

The logo consists of the text "Energy in action.™" in a blue, sans-serif font, positioned within a large, light-brown, rounded rectangular shape. Below this main shape are three smaller, light-brown, rounded rectangular shapes of varying sizes, arranged in a descending staircase pattern from left to right. At the bottom right of these shapes is the AGL logo, which features a blue square with a white sunburst icon and the letters "AGL" in white.The AGL logo is a blue square containing a white sunburst icon to the left of the letters "AGL" in white, sans-serif font.

# AGL UPSTREAM INVESTMENTS PTY LTD

## CAMDEN GAS PROJECT

### **Quarterly Produced Water Quality Monitoring Report**

Reporting Period: 1<sup>st</sup> Quarter – August / September 2013

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): 02 9963 1318

## Foreword

|                           |  |
|---------------------------|--|
| <b>PREMISES</b>           | Rosalind Park Gas Plant<br>Lot 35 Medhurst Road<br>GILEAD NSW 2560 |
| <b>LICENCE DETAILS</b>    | <a href="#"><u>Environment Protection Licence 12003</u></a>        |
| <b>LICENCEE</b>           | AGL Upstream Investments Pty Limited (AGL)                         |
| <b>LICENCEE'S ADDRESS</b> | Locked Bag 1837, North Sydney, NSW 2060                            |
| <b>MONITORING DATE</b>    | 1 <sup>st</sup> Quarter – August / September 2013                  |
| <b>MONITORING BY</b>      | AGL  |
| <b>ANALYSIS BY</b>        | ALS Laboratory, Smithfield (Work order number: ES1319191)          |
| <b>REPORT DATE</b>        | 13 September 2013  |
| <b>REPORT PREPARED BY</b> | Nicola Fry, Hydrogeologist   |

## 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 currently consists of 144 gas wells, low-pressure underground gas gathering pipes and a gas plant facility. Not all production wells are currently operational. 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 ML per year for the existing CGP and associated dewatering activities from the coal seams.

This Monitoring Report relates to the groundwater monitoring activities specified in Part 5, Monitoring and Recording Conditions, of the Environment Protection Licence. 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 (2012). 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*".

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

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

Produced water from the coal seams at 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 also not uncommon to observe elevated levels of TPH (total petroleum hydrocarbons) after specific wells have undergone maintenance activities. These values are not representative of formation water samples.

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](http://agl.com.au/Camden)

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

| EPA Identification no. | Location |
|------------------------|----------|
| 8                      | EM40     |
| 9                      | SF08     |
| 10                     | RB10     |
| 11                     | MT05     |
| 12                     | MP12     |
| 13                     | MP30     |
| 14                     | RP12     |
| 15                     | SL03     |

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

| Analyte                 | Units of measure            | Frequency | Sampling Method |
|-------------------------|-----------------------------|-----------|-----------------|
| Aluminium               | milligrams per litre        | Quarterly | Grab sample     |
| Ammonia                 | milligrams per litre        | Yearly    | Grab sample     |
| Arsenic                 | milligrams per litre        | Quarterly | Grab sample     |
| Barium                  | milligrams per litre        | Quarterly | Grab sample     |
| Benzene                 | milligrams per litre        | Yearly    | Grab sample     |
| Beryllium               | milligrams per litre        | Quarterly | Grab sample     |
| Bicarbonate             | milligrams per litre        | Quarterly | Grab sample     |
| Boron                   | milligrams per litre        | Quarterly | Grab sample     |
| Bromide                 | milligrams per litre        | Quarterly | Grab sample     |
| Cadmium                 | milligrams per litre        | Quarterly | Grab sample     |
| Calcium                 | milligrams per litre        | Quarterly | Grab sample     |
| Carbonate               | milligrams per litre        | Quarterly | Grab sample     |
| Chloride                | milligrams per litre        | Quarterly | Grab sample     |
| Chromium                | milligrams per litre        | Quarterly | Grab sample     |
| Cobalt                  | milligrams per litre        | Quarterly | Grab sample     |
| Copper                  | milligrams per litre        | Quarterly | Grab sample     |
| Electrical conductivity | microsiemens per centimeter | Quarterly | Grab sample     |
| Ethyl benzene           | milligrams per litre        | Yearly    | Grab sample     |
| Fluoride                | milligrams per litre        | Quarterly | Grab sample     |
| Iron                    | milligrams per litre        | Quarterly | Grab sample     |
| Lead                    | milligrams per litre        | Quarterly | Grab sample     |
| Magnesium               | milligrams per litre        | Quarterly | Grab sample     |
| Manganese               | milligrams per litre        | Quarterly | Grab sample     |
| Mercury                 | milligrams per litre        | Quarterly | Grab sample     |
| Methane                 | milligrams per litre        | Yearly    | Grab sample     |
| Molybdenum              | milligrams per litre        | Quarterly | Grab sample     |
| Nickel                  | milligrams per litre        | Quarterly | Grab sample     |
| Nitrate                 | milligrams per litre        | Yearly    | Grab sample     |
| Nitrite                 | milligrams per litre        | Yearly    | Grab sample     |
| Phenols                 | milligrams per litre        | Yearly    | Grab sample     |
| Polycyclic aromatic     | milligrams per litre        | Yearly    | Grab sample     |

