Memorandum

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21 November 2018

To	Aaron Clifton
From	Gonzalo Jimenez
Subject	Camden Gas Project- FY18/19 Six-monthly monitoring update – October 2018

Dear Aaron,

This memo presents the updated hydrographs for the Menangle Park and Glenlee groundwater monitoring bores to October 2018 in Figures A.1 – A.5, and the water quality results for the October 2018 sampling event in Table A.1, including the Nepean River. Results are presented for samples taken on 16 October 2018.

Key observations for this monitoring period (April 2018 to October 2018) are:

- Logger data from bore MPMB01 could not be downloaded in the field due to connection issues. A replacement logger was installed and programmed to log at 6-hourly intervals (00:00, 06:00, 12:00 and 18:00). The recovered logger is currently being investigated to retrieve the data logged since the previous download (April 2018).
- Water levels at the Menangle Park monitoring bores remain within the historic range and no increasing or decreasing overall trend identified. Bores MPMB02 and MPMB03 showed a short-term response to the rainfall events in early September 2018.
- Water level at the Glenlee monitoring bore GLMB03 remain stable.
- As noted in the April 2018 monitoring update memo (EMM 2018), the vibrating wire piezometer (VWP) sensors at GLMB01 and GLMB02 stabilised at lower piezometric pressure head levels compared with pressures observed from the former standpipe monitoring bores prior to conversion to VWPs. This data is not considered representative of formation pressures, potentially due to interference from the gravel pack surrounding the piezometers. Although the absolute pressure values post-VWP installation are not representative of formation pressures, the trends in the data are and are therefore still useful.

The groundwater quality results will be analysed and discussed in the next annual monitoring report.

The results are included in the following attached figures and table:

- Figures A.1 – A.4: Individual hydrographs for the Menangle Park and Glenlee sites;
- Figures A.5: Nested hydrographs for the Menangle Park and Glenlee sites;
- Table A.1: Water quality results for October 2018.

