Groundwater monitoring results at petroleum well sites in the Beetaloo Sub-basin in accordance with the Code of Practice – Quarter 2 2018/19 - Quarter 2 2019/20

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 Santos QNT Pty Ltd for the Tanumbirini and Inacumba petroleum well sites on EP161 in the Beetaloo sub-basin, covering the period from December 2018 to October 2019. It fulfils the Code of Pratice: 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 Santos McArthur Basin 2019-2020 Hydraulic Fracturing Program Environment Management Plan (EMP) (ref: NTEPA2019/0102-007~0011).

Groundwater Monitoring Program

Companies are required to submit groundwater monitoring data quarterly, in compliance with the the Code 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 Santos groundwater monitoring program consists of:

- a 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 in compliance with the Code; and
- an Impact Monitoring Bore, which is located 20m "downstream" of the location of each petroleum well.

These bores enable a 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 Tanumbirini and Inacumba petroleum well sites and surrounding EP161 area the Gum Ridge aquifer is used as the sole source of groundwater by pastoralists and for petroleum exploration activities. The CMB provides ongoing natural background (baseline) values and a measure of natural variation for groundwater quality at the Tanumbirini and Inacumba well sites on EP161. At both well sites the drilling of new exploration petroleum wells and hydraulic fracturing had not yet occurred during the reporting period (December 2018 to October 2019).

Summary and Interpretation of Results

The raw groundwater monitoring results reported quarterly by Santos for the Beetaloo Sub-basin are availble at Appendix 1. The number of sampling events conducted at each 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" averages and standard deviations for sampling events between December 2018 and October 2019. Fourteen sampling events were undertaken at Tanumbirini and thirteen at Inacumba 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 well site are:

- Tanumbirini petroleum well site Bore: RN040930
- Inacumba petroleum well site Bore: RN040931

Figure 1 provides graphical presentation of the natural background (baseline) interquartile range for key "indicator" analytes in the Gum Ridge aquifer at the Tanumbirini and Inacumba well sites. The well sites are approximately 20km apart, with subtle differences in the environment between each, including vegetation types, soils, land forms and systems. Site specifica data is important as it will ensure any significant variation in groundwater is able to be specifically attributed to an activity and not interpreted as a result of landscape variation.

Each analyte has been scaled appropriately as shown in the horizontal axis. For example electrical conductivity is divided by a factor of 10 so at Tanumburini the interquartile range is approximately 1290 to 1410 µS/cm. Similarly Gross Alpha is multiplied by a factor of 100 so at Tanumbirini the interquartile range is approximately 0.43 to 1.46 Bq/L. Average values for all analytes at both sites were below drinking water guidance values except for Gross Alpha radionuclides at Tanumbirini. Gross alpha at both sites 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), this is not uncommon in systems where concentrations of dissolved constituents can build up during prolonged periods of water/rock contact. For example, similar results have been reported around Katherine (1996). The groundwater will continue to be monitoried in accordance with the Code and the Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin (2018). https://www.territorystories.nt.gov.au/jspui/bitstream/10070/228526/1/WRD96073.pdf

Inacumba had significantly higher levels of chlorides, total dissolved solids and electrical conductivity, which are all closely correlated, compared to the Tanumbirini site, underscoring the importance of site specific groundwater monitoring data during this preliminary stage of exploration activities in the Beetaloo.

A groundwater extraction licence (GRF10280) has been granted to Santos for 193.5 ML per year for three years. Estimated groundwater use for the Santos 2019-2020 exploration prgram on EP161 is approximately 142 ML. At the Tanumbirini well site approximately 38.5 ML of water was extracted during the monitoring period, representing approximately 50% of groundwater use at this well site over 2019-2020 period. Figure 2 shows standing ground water level at the Tanumburini well site was relatively constant throughout the monitoring period indicating that drawdown of the Gum Ridge aquifer is unlikely at these extraction rates.

Conclusion

In accordance with the Code and Ministerial condition of approval of the EMP, results of ongoing groundwater monitoring must be provided by Santos every quarter for three years from the approval date

of the EMP (22 October 2019). These reports will be published on the DENR website as they become available. Santos has met the requirement to provide 6 months of baseline groundwater quality data prior to conducting hydraulic fracturing.

