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AGL UPSTREAM INVESTMENTS PTY LTD

GLOUCESTER GAS PROJECT

**July 2015 Monitoring Report:  
Tiedman Irrigation Program  
EPL 20358**

Reporting Period: May 2015

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## Foreword

<b>PREMISES</b>	Gloucester Coal Seam Gas Project Bucketts Way Gloucester NSW 2422
<b>LICENCE DETAILS</b>	<a href="#"><u>Environment Protection Licence 20358</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>	18 May 2015
<b>MONITORING BY</b>	Jacobs, on behalf of AGL
<b>ANALYSIS BY</b>	East West, Tamworth (Work order number: EW150487)
<b>DATE AGL OBTAINED DATA</b>	13 July 2015
<b>REPORT DATE</b>	21 July 2015
<b>REPORT PREPARED BY</b>	James Duggleby, Senior Hydrogeologist

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## 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 200 and 1,000m 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.

Conditional approval was granted to AGL by the Division of Resources and Energy (DRE) in 2012 to implement a program (the Tiedman Irrigation Program) for produced water storage, blending, and irrigation activities on AGL's Tiedman property at Stratford in New South Wales (NSW). Approval was extended to 30 April 2015 by the Office of Coal Seam Gas (OCSG) on 4 July 2014; following which, AGL did not seek further extension and on 30 April 2015 the irrigation approval expired. On 6 August 2014, the NSW Environment Protection Authority (EPA) issued Environment Protection Licence (EPL) 20358 that covers the CSG exploration, assessment and production activities in the GGP (EPA, 2014).

The Tiedman Irrigation Program is divided into two areas, being Stage 1A and 1B (Figure 1):

- > Stage 1A is serviced by a lateral move irrigator which irrigates a maximum area of 18.2 ha, including 16 plots, two crop systems (annuals and perennials), and four soil treatment depths.
- > Stage 1B comprises an area of 8.6 ha (of which approximately 4ha is currently under irrigation), including four plots and a mix of annual and perennial pasture.

This Monitoring Report relates to the monitoring activities specified in Part 5, Monitoring and Recording Conditions, of Environment Protection Licence 20358 (the Licence). This report relates specifically to the monitoring surrounding the Tiedman Irrigation Program, and details:

1. Monitoring results from the 6-monthly soil sampling event at the Tiedman Irrigation Program (18 May 2015).

As per the Licence, the monitoring encompasses the monitoring points at the locations as shown in Table 1 and Figure 1.

The specific analytes and sample frequency are shown in Table 2. The monitoring results for this reporting period are shown in Table 3.

The monitoring points that are the subject of this report are part of the GGP soil monitoring network, as described in AGL's Soil Quality Monitoring and Management Program (FK, 2012). Soil monitoring results for the Irrigation program are presented in a baseline water monitoring report (FK, 2013a) and six-monthly compliance reports (FK, 2013b, 2014a and 2014b; and Jacobs, 2015).

For monitoring points 53 – 68 (Stage 1A), samples were taken manually using a hand auger at 20 cm intervals down to the base of the respective treatment depth of 120 cm or until refusal on rock, and each depth interval from each soil sample location was be sampled and analysed.

For monitoring points 69 -81 (Stage 1B), samples were taken manually using a hand auger at 20 cm intervals down to the base of the respective treatment depth of 120 cm or until refusal on rock at 20 cm, and a lateral composite sample was formed from the different sample locations from the same depth profile located in the Stage 1B area and analysed.

The soil samples were analysed by East West Enviroag Pty Ltd, Tamworth, NSW, a National Association of Testing Authorities (NATA) and the Australasian Soil and Plant Analysis Council (ASPAC) accredited laboratory.