Yours sincerely

Gonzalo Jimenez
Hydrogeologist
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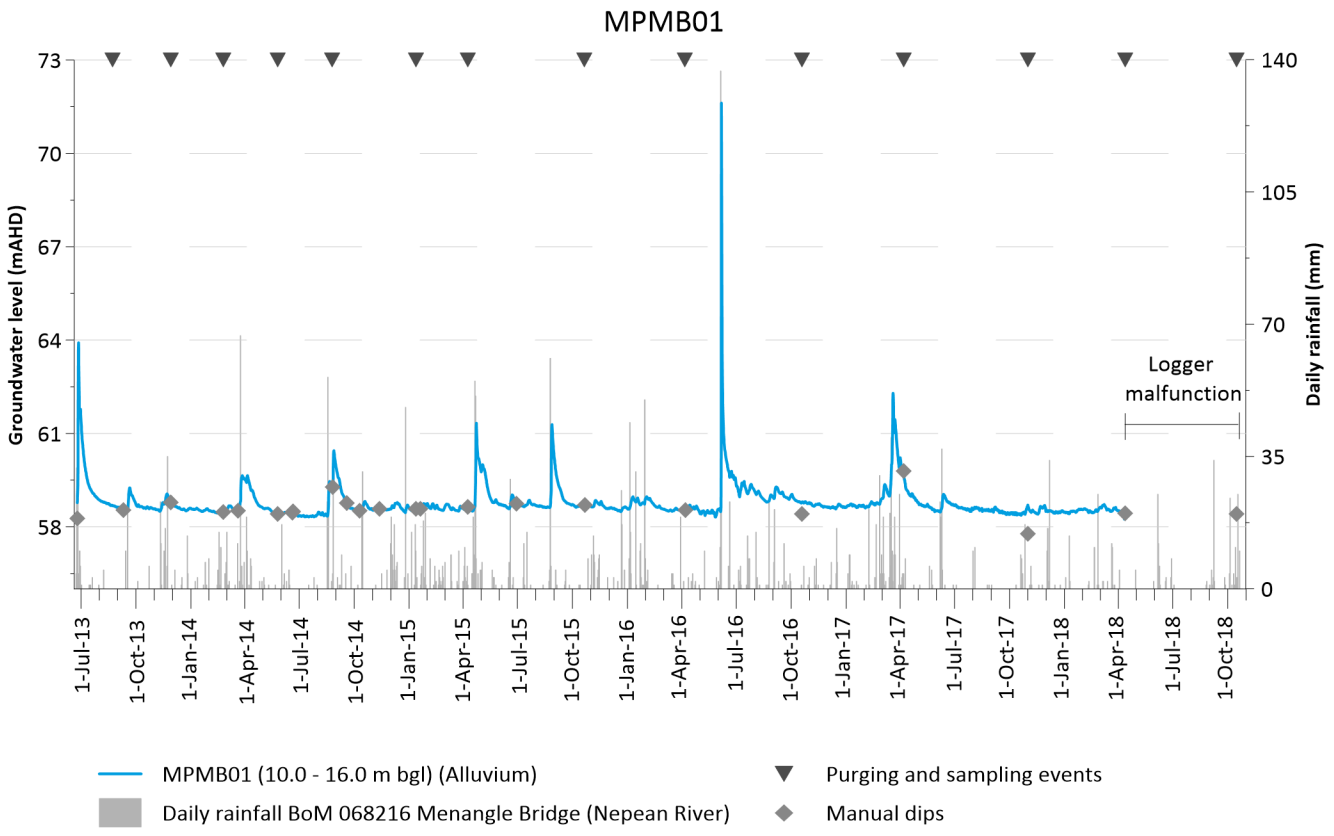
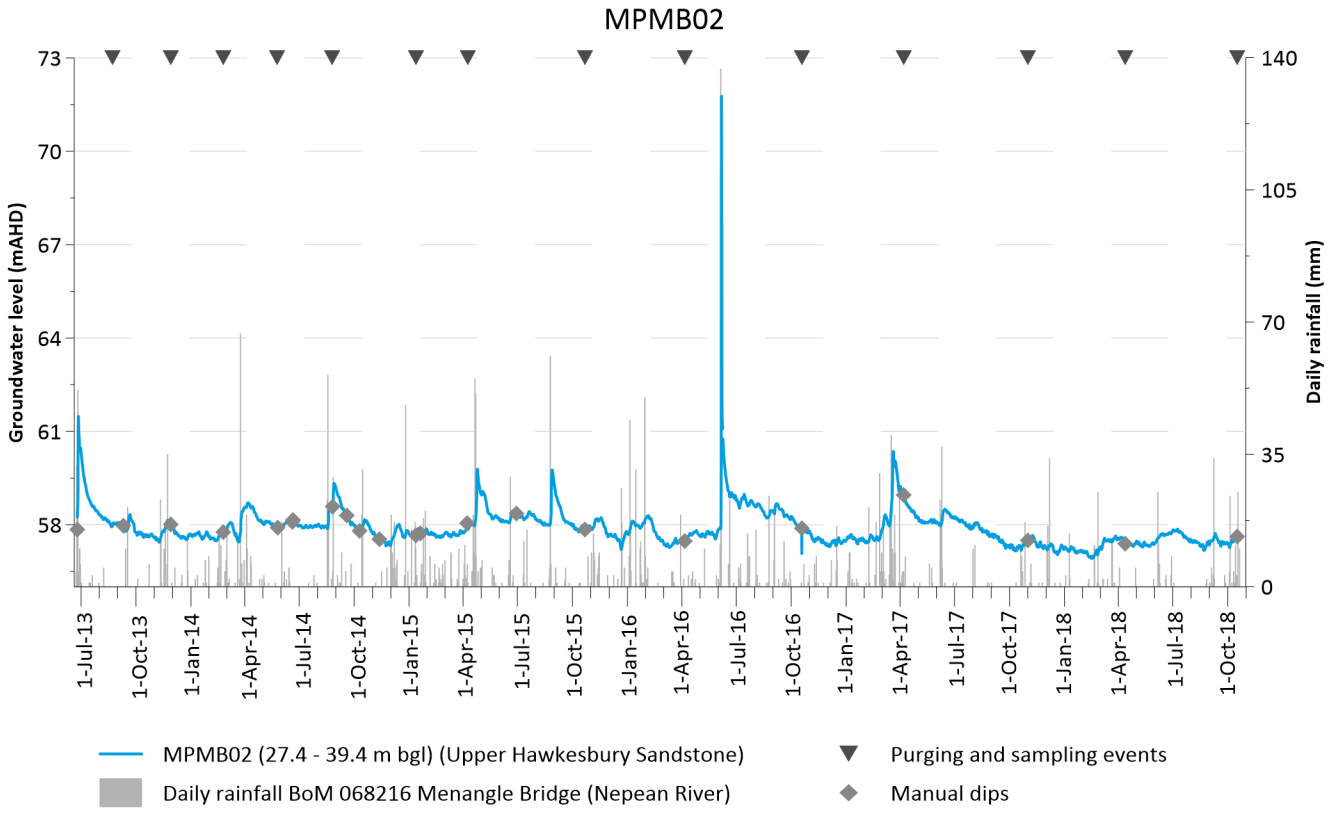
Reviewed: NF

Reference

EMM Consulting (EMM) 2018, *Camden Gas Project – FY17/18 Six-monthly monitoring update – April 2018,* prepared for AGL Energy Pty Ltd.



