

The logo consists of the text "Energy in action.™" in a blue, sans-serif font, positioned within a light beige rounded rectangular box. Below this box are three smaller, overlapping light beige rectangular shapes of varying sizes, arranged in a descending staircase pattern from left to right.

AGL UPSTREAM INVESTMENTS
PTY LTD

GLOUCESTER GAS PROJECT

July 2016 Water Monitoring Report

**Waukivory Pilot Project: Fracture Stimulation and Flow Test
EPL 20358**

Reporting Period: June 2016

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Foreword

PREMISES	Gloucester Coal Seam Gas Project Bucketts Way Gloucester NSW 2422
LICENCE DETAILS	<u>Environment Protection Licence 20358</u>
LICENCEE	AGL Upstream Investments Pty Limited (AGL)
LICENCEE'S ADDRESS	Locked Bag 1837, North Sydney, NSW 2060
MONITORING DATE(s)	14 June 2016
MONITORING BY	Parsons Brinckerhoff, on behalf of AGL
ANALYSIS BY	ALS Laboratory, Smithfield (Work order: ES1612855)
DATE AGL OBTAINED DATA	24 June & 6 July 2016
REPORT DATE	8 July 2016
REPORT PREPARED BY	James Duggleby, Senior Hydrogeologist

Introduction

On 4 February 2016 AGL Upstream Investments Pty Ltd (AGL) announced that the Gloucester Gas Project (GGP) will not proceed to final investment stage. AGL will relinquish Petroleum Exploration Licence (PEL) 285 to the NSW Government and have commenced a comprehensive decommissioning and rehabilitation program well sites and other infrastructure in the Gloucester region.

A dedicated water monitoring network has been in place, which has enabled the collection of baseline water level and water quality data for the different groundwater and surface water systems within the Gloucester Basin. As part of the network, there were more than 50 dedicated water monitoring locations and more than five years of baseline monitoring (water levels and water quality) across the Gloucester Basin.

The Gloucester Coal Seam Gas Project has Environment Protection Licence (EPL) 20358 for coal seam gas activities. This Monitoring Report relates to the water monitoring activities specified in Part 5, Monitoring and Recording Conditions, of EPL 20358. This report relates specifically to the monitoring surrounding the Waukivory Pilot Project, and details:

- > Monitoring results from six monthly samples at monitoring points 10, 11, 90 (WKMB01, WKMB02, GR-P3) (Appendix B);
- > Monitoring results from continuous water level (including piezometric level) monitoring at monitoring points 10, 11, 12, 14, 85, and 90 (WKMB01, WKMB02, WKMB03, PL03, WKMB05, GR-P3) (Appendix C and Appendix E, Figure 2, Figure 3, Figure 4); and
- > Monitoring results from continuous water level (pressure) at monitoring points 86, 87, 88, 89 (WK11, WK12, WK13, WK14) (Appendix D and Appendix E, Figure 5).

As per the EPL, monitoring encompasses the monitoring points at the locations as shown in

Table 1 and Figure 1.

The monitoring points that are the subject of this report are part of the GGP surface water and groundwater monitoring network, as described in AGL's Surface Water and Groundwater Management Plan (SGMP) for the Waukivory Pilot Project (AGL, 2015).

Two methods were used to obtain the water samples:

- > A submersible pump (12 V pump) at monitoring point 90 which is screened within relatively permeable geological material; and
- > A micro-purge™ low flow sampling pump at groundwater monitoring points 10 and 11. The micro-purge™ system allows groundwater to be drawn into the pump intake directly from the screened portion of the aquifer, eliminating the need for excessive groundwater purging.

The water quality samples are analysed by an external NATA certified laboratory (ALS Environmental, Smithfield), in accordance with the EPA Approved Methods Publication "*Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales*" (EPA, 2004), with the exception of those referenced in Section M2.6 of EPL 20358 and:

- > Sodium hypochlorite, where detections of free and total residual chlorine were used as a proxy. The EPA have acknowledged that this method is a suitable technique for representing detections of sodium hypochlorite in water (EPA, 2014a).

This report is prepared in accordance with the *Requirements for Publishing Pollution Monitoring Data* (EPA, 2012) (Publication Requirements).

