

The logo consists of a large tan square with the text "Energy in action.™" in blue. Below this square are three smaller tan squares of varying sizes, and a blue square with the AGL logo (a stylized sun icon and the letters "AGL") in white.

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AGL UPSTREAM INVESTMENTS
PTY LTD

GLOUCESTER GAS PROJECT

October 2015 Water Monitoring Report

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

Reporting Period: September 2015

AGL Upstream Investments Pty Ltd

ABN 58 115 063 744

Locked Bag 1837, St Leonards NSW 2065

Level 22, 101 Miller Street, North Sydney NSW 2060

Telephone: 02 9921 2999 Facsimile: 02 9921 2474

Complaints Line (24 hours): 1300 799 716



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)	23 September 2015
MONITORING BY	Parsons Brinckerhoff, on behalf of AGL
ANALYSIS BY	ALS Laboratory, Smithfield (Work order: ES1531965)
DATE AGL OBTAINED DATA	24 September 2015
REPORT DATE	15 October 2015
REPORT PREPARED BY	James Duggleby, Senior Hydrogeologist

Introduction

AGL is proposing to build the Gloucester Gas Project (GGP) which comprises several stages of development facilitating the extraction of coal seam gas (CSG) from the Gloucester Basin. Concept plan and project approval (Part 3A Approval) for the Stage 1 Gas Field Development Area (GFDA) was granted on 22 February 2011 under Part 3A of the Environmental Planning and Assessment Act (1979) (EP&A Act). In addition the project received approval under the Environment Protection and Biodiversity Conservation Act (1999) (EPBC Act) (EPBC Approval) on 11 February 2013.

The GGP will involve depressurising of deep groundwater and the extraction of gas from multiple coal seams within the Gloucester coal measures. Target coal seam depths will vary from site to site but are expected to range between 250 and 1,000 m below ground level (mbgl). The current GGP includes the construction, operation, and decommissioning of not more than 110 coal seam gas wells and associated infrastructure, including gas and water gathering lines within the Stage 1 GFDA. A comprehensive groundwater investigation (Phase 2 Groundwater Investigations) was completed in early 2012 to confirm the hydrogeological conceptual model across the Stage 1 GFDA (PB, 2012). Surface water and groundwater investigations are ongoing.

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 result from monthly sample at monitoring point 92 (AST2) (Appendix B).

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).

A telescopic sampler was used to collect grab samples from the flowback water monitoring point 92.

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).

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

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

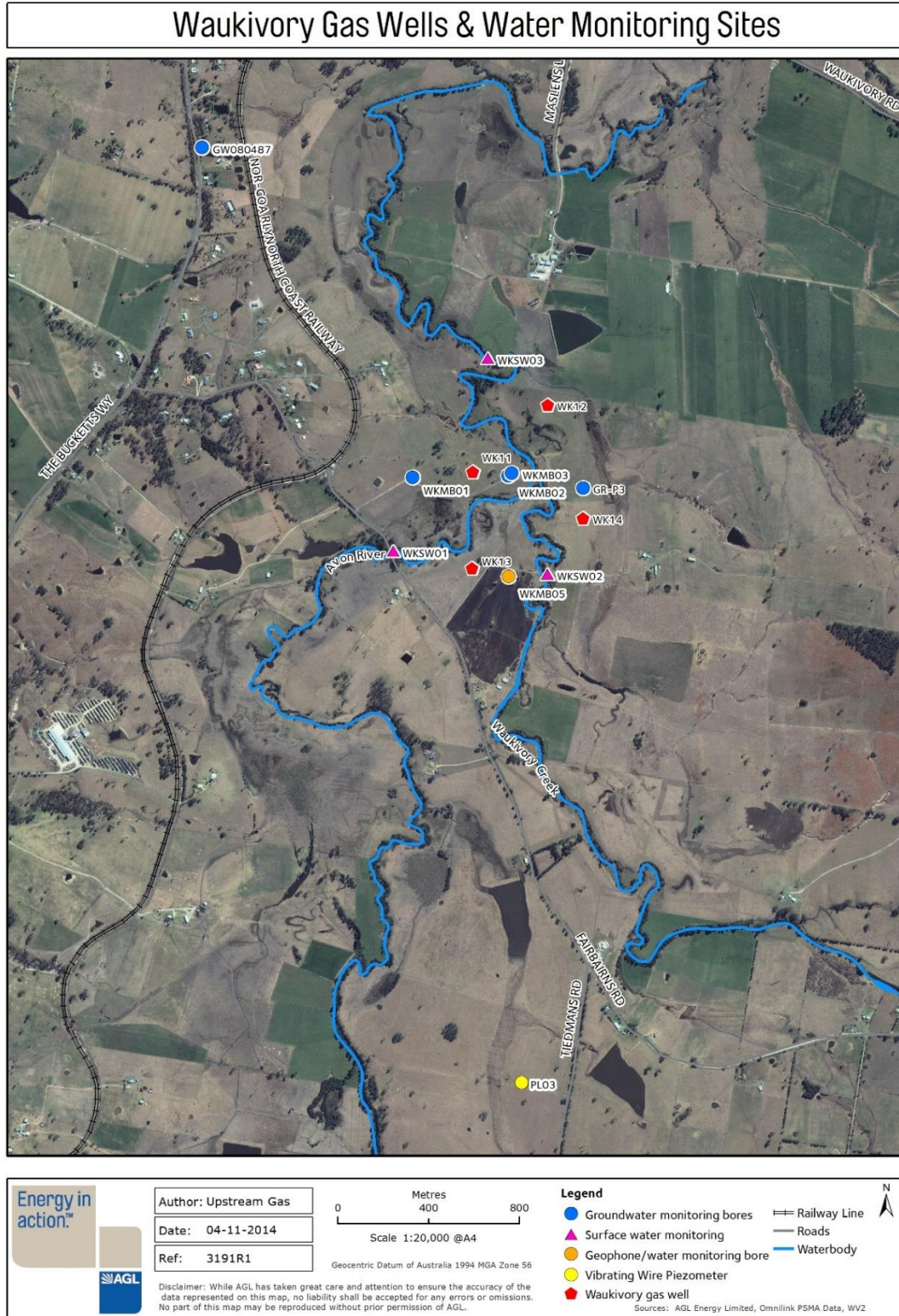
Table 1: Waukivory Pilot Project water monitoring points (as per EPL 20358)

