevated gas responses. The 171.5mm (6.75") OnTrak LWD string comprised the Gamma Ray and Resistivity tools.

Rate of penetration (ROP) and temperature data was also provided by Baker Hughes INTEQ. The logging runs were problem free.

Table 3 summarises the LWD data recorded in this well:

**TABLE 3: LOGGING WHILE DRILLING (LWD) SUMMARY**

RUN	TYPE OF LOG	REMARKS:		
		FROM (m)	TO (m)	STANDARD RESOLUTION DATA FROM TD TO CASING SHOE AT 1555m, STEP / SAMPLE VALUE 0.2m.
1	<b>Baker Hughes INTEQ OnTrak (GAMMA-RESISTIVITY)</b>			<b>MAX TEMPERATURE. 81.8°C (179F) @ 2714m</b>
	GRAFM	2699.6	1920	GAMMA RAY – APPARENT, FILTERED
	TCDM	2714.2	1933	DOWNHOLE TEMPERATURE
	RACHM	2698.4	1918.6	RESISTIVITY ATTENUATION - CORRECTED
	RPCHM	2698.4	1918.6	RESISTIVITY PHASE - CORRECTED
	ROPA	2699	1934	AVERAGE INSTANTANEOUS ROP

### 3.7 Wireline Logging:

Baker-Atlas performed the wireline-logging service at total depth. The following logs were run in Shenandoah-1A:

**TABLE 4 SUMMARY OF WIRELINE LOGGING**

RUN	TYPE OF LOG	INTERVAL		REMARKS
		FROM (m)	TO (m)	
1	<b>GAMMA-RESISTIVITY-SONIC-SP</b> (Minislam)			STANDARD RESOLUTION DATA FROM TOTAL DEPTH AT 2714m TO CASING SHOE AT 1555m. SAMPLE VALUE 0.0762m. MAX TEMPERATURE. 109°C (228F) @ 2684m AFTER 22.8 HRS STATIC MUD.
	GR	2688.5	1498	GR TO 56m INSIDE CASING
	SP	2679	1555	SPONTANEOUS POTENTIAL (SPSBDH)
	DT24	2696	1555	MAC-SONIC . FULL WAVE TD-2370m & 1700-1555m. FIRST ARRIVAL (24" INTERVAL) 2370-1700m
	RD-RS	2708	1555	DEEP AND SHALLOW RESISTIVITY
	RMLL	2713	1555	INVADED ZONE RESISTIVITY
	CAL	2713	1555	MLL CALIPER
2	<b>GAMMA-NEUTRON-DENSITY-PEF</b>			MAX TEMPERATURE. 108°C (226F) @ 2696m AFTER 34 HRS STATIC MUD.
	GR	2703.5	1555	GAMMA RAY – LOGS DEPTH MATCHED TO RUN-1.
	ZDNC- ZCOR	1543	1555	BULK DENSITY AND CORRECTION FACTOR
	CALX	1542	1555	DENSITY CALIPER
	CNC	1542	1555	NEUTRON POROSITY (LIMESTONE MATRIX)
	PE	1542.5	1555	PHOTO-ELECTRIC
3	<b>MREX</b>	2571	1820	MAGNETIC RESONANCE GAMMA RAY LOG MAX TEMPERATURE. 108°C (226F) @ 2554m AFTER 37 HRS STATIC MUD.
4	<b>STAR</b>	2529.5	1555	BOREHOLE IMAGER – FOUR INTERVALS LOGGED: 2529.5-2358.3m, 2304.6-2150m, 2150-1817.6m, 1814.8-1555m

This logging run did not encounter significant problems. The sonic was recorded in full-wave mode. The GR was recorded through the casing to tie in with the Shenandoah-1 log.

The MREX was run to provide detailed evaluation on potential reservoir quality, including permeability, and possible fluid content. This tool was focused on the mid Velkerri Formation, Moroak Sandstone and Lower Kyalla Formation zones

The STAR borehole imager tool provided high-resolution information for geological evaluation of depositional environment, bed thickness and dip, fracture identification, fluid content and rock reservoir quality. This tool was focused on four main zones of interest: 2529.5-2358.3m, 2304.6-2150m, 2150-1817.6m and 1814.8-1555m.

### Hole Conditions

Hole conditions were mainly very good in this well. Reading the shallow resistivity caliper curve coming up from total depth, the well was no more than 1" overgauge up to 2470m. Above this depth and up to 2060m, shale zones and thinly interbedded siltstone/claystone beds were washed out in places to 11". This may be related to a slower rate of penetration causing greater washing out.

At 2050m hole gauge shows a washed out sandstone to 13". The 4m section of sandstone above this wash-out has a hole gauge of around 10.2" and also coincides with a good gas peak of over 300 units from 2043-2046m logger. This suggests potential reservoir quality (as tight sandstones tend to cave more) as well as a potential gas/water contact at 2046m.

