Groundwater monitoring results at Origin Kyalla well site in the Beetaloo Sub-basin in accordance with the Code of Practice: December 2018 to October 2019

Introduction

The Scientific Inquiry into Hydraulic Fracturing in the Nothern Territory identified the need for a ground water monitoring program at each petroleum well site. A monitoring program will provide confidence that natural groundwater characteristics remain unaltered or alternatively will provide early detection of any contamination or altered hydrology that may occur as a result of the activity. Monitoring results may also provide justification for further investigation or remedial action, if necessary.

This report presents groundwater monitoring data submitted by Origin for the Kyalla petroleum well site on EP117 in the Beetaloo Sub-basin, from December 2018 to October 2019. It fulfils the Code of Practice: Onshore Petroleum Activities in the Northern Territory (the Code) 2019 requirement for 6 months of baseline monitoring of groundwater at a well site prior to undertaking hydraulic fracturing activities. This was also a condition of Ministerial approval of the Origin *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program* EP117 Environment Management Plan (EMP) ref: NTEPA2019/0033-003~0007).

Groundwater Monitoring Program

Companies are required to submit groundwater monitoring data quarterly, in compliance with the Code the Department of Environment and Natural Resources (DENR) has committed to publishing the monitoring results from interest holders to increase the transparency of monitoring and reporting of groundwater potential impacts by the onshore gas industry in the Northern Territory.

The Origin groundwater monitoring program consists of:

- Control Montoring Bore (CMB), which is located upstream and within 100m of each planned or existing petroleum well pad, screened across the Gum Ridge aquifer and a separate CMB screened across the Anthony Lagoon aquifer in compliance with the Code
- Impact Monitoring Bore (IMB), which is located 20m downstream of the location of the petroleum well

These bores enable an ongoing comparison of the groundwater upstream and downstream of the petroleum well, to allow for an immediate identification of any variation in the groundwater that can be directly related to the petroleum activity.

Groundwater quality

At the Kyalla petroleum well site and surrounding EP117 area the karstic Cambrian Limestone aquifer (CLA) system consists of both the Gum Ridge aquifer and the shallower Anthony Lagoon aquifer. These are used as a source of groundwater by pastoralists and for petroleum exploration activities. The CMB design provides ongoing natural background baseline values and a measure of natural variation for groundwater quality at the Kyalla well site on EP117 in both the Gum Ridge and the shallower Anthony Lagoon aquifers. At the Kyalla well site, the drilling of the Kyalla exploration petroleum well commenced in

September 2019. Hydraulic fracturing of the Kyalla well had not yet occurred during the reporting period February 2019 to October 2019.

Summary and Interpretation of Results

The raw groundwater monitoring results reported quarterly by Origin for the Beetaloo Sub-basin are availble at Appendix 1. The number of sampling events conducted at both CMBs at the Kyalla well site is sufficient to estimate the average of each analyte with 95% confidence and an approximate precision of +/- 10%.

Table 1 lists a summary of key indicator analyte averages and standard deviations for sampling events between February 2019 to October 2019. 11 sampling events for the Gum Ridge aquifer and 10 sampling events for the Anthony Lagoo aquifer were undertaken at Kyalla during the sampling period. Among the key analytes listed (excluding gross alpha and gross beta) chloride showed the least variation (was the most stable) between sampling events while boron showed the highest variation between sampling events. The CMB registered water bore numbers for each CMB at Kyalla are:

- Kyalla Gum Ridge aquifer Control Monitoring Bore: RN041132
- Kyalla Anthony Lagoon aquifer Control Monitoring Bore: RN040895/RN040896

Figure 1 provides graphical presentation of the natural background baseline interquartile range for key indicator analytes in the Gum Ridge and Anthony Lagoon aquifers at the Kyalla well site.