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

Water monitoring data collected in November for the Tiedman Irrigation Program (monitoring points 27 – 52) were published in an earlier report (AGL, 2015) 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](http://agl.com.au/Gloucester)

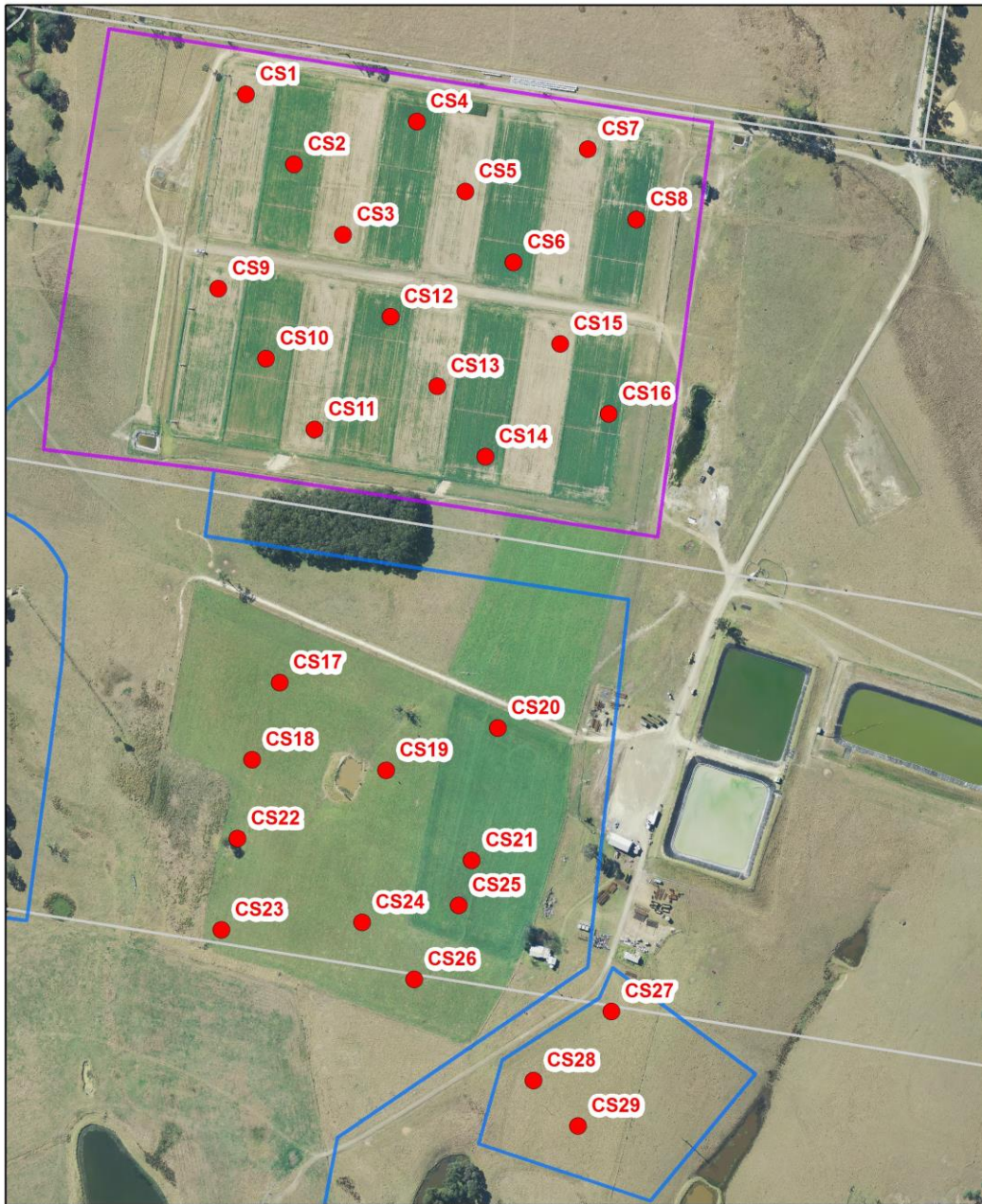


**Table 1: Soil monitoring points, Irrigation Program (as per EPL 20358)**

EPA ID no.	AGL ID	Location (Irrigation Area)	Type of monitoring point	Easting	Northing
53	CS1	Stage 1A	Soil quality	402197.4	6449446.6
54	CS2	Stage 1A	Soil quality	402238.8	6449386.7
55	CS3	Stage 1A	Soil quality	402280.6	6449326.7
56	CS4	Stage 1A	Soil quality	402343.7	6449423.3
57	CS5	Stage 1A	Soil quality	402385.2	6449363.4
58	CS6	Stage 1A	Soil quality	402426.6	6449302.9
59	CS7	Stage 1A	Soil quality	402490.2	6449399.8
60	CS8	Stage 1A	Soil quality	402531.7	6449339.6
61	CS9	Stage 1A	Soil quality	402173.9	6449280.2
62	CS10	Stage 1A	Soil quality	402214.8	6449220.5
63	CS11	Stage 1A	Soil quality	402256.4	6449160.1
64	CS12	Stage 1A	Soil quality	402321.4	6449256.5
65	CS13	Stage 1A	Soil quality	402361.5	6449197.0
66	CS14	Stage 1A	Soil quality	402402.4	6449136.6
67	CS15	Stage 1A	Soil quality	402466.6	6449233.2
68	CS16	Stage 1A	Soil quality	402508.1	6449173.2
69	CS17	Stage 1B	Soil quality	402226.4	6448943.4
70	CS18	Stage 1B	Soil quality	402202.8	6448877.5
71	CS19	Stage 1B	Soil quality	402317.4	6448868.3
72	CS20	Stage 1B	Soil quality	402413.1	6448904.5
73	CS21	Stage 1B	Soil quality	402390.9	6448791.5
74	CS23	Stage 1B	Soil quality	402176.6	6448732.1
75	CS22	Stage 1B	Soil quality	402190.3	6448810.1
76	CS24	Stage 1B	Soil quality	402297.1	6448738.4
77	CS25	Stage 1B	Soil quality	402379.8	6448753.0
78	CS26	Stage 1B	Soil quality	402341.7	6448689.7
79	CS27	Stage 1B	Soil quality	402510.5	6448662.0
80	CS28	Stage 1B	Soil quality	402443.7	6448603.1
81	CS29	Stage 1B	Soil quality	402481.8	6448564.1

Coordinate reference system: Map Grid of Australia 1994, Zone 56

Gloucester Gas Project – Tiedman Irrigation Program Soil Monitoring Sites



	Author: Upstream Gas	<p>Kilometres 0 0.05 0.1 Scale 1:3,000 @A3 Geocentric Datum of Australia 1994</p>	<p><b>Legend</b></p> <ul style="list-style-type: none"> <li>● Soil Monitoring Sites</li> <li>□ Property Boundaries</li> <li>Irrigation Areas                             <ul style="list-style-type: none"> <li>■ Stage 1A</li> <li>■ Stage 1B</li> </ul> </li> </ul>
	Date: 02/02/2015		
	Ref: 3190r1		

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.

Sources: AGL Energy Limited, MapData Sciences, SKM