From 2046m the shalier zones seemed to be washed out more than the sandstone zones. Maximum caliper readings of up to 12" were recorded up to 1870m and, mainly in sandstones, relatively deep wash-outs up to 18" were recorded up to 1810m, the start of bit run-4.

Continuing up to 1718m the well was relatively rugose in parts with wash-outs of 14" to 12", generally 10". The interval from 1718m to the casing shoe at 1555m was fairly smooth but washed out to an average of 11".

### 3.8 Log Interpretation:

The Shenandoah-1A wireline logging data was interpreted by Darrell Hoyer of Hoyer Petrophysics Inc. This interpretation employed the Archie water saturation equation with the cementation exponent,  $m$ , varying for tight sandstone. For the Moroak Sandstone  $m$  was 2.0. An apparent water resistivity of 0.15Ohmm @ 75°F was derived from the SP log.

The log interpretation plot is included in Appendix 4.

### 3.9 Net Pay Summary:

This log interpretation by Hoyer Petrophysical Incorporated has identified 292m of untested gas pay based on greater than 5% porosity and less than 80% water saturation. This is summarised below together with calculated permeability and average TOC (total organic carbon) measurements.

**TABLE 5: SUMMARY OF INTERPRETED GAS PAY**

Interval, m	Net Pay, m	Ø, %	Sw, %	Horizontal Permeability, mD	Average TOC, %
943-1016 Upper Kyalla Fm	51	7.5	50	0.025	2.4
1570-1670 Lower Kyalla Fm	88	7.5	46	0.027	2.2
1717-1802 Moroak Sandstone	68	7.3	51	12.0	
2405-2503 Velkerri Fm A & B	37	7.1	37	0.063	
2514-2557 Lower Velkerri Formation B	28	7.2	36	0.008	3

### 3.10 Geothermal Gradient:

The geothermal gradient for the well has been constructed from temperature data derived from the logging runs, as presented below. The following temperature data were available:

**TABLE 6: TEMPERATURE DATA SUMMARY**

SOURCE	TEMPERATURE °C	DEPTH m	HRS. SINCE LAST CIRCULATION
Minislam, Run-1	109	2684	22.8
Neutron-Density, Run-2	108	2696	34
MREX, Run-3	108	2554	37
STAR, Run-4	No record	-	-

Table 6 above shows temperatures versus depths and time of logging in hours post the last mud circulation. A time of 35 hours was considered sufficient for the mud to have reached geologic (formation) temperature.

These data points were plotted on a Horner semi-log plot of time versus temperature and, as is indicated on the table, a bottom hole temperature (BHT) of **108°C (226°F)** was extrapolated.

To construct a simple linear geothermal gradient, an average constant surface temperature of 21° C is assumed and this is linked to the extrapolated BHT. The geothermal gradient is calculated to be **3.21° C/ 100m** (derived from a total depth of 2714m / (108°-21°).

The BHT temperature data and the geothermal gradient plots are presented in Appendix 5.

### 3.11 Deviation Data:

Four single shot surveys (well angle only) were run in Shenandoah-1A between 1550m and 2703m. The angles measured were between 1° and 1.75°. This data was tied in to the deviation record of the Shenandoah-1 section. True vertical depth (TVD) for the last survey taken at 2703m was 2702.08m. TVD at total depth is extrapolated to 2713.6m. The east and north offsets (X and Y) were 6.6m and 37m respectively.

The deviation survey record can be viewed as Appendix 7.

### 3.12 Well Suspension

Six temporary cement plugs were set in Shenandoah-1A to isolate permeable zones. These plugs were set at 2230-2150m, 1976-1916m, 1831-1676m, 1589-1500m, 1452-1393m and near the surface from 135-75m.

#### 4.0 CONCLUSIONS

Shenandoah-1A was drilled in the Beetaloo basin from late August to early October 2009 as the re-entry and deepening phase of the Shenandoah-1 well. Several significant wet-gas shows (methane to pentane, C1-C5) were detected in the Lower Kyalla Formation and through the Moroak Sandstone.

Gas shale resources (unconventional) have been identified in the Lower Kyalla Formation and the Mid Velkerri Formation. Tight gas resource plays have been identified in the Mid Velkerri as well as in the lower part of the Moroak Sandstone. The Moroak Sandstone may contain a conventional gas accumulation as well as tight gas sandstone (unconventional). Log interpretation has identified 292m of untested gas pay based on greater than 5% porosity and less than 80% water saturation.

This well confirmed the Basin Centered Gas Accumulation (BCGA) play as a regionally extensive system extending 100km to the northern Velkerri Formation penetrated wells.

Future plans for the well include re-entry and deepening into the Bessie Creek Sandstone where reservoir quality sandstone may have been gas-charged by the Velkerri Formation.