Each analyte has been scaled appropriately as shown in the horizontal axis. For example, electrical conductivity is divided by a factor of 10 so in the Gum Ridge aquifer the interquartile range is approximately 1140 to 1340 µS/cm. Similarly gross alpha is multiplied by a factor of 100 so in the Gum Ridge aquifer the interquartile range is approximately 0.83 to 1.96 Bq/L. Average values for all analytes in both aquifers were below drinking water guidance values except for gross alpha radionuclides. Radionuclides (both alpha and beta) also had the largest variation in the range of values among the key analytes, as can be seen in Figure 1. While groundwater may on occasion exceed gross alpha drinking water standard in the Gum Ridge aquifer (Tables 1 and 2) at Kyalla, this is not uncommon in groundwater systems where concentrations of dissolved natural constituents can build up during prolonged periods of water/rock contact. For example, similar results have been reported around Katherine 1996.

https://www.territorystories.nt.gov.au/jspui/bitstream/10070/228526/1/WRD96073.pdf

The groundwater will continue to be monitored in accordance with the Code and the Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin 2018.

There was no apparent significant difference in averages and range for the key water quality indicators in the Gum Ridge Aquifer and the Anthony Lagoon Aquifer at the Kyalla well site (Table 1 and Figure 1) based on this data set.

A groundwater extraction licence GRF10285 has been granted to Origin for 175ml per year for 3 years. Estimated groundwater use for the Origin 2019 – 2020 Exploration Program on EP117 is approximately 58ml. At the Kyalla well site approximately 37ml of water was extracted during the monitoring period, representing approximately 64% of predicted groundwater use at this well site over 2019 to 2020 period. Figure 2 shows standing ground water level at the Kyalla well site increased slightly (up to almost 0.2m) during the monitoring period.

Conclusion

In accordance with the Code and Ministerial condition of approval of the EMP, results of ongoing groundwater monitoring must be provided by Origin every quarter for 3 years from the approval date of the EMP 13 September 2019. These reports will be published on the DENR website as they become available. Origin has met the requirement to provide 6 months of baseline groundwater quality data prior to conducting hydraulic fracturing at the Kyalla well site.

Table 1: Average and standard deviation results for key indicator analytes for Origin control monitoring bores, at Kyalla well site in the Gum Ridge aquifer RN041132 and Anthony Lagoon aquifer RN040895 and RN040896, on EP117 for sampling period December 2018 to October 2019.

Key analyte	**Drinking Water Guidance**	**RN041132** **Gum Ridge aquifer** **n = 4**	**RN040895** **Anthony Lagoon aquifer** **n = 7**	**RN040896** **Anthony Lagoon aquifer** **n = 10**
Standing water level AHD (m)	N.A.		156.0 ± 0.1	155.9 ± 0.02
Total volume of water extracted from bore until end Sept 2019 (ml)	N.A.	21.5	15.7	0
Electrical conductivity (µS/cm)	< 2,500	11267 ± 15	1212 ± 78	1231 ± 86
Total dissolved solids (mg/l)	< 1200	694 ± 70	727 ± 93	717 ± 38
Chloride (mg/l)	~ 250	160 ± 6.7	159 ± 7.2	172 ± 9.5
Barium (mg/l)	0.7	0.068 ± .006	0.063 ± 0.003	0.077 ± .019
Boron (mg/l)	4.0	0.21± 0.009	0.22 ± 0.01	0.20 ± 0.06
Strontium (mg/l)	N.A	0.82 ± 0.07	0.80 ± 0.06	0.67 ± 0.04
Methane mg/l	N.A.	<0.001	0.013 ± 0.0005	0.03 ± 0.01
Gross alpha (Bq/l)	0.5	1.14 ± 0.03	1.08 ± 0.45	0.33 ± 0.06
Gross beta (Bq/l)	1.0	0.36 ± 0.01	0.50 ± 0.21	0.21± 0.10