**Figure 1: Location of soil monitoring points: Irrigation Program (as per EPL 20358)**



**Table 2: Analytes monitored and frequency (as per EPL 20358) – monitoring points 53 – 81 (soil monitoring points)**

Analyte	Units of measure	Monitoring points		Monitoring points	
		53 - 68		69 - 81	
		Frequency	sampling method	Frequency	sampling method
<b>Aluminium</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Available phosphorus</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Boron</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Calcium</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Cation Exchange Capacity</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Chloride</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Copper</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Electrical conductivity</b>	microsiemens per metre	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Exchangeable sodium percentage</b>	percent	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Iron</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Magnesium</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Manganese</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Nitrogen (nitrate)</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Organic carbon</b>	percent	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>pH</b>	pH	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Phosphorus</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Potassium</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Sodium</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Soil texture</b>	Visible	Every 6 months	In situ	Every 6 months	In situ
<b>Sulfate</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6
<b>Zinc</b>	milligrams per kilogram	Every 6 months	Special Method 2	Every 6 months	Special Method 6

Notes:

- > Special Method 2 – Samples will be taken at 20 cm intervals down to the base of the respective treatment depth of 120 cm (or until refusal on rock). For each of the four treatments, each depth interval from each soil sample location will be sampled and analysed.
- > Special Method 6 - Samples will be taken at 20 cm intervals down to the base of the respective treatment depth of 120 cm (or until refusal on rock). A lateral composite sample will be formed from the different sample locations from the same depth profile located in the Stage 1B area and analysed.
- > Depth increments (cm below ground):
  - » 0 – 20
  - » 20 – 40
  - » 40 – 60
  - » 60 – 80
  - » 80 – 100
  - » 100 – 120

