Memorandum

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28 October 2016

To Aaron Clifton
From Carolina Sardella

Subject Camden Gas Project- FY17 Six-monthly monitoring update - October 2016

Dear Aaron,

This memo presents the updated hydrographs for the Denham Court, Menangle Park and Glenlee groundwater monitoring bores to October 2016 and the water quality results for the October 2016 sampling event.
Key observations for this monitoring period (April to October 2016) are as follows:

- the water level at RMB01 continues to slowly increase, as per the historical trend;
- water levels at the Menangle Park monitoring bores show a response to the rainfall and flooding event in June 2016; this response decreases with depth;
- the VWP sensors at GLMB01 and GLMB02, have not stabilised during this monitoring period. As such, the data has not been presented in this report as it is considered unreliable; and
- the Denham Court monitoring bores were decommissioned prior to the October 2016 sampling event, as such no water quality data was collected for this monitoring period for these bores; however, water level data is included up to the date when the data loggers were removed (7 October 2016).

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

Figures A.1 – A.6: Individual hydrographs for the Denham Court, Menangle Park and Glenlee sites

Figures A.7 – A.8: Nested hydrographs for the Denham Court, Menangle Park and Glenlee sites

Table A.1: Water quality results for October 2016

Yours sincerely

Carolina Sardella
Senior Hydrogeologist
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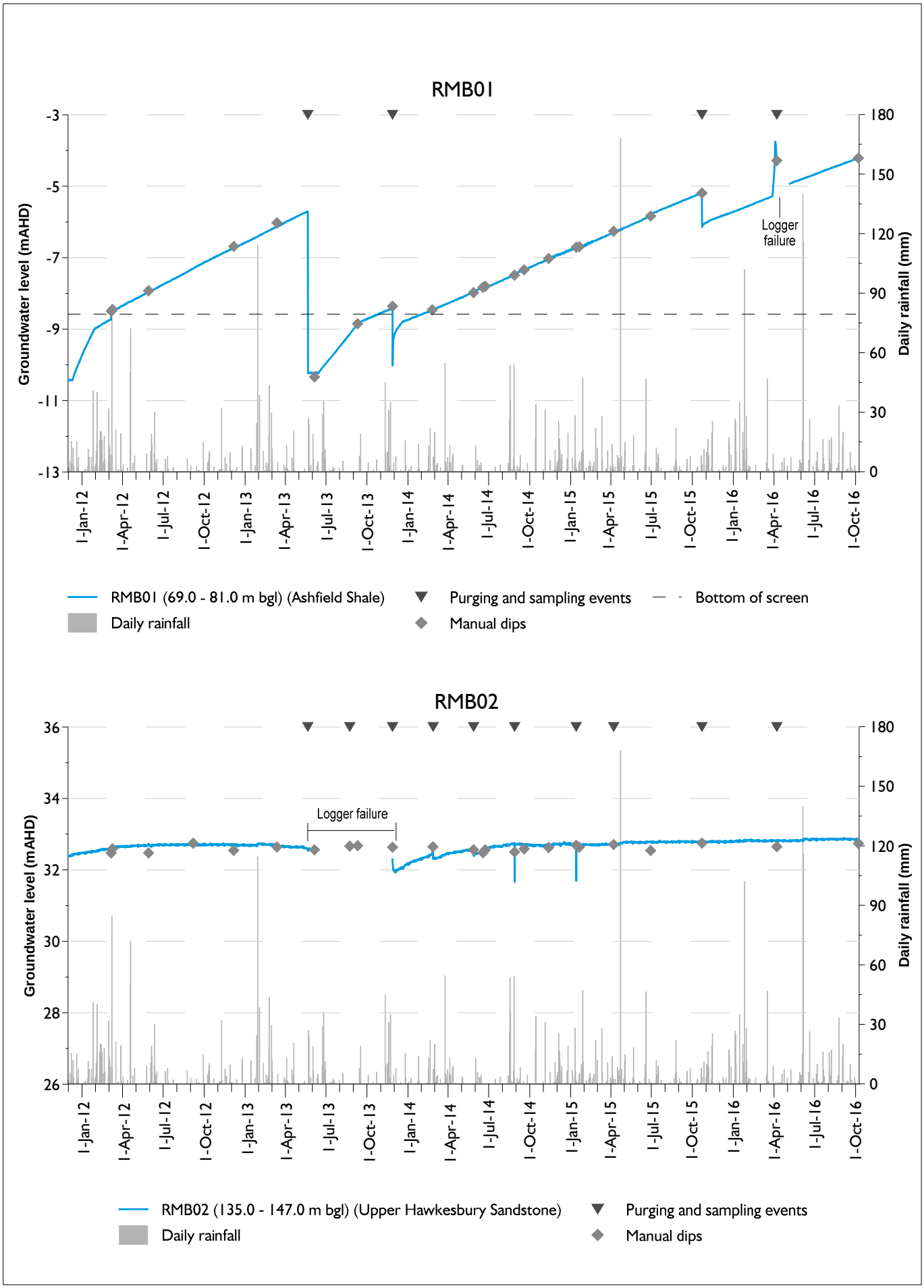