This is the final water monitoring data report for the *Waukivory Pilot: fracture stimulation and flow test*. The monitoring points listed in **Table 1** have now been decommissioned and will be rehabilitated in the coming months. The remaining water and land monitoring points in EPL 20358 will be reported in subsequent reports when the requirement for monitoring is triggered. More information on the groundwater monitoring of the GGP is available on the project website: agl.com.au/Gloucester

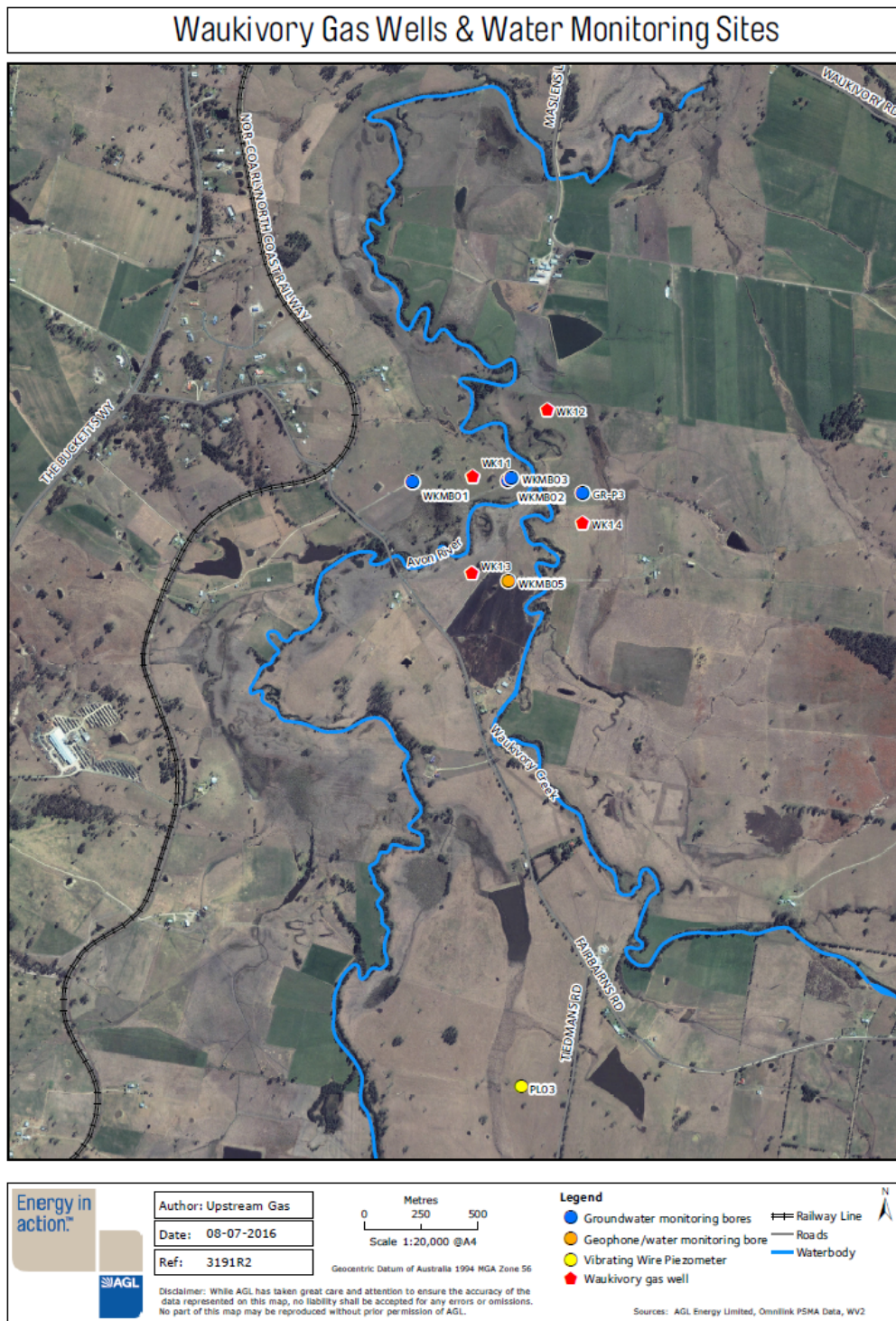
Table 1: Waukivory Pilot Project water monitoring points (as per EPL 20358)