Table 1: Average and standard deviation results for key 'indicator' analytes for Santos control monitoring bores, at Tanumbirini RN40930 and Inacumba RN40931, on EP161 for sampling period December 2018 to October 2019.

Key analyte	**Drinking Water Guidance**	**RN040930 Tanumbirini** **n = 14** **Gum Ridge aquifer**	**RN040931 Inacumba** **n = 13** **Gum Ridge aquifer**
Standing Water Level AHD (m)	N.A.	156.9 ± 0.05	158.6 ± 0.04
Total volume of water extracted from bore until end Sept'19 (ML)	N.A.	20	0
Total volume of water extracted at well site until end Sept'19 (ML)	N.A.	38.5	0
Electrical Conductivity (µS/cm)	< 2,500	1338 ± 42	1803 ± 121
Total Dissolved Solids (mg/L)	< 1200	840 ± 40	1200 ± 87
Chloride (mg/L)	~ 250	110 ± 2.2	155 ± 3.4
Barium (mg/L)	0.7	0.049 ± .003	0.030 ± .004
Boron (mg/L)	4.0	0.19 ± 0.002	0.30 ± 0.004
Strontium (mg/L)	N.A	0.84 ± 0.05	0.97 ± 0.11
Methane µg/L	N.A.	<1	<1
Gross alpha (Bq/L)	0.5	0.77 ± 0.15	0.39 ± 0.38
Gross beta (Bq/L)	1.0	0.39 ± 0.13	0.29 ± 0.17