RMB01 and RMB02 hydrographs

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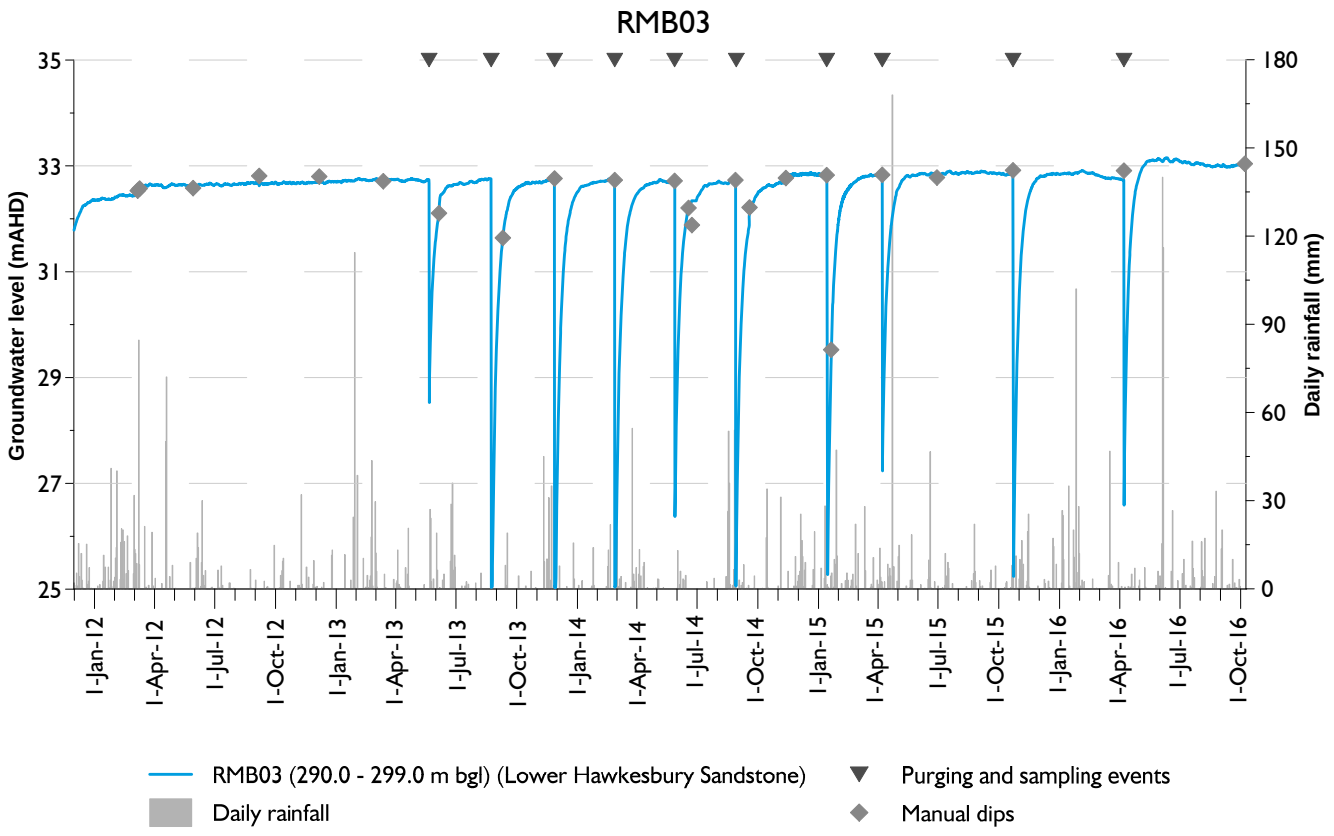
Figure A.1