Soil monitoring results  
Table 3: May 2015 soil monitoring results for monitoring points 53 - 81 (soil monitoring points)

Analyte	Units of measure	Monitoring point	53						54						55						56						57						58					
			CS-1						CS-2						CS-3						CS-4						CS-5						CS-6					
Location	Depth increment (cm bal)	Sample date	18/05/2015						18/05/2015						18/05/2015						18/05/2015						18/05/2015						18/05/2015					
Date AGI obtained data	Lowest obtainable reading	0-20	20-40	40-60	60-80	80-100	100-120	0-20	20-40	40-60	60-80	80-100	100-120	0-20	20-40	40-60	60-80	80-100	100-120	0-20	20-40	40-60	60-80	80-100	100-120	0-20	20-40	40-60	60-80	80-100	100-120	0-20	20-40	40-60	60-80	80-100	100-120	
Aluminium	mg/kg	na	0.5	0.9	299	336	217	95	49.2	163	528	471	333	180	126	0.8	23.3	1.2	0.3	0.4	0.6	0.8	275	357	142	97.1	105	3.7	1.6	2.8	0.4	0.7	0.4	0.4	0.5	3.7	4.6	
Available phosphorus	mg/kg	1	81.7	14.6	9.87	7.36	9.47	14.9	16.9	7.4	4.11	9.71	3.46	6.36	124	20	30.4	43.9	47.6	26.1	241	19.7	12.6	15.2	10.7	10	150	26.3	17	26.5	11.4	9.14	7.76	9.8	11.6	12.5		
Boron	mg/kg	0.2	0.48	0.33	0.2	<0.2	<0.2	<0.2	<0.2	0.36	0.24	<0.2	<0.2	<0.2	0.38	<0.2	<0.2	<0.2	<0.2	<0.2	0.37	0.3	<0.2	<0.2	<0.2	<0.2	0.62	0.26	0.25	0.3	0.49	0.48	0.28	<0.2	<0.2	8.36	11.6	
Calcium	mg/kg	20	2088	1044	375	253	184	237	1330	684	353	185	139	122	1685	456	643	806	550	616	3507	823	310	259	204	165	2679	927	807	2003	1617	2203	2380	1640	1024	763		
Cation Exchange Capacity	cmol/kg <sup>a</sup>	na	16.6	20.5	22.7	20.9	16	17.5	18.1	20.7	22.1	18.7	17.7	16.4	16.6	12.4	19.2	20.9	19.3	17.9	24.8	19.6	20	18.7	19.1	20.5	22.8	14.8	13.9	19.1	14.9	22.4	26.4	22.7	21.2	20.7		
Chloride	mg/kg	5	69.8	133	214	207	237	260	122	213	259	202	181	191	104	129	133	150	161	171	38.6	137	223	205	194	219	134	131	101	89	52	129	246	277	234	228		
Copper	mg/kg	0.5	0.71	0.59	0.72	0.53	0.66	<0.5	0.7	0.55	0.52	0.56	0.76	0.94	0.84	0.76	0.7	0.82	0.92	1.05	0.91	0.65	0.74	0.81	1.13	<0.5	0.86	0.8	0.95	1.04	0.89	0.69	0.69	1.01	1.6	1.39		
Electrical conductivity	uS/m	1000	24000	27000	23000	22000	22000	26000	25000	28000	27000	20000	20000	9000	38000	28000	28000	28000	26000	24000	28000	29000	27000	23000	25000	38000	24000	19000	23000	20000	28000	28000	34000	35000	28000	23000		
Exchangeable sodium percentage	%	na	8.77	9.69	12.1	13.4	16.8	18.3	11.3	9.9	12.2	13.4	15.8	16.9	8.69	10.7	12.5	13.3	14.8	13	6.08	11.7	14.5	17.8	18.9	19.5	9.22	10	10.1	7.66	11.4	9.14	7.76	9.8	11.6	12.5		
Iron	mg/kg	0.5	130	109	101	63	46.2	39.4	113	60.7	108	95.9	73.2	26.6	116	107	88.5	94.2	68.1	136	109	118	60.6	58.1	41.1	51.3	120	164	201	184	71.2	38.8	39.1	38.4	49.7	52.1		