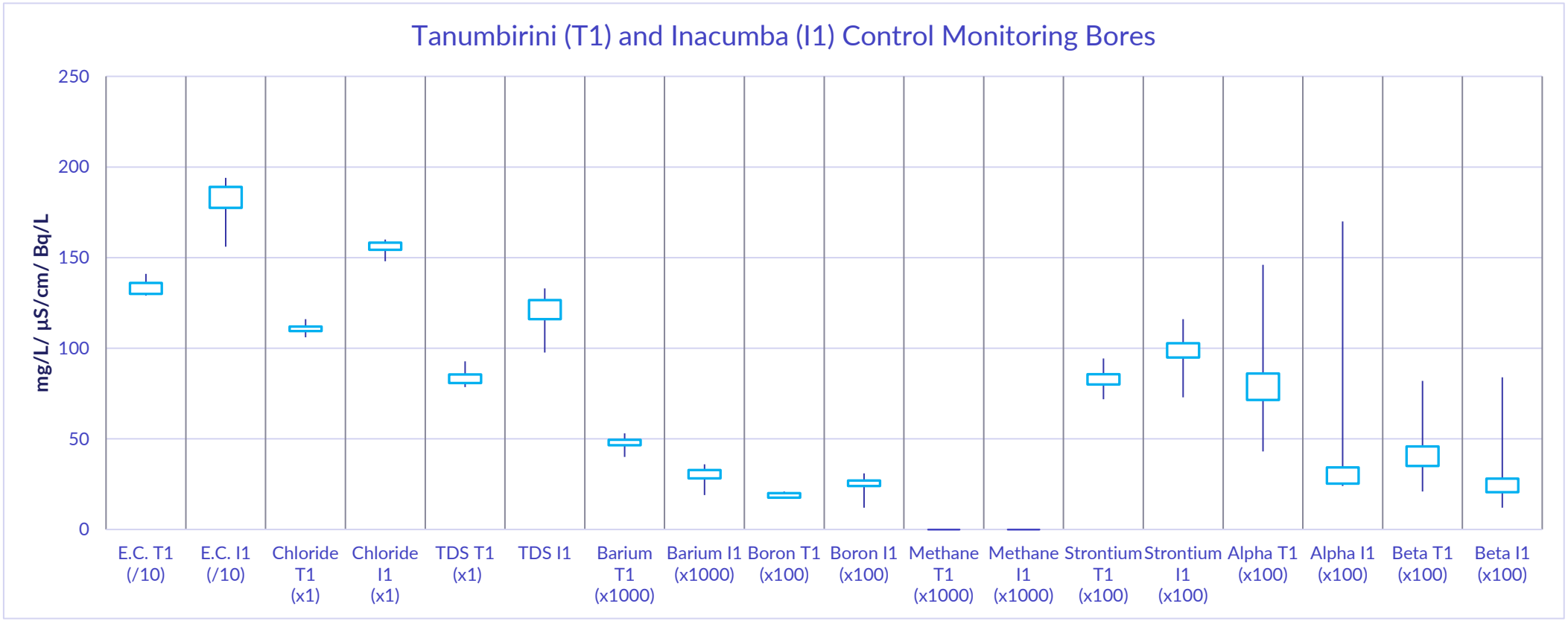
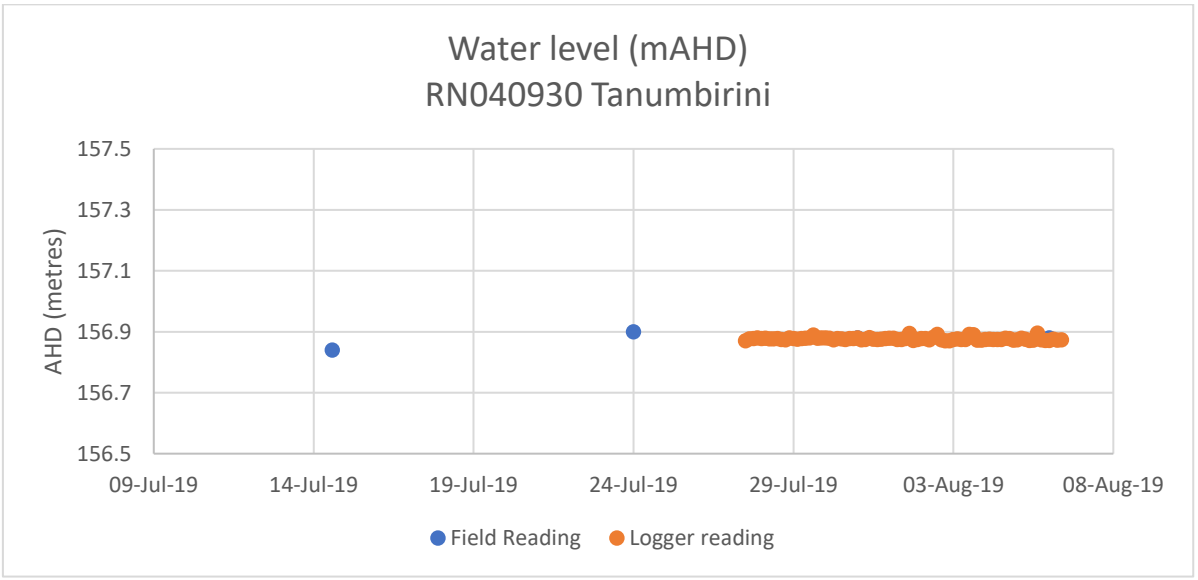


Figure 1: Natural background (baseline) interquartile range for key "indicator" analytes in the Gum Ridge aquifer at the Tanumbirini and Inacumba well sites based on sampling from Dec'18 to Oct' 19. Analytes have been scaled as indicated in the horizontal axis.



