

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

Energy in
action.™



AGL UPSTREAM INVESTMENTS PTY LTD

CAMDEN GAS PROJECT

Quarterly Produced Water Quality Monitoring Report

Reporting Period: FY16, 3rd Quarter – January / March 2016

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 | Rosalind Park Gas Plant Lot 35 Medhurst Road GILEAD NSW 2560 |
| LICENCE DETAILS | <u>Environment Protection Licence 12003</u> |
| LICENCEE | AGL Upstream Investments Pty Limited (AGL) |
| LICENCEE'S ADDRESS | Locked Bag 1837, North Sydney, NSW 2060 |
| MONITORING DATE | 3 rd Quarter – January / March 2016 (4 February 2016) |
| MONITORING BY | AGL |
| ANALYSIS BY | ALS Laboratory, Smithfield (Work order number: ES1602700) |
| DATE DATA OBTAINED | 13 February 2016 |
| REPORT DATE | 29 February 2016 |
| REPORT PREPARED BY | N. Fry, Hydrogeologist |
| REPORT REVIEWED BY | A. Clifton, NSW Environment Manager J. Duggleby, Lead Environment Business Partner |

Introduction

The Camden Gas Project (CGP) is owned and operated by AGL and is located in the Macarthur region 65 km southwest of Sydney, in the Wollondilly, Camden and Campbelltown Local Government Areas (Figure 1). The CGP has been producing gas for the Sydney region since 2001 and consists of 144 gas wells, low-pressure underground gas gathering pipes and a gas plant facility. Not all production wells are currently operational and some have been plugged and abandoned. The production wells are licensed with Water Access Licences, Works Approvals and Use Approvals under the *Water Management Act 2000* (NSW), including an allocation of 30 megalitres (ML) per year for the existing CGP and associated dewatering activities from the coal seams. In the 2014-15 financial year, approximately 2.2 ML of water was produced from the coal seams for the entire CGP operating wellfield.

This Monitoring Report relates to the groundwater monitoring activities specified in Part 5, Monitoring and Recording Conditions, of the Environment Protection Licence 12003. The Licence conditions stipulate groundwater monitoring is required to be carried out at the locations as shown in Table 1 and Figure 1. The specific analytes and frequency tested are shown in Table 2.

The monitoring points that are the subject of this report are part of the CGP groundwater monitoring network, as described in AGL's CGP Groundwater Management Plan (2015). Water samples are taken from each gas well at the separator. The deep groundwater (when brought to the surface) is known as produced water. 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 dissolved methane, phenols and PAHs, which were analysed with an alternate method following written approval from the EPA (EPA, 2014) (refer to Table 2 for analytical methodology).

Many of the operating wells within the CGP produce very low volumes of water; frequently, there is not enough water present to allow for sampling at these monitoring points. For the monitoring event in this reporting period (FY16 Q3) samples from only one monitoring point was able to be taken as there was not enough water present to sample at the remaining monitoring points. Samples were tested for all Quarterly analytes shown in Table 2.

This report (including amendments) is prepared in accordance with the *Requirements for Publishing Pollution Monitoring Data* (EPA, 2013) (Publication Requirements).

Table 3 displays the results of this quarter's monitoring.

Produced water from the coal seams at the CGP ranges in quality as a result of localised natural variations within the coal. Electrical conductivity (which is a measure of salinity) typically varies between about 7,000 and 15,000 $\mu\text{S}/\text{cm}$. However, it is not unusual to see values outside of this range. Low volume water producing wells frequently show very low electrical conductivity values as a result of evaporation and condensation processes occurring in the well bore (PB, 2013). These very low values are not representative of formation water samples. It is noted that the result obtained from this monitoring event (FY16 Q3) at monitoring point 10 (RB10) is a typical value of electrical conductivity for produced water within the CGP.