Magnesium	mg/kg	10	499	1141	1650	1663	1300	1440	826	1057	1419	1323	1390	1316	743	974	1564	1615	1568	1391	625	1136	1307	1414	1523	1647	769	973	952	858	553	1041	1422	1416	1550	1637		
Manganese	mg/kg	0.5	16.6	1.99	0.68	<0.5	1.01	0.52	3.97	1.99	0.75	0.61	<0.5	0.5	5.48	2.85	3.14	3.31	7.97	12.9	10.7	1.1	<0.5	<0.5	<0.5	0.56	14.2	18.6	21.1	22.5	18.7	2.41	0.74	0.56	1.93	0.65		
Nitrogen (nitrate)	mg/kg	0.5	4.4	0.7	0.9	<0.5	1.2	1	4.3	1.3	<0.5	2.2	<0.5	<0.5	4.6	1.3	0.6	1.2	0.6	<0.5	6.5	1.5	<0.5	<0.5	<0.5	<0.5	5	2.4	<0.5	3.3	4.8	1.4	0.7	<0.5	1.1	<0.5		
Organic carbon	%	0.05	1.83	0.88	0.5	0.29	0.45	0.2	1.15	0.83	1.59	0.37	0.14	0.1	1.19	0.51	0.43	0.66	1.86	0.43	2.07	0.63	0.41	0.31	0.16	0.14	1.43	0.76	0.5	0.94	1.11	0.42	0.25	0.09	0.48	0.22		
pH <sup>b</sup>	na	5.68	4.19	4.14	4.18	4.18	4.3	4.5	4.11	4.12	4.18	4.13	4.25	6.41	4.84	5.48	5.76	5.72	5.96	6.56	4.32	4.26	4.27	4.3	4.35	6.64	5.5	5.31	5.83	6.42	6.38	6.37	6.15	5.37	5.32			
Phosphorus	mg/kg	37	484	91.4	56.6	49.6	<37.5	47.1	173	96.2	65.3	68.6	54.3	41.7	36.2	91.4	110	178	140	173	646	107	64.1	54.7	<37.5	40.2	559	145	103	198	173	71	48.9	62.8	82.6	76.7		
Potassium	mg/kg	10	189	193	246	230	262	218	264	281	308	261	408	330	279	239	430	254	228	220	213	241	260	294	302	343	753	215	328	439	225	333	228	229	246	338		
Sodium	mg/kg	10	334	458	632	643	619	733	468	471	622	575	645	637	331	303	552	639	655	619	347	528	668	764	831	922	484	340	324	337	393	470	471	502	565	596		
Soil texture <sup>c</sup>	na	CL	LMC	LMC	MC	MC	MC	LMC	MC	MC	MC	MC	MC	MC	CL	LMC	MC	MC	MC	MC	CL	LMC	MC	MC	MC	CL	CL	LMC	FSC	CL	MC	MC	LMC	LMC	LMC	LMC		
Sulfate	mg/kg	9	143	150	58.8	41.1	34.2	45.6	139	121	61.8	49.8	46.2	53.4	381	281	256	174	136	97.2	158	158	150	104	61.8	64.5	223	159	137	159	138	195	195	178	160	78		
Zinc	mg/kg	0.5	1.64	<0.5	<0.5	<0.5	0.61	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.79	0.54	0.69	1.08	0.66	<0.5	4.87	<0.5	<0.5	<0.5	0.6	0.87	2.7	0.91	0.83	0.95	1.83	0.54	<0.5	0.66	1.82	1.55		

Notes:  
 na - not available  
 nsc - no sample collected; refusal on rock  
 bgl - below ground level  
 a - Cation Exchange Capacity is reported in cmol/kg, although it is noted the EPL requires CEC to be reported in mg/kg which is an inappropriate unit of measure for this analyte.  
 b - The calcium chloride method has been used to measure soil pH  
 c - Nonhorthe texture classification:  
 CL - Clay loam  
 CS - Clayey sand  
 FSC - Fine sandy clay  
 FSCL - Fine sandy clay loam  
 LC - Light clay  
 LMC - Light medium clay  
 MC - Medium clay  
 SC - Sandy clay



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