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Engineering, Environmental & Planning
Consultancy Services

Brookhill Landfill Site

Flintshire County Council Waste Management Services

Annual Monitoring Review 2019

Prepared by:

Caulmert Limited
InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672666
Fax: 01248 672601
Email: dianabrookshaw@caulmert.com
Web: www.caulmert.com

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Project Director:	**Andy Stocks**
Project Manager:	**Diana Brookshaw**
Caulmert Limited:	**InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG**
Tel:	**01248 672666**

Author	Harry Caulfield	**Date**	13/12/2019
Reviewer	Diana R. Brookshaw	**Date**	12/03/2020
Approved	Diana R. Brookshaw	**Date**	30/03/2020

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BROOKHILL LANDFILL SITE - ANNUAL MONITORING REVIEW 2019

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1.0 INTRODUCTION

1.1 Background

1.1.1 This report has been compiled in compliance with the Environmental Permit (EP) Number AP3739KS for Brookhill Landfill Site, which requires that an annual review of the monitoring data collected at the site be carried out. The data reviewed in this report was collected from 1st January 2019 to 31st December 2019.

1.1.2 This report records the monitoring data for landfill gas, leachate, groundwater, surface water and dust, and discusses this data in relation to emission limits set in the EP. It also reports on fugitive emissions as performance parameters.

1.1.3 Previous monitoring data, collected between the 1st of January 2009 and the 31st of December 2018 has also been included in visual representation of the data as requested by Natural Resources Wales. This allows recent data to be viewed in the context of longer-term trends.

1.2 Site Location and Surrounding Land-use

1.2.1 Brookhill Landfill Site is located approximately 1.5 km north of Buckley, Flintshire, North Wales at NGR SJ278656. The site is accessed via the Pinfold Industrial Estate, Pinfold Lane, which is located off the A494 Mold to Ewloe Road.

1.2.2 The site is bound to the east by a wooded, disused railway leading to open grassland. Agricultural land lies to the west of the site. The Pinfold Industrial Estate and a number of residential properties (on the outskirts of Buckley, approximately 400 m away) are situated to the south of the site. A restored refuse tip (Ewloe Barn Landfill) lies to the north of the site. It is currently used for rough grassland leading to open grazing land and some woodland.

1.2.3 Brookhill Landfill Site has been developed in a former quarry, which was worked for Buckley Fireclay and the siltstones and mudstones beneath the Fireclay (known as the Warrant) for use in the manufacturing of bricks and tiles.

1.2.4 In 1997, in preparation for the engineering of the landfill site, further Fireclay was removed together with a quantity of coal in the quarry base under agreement with the Coal Authority.

1.2.5 Brookhill Landfill Site started accepting waste in 1999. The wastes permitted at the site were stipulated within the site permit. The general waste streams which were permitted at the site through its history can be summarised as:

- Domestic food and organic wastes – approximately 60%
- Non-hazardous industrial wastes, (including plastic, paper, cardboard, wood,
- stone and sand, etc) – approximately 40%
- Most special wastes (allowed until June 2004).

1.2.6 The special wastes which were tipped at the site were accepted pre-June 2004 (under the WML for the site). Therefore, they would have been deposited predominantly within Cell 1, and the lower parts of Cells 2, 3 and 4. It is likely that none of the waste tipped in Cells 5 and 6 contains any 'special waste' waste streams.

1.2.7 The site ceased accepting waste in late 2007. The final capping and restoration phases were undertaken during 2010.

2.0 ENVIRONMENTAL CONTEXT

2.1 Geology

2.1.1 Brookhill Landfill is situated within the Buckley Formation part of the Middle Coal Measures. Strata visible in the quarry walls prior to waste emplacement consist of the Warrant siltstone, overlain with the mudstone of the Buckley Fireclay, overlain with Buckley Fireclay Sandstones. The strata generally dip approximately 15º to the north east exposing the youngest beds of Buckley Formation in the eastern quarry wall prior to infilling. On a regional scale the quarry is situated within a faulted block with the major faults located 70 m to the west and 180 m to the east of the site.

2.1.2 Prior to filling, the Warrant could be seen exposed on the western face of the quarry and beneath the Fireclay to the north. The Warrant is described as consisting of highly weathered grey mudstones and moderately weathered red-brown siltstones with extremely closely-spaced fractures and discontinuities.

2.1.3 Buckley Fireclay could be seen to the north of the site prior to infilling. The strata can be divided up into the upper and lower Fireclays, which are separated by a thinly bedded layer of sandstone and basal black clay/mudstone. The Buckley Fireclays are described as being dark red-brown, thinly and thickly laminated highly weathered mudstones. The Buckley Fireclay sandstone interbedded with the mudstones and exposed at the quarry face prior to landfilling is orange-brown, fine to medium grained, thinly to thickly bedded, jointed with some joints infilled with clay, others exhibiting some seepage flow.

2.1.4 The site lies above several coal seams at depths between 100 m (16 mAOD) to 370 m beneath the site, forming part of the Middle and Lower Coal Measures. A thin coal seam, at the base of the Buckley Fireclay approximately 0.5m thick, has been worked in the centre of the site.

2.1.5 The 1:50,000 BGS geological map of the area shows that the drift geology consists in general of Boulder Clay/Glacial Till above the solid geology. However, in the area of the site itself, no drift deposits are present.

2.2 Hydrogeology

2.2.1 Accounts of visual inspections made of the quarry walls prior to landfilling report water seepages from the siltstones in the Warrant and from joints within the Buckley Fireclay Sandstone. Some seepage has also been observed through discontinuous i.e. intervening sandstone in the Fireclay strata.

2.2.2 The groundwater regime around the site is described in the revised Hydrogeological Risk Assessment (2008), and was updated in the Brookhill Landfill Hydrogeological Review (2014) prepared by RukHydro Ltd for Natural Resources Wales.

2.3 Hydrology

2.3.1 Topographic falls and corresponding surface water flows are in a north-easterly direction, towards Wepre Brook, approximately 2 km from the site boundary. The Brook runs into the River Dee which is approximately 5 km from the site.

2.3.2 During and following wet weather periods, surface water run-off to the south and west of the site is channelled around the western site perimeter before flowing overland to the Wepre Brook.

3.0 LANDFILL GAS

3.1 Monitoring regime

3.1.1 The in-waste gas field at Brookhill is monitored on a regular basis, and the gas wells are regulated to balance the gas field to ensure that the gas plant is supplied with landfill gas of high calorific content and low oxygen concentration. A summary table of the in-waste data is included in Appendix 1.

3.1.2 Routine landfill gas monitoring around the site perimeter is carried out on a weekly basis at boreholes BH1, BH3-BH21 and BH23-BH25. Methane, carbon dioxide, oxygen, relative pressure and atmospheric pressure were recorded on each visit.

3.1.3 Perimeter borehole locations are shown on Drawing 3031-CAU-XX-XX-DR-O-1802. Appendix 1 contains a landfill gas monitoring data summary table. Methane and carbon dioxide data from all boreholes is also displayed in time-series graphs in Appendix 1. The time-series graphs show methane and carbon dioxide concentrations in the perimeter boreholes recorded between January 2009 and December 2019. The perimeter landfill gas data obtained during the review period was compared with the EP limits.

3.2 In waste Boreholes

3.2.1 The gas field at Brookhill is monitored and balanced on a regular basis. Methane, carbon dioxide, oxygen, balance, relative pressure, hydrogen sulphide and carbon monoxide were recorded on each visit. In accordance with Condition 4.2.2 of the EP for the site, monitoring data for the in waste boreholes is submitted to the NRW monthly. Quarterly results are listed and discussed in quarterly reviews for the site. Here, the data collected between the 1st January 2019 and 31st December 2019 is summarised in Appendix 1.

3.2.2 Methane concentration was on average 46.46%, varying between 0% (at GV 28 and R5) and 77% (at GV 22). The average methane concentration increased slightly when compared to the previous review (44.67 %). This suggests the recent improvements within the gas extraction system (removal of leachate from the gas wells) has been beneficial in terms of landfill gas management. Most boreholes (except e.g. GV23 and GV28) had sufficient levels of methane and low 0_2, making them suitable for extraction. GV19 was not monitored during the review period as it is due for decommissioning.

3.3 Trace Gas Monitoring

3.3.1 Annual trace gas monitoring was carried out by Envirodat Air Quality and Environmental Consultants on 15th of October 2019 (see report included in Appendix 1). The sample point was described as 'Inlet Line to Utilisation Plant'. The ambient temperature was 15°C and the atmospheric pressure, 983 mbar.

3.3.2 Bulk landfill gas was sampled for methane, carbon dioxide and oxygen and was reported to contain the following concentrations (similar to the results in 2018):

- Methane 53.6 % v/v
- Carbon dioxide 37.5 % v/v
- Oxygen 0.7 % v/v

3.3.3 Laboratory analysis was undertaken for components identified in Table 1.1 of the Environment Agency document 'Guidance for Monitoring Trace Gas Components in Landfill Gas (LFTGN 04).

3.3.4 Of the 29 trace gases, 15 were detected. These were acetaldehyde (ethanal), formaldehyde (Methanal), *vinyl chloride*, 1-pentene, *furan,* benzene, carbon disulphide, *dichloromethane*, *1,2 dichloroethene*, *1,2 dichloroethane*, dimethyl sulphide, styrene, toluene, trichloroethylene and hydrogen sulphide (see report included in Appendix 1). This is an increase in the previous year where 12 trace gasses were detected. Gases which were detected in 2019, but not in 2018 are shown in italics within the list above. In 2019 arsenic (as As), 1,2-dychloroethylene (detected in 2018), were not detected.

3.4 Engine and Flare Emission Monitoring

3.4.1 Monitoring of the emissions from the landfill gas engine was carried out on the 15th of October 2019. The engine exhaust was sampled for oxides of nitrogen (as NO_2), carbon monoxide (CO), volatile organic compounds (VOCs as carbon), moisture and oxygen in accordance with the requirements in Table S4.2 in the EP.

3.4.2 Concentrations of NO_2 for the engine exceeded the compliance limit for the engine (500 $mg(N)m^{-3}$) with a concentration of 647 ±28 $mg(N)m^{-3}$. Concentrations of CO and VOCs were below the respective emission limits for the engine. The NOx result on the engine was reported above the permit limits, but is within the overall uncertainties as detailed in LFTGN08, and is therefore considered as being compliant.

3.4.3 The emissions from the flare at Brookhill were due to be monitored in line with Standard landfill's plant after the new engine at this site was commissioned. Due to unforeseen circumstances, this monitoring was delayed, and will be scheduled at the earliest opportunity. The results of the flare emission stack monitoring will be forwarded to NRW as soon as they become available.

3.5 Perimeter Boreholes

Methane

3.5.1 As with the previous review, all perimeter gas boreholes had methane concentrations below their respective EP limits during 2019.

3.5.2 Methane concentrations have remained below 1.0 % in all locations except BH8 and BH9. Average concentrations ranged from 0.0 % in BH5 and BH 6 to 9.11 % in BH9 during 2019.

3.5.3 Methane concentrations in BH8 and BH9 remained below their compliance limits with maximum concentrations of 32.2 % and 29.6 % respectively. It should be noted the both BH8 and BH9 have shown a decreasing trend over the current review period.

Carbon Dioxide

3.5.4 Carbon Dioxide was detected in all perimeter boreholes but remained below the relevant EP limits throughout the review period.

3.5.5 Concentrations throughout the site fluctuated during the review period. These fluctuations were not accompanied by increase in methane concentrations at those locations except for BH8 and BH9. It's therefore unlikely to reflect lateral emissions of landfill gas from the site. Ongoing monitoring will continue to be reviewed in accordance with the permit, and these trends will be reassessed.

3.5.6 Average concentrations across the site ranged from 0.29 % in BH7 to 5.04 % in BH9. No overall increases in CO_2 were noted in any other boreholes around the site.

4.0 LEACHATE

4.1 Introduction

4.1.1 Leachate levels at leachate chambers LC1B, LC2B, LC4B and LC6B are recorded monthly. During a meeting with Natural Resources Wales on the 16th of April 2013, it was agreed that leachate levels within LC3 and LC5 should no longer be reported, as it is not possible for them to be dipped to the base of the well. They have therefore been excluded from the data analysis within this report.

4.1.2 Leachate levels were also recorded at six retrofitted remote leachate monitoring points, named R1 – R6, at monthly intervals throughout the review period.

4.1.3 Additionally, in line with the EP, samples from these chambers were sampled and analysed quarterly for the range of determinants listed below.

Alkalinity, pH, ammoniacal nitrogen, calcium, chloride, magnesium, potassium, sodium, sulphate, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC) and Total Oxidised Nitrogen (TON).

4.1.4 Samples collected from the leachate chambers in December 2019 were also analysed for the annual suite below:

Cyanide, metals – cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc, mineral oils, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), phenoxy acid herbicides, combined pesticides/herbicides and misc. organics.

4.1.5 Well locations are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.

4.2 Leachate Levels

4.2.1 Leachate levels were recorded monthly during the review period. Graphs and tables displaying leachate head (in metres above cell base) can be found in Appendix 2. The leachate levels in metres above Ordnance Datum (mAOD) were also compared to the groundwater levels in the nearest groundwater monitoring boreholes to assess hydraulic containment during the review period. The graphs are included in Appendix 2.

4.2.2 Table S4.1 in the EP requires that leachate levels must not exceed 2 m above the base of Cells 1 and 6, and 3 m above the cell base of Cells 2-5.

4.2.3 Pumped leachate levels recorded during this review period are summarised in Table 1 below. As discussed with NRW, 'pumped' leachate levels are recorded after pumps are switched off for up to 4 hours before a dip is obtained. During 2019, 'rest' levels of leachate were recorded, which reflect the head of leachate after 48 hours of recovery (which has been demonstrated to be sufficient amount of time for leachate head to rebound to rest level, in accordance with

report number 3448-VAU-XX-XX-RP-V-9107.A0-C1. The rest leachate levels are reported in relation to the compliance limits in Table 2 and plotted in Appendix 2.

4.2.4 As rest levels of leachate are now being obtained, compliance is assessed and reported against those. Pumped leachate levels are provided for completeness, and to provide additional information regarding the efficiency of the leachate management strategy at the site.

Leachate Wells

4.2.5 As can be seen in Table 2, pumped leachate levels were consistent throughout 2019, often close to the base of the respective wells, indicating that leachate extraction is optimised. A CQA plan for the installation of additional infrastructure in Cell 1 and Cell 6 to aid in leachate management in those cells has now been approved and arrangements are being made for this drilling to be undertaken as soon as reasonably practicable.

Table 1: Leachate Pumped Levels (levels above the EP limit are highlighted in orange)

Landfill Cell	Monitoring Point	**Pumped** Leachate Level (mAOD)			Compliance Limit (mAOD)
		Minimum	Maximum	Average	
Cell 1	BK LC 1B	119.30	119.40	119.34	119
	BK R1	118.68	119.53	119.17	
Cell 2	BK LC 2B	115.02	115.16	115.10	117
	BK R2	116.73	116.84	116.78	
Cell 3	BK R3*	111.40	111.64	111.55	113.37
Cell 4	BK LC 4B*	114.77	115.07	114.92	115
	BK R4	115.33	116.48	115.93	115.6
Cell 5	BK R5	116.68	116.95	116.76	115.91
Cell 6	BK LC 6B	123.69	123.99	123.81	122
	BK R6	120.63	122.13	121.88	122.24

4.2.6 Leachate ***rest levels*** are tabulated in Table 3 in relation to the relevant compliance limits. The recorded rest levels were similar over the review period, indicating that the current leachate extraction strategy at the site continues to be efficient in managing leachate head to levels close to the compliance limits. On average both LC2B and well R3 have recorded rest leachate levels below its compliance limits during 2019. It is noted that in wells which exceed the compliance limit, the amount they exceed by is slowing decreasing over time in the majority of the wells. This is likely as a result of the ongoing extraction of leachate from gas wells at the site[1].

[1] Caulmert Ltd, February 2019; Document reference 3448-CAU-XX-XX-RP-V-9107-A0-C1: Brookhill Improvement Actions; Trial of Leachate Extraction from Gas Wells – Interpretative report.

Table 2: Rest Leachate Levels (mAOD) (exceedances of the EP limit are shown in yellow)

Landfill Cell	Monitoring Point	**Rest** Leachate Level (mAOD)			Compliance Limit (mAOD)
		Minimum	Maximum	Average	
Cell 1	BK LC 1B	119.75	120.40	120.23	119
	BK R1	119.18	120.29	119.92	
Cell 2	BK LC 2B	115.81	116.49	116.20	117
	BK R2	117.49	117.64	117.54	
Cell 3	BK R3*	112.22	113.10	112.64	113.37
Cell 4	BK LC 4B*	115.72	116.30	116.09	115
	BK R4	116.25	117.48	116.79	115.6
Cell 5	BK R5	118.03	118.23	118.12	115.91
Cell 6	BK LC 6B	124.74	124.97	124.89	122
	BK R6	122.04	123.04	122.91	122.24

4.2.7 Graphs shown in Appendix 3 relate the reported leachate levels to the surrounding groundwater level. For all cells operated on the principle of hydraulic containment (Cells 2-6), all of the reported pumped leachate levels represent conditions of hydraulic containment throughout the review period.

4.2.8 The protocols for obtaining leachate levels that can be considered representative for the site, hydrogeological risks posed by the site, and how leachate is managed are currently under review, in discussion with NRW and will be formalised in the HRA review and updated leachate management plan for the site, which are to be completed in 2020 upon completion of additional works at the site.

Gas Wells

4.2.9 As indicated in interpretive report 3448-CAU-XX-XX-RP-V-91071, a brief update and review of the progress of the leachate extraction trial is to be included in the quarterly and annual reports.

4.2.10 Within the GV wells, the majority of counters have been stuck on at least one occasion throughout the 2019. Therefore, the results re associated with some uncertainty, and likely under-report the amount of leachate removed from the site in this period.

4.2.11 At GV36, counter readings steadily increased during the first half of 2019. During the second half the data appears anomalous, the gas well is reported as pumping fast, however this could not be verified by the counter readings due to the pump counter sticking. During December the counter within GV36 appeared to be working correctly with counter readings increasing by 56705.

4.2.12 Similarly, within GV39, levels steadily increased throughout the first half of 2019. Pump counts began to plateau from July onwards with no change in counter readings between November and December. GV42 followed the same trend as GV39 during 2019.

4.2.13 Counter readings within GV41 increased throughout the review period. Counter readings increased significantly during the second half of the review period. This may reflect increased recharge from heavier rainfall when approaching the winter months.

4.2.14 During April, counter readings within GV44 decreased, this is due to a new counter being added. Counter readings increased slowly throughout the remainder of the year with the exception of December where no increase was noted (possibly due to counter or pump malfunction).

4.2.15 From January to November, counter readings within GV45 increased steadily. Readings between November and December continued to increase, however, at a decreased rate compared to the previous months.

4.2.16 The counter was stuck at GV46 between January and July with a constant reading of 22172. During the second half readings increased significantly from 221752 to 165720. It should be noted the readings from both November and December were the same. Both GV48 and GV49 followed a similar trend to GV46.

4.2.17 Leachate head continues to be well maintained (Appendix 2, Graph 4), with the majority of wells showing levels within 0.5 m of each other throughout the review period. GV42 showed the greatest range in leachate levels of 7.15 m, however it should be noted that levels have remained consistent since April 2019.

4.2.18 The levels have remained low, while extraction rates are relatively stable, suggesting that steady state may be being approached and leachate extraction from these wells should be continued.

4.2.19 The extraction in individual areas as well as from the gas-well system as a whole will continue to be reviewed in relation to leachate dynamics and ongoing leachate management strategy for the site.

4.3 Leachate Quality

4.3.1 A summary of the leachate quarterly quality analysis from 2019 is shown in Table 2 in Appendix 2 along with graphs showing trends in leachate quality between January 2009 and December 2019. Due to a laboratory error, the quarterly parameters were not determined in the samples of leachate collected in December. Additional samples were collected in February and scheduled for the quarterly leachate suite. The results will be provided as soon as they become available.

4.3.2 All leachate monitoring locations were sampled quarterly for the following parameters:

alkalinity, ammoniacal nitrogen, biological oxygen demand (BOD), calcium, chloride, chemical oxygen demand (COD), magnesium, total organic carbon (TOC), pH, potassium, sodium, sulphate and total oxidised nitrogen (TON).

Plus, the following annual hazardous substances screen during December:

Inorganics (total and free cyanide), Filtered metals (cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc), Mineral oils (C10 – C40), Semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), combined pesticides / herbicides and miscellaneous organics .

4.3.3 Average ammoniacal nitrogen concentration in the leachate across the site increased every year between 2009 and 2012. In 2009 the average was 1863 mg/l, and it reached 2775 mg/l in 2012. This is likely to represent the peak leachate strength. Concentrations appeared to plateau between 2014 and 2018, with average ammoniacal nitrogen concentrations of 2205 mg/l, 2008 mg/l, 2301 mg/l, 1988 mg/l and 1816 mg/l respectively. The overall average ammoniacal nitrogen concentration for the site as a whole in 2019 was very similar to that in 2018, at 1847 mg/l. Average concentrations at each location showed a decrease in 2019, with the exception of LC3 and LC6. These results are consistent with an interpretation of leachate strength decreasing over time.

4.3.4 The average chloride concentration in the leachate in 2019 was 1950 mg/l, a continued decrease compared to the averages of the previous reviews 2006 mg/l (2018) and 2638 mg/l (2017). This is lower than the peak chloride concentration recorded in 2011 (3464 mg/l) and is consistent with an interpretation of leachate strength decreasing since 2011-2012.

4.3.5 Yearly averages of Calcium, pH, COD and TOC have continued the decreasing trend seen since 2012. Concentrations of magnesium, potassium, sodium and TON have remained relatively stable with the exception of LC4B which showed a decreasing trend in TON. Average sulphate concentrations increase within LC2, LC4B, LC5 and LC6 compared to the previous review. This increase also increased the site average sulfate concentrations from 14.78 mg/l (2018) to 89.78 mg/l (2019)

Annual Suite

4.3.6 No free cyanide was detected in the leachate chambers. Total cyanide was recorded in LC4B and LC5 with concentrations of 0.08 mg/l and 0.1 mg/l respectively. All other locations were below the limit of detection. No mercury was detected at any of the leachate locations.

4.3.7 Mineral Oils (>C10 to C40) were detected in LC4B, LC5 and LC6 at 0.607 mg/l, 0.246 mg/l and 0.106 mg/l respectively. Concentrations were below the limit of detection in all other monitoring locations.

4.3.8 During December the annual monitoring suite was carried out. Cyanide (total) concentrations were detected within LC4B and LC5 at 0.08 mg/l and 0.1 mg/l respectively. Of the 60 Semi-volatile organic compounds, two were detected within LC4B whilst LC5 contained 5.

4.3.9 The number of volatile organic compounds (66 in total) detected during 2019 was sixteen. Concentrations of 4-Bromofluorobenzene, benzene, chlorobenzene, dibromofluoromethane and Toluene-d8 were detected at all monitoring locations. Of the miscellaneous organics, only dibutyl tin was detected within LC5 at 0.000812 mg/l. No pesticides or herbicides were detected at any of the monitoring locations.

4.4 Emissions to sewer

4.4.1 The leachate treatment plant at the site accepts leachate from Brookhill and the nearby Standard landfill site. The treated effluent is discharged to public sewer and is thereby subject to a trade effluent agreement (discharge consent, DC).

4.4.2 The treated leachate discharge (Final Discharge, FD) is monitored on a weekly basis for:

ammoniacal nitrogen, chromium, chemical oxygen demand (COD), copper, lead, nickel, pH, suspended solids and zinc.

Ammoniacal Nitrogen

5.4.1 The ammoniacal nitrogen discharge consent limit (50 mg/l) was exceeded once in 2019, with a maximum concentration of 53.9 mg/l recorded on the 4th April. An annual average of 8.6 mg/l was calculated for 2019, an increase compared to the previous reviews 1.57 mg/l (2018). However, this is similar to those recorded in 2017 and 2016 at 10.9 mg/l and 9.8mg/l respectively.

Chemical Oxygen Demand (COD)

5.4.2 COD remained below the discharge consent limit of 2000 mg/l in 2019, with a maximum concentration's of 1930 mg/l recorded October. An annual average of 1034 was recorded for 2019, a decrease than the previous year's average of 1431 mg/l.

Suspended Solids

5.4.3 The suspended solids discharge consent limit (500 mg/l) was exceeded in February, May amd August with concentrations of 543 mg/l, 880 mg/l and 550 mg/l respectively. An average suspended solids concentration of 531.2 mg/l was also above the consent limit. The recorded average suspended solids concentration represents an increase when compared to the previous year's average of 496 mg/l.

5.0 GROUNDWATER

5.1 Introduction

5.1.1 During the review period groundwater levels were recorded on a monthly basis in groundwater monitoring boreholes GW1, GW2A, GW3A, GW4, GW5A, GW6, GW7 and GW8 (also referred to as GW1-GW8 for chemical analysis). Levels were also recorded in GW1A (also referred to as GW1.1), and in two piezometers, which are located at shallower horizons at GW4 and GW6 and are referred to as GW4.1 and GW6.1 respectively. Borehole locations are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.

5.1.2 Samples for chemical analysis were taken monthly from the 8 groundwater monitoring boreholes GW1 – GW8 and analysed for a range of determinants listed below:

ammoniacal nitrogen, chloride, dissolved oxygen, electrical conductivity and pH

5.1.3 All groundwater monitoring boreholes are also sampled quarterly for the following parameters:

alkalinity, cadmium, calcium, chemical oxygen demand (COD), chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, sulphate, total organic carbon (TOC), total oxidised nitrogen (TON) and zinc.

Plus, the following annual hazardous substances screen:

gasoline range organics (GRO) (C4 – C10), gasoline range organics (GRO) (C10-C12), benzene, toluene, ethyl benzene, m-& p-xylenes, o-xylenes, total xylenes, BTEX and MTBE.

5.2 Groundwater Levels

5.2.1 Groundwater levels were recorded monthly during the review period. The seasonal trend noted in the previous annual reviews is also evident in 2019, with seasonal decrease from March to September and highest levels being recorded in the winter months. When averaged for the year, groundwater levels in most boreholes were comparable to those in 2018 except for GW6.1 and GW6 and GW8, where leachate levels decreased by ~5-8m compared to the previous average level at these locations. These trends will be reviewed in the context of site management as part of the hydrogeological risk assessment for the site.

5.3 Groundwater Quality

5.3.1 Monthly groundwater sampling was undertaken at groundwater points GW1-GW8, as per the schedule outlined above. In April, July and October samples were analysed for the quarterly suite, and in December for the annual hazardous substances screen. Tables 1 and 2 in Appendix 3 summarise monthly and quarterly monitoring data from 2019. Time-series graphs for all parameters between 2009 and 2019 are also included in Appendix 3.

5.3.2 GW2A, GW3A and GW4 have EP limits for ammoniacal nitrogen, chloride, nickel, zinc, total xylenes and toluene, as these boreholes are regarded as being down-gradient of the site. The groundwater regime around the site has been under discussions during recent years, and revised EP limits have been discussed. For the purpose of this report, the current EP limits have been used.

Ammoniacal Nitrogen

5.3.3 The groundwater EP limit for ammoniacal nitrogen (1.7 mg/l) was exceeded in GW2A, GW3A and GW4 during 2019. Concentrations increased throughout the review period in GW4 Conversely, ammoniacal nitrogen within GW8 decreased consistently throughout the review period.

5.3.4 As in the previous year, concentrations were highest in GW3A, where ammoniacal nitrogen was on average 17.54 mg/L significantly less than 2018 (43.19 mg/l). The maximum concentration recorded there was 41.7 mg/L, reported in January. this was significantly less than seen in the previous review were the maximum concentration was 124 mg/l.

5.3.5 Concentrations in GW4 were on average 6.65 mg/L, higher than the 2018 average of 3.58 mg/L. Concentrations in GW2A decreased slightly compared to 2018 with an average of 5.05 mg/l and remained below maximum historical average of 31.64 mg/l in 2014.

5.3.6 Average concentrations within the remaining groundwater boreholes ranged between 1.51 mg/l in GW1 and 20.5 mg/l in GW8.

5.3.7 Unlike the 2018 review, GW3A did not consistently contain the highest concentrations of ammoniacal nitrogen of the groundwater locations. During Quarter 3 concentrations were higher within GW1, GW1.1, GW4 and GW8.The observed trends will be reviewed further as part of improvement works and the hydrogeological risk assessment review for the site.

Chloride

5.3.8 As in the past 3 Annual Reviews, the chloride EP limit (60 mg/l) was exceeded in GW2A and GW3A throughout 2019. At GW4 concentrations also exceeded the EP limit on one occasion during August, but remained below the limit during the remainder of the year. For these

boreholes, highest chloride concentrations were detected in GW4, with a maximum of 170 mg/l, a decrease from the previous year's maximum concentration of 170 mg/l. However, on average both GW2A (103.44 mg/l) and GW3 (123.09 mg/l) were significantly higher than GW4 (54.14 mg/l)

5.3.9 In GW1, GW.1.1, GW5, GW6, GW7 and GW8 the average chloride concentrations were 78.46 mg/l, 198.76 mg/l, 93.03 mg/l, 38.09 mg/l, 119.56 mg/l and 124.07 mg/l respectively, similar to the previous reviews.

Nickel

5.3.10 The compliance limit for nickel (0.15 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2019. The graph in Appendix 3 shows that nickel concentrations in these locations have been below the trigger level since July 2010.

Zinc

5.3.11 Similarly, to the previous years, the compliance limit for zinc (0.254 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2019. A graph in Appendix 3 shows that this trigger level was not exceeded on any occasion between January 2009 and December 2019.

Toluene

5.3.12 Toluene was below the compliance limit all locations throughout 2019. Concentrations remained below 0.001 mg/l, a considerable improvement compared to the previous review period (2018) were the maximum concentration was 1.13 mg/l in GW3A (it should be noted that this value represents a significant outlier and may be eroneous).

Xylenes

5.3.13 No xylenes were detected in boreholes GW2A, GW3A and GW4, or any of the other groundwater monitoring points between January 2009 and December 2019.

Benzene

5.3.14 As in the past two reviews, no benzene was detected at any location on any monitoring visit in 2019.

Annual Suite

5.3.15 During December the Annual monitoring round was carried out. No semi-volatile or volatile organic compounds were detected within any of the groundwater locations with the exception of GW8. Bis(2-Ethylhexyl) phthalate (aq) was detected within GW8 at a concentration of 0.00279 mg/l all other locations remained below the detection limit.