|                                     |                      |           |             |
|-------------------------------------|----------------------|-----------|-------------|
| <b>Potassium</b>                    | milligrams per litre | Quarterly | Grab sample |
| <b>Reactive Phosphorus</b>          | milligrams per litre | Yearly    | Grab sample |
| <b>Selenium</b>                     | milligrams per litre | Quarterly | Grab sample |
| <b>Silica</b>                       | milligrams per litre | Quarterly | Grab sample |
| <b>Sodium</b>                       | milligrams per litre | Quarterly | Grab sample |
| <b>Strontium (dissolved)</b>        | milligrams per litre | Quarterly | Grab sample |
| <b>Sulfate</b>                      | milligrams per litre | Quarterly | Grab sample |
| <b>Toluene</b>                      | milligrams per litre | Yearly    | Grab sample |
| <b>Total dissolved solids</b>       | milligrams per litre | Quarterly | Grab sample |
| <b>Total petroleum hydrocarbons</b> | milligrams per litre | Yearly    | Grab sample |
| <b>Uranium</b>                      | milligrams per litre | Quarterly | Grab sample |
| <b>Vanadium</b>                     | milligrams per litre | Quarterly | Grab sample |
| <b>Xylene</b>                       | milligrams per litre | Yearly    | Grab sample |
| <b>Zinc</b>                         | milligrams per litre | Quarterly | Grab sample |



## Groundwater Monitoring Results

Table 3 - Produced water monitoring results for 1<sup>st</sup> Quarter - August/September 2013

| Monitoring point         | 8                          | 9                          | 10         | 11                         | 12                         | 13         | 14                         | 15                         |
|--------------------------|----------------------------|----------------------------|------------|----------------------------|----------------------------|------------|----------------------------|----------------------------|
| Location                 | EM40                       | SF08                       | RB10       | MT05                       | MP12                       | MP30       | RP12                       | SL03                       |
| Sampled date/<br>comment | Not enough water to sample | Not enough water to sample | 29/08/2013 | Not enough water to sample | Not enough water to sample | 05/09/2013 | Not enough water to sample | Not enough water to sample |