EPA Identification no.	Monitoring Point	Type of monitoring point	Easting (m)	Northing (m)
10	WKMB01	Groundwater monitoring bore	402153.63	6452566.28
11	WKMB02	Groundwater monitoring bore	402575.54	6452572.49
12	WKMB03	Groundwater monitoring bore	402589.87	6452584.93
14	PL03	Vibrating wire piezometer (groundwater)	402633.90	6449898.67
85	WKMB05	Packer and piezometer completion: multizone monitoring well (groundwater)	402576.59	6452128.62
86	WK11	Gas well	402419.02	6452589.82
87	WK12	Gas well	402748.92	6452883.77
88	WK13	Gas well	402416.74	6452164.46
89	WK14	Gas well	402906.10	6452384.08
90	GR-P3	Private groundwater bore	402905.50	6452518.71

Notes:

Coordinate reference system: Map Grid of Australia 1994

Figure 1: Location of groundwater and surface water quality monitoring points: Waukivory Pilot Program (as per EPL 20358)





References

- AGL, 2015. Surface Water and Groundwater Management Plan for the Waukivory Pilot Program – Gloucester Gas Project. Available online: http://www.agl.com.au/~media/AGL/About%20AGL/Documents/How%20We%20Source%20Energy/Gloucester%20Document%20Repository/Water%20Plans/20150506_Surface%20Water%20and%20Groundwater%20Management%20Plan%20for%20the%20Waukivory%20Pilot%20Program.pdf
- Environment Protection Authority (EPA), 2014a. Letter correspondence to AGL Energy Limited. EPA reference: DOC14/192084-03; SF14/602, delivered on the 20 October 2014, signed: Carmen Dwyer, Special Project Manager – Coal Seam Gas.
- Environment Protection Authority (EPA), 2014b. Letter correspondence to AGL Energy Limited. EPA reference: DOC14/279381-01; SF14/602, delivered on the 1 December 2014, signed: Brett Nudd, Acting Special Project Manager – Coal Seam Gas.
- Environment Protection Authority (EPA), 2004. Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales, The Department of Environment and Conservation, Sydney, Australia. Available online: <http://www.environment.nsw.gov.au/resources/water/approvedmethods-water.pdf>
- The State of NSW and Environment Protection Authority (EPA), 2012. Requirements for publishing pollution monitoring data. Environment Protection Authority, Sydney, Australia. Available online: <http://www.epa.nsw.gov.au/resources/licensing/130742reqpubpmdata.pdf>

Appendix A: Analytes monitored and frequency required for monitoring points in Table 1 (as per EPL 20358 (dated 4 May 2016))

Pollutant	Units of measure	10 ^a , 11 ^a , 90 ^a		12 ^a , 14 ^a , 85 ^b		86 ^c , 87 ^c , 88 ^c , 89 ^c	
		Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method
Aluminium	milligrams per litre	Special Frequency 3	Grab sample				
Ammonia	milligrams per litre	Special Frequency 3	Grab sample				
Arsenic	milligrams per litre	Special Frequency 3	Grab sample				
Barium	milligrams per litre	Special Frequency 3	Grab sample				
Benzene	micrograms per litre	Special Frequency 3	Grab sample				
Beryllium	milligrams per litre	Special Frequency 3	Grab sample				
Bicarbonate	milligrams per litre	Special Frequency 3	Grab sample				
Boron	milligrams per litre	Special Frequency 3	Grab sample				
Cadmium	milligrams per litre	Special Frequency 3	Grab sample				
Calcium	milligrams per litre	Special Frequency 3	Grab sample				
Carbonate	milligrams per litre	Special Frequency 3	Grab sample				
Chloride	milligrams per litre	Special Frequency 3	Grab sample				
Chromium	milligrams per litre	Special Frequency 3	Grab sample				
Cobalt	milligrams per litre	Special Frequency 3	Grab sample				
Copper	milligrams per litre	Special Frequency 3	Grab sample				
Electrical conductivity	microsiemens per centimetre	Special Frequency 3	Grab sample				
Ethyl benzene	micrograms per litre	Special Frequency 3	Grab sample				
Fluoride	milligrams per litre	Special Frequency 3	Grab sample				
Iron	milligrams per litre	Special Frequency 3	Grab sample				
Lead	milligrams per litre	Special Frequency 3	Grab sample				
Magnesium	milligrams per litre	Special Frequency 3	Grab sample				
Manganese	milligrams per litre	Special Frequency 3	Grab sample				
Mercury	milligrams per litre	Special Frequency 3	Grab sample				
Methane	milligrams per litre	Special Frequency 3	Grab sample				
Molybdenum	milligrams per litre	Special Frequency 3	Grab sample				
Nickel	milligrams per litre	Special Frequency 3	Grab sample				
Nitrate	milligrams per litre	Special Frequency 3	Grab sample				
Nitrite	milligrams per litre	Special Frequency 3	Grab sample				
pH	pH	Special Frequency 3	Grab sample				
Phosphorus (total)	milligrams per litre	Special Frequency 3	Grab sample				
Potassium	milligrams per litre	Special Frequency 3	Grab sample				
Reactive Phosphorus	milligrams per litre	Special Frequency 3	Grab sample				
Selenium	milligrams per litre	Special Frequency 3	Grab sample				
Silica	milligrams per litre	Special Frequency 3	Grab sample				
Sodium	milligrams per litre	Special Frequency 3	Grab sample				
Sodium Hypochlorite	milligrams per litre	Special Frequency 3	Special Method 7				
Standing water level	meters (Australian Height Datum)	Special Frequency 8	Special Method 5	Special Frequency 8	Special Method 5	Special Frequency 9	Special Method 3
Strontium (dissolved)	milligrams per litre	Special Frequency 3	Grab sample				
Sulfate	milligrams per litre	Special Frequency 3	Grab sample				
Toluene	micrograms per litre	Special Frequency 3	Grab sample				
Total dissolved solids	milligrams per litre	Special Frequency 3	Grab sample				
Total organic carbon	milligrams per litre	Special Frequency 3	Grab sample				
Total suspended solids	milligrams per litre	Special Frequency 3	Grab sample				
Uranium	milligrams per litre	Special Frequency 3	Grab sample				
Vanadium	milligrams per litre	Special Frequency 3	Grab sample				
Xylene	micrograms per litre	Special Frequency 3	Grab sample				
Zinc	milligrams per litre	Special Frequency 3	Grab sample				