5.3.16 Free cyanide was detected within GW4 and GW5A at 0.18 mg/l and 0.23 mg/l respectively. Total cyanide was also detected within these locations at 4.33 mg/l (GW4) and 4.12 mg/l (GW5A). GW8 also contained concentrations of total cyanide at 0.09 mg/l. All other locations remained below the limit of detection for both free and total cyanide.

5.3.17 Similar to the previous review, no carbon tetrachloride was detected during 2019. Carbon disulphide was recorded above the detection limit at GW8 during to first half of the review period at 0.00186 mg/l (quarter 1) and 0.00428 mg/l (quarter 2). all other locations remained below the detection limit during this review period.

6.0 SURFACE WATER

6.1 Introduction

6.1.1 Surface water samples are routinely taken from three locations; SW2, P2 and P4 which are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.

6.1.2 Water flows in a northerly direction alongside the outside perimeter fence of the western boundary of the site and accumulates in a pond at SW2 before slowly seeping through a man-made underground bypass drain which runs along the outside of the site towards the northern boundary. P2 is a pond to the west, which collects surface water run-off from the landfill. P4 is located in a field to the north west of the site, beyond landfill gas monitoring borehole BH10.

6.1.3 No samples have been collected from SW2 or P2 during this review period.

6.1.4 Surface water samples are analysed on a monthly basis for:

ammoniacal nitrogen, chloride, chemical oxygen demand (COD), pH and total suspended solids.

6.1.5 In the EP, Table S4.3 requires that only location P2 be controlled by chemical quality limits. As agreed with NRW, water in P2 is only sampled when there is the likelihood of an overflow to the discharge point[2].

6.1.6 A table displaying a summary of the laboratory analysis of the surface water samples from P2, P4 and SW2 collected during 2019 is presented in Appendix 4. Time-series graphs for all parameters between January 2009 and December 2019 are also included in Appendix 4.

6.2 Surface Water Quality

Ammoniacal Nitrogen

6.2.1 The average ammoniacal nitrogen concentration in P4 in 2019 was 3.09 mg/l, a decrease compared to the 2018 average of 4.4 mg/l.

Chemical Oxygen Demand (COD)

6.2.2 COD in P4 ranged between 65 mg/l and 121 mg/l, an increase compared to the previous review (2018) were COD concentrations ranged from 49.3 mg/L to 113 mg/L.

Chloride

6.2.3 Concentrations varied between 26.9 mg/L and 52 mg/L in P4. Concentrations decreased considerably when compared to the previous review were concentrations ranged from 60.1 mg/l and 86 mg/l.

[2] E-mail correspondence, 14.07.2014, Alison Soper (NRW) to Phil Mulhall (FCC).

pH

6.2.4 pH has remained between 5 and 9 in all locations since January 2009. Average pH concentrations within P4 during 2019 were 7.94.

Suspended Solids

6.2.5 The average concentration within P4 was 20.73 mg/l during 2019. A considerable decrease since 2018 were the average suspended solid concentration was 34.53 mg/l

7.0 FUGITIVE EMISSIONS

7.1 Introduction

7.1.1 Fugitive emissions to air are interpreted as fugitive gas emissions which might be escaping through the capped and uncapped areas of the site and dust releases from the site. Additionally, fugitive emissions of substances to water and sewer and their minimisation are considered.

7.2 Fugitive emissions to air

7.2.1 An FID Walkover and flux box survey was undertaken by Caulmert on the 13th August 2019. The report is enclosed in Appendix 1.

7.2.2 Overall, fewer point source emissions were detected during this survey, 5, than during the previous surface emissions monitoring survey in August 2018, where 13 emissions were recorded. Of the 5 emissions recorded in this survey, two were at the maximum level of detection (>10,000 ppm). This is an increase compared to the previous review (2018) which recorded no maximum limit of detection concentrations.

7.2.3 Upon remediation of the identified point source emissions identified in the report, the surveyed areas would be compliant with the emission standards in LFTGN07.

7.3 Particulates Monitoring

7.3.1 Quarterly dust monitoring was undertaken at the site, as required by the EP. Four monitoring rounds were completed during this review period, in March, June, September and December. Table 3 below shows the gross dust depositional rates.

Table 3: Results from dust monitoring at Brookhill

Period	Mar-19	Jun-19	Sep-19	Dec-19	Permit Level
Dust Concentration (mg/m²/day)					
Location 1: Site perimeter	<7.97	19.76	30.04	<10	200
Location 2: Industrial estate	<7.97	<4.12	10.01	<10	200
Location 3: Oaks farm	<7.97	4.12	86.78	14.9	200

7.3.2 All monitoring results were significantly below the Permit level, and often below the detection limit of the method. This is consistent with the results obtained last year.

7.4 Fugitive emissions to water and sewer

7.4.1 Fugitive emissions of substances to water or sewer were controlled by the site ensuring, that all monitored parameters in leachate were below the site EP limits and that leachate levels

were kept as low as possible. Groundwater, surface water and any discharges to sewer were monitored for more parameters than required by the EP. The additional parameters analysed are discussed above in the relevant sections of this report.

7.4.2 The chemical analysis of the Final Discharge (FD) from the leachate treatment plant indicates that the efficiency of the leachate treatment plant was similar to that in 2019. The concentrations of parameters in surface water were similar to those recorded in the previous review period.

8.0 ANNUAL PRODUCTION/TREATMENT

8.1 Introduction

8.1.1 Annual production/treatment at Brookhill during the period January to December 2019 is reported in accordance with the EP for the site. Table S5.2 in the EP variation YP3835MJ (May 2008) has been reproduced and is presented as Table 4 below.

Table 4: Annual Production/Treatment

Annual production/treatment	
Leachate:	**Cubic metres/year:**
Disposed of offsite:	0
Disposed of to any onsite effluent treatment plant:	21,455
Recirculated into the waste mass.	0
Surface water and/or groundwater:	**Cubic metres/year:**
Disposed of offsite:	0
Disposed of to any onsite effluent treatment plant.	0
Landfill gas:	**Normalised cubic metres/year:**
Combustion in flares:	*TBC**
Combustion in gas engines:	*TBC*
Other methods of gas utilisation.	0

** Results are not available at the time of completion. They will be forwarded separately as soon as they are available.*

9.0 PERFORMANCE PARAMETERS

9.1 Introduction

9.1.1 The performance parameters at Brookhill for the period of January 2019 to end of 2019 were not available at the time of the completion of the report (*). When they become available, they will be forwarded separately to NRW as per the format of Table 5 below, which is a reproduction of Table S5.3 in the EP variation YP3835MJ (May 2008).

Table 5: Performance Parameters

Parameter	Frequency of assessment	Annual total	Unit
Energy Used (including for leachate treatment)	Annually	*TBC**	MWh of Electricity

9.1.2 It should be noted that typically the usage of energy at the site represents ~10% of the amount of energy exported at the same time.

10.0 TOPOGRAPHICAL SURVEY

10.1 Introduction

10.1.1 The latest topographical survey for the site was conducted on the 8th May 2019 (survey number 10418a Brookhill) and is appended for reference. Using this survey, and the survey completed in April 2018 an estimate of the settlement was made. The difference between the two surveys was approximately 4,700 m^3 over the 13 months between the two surveys. In the preceding 12 months, the settlement was 2,939 m^3 (reported in the 2018 annual review). The data suggests greater settlement in 2019 compared to the previously-reported period. This is likely due to the increase in leachate extraction at the site during 2019.

11.0 SUMMARY

11.1 Landfill gas

11.1.1 Landfill gas in most in-waste boreholes was of good quality for utilisation, with average methane concentration of 46.46 % across the site. Of the 15 new gas extraction wells installed at the site in September/October 2015, GV35 – GV49 the majority are performing well and have a high concentration of methane and low oxygen.

11.1.2 Annual trace gas monitoring was carried out by Envirodat Air Quality and Environmental Consultants on 15th of October 2019. Of the 29 trace gases, 15 were detected, a slight increase compared to 2018 (when 12 were reported. see report included in Appendix 1).

11.1.3 Monitoring of the emissions from the landfill gas engine was carried out on the 15th of October 2019. The reported concentrations of NO_2 exceeded the engine emissions limit, but within the overall uncertainties detailed in LFTGN08, and therefore it is considered to represent a compliant result

11.1.4 Landfill gas concentration were monitored in perimeter monitoring boreholes around the site on a weekly basis. None of the monitored perimeter gas boreholes were in breach of their respective methane compliance limits during 2019. Similarly, carbon dioxide concentrations were below their respective EP limits at all locations.

11.2 Leachate

11.2.1 Leachate head levels were below the EP limits throughout the year in LC2B and R3. Comparison between the reported leachate levels and the surrounding groundwater levels suggests that despite the noted exceedances, leachate levels in the hydraulically contained cells remained below the surrounding groundwater, maintaining hydraulic containment. The protocols for establishing representative leachate levels for the site, and the leachate management strategies are currently under review in discussion with NRW.

11.2.2 Leachate samples were analysed quarterly. Leachate quality in LC1B - LC6B during this review period was similar to that of the past three reviews (2016 to 2018). Average ammoniacal nitrogen concentration across the leachate wells increased slightly but remained well below the historical maxima, which is consistent with the interpretation of peak leachate strength having been reached in 2011/2012 and leachate strength now decreasing.

11.2.3 The chemical analysis of the Final Discharge (FD) from the leachate treatment plant indicates that the efficiency of the leachate treatment plant improved through 2019 with the exception of suspended solid concentrations. However, it should be noted that suspended solid concentrations remained blow historical maxima which reflects the improvements made to the operation and infrastructure of the plant in 2016, and adequate ongoing management.

11.3 Groundwater

11.3.1 Groundwater level results indicate a general seasonal decrease in water level within groundwater monitoring points from March to September, before a steady increase through the remainder of 2019. Groundwater levels overall remained similar to those in 2018 except for GW6.1, GW6 and GW8 where a decrease in the groundwater level relative to previous years was observed. This decrease in groundwater levels will be monitored closely, and its potential impacts on the management of the site considered as part of the HRA review for the site.

11.3.2 The EP limit for ammoniacal nitrogen of 1.7 mg/l was exceeded in locations GW2A, GW3A and on occasion at GW4 during 2019. Concentrations remained below historic maxima for the site and followed a similar pattern of seasonal variation.

11.3.3 The chloride EP limit (60 mg/l) was exceeded in GW2A, GW3A and GW4 during 2019. At GW4, chloride concentrations exceeded the EP limit once were as GW2 and GW3A consistently breached the EP limit.

11.3.4 Zinc and Nickel concentrations remained below the trigger limits in GW2A, GW3 and GW4 throughout 2019. As previously noted, no xylenes, toluene or mercury were detected in any of the samples.

11.3.5 During the Annual suite Bis(2-Ethylhexyl) phthalate (aq) and carbon disulphide was detected within GW8. Free Cyanide was also detected within GW4 and GW5A.

11.4 Surface Water

11.4.1 No water quality data was reported at SW2 or P2.

11.4.2 The surface water quality parameters within P4 increased slightly when compared to that in 2018 with the exception of COD. COD concentrations increased slightly but not significantly.

11.5 Fugitive emissions to air

11.5.1 Fugitive emissions to air were monitored by way of an FID Walkover survey and flux box monitoring, completed in August 2019. The report is enclosed in Appendix 2.

11.6 Dust

11.6.1 Dust monitoring results show that dust emissions were very low and significantly below the compliance limit of 200 mg/m^2/day throughout the review period.

DRAWINGS

3031-CAU-XX-XX-DR-O-1802

Environmental Monitoring Plan

10814a Rev.0 – 8th May 2019

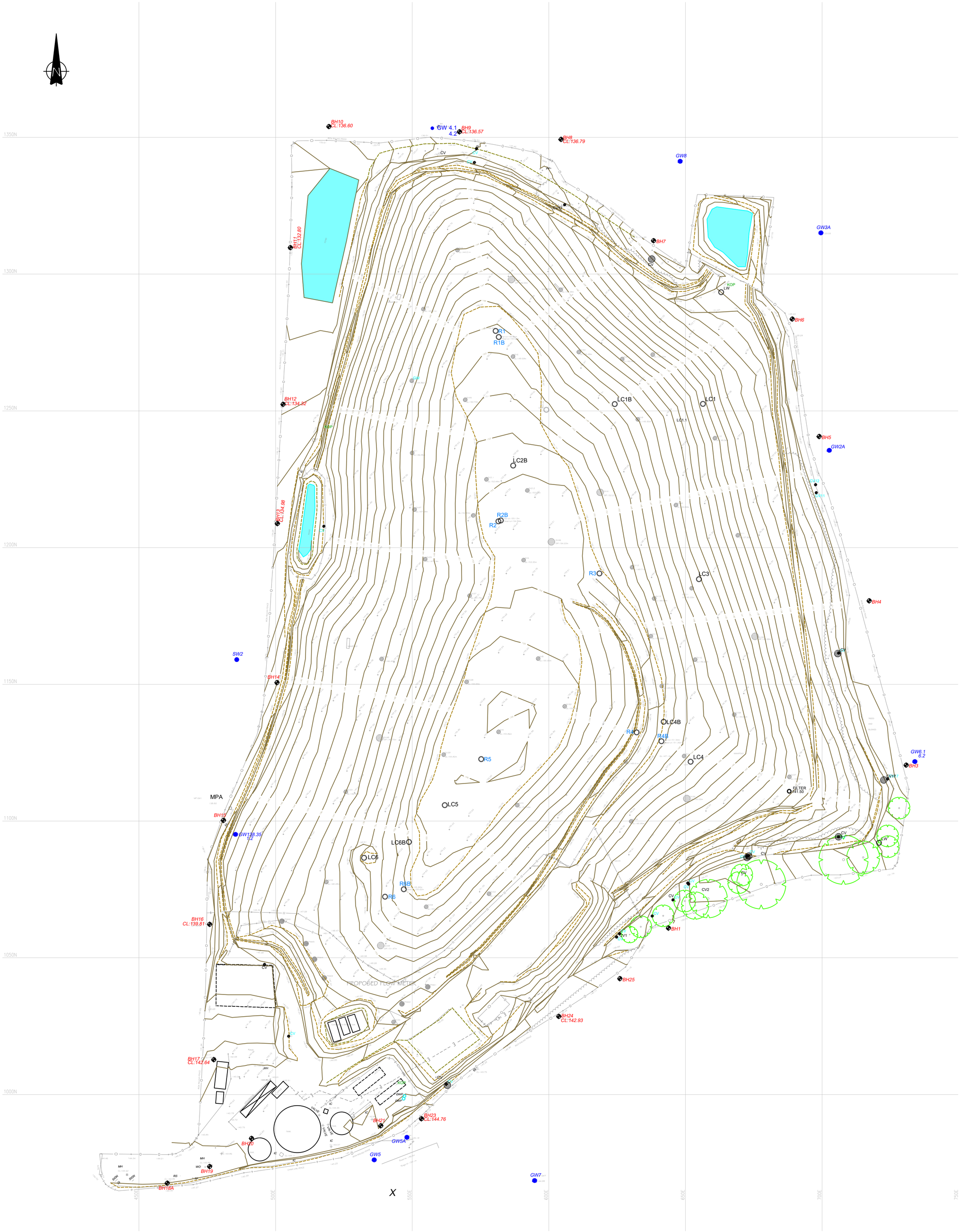
2019 topographical survey

NOTES

1. SURVEY INFORMATION PROVIDED BY STAFSURV, REF: 9193aRev1 Brookhill 06-04-2017

LEGEND

BH14	GAS BOREHOLE
GW5	GROUND WATER MONITORING BOREHOLE
LC5	LEACHATE WELL
SW2	SURFACE WATER MONITORING POINT
CV	COAL VENT



P1	ISSUED FOR COMMENT	EJD	DB	DB	30.1.18
REV	MODIFICATIONS	BY	CH	AP	DATE

FLINTSHIRE COUNTY COUNCIL WASTE MANAGEMENT SERVICES

BROOKHILL LANDFILL SITE

ENVIRONMENTAL MONITORING PLAN

DRAWN BY: EJD	DATE: 30.01.2018	
CHECKED BY: DB	SCALE @ A1: 1:750	
APPROVED BY: DB	ISSUE: S1	REVISION: P1

DRAWING NUMBER: 3031-CAU-XX-XX-DR-O-1802

Caulmert engineering environmental planning

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CAD FILE REF: S:\Public\Clients\F\Flintshire County Council Waste Management Services\3031 – Environmental Management 2017\6-Drawings & Models\02-WIP\CAD\2D\Internal\3031-CAU-XX-XX-DR-O-1802 P1.dwg

MP GW8
131.08

MPE
123.02

MP GW1
138.82

MP GW7
144.99

POND

POND

IRON RAILING FENCE

IRON RAILING FENCE

IRON RAILING FENCE

IRON RAILING FENCE

IRON RAILING FENCE

IRON RAILING FENCE

IRON RAILING FENCE

CHAIN LINK FENCE

GATE

GATE

MANIFOLD

MANIFOLD

MANIFOLD

MANIFOLD

KOP

KOP

KOP

KOP

TREES AND BUSHES

TANK

TANK

TANK

OFFICE

WEIGHBRIDGE

WHEELWASH

BOX

BOX

BOX

BOX

MARK

MARK

GV01

GV02

GV2.2

GV03

GV04

GV44

GV07

GV06

GV14

GV08

GV42

GV45

GV47

GV26

GV41

GV40

GV12

GV46

GV25

GVA

GV27

GV13

GV3.1

GV24

GVB

GV14

GV39

GV20

GV30

GV15

GV16

GVC

GV48

GV38

GV29

GV18

GV17

GV23

GV31

GV37

GV36

GV19

GV35

GV22

GV32

GV33

GV40

GV34

R1

R1B

R2

R2B

R3

R4B

R5

R6

R6B

LC1

LC2B

LC2R

LC1B

LC3

LC4B

LC4

LC5

LC6

1LC6B

LC?

Dip Lvl:149.83m
Head Lvl:149.70m

Dip Lvl:150.75m
Head Lvl:150.57m

Dip Lvl:150.32m

Dip Lvl:147.35m
Head Lvl:147.25m

Dip Lvl:140.30m
Head Lvl:140.26m

Dip Lvl:154.07m
Head Lvl:154.01m

Dip Lvl:153.93m
Head Lvl:153.81m

Dip Lvl:155.05m
Head Lvl:154.87m

Dip Lvl:153.59m
Head Lvl:153.55m

Dip Lvl:145.34m
Head Lvl:145.31m

Dip Lvl:150.29m
Head Lvl:150.19m

Head Lvl:150.44m

Dip Lvl:151.50m

Dip Lvl:147.52m
Head Lvl:147.47m

Dip Lvl:156.13m
Head Lvl:156.10m

Dip Lvl:156.95m
Head Lvl:156.88m

Dip Lvl:154.64m
Head Lvl:154.58m

Dip Lvl:151.26m
Head Lvl:151.13m

Dip Lvl:155.80m
Head Lvl:155.65m

Dip Lvl:152.83m

Dip Lvl:149.74m

GL:149.56m Prop. LW6A

Prop. LW6
GL:149.18m

Prop. LW1
GL:138.09m

GV09 Prop. LW1A
GL:144.76m

GV12
SAMPLING POINT

PINW1

PINW2

PINW3

PINW4

PINW5

GPS0013

BH12
CL:134.32

BH
CL:132.80

BH
CL:134.98

BH
CL:139.81

BH17
CL:142.64

BH
CL:142.93

BH
CL:143.75

BH
CL:144.76

BH
CL:145.19

BH
CL:144.95

MH
CL:143.23

MH
CL:143.99

CV

CV12

CV17

Eaves ht: 149.5m
Ridge ht: 150.1m

1350N
1300N
1250N
1200N
1150N
1100N
1050N
1000N
950N

500E
550E
600E
650E
700E

NOTES

Site Grid Shown

Levels Relate to Site Datum

LC5 — Leachate Well

GV31 — Gas Vent Switched On

PIN6 — Pin Gas Ven

Solar Panel

Leachate Pipe
Main 90mmø Branch 63mmø

Air Line
Main 63mmø Branch 32mmø

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www.stafsurv.com

Vernon Courtyard, Main Road, Sudbury, Derbyshire. DE6 5HS
T 01283 584800 > F 01284 584844 > E info@stafsurv.com

CYNGOR
Sir y Fflint
Flintshire
COUNTY COUNCIL

English Cymraeg

SITE
Brookhill
Landfill
Site

PROJECT
Site Survey

SCALE
1:500 @ A1

DATE
08-05-2019

DRAWING No.
10418a Rev.0

APPENDIX 1

Perimeter Landfill Gas Monitoring Summary Table

Landfill Gas Time-Series Graphs

In Waste Gas Monitoring Summary Table

Report number R19304 – Emissions to Air from the Landfill Gas Engine Located at Brookhill Landfill Site, Buckley

Report number R19304TG – Analysis of the trace landfill gas

Surface Emissions Report

APPENDIX 1 – LANDFILL GAS

Table 1: In-Waste Landfill Gas

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
G010MA	Min	46.5	33	0.4	0	0
	Max	54.7	36.6	1	3	0
	Average	51.66	35.68	0.62	1.4	0
	Count	5	5	5	5	5
G010MB	Min	42.3	32	0.3	0	0
	Max	54.5	35.6	2.4	3	0
	Average	49.16	34.16	1.2	1.12	0
	Count	8	8	8	8	8
G01MDA	Min	47.2	33.9	0.1	0	0
	Max	54.2	37.9	1.1	3	0
	Average	52.3	35.83	0.44	1.57	0
	Count	7	7	7	7	7
G01MDB	Min	42.7	31.6	0.3	0	0
	Max	54.3	36.1	2.5	3	0
	Average	50	34.55	0.97	1.25	0
	Count	12	12	12	12	12
GV1	Min	0.1	1.5	0.1	0	0
	Max	40.4	31.3	19.5	0	0
	Average	24.14	19.8	7.34	0	0
	Count	5	5	5	5	5
GV10	Min	30.8	20.7	0.1	0	0
	Max	51.2	29.8	1.1	2	0
	Average	44.52	26.92	0.4	0.5	0
	Count	6	6	6	6	6
GV11	Min	25.2	19.2	0.2	0	0
	Max	55	27.7	0.9	1	0
	Average	41.54	25.58	0.62	0.6	0
	Count	5	5	5	5	5
GV12	Min	55.1	38.1	0.6	1	0
	Max	58.3	40.4	0.7	2	0
	Average	57.2	39.47	0.63	1.67	0
	Count	3	3	3	3	3
GV13	Min	0.2	4.9	5.9	0	0
	Max	35.1	25.7	14.3	1	0
	Average	16.57	13.89	11.29	0.43	0
	Count	7	7	7	7	7
GV14	Min	32.4	28.2	0	0	0
	Max	62.2	40.7	1.2	3	0
	Average	52.48	36.67	0.29	1.9	0
	Count	10	10	10	10	10
GV15	Min	48.5	36.7	0	0	0
	Max	60.1	41.6	1.5	4	0
	Average	56	40.14	0.64	2	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	7	7	7	7	7
GV16	Min	16.9	12.4	0.6	0	0
	Max	64	39.7	13.6	3	0
	Average	41.41	27.96	5.03	1.11	0
	Count	9	9	9	9	9
GV17	Min	6.5	11.6	0.2	0	0
	Max	63.8	39.4	4.6	3	0
	Average	41.84	29.9	1.98	1.8	0
	Count	5	5	5	5	5
GV18	Min	54.4	39.2	0	0	0
	Max	59.9	42.2	0.7	4	0
	Average	58.13	41.19	0.3	2.43	0
	Count	7	7	7	7	7
GV21	Min	62.8	36.4	0.2	0	0
	Max	62.8	36.4	0.2	0	0
	Average	62.8	36.4	0.2	0	0
	Count	1	1	1	1	1
GV22	Min	77	28.5	0.7	0	0
	Max	77	28.5	0.7	0	0
	Average	77	28.5	0.7	0	0
	Count	1	1	1	1	1
GV23	Min	0.1	3.4	16.7	0	0
	Max	0.1	3.6	17.2	0	0
	Average	0.1	3.5	16.95	0	0
	Count	2	2	2	2	2
GV24	Min	59.4	36.1	0	0	0
	Max	65.7	39.5	0.7	4	0
	Average	62.08	38.02	0.2	1.75	0
	Count	4	4	4	4	4
GV25	Min	39.9	28.8	0	0	0
	Max	50.8	32.2	1.5	3	0
	Average	45.73	31	0.38	1.17	0
	Count	6	6	6	6	6
GV26	Min	50.8	32	0	0	0
	Max	63	41	3.7	4	0
	Average	55.76	35.7	0.74	1.86	0
	Count	7	7	7	7	7
GV27	Min	45.8	35.8	0	0	0
	Max	62.5	41.7	1.1	2	0
	Average	56.13	38.93	0.47	0.83	0
	Count	6	6	6	6	6
GV28	Min	0	1.8	15.6	0	0
	Max	4.5	6.4	18.1	3	0
	Average	0.87	3.07	16.98	0.5	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	6	6	6	6	6
GV29	Min	54.1	31.4	0	0	0
	Max	59.8	38.8	1.3	2	1
	Average	56.76	36.33	0.47	0.86	0.14
	Count	7	7	7	7	7
GV3	Min	62.6	32.1	0	0	0
	Max	70.4	35.7	0.8	2	0
	Average	68.01	34.04	0.26	0.38	0
	Count	8	8	8	8	8
GV30	Min	50.4	37.5	0	2	0
	Max	58.4	42	0.5	4	0
	Average	54.4	39.75	0.25	3	0
	Count	2	2	2	2	2
GV301	Min	19.3	14.4	0.1	0	0
	Max	64.7	36.8	10.8	3	0
	Average	47.88	28.33	4.05	1.33	0
	Count	6	6	6	6	6
GV31	Min	47.6	31.3	0	0	0
	Max	64.5	40.6	0.9	3	0
	Average	59.26	36.82	0.35	1.12	0
	Count	8	8	8	8	8
GV32	Min	60.2	42.2	0.5	2	0
	Max	60.8	42.6	0.7	2	0
	Average	60.5	42.4	0.6	2	0
	Count	2	2	2	2	2
GV33	Min	31.6	29.4	0	0	0
	Max	63.1	42.3	1.4	3	4
	Average	49.54	35.2	0.48	1.12	0.5
	Count	8	8	8	8	8
GV35	Min	39	35.9	0	0	0
	Max	61.6	42.2	0.6	2	0
	Average	54.68	39.57	0.23	0.78	0
	Count	9	9	9	9	9
GV36	Min	25	24	0	0	0
	Max	71.1	34.4	1.9	4	0
	Average	55.37	31.92	0.36	1.67	0
	Count	9	9	9	9	9
GV37	Min	27	26	0.1	0	0
	Max	69.3	36.4	2.2	2	2
	Average	48.43	32	0.87	0.78	0.22
	Count	9	9	9	9	9
GV38	Min	28.8	26.7	0.2	0	0
	Max	67.4	36.7	3	3	0
	Average	46.03	30.64	1.08	0.93	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	14	14	14	14	14
GV39	Min	33.9	24.3	0	0	0
	Max	69.3	34.9	4.3	4	0
	Average	50	30.62	0.68	1.08	0
	Count	12	12	12	12	12
GV4	Min	23.5	20.6	0.3	0	0
	Max	74.2	39	1.3	2	0
	Average	55.93	29.1	0.65	0.64	0
	Count	11	11	11	11	11
GV40	Min	34.6	30.7	0.1	0	0
	Max	66.2	35.4	1.5	3	0
	Average	48.79	32.98	0.44	0.92	0
	Count	13	13	13	13	13
GV41	Min	44.5	35.2	0	0	0
	Max	61.6	39.9	0.7	3	0
	Average	54.71	37.66	0.29	1.1	0
	Count	10	10	10	10	10
GV42	Min	36.9	23.3	0.1	0	0
	Max	74.5	31.5	4.3	2	0
	Average	56.33	27.51	1.53	0.7	0
	Count	10	10	10	10	10
GV43	Min	30.7	28	0.1	0	0
	Max	66.7	37.3	1.5	3	0
	Average	49.87	32.08	0.47	0.77	0
	Count	13	13	13	13	13
GV44	Min	7.9	16.2	0.4	0	0
	Max	66	36.2	3.2	2	0
	Average	41.23	28.02	1.14	0.5	0
	Count	10	10	10	10	10
GV45	Min	29	29.1	0	0	0
	Max	64.9	40.1	0.8	3	0
	Average	52.54	35.07	0.24	0.86	0
	Count	14	14	14	14	14
GV46	Min	0.1	1.7	0	0	0
	Max	60.5	43.6	16.6	4	0
	Average	45.86	32.54	3.57	2.08	0
	Count	12	12	12	12	12
GV47	Min	25.4	15.4	0	1	0
	Max	54.5	33.2	6.9	4	1
	Average	47.08	26.42	2.12	2.25	0.25
	Count	4	4	4	4	4
GV48	Min	56.8	34.4	0	0	0
	Max	61.6	43.3	1.3	19	3
	Average	59.94	39.28	0.5	3.75	0.5