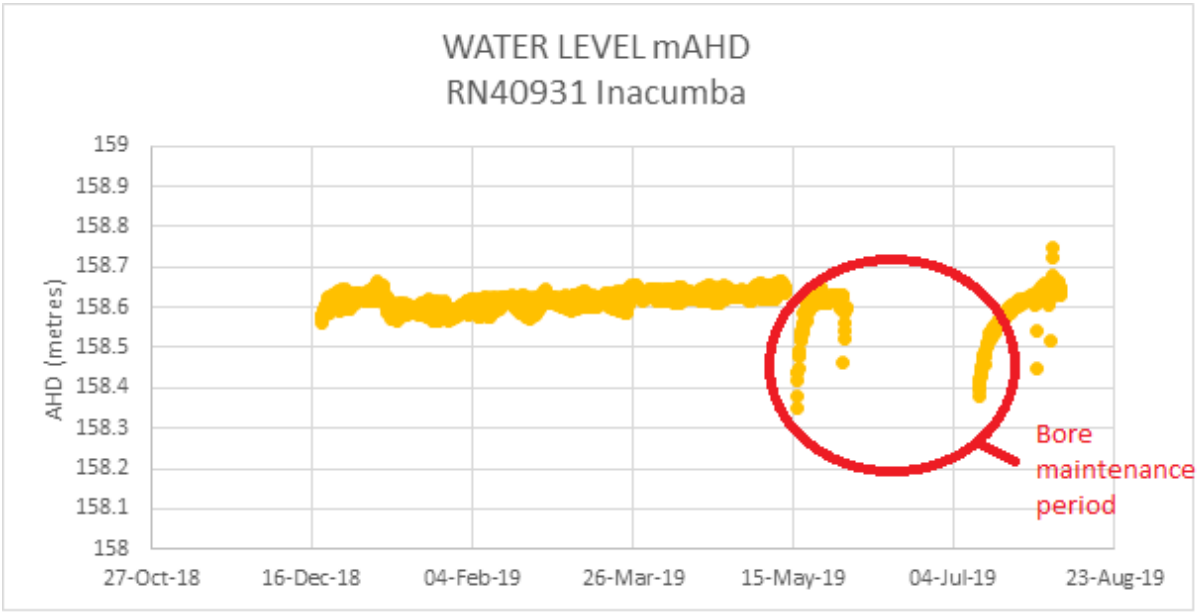


Figure 2: Groundwater level expressed as metres above Australian Height Datum (AHD) for RN040930 and RN040931

Appendix 1: Raw data from groundwater monitoring at petroleum well sites in the Beetaloo Sub-basin in accordance with the Code of Practice – Quarter 2 2018/19 - Quarter 2 2019/20

Raw data from Inacumba petroleum well site Bore: RN040931

	CHEMICAL NAME	Result Unit	No. results	Min	Median	Max	Limit of Detection	17/12/18	29/7/19	03/8/19	06/8/19	19/8/19	27/8/19	28/8/19	11/9/19	12/9/19	25/9/19	26/9/19	09/10/19	10/10/19
General, anions, cations and metals	Total Alkalinity as $CaCO_3$	mg/L	13	363	455	470	1	363	451	461	463	463	459	470	447	455	408	456	364	426
	Electrical Conductivity @ 25°C	µS/cm	13	1560	1830	1940	1	1560	1900	1940	1930	1830	1830	1810	1860	1890	1670	1790	1580	1770
	Total Dissolved Solids @180°C	mg/L	13	976	1200	1330	10	976	1130	1170	1160	1200	1240	1230	1250	1270	1150	1270	1160	1330
	Suspended Solids	mg/L	12	9	20.5	36	5	35	15	13	20		11	36	9	20	24	23	21	31
	Mercury	mg/L	13	0	-	0	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Mercury	mg/L	13	0	-	0	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Calcium	mg/L	13	90	143	163	1	134	150	163	159	138	162	155	139	143	114	147	90	133
	Magnesium	mg/L	13	88	106	122	1	88	109	117	115	97	122	106	103	102	103	114	102	106
	Potassium	mg/L	13	22	27	29	1	22	29	28	28	25	28	27	26	26	27	28	27	26
	Chloride	mg/L	13	148	156	160	1	148	154	156	155	151	159	152	155	156	160	159	156	159
	Fluoride	mg/L	13	1.8	2.7	3	0.1	1.8	2.7	2.8	2.7	3	2.7	2.8	2.6	2.7	2.5	2.8	2.2	2.5
	pH - Lab	pH Unit	13	7.36	7.83	8.11	0.01	8.06	7.42	7.36	7.47	8.03	7.96	8	7.51	7.43	8.11	7.81	7.93	7.83
	Nitrite as N	mg/L	13	0	-	0	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrate as N	mg/L	13	0.02	0.055	0.09	0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.09	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate as SO4 2-	mg/L	13	328	384	451	1	328	444	451	450	396	368	386	380	384	343	377	346	407