Notes:

- Special Frequency 3 – 6 monthly
- Special Frequency 8 – Every 6 hours. Note that these monitoring points may form part of AGL's rehabilitation works, and should a monitoring point be rehabilitated, then monitoring will no longer be required from that point.
- Special Frequency 9 – Every 6 hours when using an automated datalogger, or, once every fortnight using a Sonolog in the event of failure of an automated datalogger.
- Special Method 1 - manual dip
- Special Method 3 - Use of an automated datalogger. As a back up contingency, by use of Sonolog in the event of failure of an automated datalogger.
- Special Method 5 - Automated datalogger
- Special Method 7 - Sodium hypochlorite is monitored through its elemental constituents. Free residual chlorine and total chlorine are monitored using existing validated methods.
- Shaded grey = not required to be analysed

^aDatalogger recording and sampling requirements from the points 10,11,90,12 ceased on 14 /06/2016 in advance of the decommissioning and rehabilitation of the monitoring bores.

^bDatalogger recording from the point 85 ceased on 12/05/2016 in advance of the decommissioning and rehabilitation of the monitoring well.

^cDatalogger recording for points 86,87,88 and 89 ceased on 23/06/2015 in advance of decommissioning and rehabilitation of the gas wells.

^dDatalogger recording from point 14 ceased on 16/06/2016 in advance of decommissioning of the monitoring bore.



Appendix B: Water quality monitoring data for points 10, 11, 90

Analysis by: ALS Laboratory, Smithfield (Work order: ES1612855)

Monitoring points	10	11	90
Location	WKMB01	WKMB02	GR-P3
Sampled date	14/06/2016	14/06/2016	14/06/2016
Date AGL obtained data	24/06/2016	24/06/2016	24/06/2016
Monitoring event	6-monthly sample	6-monthly sample	6-monthly sample