RMB03 monitoring bore

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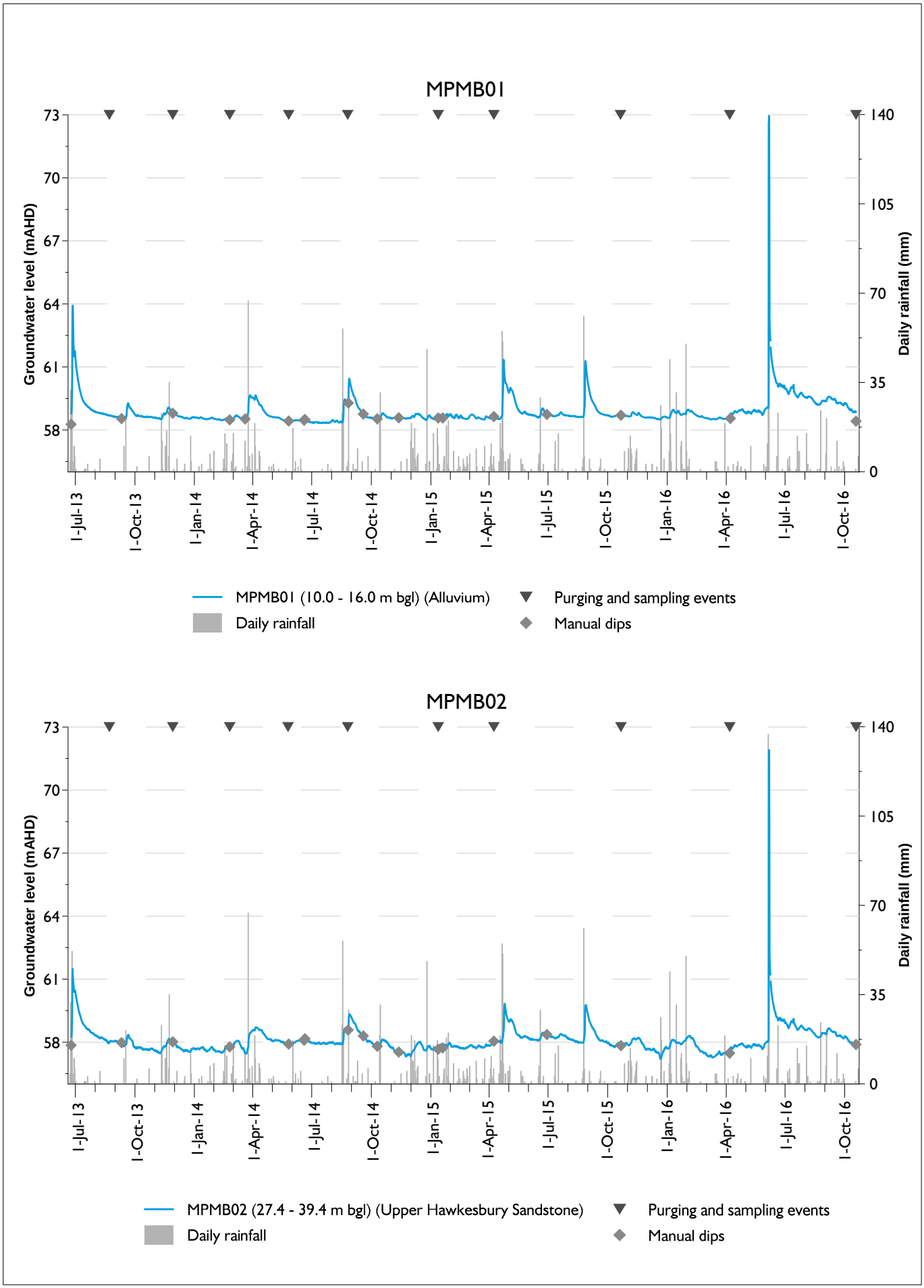
Figure A.2



MPMB01 and MPMB02 hydrographs

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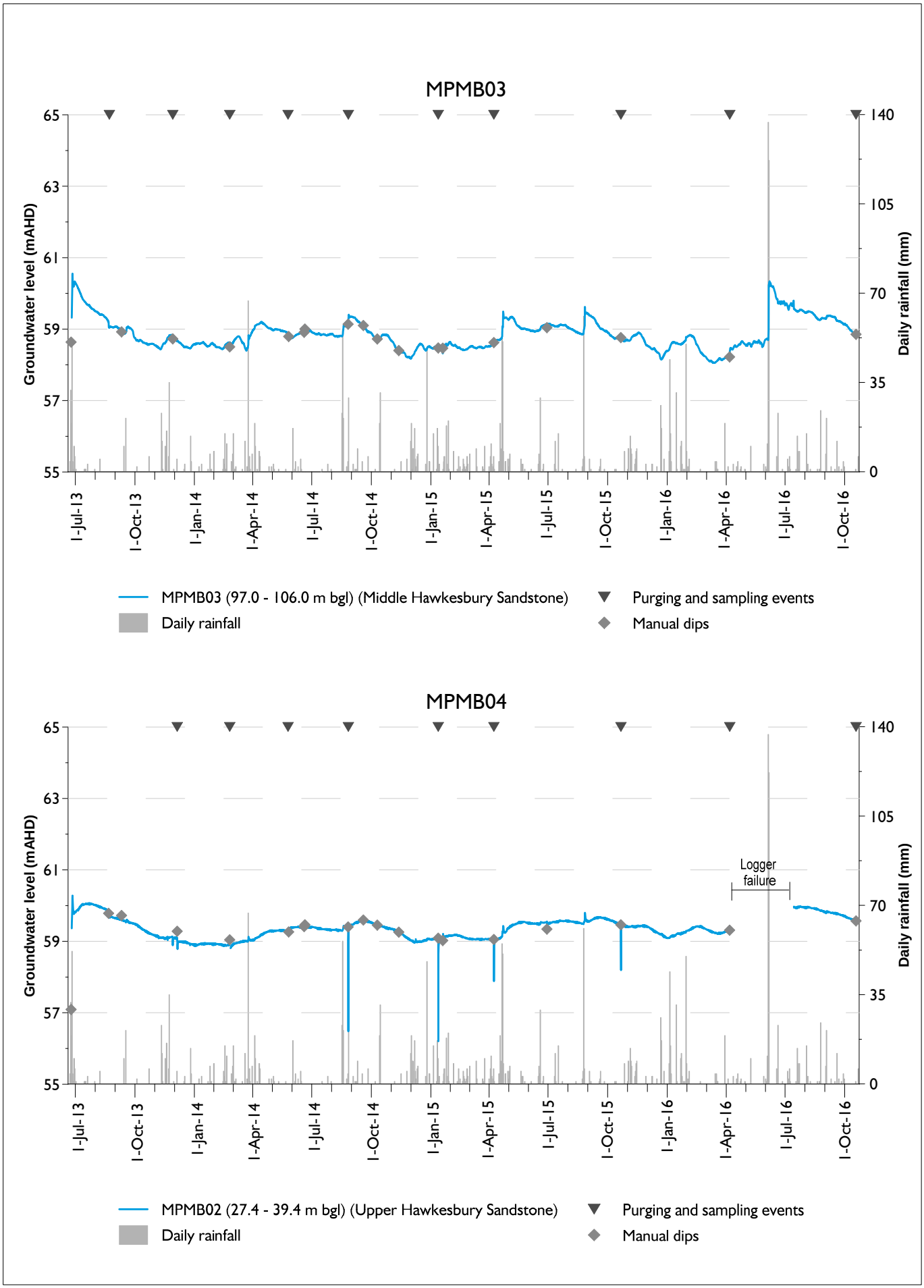
Figure A.3