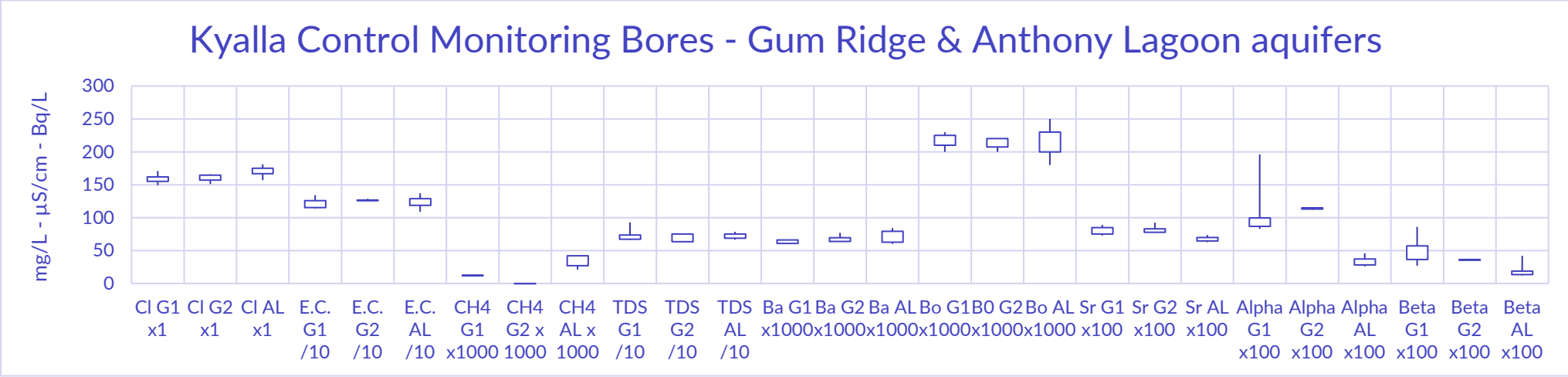

Figure 1: Natural background baseline interquartile range for key indicator analytes in the Gum Ridge aquifer and Anthony Lagoon aquifer at the Kyalla well site based on sampling events from February 2019 to October 2019. Analytes have been scaled as indicated in the horizontal axis.