|               | Analyte  | Units | Limit of reporting |  |  |        |  |  |        |  |
|---------------|--|-------|--------------------|--|--|--------|--|--|--------|--|
| Physical      | Electrical conductivity *(lab)                 | µS/cm | 1                  |  |  | 10,500 |  |  | 10,800 |  |
|               | TDS  | mg/L  | 10                 |  |  | 6450   |  |  | 7940   |  |
|               | TSS  | mg/L  | 5                  |  |  | 20     |  |  | <5     |  |
| Major Cations | Calcium (Filtered)                             | mg/L  | 1                  |  |  | 5      |  |  | 4      |  |
|               | Magnesium (Filtered)                           | mg/L  | 1                  |  |  | 5      |  |  | 3      |  |
|               | Potassium (Filtered)                           | mg/L  | 1                  |  |  | 30     |  |  | 65     |  |
|               | Sodium (Filtered)                              | mg/L  | 1                  |  |  | 3730   |  |  | 3610   |  |
|               | Cations Total                                  | meq/L | 0.01               |  |  | 164    |  |  | 159    |  |
| Major Anions  | Alkalinity (Bicarbonate as CaCO <sub>3</sub> ) | mg/L  | 1                  |  |  | 7020   |  |  | 6660   |  |
|               | Alkalinity (Carbonate as CaCO <sub>3</sub> )   | mg/L  | 1                  |  |  | 200    |  |  | 175    |  |
|               | Alkalinity (Hydroxide) as CaCO <sub>3</sub>    | mg/L  | 1                  |  |  | <1     |  |  | <1     |  |
|               | Alkalinity (total) as CaCO <sub>3</sub>        | mg/L  | 1                  |  |  | 7220   |  |  | 6840   |  |
|               | Chloride                                       | mg/L  | 1                  |  |  | 134    |  |  | 258    |  |
|               | Anions Total                                   | meq/L | 0.01               |  |  | 148    |  |  | 144    |  |



|                             |                                     |       | Monitoring point | 8    | 9      | 10      | 11   | 12    | 13      | 14   | 15   |
|-----------------------------|-------------------------------------|-------|------------------|------|--------|---------|------|-------|---------|------|------|
|                             |                                     |       | Location         | EM40 | SF08   | RB10    | MT05 | MP12  | MP30    | RP12 | SL03 |
| <b>Ionic Balance</b>        | <b>Ionic Balance</b>                | %     | 0.01             |      |        | 4.95    |      |       | 4.94    |      |      |
| <b>Metals</b>               | <b>Aluminium (Filtered)</b>         | mg/L  | 0.01             |      |        | <0.1    |      |       | <0.01   |      |      |
|                             | <b>Arsenic (Filtered)</b>           | mg/L  | 0.001            |      |        | <0.010  |      |       | 0.003   |      |      |
|                             | <b>Barium (Filtered)</b>            | mg/L  | 0.001            |      |        | 10.4    |      |       | 11.6    |      |      |
|                             | <b>Beryllium (Filtered)</b>         | mg/L  | 0.001            |      |        | <0.010  |      |       | <0.001  |      |      |
|                             | <b>Boron (Filtered)</b>             | mg/L  | 0.05             |      |        | <0.50   |      |       | 0.16    |      |      |
|                             | <b>Cadmium (Filtered)</b>           | mg/L  | 0.0001           |      |        | <0.0010 |      |       | <0.0001 |      |      |
|                             | <b>Chromium (III+VI) (Filtered)</b> | mg/L  | 0.001            |      |        | <0.010  |      |       | <0.001  |      |      |
|                             | <b>Cobalt (Filtered)</b>            | mg/L  | 0.001            |      |        | <0.010  |      |       | 0.009   |      |      |
|                             | <b>Copper (Filtered)</b>            | mg/L  | 0.001            |      |        | <0.010  |      |       | <0.001  |      |      |
|                             | <b>Iron (Filtered)</b>              | mg/L  | 0.05             |      |        | 2.72    |      |       | 0.44    |      |      |
|                             | <b>Lead (Filtered)</b>              | mg/L  | 0.001            |      |        | <0.010  |      |       | 0.008   |      |      |
|                             | <b>Manganese (Filtered)</b>         | mg/L  | 0.001            |      |        | 0.018   |      |       | 0.032   |      |      |
|                             | <b>Mercury (Filtered)</b>           | mg/L  | 0.0001           |      |        | <0.0001 |      |       | <0.0001 |      |      |
|                             | <b>Molybdenum (Filtered)</b>        | mg/L  | 0.001            |      |        | 0.016   |      |       | 0.051   |      |      |
|                             | <b>Nickel (Filtered)</b>            | mg/L  | 0.001            |      |        | <0.010  |      |       | 0.02    |      |      |
|                             | <b>Selenium (Filtered)</b>          | mg/L  | 0.01             |      |        | <0.10   |      |       | <0.01   |      |      |
| <b>Strontium (Filtered)</b> | mg/L                                | 0.001 |                  |      | 3.13   |         |      | 2.81  |         |      |      |
| <b>Uranium (Filtered)</b>   | mg/L                                | 0.001 |                  |      | <0.010 |         |      | 0.005 |         |      |      |