MPMB03 and MPMB04 hydrographs

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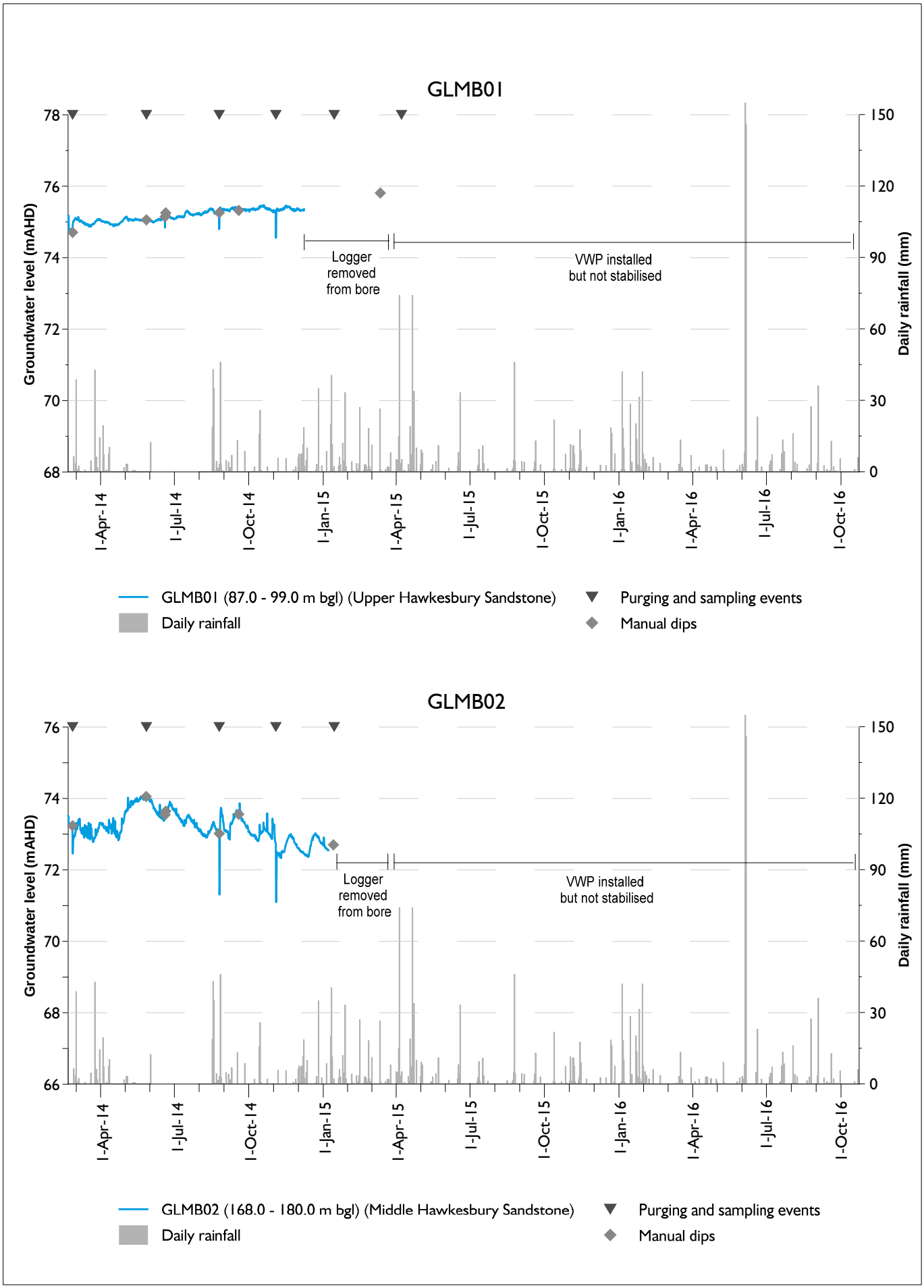
Figure A.4