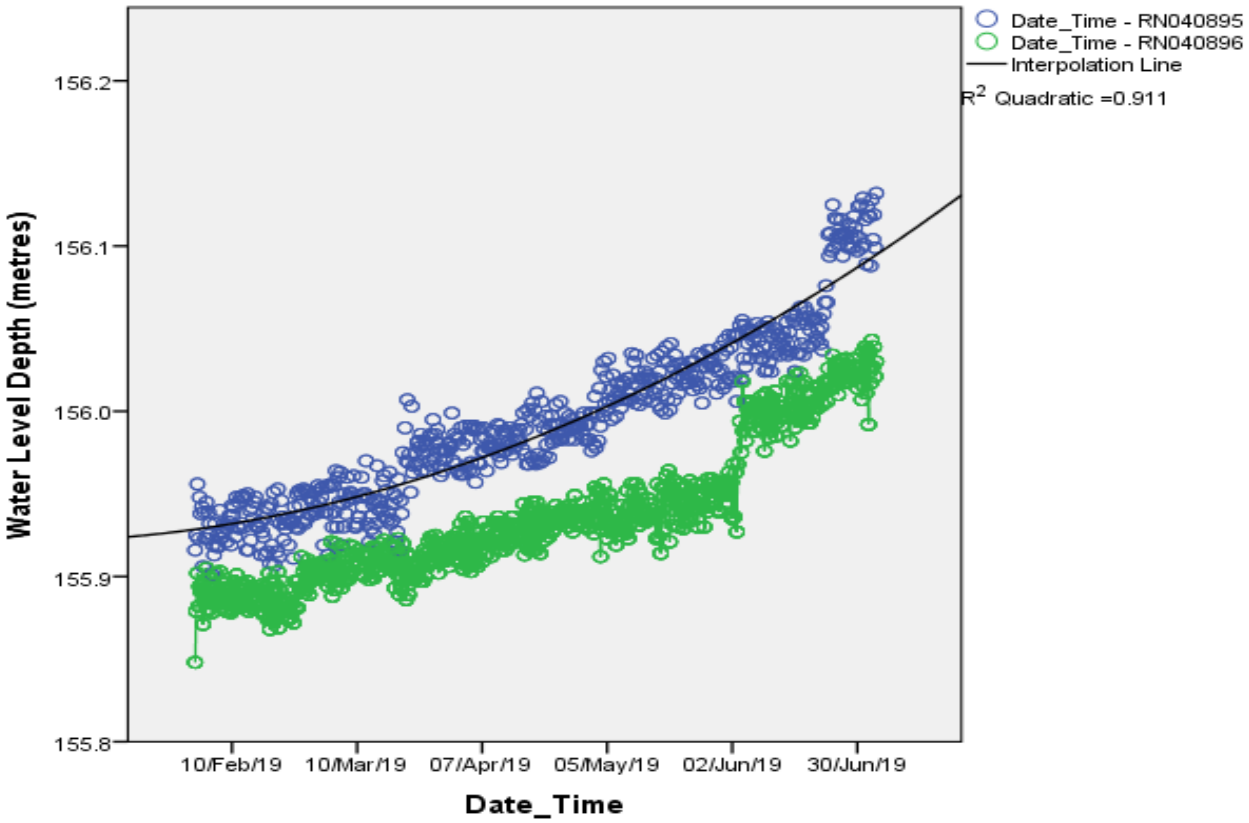

Figure 2: Standing water level in RN040895 and RN040896 at Kyalla well site relative to Australian Height Datum (AHD)