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	8	8	8	8	8
GV49	Min	0.4	5.8	0	0	0
	Max	62.2	42.2	16.1	3	0
	Average	45.02	31.27	1.8	0.85	0
	Count	13	13	13	13	13
GV6	Min	0.1	1.2	0.1	0	0
	Max	66	40.4	19.4	9	0
	Average	29.63	18.8	9.73	1.11	0
	Count	9	9	9	9	9
GV7	Min	27.9	24.1	0	0	0
	Max	72.5	37.4	4.2	2	0
	Average	52.46	29.02	0.92	0.62	0
	Count	13	13	13	13	13
GV8	Min	3	3.9	1.1	1	0
	Max	42.1	30.2	16.6	12	0
	Average	20.21	13.84	10.64	6.43	0
	Count	7	7	7	7	7
GV9	Min	35.8	29.7	0	0	0
	Max	69.5	37.4	0.7	3	0
	Average	51.78	32.22	0.28	1.17	0
	Count	12	12	12	12	12
GVA	Min	33.1	19.1	0.3	3	0
	Max	59.8	42.8	4.7	36	0
	Average	43.33	28.3	3	22.33	0
	Count	3	3	3	3	3
GVB	Min	47.9	33.3	0.3	0	0
	Max	51	36.5	0.6	1	0
	Average	49.1	35.17	0.4	0.33	0
	Count	3	3	3	3	3
GVC	Min	55.9	37.1	0	0	0
	Max	61.4	42.5	1.1	4	2
	Average	58.78	40.12	0.31	2.25	0.38
	Count	8	8	8	8	8
GW34	Min	0.6	4.9	0.9	0	0
	Max	39.8	22.2	14.6	3	0
	Average	21.79	14.24	6.09	1.14	0
	Count	7	7	7	7	7
LC1B	Min	3.7	6	0.2	0	0
	Max	65.2	36.5	16.8	1	0
	Average	34.82	21.35	8.01	0.62	0
	Count	8	8	8	8	8
LC2B	Min	0.2	2.5	0	0	0
	Max	62.7	41.1	18.8	3	0
	Average	46.19	30.99	4.8	1.56	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	9	9	9	9	9
LC2R	Min	0.1	1.2	0.1	0	0
	Max	66.1	36.9	18.9	2	0
	Average	36.78	22.87	6.1	0.67	0
	Count	9	9	9	9	9
LC3	Min	3.3	6.6	4.4	0	0
	Max	45.8	29.6	15.5	3	0
	Average	21.08	15.32	11.42	0.75	0
	Count	4	4	4	4	4
LC4	Min	17.2	10.7	0.2	0	0
	Max	62.8	37	13.7	28	0
	Average	38.3	23.86	6.64	12	0
	Count	7	7	7	7	7
LC4B	Min	4.5	4.5	3.2	0	0
	Max	48.7	36.6	14.6	7	0
	Average	19.77	14.13	9.64	3.57	0
	Count	7	7	7	7	7
LC5	Min	7	18.9	0	0	0
	Max	59.1	43.1	7.7	3	0
	Average	49.02	37.62	2.11	1.45	0
	Count	11	11	11	11	11
LC6	Min	1.8	13	0.2	0	0
	Max	68.9	40.1	9.7	2	0
	Average	46.61	32.2	2.89	0.57	0
	Count	7	7	7	7	7
LC6B	Min	50.1	32.8	0.2	0	0
	Max	69.6	39.9	1.2	2	0
	Average	60.3	37.67	0.5	0.71	0
	Count	7	7	7	7	7
M010MA	Min	52.8	38.1	0.2	0	0
	Max	61.5	40.7	0.7	4	0
	Average	57.4	39.5	0.46	2.14	0
	Count	7	7	7	7	7
M010MB	Min	54.6	38.6	0.1	0	0
	Max	60.4	41	0.8	3	0
	Average	57.36	39.79	0.34	2.29	0
	Count	7	7	7	7	7
M050MA	Min	52.4	36	0.1	1	0
	Max	54.4	36.3	0.3	7	1
	Average	53.4	36.15	0.2	4	0.5
	Count	2	2	2	2	2
M050MB	Min	52.2	31.3	0	2	0
	Max	54	37.4	0.5	2	0
	Average	53.1	34.35	0.25	2	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	2	2	2	2	2
PRG17	Min	44.3	30.3	1	0	0
	Max	50.9	33.4	1.1	1	0
	Average	47.6	31.85	1.05	0.5	0
	Count	2	2	2	2	2
PRG39	Min	5.5	15.8	0.1	0	0
	Max	68.2	34.5	13.3	5	0
	Average	36.85	25.15	6.7	2.5	0
	Count	2	2	2	2	2
PRG41	Min	48.8	37.8	0.1	0	0
	Max	48.8	37.8	0.1	0	0
	Average	48.8	37.8	0.1	0	0
	Count	1	1	1	1	1
PRG42	Min	37.1	23.7	1.2	0	0
	Max	67.8	28.6	4.5	1	0
	Average	52.45	26.15	2.85	0.5	0
	Count	2	2	2	2	2
PRG44	Min	29.4	23.4	0.8	2	0
	Max	29.4	23.4	0.8	2	0
	Average	29.4	23.4	0.8	2	0
	Count	1	1	1	1	1
PRG45	Min	34.2	29.9	0.1	0	0
	Max	64.4	37.5	0.9	3	0
	Average	49.3	33.7	0.5	1.5	0
	Count	2	2	2	2	2
PRG46	Min	58.4	39.6	0.8	3	0
	Max	58.4	39.6	0.8	3	0
	Average	58.4	39.6	0.8	3	0
	Count	1	1	1	1	1
PRG48	Min	52.4	35.7	0.5	3	0
	Max	52.4	35.7	0.5	3	0
	Average	52.4	35.7	0.5	3	0
	Count	1	1	1	1	1
PRG49	Min	59.2	37.4	0.5	0	0
	Max	60.1	39.6	0.7	3	0
	Average	59.65	38.5	0.6	1.5	0
	Count	2	2	2	2	2
PRL3	Min	17.7	12.6	4.4	0	0
	Max	46	29.6	12.6	2	0
	Average	31.85	21.1	8.5	1	0
	Count	2	2	2	2	2
PRL5	Min	8.4	16.6	0.7	2	0
	Max	8.4	16.6	0.7	2	0
	Average	8.4	16.6	0.7	2	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	1	1	1	1	1
PRL6	Min	36.8	22.9	2.8	4	0
	Max	36.8	22.9	2.8	4	0
	Average	36.8	22.9	2.8	4	0
	Count	1	1	1	1	1
PRLC4	Min	18	11.4	13.1	0	0
	Max	18	11.4	13.1	0	0
	Average	18	11.4	13.1	0	0
	Count	1	1	1	1	1
PRR2B	Min	35	21.1	3.5	0	0
	Max	35	21.1	3.5	0	0
	Average	35	21.1	3.5	0	0
	Count	1	1	1	1	1
PRR3	Min	10.8	6.9	11.8	0	0
	Max	23.3	14.8	16	1	0
	Average	17.05	10.85	13.9	0.5	0
	Count	2	2	2	2	2
PRR6B	Min	62	39.4	0	3	0
	Max	62	39.4	0	3	0
	Average	62	39.4	0	3	0
	Count	1	1	1	1	1
PW1	Min	35.4	19	7.9	0	0
	Max	35.4	19	7.9	0	0
	Average	35.4	19	7.9	0	0
	Count	1	1	1	1	1
PW2	Min	1.3	8.7	1	0	0
	Max	29.5	24.9	15.2	4	0
	Average	15.4	16.8	8.1	2.33	0
	Count	2	2	2	3	3
PW3	Min	16.3	14	2.2	0	0
	Max	21.7	18.9	5.3	0	0
	Average	19	16.45	3.75	0	0
	Count	2	2	2	2	2
PW4	Min	25	17.5	1	0	0
	Max	31.5	21.6	2.8	0	0
	Average	28.25	19.55	1.9	0	0
	Count	2	2	2	2	2
PW5	Min	32.7	21.1	0.6	0	0
	Max	46.6	28.6	2.6	0	0
	Average	41.9	26.1	1.3	0	0
	Count	3	3	3	3	3
PW6	Min	0.3	6.5	1.4	0	0
	Max	59.9	33.7	15.4	1	0
	Average	30.05	22.02	7.95	0.25	0

APPENDIX 1 – LANDFILL GAS

Monitoring Point		CH4 %	CO2 %	O2 %	CO ppm	H2S ppm
	Count	4	4	4	4	4
R1	Min	11.2	11.2	0.6	0	0
	Max	68.3	34.1	11.7	1	0
	Average	49.21	26.42	3.86	0.2	0
	Count	10	10	10	10	10
R1B	Min	38.5	27.5	0.1	0	0
	Max	67.5	37.9	2.4	2	0
	Average	57.47	33.57	0.91	0.5	0
	Count	14	14	14	14	14
R2B	Min	10.8	12.2	0.4	0	0
	Max	67.7	37.7	3.6	20	0
	Average	51.45	29.98	1.58	5.67	0
	Count	12	12	12	12	12
R3	Min	0.3	7.4	0.5	0	0
	Max	24.4	16.5	16.1	1	0
	Average	7.42	10.98	11.72	0.2	0
	Count	5	5	5	5	5
R4B	Min	0.4	8.1	0	0	0
	Max	65.5	40.9	13.2	10	0
	Average	47.19	33.81	2.24	3	0
	Count	11	11	11	11	11
R5	Min	0	1.9	0.5	0	0
	Max	50.9	36.1	16.9	3	0
	Average	11.73	13.26	7.84	1	0
	Count	7	7	7	7	7
R6B	Min	51.8	38	0	1	0
	Max	63.7	41.5	2.3	3	0
	Average	57.79	39.48	0.84	1.83	0
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Table 2: Perimeter Landfill Gas (% v/v)

Location	Data	CH4 (%v/v)	Trigger (%v/v)	CO2 (%v/v)	Trigger (%v/v)
BK BH 1	Min	0	1	0.1	8.8
	Average	0.1		1.5	
	Max	0.01		0.67	
	Count	49		49	
BK BH 3	Min	0	1	0	3.1
	Average	0.1		2.4	
	Max	0.02		0.61	
	Count	49		49	
BK BH 4	Min	0	1	0.1	5.1
	Average	0.2		5	
	Max	0.01		1.36	
	Count	48		48	
BK BH 5	Min	0	1	0.1	1.5
	Average	0		1.4	
	Max	0		0.54	
	Count	48		48	
BK BH 6	Min	0	1	0.1	1.5
	Average	0		1.4	
	Max	0		0.49	
	Count	48		48	
BK BH 7	Min	0	1	0	10
	Average	0.2		0.8	
	Max	0.01		0.29	
	Count	49		49	
BK BH 8	Min	0.8	32.2	0.9	3.6
	Average	13.2		3.5	
	Max	5.89		2.82	
	Count	49		49	
BK BH 9	Min	3	29.6	2	10.4
	Average	29		10.2	
	Max	9.11		5.04	
	Count	49		49	
BK BH 10	Min	0	1	0.1	3.9
	Average	0.7		1.7	
	Max	0.25		0.78	
	Count	49		49	

APPENDIX 1 – LANDFILL GAS

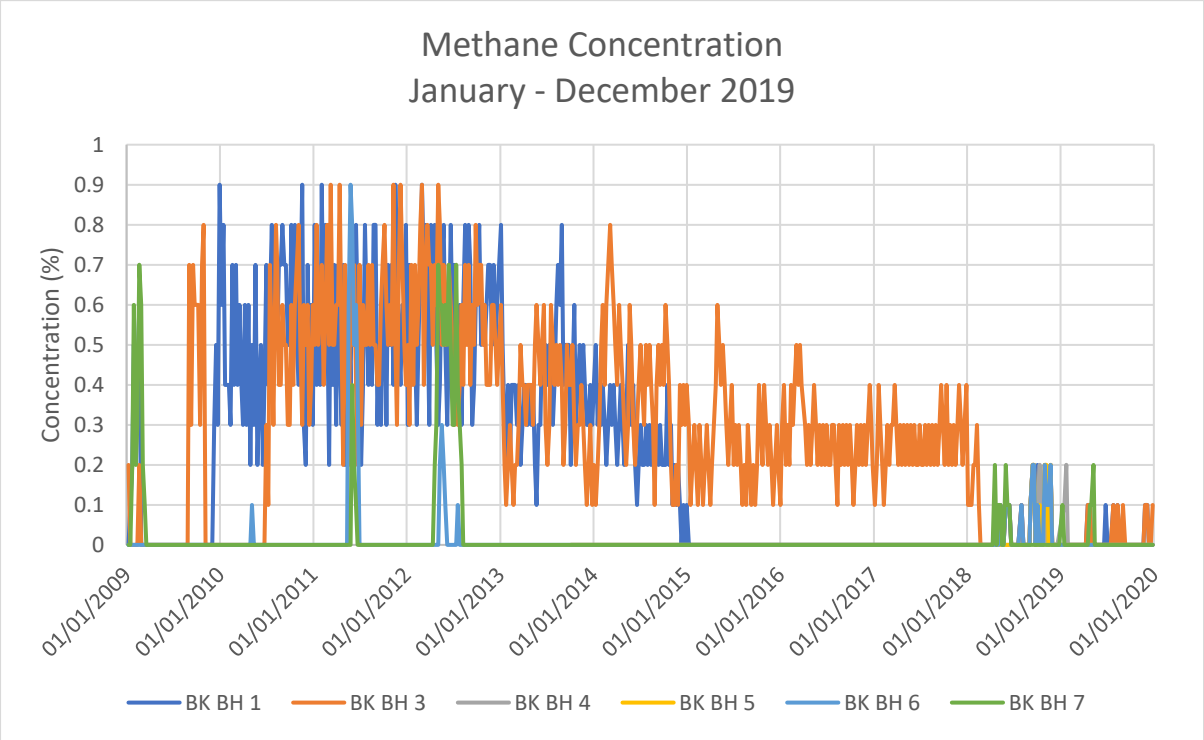
Location	Data	CH4 (%v/v)	Trigger (%v/v)	CO2 (%v/v)	Trigger (%v/v)
BK BH 11	Min	0	1	0	6.5
	Average	0.5		2.4	
	Max	0.14		0.75	
	Count	49		49	
BK BH 12	Min	0	1	0.2	6.6
	Average	0.1		6.2	
	Max	0.01		1.6	
	Count	49		49	
BK BH 13	Min	0	1	0.1	9.4
	Average	0.1		1.9	
	Max	0.01		0.71	
	Count	49		49	
BK BH 14	Min	0	1	0	3.5
	Average	0.1		2.4	
	Max	0.01		0.35	
	Count	49		49	
BK BH 15	Min	0	1	0.1	17.6
	Average	0.1		1.8	
	Max	0.01		0.45	
	Count	49		49	
BK BH 16	Min	0	1	0.1	11.4
	Average	0.6		5.1	
	Max	0.04		1.81	
	Count	49		49	
BK BH 17	Min	0	1	0	12.9
	Average	0.1		1.9	
	Max	0.02		0.35	
	Count	49		49	
BK BH 18	Min	0	1	0	21.2
	Average	0.7		9.2	
	Max	0.06		3.88	
	Count	49		49	
BK BH 19	Min	0	1	0.2	11.2
	Average	0.3		3.5	
	Max	0.03		1.89	
	Count	49		49	
BK BH 20	Min		1		10.7
	Average				

APPENDIX 1 – LANDFILL GAS

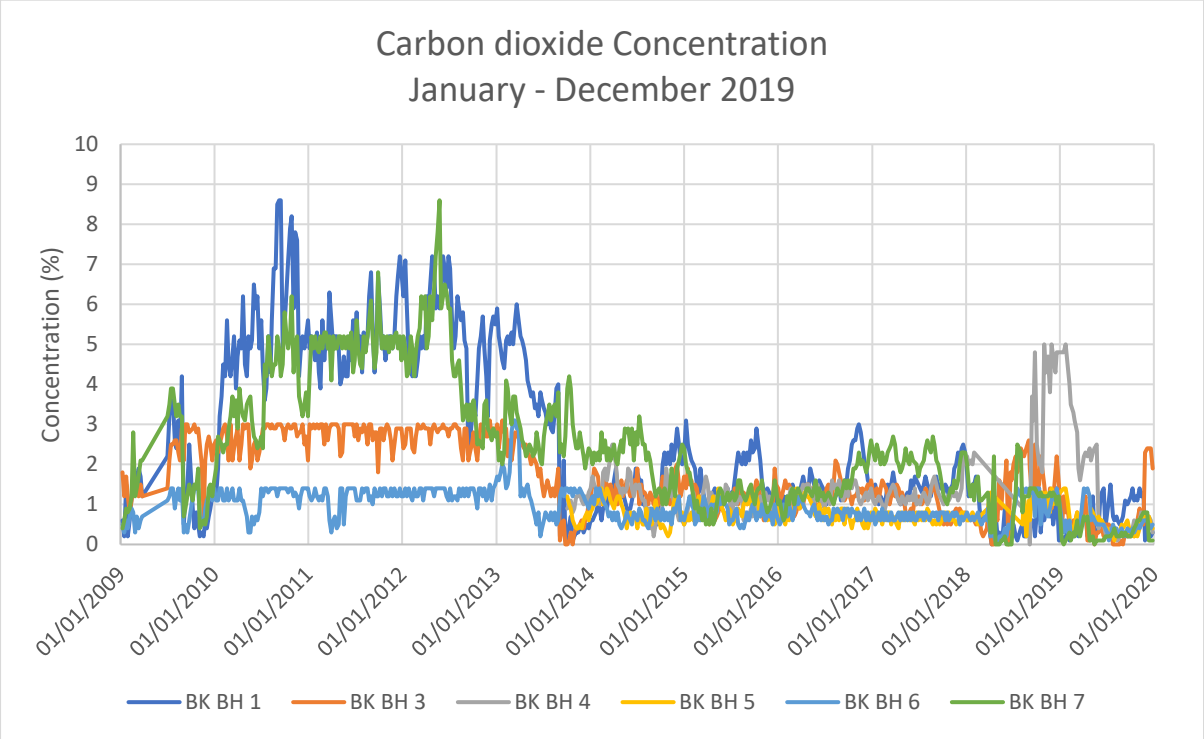
Location	Data	CH4 (%v/v)	Trigger (%v/v)	CO2 (%v/v)	Trigger (%v/v)
	Max				
	Count				
BK BH 21	Min	0	1	0	21.7
	Average	0.1		5.6	
	Max	0.02		1.64	
	Count	49		49	
BK BH 23	Count	0	1	0.1	7.3
	Min	0.2		6.7	
	Average	0.01		2.46	
	Max	49		49	
BK BH 24	Count	0	1	0	1.5
	Min	0.1		1.4	
	Average	0.01		0.4	
	Max	48		48	
BK BH 25	Count	0	1	0.1	9.9
	Min	0.1		4.4	
	Average	0.02		1.33	
	Max	49		49	

APPENDIX 1 – LANDFILL GAS

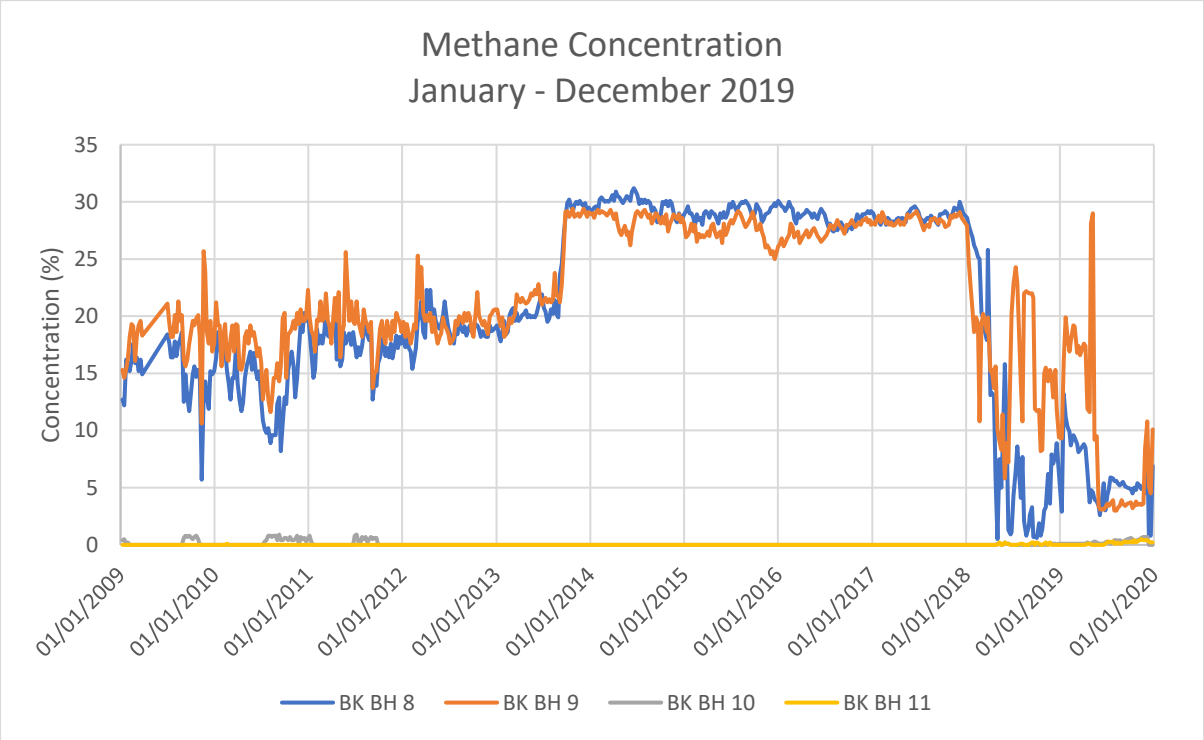
Graph 1a: Perimeter Landfill Gas - Methane concentration in BH1, BH3, BH4, BH5, BH6 and BH7



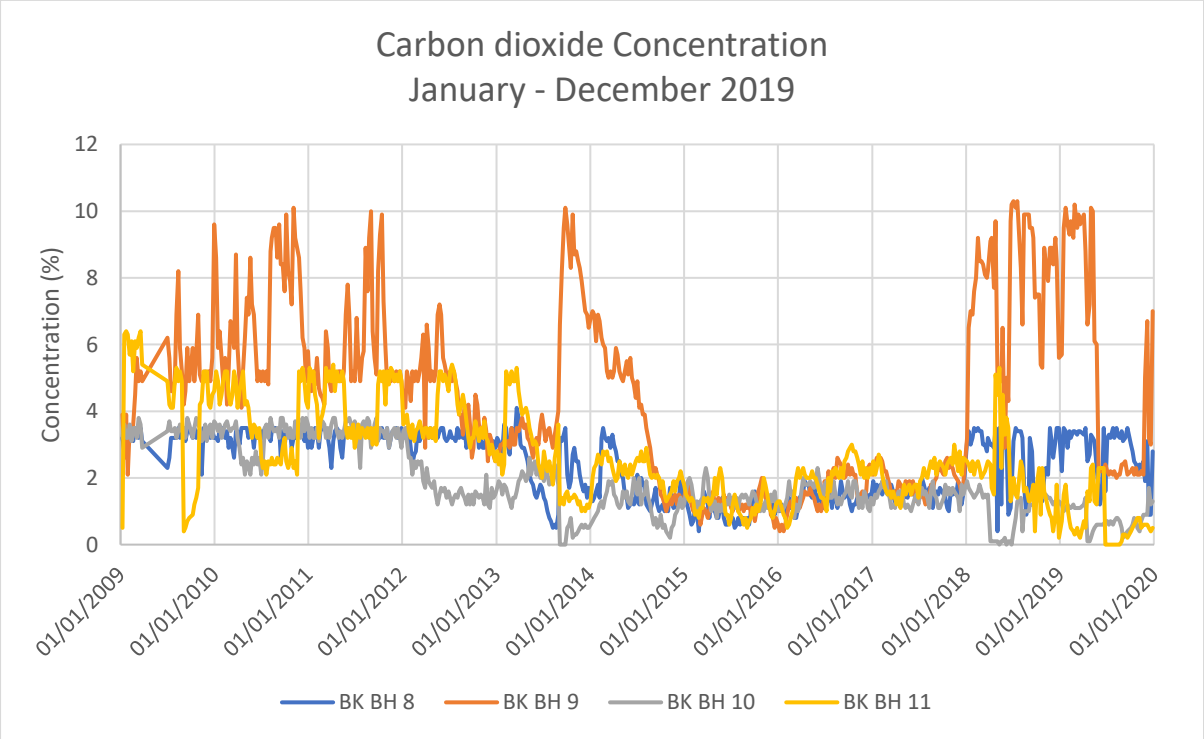
Graph 1b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH1, BH3, BH4, BH5, BH6 and BH7



Graph 2a: Perimeter Landfill Gas - Methane concentration in BH08, BH09, BH10 and BH11

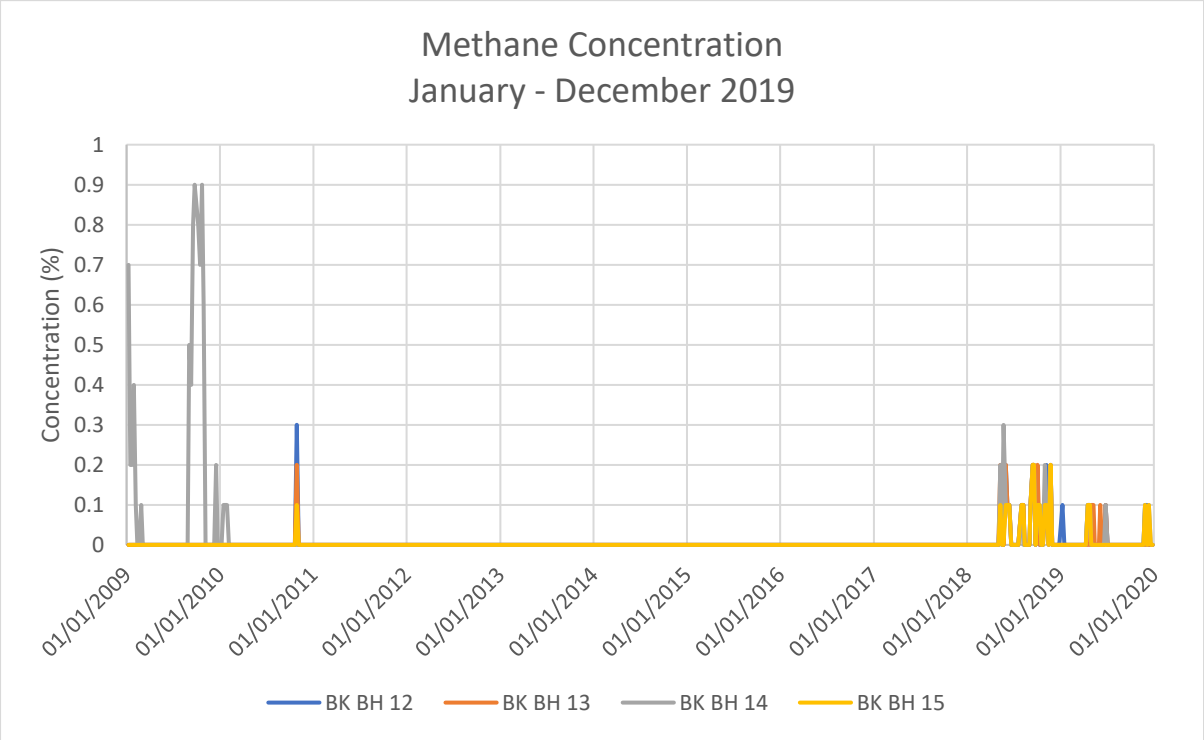


Graph 2b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH08, BH09, BH10 and BH11

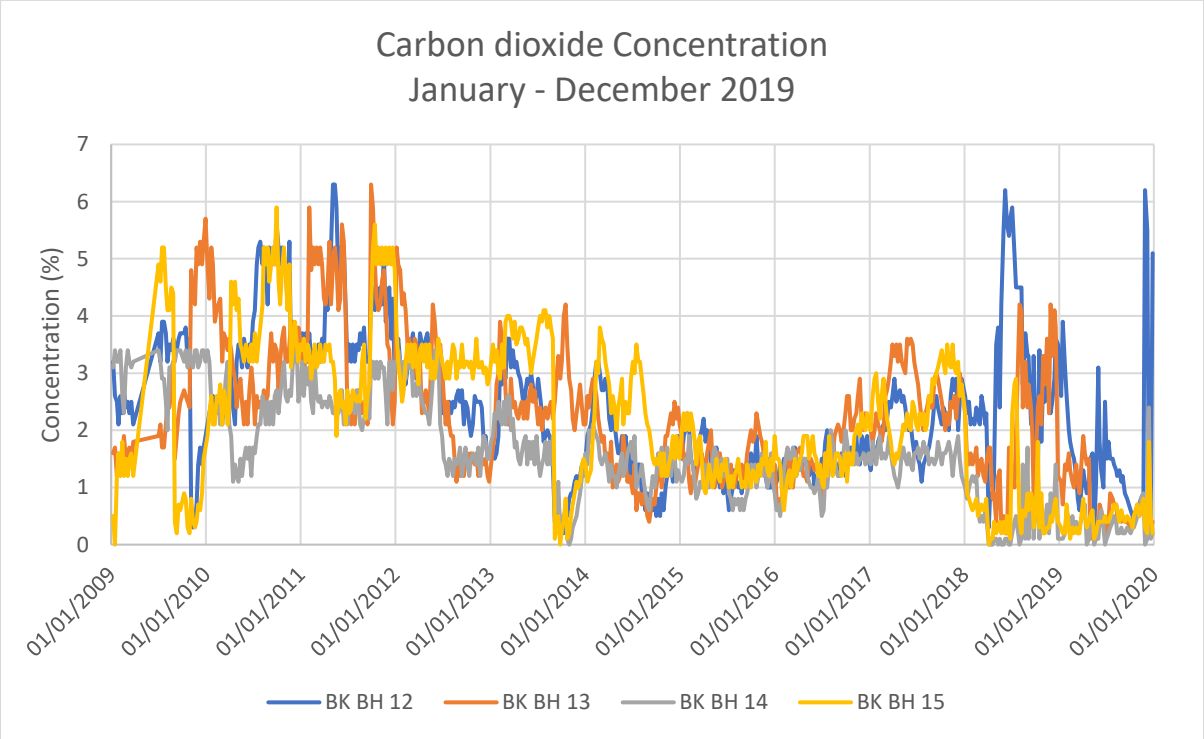


APPENDIX 1 – LANDFILL GAS

Graph 3a: Perimeter Landfill Gas - Methane concentration in BH12, BH13, BH14 and BH15