GLMB01 and GLMB02 hydrographs

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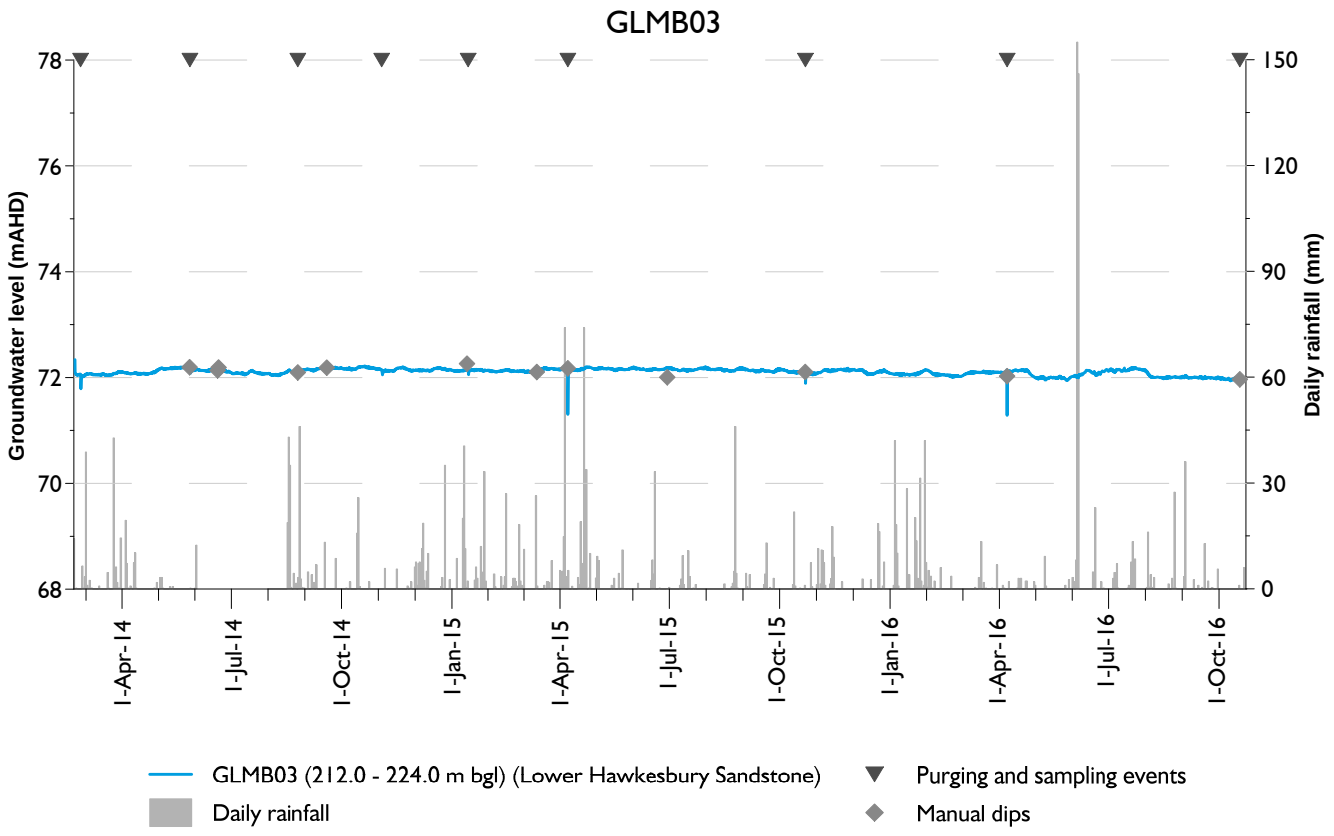
Figure A.5