	Gross alpha	Bq/L	13	0.24	0.27	1.7	0.05	1.7	0.27	0.27	0.26	0.36	0.32	0.24	0.27	0.25	0.27	0.35	0.24	0.4
	Gross beta activity - 40K	Bq/L	13	0.12	0.27	0.84	0.10	0.84	0.33	0.2	0.28	0.26	0.28	0.27	0.12	0.2	0.27	0.28	0.22	0.24
	Arsenic	mg/L	13	0.001	0.0015	0.003	0.001	0.003	0.001	0.002	<0.001	0.002	0.002	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001
	Arsenic	mg/L	13	0.001	0.002	0.01	0.001	0.01	0.001	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Barium	mg/L	13	0.019	0.031	0.036	0.001	0.028	0.036	0.032	0.026	0.029	0.03	0.033	0.031	0.031	0.019	0.036	0.027	0.033
	Barium	mg/L	13	0.03	0.036	0.044	0.001	0.036	0.038	0.034	0.034	0.032	0.03	0.033	0.037	0.038	0.037	0.04	0.035	0.044
	Boron	mg/L	13	0.12	0.25	0.31	0.05	0.31	0.26	0.27	0.28	0.27	0.23	0.25	0.24	0.24	0.12	0.28	0.23	0.25
	Boron	mg/L	13	0.24	0.26	0.3	0.05	0.27	0.25	0.24	0.26	0.3	0.3	0.3	0.28	0.3	0.26	0.25	0.26	0.26
	Cadmium	mg/L	13	0	-	0	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Cadmium	mg/L	13	0	-	0	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	13	0	-	0	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Chromium	mg/L	13	0	-	0	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Copper	mg/L	13	0	-	0	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Copper	mg/L	13	0	-	0	0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
	Iron	mg/L	13	0.24	2.895	9.58	0.05	<0.05	3.3	2.21	2.02	2.49	5.37	8.65	1.39	6.37	<0.05	9.58	<0.05	0.24
	Iron	mg/L	13	3.67	8.9	19.1	0.05	7.33	3.67	8.28	9.52	4.28	5.7	13.3	5.03	11.3	14.6	16.4	13.1	19.1
	Lead	mg/L	13	0	-	0	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Lead	mg/L	13	0	-	0	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Lithium	mg/L	13	0.19	0.416	0.485	0.001	0.416	0.406	0.396	0.423	0.424	0.448	0.424	0.422	0.413	0.19	0.485	0.358	0.394
	Lithium	mg/L	13	0.365	0.452	0.515	0.001	0.365	0.475	0.435	0.463	0.452	0.503	0.515	0.431	0.448	0.484	0.461	0.45	0.433