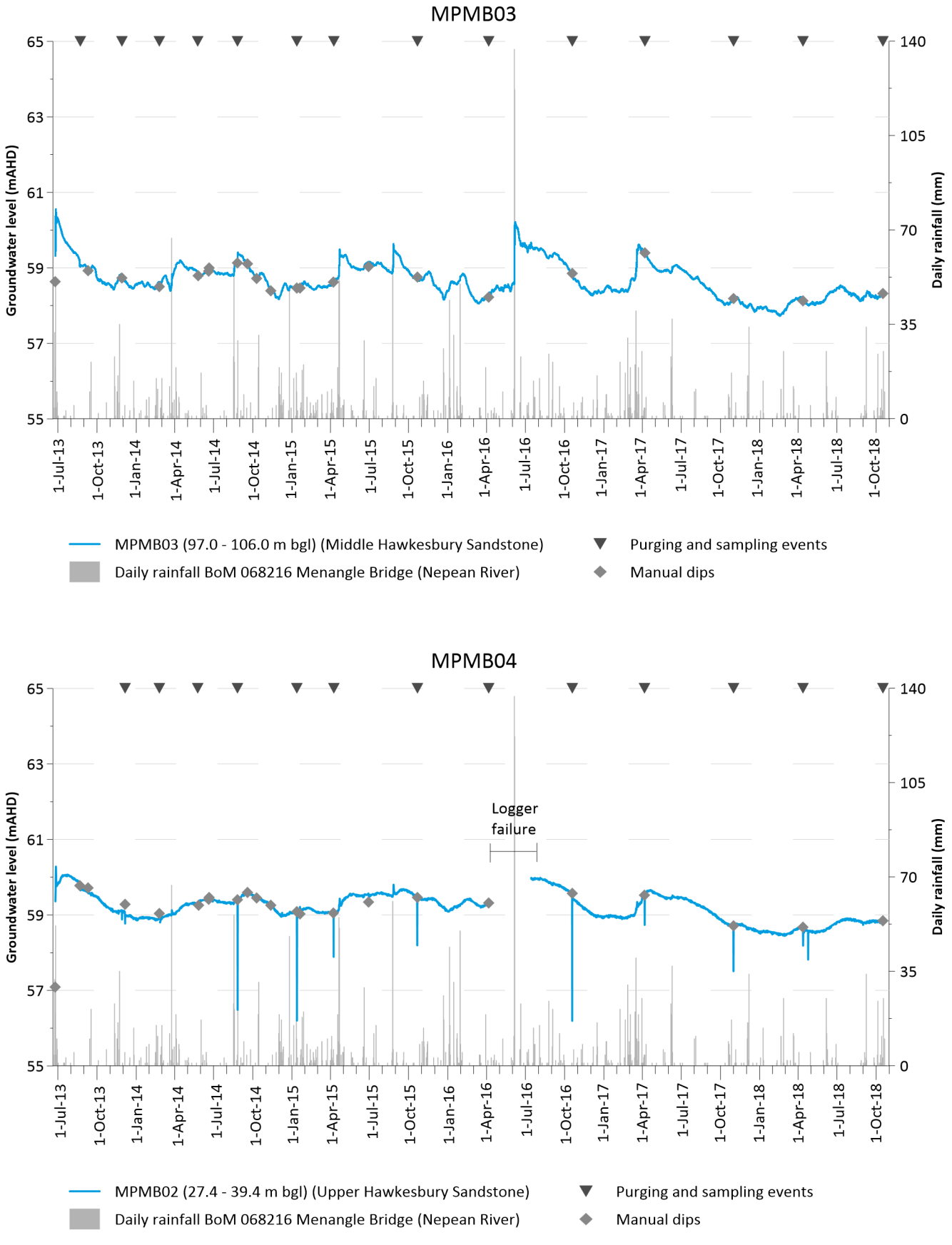


MPMB01 and MPMB02 hydrographs

Camden Gas Project

Six-monthly Monitoring Event - October 2018

Figure A.1

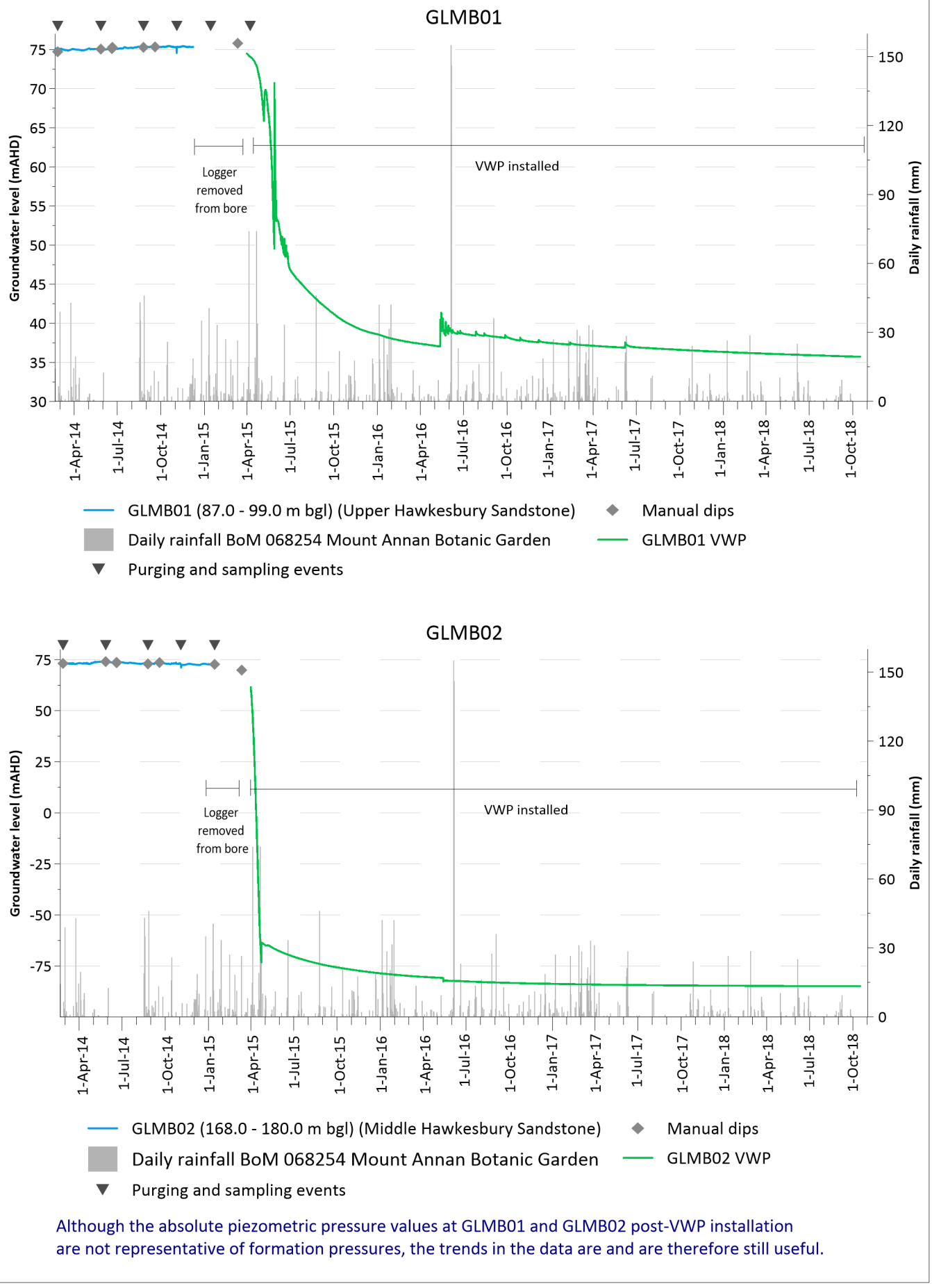


MPMB03 and MPMB04 hydrographs

Camden Gas Project

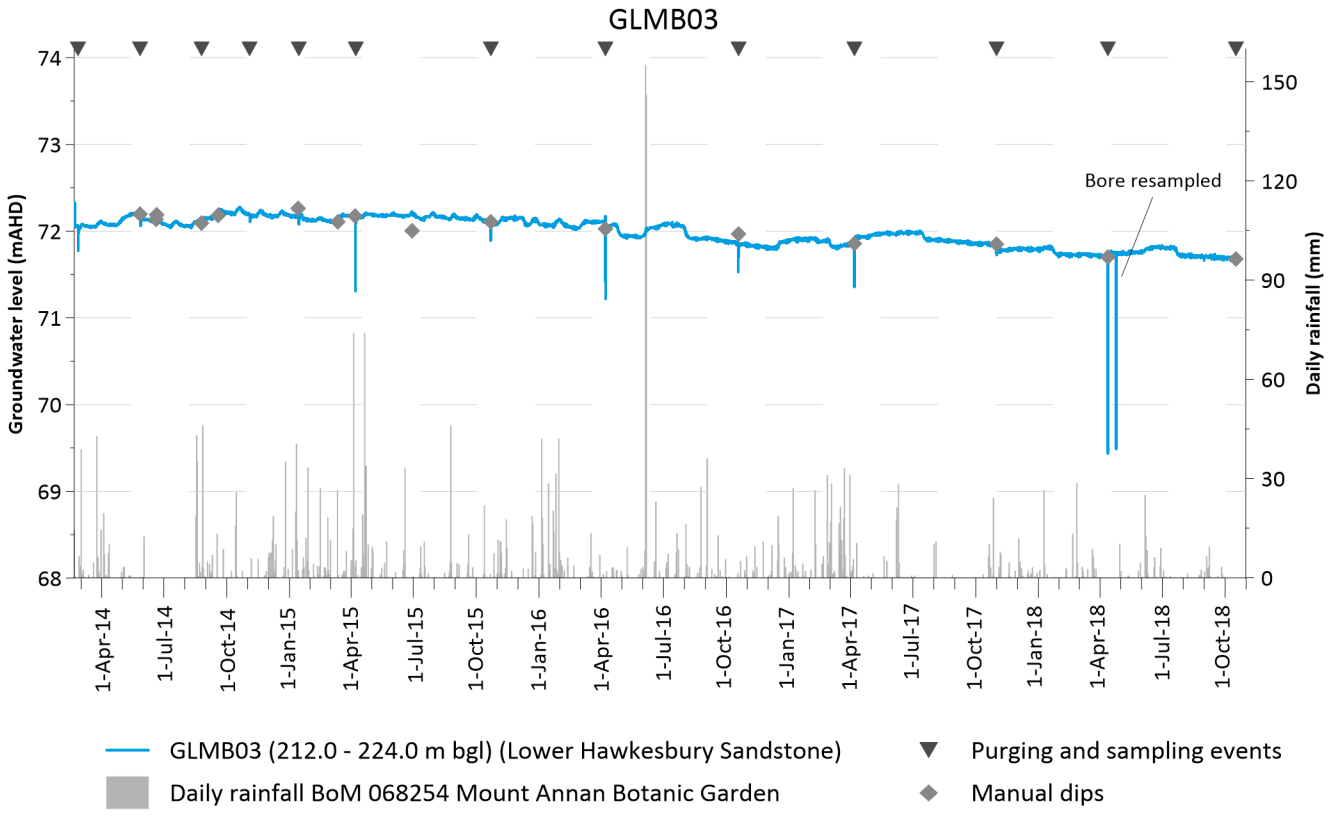
Six-monthly Monitoring Event - October 2018

Figure A.2



Although the absolute piezometric pressure values at GLMB01 and GLMB02 post-VWP installation are not representative of formation pressures, the trends in the data are and are therefore still useful.

GLMB01 and GLMB02 hydrographs
Camden Gas Project
Six-monthly Monitoring Event - October 2018
Figure A.3