More information on the hydrogeology and groundwater of the CGP is available in the Hydrogeological Summary (AGL, 2013) which can be viewed at the CGP website: agl.com.au/Camden

Table 1- Groundwater quality monitoring points (as per EPL 12003)

| EPA monitoring point | Location | Easting (m) | Northing (m) |
|----------------------|----------|-------------|--------------|
| 8 | EM40 | 290847.38 | 6226891.16 |
| 9 | SF08 | 291443.09 | 6228310.08 |
| 10 | RB10 | 288211.17 | 6219746.92 |
| 11 | MT05 | 290356.75 | 6221081.15 |
| 12 | MP12 | 293574.90 | 6224380.09 |
| 13 | MP30 | 291760.40 | 6225066.50 |
| 14 | RP12 | 293397.37 | 6222719.00 |
| 15 | SL03 | 294583.77 | 6224486.19 |

Coordinate reference system: Map Grid of Australia 1994 Zone 56

Table 2 – Analytes monitored, frequency (as per EPL 12003) and methodology

| Analyte | Units of measure | Frequency | Sampling Method | Analytical method |
|---|-----------------------------|-----------|-----------------|--|
| Aluminium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Ammonia | milligrams per litre | Yearly | Grab sample | APHA (1998) section 4500-NH3 |
| Arsenic | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Barium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Benzene | milligrams per litre | Yearly | Grab sample | USEPA (1996b) method 8260B |
| Beryllium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Bicarbonate | milligrams per litre | Quarterly | Grab sample | APHA (1998) 2320 |
| Boron | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Bromide | milligrams per litre | Quarterly | Grab sample | APHA (1998) section 4110 |
| Cadmium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Calcium | milligrams per litre | Quarterly | Grab sample | APHA (1998) section 3030B then APHA (1998) section 3120 |
| Carbonate | milligrams per litre | Quarterly | Grab sample | APHA (2012) 2320B |
| Chloride | milligrams per litre | Quarterly | Grab sample | APHA (1998) section 4110 |
| Chromium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Cobalt | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Copper | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Electrical conductivity | microsiemens per centimetre | Quarterly | Grab sample | APHA (1998) section 2510 B |
| Ethyl benzene | milligrams per litre | Yearly | Grab sample | USEPA (1996b) method 8260B |
| Fluoride | milligrams per litre | Quarterly | Grab sample | APHA (1998) section 4500-F- C |
| Iron | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Lead | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Magnesium | milligrams per litre | Quarterly | Grab sample | APHA (1998) section 3030B then APHA (1998) section 3120 |
| Manganese | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Mercury | milligrams per litre | Quarterly | Grab sample | Preliminary treatment APHA (1998) section 3030B; Then APHA (1998) section 3112 |
| Methane | milligrams per litre | Yearly | Grab sample | In house static headspace GC/FID technique |
| Molybdenum | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Nickel | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Nitrate | milligrams per litre | Yearly | Grab sample | APHA (1998) section 4500-NO3-F |
| Nitrite | milligrams per litre | Yearly | Grab sample | APHA (1998) section 4500-NO3-F (with cadmium column removed) |
| Phenols | milligrams per litre | Yearly | Grab sample | USEPA (1996a) method 8270 D |
| Polycyclic aromatic hydrocarbons | milligrams per litre | Yearly | Grab sample | USEPA (1996a) method 8270 D |
| Potassium | milligrams per litre | Quarterly | Grab sample | Preliminary treatment APHA (1998) section 3030B then APHA (1998) section 3120 |
| Reactive Phosphorus | milligrams per litre | Yearly | Grab sample | APHA (1998) section 4500-P B; followed by APHA (1998) section 4500-P E |
| Selenium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Silica | milligrams per litre | Quarterly | Grab sample | APHA 21st ed., 3120 |
| Sodium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Strontium (dissolved) | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3030(E-K) then USEPA (1994f) method 6020 |