	CHEMICAL NAME	Result Unit	No. results	Min	Median	Max	Limit of Detection	17/12/18	29/7/19	03/8/19	06/8/19	19/8/19	27/8/19	28/8/19	11/9/19	12/9/19	25/9/19	26/9/19	09/10/19	10/10/19
	Manganese	mg/L	13	0.081	0.197	0.249	0.001	0.142	0.203	0.081	0.234	0.133	0.21	0.249	0.123	0.226	0.108	0.232	0.164	0.197
	Manganese	mg/L	13	0.137	0.218	0.269	0.001	0.163	0.221	0.231	0.255	0.137	0.183	0.269	0.137	0.249	0.213	0.237	0.191	0.218
	Selenium	mg/L	13	0	-	0	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Selenium	mg/L	13	0	-	0	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Silver	mg/L	13	0	-	0	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Silver	mg/L	13	0	-	0	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Strontium	mg/L	13	0.428	0.957	1.02	0.001	0.868	0.957	1.02	0.99	0.984	0.974	0.98	0.916	0.934	0.428	1	0.671	0.871
	Strontium	mg/L	13	0.729	0.97	1.16	0.001	0.835	0.958	1	1.02	1.03	1.13	1.16	0.946	0.97	0.879	1.03	0.729	0.959
	Zinc	mg/L	13	0.012	0.024	0.098	0.005	0.014	0.047	0.078	0.017	0.044	0.05	0.023	0.024	0.016	0.098	0.012	<0.005	<0.005
	Zinc	mg/L	13	0.031	0.05	0.473	0.005	0.041	0.052	0.081	0.067	0.056	0.05	0.064	0.04	0.031	0.473	0.047	0.043	0.044
Diss. pet. gases	Ethane	µg/L	13	0	-	0	1-10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Methane	µg/L	13	0	-	0	1-10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Propane	µg/L	13	0	-	0	1-10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total recoverable hydrocarbons	C6 - C10 Fraction	µg/L	13	0	-	0	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	C6 - C10 Fraction minus BTEX (F1)	µg/L	13	0	-	0	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	C6 - C9 Fraction	µg/L	13	0	-	0	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	>C10 - C16 Fraction	µg/L	13	0	-	0	100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	13	0	-	0	100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	>C16 - C34 Fraction	µg/L	13	0	-	0	100	280	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	>C34 - C40 Fraction	µg/L	13	0	-	0	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	>C10 - C40 Fraction (sum)	µg/L	13	0	-	0	100	380	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	C6 - C36 Fraction (Sum)	µg/L	13	0	-	0	20					<20	<20	<20	<20	<20	<20	<20	<20	<20
BTEX	Benzene	µg/L	13	0	-	0	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ethylbenzene	µg/L	13	0	-	0	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	meta- & para-Xylene	µg/L	13	0	-	0	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Naphthalene	µg/L	13	0	-	0	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	ortho-Xylene	µg/L	13	0	-	0	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Sum of BTEX	µg/L	13	0	-	0	1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Toluene	µg/L	13	0	-	0	2	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Total Xylenes	µg/L	13	0	-	0	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
PAH Suite	3-Methylcholanthrene	µg/L	13	0	-	0	0.1		<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	7.12-Dimethylbenz(a)anthracene	µg/L	13	0	-	0	0.1		<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthylene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Anthracene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benz(a)anthracene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(a)pyrene	µg/L	13	0	-	0	0.05	<0.5	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Benzo(a)pyrene TEQ (zero)	µg/L	13	0	-	0	0.1	<0.5	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(b+j)fluoranthene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(g.h.i)perylene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