Analyte	Units of measure	Limit of reporting	10	11	90	Analyte
Aluminium	mg/L	0.01	0.01	0.12	<0.01	Aluminium
Ammonia	mg/L	0.01	0.54	0.38	0.03	Ammonia
Arsenic	mg/L	0.001	<0.001	0.001	<0.001	Arsenic
Barium	mg/L	0.001	0.312	0.073	0.489	Barium
Benzene	µg/L	1	<1	<1	<1	Benzene
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	Beryllium
Bicarbonate	mg/L	1	966	215	401	Bicarbonate
Boron	mg/L	0.05	0.10	<0.05	<0.05	Boron
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	Cadmium
Calcium	mg/L	1	10	2	131	Calcium
Carbonate	mg/L	1	<1	174	<1	Carbonate
Chloride	mg/L	0.1	931	157	1160	Chloride
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	Chromium
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	Cobalt
Copper	mg/L	0.001	<0.001	<0.001	<0.001	Copper
Electrical conductivity	µS/cm	1	4350	922	4300	Electrical conductivity
Ethyl benzene	µg/L	2	<2	<2	<2	Ethyl benzene
Fluoride	mg/L	0.1	1.9	0.5	0.3	Fluoride
Iron	mg/L	0.05	<0.05	0.30	0.30	Iron
Lead	mg/L	0.001	<0.001	<0.001	<0.001	Lead
Magnesium	mg/L	1	1	<1	73	Magnesium
Manganese	mg/L	0.001	0.007	0.004	0.675	Manganese
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	Mercury
Methane	mg/L	0.01	14.3	5.38	0.024	Methane
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	Molybdenum
Nickel	mg/L	0.001	<0.001	<0.001	0.002	Nickel
Nitrate	mg/L	0.01	0.02	0.02	0.04	Nitrate
Nitrite	mg/L	0.01	<0.01	<0.01	<0.01	Nitrite
pH	pH Unit	0.01	8.11	9.66	6.70	pH
Phosphorus (total)	mg/L	0.01	0.07	0.09	0.06	Phosphorus (total)
Potassium	mg/L	1	2	9	2	Potassium
Reactive Phosphorus	mg/L	0.01	0.06	0.08	0.03	Reactive Phosphorus
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	Selenium
Silica	mg/L	0.05	15.7	21.4	36.3	Silica
Sodium	mg/L	1	981	209	636	Sodium
Sodium Hypochlorite (reported as free chlorine)	mg/L	0.2	<0.2	<0.2	<0.2	Sodium Hypochlorite (reported as free chlorine)
Sodium Hypochlorite (reported as residual chlorine)	mg/L	0.2	<0.2	<0.2	<0.2	Sodium Hypochlorite (reported as residual chlorine)
Standing water level	mAHD	0.01	Refer to Appendix C and E			Standing water level
Strontium (dissolved)	mg/L	0.001	1.47	0.220	2.27	Strontium (dissolved)
Sulfate	mg/L	1	30	26	88	Sulfate
Toluene	µg/L	2	<2	<2	<2	Toluene
Total dissolved solids	mg/L	10	2460	551	2550	Total dissolved solids
Total organic carbon	mg/L	1	<1	6	2	Total organic carbon
Total suspended solids	mg/L	5	<5	5	37	Total suspended solids
Uranium	mg/L	0.001	<0.001	<0.001	0.003	Uranium
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	Vanadium
Xylene	µg/L	2	<2	<2	<2	Xylene
Zinc	mg/L	0.005	<0.005	<0.005	0.015	Zinc





Appendix C: Continuous water level monitoring results for monitoring points 10, 11, 12, 14, 85, and 90 (tabulated summary)

Note: Datalogger recording and sampling requirements from the points 10,11,90,12 ceased on 14 June 2016 in advance of the decommissioning and rehabilitation of the monitoring bores. Datalogger recording at monitoring point 14 ceased on 16 June in advance of decommissioning of the monitoring bore. Datalogger recording at monitoring point 85 ceased on 13 May 2016 in advance of decommissioning and rehabilitation of the monitoring well.

Monitoring point	10	11	12	14		85						90
Location	WKMB01	WKMB02	WKMB03	PL03		WKMB05						GR-P3
				Sensor 2	Sensor 3	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	
Monitored interval (mbgl)	47-53	51-60	200-209	496	463	340.0-343.0	426.0-429.0	584.0-587.0	595.4-598.4	698.5-701.5	711.0-714.0	5.0-9.0
Data type	Standing water level											
Units	mAHD (metres Australian Height Datum)											
Data start	02/02/2016	02/02/2016	02/02/2016	01/04/2015	01/04/2015	03/02/2016	03/02/2016	03/02/2016	03/02/2016	03/02/2016	03/02/2016	03/02/2016
Date data downloaded	14/06/2016	14/06/2016	14/06/2016	16/06/2016	16/06/2016	13/05/2016	13/05/2016	13/05/2016	13/05/2016	13/05/2016	13/05/2016	14/06/2016
Date data supplied to AGL	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/2016	6/07/16
Monitoring frequency required by licence	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours	Every 6 hours
No. of times measured during monitoring period	6905	535	534	1716	1771	331	331	331	327	331	331	531
Min. value	86.47	96.28	84.77	75.50	43.82	103.07	99.48	110.74	117.95	139.04	166.65	97.17
Mean value	95.81	96.53	98.62	78.11	48.37	103.46	100.41	111.66	118.56	140.36	167.73	97.60
Median value	95.96	96.48	98.78	77.37	44.89	103.47	100.43	111.67	118.63	140.45	167.78	97.56
Max. value	96.07	97.10	98.84	82.59	47.27	103.59	100.69	112.07	118.84	140.90	167.93	98.17