| Analyte | Units of measure | Frequency | Sampling Method | Analytical method |
|-------------------------------------|----------------------|-----------|-----------------|---|
| Sulfate | milligrams per litre | Quarterly | Grab sample | APHA(1998) section 4500 SO42--E |
| Toluene | milligrams per litre | Yearly | Grab sample | USEPA (1996b) method 8260B |
| Total dissolved solids | milligrams per litre | Quarterly | Grab sample | APHA (1998) section 2540C |
| Total petroleum hydrocarbons | milligrams per litre | Yearly | Grab sample | USEPA (1996h) method 8015B |
| Uranium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Vanadium | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |
| Xylene | milligrams per litre | Yearly | Grab sample | USEPA (1996b) method 8260B |
| Zinc | milligrams per litre | Quarterly | Grab sample | USEPA (1992a) method 3005A then USEPA (1994f) method 6020 |

Groundwater Monitoring Results

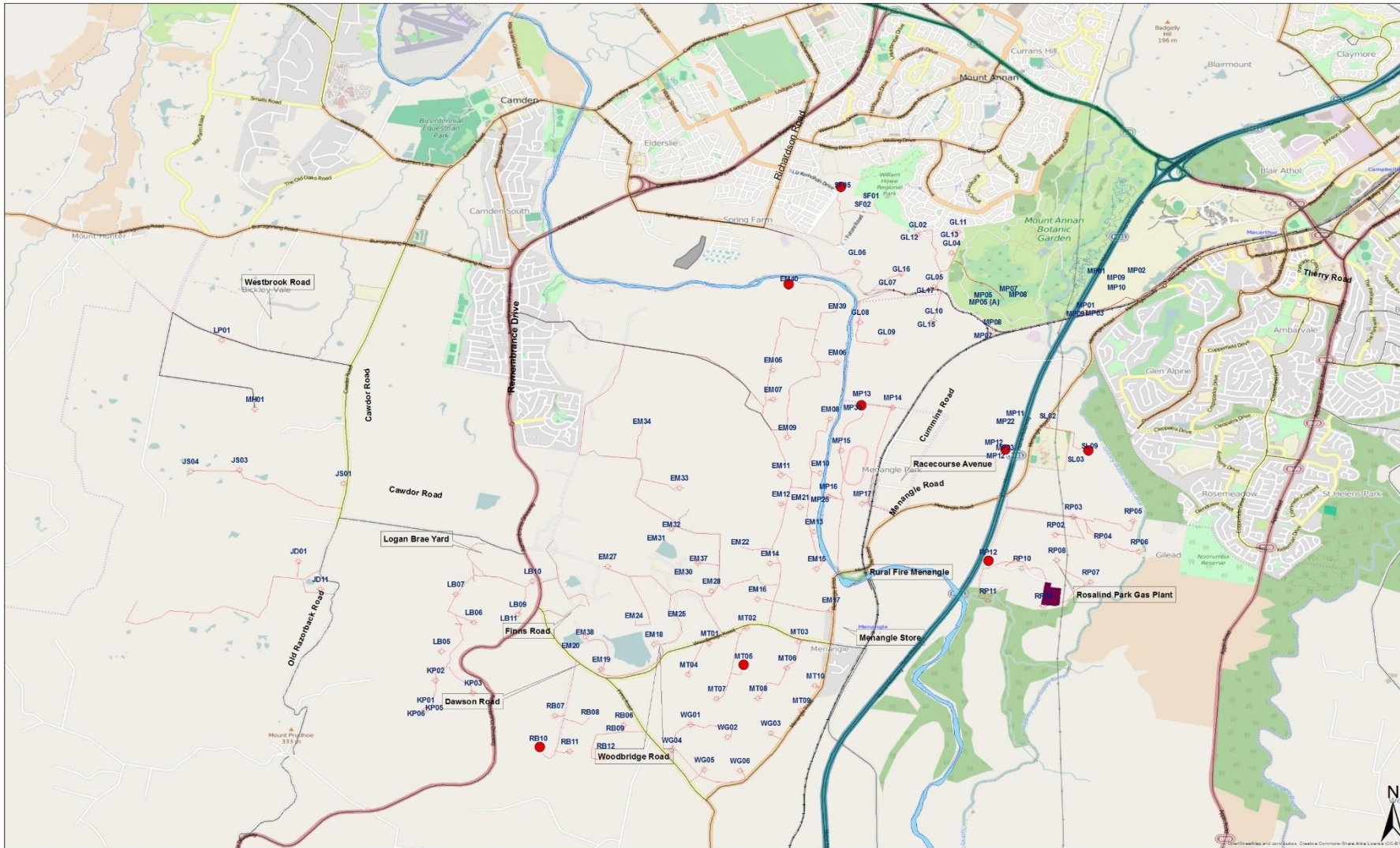
Table 3 - Produced water monitoring results for 3rd Quarter – January / March 2016