GLMB03 hydrograph

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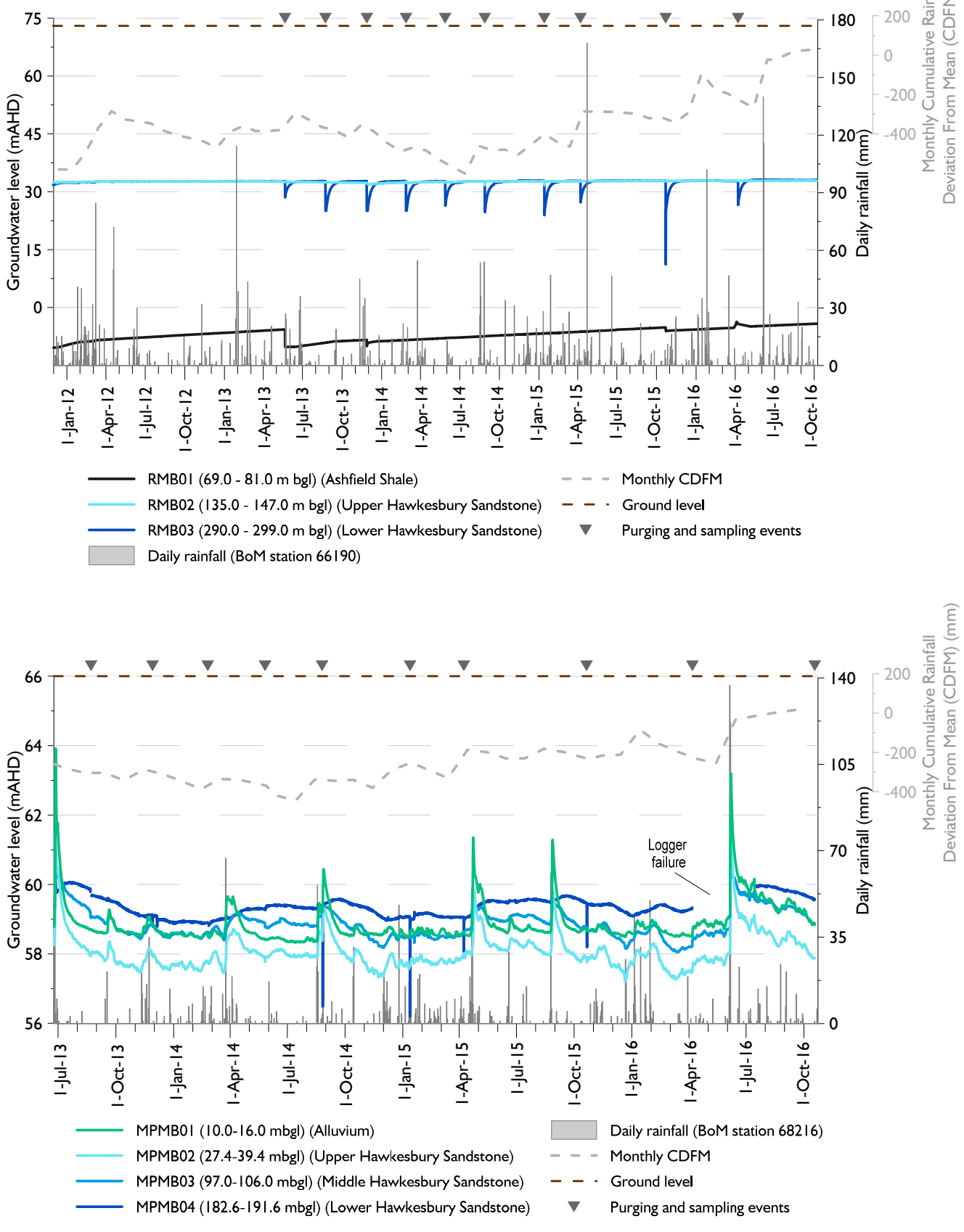
Figure A.6



RMB and MPMB hydrographs

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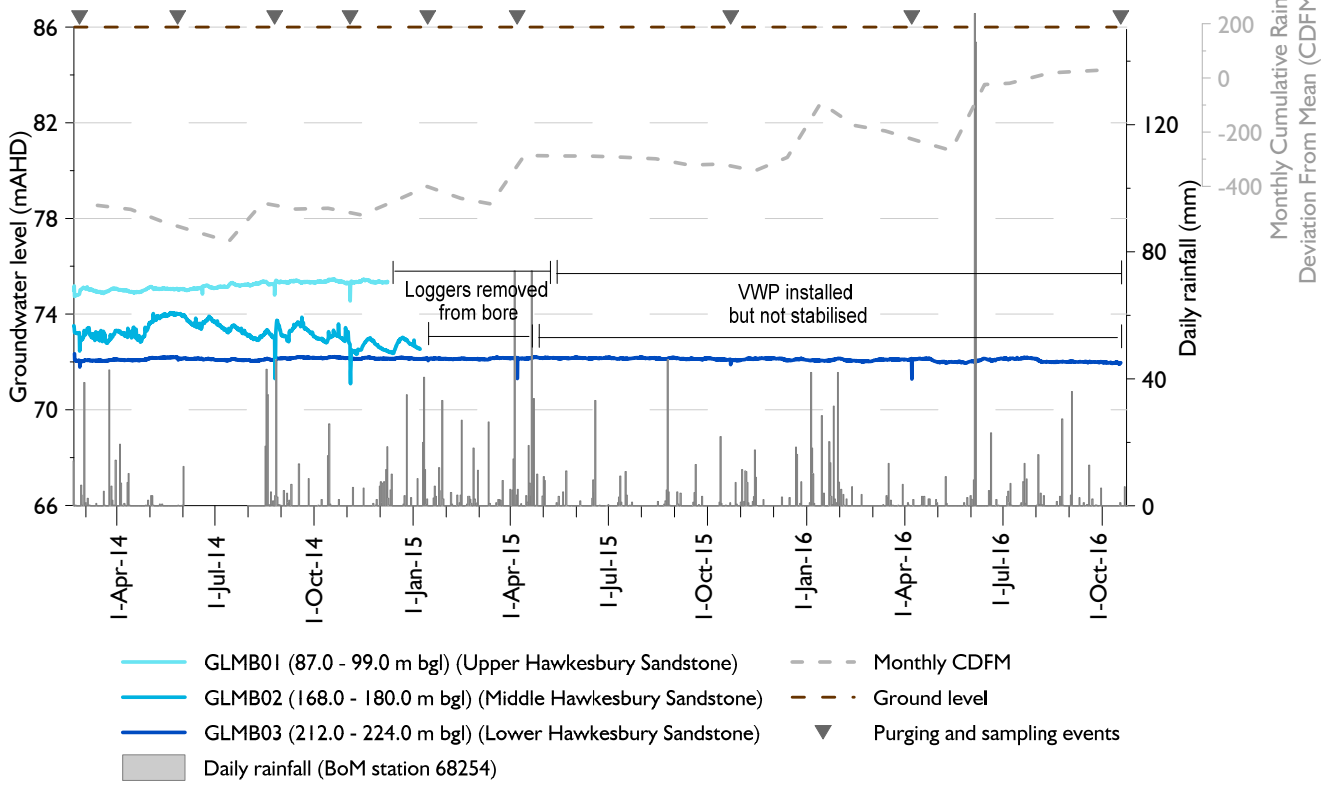
Figure A.7