|             |                              |      | Monitoring point | 8    | 9    | 10     | 11   | 12   | 13     | 14   | 15   |
|-------------|------------------------------|------|------------------|------|------|--------|------|------|--------|------|------|
|             |                              |      | Location         | EM40 | SF08 | RB10   | MT05 | MP12 | MP30   | RP12 | SL03 |
| Metals      | Vanadium (Filtered)          | mg/L | 0.01             |      |      | <0.10  |      |      | <0.01  |      |      |
|             | Zinc (Filtered)              | mg/L | 0.005            |      |      | <0.050 |      |      | 0.009  |      |      |
| Other       | Bromine (Filtered)           | mg/L | 0.1              |      |      | <1.0   |      |      | 1.2    |      |      |
|             | Fluoride                     | mg/L | 0.1              |      |      | 1.2    |      |      | 1.8    |      |      |
|             | Iodine (Filtered)            | mg/L | 0.1              |      |      | <1.0   |      |      | <0.1   |      |      |
|             | Sulphate (Filtered)          | mg/L | 1                |      |      | <10    |      |      | <1     |      |      |
| Inorganics  | Ammonia as N                 | mg/L | 0.01             |      |      | 4.74   |      |      | 12.7   |      |      |
|             | Nitrate (as N)               | mg/L | 0.01             |      |      | <0.01  |      |      | 0.04   |      |      |
|             | Nitrite (as N)               | mg/L | 0.01             |      |      | <0.01  |      |      | <0.01  |      |      |
|             | Nitrogen (Total Oxidised)    | mg/L | 0.01             |      |      | <0.01  |      |      | 0.04   |      |      |
|             | Reactive Phosphorus as P     | mg/L | 0.01             |      |      | 0.10   |      |      | 0.08   |      |      |
|             | Silica as SiO2 (Filtered)    | mg/L | 0.1              |      |      | 16.4   |      |      | 12.2   |      |      |
|             | Hardness as CaCO3 (Filtered) | mg/L | 1                |      |      | 33     |      |      | 22     |      |      |
|             | Methane                      | mg/L | 0.01             |      |      | 0.331  |      |      | 0.253  |      |      |
| PAH/Phenols | 2,4-dimethylphenol           | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |
|             | 2-methylphenol               | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |
|             | 2-nitrophenol                | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |
|             | 3-&4-methylphenol            | mg/L | 0.002            |      |      | <0.002 |      |      | <0.002 |      |      |
|             | 4-chloro-3-methylphenol      | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |

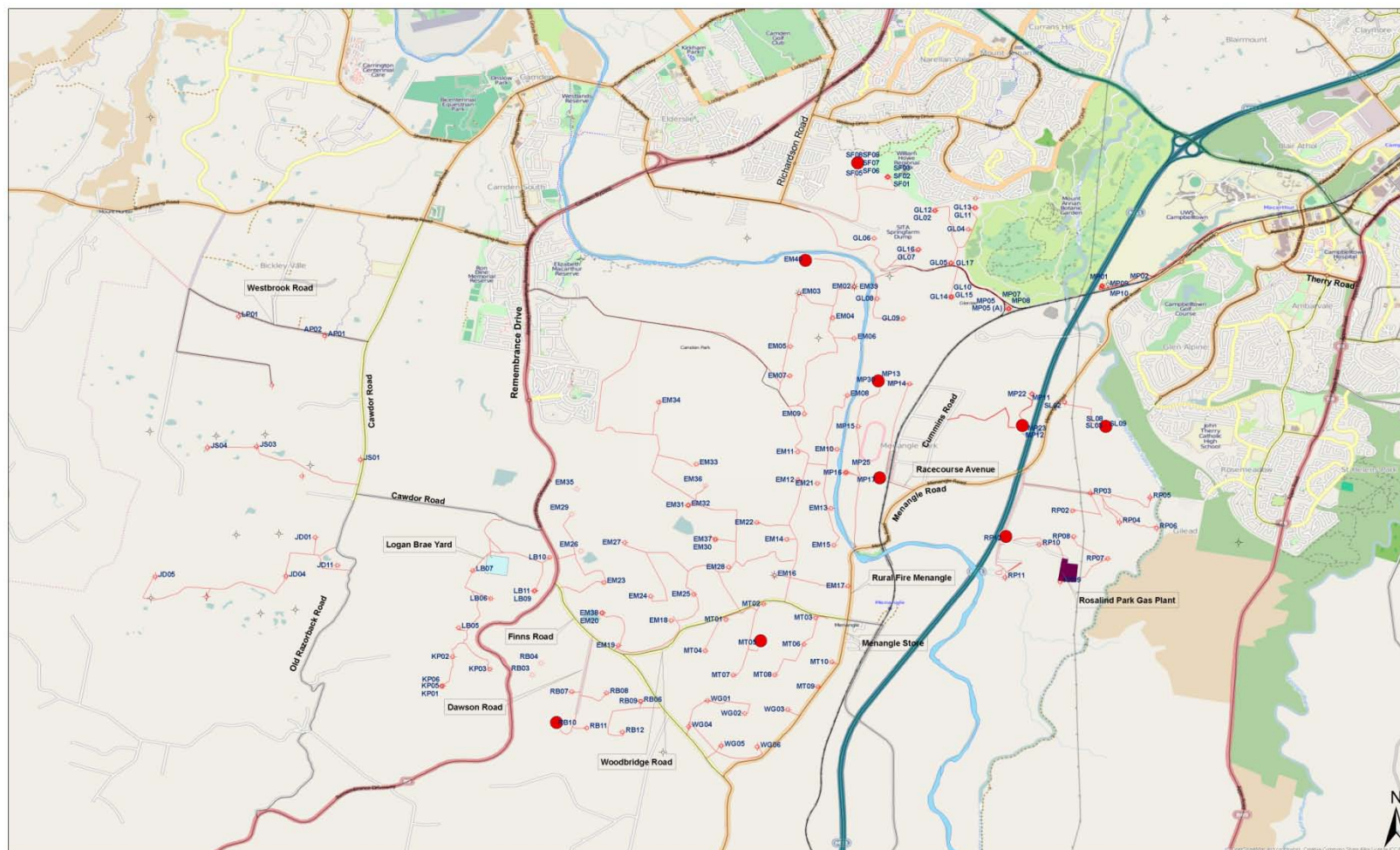


|                     |                         |       | Monitoring point | 8    | 9      | 10      | 11   | 12     | 13      | 14   | 15   |
|---------------------|-------------------------|-------|------------------|------|--------|---------|------|--------|---------|------|------|
|                     |                         |       | Location         | EM40 | SF08   | RB10    | MT05 | MP12   | MP30    | RP12 | SL03 |
| PAH/Phenols         | Acenaphthene            | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Acenaphthylene          | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Anthracene              | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Benz(a)anthracene       | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Benzo(a) pyrene         | mg/L  | 0.0005           |      |        | <0.0005 |      |        | <0.0005 |      |      |
|                     | Benzo(b)fluoranthene    | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Benzo(g,h,i)perylene    | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Benzo(k)fluoranthene    | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Chrysene                | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Dibenz(a,h)anthracene   | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Fluoranthene            | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Fluorene                | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Indeno(1,2,3-c,d)pyrene | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | Naphthalene             | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
|                     | PAHs (Sum of total)     | mg/L  | 0.0005           |      |        | <0.0005 |      |        | <0.0005 |      |      |
|                     | Phenanthrene            | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |
| Phenol              | mg/L                    | 0.001 |                  |      | <0.001 |         |      | <0.001 |         |      |      |
| Pyrene              | mg/L                    | 0.001 |                  |      | <0.001 |         |      | <0.001 |         |      |      |
| Halogenated Phenols | 2,4,5-trichlorophenol   | mg/L  | 0.001            |      |        | <0.001  |      |        | <0.001  |      |      |