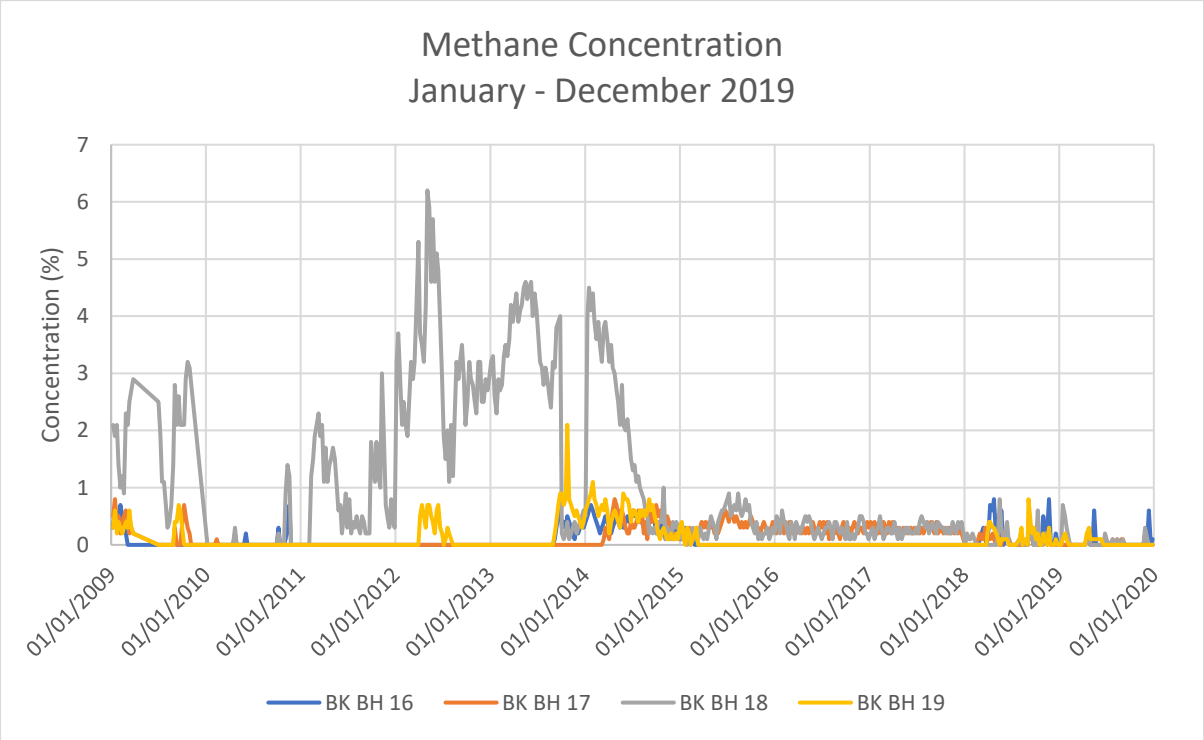


Graph 3b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH12, BH13, BH14 and BH15

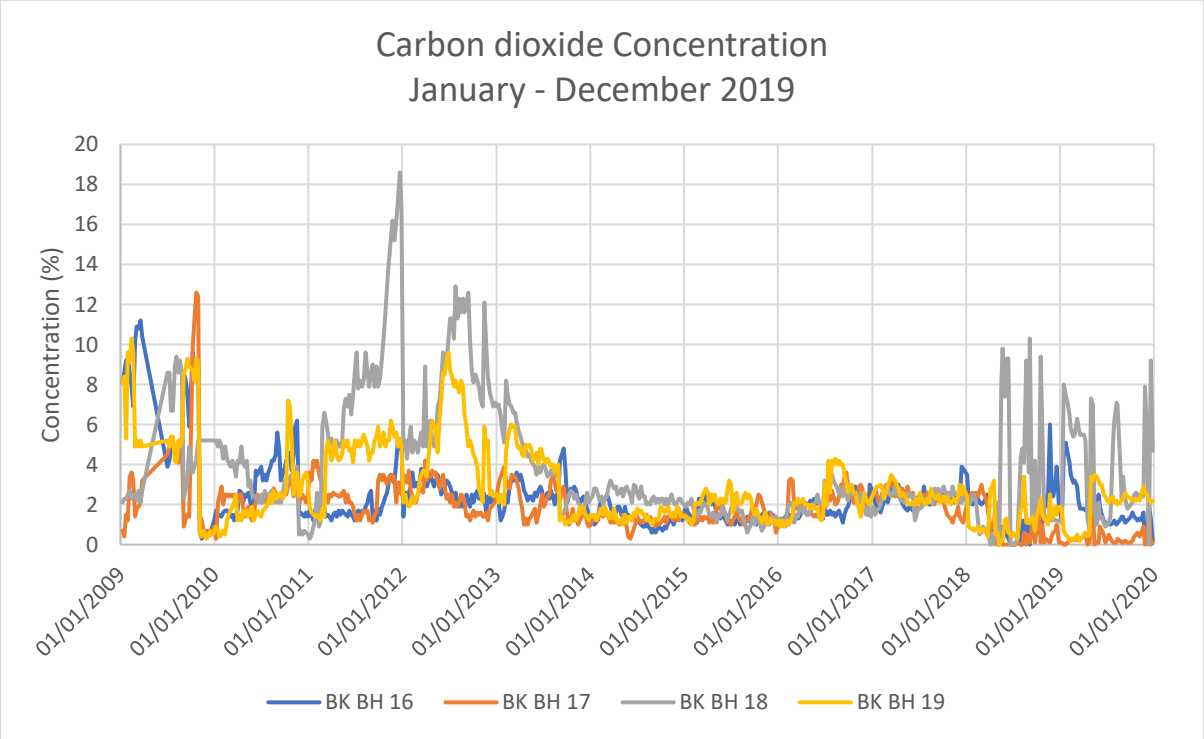


APPENDIX 1 – LANDFILL GAS

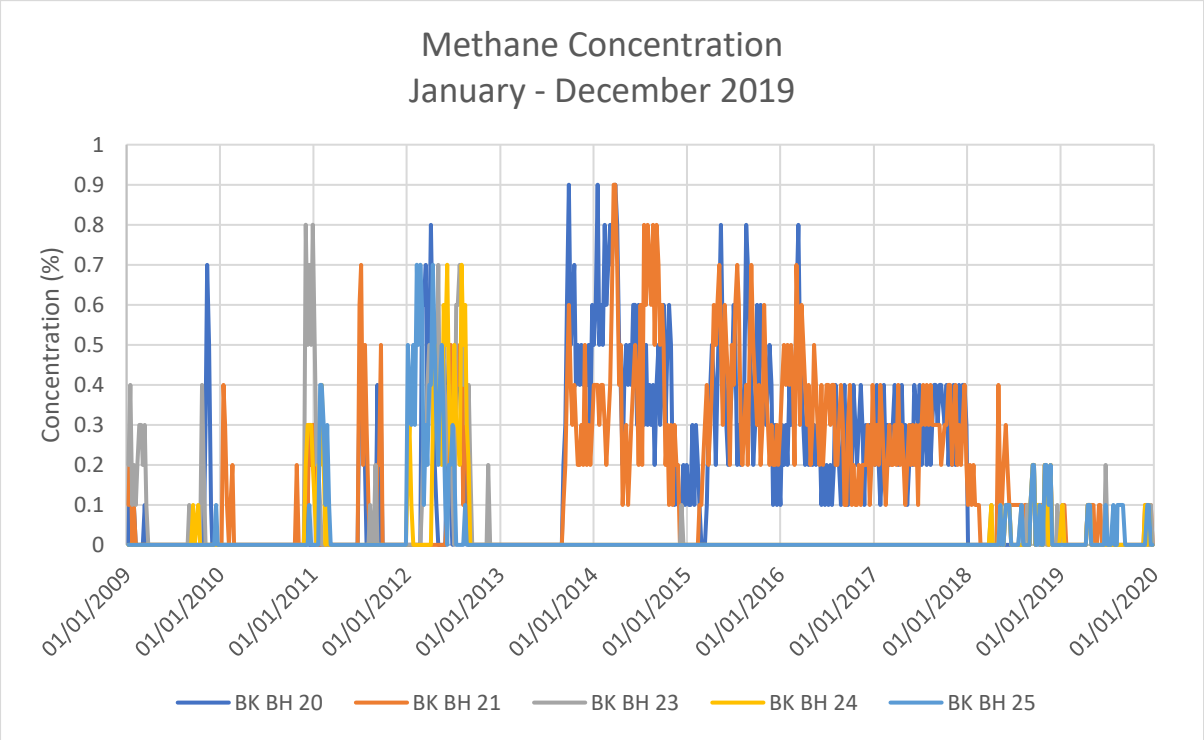
Graph 4a: Perimeter Landfill Gas - Methane concentration in BH16, BH17, BH18 and BH19



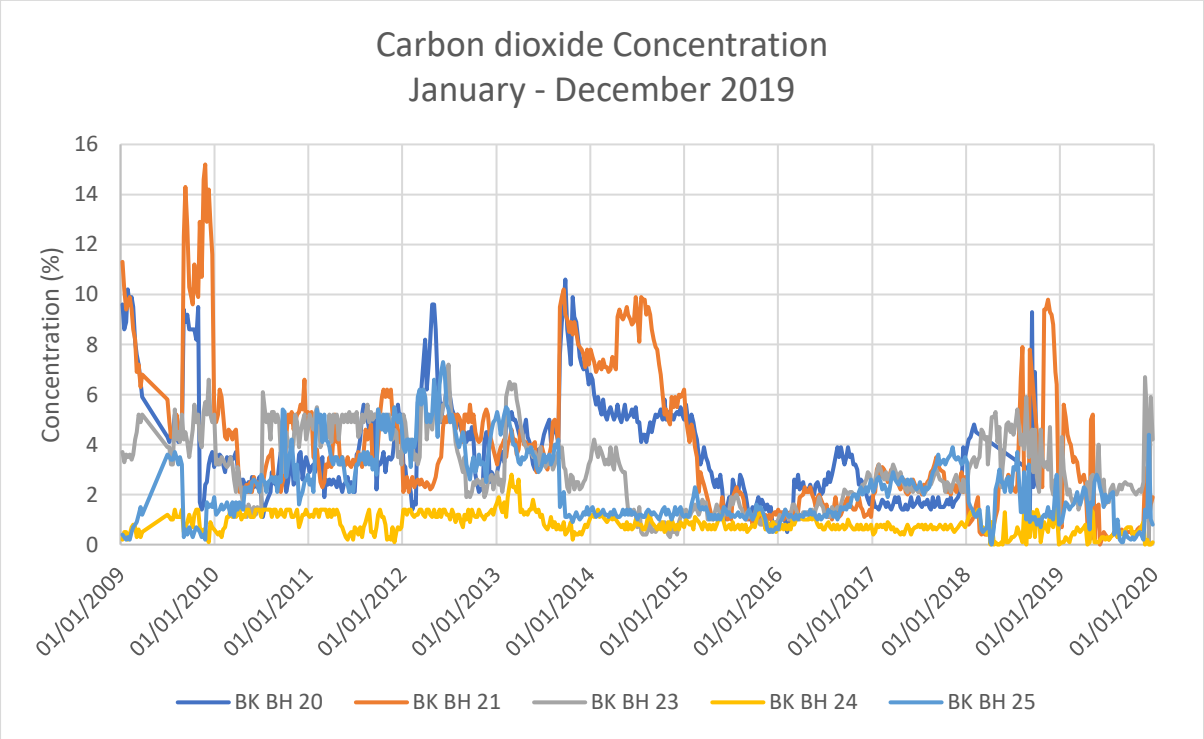
Graph 4b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH16, BH17, BH18 and BH19



Graph 5a: Perimeter Landfill Gas - Methane concentration in BH20, BH21, BH23, BH24 and BH25



Graph 5b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH20, BH21 and BH23 - BH25



Report for the Periodic Monitoring of Emissions to Air from the Landfill Gas Engine Stack Located at Brookhill Landfill Site, Buckley.

Part 1: **Executive Summary**

Permit Number: BV7273 (YP3835MJ)

Operator: Flintshire County Council

Installation: Brookhill Landfill Site (Engine)

MCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
4251

Monitoring dates:	15th October 2019
Job Number:	**R19304**
Version:	1
Address:	**Flintshire County Council** Brookhill Landfill Site Brookhill Way, Pinfold Industrial Estate Flintshire, CH7 3PL
Monitoring Organisation:	**EnviroDat Ltd**
Address:	Cutbush Commercial Cutbush Lane East Reading, RG2 9AF
Date of Report:	19th November 2019
Report Approved By:	David Littlewood
MCERTS Registration Number:	MM 06 772 (Level II, TE1, 2, 3 & 4)
Function:	Operations Manager (Team Leader)
Signed:	

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Notes to Report.

a). EnviroDat Ltd, Report Template V11.

b). This report should not be reproduced except in full, without written approval of Envirodat Ltd.

c). Opinions and Interpretations herein are outside the scope of UKAS/MCerts Accreditation.

PART 1: EXECUTIVE SUMMARY

1.1 Monitoring Objectives

Flintshire County Council operates a landfill gas engine and a flare stack at its facility located at Brookhill Landfill site. This combustion plant has the potential to pollute the atmosphere. Consequently, these processes are subject to regulation and periodic environmental monitoring is necessary under this regulation.

Methane is produced as a by-product of the decomposition of organic waste that is buried within the site (methanogenesis). This methane is extracted and pumped through inert piping to the engine or flare for combustion, the scale of which is dictated according to local engineering, operational requirements and methanogenic rate. The flare is designed to operate when excess gas is produced or for periods of engine maintenance.

EnviroDat Limited was requested to undertake a monitoring campaign on the engine stack. This work forms part of the annual compliance test.

The pollutants monitored within the engine emissions, as required under permit BV7273, are summarised below:

Substances to be monitored	**Emission Point Identification**
	Engine
Oxides of Nitrogen (as NO2)	✓
Carbon Monoxide	✓
Volatile Organic Compounds (VOCs)	✓
Oxygen (for correction)	✓
Moisture (for correction)	✓
Special requirements	None requested

1.2 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Estimate of Uncertainty (2σ at 95% confidence)	Units	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method (see note below)	Operating Status
Engine	Oxides of Nitrogen (as NO_2)	500	**647**	±28	$mg(N)m^{-3}$	101.3kPa, 273K, dry gas, 5% Oxygen	15/10/19	09:40-10:40	BS EN 14792	A	At 73% MCR
	Carbon Monoxide	1400	**816**	±46	$mg(N)m^{-3}$				BS EN 15058	A	
	Volatile Organic Compounds (VOCs as carbon)	1000	**804**	±35	$mg(N)m^{-3}$				BS EN 12619	A	
	Moisture	-	**11.3**	n/a	%	101.3kPa, 273K, dry gas			BS EN 14790	A	
	Oxygen	-	**6.51**	±0.37	%				BS EN 14789	A	

NOTE:

A. EnviroDat Ltd MCerts/UKAS Accredited for sampling and analysis.

B. EnviroDat Ltd Mcerts/UKAS Accredited for sampling only, UKAS Accredited analysis conducted by sub-contract laboratory.

C. EnviroDat Ltd UKAS Accredited for sampling only (further clarification is given in section 1.4). Analysis of this component is not UKAS Accredited.

D. The method for sampling and analysis is not UKAS or MCerts Accredited, method follows documented in-house procedure (further clarification is given in section 1.4).

1.3 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results			
								Substance	CEMS Results	Periodic Monitoring Results	Units
Engine	15/10/19	Combustion	Continuous	Landfill Gas	N/A	None	Producing 290kWe (73% MCR)	N/A	N/A	N/A	N/A

1.4 Monitoring Deviations

Emission Point Reference	Substance Deviations	Monitoring Deviations	Other Relevant Issues
Engine	None	None	None

PART 2: SUPPORTING INFORMATION

2.1 Appendix I: General Information

2.1.1 Monitoring organisation staff details

Monitoring at Brookhill Landfill Site was conducted by the following EnviroDat Engineer:

Team Leader, David Littlewood – MCerts Level II (TE1, 2, 3 & 4) MM06 772

2.1.2 Monitoring method details

Parameter	Standard Reference Method/Alternative	EnviroDat Procedure	MCerts Accreditation
Oxides of Nitrogen (as NO_2)	BS EN 14792	SP14792	MCerts
Carbon Monoxide (CO)	BS EN 15058	SP15058	MCerts
Volatile Organic Compounds (VOCs)	BS EN 12619	SP12619	MCerts
Moisture (H_2O)	BS EN 14790	SP14790	MCerts
Oxygen (O_2)	BS EN 14789	SP14789	MCerts

2.1.3 Monitoring organisation equipment and gas check list references

EQUIPMENT – VK19LCV			
Item	**Reference**	**Calibration Due**	**PAT Due**
Portable Gas Analyser	PGA#07	03-Mar-20	Oct-20
Flame Ionisation Detector Analyser	FID#01	12-May-20	Oct-20
Gas Conditioner	COND#02	25-Feb-20	Oct-20
Data Logger	DL#05	03-Nov-19	Oct-20
Digital Barometer	DB#29	12-Mar-20	-
NOx Converter	CONV#06	13-Jan-20	Oct-20
Balance	BAL#04	31-Mar-20	-
Heated Line[1]	HL#14	12-Feb-20	-
Heated Line[2]	HL#05	01-Jan-20	-
Heated Line Controller[1]	HLC#14	12-Feb-20	Oct-20
Heated Line Controller[2]	HLC#04	01-Jan-20	Oct-20
Heated Filter Holder	HFH#02	31-Jan-20	Oct-20
'Apex' Kit	Apex#02	See each item	Oct-20
Dry Gas Meter ('Apex')	DGM#07	26-Aug-20	-
Thermocouple Reader[1] ('Apex')	TCR#11	26-Aug-20	-
Thermocouple Reader[2] ('Apex')	TCR#13	26-Aug-20	-
Thermocouple Reader[3] ('Apex')	TCR#14	26-Aug-20	-
Thermocouple Reader[4]	TCR#15	02-Jan-20	-
Manometer ('Apex' Orange)	MAN#06	26-Aug-20	-
Manometer ('Apex' Red)	MAN#07	26-Aug-20	-
Timepiece[1] ('Apex')	TP#09	26-Aug-20	-
Timepiece[2]	TP#08	01-Jan-20	-
Thermocouple[1] ('Apex' Dogleg Exit)	TC#03	02-Jan-20	-

Thermocouple[2] ('Apex' Dry Gas Meter)	TC#07	26-Aug-20	-
Thermocouple[3]	TC#27	02-Jan-20	-
Thermocouple[4]	TC#56	02-Jan-20	-
Thermocouple[5]	TC#37	31-Jan-20	-
Tape Measure	TM#07	24-Oct-19	-

GAS CYLINDERS – VK19LCV			
	Certificate No.	**Level (ppm)**	**Validity**
'Zero' Gas (%)[1]	VC2966221	99.999%	-
'Zero' Gas (%)[2]	N10000018	8.11% O_2 in N2	-
Oxygen Span Gas (%)	VC77973	8.78	15-Sep-20
VOC Span Gas	VC77973	668	15-Sep-20
Carbon Monoxide Span Gas	VC115361	1236	13-Jan-20
Nitrogen Dioxide Span Gas	VC115361	258.9	13-Jan-20

2.2 Appendix II: Emission Point Reference Data & Results

2.2.1 Photograph of Sampling Location on Engine



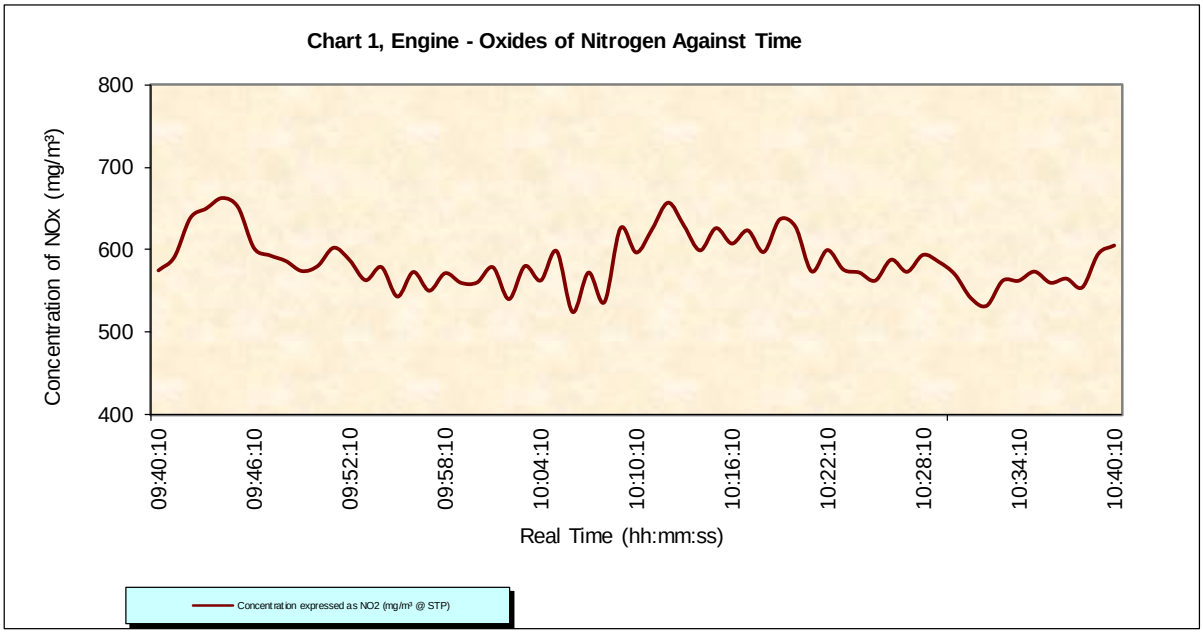
2.2.2 Homogeneity testing

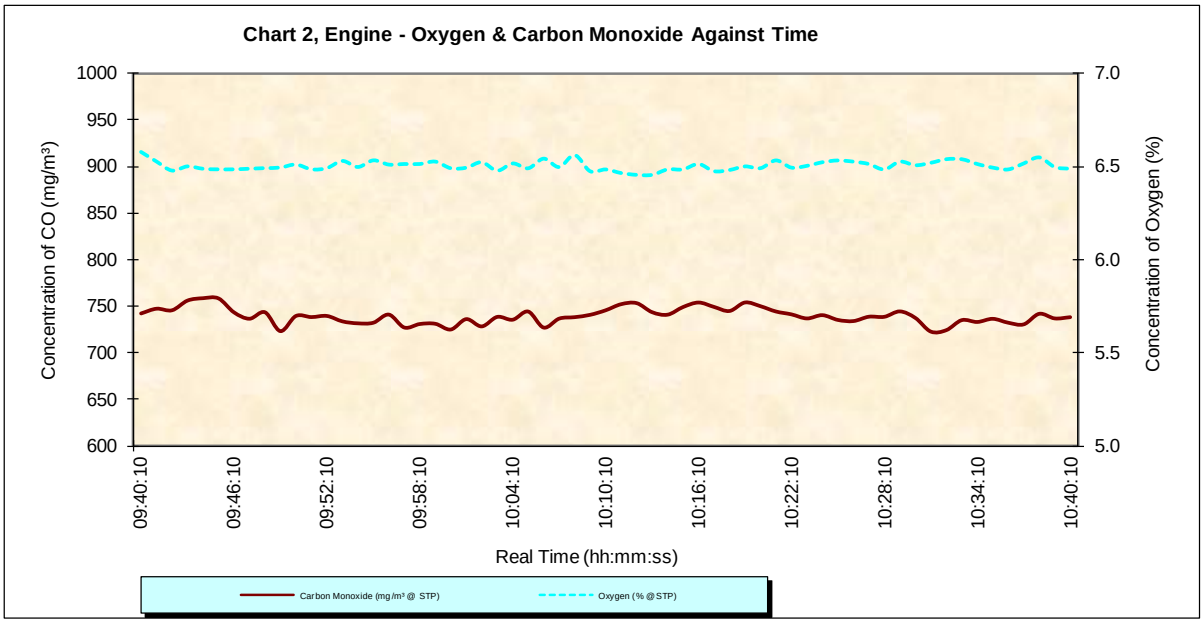
BS EN 15259 stipulates that the exhaust gases emitted from combustion processes are tested to ensure homogeneity and that a representative sample is obtained during the monitoring, subject to a number of caveats as elucidated in Environment Agency guidance MID15259. The details of the testing at each emission point are summarised below:

Stack	Result of Homogeneity Testing
Engine	N/A –homogeneity testing only required on stacks exceeding 1.13 m diameter, as specified in MID 15259. Homogeneity assumed and single point sampling acceptable

2.2.3 Gas analyser site measurements and calibrations

The data in Charts 1 - 3 and in Table 1 are expressed in mgm^{-3} @ STP and is uncorrected for O_2. In addition, VOC results are expressed as carbon equivalent. This data was subsequently converted to reference oxygen concentrations (Section 1.2) with the addition of moisture correction for VOCs. Analyser calibration data is shown in Table 2.


Chart 1, Engine - Oxides of Nitrogen Against Time
Concentration of NOx (mg/m³)
800
700
600
500
400
09:40:10
09:46:10
09:52:10
09:58:10
10:04:10
10:10:10
10:16:10
10:22:10
10:28:10
10:34:10
10:40:10
Real Time (hh:mm:ss)
Concentration expressed as NO2 (mg/m³ @ STP)


Chart 2, Engine - Oxygen & Carbon Monoxide Against Time
Concentration of CO (mg/m³)
1000
950
900
850
800
750
700
650
600
Concentration of Oxygen (%)
7.0
6.5
6.0
5.5
5.0
09:40:10
09:46:10
09:52:10
09:58:10
10:04:10
10:10:10
10:16:10
10:22:10
10:28:10
10:34:10
10:40:10
Real Time (hh:mm:ss)
Carbon Monoxide (mg/m³ @ STP)
Oxygen (% @ STP)

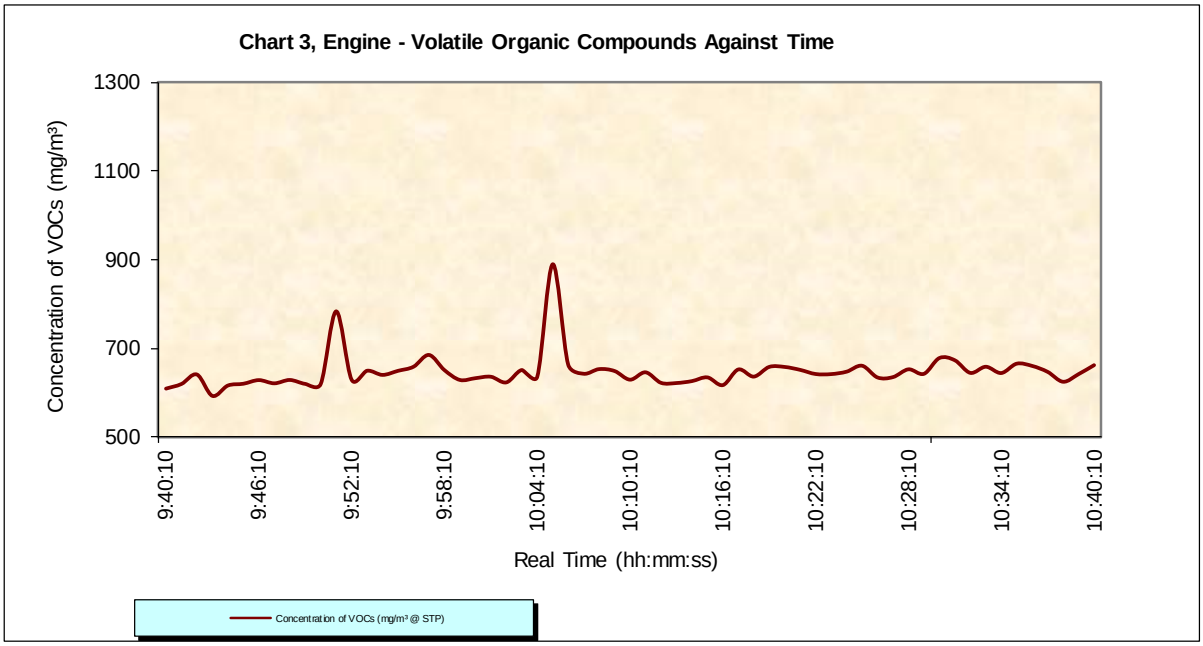


Table 1 – Engine, Raw Data

Time	Oxygen (%)	VOC (mgC/m³)	CO (mg/m³)	Nox (mg/m³)	Comment
09:40:10	6.6	608.8	741.9	574.5	
09:41:10	6.5	619.2	747.0	590.9	
09:42:10	6.5	640.4	745.3	638.1	
09:43:10	6.5	592.4	755.8	649.7	
09:44:10	6.5	615.7	758.3	662.4	
09:45:10	6.5	619.7	758.1	651.1	
09:46:10	6.5	627.9	743.1	601.5	
09:47:10	6.5	620.7	736.3	592.7	
09:48:10	6.5	628.2	743.2	585.9	
09:49:10	6.5	619.4	722.9	573.8	
09:50:10	6.5	618.9	739.2	580.0	
09:51:10	6.5	782.5	738.0	602.0	
09:52:10	6.5	628.7	739.2	587.0	
09:53:10	6.5	649.0	733.4	562.7	
09:54:10	6.5	639.6	731.3	578.6	
09:55:10	6.5	648.8	732.0	542.8	
09:56:10	6.5	658.0	740.7	572.6	
09:57:10	6.5	684.5	726.8	549.9	
09:58:10	6.5	650.4	730.6	571.2	
09:59:10	6.5	628.2	730.8	559.4	
10:00:10	6.5	632.3	724.7	559.9	
10:01:10	6.5	635.5	735.8	578.3	

Time	Oxygen (%)	VOC (mgC/m³)	CO (mg/m³)	Nox (mg/m³)	Comment
10:02:10	6.5	622.8	728.0	539.7	
10:03:10	6.5	650.6	738.2	579.7	
10:04:10	6.5	635.3	735.2	562.3	
10:05:10	6.5	888.4	744.0	597.9	
10:06:10	6.5	662.8	726.7	524.1	
10:07:10	6.5	642.2	736.4	571.9	
10:08:10	6.6	652.7	738.0	536.2	
10:09:10	6.5	648.3	740.5	625.6	
10:10:10	6.5	628.9	745.3	596.2	
10:11:10	6.5	645.4	751.9	624.8	
10:12:10	6.5	621.8	753.0	656.7	
10:13:10	6.5	621.3	743.3	628.6	
10:14:10	6.5	625.7	740.6	598.8	
10:15:10	6.5	634.0	748.8	625.8	
10:16:10	6.5	616.7	753.7	607.1	
10:17:10	6.5	651.9	748.9	623.1	
10:18:10	6.5	635.8	744.6	596.9	
10:19:10	6.5	657.6	753.7	636.3	
10:20:10	6.5	657.5	749.7	627.3	
10:21:10	6.5	650.9	744.0	573.4	
10:22:10	6.5	641.6	740.9	599.2	
10:23:10	6.5	641.4	736.6	575.6	
10:24:10	6.5	646.9	740.1	572.0	
10:25:10	6.5	660.2	735.0	562.2	
10:26:10	6.5	633.9	733.8	587.6	
10:27:10	6.5	634.7	738.4	572.8	
10:28:10	6.5	652.2	738.3	593.3	
10:29:10	6.5	642.1	744.1	584.8	
10:30:10	6.5	677.6	737.1	569.7	
10:31:10	6.5	672.4	722.4	541.1	
10:32:10	6.5	644.1	724.0	531.7	
10:33:10	6.5	658.0	734.8	562.0	
10:34:10	6.5	643.8	732.8	562.0	
10:35:10	6.5	664.9	736.2	573.1	
10:36:10	6.5	659.7	732.0	559.6	
10:37:10	6.5	646.4	730.2	564.6	
10:38:10	6.6	624.2	741.6	554.0	
10:39:10	6.5	641.4	736.6	594.5	
10:40:10	6.5	661.5	737.9	604.7	