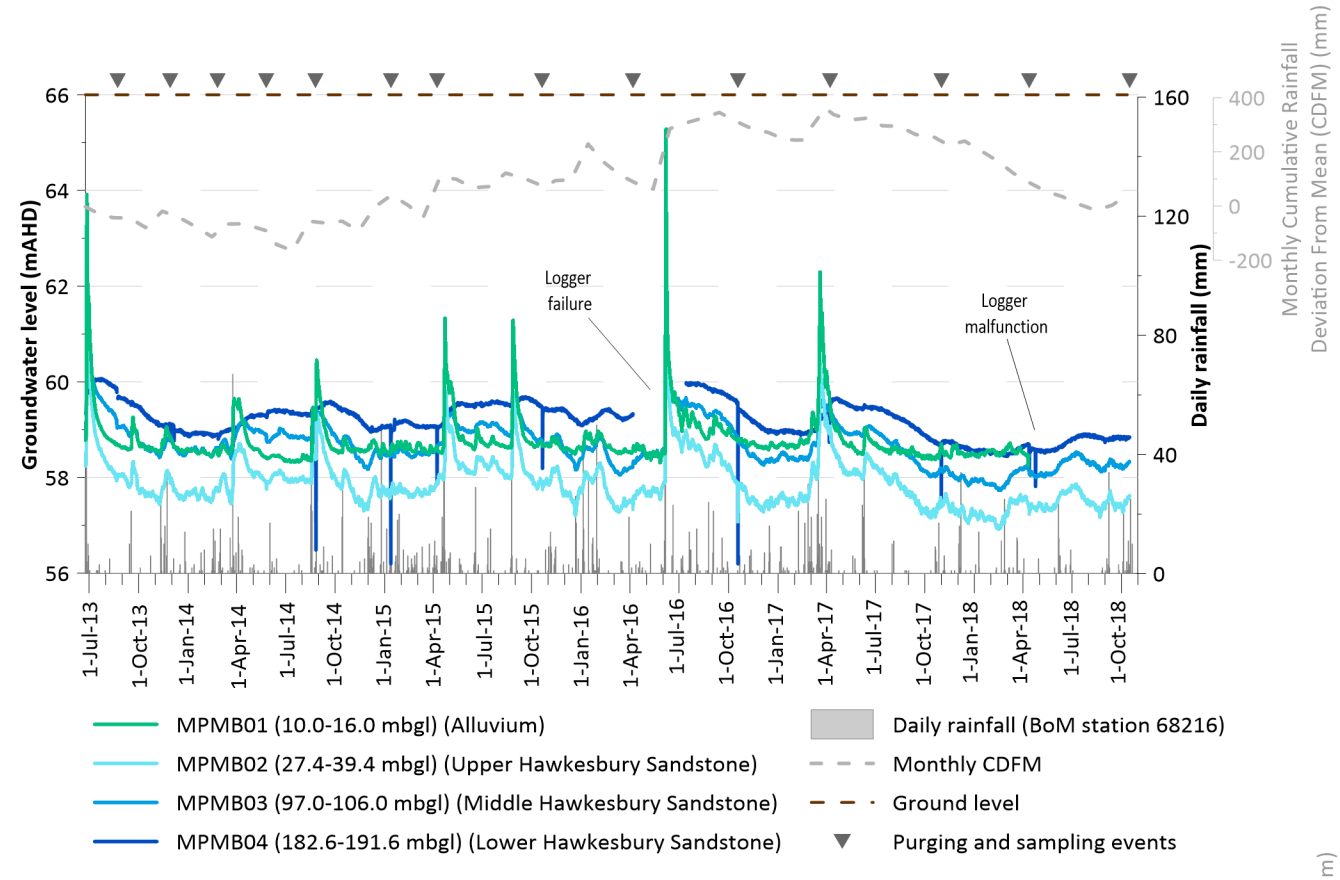


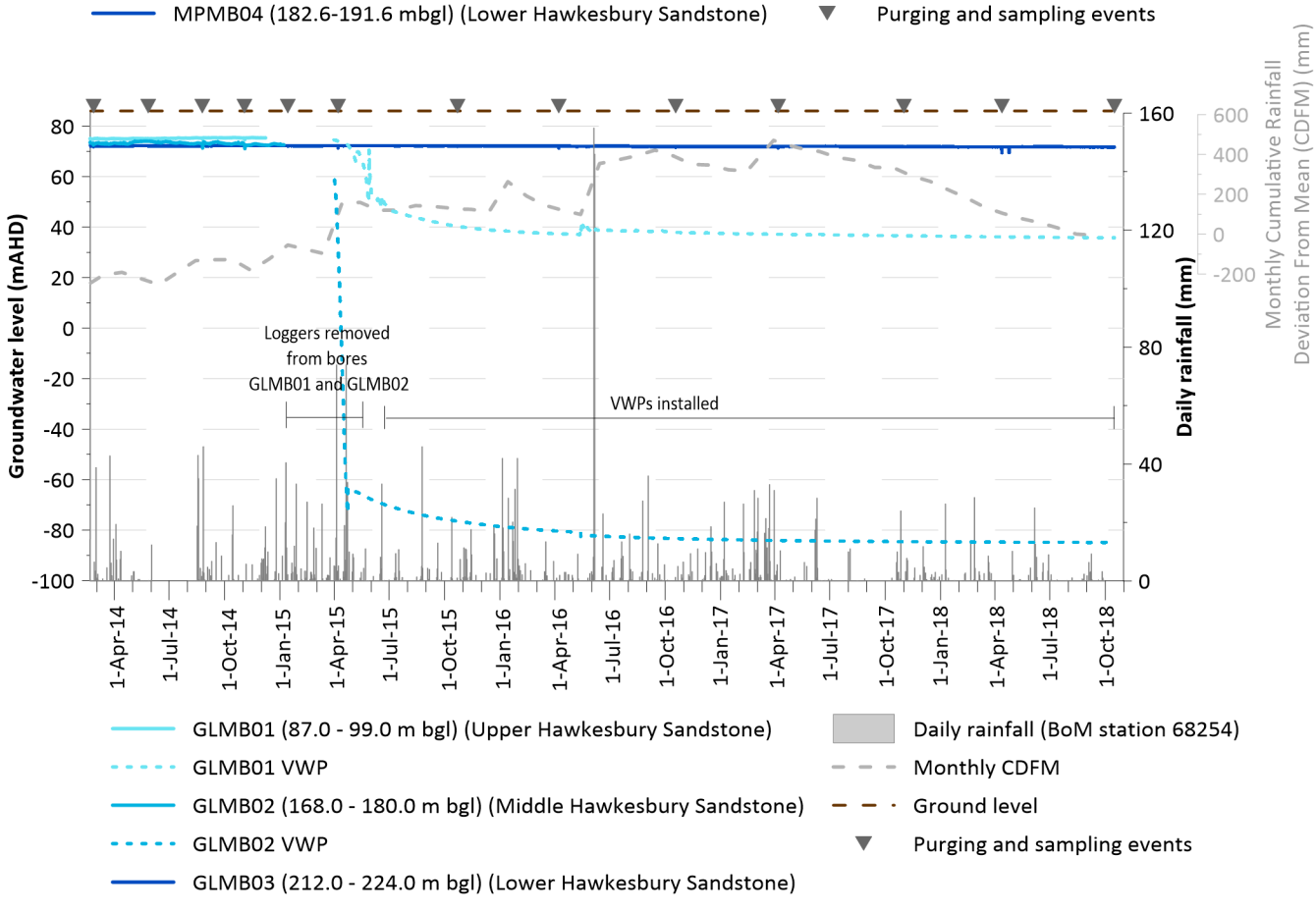
GLMB03 hydrograph

Camden Gas Project

Six-monthly Monitoring Event - October 2018

Figure A.4





Although the absolute piezometric pressure values at GLMB01 and GLMB02 post-VWP installation are not representative of formation pressures, the trends in the data are and are therefore still useful.

EMM

MPMB and GLMB hydrographs
Camden Gas Project
Six-monthly Monitoring Event - October 2018
Figure A.5