Appendix 1: Kyalla EP117 groundwater monitoring data

							BTEX							Inorganics																				
			Ethane	Ethene	Propane	Propene	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Sum of BTEX	Alkalinity (Bicarbonate) as CaCO3	Alkalinity (Carbonate) as CaCO3	Alkalinity (Hydroxide) as CaCO3	Alkalinity (Total) as CaCO3	Anions Total	Bicarbonate	Calcium (Filtered)	Carbonate	Cations Total	Chloride	Electrical Conductivity (Lab)	Fluoride	Ionic Balance	Magnesium (Filtered)	Methane	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate (as N)	pH (Lab)
Limit of detection			µg/L 10	µg/L 10	mg/L 0.01	µg/L 10	µg/L 1	µg/L 2	µg/L 2	µg/L 2	µg/L 2	µg/L 2	µg/L 1	mg/L 1	mg/L 1	mg/L 1	mg/L 1	meq/L 0.01	mg/L	mg/L 1	mg/L	meq/L 0.01	mg/L 1	µS/cm 1	mg/L 0.1	% 0.01	mg/L 1	mg/L 0.01	mg/L 0.01	mg/L 0.01	mg/L 0.01	pH_Units 0.01
	Sampled_Date_Time	RN																															
Gum Ridge Aquifer	1/02/2019	RN040895	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	340	<1	<1	340	15.9	414.8	110	0.6	14.2	171	1220	1.4	5.65	49	<0.01	<0.01	<0.01	<0.01	7.23
	23/02/2019	RN040895	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	306	<1	<1	306	14.1	373.32	95	0.6	12.5	164	1180	1.3	5.9	40	<0.01	<0.01	<0.01	<0.01	7.44
	23/02/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040895	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	303	<1	<1	303	13.4	369.66	100	0.6	13.8	160	1160	1.3	1.53	46	<0.01	<0.01	<0.01	<0.01	7.46
	3/05/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040895	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	275	<1	<1	275	12.1	335.5	79	0.6	11.7	156	1150	1.4	1.57	39	0.012	0.02	<0.01	0.02	7.37
	3/06/2019	RN040895	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	274	<1	<1	274	12.3	334.28	88	0.6	12.2	149	1300	1.4	0.32	39	0.012	<0.01	<0.01	<0.01	7.63
	4/07/2019	RN040895	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	268	<1	<1	268	12.5	-	89	-	12.4	154	1340	1.2	0.46	40	0.013	<0.01	<0.01	<0.01	7.73
	4/07/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/08/2019	RN040895	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	255	<1	<1	255	12	-	87	-	12.3	157	1140	1.3	1.05	40	<0.01	<0.01	<0.01	<0.01	7.47
	17/08/2019	RN041132	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	271	<1	<1	271	13.7	-	109	-	14	159	1290	1.6	1.16	49	<0.01	0.01	<0.01	0.01	7.36
	17/08/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	298	<1	<1	298	13.6	-	94	-	12.5	151	1260	1.5	4.12	41	<0.01	<0.01	<0.01	<0.01	7.56
	16/10/2019	RN041132	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	292	<1	<1	292	13.4	-	86	-	12	166	1260	1.4	5.35	40	<0.01	<0.01	<0.01	<0.01	7.5
	16/10/2019	RN041132	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	292	<1	<1	292	13.3	-	84	-	11.7	164	1260	1.4	6.22	39	<0.01	0.03	<0.01	0.03	7.48
Anthony Lagoon Aquifer	1/02/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	292	<1	<1	292	13.1	356.24	81	0.6	12.5	157	1090	1	2.11	41	<0.01	0.07	<0.01	0.07	7.31
	23/02/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	259 - 261	<1	<1	259 - 261	13.9 - 14.1	315.98 - 318.42	79 - 82	0.6	12 - 12.3	190 - 192	1180 - 1190	0.9 - 1	6.84 - 7.35	40	<0.01	0.02	<0.01	0.02	7.39 - 7.43
	23/02/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	268	<1	<1	268	12.9	326.96	88	0.6	13.6	168	1150	1	2.57	45	<0.01	0.04	<0.01	0.04	7.51
	3/05/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	246 - 248	<1	<1	246 - 248	11.9 - 12.1	300.12 - 302.56	70 - 71	0.6	11.7 - 11.8	174	1180 - 1190	1.1	0.96 - 1.03	40	0.03 - 0.042	0.04 - 0.05	<0.01	0.04 - 0.05	7.43 - 7.46
	3/06/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	249	<1	<1	249	12.6	303.78	82	0.6	12.9	164	1340	1	1.03	42	0.042	<0.01	<0.01	<0.01	7.68
	4/07/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	245	<1	<1	245	12	-	83	-	12.6	167	1370	1.1	2.3	41	0.029	0.01	<0.01	0.01	7.72
	4/07/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17/08/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	224	<1	<1	224	13	-	83	-	13	181	1200	1	0.03	45	0.021	0.02	<0.01	0.02	7.47
	17/08/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	244	<1	<1	244	13.1	-	76	-	11.9	172	1250	1.1	4.91	41	0.043	0.02	<0.01	0.02	7.59
	14/09/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	16/10/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	256	<1	<1	256	13	-	78	-	12.1	175	1270	1.1	3.26	41	<0.01	0.05	<0.01	0.05	7.85
	16/10/2019	RN040896	<10	<10	<0.01	<10	<1	<2	<2	<2	<2	<2	<1	264	<1	<1	264	13.2	-	78	-	12.2	177	1270	1.1	3.72	41	<0.01	0.04	<0.01	0.04	7.89