Table 2 – Engine, Analyser Calibration Data

ANALYSER CALIBRATION DATA					
Pre Sampling Check					
		NO (ppm)	**CO (ppm)**	**O2 (%)**	**VOC's (ppm)**
Range		500	2000	25	1000
Zero Gas	**Cylinder No.**	VC2966221			Scrubbed Air/N10000018
Span Gas	**Cylinder No.**	VC115361	VC115361	VC77973	VC77973
	Certified Value	258.9	1236	8.78	668
Zero Check	**Value**	0.2	1	0.06	2
	Within 2% of span	YES	YES	YES	YES
Down Line Zero & Span Check					
Zero Gas	**Value**	0.3	2	0.1	1
	<2% of span	**YES**	**YES**	**YES**	**YES**
Span Gas	**Value**	258.4	1230	8.74	660
	Within 2% of span	YES	YES	YES	YES
Post Sampling Drift Check					
Zero Gas	**Value**	3.2	3	0.05	-5
	Drift (%)	1.1	0.1	0.6	0.9
	Validation	**No Correction Required**	**No Correction Required**	**No Correction Required**	**No Correction Required**
Span Gas	**Value**	257.9	1228	8.75	662
	Drift (%)	0.2	0.2	0.1	0.3
	Validation	**No Correction Required**	**No Correction Required**	**No Correction Required**	**No Correction Required**

2.3 Appendix III: Uncertainty Calculations

2.3.1 Engine, Uncertainty Calculations

NOx - Measurement performance related to stationary conditions		
Performance characteristic	**Uncertainty**	**Value of uncertainty quantity**
Standard deviation of repeatability at zero	u_{r0}	0.80
Standard deviation of repeatability at span level	u_{rs}	0.10
Lack of fit	u_{fit}	2.37
Drift	u_{0dr}	9.30
volume or pressure flow dependence	u_{spres}	0.06
atmopsheric pressure dependence	u_{apres}	1.18
ambient temperature dependence	u_{temp}	0.23
NH3 (20 mg/m3)	u_{interf}	0.14
CO2 (15%)	-	0.02
H2O (30%)	-	0.01
Error in logger voltage	-	0.50
Dependence on voltage	u_{volt}	0.03
Converter efficiency	u_{ceff}	2.71
losses in the line (leak)	u_{leak}	6.77
Uncertainty of calibration gas	u_{calib}	6.77

NOx Measurement uncertainty		Result	585.92	mg/m^3
Combined uncertainty			13.88	mg/m^3
Expanded uncertainty	k =	2	27.77	mg/m^3
Uncertainty corrected to std conds			27.77	mg.m-3 (corrected)
Expanded uncertainty	**expressed with a level of confidence of 95%**		**5.55**	**% ELV**
Expanded uncertainty	**expressed with a level of confidence of 95%**		**27.77**	**$mg.m^{-3}$ of result**

CO - Measurement performance related to stationary conditions		
Performance characteristic	**Uncertainty**	**Value of uncertainty quantity**
Standard deviation of repeatability at zero	u_{r0}	0.80
Standard deviation of repeatability at span level	u_{rs}	0.10
Lack of fit	u_{fit}	5.77
Drift	u_{0dr}	18.70
volume or pressure flow dependence	u_{spres}	0.00
atmopsheric pressure dependence	u_{apres}	2.31
ambient temperature dependence	u_{temp}	0.00
CO2 (15%)	u_{interf}	0.00
N2O (40mgm3)	-	0.00
CH4 (57mgm3)	-	0.00
H2O (1%)	-	0.00
Dependence on voltage	u_{volt}	0.03
Error in Logger reading	-	2.00
losses in the line (leak)	u_{leak}	8.54
Uncertainty of calibration gas	u_{calib}	8.54

CO Measurement uncertainty		Result	739.24	mg/m^3
Combined uncertainty			23.20	mg/m^3
Expanded uncertainty	k =	2	46.40	mg/m^3
Uncertainty corrected to std conds			46.40	mg.m-3 (corrected)
Expanded uncertainty	**expressed with a level of confidence of 95%**		**3.31**	**% ELV**
Expanded uncertainty	**expressed with a level of confidence of 95%**		**46.40**	**$mg.m^{-3}$ of result**

VOC - Measurement performance related to stationary conditions		
Performance characteristic	**Uncertainty**	**Value of uncertainty quantity**
Standard deviation of repeatability at zero	u_{r0}	0.80
Standard deviation of repeatability at span level	u_{rs}	0.10
Lack of fit	u_{fit}	3.74
Drift	u_{0dr}	13.09
volume or pressure flow dependence	u_{spres}	0.00
atmopsheric pressure dependence	u_{apres}	1.50
ambient temperature dependence	u_{temp}	0.00
NH3 (20 mg/m3)	u_{interf}	0.00
CO2 (15%)	-	0.00
H2O (30%)	-	0.00
Error on Logger voltage	-	1.00
Dependence on voltage	u_{volt}	0.03
losses in the line (leak)	u_{leak}	7.46
Uncertainty of calibration gas	u_{calib}	7.46

VOC Measurement uncertainty		Result	646.41	mg/m^3
Combined uncertainty			17.32	mg/m^3
Expanded uncertainty	k =	2	34.63	mg/m^3
Uncertainty corrected to std conds			34.63	mg.m-3 (corrected)
Expanded uncertainty	**expressed with a level of confidence of 95%**		**3.46**	**% ELV**
Expanded uncertainty	**expressed with a level of confidence of 95%**		**34.63**	**mg.m^{-3} of result**

Oxygen - Measurement performance related to stationary conditions		
Performance characteristic	**Uncertainty**	**Value of uncertainty quantity**
Standard deviation of repeatability at zero	u_{r0}	0.20
Standard deviation of repeatability at span level	u_{rs}	0.03
Lack of fit	u_{fit}	0.08
Drift	u_{0dr}	0.10
volume or pressure flow dependence	u_{spres}	0.00
atmopsheric pressure dependence	u_{apres}	0.01
ambient temperature dependence	u_{temp}	0.03
CO2 (15%)	-	0.00
NO(300)	-	0.06
NO2(30)	-	0.00
dependence on voltage	u_{volt}	0.02
losses in the line (leak)	u_{leak}	0.08
Error in Logger voltage	-	0.03
Uncertainty of calibration gas	u_{calib}	0.08

O2 Measurement uncertainty		Result	6.51	%vol
Combined uncertainty			0.18	%vol
% of value			2.83	%
Expanded uncertainty	**expressed with a level of confidence of 95%**		**5.67**	**% of value**
Expanded uncertainty	**expressed with a level of confidence of 95%**		**0.37**	**% vol**

2.4 Appendix IV: Moisture Calculations

2.4.1 Engine, Moisture Calculation

Test No	T1		Site	FCC	
Date	15-10-19			Brookhill	
pbar (mbar)	982		Stack	Engine	
pbar (mnHg)	737		Job Number:	R19304	
Nozzle Diameter (mm)	n/a		Site Team:	DL	
Temp of Meter (in)/(out) deg. C	17		Data Entered By:		DL
ΔH_{ave} (mmH_2O)	10.0				
DGM Cal Factor (Y)	1.0328		Enter Data into coloured cells only		

Start Volume Reading	347.2420	m^3	Start time	09:40	hr:min
End Volume Reading	347.7742	m^3	End time	10:40	hr:min
Volume Sampled	0.5497	m^3	Total time	01:00	hr:min

IMPINGER	1	2	3	4	Initials of Analyst
Absorber Solution (Type):	H2O	H2O	KO IMP	SILICA	
Sample No:	n/a	n/a	n/a	n/a	
Analysis Required:	n/a	n/a	n/a	n/a	
Initial Weight of Impingers plus absorber (g)	958.2	878.4	625.4	912.1	DL
Final Weight of Impingers plus absorber (g)	1002.4	880.0	625.9	917.0	DL
Weight Gain (g)	44.2	1.6	0.5	4.9	

Total Weight Gain (1+2+3+4) (g)	51.2

Gas Volume of water at 0 °C (l)	63.74
Gas Meter volume at 0 °C (l)	502.10

Moisture content of Gases (%)	11.3

EnviroDat Limited, Cutbush Commercial
Cutbush Lane East, Reading, RG2 9AF

4251

ANALYSIS OF THE TRACE LANDFILL GAS

AT

Brookhill Landfill Site

Brookhill Way
Pinfold Industrial Estate
Buckley, Flintshire
CH7 3PL

Commissioned by: Paul Murphy

Of

Flintshire County Council

Waste Management Service
Alltami Depot
Mold Road - Alltami, Flintshire
CH7 6LG

Date of Survey:	15th October 2019
Compiled By:	David Littlewood *Operations Manager*

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CH7 6LG

Date of Survey:	15th October 2019
Compiled By:	David Littlewood *Operations Manager* MCerts Level II (TE1, 2, 3 & 4)
Signed:	
Dated:	19th November 2019

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1. INTRODUCTION

2. PLANT DESCRIPTION

3. SAMPLING PROCEDURES

4. RESULTS

APPENDICES:

APPENDIX A: Site Information & Preliminary Gas Measurements
APPENDIX B: Trace Gas Results
APPENDIX C: Trace Gas Chart
APPENDIX D: Siloxane Results

Notes to Report.
a). EnviroDat Ltd, Report Template V10.
b). This report should not be reproduced except in full, without written approval of Envirodat Ltd.
c). Opinions and Interpretations herein are outside the scope of UKAS/MCerts Accreditation.

1. INTRODUCTION

1.1 EnviroDat Limited was commissioned by Paul Murphy, on behalf of Flintshire County Council, to measure the trace gas and siloxane components from landfill gas located at Brookhill Landfill Site. Sampling was performed on the 15th October 2019.

1.2 The sampling was conducted in response to permit requirements (Permit No. BV7273/ YP3835MJ). Monitoring was conducted with reference to the Environment Agency document 'Guidance for Monitoring Trace Components in Landfill Gas' (LFTGN 04).

2. PLANT DESCRIPTION

2.1 Landfill gas is currently utilised by the engine plant. Samples of the fuel gas were taken from a feed system for trace gas analysis after the gas booster on the inlet to the engine.

3. SAMPLING PROCEDURES

3.1 Trace gas sampling was performed from the fuel gas inlet, with analysis for components identified in Table 1.1 of the EA LFTGN04 guidance note. General site information is presented in Appendix A.

3.2 Mixed bed, automated thermal desorption (ATD) tubes were used for sampling of the priority volatile organic species prior to analysis by gas chromatography with mass spectrometry (GC/MS), in accordance with EA recommendations and documented EnviroDat protocol, SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at Marchwood Scientific Services (MSS) Ltd.

3.3 The LFTGN04 designated 'priority' carbonyl components (i.e. methanal and ethanal) were sampled onto dinitrophenylhydrazine (DNPH) impregnated, silica gel sorbent tubes prior to analysis by high performance liquid chromatography (HPLC) incorporating an ultraviolet (UV) detection system, in accordance with EA recommendations and SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at MSS.

3.4 Arsenic was sampled onto an activated charcoal sorbent tube prior to analysis by inductively coupled plasma/mass spectrometry (ICP/MS), in accordance with EA recommendations and SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at MSS.

3.5 Hydrogen sulphide was sampled into a Tedlar bag with analysis by GC/TCD/FID (by MSS) in accordance with SPTGN04. The results are presented in Appendix B.

3.6 Siloxanes sampling was affected using EnviroDat Ltd. documented internal protocol SP SILOX. This involves passing a metered volume of the gas through solid sorbent material whereby the siloxane congeners are captured and concentrated to allow analysis by gas chromatography utilising mass spectrometric detection (GC/MS). The analysis was carried out at MSS and is UKAS accredited for sampling and analysis.

4. RESULTS

4.1 Preliminary measurements of the ‘bulk gases’ are given in Appendix A.

4.2 Measured concentrations of the EA ‘priority’ trace components for the landfill gas are given in Appendix B and shown graphically in Appendix C.

4.3 Measured concentrations of the siloxane components for the landfill gas are given in Appendix D.

APPENDIX A

Site Information & Preliminary Gas Measurements

TABLE A: Site Information & Preliminary Gas Measurements

Sample Position Details			
Date	15/10/19	**Site**	FCC Brookhill
Ambient Temperature	15°C	**Atmospheric Pressure**	983mbar
Monitoring Organisation (s)	EnviroDat Ltd	**Analytical Laboratory**	Marchwood Scientific Services Ltd
Location of Sampling Point	Inlet Line to Utilisation Plant	**Area of Influence of collection system sampled**	All capped areas of the site
Type of Sampling Point	Nipple & Tap	**Temperature of gas**	13°C, at sample flow meter
Vacuum on Sampling	None, Positive pressure	**Type of waste**	Domestic, Industrial, Commercial & Hazardous
		Age of Waste	-
Status of Gas System	Fully Operational, Steady State	**Other**	-

Parameter	Concentration	Units	Comments
Methane*	53.6	%	-
Carbon Dioxide*	37.5	%	-
Oxygen*	0.7	%	-
Nitrogen	8.2	%	Assumed to be balance of gas
Hydrogen Sulphide	-	ppmv	See Appendix B
Carbon Monoxide	-	ppmv	Not required

Notes: *Raw result obtained from client analyser

APPENDIX B

Trace Gas Results

TABLE B: Trace Gas Results

Trace Gases							
	Test Duration	Flow Rate	Flowmeter	Volume	Ambient T	Barometric P	Volume
	(min)	(ml/min)	CAL Factor	(l as sampled)	(^{o}C)	(kPa)	(l @ STP)
Arsenic	60	200	0.999	**11.99**	15	98.3	**11.02**
Aldehydes	20	200	0.999	**4.00**	15	98.3	**3.67**
VOC	6	50	0.9922	**0.30**	15	98.3	**0.27**

Compound	Mass of TG (ng)	LoD of TG (ng)	Concentration		Units	Analysis Notes (See below)	Analysis UKAS Acredited (Y/N)
Arsenic (as As)		100	<	**9**	µg/m^3	-	N
Acetaldehyde (Ethanal)	200	100		**54**	µg/m^3	-	Y
Formaldehyde (Methanal)	100	100		**27**	µg/m^3	-	Y
Vinyl chloride	290	10		**1059**	µg/m^3	-	N
1,3-butadiene		10	<	**37**	µg/m^3	-	N
Methanethiol		50	<	**183**	µg/m^3	-	N
Chloroethane		10	<	**37**	µg/m^3	-	N
1-pentene	110	20		**402**	µg/m^3	-	N
1,4-epoxy-1,3-butadiene (Furan)	160	10		**585**	µg/m^3	-	N
Ethanethiol		50	<	**183**	µg/m^3	-	N
1,1-dichloroethene		5	<	**18**	µg/m^3	-	N
Dimethyl sulphide	17	10		**62**	µg/m^3	-	N
Dichloromethane	230	10		**840**	µg/m^3	-	N
Carbon disulphide	780	10		**2849**	µg/m^3	-	N
1,2-dichloroethene (trans + cis)	185	10		**676**	µg/m^3	-	N
1,1-dichloroethane		5	<	**18**	µg/m^3	-	N
Propanethiol		40	<	**146**	µg/m^3	-	N
1,2-dichloroethane	8	5		**29**	µg/m^3	-	N
Carbon tetrachloride		5	<	**18**	µg/m^3	-	N
Benzene	2800	1		**10229**	µg/m^3	**c**	N
Trichloroethylene	51	5		**186**	µg/m^3	-	N
Butanethiol		40	<	**146**	µg/m^3	-	N
Dimethyl disulphide		10	<	**37**	µg/m^3	-	N
Toluene	4700	5		**17170**	µg/m^3	**b**	N
Butyric acid		10	<	**37**	µg/m^3	-	N
Ethyl butyrate		10	<	**37**	µg/m^3	-	N
2-Butoxyethanol		10	<	**37**	µg/m^3	-	N
Styrene	260	5		**950**	µg/m^3	-	N

Compound	Concentration of H_2S (%)	LoD of H_2S (%)	Concentration	Units	Analysis Notes (See below)	Analysis UKAS Acredited (Y/N)
Hydrogen sulphide	0.003	0.001	**45641**	µg/m^3	-	N

*H2S value is equivalent to 30ppm

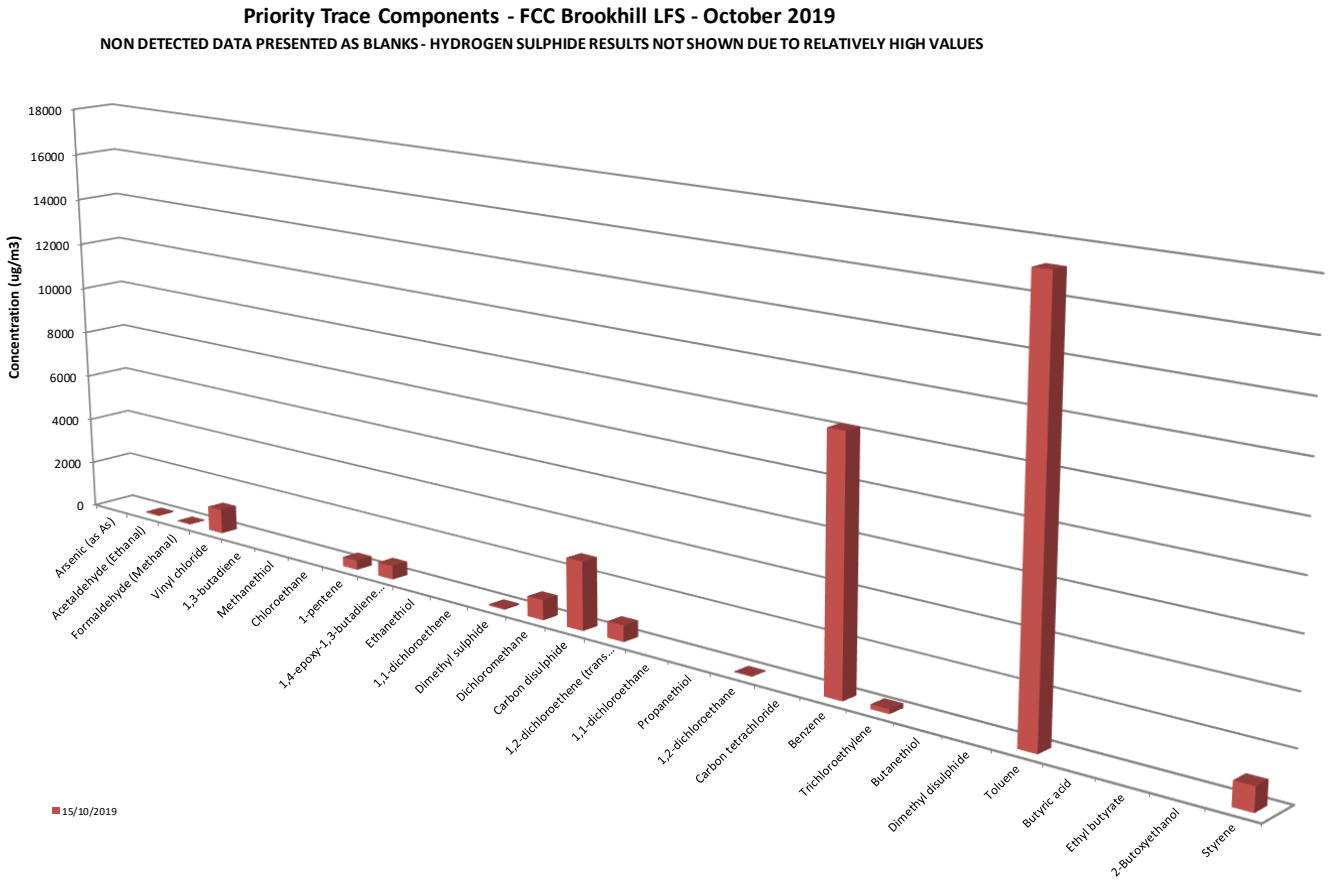
(a) – Results have been blank corrected
(b) – Results should be considered a minimum due to detector saturation
(c) – Results should be viewed with caution due to being outside of the instrument calibration range

Reference to UKAS (final column) relates to the accreditation status of the analysis only, sampling is covered under EnviroDat Accreditation scope.

APPENDIX C

Trace Gas Chart

TABLE C: Trace Gas Chart



APPENDIX D

Siloxane Results

TABLE D(i): Siloxane Results

Test No	**T1**
Date	**15/10/2019**
Site	**Brookhill LFS**
Stack	**Fuel Gas Line**
Reference Conditions - Oxygen (%)	**n/a**
- Temperature (^{o}C)	**0**
- Pressure (kPa)	**101.3**
Job Number	**R19304**
Site Team	**DL**
Test Conducted By	**DL**
Data Entered By	**DL**

Test Start Time	10:18
Test End Time	10:38
Test Duration (min)	**20**
Flowmeter Rate at Start (ml/min)	200
Flowmeter Rate at End (ml/min)	200
Mean Flowmeter Rate (ml/min)	**200**
Uncorrected Volume Sampled (l)	**4.00**

Barometric Pressure (kPa)	98.4
Ambient Temperature (^{o}C)	16
Flowmeter Calibration Factor (f)	0.999
Stack Oxygen Level (%)	n/a
Volume Sampled @ Reference Conditions	**3.67**

Primary Tube Reference Identification Number	7898716878
Security Tube Reference Identification Number	7898716050
Blank Tube Reference Identification Numbers	7898716047/7898716051
Mass of Siloxane on Primary Tube (ug)	649.3
Mass of Siloxane on Security Tube (ug)	5
Breakthrough (Reject if > 5%)	Accepted
Total Mass of Siloxane in Sample (ug)	**654.3**

Siloxane Concentration (mg/m^3 @ STP and Ref O_2)	**178.49**

TABLE D(ii): Siloxane/Silicon Congener Breakdown

Siloxane	Siloxane Concentration (mg/m^3 @ STP)	Organic Silicon Concentration (mg/m^3 @ STP)
Decamethylcyclopentasiloxane	98.34	37.27
Decamethyltetrasiloxane	< 0.27	< 0.10
Hexamethylcyclotrisiloxane	1.50	0.57
Hexamethyldisiloxane	5.16	1.78
Octamethylcyclotetrasiloxane	71.06	26.93
Octamethyltrisiloxane	0.74	0.26
Dodecamethylcyclohexasiloxane	1.15	0.43
Dodecamethylpentasiloxane	< 0.27	< 0.10
Total Siloxane Concentration:	**178.49**	
	Total Silicon Concentration:	**67.44**

CAULMERT LIMITED

Engineering, Environmental & Planning
Consultancy Services

Brookhill Landfill Site

Flintshire County Council Waste Management Services

Surface Emissions Monitoring Survey

September 2019

Prepared by:

Caulmert Limited
InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672666
Fax: 01248 672601
Email: seanobrien@caulmert.com
Web: www.caulmert.com

Doc ref: 3898-CAU-XX-XX-RP-V-0304.S3-P1

September 2019

Caulmert
Engineering, Environmental and Planning

APPROVAL RECORD

Site: **Brookhill Landfill Site**

Client: **Flintshire County Council Waste Management Services**

Document Title: **Surface Emissions Monitoring Survey**

Document Ref: **3898-CAU-XX-XX-RP-V-0304**

Report Status: **Draft**

Project Manager: **Diana Brookshaw**

Caulmert Limited: **Intec, Parc Menai, Bangor, Gwynedd, LL57 4FG**

Tel: **01248 672666**

Author	Sean O'Brien	**Date**	15/08/2019
Reviewer	Diana Brookshaw	**Date**	03/09/2019
Approved	Diana Brookshaw	**Date**	03/09/2019

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BROOKHILL LANDFILL SITE
SURFACE EMISSIONS MONITORING REPORT

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3.0 RESULTS 3

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APPENDICES

Appendix 1: Drawing: 3898-CAU-XX-XX-DR-V-1801 P01.01
Appendix 2: FID Calibration Certificate
Appendix 3: Photographic Log

1.0 INTRODUCTION

1.0.1 Caulmert Ltd was appointed by Flintshire County Council Waste Management Services (Flintshire CC) to carry out a surface emissions monitoring survey, comprising a Flame Ionisation Detector (FID) walkover at Brookhill Landfill Site in Buckley, Flintshire.

1.0.2 The survey was undertaken on the 13th of August 2019 and covered the entirety of the site, as shown in the drawing in Appendix 1.

1.0.3 This report presents the findings of the survey and recommends remediation where required.

2.0 METHODOLOGY

2.0.1 The survey was undertaken in accordance with Environment Agency Technical Guidance Note LFTGN07 'Guidance on monitoring landfill gas surface emissions' 2010.

2.0.2 An FID walkover survey was carried out across the permanently-capped Site following a 50 m grid. Where methane was detected, the line was altered slightly to locate the source. The sampling probe was kept within the recommended 5 cm of the cap surface.

2.0.3 Landfill infrastructure features were assessed on an individual basis, including:

- interfaces between capped zones;
- gas wells and monitoring points;
- junctions in gas collection pipework;
- pathways where pipework may be buried in trenches; and
- leachate sumps, towers risers and other monitoring points.

2.0.4 A Crowcon Gas-Tec FID was used for the walkover survey. A calibration certificate for the unit is enclosed in Appendix 2.

2.0.5 Flux box monitoring was undertaken across all Cells in 2017 and since no change to the capping has been made in the interim, did not require monitoring in 2019. As stated in LFTGN07 and the environmental permit, when an area has demonstrated that it is within compliance of the emission standards via a flux box survey, monitoring by a walkover survey alone in the following 4 years is sufficient to verify its continued compliance unless there is a change to the cap. If the cap is altered during this period, a new flux box survey will be required to confirm the effectiveness of the changes.

3.0 RESULTS

3.0.1 Brookhill Landfill is permanently capped with established vegetation and has landfill gas and leachate extraction infrastructure. Solar panel installations are situated across the top and southern facing flank of the landfill.

3.0.2 An FID walkover survey was undertaken on the 13th of August. The gas extraction engine was operational during the time the walkover survey occurred.

3.0.3 Table 3.1 below summarizes the weather conditions from the nearby Hawarden Weather Station. Additionally, on site observations were made to monitor changes in temperature, wind speed and precipitation to ensure monitoring was conducted in suitable conditions.

Table 3.1: Meteorological Summary

Date	TIME	Barometric pressure (average hPa)	Wind Speed (average km/hr)	Temperature (average ˚C)	Precipitation (average mm)
13/08/2018	09:00	1016.0	9	15	0
	10:00	1016.0	13	16	0
	11:00	1015.9	15	17	0
	12:00	1015.9	13	16	0

3.0.4 Weather conditions on the 13th of August were relatively cool but sunny, with clear skies and a light westerly breeze. No persistent or heavy rain was experienced during the monitoring period and the ground conditions remained dry.

3.0.5 Table 3.2 below details 5 Point Source Emissions (PSEs) detected during the FID walkover survey with references for the corresponding Photographic Log (Appendix 3). The location of each PSE is displayed on drawing 3898-CAU-XX-XX-DR-V-0300 in Appendix 1.

Table 3.2: Summary of PSEs

PSE	ID/Location	Methane Concentration (ppm)	Source of Emission	Photo No.
1	LC1	>10,000	Well head and base of concrete chamber	1
2	R3	200	Well head	-
3	LC3	>10,000	Well head	3
4	GV3.1	40	Top pipe joint	4
5	GV18	1000	Ambient inside concrete chamber	-

3.0.6 The highest methane emissions detected were at the maximum limit of the FID (10,000 ppm) at LC1 and LC3.

3.0.7 Concentrations were low (<100ppm) at GV3.1, and moderate at R3. These emissions were potentially due to loose fittings or perished seals on the well head connections. The concentration detected at GV18 was ambient inside the concrete chamber and a specific fault could not be identified.

3.0.8 All of the detected emissions were from marked leachate or gas extraction wells, with no emissions detected from surface locations. No vegetation die-back was observed on the site.

3.0.9 Two features were identified that did not produce any detectable emissions, but had the potential too. The rubber well head boot on LC4B was dry rotting (Appendix 3, Photo 2) and a small area of capping material had been eroded or displaced by wildlife to expose the plastic capping liner (Appendix 3, Photo 5).

4.0 RECOMMENDATIONS

4.0.1 It is recommended that the well headworks be serviced at all PSEs identified at specific wells, or within the chambers these wells are housed in. Fixtures such as pump connections, monitoring points, clamps, valves and the main head works seal should be serviced to improve the seal on these wells.

4.0.2 Two features were identified that would benefit from remediation, though no emissions were detected. The rubber well head boot on LC4B was also noted to be dry rotting (Appendix 3, Photo 2) and should be replaced before it cracks to prevent future emissions from this location. A small area of capping material had been eroded or displaced by wildlife to expose the plastic capping liner (Appendix 3, Photo 5). This should be covered with a suitable fill material to prevent damage to the plastic.