Appendix D: Continuous water level monitoring results for monitoring points 86, 87, 88, and 89 (tabulated summary)

Monitoring point	86	87	88	89
Location	WK11	WK12	WK13	WK14
Data type	Standing water level			
Units	mAHD (metres Australian Height Datum)			
Data start	01/01/2016	01/01/2016	01/01/2016	01/01/2016
Date data downloaded	18/06/2016	19/06/2016	07/05/2016	10/05/2016
Date data supplied to AGL	06/07/2016	06/07/2016	06/07/2016	06/07/2016
Monitoring frequency as required by licence	Every 6 hours when using an automated datalogger; or, once every fortnight using a Sonolog in the event of failure of an automated datalogger			
No. of times measured during monitoring period	314	128	144	133
Min. value	-804.40	-485.97	-795.20	-644.80
Mean value	-570.97	-381.49	-748.85	-554.54
Median value	-561.90	-392.97	-756.70	-550.80
Max. value	-328.40	-105.97	-666.20	-462.80

Appendix E: Continuous water level monitoring results (hydrographs)

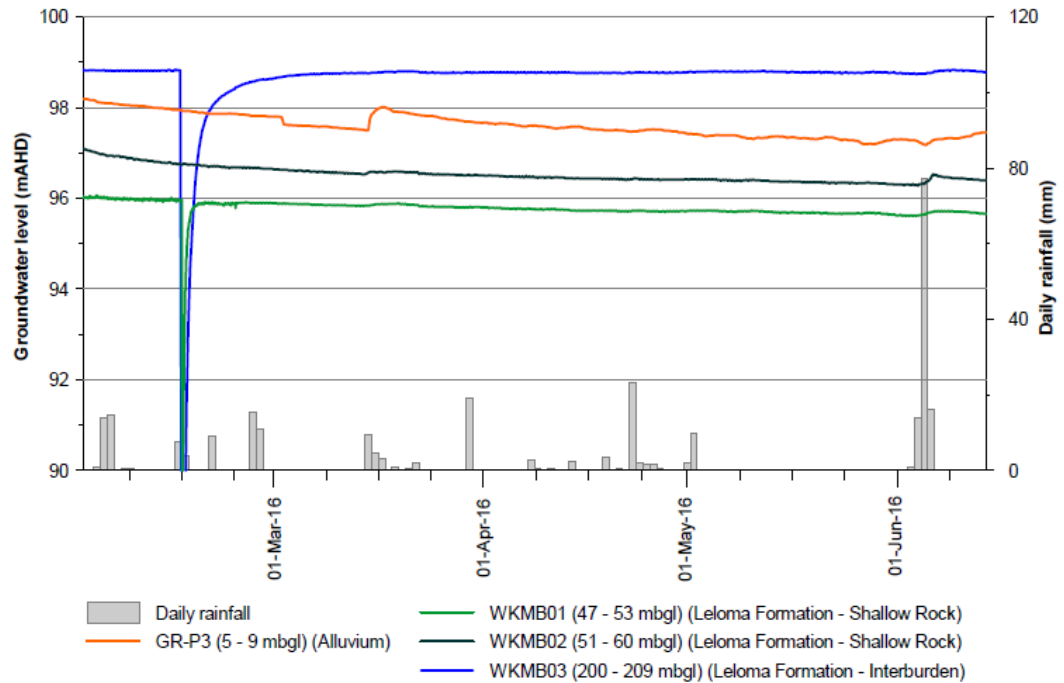


Figure 2: Continuous water level monitoring results for monitoring points 10 (WKMB01), 11 (WKMB02), 12 (WKMB03), and 90 (GR-P3) for the period 2 February 2016 – 14 June 2016.