Table A.1 Water quality results six-monthly monitoring event - October 2018

		Field ID	16/10/2018	16/10/2018	16/10/2018	16/10/2018	16/10/2018	16/10/2018
		Date	GLMB03	MPMB01	MPMB02	MPMB03	MPMB04	Nepean River
		Water level (mbgl)	14.757	8.774	9.513	8.647	8.070	N/A
	Units	EQL						
Field parameters								
Dissolved Oxygen	mg/L		0.02	0.03	0.03	0.03	0.03	6.09
pH (field)	pH units		8.73	4.95	6.30	6.89	9.54	8.18
Electrical conductivity (field)	uS/cm		4,639	755	813	1,036	608	239
Electrical conductivity (lab)	µS/cm	1	5,550	887	934	1,190	718	292
Temp (Field)	°C		22.1	20.1	21.6	20.2	21.1	21.2
Dissolved oxygen (field)	%		0.2	0.3	0.3	0.3	0.3	68.7
Total dissolved solids (field)	mg/L		3,016	488	527	676	397	155
Total dissolved solids (lab)	mg/L	10	2,840	450	468	602	408	147
Suspended solids	mg/L	5	14	48	56	8	10	<5
Redox (field)	mV		-175.4	168.6	-81.3	-123.9	-195.7	-42.8
Laboratory analytes								
pH (Lab)	pH_Units	0.01	8.10	5.75	6.85	7.74	9.84	7.98
Alkalinity (Hydroxide) as CaCO3	mg/L	1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity-mg CaCO3/L	mg/L	1	<1	<1	<1	<1	119	<1
Bicarbonate Alkalinity-mg CaCO3/L	mg/L	1	1,980	14	183	495	75	58
Alkalinity (total) as CaCO3	mg/L	1	1,980	14	183	495	194	58
Sulfate as SO4 - Turbidimetric	mg/L	1	<5	3	5	<1	<1	8
Chloride	mg/L	1	728	252	172	74	79	36
Calcium	mg/L	1	134	10	34	88	2	4
Magnesium	mg/L	1	125	20	29	23	<1	4
Sodium	mg/L	1	915	103	86	110	126	36
Potassium	mg/L	1	36	1	4	12	7	2
Reactive Silica	mg/L	0.05	15.70	17.60	11.00	9.17	7.74	0.41
Fluoride	mg/L	0.1	<0.1	<0.1	0.10	0.10	0.50	<0.1
Bromide	mg/L	0.01	1.29	0.43	0.29	0.13	0.15	0.07
Cyanide Total	mg/L	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Dissolved metals								
Aluminium	mg/L	0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	0.028	<0.001	0.004	0.002	0.003	<0.001
Barium	mg/L	0.001	21.900	0.650	0.533	3.240	0.484	0.110
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05
Bromine	mg/L	0.1	1.5	0.5	0.3	0.1	0.2	<0.1
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	0.041	<0.001	0.001	<0.001	<0.001
Copper	mg/L	0.001	0.002	0.003	<0.001	<0.001	0.002	0.002
Iron	mg/L	0.05	0.35	0.13	4.20	1.41	<0.05	0.05
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.013	0.434	0.179	0.040	0.001	0.005
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.001	<0.001	<0.001	<0.001	0.008	0.002
Nickel	mg/L	0.001	0.001	0.015	0.002	<0.001	<0.001	0.003
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	0.001	5.280	0.130	0.454	0.878	0.106	0.054
Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	0.048	0.055	0.005	0.008	0.012	0.009
Nutrients								
Ammonia (as N)	mg/L	0.01	3.54	0.03	0.11	1.01	0.82	<0.01
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	0.03	0.36	<0.01	<0.01	0.03	0.01
Nitrite + Nitrate as N	mg/L	0.01	0.03	0.36	<0.01	<0.01	0.03	0.01
Total phosphorus	mg/L	0.01	<0.01	0.02	0.02	<0.01	<0.01	<0.01
Reactive phosphorus (as P)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total organic carbon	mg/L	1	32	2	<1	<1	4	3
Dissolved gases								
Methane	mg/L	0.01	27.00	0.03	0.82	22.70	32.40	<0.01
Ethane	mg/L	0.01	0.17	<0.01	<0.01	<0.01	<0.01	<0.01
Ethene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Propane	mg/L	0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01
Propene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Butene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Butane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenolic compounds								
Phenol	µg/L	1	<1	<1	<1	<1	<1	<1
2-chlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1
3-&4-methylphenol	µg/L	2	<2	<2	<2	<2	<2	<2
2-nitrophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4-dimethylphenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,6-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
4-chloro-3-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4,6-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4,5-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
Pentachlorophenol	µg/L	2	<2	<2	<2	<2	<2	<2
Polycyclic aromatic hydrocarb								
Acenaphthene	µg/L	1	<1	<1	<1	<1	<1	<1
Acenaphthylene	µg/L	1	<1	<1	<1	<1	<1	<1
Fluorene	µg/L	1	<1	<1	<1	<1	<1	<1
Phenanthrene	µg/L	1	<1	<1	<1	<1	<1	<1
Anthracene	µg/L	1	<1	<1	<1	<1	<1	<1
Fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1
Pyrene	µg/L	1	<1	<1	<1	<1	<1	<1
Benz(a)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1
Chrysene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(k)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(b&j)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(a) pyrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc (Zero)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1,2,3-c,d)pyrene	µg/L	1	<1	<1	<1	<1	<1	<1
Dibenz(a,h)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(g,h,i)perylene	µg/L	1	<1	<1	<1	<1	<1	<1
PAHs (Sum of total)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total petroleum hydrocarbons								
C 6 - C 9 Fraction	µg/L	20	120	<20	<20	<20	50	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50	<50	<50
TPH+C10 - C36 (Sum of total)	µg/L	50	<50	<50	<50	<50	<50	<50
Total recoverable hydrocarbons								
C6-C10 fraction	µg/L	20	120	<20	<20	<20	60	<20
C6 - C10 fraction minus BTEX	µg/L	20	20	<20	<20	<20	20	<20
C10 - C16 fraction	µg/L	100	<100	<100	<100	<100	<100	<100
TRH >C10-C16 less Naphthalene (F2)	µg/L	100	<100	<100	<100	<100	<100	<100
C16 - C34 fraction	µg/L	100	<100	<100	<100	<100	<100	<100
C34 - C40 fraction	µg/L	100	<100	<100	<100	<100	<100	<100
C10 - C40 fraction (Sum)	µg/L	100	<100	<100	<100	<100	<100	<100
Aromatic hydrocarbons								
Benzene	µg/L	1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	97	<2	<2	<2	40	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	<2	<2	<2	<2	<2	<2
Total BTEX	µg/L	1	97	<1	<1	<1	40	<1
Naphthalene	µg/L	1	<1	<1	<1	<1	<1	<1

Note: mbgl - metres below ground level; EQL - laboratory estimated quantitation limit