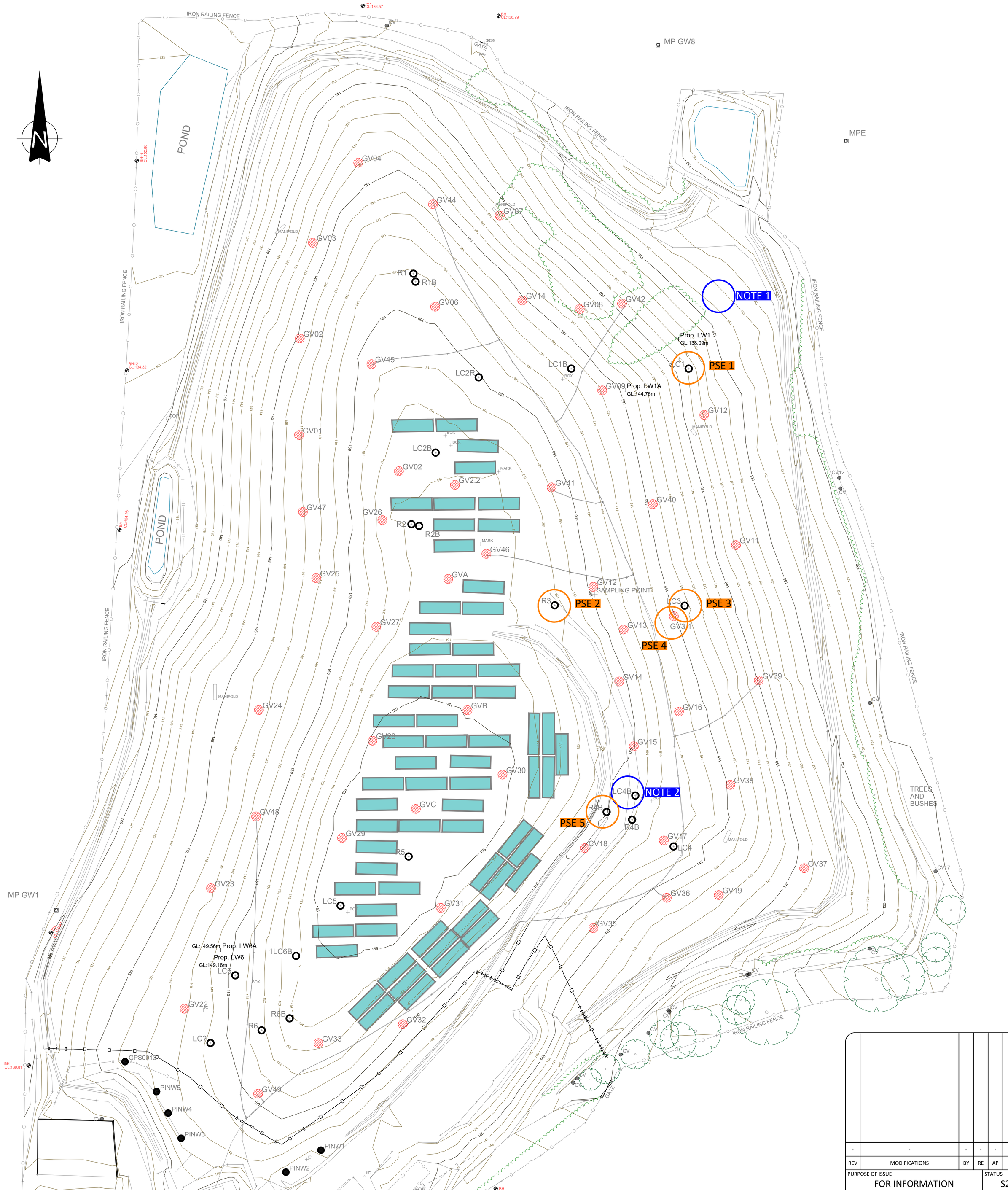
4.0.3 Dense vegetation prevented access to LC1B, GV01, GV02, GV08, GV09 and GV32 during this visit. It is recommended that access to these is improved and all seals and fittings serviced to reduce the likelihood of point source emissions at these locations.

4.0.4 Overall, fewer point source emissions were detected during this survey (5) than during the previous surface emissions monitoring survey in 2018, where 13 emissions were recorded.

4.0.5 Of the 5 emissions recorded in this survey, two were recorded at the maximum level of detection. This is low compared to the 14 PSEs which were recorded at the maximum limit in the 2017 survey. No emissions were detected at the maximum level during 2018, however. Overall, it is considered that the emissions detected during this visit show that repairs of previously-identified sources are timely and effective, resulting in a continued trend of decreased fugitive emissions of landfill gas from the site.

4.0.6 Following remediation of the point source emissions outlined above, it is considered that the surveyed areas of the site are compliant with the emission standards in LFTGN07.

Appendix 1



PSE	ID/Location	Methane Concentration (ppm)	Source of Emission	Photo No.
1	LC1	>10,000	Well head and base of concrete chamber	1
2	R3	200	Well head	-
3	LC3	>10,000	Well head	3
4	GV3.1	40	Top pipe joint	4
5	GV18	1000	Ambient inside concrete chamber	-
Note 1	-	-	exposed plastic cap liner	5
Note 2	LC4B	-	Cracking well head rubber	2

REV	MODIFICATIONS	BY	RE	AP	DATE
-	-	-	-	-	-

PURPOSE OF ISSUE: FOR INFORMATION
STATUS: S2

CLIENT: CYNGOR Sir y Fflint Flintshire COUNTY COUNCIL

PROJECT: BROOKHILL LANDFILL

TITLE: BROOKHILL FID WALKOVER SURVEY

DESIGNED BY	DRAWN BY	REVIEWED BY	AUTHORISED BY
SO	EJD	SO	SO

DATE	SCALE @ A1	JOB REF:	REVISION
28.08.2019	1:1000	3898	P01

DRAWING NUMBER: 3898-CAU-XX-XX-DR-V-1801

Caulmert engineering environmental planning

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Appendix 2

Gas & Environmental Services Ltd

Units 1 & 3, Little Ridge Industrial Estate
Welwyn Garden City
Herts, AL7 2BH
Telephone: 01707 373751 Fax: 01707 373752
E-mail: info@gesuk.com Website: www.gesuk.com

British Gas approved test house ~
Repair and maintenance of electronic equipment

Certificate of Test and Calibration

Calibration date 29th July 2019

Instrument details Gastec Mk 5

Serial number GESGT5160001

Customer **Gas & Environmental Services Ltd (Hire Instrument)**

The above instrument has been serviced in accordance with the manufacturers and British Gas recommended procedures for recalibration and checking of Gastec gas detectors.

The instrument was calibrated using gas standards that are traceable to national standards.

The instrument meets the requirements of British Gas standards, provided it is used and maintained in accordance with the manufacturers instructions

Recalibration is recommended to be carried out at six months from the date on this certificate.

Methane Gas Standard	Range	Readings	Cylinder number
80 ppm	One	78ppm	APE1108548
80 ppm	Two	77ppm	APE1108548
500 ppm	Two	472ppm	618167
800 ppm	Two	796ppm	CTC08346501
80 ppm	Three	77ppm	APE1108548
500 ppm	Three	481ppm	618167
800 ppm	Three	805ppm	CTC08346501
8000 ppm	Three	8032ppm	APL1015250

Certified By:

Terry Evans
Gas & Environmental Services Ltd

Appendix 3

PHOTOGRAPHIC LOG

Photo No.	PSE No	ID	Description
1	1	LC1	Well head and base of concrete chamber
2	-	LC4B	**Note 1:** Cracking rubber boot
3	3	LC3	Well head
4	4	GV3.1	Joint in pipework
5	-	-	**Note 2:** exposed capping plastic



Photo 1



Photo 2



Photo 3



Photo 4



Photo 5

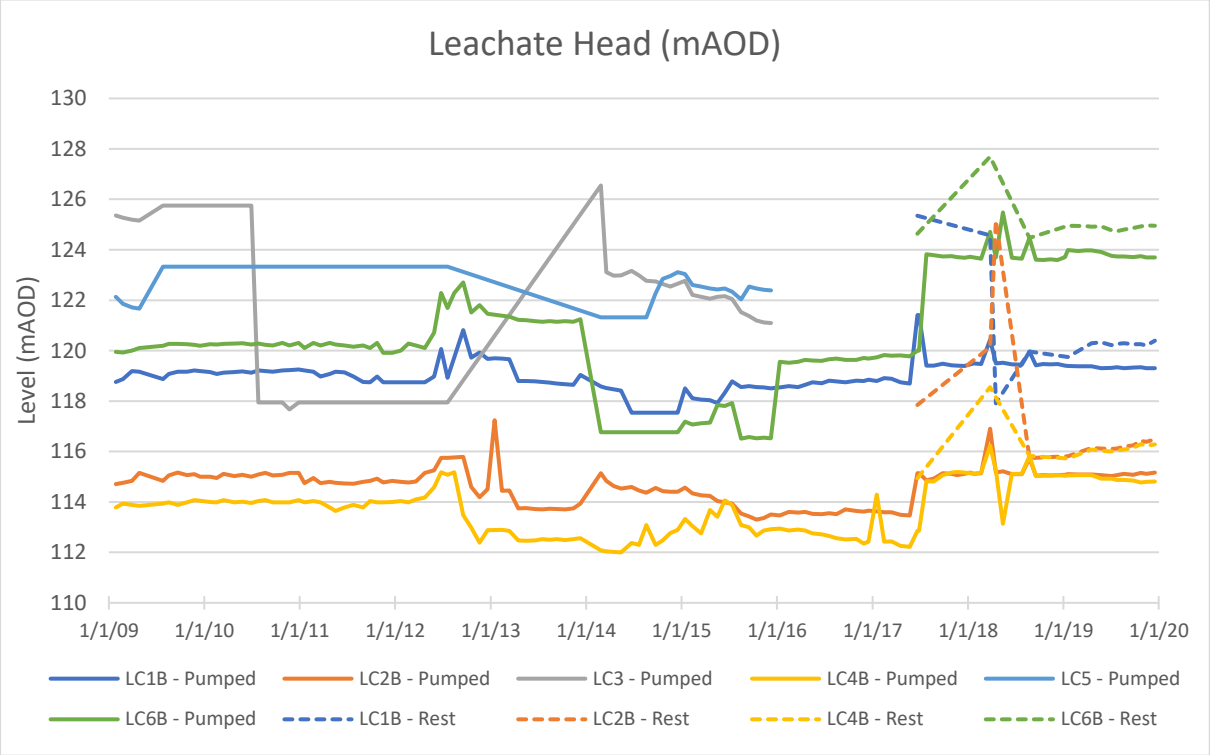


Registered Office:
InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672671
Fax: 01248 672601
Email: contact@caulmert.com
Web: www.caulmert.com

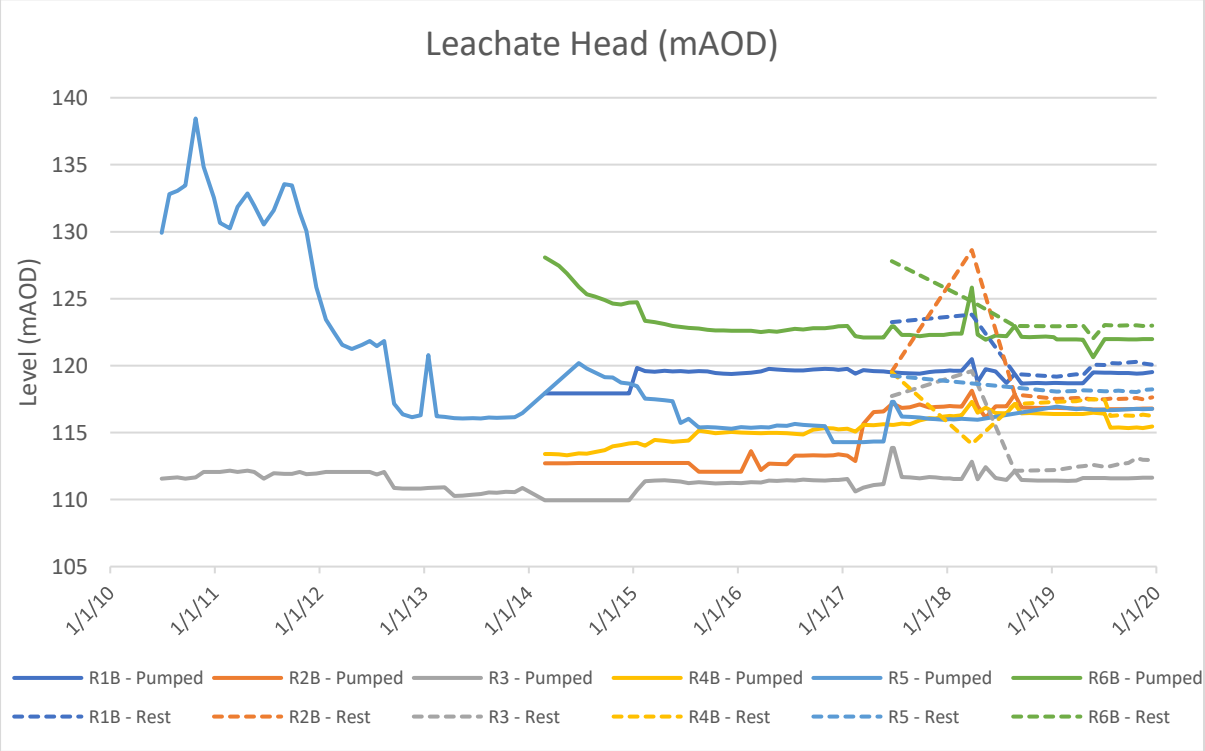
APPENDIX 2

Leachate Level and Quality Summary Tables and Time-Series Graphs

APPENDIX 2 - LEACHATE

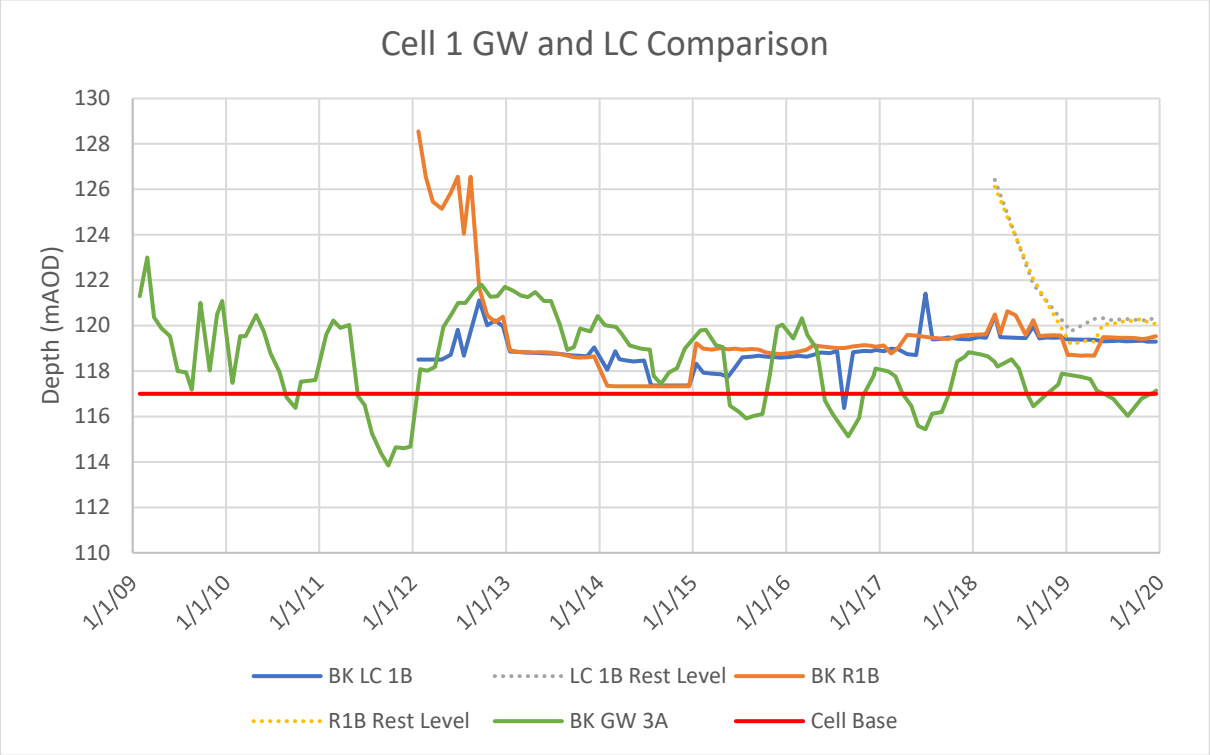


Graph 1: Leachate Levels as mAOD at LC Series Wells

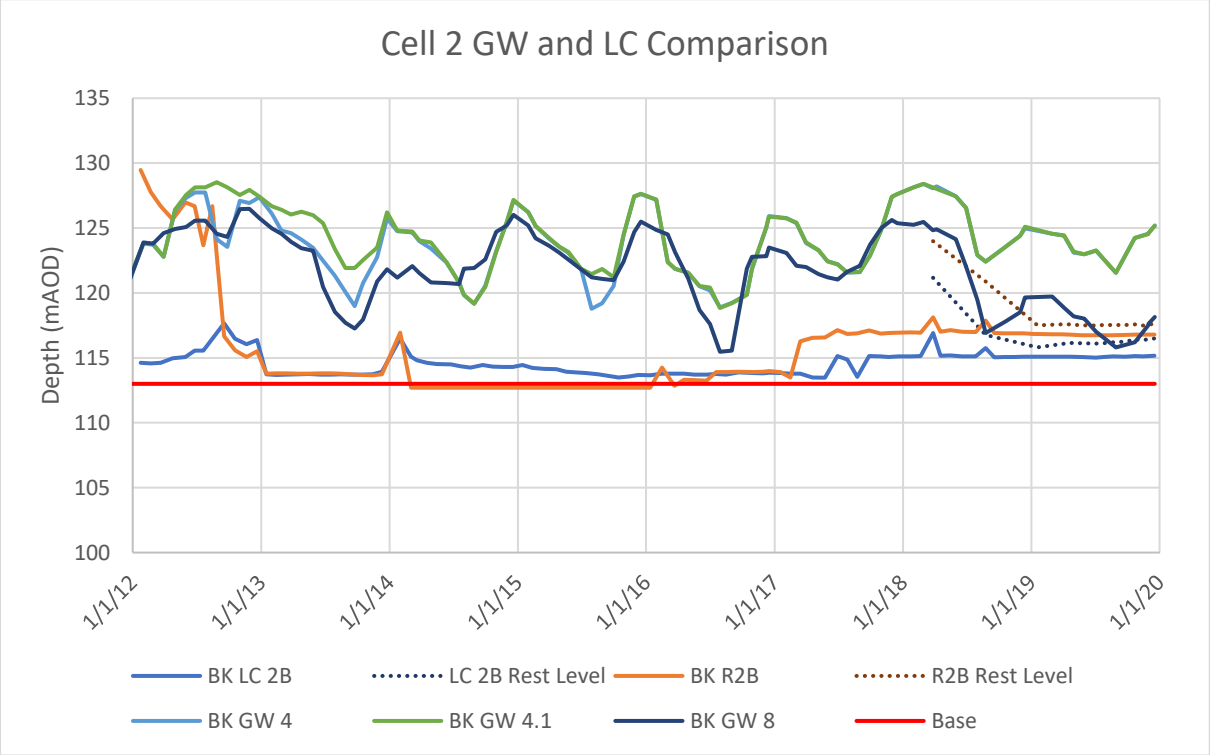


Graph 2: Leachate Levels as mAOD at Remote Leachate Monitoring Points

APPENDIX 2 - LEACHATE

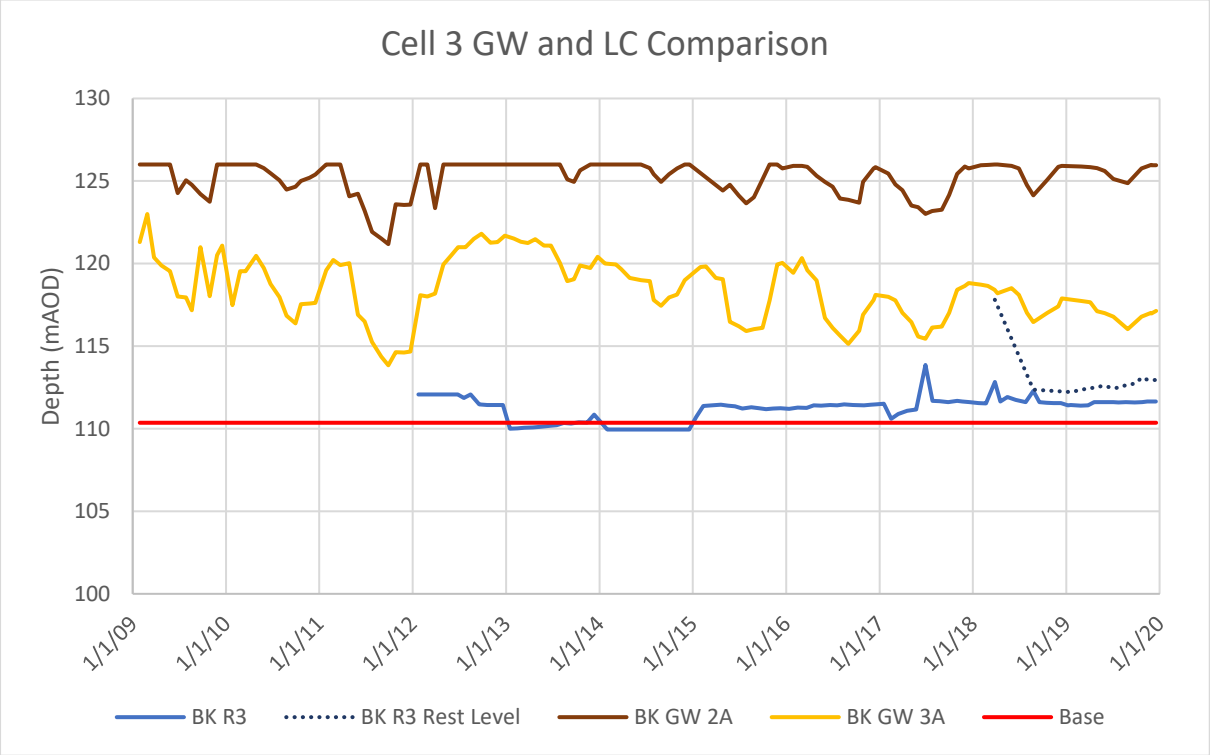


Graph 3: Groundwater and Leachate level comparison in Cell 1

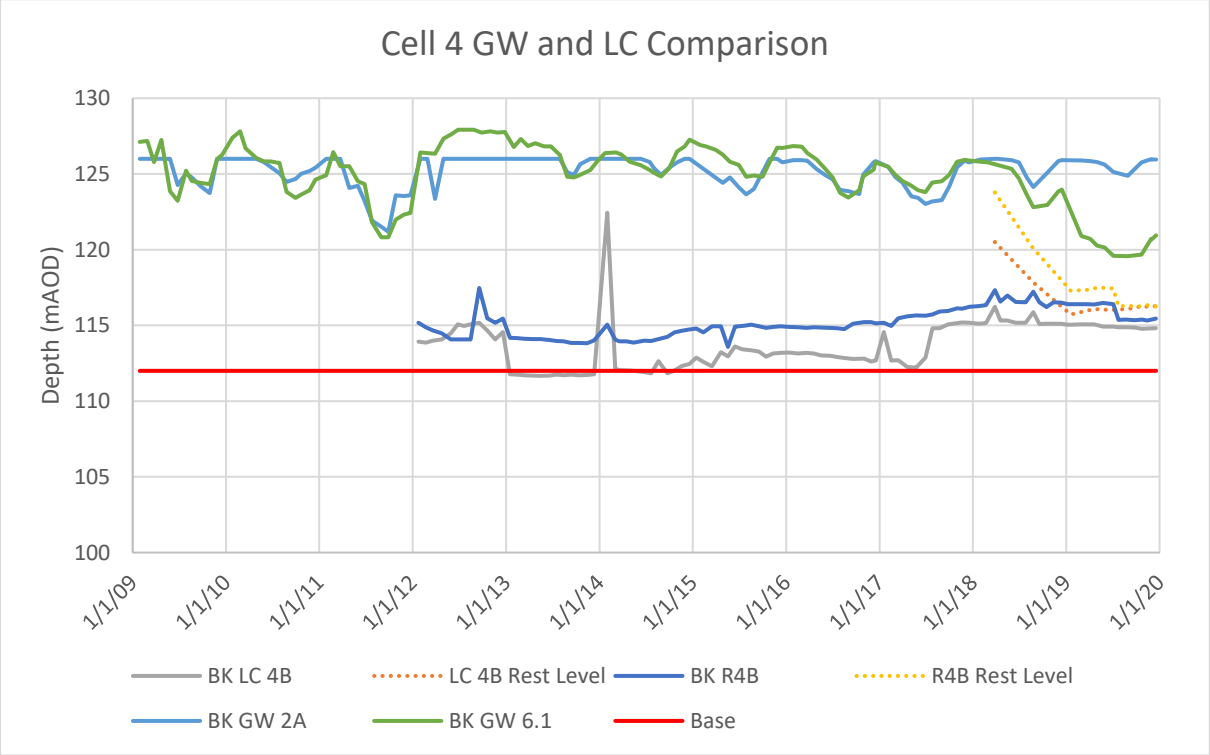


Graph 4: Groundwater and Leachate level comparison in Cell 2

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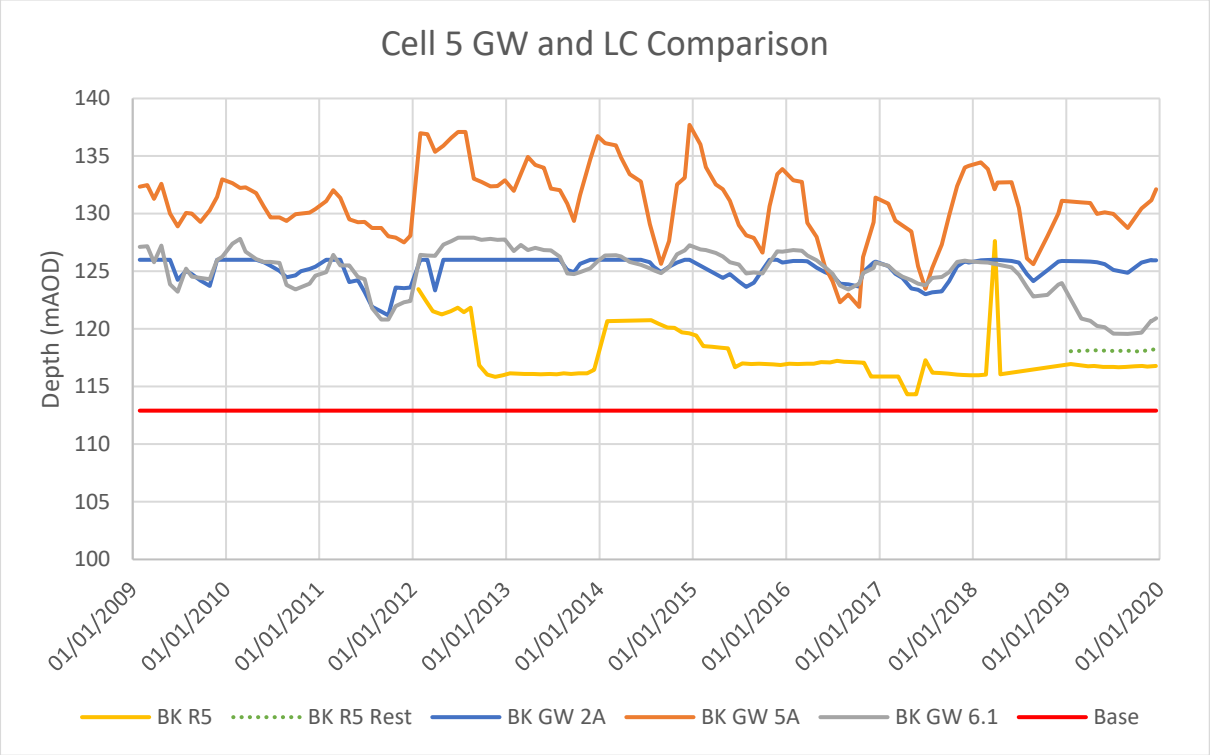


Graph 5: Groundwater and Leachate level comparison in Cell 3

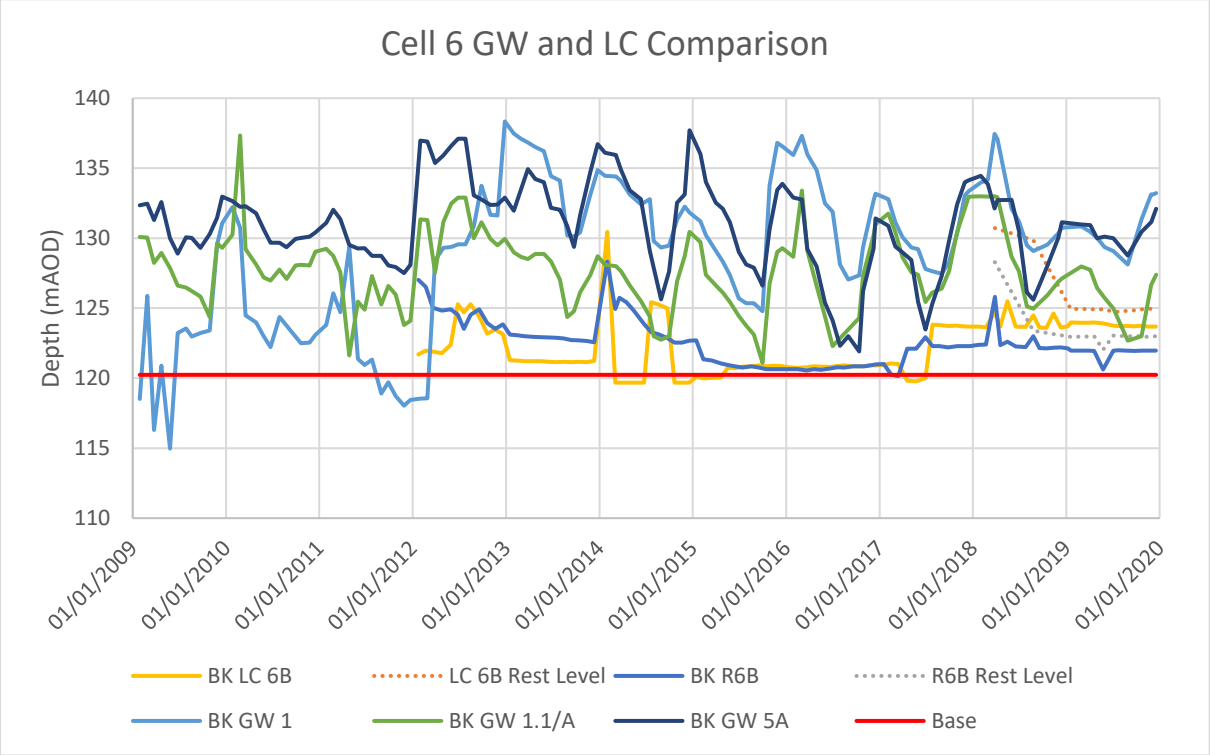


Graph 6: Groundwater and Leachate level comparison in Cell 4

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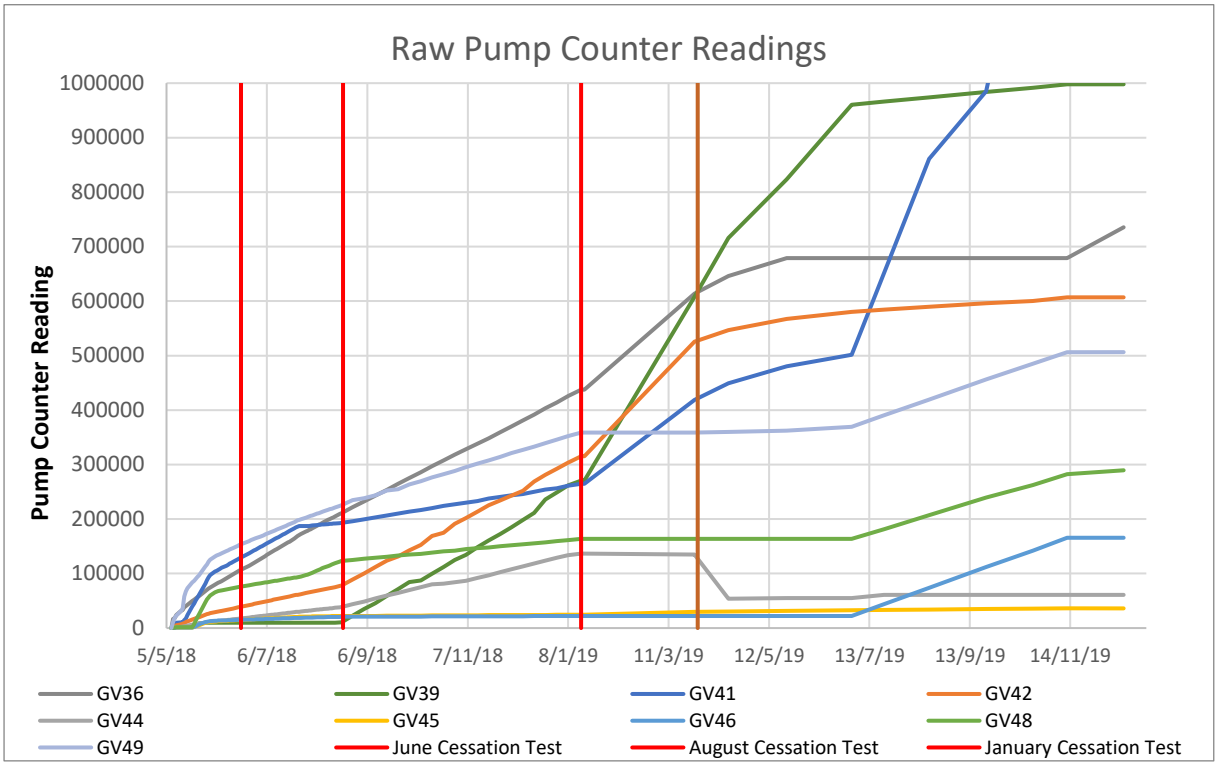