	CHEMICAL NAME	Result Unit	No. results	Min	Median	Max	Limit of Detection	17/12/18	29/7/19	03/8/19	06/8/19	19/8/19	27/8/19	28/8/19	11/9/19	12/9/19	25/9/19	26/9/19	09/10/19	10/10/19
	Benzo(k)fluoranthene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Chrysene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenz(a.h)anthracene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluoranthene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluorene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Indeno(1.2.3.cd)pyrene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Naphthalene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Phenanthrene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Pyrene	µg/L	13	0	-	0	0.1	<1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Sum of polycyclic aromatic hydrocarbons (PAHs)	µg/L	13	0	-	0	0.1	<0.5	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 3: Raw data from Tanumbirini petroleum well site Bore: RN040930

	CHEMICAL NAME	Result Unit	No. results	Min	Median	Max	Limit of Detection	14/7/19	24/7/19	31/7/19	6/8/19	14/8/19	19/8/19	27/8/19	28/08/19	10/09/19	11/09/19	25/09/19	26/09/19	10/10/19
General, anions, cations and metal	Total Alkalinity as CaCO3	mg/L	13	389	413	467	1	467	424	419	424	441	410	407	410	413	404	419	412	389
	Electrical Conductivity @ 25°C	µS/cm	13	1290	1320	1410	1	1330	1400	1410	1410	1320	1300	1310	1300	1360	1360	1300	1300	1290
	Total Dissolved Solids @180°C	mg/L	13	786	843	928	10	805	805	789	812	835	786	894	855	845	856	843	871	928
	Suspended Solids	mg/L	13	6	6	6	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	6
	Mercury	mg/L	13	>0.0001	-	>0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Mercury	mg/L	13	>0.0001	-	>0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Calcium	mg/L	13	126	141	152	1	147	152	149	148	141	127	141	142	132	132	126	140	136
	Magnesium	mg/L	13	53	57	63	1	60	63	62	63	54	53	56	57	55	55	54	60	57
	Potassium	mg/L	13	11	12	13	1	13	12	12	12	12	11	11	11	11	11	11	12	12
	Chloride	mg/L	13	107	111	116	1	112	109	112	110	108	107	112	111	110	110	116	112	113
	Fluoride	mg/L	13	0.6	0.7	0.7	0.1	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.6
	pH - Lab	pH Unit	13	7.27	7.77	8.02	0.01	7.78	7.4	7.27	7.41	7.37	8.02	7.96	8.01	7.71	7.6	7.96	7.96	7.77
	Nitrite as N	mg/L	13	>0.01	-	>0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrate as N	mg/L	13	>0.01	-	>0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate as SO4 2-	mg/L	13	139	173	180	1-5	139	180	177	164	168	175	164	174	163	163	173	180	178
	Gross alpha	Bq/L	13	0.43	0.79	1.1	0.05-0.55	0.43	0.79	0.86	0.87	1.1	0.75	0.67	0.75	0.68	0.76	0.86	0.82	0.8
	Gross beta activity - 40K	Bq/L	13	0.21	0.415	0.5	0.1-1.1	0.21	0.46	0.44	0.45	<1.1	0.4	0.27	0.34	0.35	0.35	0.5	0.49	0.43
	Arsenic	mg/L	13	0.004	0.007	0.008	0.001	0.004	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.007	0.005	0.005	0.005
	Arsenic	mg/L	13	0.001	0.007	0.014	0.001	0.001	0.006	0.007	0.007	0.008	0.008	0.006	0.007	0.014	0.007	0.006	0.006	0.006
	Barium	mg/L	13	0.039	0.044	0.047	0.001	0.043	0.046	0.047	0.039	0.044	0.043	0.046	0.046	0.044	0.044	0.041	0.045	0.044
	Barium	mg/L	13	0.044	0.048	0.053	0.001	0.053	0.049	0.048	0.048	0.048	0.049	0.044	0.045	0.052	0.05	0.047	0.048	0.046
	Boron	mg/L	13	0.17	0.18	0.2	0.05	0.18	0.19	0.19	0.19	0.18	0.19	0.18	0.18	0.17	0.17	0.18	0.2	0.17
	Boron	mg/L	13	0.17	0.18	0.21	0.05	0.19	0.17	0.17	0.17	0.18	0.21	0.2	0.21	0.2	0.19	0.18	0.17	0.18