|                     |                           |      | Monitoring point | 8    | 9    | 10     | 11   | 12   | 13     | 14   | 15   |
|---------------------|---------------------------|------|------------------|------|------|--------|------|------|--------|------|------|
|                     |                           |      | Location         | EM40 | SF08 | RB10   | MT05 | MP12 | MP30   | RP12 | SL03 |
| Halogenated Phenols | 2,4,6-trichlorophenol     | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |
|                     | 2,4-dichlorophenol        | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |
|                     | 2,6-dichlorophenol        | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |
|                     | 2-chlorophenol            | mg/L | 0.001            |      |      | <0.001 |      |      | <0.001 |      |      |
|                     | Pentachlorophenol         | mg/L | 0.002            |      |      | <0.002 |      |      | <0.002 |      |      |
| TPH                 | C6 - C9                   | mg/L | 0.02             |      |      | <0.02  |      |      | <0.1   |      |      |
|                     | C10 - C14                 | mg/L | 0.05             |      |      | <0.05  |      |      | 1.97   |      |      |
|                     | C15 - C28                 | mg/L | 0.1              |      |      | 1.02   |      |      | 7.78   |      |      |
|                     | C29-C36                   | mg/L | 0.05             |      |      | 0.5    |      |      | 0.28   |      |      |
|                     | +C10 - C36 (Sum of total) | mg/L | 0.05             |      |      | 1.52   |      |      | 10     |      |      |
| BTEX                | Benzene                   | mg/L | 0.001            |      |      | <0.001 |      |      | <0.005 |      |      |
|                     | Ethylbenzene              | mg/L | 0.002            |      |      | <0.002 |      |      | <0.005 |      |      |
|                     | Toluene                   | mg/L | 0.002            |      |      | <0.002 |      |      | 0.005  |      |      |
|                     | Total BTEX                | mg/L | 0.001            |      |      | <0.001 |      |      | 0.005  |      |      |
|                     | Xylene (m & p)            | mg/L | 0.002            |      |      | <0.002 |      |      | <0.005 |      |      |
|                     | Xylene (o)                | mg/L | 0.002            |      |      | <0.002 |      |      | <0.005 |      |      |
|                     | Xylene Total              | mg/L | 0.002            |      |      | <0.002 |      |      | <0.005 |      |      |





|   |   |   |   |                 |
|---|---|---|---|-----------------|
|  | Author: Upstream Gas  | <b>Camden Gas Project<br/>Produced Water Monitoring Network</b> | <b>Legend</b><br>● Produced Water Monitoring Site<br>◊ Wells<br>— Public Roads<br>— Hume Highway<br>— Emergency Road Not for Public Use | — Private Roads |
|   | Date: 5/6/2013  |   |   | — Nepean River  |
|   | Ref: 3091   |   |   | — Railway       |
|  | 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. |   | — Logan Brae Yard   | <b>Figure 1</b> |
|   | Kilometres<br>0 1 2<br>Scale 1:25,500@A1  |   | ■ RGP   |                 |

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

## References

AGL, 2012. Groundwater Management Plan. AGL document. Last revised November 2012. Available online:

<http://www.agl.com.au/~ /media/AGL/About%20AGL/Documents/How%20We%20Source%20Energy/CSG%20and%20the%20Environment/Camden/Assessments%20and%20Reports/2012/November/Groundwater%20Management%20Plan%20for%20the%20Camden%20Gas%20Project%20%20%20Nov%202012.pdf>

AGL, 2013. Hydrogeological Summary of the Camden Gas Project area. 31<sup>st</sup> 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>

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[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](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)