EPA Identification no.	Monitoring Point	Type of monitoring point	Easting (m)	Northing (m)
7	WKSW03	Stream gauge (surface water)	402486.36	6453090.65
8	WKSW02	Stream gauge (surface water)	402748.00	6452139.00
9	WKSW01	Stream gauge (surface water)	402069.00	6452241.00
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
91	GW080487	Private groundwater bore	401226.00	6454020.00
92	AST2	Above ground storage tank	Located on the WK13 work pad	

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), 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>
- Parsons Brinckerhoff (PB), 2012. Phase 2 Groundwater Investigations – Stage 1 Gas Field Development Area, Gloucester Gas Project. Report dated January 2012, PR_5630. Available online: <http://www.agl.com.au/~media/AGL/About%20AGL/Documents/How%20We%20Source%20Energy/CSG%20and%20the%20Environment/Gloucester/Assessments%20and%20Reports/2012/January/PB%20Gloucester%20Groundwater%20Report%20Phase%202%20Appendices%20E-P.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 17 September 2015))

Pollutant	Units of measure	Monitoring points											
		7,8,9		10,11,90		91		14,85		86,87,88,89		92	
		Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method	Frequency	Sampling method
Aluminium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Ammonia	milligrams per litre			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Arsenic	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Barium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Benzene	micrograms per litre*			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample					Monthly	Grab sample
Beryllium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Bicarbonate	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Boron	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Cadmium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Calcium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Carbonate	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Chloride	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Chromium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Cobalt	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Copper	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Ethyl benzene	micrograms per litre*			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample					Monthly	Grab sample
Electrical conductivity	microsiemens per centimetre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Fluoride	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Iron	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Lead	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Magnesium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Manganese	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Mercury	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Methane	milligrams per litre			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Molybdenum	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Monoethanolamine Borate	micrograms per litre	Special Frequency 5	Method approved in writing by the Authority	Special Frequency 3	Method approved in writing by the Authority	Special Frequency 3	Method approved in writing by the Authority			Special Frequency 4	Method approved in writing by the Authority		
Nickel	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Nitrate	milligrams per litre			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Nitrite	milligrams per litre			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
pH	pH	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Phosphorus (total)	milligrams per litre			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Potassium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Reactive Phosphorus	milligrams per litre			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Selenium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Silica	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Sodium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Sodium Hypochlorite	milligrams per litre	Special Frequency 5	Special Method 7	Special Frequency 3	Special Method 7	Special Frequency 3	Special Method 7			Special Frequency 4	Special Method 7		
Standing water level	meters (Australian Height Datum)			Special Frequency 8	Special Method 5	Special Frequency 6	Special Method 1	Special Frequency 8	Special Method 5	Special Frequency 9	Special Method 3		
Strontium (dissolved)	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Sulfate	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Toluene	micrograms per litre*			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample					Monthly	Grab sample
Total dissolved solids	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Total organic carbon	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Total suspended solids	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Uranium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Vanadium	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		
Xylene	micrograms per litre*			Special Frequency 3	Grab sample	Special Frequency 3	Grab sample					Monthly	Grab sample
Zinc	milligrams per litre	Special Frequency 5	Grab sample	Special Frequency 3	Grab sample	Special Frequency 3	Grab sample			Special Frequency 4	Grab sample		