GLMB hydrographs

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Figure A.8

TABLE A.1 - Water quality results October 2016

			Site ID	GLMB03	MPMB01	MPMB02	MPMB03	MPMB04	QA = MPMB02	ANZECC 2000 guideline values for fresh water ecosystems 95%*	Nepean River
			Sample date	18/10/2016	18/10/2016	18/10/2016	18/10/2016	18/10/2016	18/10/2016		18/10/2016
Chemical group	**Analyte**	**Units**	**Limit of recording**								
General parameters	pH (field)	pH units		7.71	5.36	6.77	7.09	9.99	-	6.5 - 8.0**	6.59
	Electrical conductivity (field)	µS/cm	1	4569	823	725	984	604	-	125 - 2,200**	154
	Electrical conductivity (lab)			4840	851	732	1010	619	728		168
	Temperature	°C		19.7	23.1	24	20.4	26	-		24
	Dissolved oxygen	%		7.2	4	4.3	7.7	5.4	-	80 - 110**	64.6
	Total dissolved solids (field)	mg/L		2971	533	474.5	63	390	-		100.1
	Total dissolved solids (lab)	mg/L	1	2880	527	408	551	371	414		98
	Suspended solids	mg/L	5	6	37	915	30	8	889		<5
	Redox	mV		-72.7	119.4	-85.5	-120.7	-271	-		87.5
Laboratory analytes	Hydroxide alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	<1		<1
	Carbonate alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	80	<1		<1
	Bicarbonate alkalinity as $CaCO_3$	mg/L	1	1790	21	144	431	72	144		22
	Total alkalinity as $CaCO_3$	mg/L	1	1790	21	144	431	152	144		22
	Sulphate as SO_4^{2-}	mg/L	1	<10	3	6	<1	<1	6		6
	Chloride	mg/L	1	654	267	143	68	87	142		33
	Calcium	mg/L	1	97	13	30	89	4	30		3
	Magnesium	mg/L	1	65	24	30	23	<1	29		3
	Sodium	mg/L	1	967	121	78	113	131	77		16
	Potassium	mg/L	1	35	2	3	12	7	3		1
	Reactive Silica	mg/L	0.05	18.4	18.1	11.1	8.76	5.77	11.2		1.71
	Fluoride	mg/L	0.1	0.1	<0.1	0.1	0.1	0.5	0.1		<0.1
	Bromide	mg/L	0.01	1.24	0.475	0.258	0.123	0.167	0.255		0.06
	Cyanide Total	mg/L	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.007	<0.004
Dissolved metals	Aluminium	mg/L	0.01	<0.01	0.02	0.02	<0.01	0.04	0.02	0.055	0.01
	Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
	Arsenic	mg/L	0.001	0.039	<0.001	0.012	0.033	0.003	0.012		<0.001
	Barium	mg/L	0.001	16.1	0.682	0.489	3.09	0.32	0.494		0.028
	Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
	Boron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.37	<0.05
	Bromine	mg/L	0.1	1.4	0.5	0.3	0.1	0.2	0.3		<0.1
	Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
	Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
	Cobalt	mg/L	0.001	<0.001	0.045	0.002	0.003	<0.001	0.002		<0.001
	Copper	mg/L	0.001	<0.001	0.006	<0.001	<0.001	<0.001	0.003	0.0014	0.007
	Iron	mg/L	0.05	0.46	0.7	4.53	4.11	<0.05	4.25		0.08
	Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0034	<0.001
	Manganese	mg/L	0.001	0.014	0.503	0.183	0.161	0.002	0.173	1.9	0.017
	Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0006	<0.0001
	Molybdenum	mg/L	0.001	0.004	<0.001	<0.001	<0.001	0.006	<0.001		<0.001
	Nickel	mg/L	0.001	<0.001	0.016	0.002	<0.001	<0.001	0.002	0.011	<0.001
	Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.011	<0.01
	Strontium	mg/L	0.001	3.73	0.14	0.299	0.82	0.079	0.294		0.028
	Uranium	mg/L	0.001	<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		<0.01
	Zinc	mg/L	0.005	0.135	0.047	0.005	0.007	0.083	0.008	0.008	0.007
Nutrients	Ammonia (as N)	mg/L	0.01	3.11	<0.01	0.09	0.94	0.93	0.08	0.02*	0.01
	Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Nitrate (as N)	mg/L	0.01	<0.01	0.22	<0.01	<0.01	<0.01	<0.01		0.11
	Nitrate + Nitrite (as N)	mg/L	0.01	<0.01	0.22	<0.01	<0.01	<0.01	<0.01		0.11
	Total phosphorus	mg/L	0.01	0.02	0.01	0.18	0.05	0.02	0.2	0.05*	<0.01