			Inorganics						Metals														
			Potassium (Filtered)	Silicon as Si (Filtered)	Sodium (Filtered)	Sulphate as SO4 (Filtered)	Suspended Solids	Total Dissolved Solids	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead
Limit of detection			mg/L 1	mg/L 0.05	mg/L 1	mg/L 1	mg/L 5	mg/L 10	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.05	mg/L 0.05	mg/L 0.0001	mg/L 0.0001	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.05	mg/L 0.05	mg/L 0.001
	Sampled_Date_Time	RN																					
Gum Ridge Aquifer	1/02/2019	RN040895	14	7.73	99	205	<5	927	0.008	0.008	0.064	0.054	0.23	0.21	<0.0001	<0.0001	<0.001	<0.001	0.004	0.031	0.48	0.36	0.011
	23/02/2019	RN040895	13	9.58	96	162	29	737	0.009	0.004	0.061	0.055	0.22	0.22	0.0001	<0.0001	<0.001	<0.001	0.011	<0.001	1.41	<0.05	0.011
	23/02/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040895	15	10.7	108	138	<5	733	0.011	0.01	0.061	0.064	0.22	0.23	0.0002	0.0001	<0.001	<0.001	0.002	<0.001	1.16	1.16	0.004
	3/05/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040895	13	9.16	98	107	<5	695	0.009	0.008	0.061	0.059	0.2	0.21	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	1.19	1.16	<0.001
	3/06/2019	RN040895	14	9.98	98	126	8	670	0.009	0.008	0.066	0.062	0.21	0.25	<0.0001	<0.0001	<0.001	<0.001	0.008	0.001	1.44	1.13	0.001
	4/07/2019	RN040895	13	9.87	100	136	6	660	0.008	0.007	0.066	0.061	0.23	0.22	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.95	0.83	<0.001
	4/07/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/08/2019	RN040895	14	10.5	99	121	6	672	0.005	0.005	0.067	0.067	0.21	0.25	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.63	0.83	<0.001
	17/08/2019	RN041132	15	8.68	96	183	14	762	0.004	0.004	0.067	0.062	0.2	0.25	<0.0001	<0.0001	<0.001	<0.001	0.007	0.002	2.54	0.89	0.006
	17/08/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	14	9.42	94	162	<5	746	0.004	0.005	0.064	0.06	0.21	0.2	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.5	0.47	0.001
	16/10/2019	RN041132	14	9.62	94	138	5	638	0.005	0.004	0.063	0.062	0.22	0.21	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.67	0.6	<0.001
	16/10/2019	RN041132	13	9.52	92	136	<5	630	0.005	0.004	0.077	0.06	0.22	0.2	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.69	0.53	<0.001
Anthony Lagoon Aquifer	1/02/2019	RN040896	13	9.73	110	135	<5	787	0.002	0.002	0.06	0.051	0.25	0.22	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.68	0.4	0.004
	23/02/2019	RN040896	11 - 12	10 - 10.1	104 - 106	164 - 167	58 - 73	712 - 738	0.007 - 0.008	0.004	0.122 - 0.127	0.104 - 0.105	0.2 - 0.21	0.19 - 0.2	<0.0001	<0.0001	0.002	<0.001	<0.001	<0.001	2.56 - 2.8	<0.05	<0.001
	23/02/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040896	14	11.6	119	137	<5	716	0.003	0.003	0.08	0.087	0.22	0.23	<0.0001	<0.0001	<0.001	<0.001	0.012	<0.001	0.53	0.6	0.006
	3/05/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040896	12	9.16 - 9.25	106 - 108	102 - 106	<5	701 - 704	0.006 - 0.007	0.006	0.085 - 0.089	0.081 - 0.082	0.2	0.2	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.6 - 0.65	0.52 - 0.57	<0.001
	3/06/2019	RN040896	13	10.1	115	145	7	682	0.006	0.005	0.084	0.077	0.21	0.21	<0.0001	<0.0001	<0.001	<0.001	0.011	<0.001	1.66	1.55	0.002
	4/07/2019	RN040896	12	9.84	110	117	8	698	0.005	0.004	0.079	0.075	0.23	0.22	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.69	0.55	<0.001
	4/07/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17/08/2019	RN040896	13	10.1	110	162	10	750	0.003	0.003	0.067	0.064	0.18	0.21	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	1.09	0.89	<0.001
	17/08/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN040896	12	9.51	102	164	6	754	0.002	0.002	0.063	0.06	0.2	0.21	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.69	0.78	<0.001
	14/09/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	16/10/2019	RN040896	14	9.47	104	140	<5	664	0.001	0.001	0.062	0.059	0.22	0.21	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.58	0.45	<0.001
	16/10/2019	RN040896	14	9.32	106	140	<5	692	0.001	0.001	0.064	0.06	0.23	0.2	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.54	0.4	<0.001