Notes:

Special Frequency 3 – 6 monthly

Special Frequency 4 – Every fortnight for the first 8 weeks of extraction from the commencement of the Waukivory pilot flow testing, then every 2 months thereafter until the cessation of the Waukivory pilot flow testing. Should the flow be suspended during that stage, then the timeframes will also be suspended and recommence when flows from the wells recommence.

Special Frequency 5 – One sampling event within 24 hours of the completion of the fracture stimulation of each well, and one sampling event one week after the completion of the fracture stimulation of each well & 6 months after cessation of fracture stimulation, then monthly for the next 12 months. Sampling requirements to be reassessed in May 2016.

Special Frequency 6 - One monitoring event to determine water level prior to the Waukivory Pilot Project fracture stimulation

Special Frequency 8 – Every 6 hours

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

*EPL20358 (issued 17 September 2015) contains inconsistencies in the required Units of Measure for Benzene, Toluene, Ethyl Benzene and Xylene. For consistency with laboratory data BTEX concentrations are reported here in micrograms per litre.



Appendix B: Water quality monitoring data for point 92

Analysis by: ALS Laboratory, Smithfield (Work order: ES1531965)

Monitoring points	92
Location	AST2
Sampled date	23/09/2015
Date AGL obtained data	24/09/2015
Monitoring event (see key below)	a

Analyte	Units of measure	Limit of reporting		Analyte
Aluminium	mg/L	0.01		Aluminium
Ammonia	mg/L	0.01		Ammonia
Arsenic	mg/L	0.001		Arsenic
Barium	mg/L	0.001		Barium
Benzene	µg/L	1	<1	Benzene
Beryllium	mg/L	0.001		Beryllium
Bicarbonate	mg/L	1		Bicarbonate
Boron	mg/L	0.05		Boron
Cadmium	mg/L	0.0001		Cadmium
Calcium	mg/L	1		Calcium
Carbonate	mg/L	1		Carbonate
Chloride	mg/L	0.1		Chloride
Chromium	mg/L	0.001		Chromium
Cobalt	mg/L	0.001		Cobalt
Copper	mg/L	0.001		Copper
Ethyl benzene	µg/L	2	<2	Ethyl benzene
Electrical conductivity	µS/cm	1		Electrical conductivity
Fluoride	mg/L	0.1		Fluoride
Iron	mg/L	0.05		Iron
Lead	mg/L	0.001		Lead
Magnesium	mg/L	1		Magnesium
Manganese	mg/L	0.001		Manganese
Mercury	mg/L	0.0001		Mercury
Methane	mg/L	0.01		Methane
Molybdenum	mg/L	0.001		Molybdenum
Monoethanolamine Borate	µg/L	1		Monoethanolamine Borate
Nickel	mg/L	0.001		Nickel
Nitrate	mg/L	0.01		Nitrate
Nitrite	mg/L	0.01		Nitrite
pH	pH Unit	0.01		pH
Phosphorus (total)	mg/L	0.01		Phosphorus (total)
Potassium	mg/L	1		Potassium
Reactive Phosphorus	mg/L	0.01		Reactive Phosphorus
Selenium	mg/L	0.01		Selenium
Silica	mg/L	0.05		Silica
Sodium	mg/L	1		Sodium
Sodium Hypochlorite (reported as free chlorine)	mg/L	0.2		Sodium Hypochlorite (reported as free chlorine)
Sodium Hypochlorite (reported as residual chlorine)	mg/L	0.2		Sodium Hypochlorite (reported as residual chlorine)
Standing water level	mAHD	0.01		Standing water level
Strontium (dissolved)	mg/L	0.001		Strontium (dissolved)
Sulfate	mg/L	1		Sulfate
Toluene	µg/L	2	<2	Toluene
Total dissolved solids	mg/L	10		Total dissolved solids
Total organic carbon	mg/L	1		Total organic carbon
Total suspended solids	mg/L	5		Total suspended solids
Uranium	mg/L	0.001		Uranium
Vanadium	mg/L	0.01		Vanadium
Xylene	µg/L	2	<2	Xylene
Zinc	mg/L	0.005		Zinc

Key:

Shaded grey = not required to be reported

Monitoring event:

a monthly sample