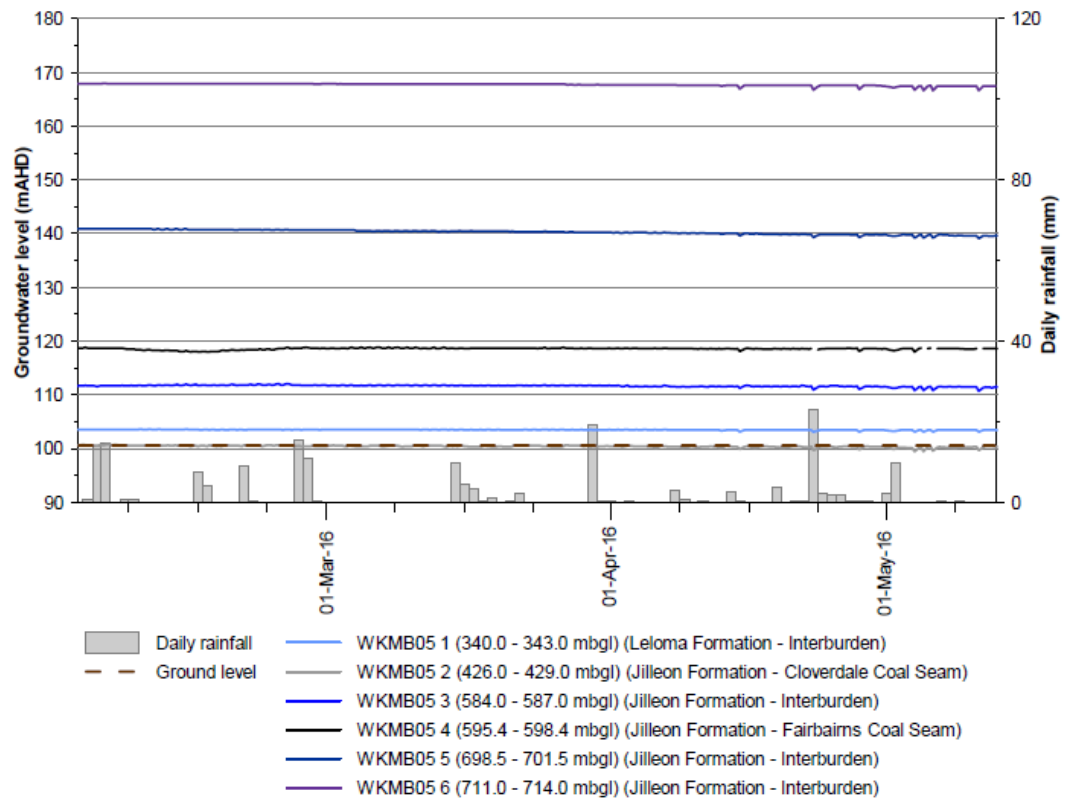


Figure 3: Continuous water level monitoring results for monitoring point 85 (WKMB05) for the period 3 February 2016 – 13 May 2016.