Graph 7: Groundwater and Leachate level comparison in Cell 5

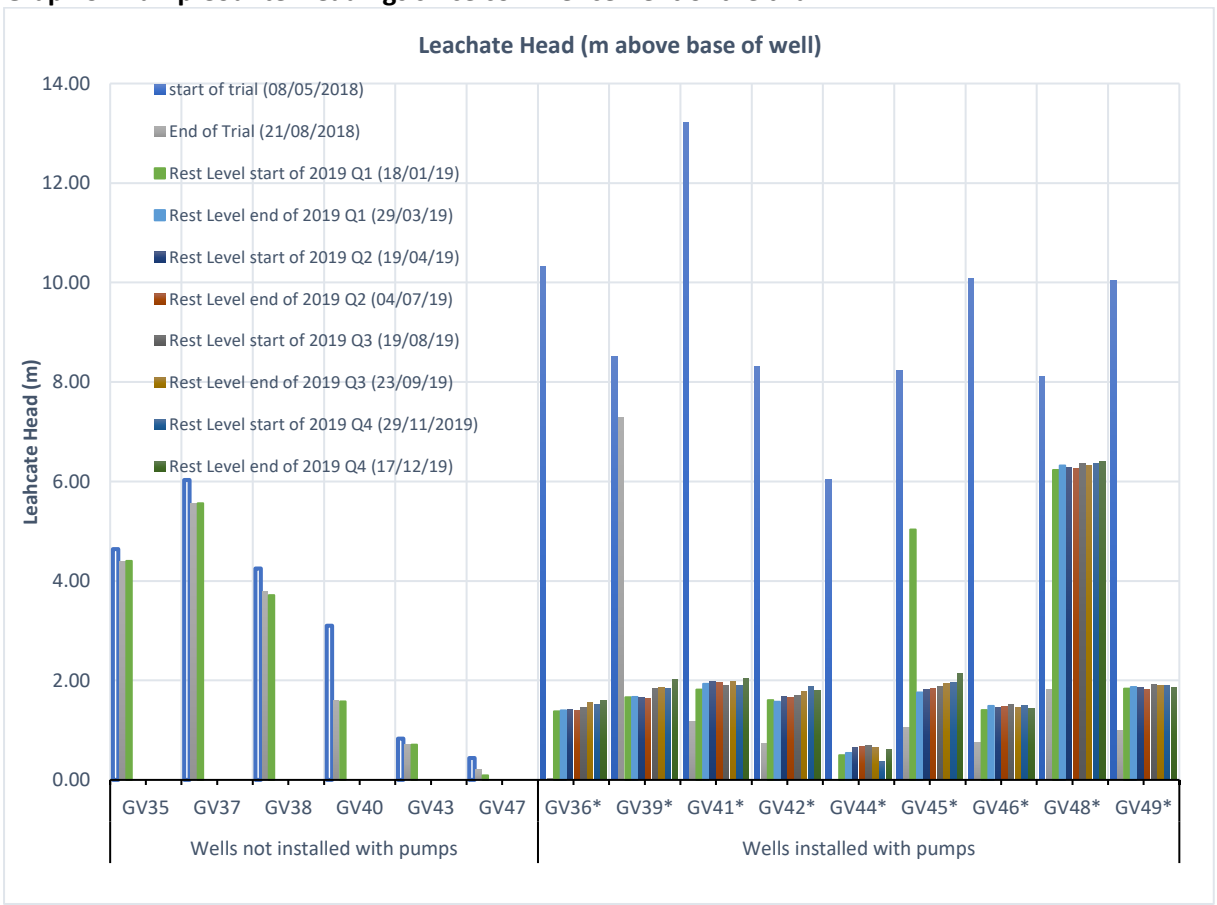


Graph 8: Groundwater and Leachate level comparison in Cell 6

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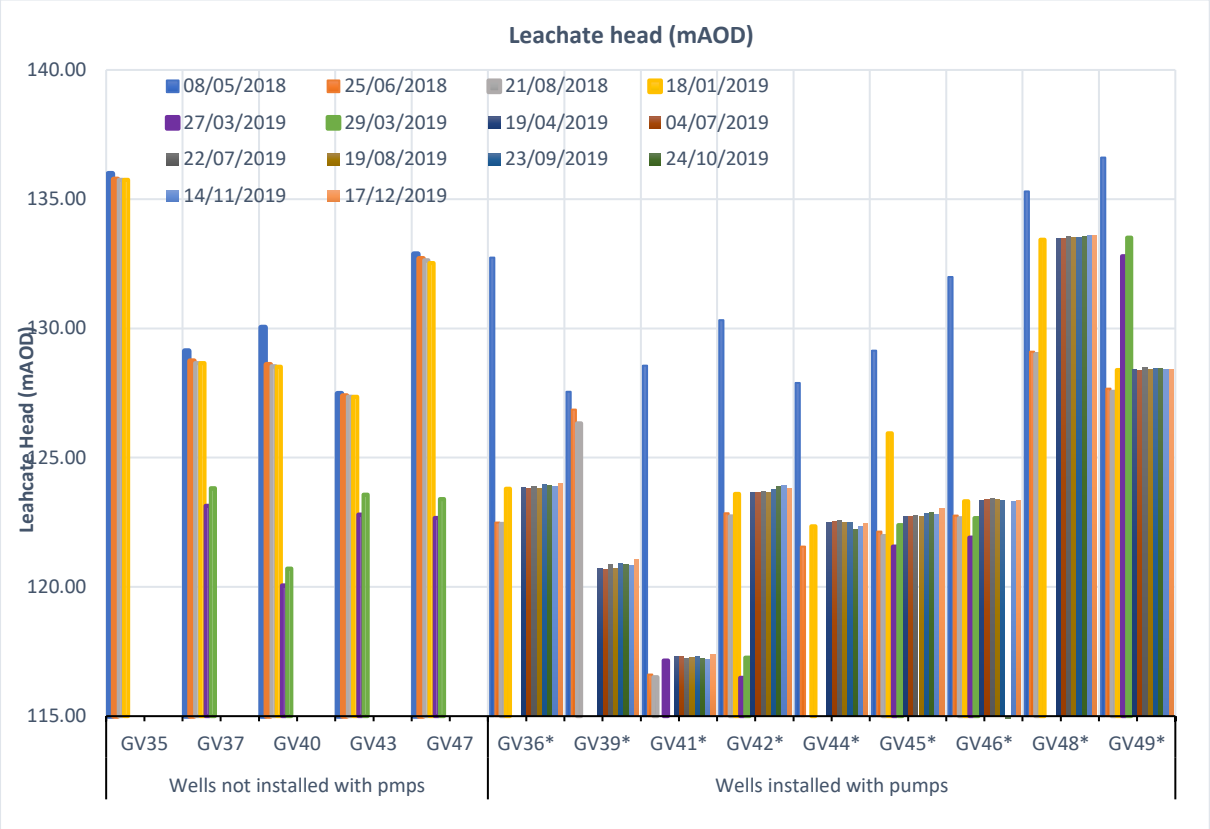


Graph 9: Pump Counter readings since commencement of the trial

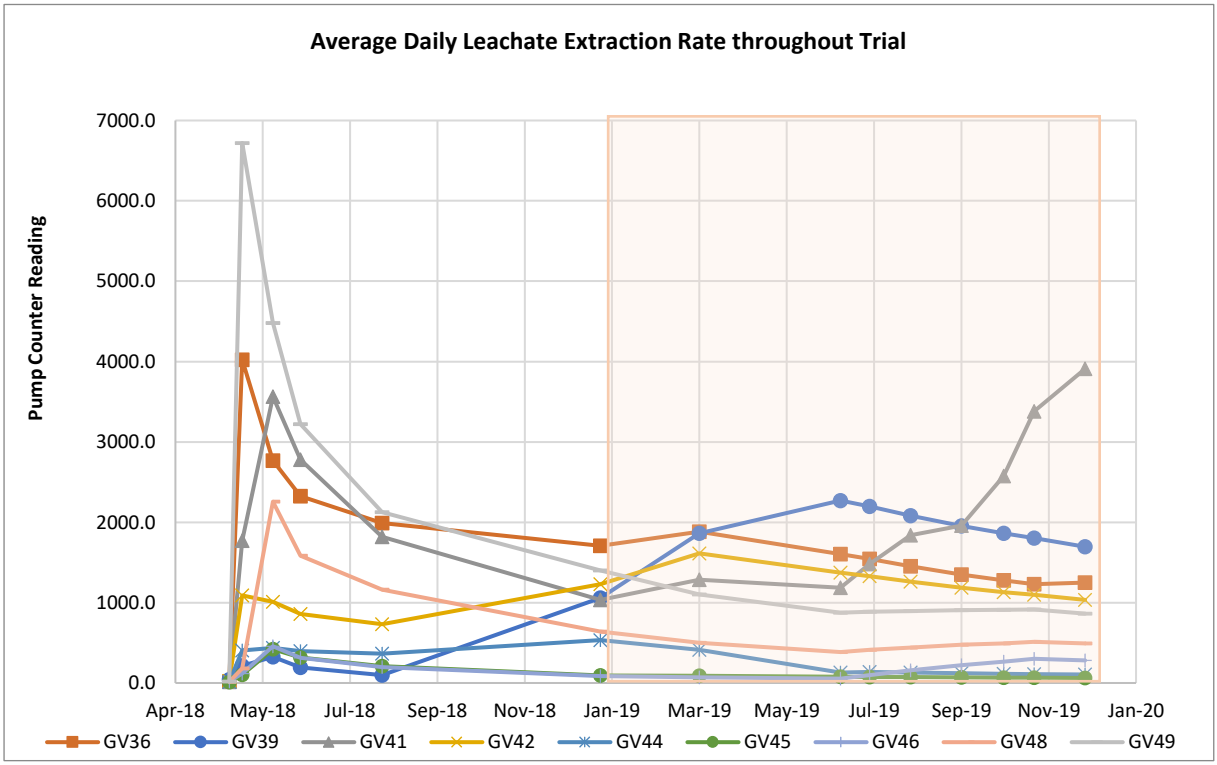


Graph 10: Leachate in GV wells at various stages throughout the trial

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Graph 11: Leachate head in the gas wells at various stages since trial commencement



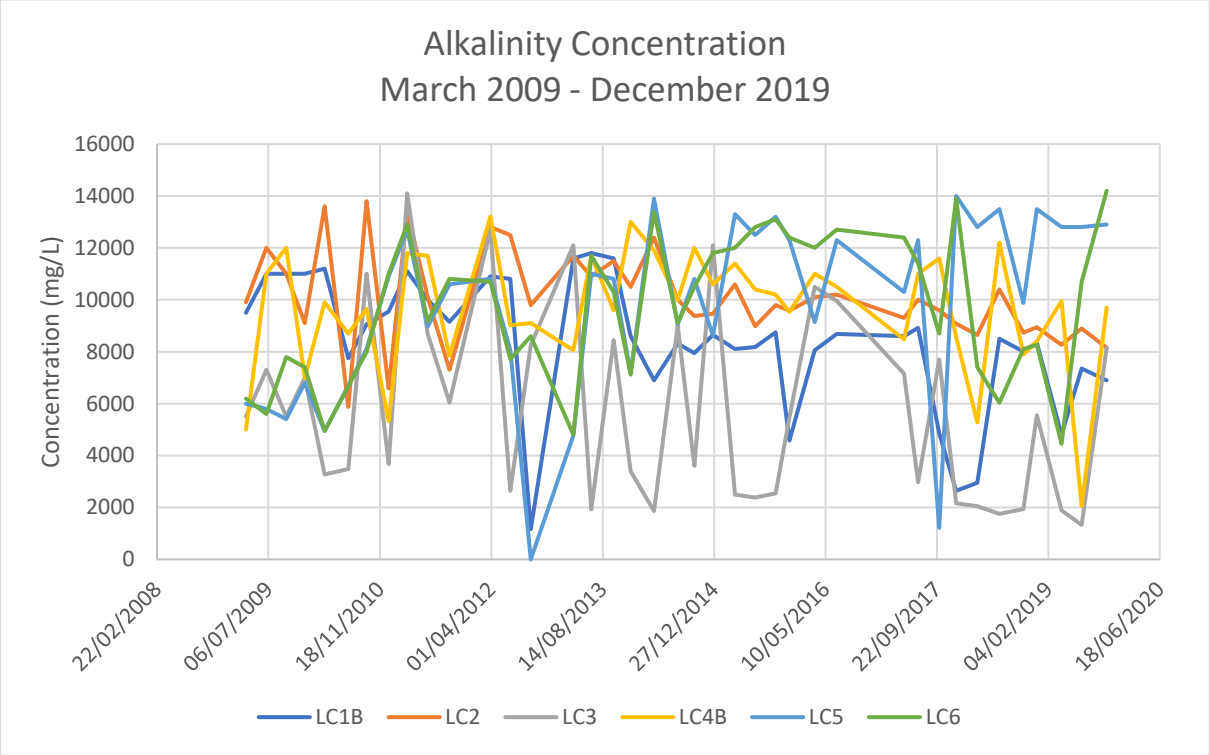
Graph 12: Daily Leachate Extraction Rates since commencement of trial (Box denotes current review period)

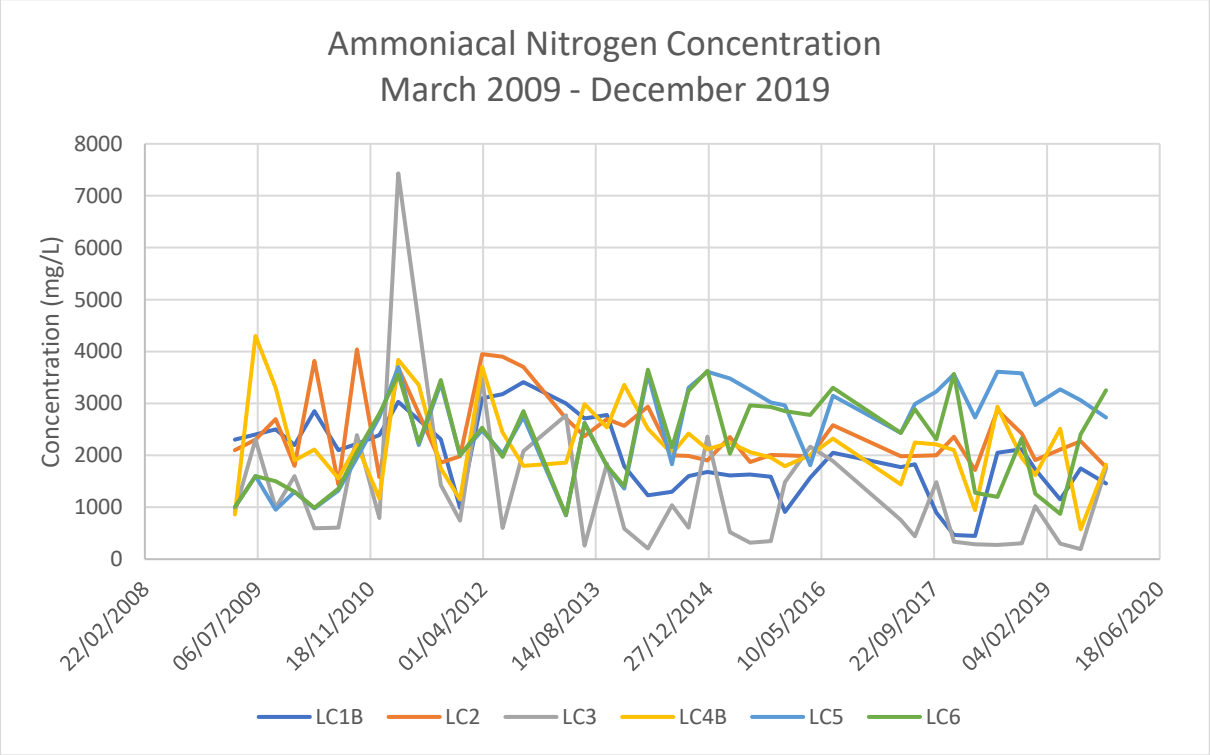
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Table 2: Leachate Quality Summary - Quarterly Suite (all parameters are in mg/l)

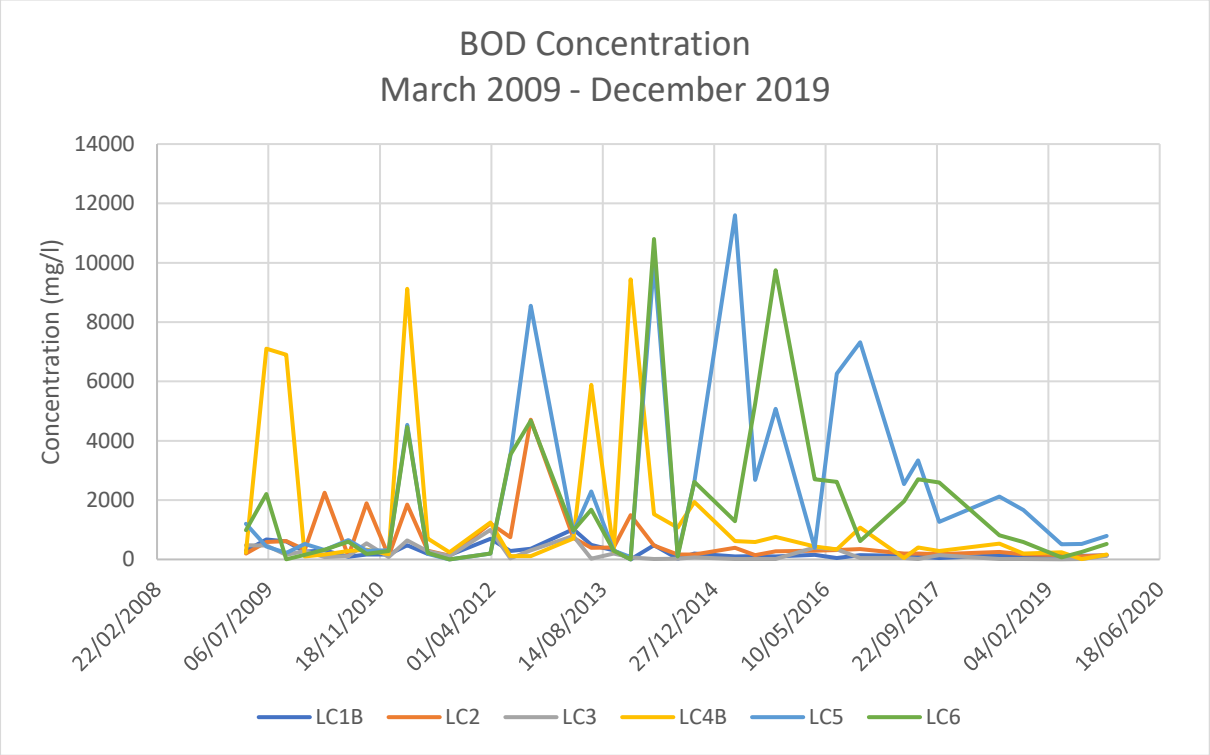
	LC1B			LC2			LC3		
Sample Description	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity, Total as CaCO3	4800	7350	6350	8150	8900	8440	1330	8150	3790
Ammoniacal Nitrogen as N	1150	1750	1453.33	1770	2270	2050	194	1750	747.33
BOD, Unfiltered	64.6	129	103.87	105	142	128.67	5	124	46.33
Calcium	83.1	122	96.73	25.4	33.2	29.43	27.6	153	99.87
Chloride	1320	2130	1770	2000	2210	2070	270	1990	868
COD, unfiltered	1230	2170	1813.33	2140	3230	2560	240	2370	954
Magnesium	80.7	84.9	82.8	51.3	91.2	71.25	52.6	57.8	55.2
Organic Carbon, Total	408	582	514	735	857	788	38.2	740	282.97
pH	7.81	8.11	7.95	7.77	7.98	7.86	7.28	8.07	7.73
Potassium	512	682	597	760	921	840.5	103	105	104
Sodium	1030	1550	1290	1600	1650	1625	207	209	208
Sulphate	1.74	10	7.25	8.88	79.8	36.23	1.02	35.3	17.91
Total Oxidised Nitrogen as N	0.04	2.89	1.14	0.04	1.57	0.7	0.02	0.39	0.24
	LC4B			LC5			LC6		
Sample Description	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity, Total as CaCO3	2060	9960	7240	12800	12900	12833.33	4450	14200	9783.33
Ammoniacal Nitrogen as N	575	2510	1635	2730	3270	3020	870	3250	2176.67
BOD, Unfiltered	10	236	136.33	516	789	607.33	69.1	526	283.37
Calcium	71.2	77.9	74.8	33.4	36	34.77	0.2	48.9	27.17
Chloride	673	4350	3087.67	3140	3760	3406.67	1300	3370	2640
COD, unfiltered	356	4280	2845.33	6640	7680	7076.67	1030	8210	4493.33
Magnesium	34.2	90.6	62.4	67.2	84.7	75.95	0.036	52.5	26.27
Organic Carbon, Total	169	1330	926.33	1830	2860	2310	353	2500	1354.33
pH	7.75	8.13	7.98	8.04	8.22	8.14	8.06	8.12	8.1
Potassium	107	872	489.5	843	908	875.5	0.2	804	402.1
Sodium	338	2820	1579	2510	2940	2725	0.0967	3130	1565.05
Sulphate	10	614	264	4.84	355	122.4	10	232	90.9
Total Oxidised Nitrogen as N	0.5	35.3	12.43	0.04	0.5	0.19	0.04	1.5	0.85

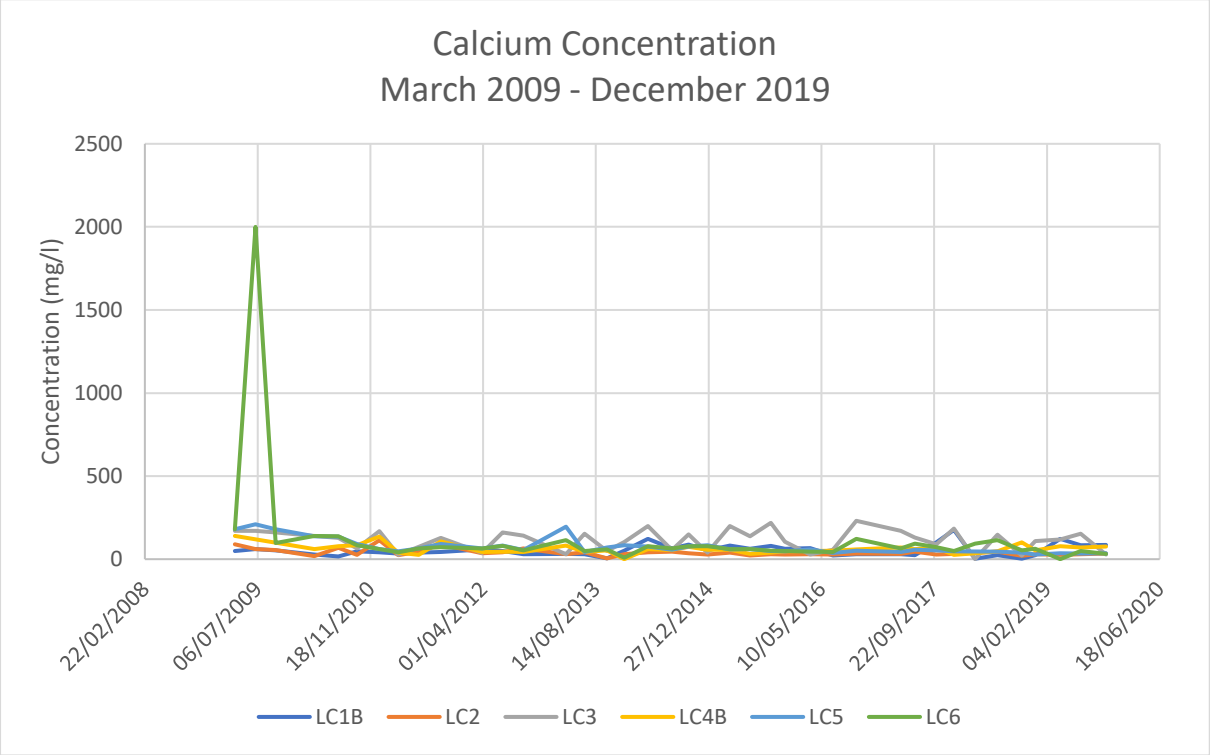
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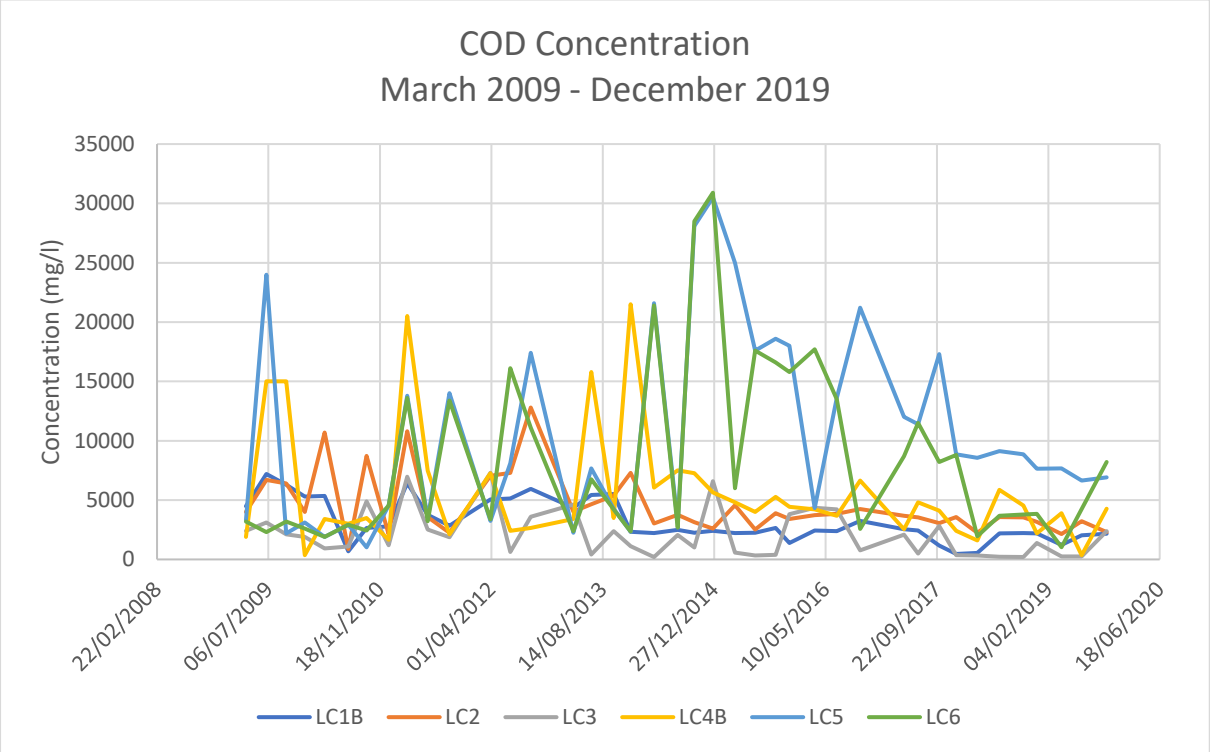