| | | | Monitoring point | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|--------------------|---------------------------------|--------------------|------------------|---------------------------------------|---------------------------------------|-----------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| | | | Location | EM40 | SF08 | RB10 | MT05 | MP12 | MP30 | RP12 | SL03 |
| | | | Sampled Date | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | 4/2/2016 | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) |
| | | | Data obtained | na | na | 13/2/2016 | na | na | na | na | na |
| Analyte | Units | Limit of reporting | | | | | | | | | |
| Physicochemical | Electrical Conductivity @ 25°C | µS/cm | 1 | - | - | 12200 | - | - | - | - | - |
| | Total Dissolved Solids @180°C | mg/L | 10 | - | - | 9160 | - | - | - | - | - |
| Major Cations | Calcium | mg/L | 1 | - | - | 23 | - | - | - | - | - |
| | Magnesium | mg/L | 1 | - | - | 10 | - | - | - | - | - |
| | Potassium | mg/L | 1 | - | - | 25 | - | - | - | - | - |
| | Sodium | mg/L | 1 | - | - | 3610 | - | - | - | - | - |
| Major Anions | Bicarbonate Alkalinity as CaCO3 | mg/L | 1 | - | - | 8000 | - | - | - | - | - |
| | Carbonate Alkalinity as CaCO3 | mg/L | 1 | - | - | 485 | - | - | - | - | - |
| | Chloride | mg/L | 0.1 | - | - | 135 | - | - | - | - | - |
| Metals (dissolved) | Aluminium | mg/L | 0.01 | - | - | 0.01 | - | - | - | - | - |
| | Arsenic | mg/L | 0.001 | - | - | 0.005 | - | - | - | - | - |
| | Barium | mg/L | 0.001 | - | - | 9.98 | - | - | - | - | - |
| | Beryllium | mg/L | 0.001 | - | - | <0.001 | - | - | - | - | - |
| | Boron | mg/L | 0.05 | - | - | 0.12 | - | - | - | - | - |
| | Cadmium | mg/L | 0.0001 | - | - | <0.0001 | - | - | - | - | - |
| | Chromium | mg/L | 0.001 | - | - | 0.004 | - | - | - | - | - |
| | Cobalt | mg/L | 0.001 | - | - | <0.001 | - | - | - | - | - |
| | Copper | mg/L | 0.001 | - | - | <0.001 | - | - | - | - | - |
| | Iron | mg/L | 0.05 | - | - | 0.44 | - | - | - | - | - |

| Monitoring point | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|------------------|---------------------------------------|---------------------------------------|-----------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|
| Location | EM40 | SF08 | RB10 | MT05 | MP12 | MP30 | RP12 | SL03 |
| Sampled Date | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | 4/2/2016 | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) | Not enough water to sample (4/2/2016) |
| Data obtained | na | na | 13/2/2016 | na | na | na | na | na |