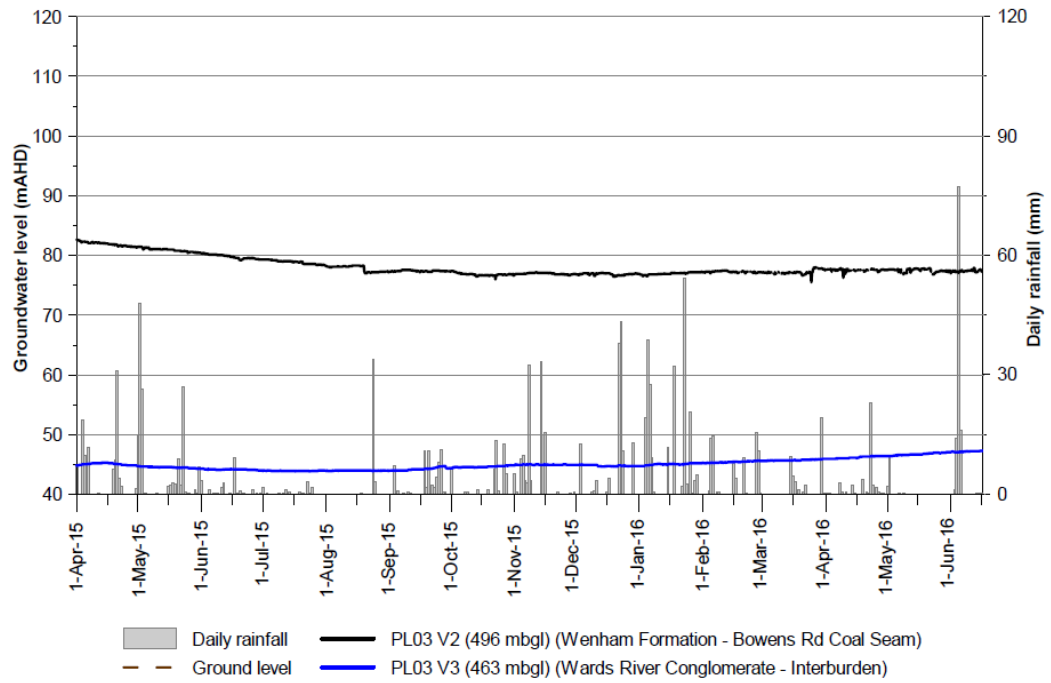


Figure 4: Continuous water level monitoring results for monitoring point 14 (PL03) for the period 1 April 2015 – 16 June 2016.

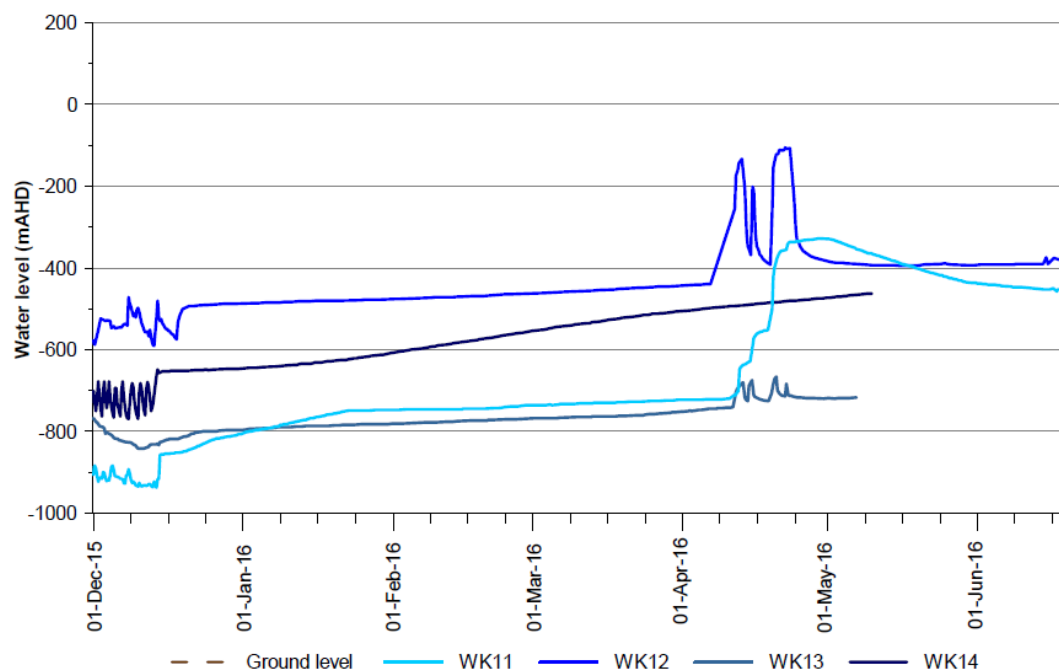


Figure 5: Continuous water level monitoring results for monitoring points 86 (WK11), 87 (WK12), 88 (WK13), and 89 (WK14) for the period 1 January 2016 - 19 June 2016.

Note (**Figure 5**): Water levels (pressure levels) in the pilot wells are highly variable and dependent on pump commissioning and operation (including fluctuating pumping rates). When pumping is taking place, pressure level declines (drawdown) are observed in the pilot wells and when pumping ceases the pressure levels re-equilibrate (recover) to that of the target formations. The pump commissioning and flowback phases comprise periods where the pumps have been in operation and periods where pumping has ceased either due to workover intervention or suspension.

Fluctuations in April 2016 occur as a result of gas venting from the wells in advance of the decommissioning and rehabilitation program.

Datalogger recording from point 86 ceased on 18 June 2016 in advance of decommissioning.

Datalogger recording from point 87 ceased on 19 June 2016 in advance of decommissioning.

Datalogger recording from point 88 ceased on 07 May 2016 in advance of decommissioning.

Datalogger recording from point 89 ceased on 10 May 2016 in advance of decommissioning.