	Reactive phosphorus (as P)	mg/L	0.01	0.07	<0.01	<0.01	<0.01	0.01	<0.01	0.02*	<0.01
	Total organic carbon	mg/L	1	<1	1	2	<1	7	<1		4
Dissolved gases	Methane	mg/L	0.01	36.4	0.03	0.242	54.3	39.6	0.247		<0.01
	Ethane	mg/L	0.01	0.182	<0.01	<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		<0.01
	Propane	mg/L	0.01	0.041	<0.01	<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		<0.01
	Butene	mg/L	0.01	<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		<0.01
Phenolic compounds	Phenol	µg/L	1	<1	<1	<1	<1	2	<1	320	<1
	2-chlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	490	<1
	2-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	3-&4-methylphenol	µg/L	2	<2	<2	<2	<2	<2	<2		<2
	2-nitrophenol	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	2,4-dimethylphenol	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	2,4-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	160	<1
	2,6-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	4-chloro-3-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	2,4,6-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	20	<1
	2,4,5-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Pentachlorophenol	µg/L	2	<2	<2	<2	<2	<2	<2	10	<2
Polycyclic aromatic hydrocarbons	Acenaphthene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Acenaphthylene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Fluorene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Phenanthrene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Anthracene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Pyrene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Benz(a)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Chrysene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Benzo(k)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Benzo(b&j)fluoranthene	µg/L	1	<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		<0.5
	Benzo(a)pyrene TEQ calc (Zero)	µg/L	0.5	<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		<1
	Dibenz(a,h)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1		<1
	Benzo(g,h,i)perylene	µg/L	1	<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		<0.5
Total petroleum hydrocarbons	C_6-C_9 fraction	µg/L	20	170	<20	<20	<20	60	<20		<20
	C_{10}-C_{14} fraction	µg/L	50	<50	<50	<50	<50	<50	<50		<50
	C_{15}-C_{28} fraction	µg/L	100	<100	<100	<100	<100	<100	<100		<100
	C_{29}-C_{36} fraction	µg/L	50	<50	<50	<50	<50	<50	<50		<50
	C_{10}-C_{36} fraction (sum)	µg/L	50	<50	<50	<50	<50	<50	<50		<50
Total recoverable hydrocarbons	C_6-C_{10} fraction	µg/L	20	170	<20	<20	<20	60	<20		<20
	C_6-C_{10} fraction minus BTEX	µg/L	20	50	<20	<20	<20	<20	<20		<20
	$>C_{10}$-C_{16} fraction	µg/L	100	<100	<100	<100	<100	<100	<100		<100
	$>C_{16}$-C_{34} fraction	µg/L	100	<100	<100	<100	<100	<100	<100		<100
	$>C_{34}$-C_{40} fraction	µg/L	100	<100	<100	<100	<100	<100	<100		<100
	$>C_{10}$-C_{40} fraction (sum)	µg/L	100	<100	<100	<100	<100	<100	<100		<100
Aromatic hydrocarbons	Benzene	µg/L	1	<1	<1	<1	<1	<1	<1	950	<1
	Toluene	µg/L	2	122	<2	<2	<2	48	<2		<2
	Ethylbenzene	µg/L	2	<2	<2	<2	<2	<2	<2		<2
	Xylene (m & p)	µg/L	2	<2	<2	<2	<2	<2	<2		<2
	Xylene (o)	µg/L	2	<2	<2	<2	<2	<2	<2	350	<2
	Xylene Total	µg/L	2	<2	<2	<2	<2	<2	<2		<2
	Total BTEX	µg/L	1	122	<1	<1	<1	48	<1		<1
	Naphthalene	µg/L	1	<1	<1	<1	<1	<1	<1	16	<1

*Notes: * ANZECC (2000) Water Quality Guidelines only apply to Nepean River sample.*

*** ANZECC (2000) Water Quality Guidelines: 95% protection levels for the protection of freshwater aquatic ecosystems, south-east Australia, low lying river ecosystems.*