			Metals															
			Lead (Filtered)	Lithium	Lithium (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Nickel	Nickel (Filtered)	Selenium	Selenium (Filtered)	Silver	Silver (Filtered)	Strontium	Strontium (Filtered)	Zinc	Zinc (Filtered)
Limit of detection			mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.0001	mg/L 0.0001	mg/L 0.001	mg/L 0.001	mg/L 0.01	mg/L 0.01	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.001	mg/L 0.005	mg/L 0.005
	Sampled_Date_Time	**RN**																	
Gum Ridge Aquifer	1/02/2019	RN040895	0.006	0.051	0.048	0.091	0.09	<0.0001	<0.0001	0.052	0.047	<0.01	<0.01	<0.001	<0.001	0.85	0.745	0.07	0.068
	23/02/2019	RN040895	<0.001	0.043	0.044	0.042	0.037	<0.0001	<0.0001	0.01	0.006	<0.01	<0.01	<0.001	<0.001	0.767	0.684	0.166	<0.005
	23/02/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040895	<0.001	0.046	0.045	0.032	0.038	<0.0001	<0.0001	0.02	0.01	<0.01	<0.01	<0.001	<0.001	0.892	0.821	0.055	0.015
	3/05/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040895	<0.001	0.044	0.045	0.026	0.027	<0.0001	<0.0001	0.004	0.002	<0.01	<0.01	<0.001	<0.001	0.728	0.702	0.006	<0.005
	3/06/2019	RN040895	<0.001	0.044	0.042	0.03	0.027	<0.0001	<0.0001	0.024	0.008	<0.01	<0.01	<0.001	<0.001	0.848	0.746	0.094	0.02
	4/07/2019	RN040895	<0.001	0.044	0.046	0.025	0.024	<0.0001	<0.0001	0.003	0.003	<0.01	<0.01	<0.001	<0.001	0.792	0.727	0.008	<0.005
	4/07/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/08/2019	RN040895	<0.001	0.044	0.048	0.018	0.019	<0.0001	<0.0001	0.007	0.002	<0.01	<0.01	<0.001	<0.001	0.734	0.771	0.018	0.006
	17/08/2019	RN041132	<0.001	0.044	0.049	0.075	0.072	<0.0001	<0.0001	0.027	0.027	<0.01	<0.01	<0.001	<0.001	0.8	0.805	0.074	0.044
	17/08/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	<0.001	0.041	0.04	0.024	0.024	<0.0001	<0.0001	0.005	0.006	<0.01	<0.01	<0.001	<0.001	0.776	0.759	0.02	0.009
	16/10/2019	RN041132	<0.001	0.043	0.04	0.019	0.017	<0.0001	<0.0001	0.004	0.003	<0.01	<0.01	<0.001	<0.001	0.778	0.72	0.011	<0.005
	16/10/2019	RN041132	<0.001	0.048	0.038	0.021	0.016	<0.0001	<0.0001	0.008	0.004	<0.01	<0.01	<0.001	<0.001	0.924	0.694	0.026	0.02
Anthony Lagoon Aquifer	1/02/2019	RN040896	0.003	0.056	0.052	0.023	0.017	<0.0001	<0.0001	0.002	<0.001	<0.01	<0.01	<0.001	<0.001	0.694	0.611	0.018	0.008
	23/02/2019	RN040896	<0.001	0.066 - 0.068	0.056 - 0.058	0.119 - 0.124	0.076 - 0.078	<0.0001	<0.0001	0.001 - 0.003	<0.001	<0.01	<0.01	<0.001	<0.001	0.673 - 0.686	0.564 - 0.59	0.011 - 0.012	<0.005
	23/02/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040896	<0.001	0.052	0.055	0.047	0.05	<0.0001	<0.0001	0.016	0.002	<0.01	<0.01	<0.001	<0.001	0.736	0.718	0.026	0.007
	3/05/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040896	<0.001	0.05 - 0.051	0.048 - 0.05	0.045 - 0.047	0.04 - 0.042	<0.0001	<0.0001	<0.001	<0.001	<0.01	<0.01	<0.001	<0.001	0.624 - 0.631	0.594 - 0.611	<0.005	<0.005
	3/06/2019	RN040896	<0.001	0.051	0.051	0.067	0.063	<0.0001	<0.0001	0.018	0.002	<0.01	<0.01	<0.001	<0.001	0.707	0.629	0.098	0.015
	4/07/2019	RN040896	<0.001	0.051	0.053	0.043	0.041	<0.0001	<0.0001	0.001	<0.001	<0.01	<0.01	<0.001	<0.001	0.679	0.657	0.012	<0.005
	4/07/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17/08/2019	RN040896	<0.001	0.059	0.063	0.052	0.046	<0.0001	<0.0001	0.003	<0.001	<0.01	<0.01	<0.001	<0.001	0.65	0.65	0.016	<0.005
	17/08/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN040896	<0.001	0.056	0.063	0.041	0.043	<0.0001	<0.0001	0.001	<0.001	<0.01	<0.01	<0.001	<0.001	0.627	0.618	0.01	0.009
	14/09/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	16/10/2019	RN040896	<0.001	0.052	0.044	0.034	0.03	<0.0001	<0.0001	<0.001	<0.001	<0.01	<0.01	<0.001	<0.001	0.63	0.603	0.094	0.074
	16/10/2019	RN040896	<0.001	0.053	0.045	0.033	0.029	<0.0001	<0.0001	<0.001	<0.001	<0.01	<0.01	<0.001	<0.001	0.651	0.61	0.08	0.073