	CHEMICAL NAME	Result Unit	No. results	Min	Median	Max	Limit of Detection	14/7/19	24/7/19	31/7/19	6/8/19	14/8/19	19/8/19	27/8/19	28/08/19	10/09/19	11/09/19	25/09/19	26/09/19	10/10/19
	Cadmium	mg/L	13	0.0001	0.0001	0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Cadmium	mg/L	13	0.0001	0.00015	0.0002	0.0001	0.0002	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	13	<0.001	-	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Chromium	mg/L	13	<0.001	-	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
	Copper	mg/L	13	<0.001	-	0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Copper	mg/L	13	<0.001	-	0.015	0.001	<0.001	0.015	0.013	0.002	<0.001	0.01	<0.001	0.004	0.011	0.003	0.007	0.007	0.005
	Iron	mg/L	13	0.15	0.355	0.68	0.05	0.15	0.25	0.22	<0.05	0.34	0.45	0.44	0.4	0.27	0.68	0.28	0.37	0.53
	Iron	mg/L	13	0.21	0.44	3.62	0.05	0.32	0.35	0.28	0.21	0.41	0.87	0.21	0.44	3.62	0.9	0.46	0.5	1.82
	Lead	mg/L	13	0.001	0.0015	0.003	0.001	0.003	0.002	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Lead	mg/L	13	0.002	0.0055	0.028	0.001	0.002	0.028	0.021	0.005	0.006	0.009	<0.001	0.005	0.016	0.005	0.003	0.003	0.008
	Lithium	mg/L	13	0.057	0.068	0.076	0.001	0.057	0.073	0.073	0.069	0.066	0.076	0.068	0.065	0.064	0.065	0.068	0.075	0.066
	Lithium	mg/L	13	0.057	0.072	0.082	0.001	0.057	0.069	0.072	0.075	0.069	0.076	0.08	0.082	0.078	0.074	0.067	0.066	0.066
	Manganese	mg/L	13	0.008	0.016	0.046	0.001	0.008	0.018	0.016	0.016	0.015	0.019	0.016	0.016	0.046	0.019	0.015	0.017	0.027
	Manganese	mg/L	13	0.008	0.017	0.057	0.001	0.008	0.018	0.017	0.017	0.016	0.022	0.016	0.017	0.057	0.022	0.017	0.017	0.031
	Selenium	mg/L	13	<0.01	-	0	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Selenium	mg/L	13	<0.01	-	0.05	0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Silver	mg/L	12	<0.001	-	<0.001	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Silver	mg/L	12	<0.001	-	<0.001	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Strontium	mg/L	12	0.756	0.7935	0.857	0.001		0.84	0.835	0.819	0.786	0.781	0.804	0.8	0.756	0.768	0.767	0.857	0.787
	Strontium	mg/L	12	0.764	0.8415	0.944	0.001		0.848	0.834	0.833	0.834	0.873	0.9	0.944	0.764	0.789	0.859	0.85	0.835
	Zinc	mg/L	13	0.01	0.027	0.07	0.005	0.01	0.068	0.07	0.02	0.027	0.047	0.035	0.025	0.013	0.039	0.023	0.033	0.019
	Zinc	mg/L	13	0.01	0.049	0.098	0.005	0.01	0.098	0.095	0.049	0.034	0.064	0.026	0.034	0.057	0.05	0.032	0.039	0.052
Diss. pet.	Ethane	µg/L	13	<1	-	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Diss. pet.	Methane	µg/L	13	<1	-	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Diss. pet.	Propane	µg/L	13	<1	-	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total recoverable hydrocarbons	C6 - C10 Fraction	µg/L	13	<20	-	<20	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Total recoverable hydrocarbons	C6 - C10 Fraction minus BTEX (F1)	µg/L	13	<20	-	<20	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Total recoverable hydrocarbons	C6 - C9 Fraction	µg/L	13	<20	-	<20	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Total recoverable hydrocarbons	>C10 - C16 Fraction	µg/L	13	<100	-	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Total recoverable hydrocarbons	>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	13	<100	-	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Total recoverable hydrocarbons	>C16 - C34 Fraction	µg/L	13	<100	-	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Total recoverable hydrocarbons	>C34 - C40 Fraction	µg/L	13	<100	-	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Total recoverable hydrocarbons	>C10 - C40 Fraction (sum)	µg/L	13	<100	-	<100	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Total recoverable hydrocarbons	C6 - C36 Fraction (Sum)	µg/L	9	<20	-	<20	20					<20	<20	<20	<20	<20	<20	<20	<20	<20
BTEX	Benzene	µg/L	13	<1	-	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
BTEX	Ethylbenzene	µg/L	13	<2	-	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
BTEX	meta- & para-Xylene	µg/L	13	<2	-	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
BTEX	Naphthalene	µg/L	13	<5	-	<5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
BTEX	ortho-Xylene	µg/L	13	<2	-	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
BTEX	Sum of BTEX	µg/L	13	<1	-	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

	CHEMICAL NAME	Result Unit	No. results	Min	Median	Max	Limit of Detection	14/7/19	24/7/19	31/7/19	6/8/19	14/8/19	19/8/19	27/8/19	28/08/19	10/09/19	11/09/19	25/09/19	26/09/19	10/10/19
	Toluene	µg/L	13	<2	-	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Total Xylenes	µg/L	13	<2	-	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
PAH Suite	3-Methylcholanthrene	µg/L	10	<0.1	-	<0.1	0.1		<0.1	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	7.12-Dimethylbenz(a)anthracene	µg/L	10	<0.1	-	<0.1	0.1		<0.1	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthylene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Anthracene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benz(a)anthracene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(a)pyrene	µg/L	11	<0.05	-	<0.05	0.05-0.5		<0.05	<0.05	<0.05	<0.5		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Benzo(a)pyrene TEQ (zero)	µg/L	11	<0.1	-	<0.1	0.1-0.5		<0.1	<0.1	<0.1	<0.5		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(b+j)fluoranthene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(g.h.i)perylene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo(k)fluoranthene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Chrysene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenz(a.h)anthracene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluoranthene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluorene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Indeno(1.2.3.cd)pyrene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Naphthalene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Phenanthrene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Pyrene	µg/L	11	<0.1	-	<0.1	0.1-1		<0.1	<0.1	<0.1	<1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Sum of polycyclic aromatic hydrocarbons (PAHs)	µg/L	11	<0.1	-	<0.1	0.1-0.5		<0.1	<0.1	<0.1	<0.5		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1