| | Analyte | Units | Limit of reporting | | | | | | | |
|--------------|------------------------|-------|--------------------|---|---|---------|---|---|---|---|
| | Lead | mg/L | 0.001 | - | - | <0.001 | - | - | - | - |
| | Manganese | mg/L | 0.001 | - | - | 0.002 | - | - | - | - |
| | Mercury | mg/L | 0.0001 | - | - | <0.0001 | - | - | - | - |
| | Molybdenum | mg/L | 0.001 | - | - | 0.004 | - | - | - | - |
| | Nickel | mg/L | 0.001 | - | - | 0.002 | - | - | - | - |
| | Selenium | mg/L | 0.01 | - | - | <0.01 | - | - | - | - |
| | Strontium | mg/L | 0.001 | - | - | 3.38 | - | - | - | - |
| | Uranium | mg/L | 0.001 | - | - | <0.001 | - | - | - | - |
| | Vanadium | mg/L | 0.01 | - | - | <0.01 | - | - | - | - |
| | Zinc | mg/L | 0.005 | - | - | <0.005 | - | - | - | - |
| Other | Bromide | mg/L | 0.01 | - | - | 0.360 | - | - | - | - |
| | Fluoride | mg/L | 0.1 | - | - | 1.4 | - | - | - | - |
| | Sulfate | mg/L | 1 | - | - | 2 | - | - | - | - |
| | Silicon as SiO2 | mg/L | 0.1 | - | - | 17.2 | - | - | - | - |

Key:
- not analysed
na not applicable



| | | | |
|--|--|--|---|
| | Author: Upstream Gas | <h3>Camden Gas Project</h3> <h4>Ground Water Monitoring Network</h4> | Legend <ul style="list-style-type: none"> ● EPL monitoring point (gas well) ★ Wells — Public Roads — Emergency Road Not for Public Use — Private Roads — Railway ■ RGP — Nepean River — Hume Highway |
| | Date: 11/09/2015 | | |
| | Ref: 3091r5 | | |
| | <p>Disclaimer: While AGL has taken great care and attention to ensure the accuracy of the data represented on this map, no liability shall be accepted for any errors or omissions. No part of this map may be reproduced without prior permission of AGL.</p> | | <p>Kilometres</p> <p>0 1 2</p> <p>Scale 1:25,500@A1</p> |

Figure 1- CGP and produced water monitoring locations as listed in EPL12003 (CSG wells)

References

AGL, 2015. Groundwater Management Plan. AGL document. Dated 30 October 2015. Available online: https://www.agl.com.au/~media/AGL/About%20AGL/Documents/How%20We%20Source%20Energy/Camden%20Document%20Repository/Water%20Plans/20151030_Camden%20Gas%20Project%20%20Groundwater%20Management%20Plan.pdf

AGL, 2013. Hydrogeological Summary of the Camden Gas Project area. Dated 31 January 2013. Available online:

<http://www.agl.com.au/~media/AGL/About%20AGL/Documents/How%20We%20Source%20Energy/CSG%20and%20the%20Environment/Camden/Assessments%20and%20Reports/2013/January/Hydrogeological%20Summary%20of%20the%20Camden%20Gas%20Project%20Area.pdf>

Environment Protection Authority (EPA), 2014. Letter correspondence to AGL Upstream Investments Pty Ltd., titled: *Environment Protection Licence 12003*, EPA reference: EF13/2522:DOC14/95163-07:CK, dated 28 August 2014, signed: Greg Newman (Acting Manager Illawarra).

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), 2013. Requirements for publishing pollution monitoring data. Environment Protection Authority, Sydney, Australia. Available online: <http://www.epa.nsw.gov.au/resources/licensing/130742reqpubpmdata.pdf>

Parsons Brinckerhoff (PB), 2013. Water Quality Investigation Camden Gas Project. Report for AGL Upstream Investments Pty Ltd, Document number: 2114759C PT_7196, dated 2 July 2013. Available online:

http://www.agl.com.au/~media/AGL/About%20AGL/Documents/How%20We%20Source%20Energy/CSG%20and%20the%20Environment/Camden/Assessments%20and%20Reports/2013/September/2114759C%20%20PT_7196_RevD_web.pdf