			PAH/Phenols																			Radionucleides		TPH												VOC	
			Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(a)pyrene TEQ (zero)	Benzo(b&j)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Sum of polycyclic aromatic hydrocarbons	Total Reportable PAH	Gross alpha	Gross beta activity - 40K	C6 - C9 Fraction	C6 - C10 Fraction	C6 - C10 Fraction minus BTEX (F1)	C10 - C14 Fraction	C10 - C16 Fraction	C10 - C16 Fraction minus Naphthalene (F2)	C15 - C28 Fraction	C16 - C34 Fraction	C29 - C36 Fraction	C34 - C40 Fraction	C10 - C36 Fraction (Sum)	C10 - C40 Fraction (Sum)	Butane	Butene
Limit of detection			µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 0.5	µg/L 0.5	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 1	µg/L 0.5	µg/L 0.5	Bq/L 0.05	Bq/L 0.1	µg/L 20	µg/L 20	µg/L 20	µg/L 50	µg/L 100	µg/L 100	µg/L 100	µg/L 100	µg/L 50	µg/L 100	µg/L 50	µg/L 100	mg/L 0.01	µg/L 10
Sampled_Date_Time	RN																																				
Gum Ridge Aquifer	1/02/2019	RN040895	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	1.96	0.86	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	23/02/2019	RN040895	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.92	0.6	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	23/02/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040895	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.83	0.27	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	3/05/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040895	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.85	0.41	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	3/06/2019	RN040895	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	1.02	0.48	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	4/07/2019	RN040895	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	0.92	0.35	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	4/07/2019	RN040895	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/08/2019	RN040895	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	-	-	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	17/08/2019	RN041132	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	-	-	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	17/08/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN041132	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	-	-	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	16/10/2019	RN041132	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	1.12	0.35	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	16/10/2019	RN041132	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	1.16	0.37	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
Anthony Lagoon Aquifer	1/02/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.46	0.42	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	23/02/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.32 - 0.34	0.28 - 0.34	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	23/02/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20/03/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.39	0.19	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	3/05/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3/05/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.29 - 0.36	0.16 - 0.23	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	3/06/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<0.5	0.32	0.18	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	4/07/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	0.32	0.12	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	4/07/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17/08/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	-	-	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	17/08/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/09/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	-	-	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	14/09/2019	RN040896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	16/10/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	0.26	0.15	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10
	16/10/2019	RN040896	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	-	0.27	0.13	<20	<20	<20	<50	<100	<100	<100	<100	<50	<100	<50	<100	<0.01	<10