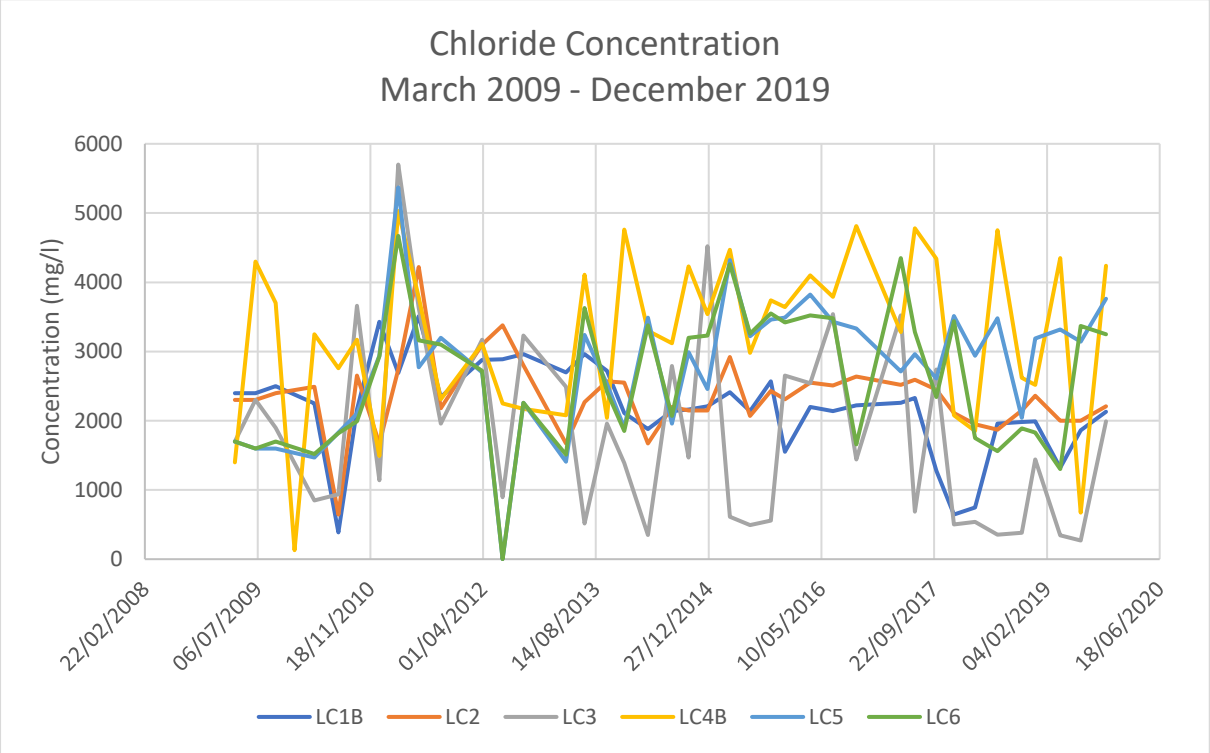
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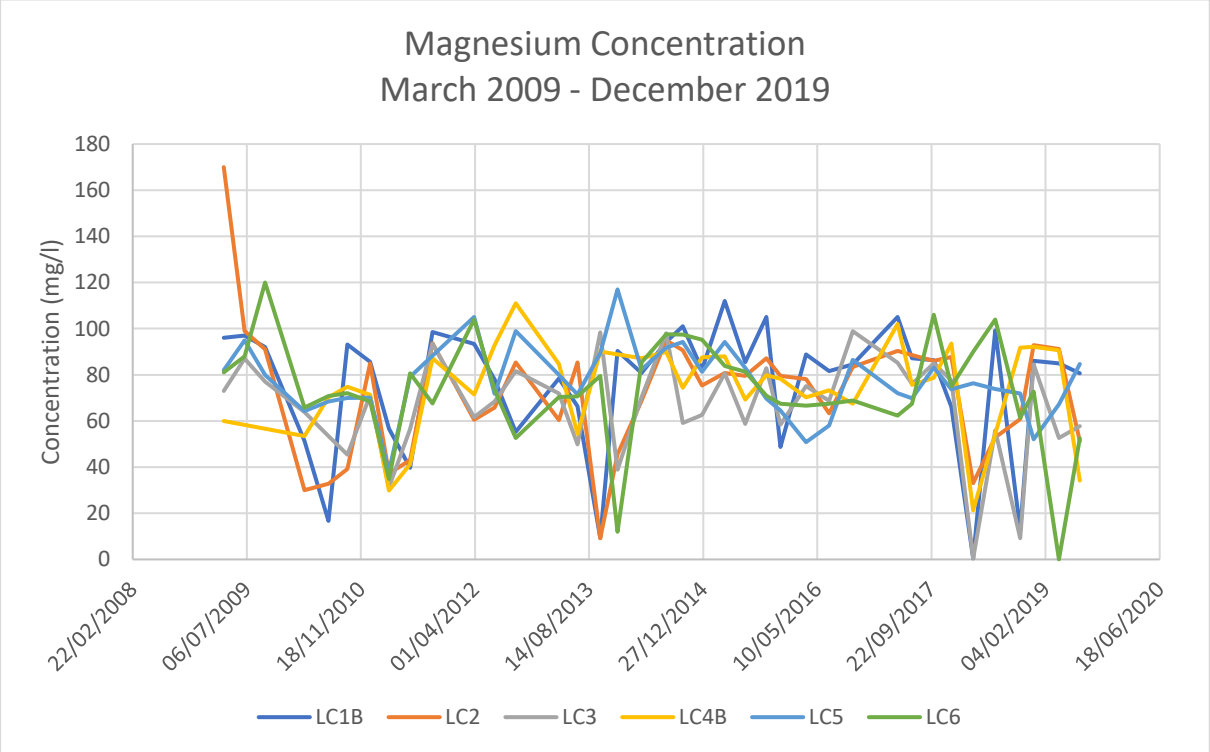


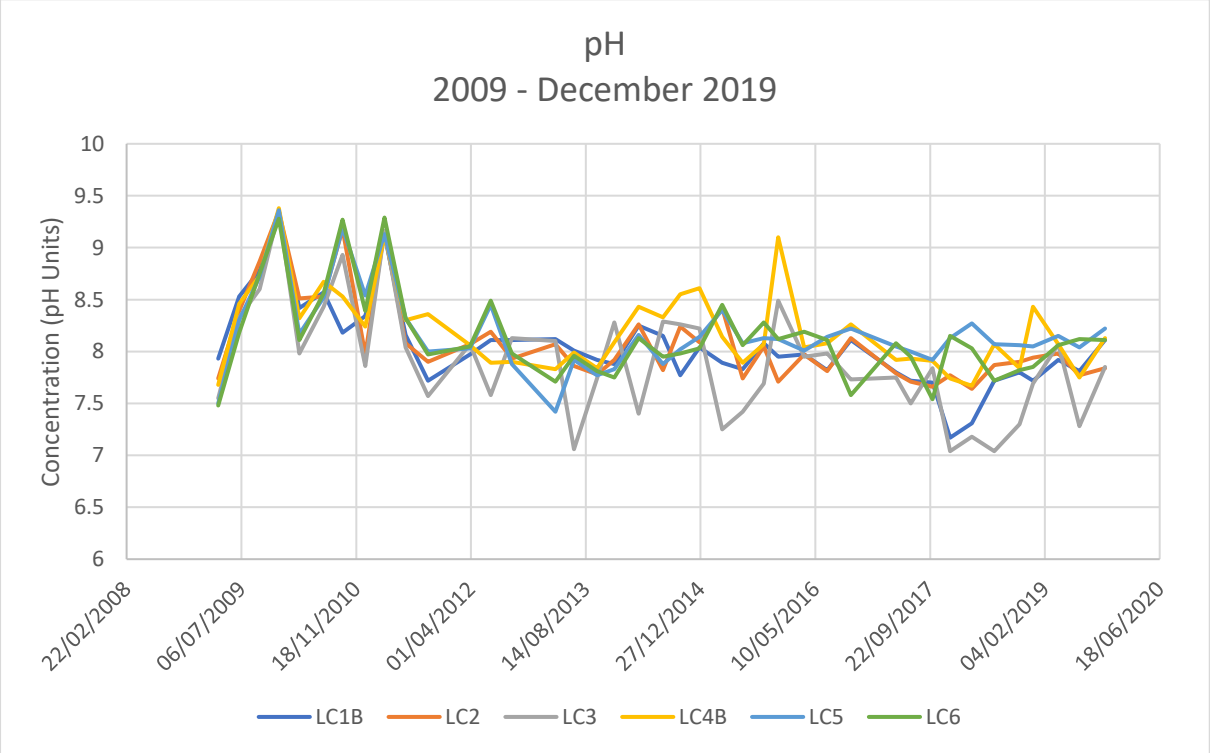
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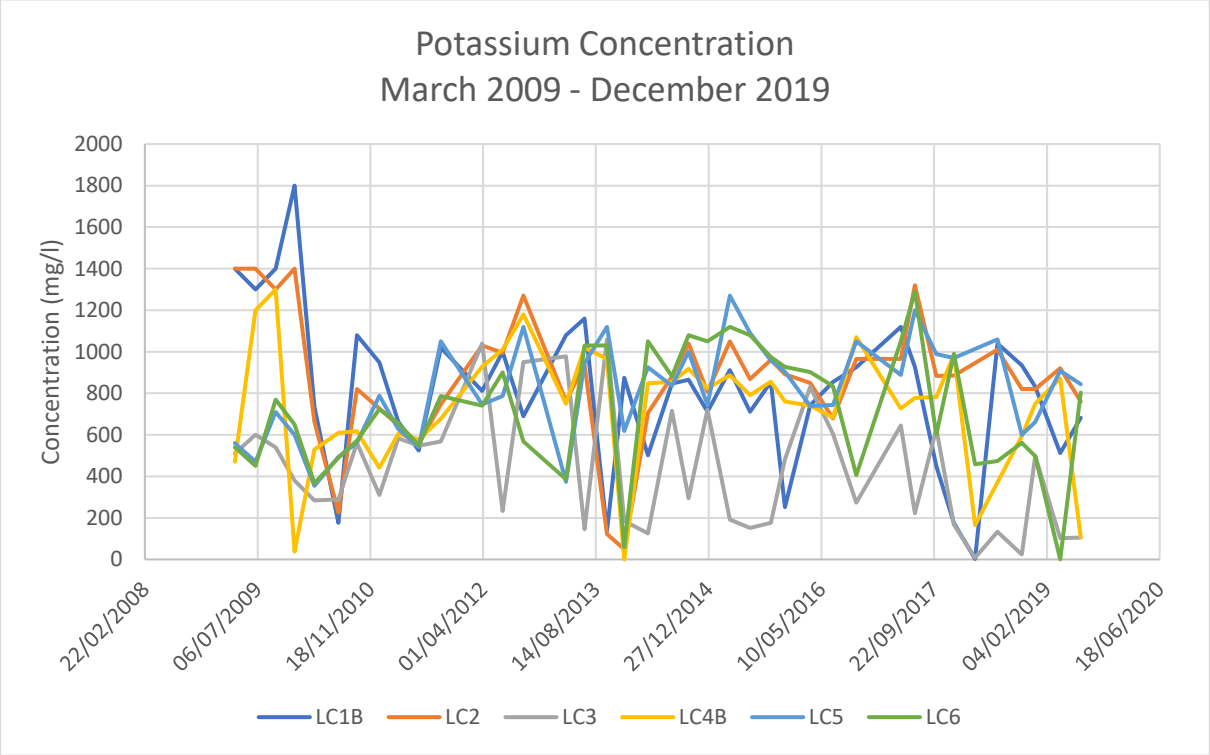


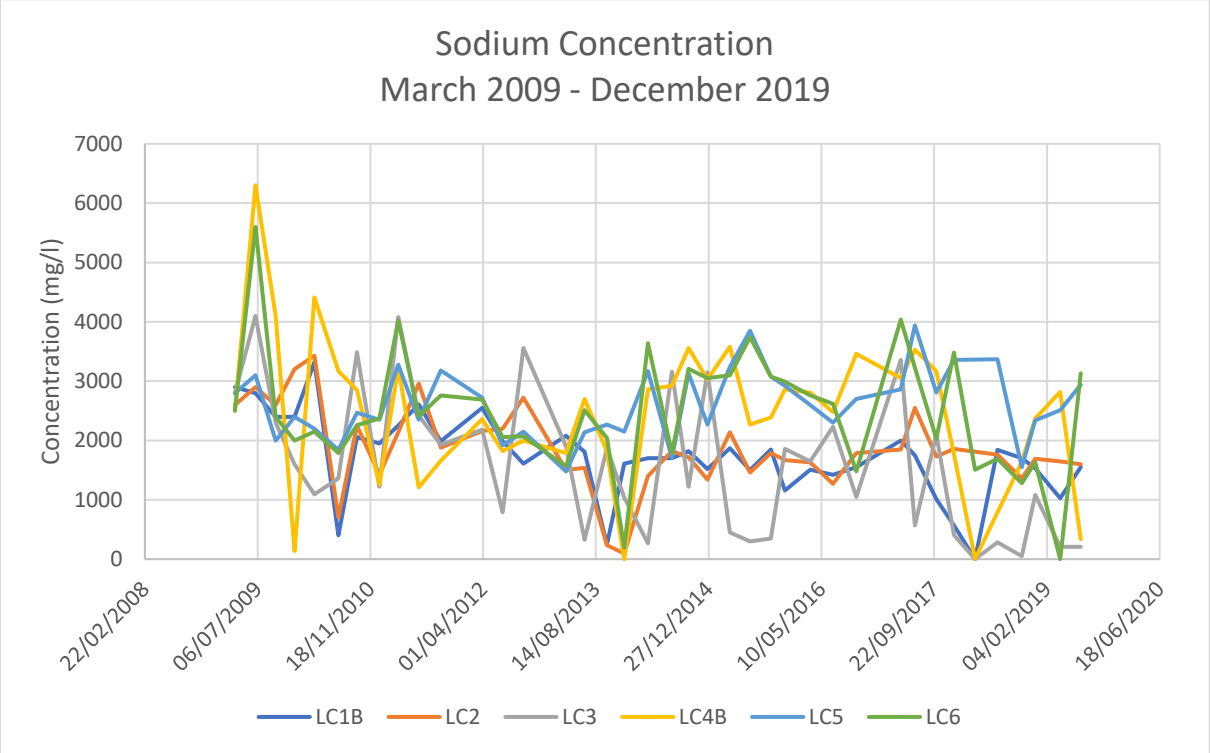
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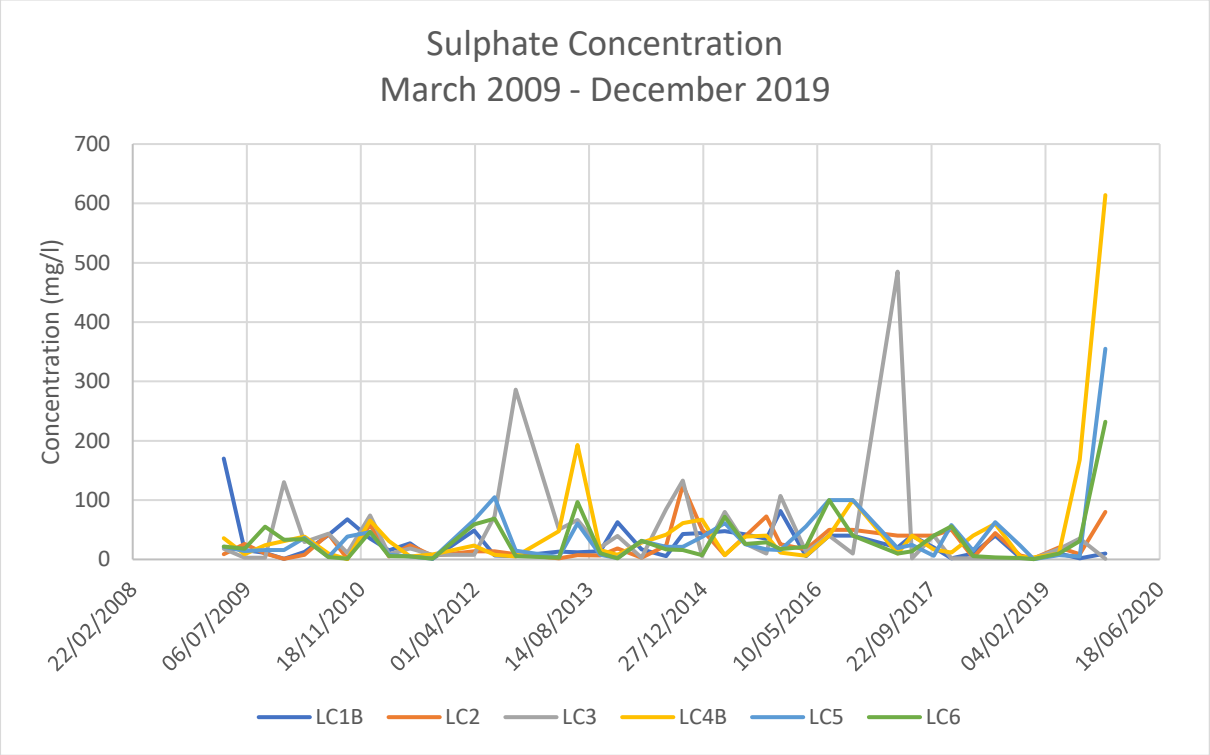


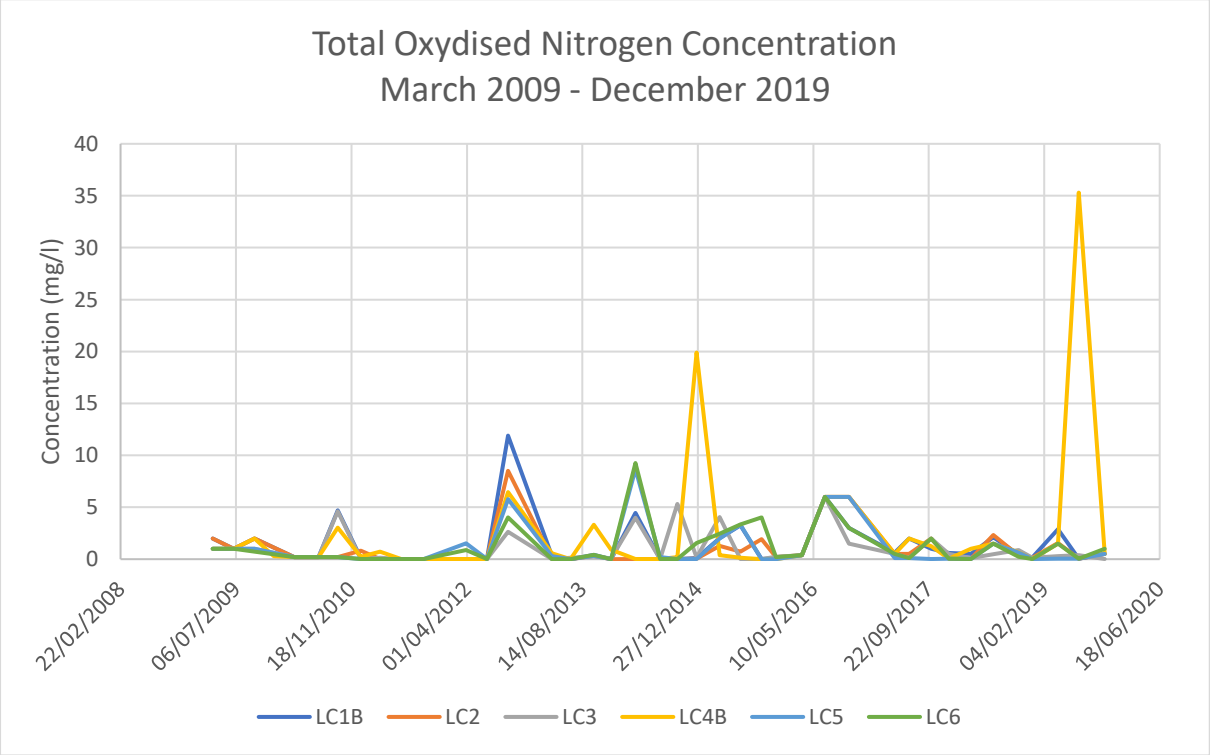
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Table 3: Leachate Quality Summary - Annual Suite

Sample Description		LC1B	LC2B	LC3	LC4B	LC5	LC6
Date Sampled		17/12/2019	17/12/2019	17/12/2019	17/12/2019	17/12/2019	17/12/2019
Inorganics							
Cyanide, Free	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cyanide, Total	mg/l	<0.05	<0.05	<0.05	0.08	0.1	<0.05
Filtered (Dissolved) Metals							
Cadmium (diss.filt)	mg/l	<0.0008	<0.00008	<0.00008	<0.0008	0.000229	<0.00008
Chromium (diss.filt)	mg/l	0.0734	0.0829	0.048	0.169	0.257	0.0533
Copper (diss.filt)	mg/l	0.00393	0.00152	0.0147	0.0724	0.0327	0.0151
Iron (Dis.Filt)	mg/l	6.11	8.47	24.3	7.09	8.65	8.94
Lead (diss.filt)	mg/l	<0.002	0.000951	<0.0002	0.00949	0.0225	0.000774
Manganese (diss.filt)	mg/l	0.197	0.0878	0.932	0.164	0.287	0.266
Mercury (diss.filt)	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel (diss.filt)	mg/l	0.288	0.351	0.263	0.35	0.539	0.265
Zinc (diss.filt)	mg/l	0.0262	0.0215	0.0221	0.19	0.722	0.0323
Mineral Oil / Oils & Greases							
Mineral oil >C10 C40 (aq)	mg/l	<0.1	<0.1	<0.1	0.607	0.246	0.106
Semi-Volatile Organic Compounds (SVOCs)							
1,2,4-Trichlorobenzene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
1,2-Dichlorobenzene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
1,3-Dichlorobenzene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
1,4-Dichlorobenzene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2,4,5-Trichlorophenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2,4,6-Trichlorophenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2,4-Dichlorophenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2,4-Dimethylphenol (aq)	mg/l	<0.008	<0.04	<0.01	0.0503	0.0405	<0.02
2,4-Dinitrotoluene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2,6-Dinitrotoluene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2-Chloronaphthalene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2-Chlorophenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2-Methylnaphthalene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2-Methylphenol (aq)	mg/l	<0.008	<0.04	<0.01	0.0913	0.0661	<0.02
2-Nitroaniline (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
2-Nitrophenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
3-Nitroaniline (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
4-Bromophenylphenylether (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
4-Chloro-3-methylphenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
4-Chloroaniline (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
4-Chlorophenylphenylether (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
4-Methylphenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	0.225	<0.02
4-Nitroaniline (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
4-Nitrophenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Acenaphthene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Acenaphthylene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Anthracene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Azobenzene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Benzo(a)anthracene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Benzo(a)pyrene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Benzo(b)fluoranthene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Benzo(g,h,i)perylene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Benzo(k)fluoranthene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
bis(2-Chloroethoxy)methane (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
bis(2-Chloroethyl)ether (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
bis(2-Ethylhexyl) phthalate (aq)	mg/l	<0.016	<0.08	<0.02	<0.08	0.112	<0.04

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Butylbenzyl phthalate (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Carbazole (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Chrysene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Dibenzo(a,h)anthracene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Dibenzofuran (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Diethyl phthalate (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Dimethyl phthalate (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Fluoranthene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Fluorene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Hexachlorobenzene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Hexachlorobutadiene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Hexachlorocyclopentadiene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Hexachloroethane (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Indeno(1,2,3-cd)pyrene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Isophorone (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Naphthalene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
n-Dibutyl phthalate (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
n-Dioctyl phthalate (aq)	mg/l	<0.04	<0.2	<0.05	<0.2	<0.2	<0.1
Nitrobenzene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
n-Nitroso-n-dipropylamine (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Pentachlorophenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Phenanthrene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Phenol (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	0.0951	<0.02
Pyrene (aq)	mg/l	<0.008	<0.04	<0.01	<0.04	<0.04	<0.02
Volatile Organic Compounds (VOCs)							
1,1,1,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trimethylbenzene	mg/l	0.00438	0.00989	<0.001	0.00487	0.00396	0.0143
1,2-Dibromo-3-chloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dibromoethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trimethylbenzene	mg/l	0.00148	0.00242	<0.001	0.00151	<0.001	0.00291
1,3-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	mg/l	0.00148	0.00275	<0.001	0.00957	0.0028	0.00377
2,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Bromofluorobenzene**	%	94.1	95.7	96.8	94	89.2	90.6
4-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-iso-Propyltoluene	mg/l	0.00139	0.0138	<0.001	0.00401	0.00508	0.0076
Benzene	mg/l	0.00224	0.00211	0.00172	0.00289	0.00478	0.00797
Bromobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromodichloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromoform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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Carbon disulphide	mg/l	<0.001	<0.001	<0.001	<0.001	0.00296	0.00445
Carbontetrachloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	mg/l	0.0021	0.00152	0.00149	0.00152	0.00356	0.00349
Chloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	mg/l	<0.001	<0.001	<0.001	0.002	0.00245	<0.001
cis-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromofluoromethane**	%	110	109	115	113	106	106
Dibromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichlorodifluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichloromethane	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	mg/l	0.0112	0.0203	<0.001	0.00497	0.00825	0.00846
Hexachlorobutadiene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isopropylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.0107
m,p-Xylene	mg/l	0.0166	0.0356	<0.001	0.0144	0.0144	0.0182
Methyl tertiary butyl ether (MTBE)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphthalene	mg/l	0.00315	0.0121	<0.001	0.00344	0.00678	0.00559
n-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
o-Xylene	mg/l	0.00693	0.0117	<0.001	0.00597	0.00696	0.00565
Propylbenzene	mg/l	<0.001	0.00123	<0.001	<0.001	<0.001	<0.001
sec-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Styrene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
tert-Amyl methyl ether (TAME)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
tert-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/l	0.00138	0.00579	<0.001	0.0156	0.0192	0.0096
Toluene-d8**	%	99.4	98.6	99.3	97.2	97.4	96.4
trans-1,2-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichlorofluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vinyl chloride	mg/l	<0.001	<0.001	<0.001	0.00334	<0.001	<0.001
Combined Pesticides / Herbicides							
Aldrin	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
alpha-HCH	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Atrazine	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Azinphos ethyl	mg/l	<0.00004	<0.0001	<0.0001	<0.0002	<0.0002	<0.00004
Azinphos methyl	mg/l	<0.00004	<0.0001	<0.0001	<0.0002	<0.0002	<0.00004
beta-HCH	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Carbophenothion	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Chlorfenvinphos	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Chlorothalonil	mg/l	<0.00002	<0.00002	<0.00005	<0.00005	<0.00005	<0.00002
Chlorpyriphos	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Chlorpyriphos-methyl	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
cis-Chlordane	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Diazinon	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Dichlorvos	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Dieldrin	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Dimethoate	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Disulfoton	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Endosulphan I	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Endosulphan II	mg/l	<0.00004	<0.0001	<0.0001	<0.0002	<0.0002	<0.00002
Endosulphan Sulphate	mg/l	<0.00004	<0.0001	<0.0001	<0.0002	<0.0002	<0.00002
Endrin	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Ethion	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002

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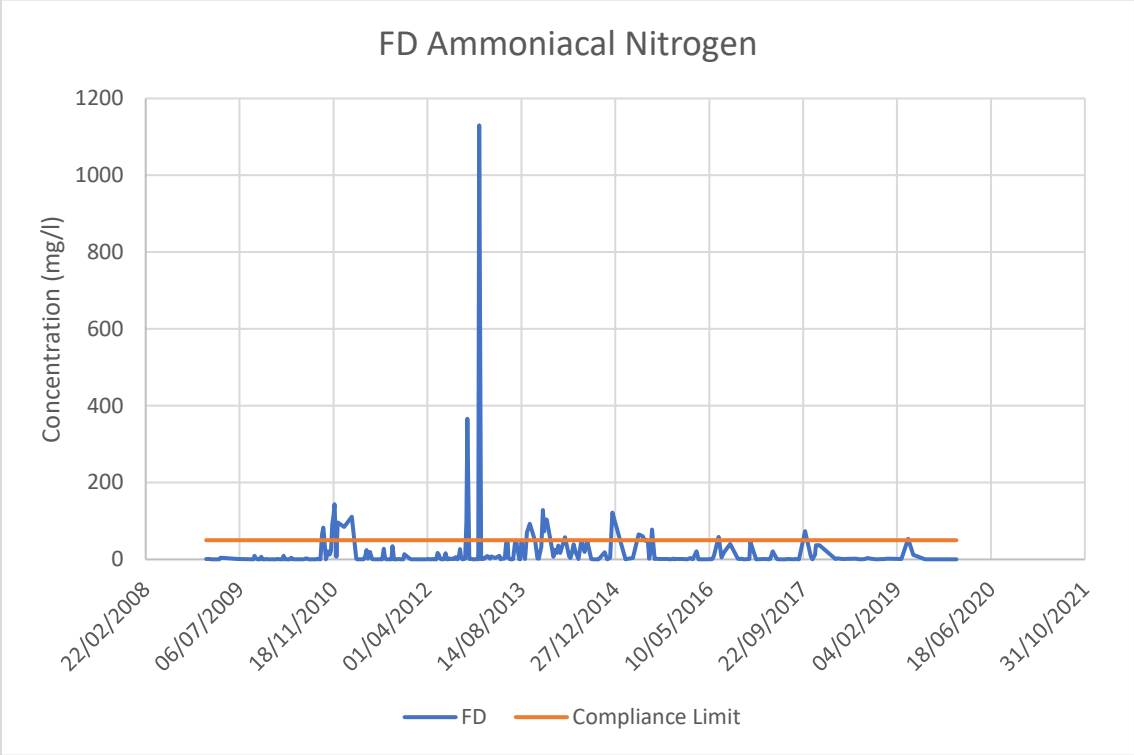
Etrimphos	mg/l	<0.00002	<0.00002	<0.00005	<0.00005	<0.00005	<0.00002
Fenitrothion	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Fenthion	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
gamma-HCH (Lindane)	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Heptachlor	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Heptachlor epoxide	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Hexachlorobenzene	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Isodrin	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Malathion	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Methyl Parathion	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Mevinphos	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
o,p'-DDD (TDE)	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
o,p'-DDE	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
o,p'-DDT	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
p,p'-DDD (TDE)	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
p,p'-DDE	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
p,p'-DDT	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
p,p'-Methoxychlor	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Parathion	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Pendimethalin	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Permethrin I	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Permethrin II	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Phosalone	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Pirimiphos-methyl	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Propetamphos	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Quintozene (PCNB)	mg/l	<0.00002	<0.00002	<0.00005	<0.00005	<0.00005	<0.00002
Simazine	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Tecnazene	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Telodrin	mg/l	<0.00002	<0.00002	<0.00005	<0.00005	<0.00005	<0.00002
trans-Chlordane	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Triadimefon	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Triallate	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Triazophos	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00002
Trifluralin	mg/l	<0.00002	<0.00005	<0.00005	<0.0001	<0.0001	<0.00001
Miscellaneous Organics							
Dibutyl tin	mg/l	<0.0003	<0.00015	<0.0003	<0.0003	0.000812	<0.00015
Surrogate	%	95.2	79.3	78.4	92.2	71.4	84.8
Tetrabutyl tin	mg/l	<0.00012	<0.00006	<0.00012	<0.00012	<0.00012	<0.00006
Tributyl tin	mg/l	<0.00006	<0.00003	<0.00006	<0.00006	<0.00006	<0.00003
Triphenyl tin	mg/l	<0.00006	<0.00003	<0.00006	<0.00006	<0.00006	<0.00003

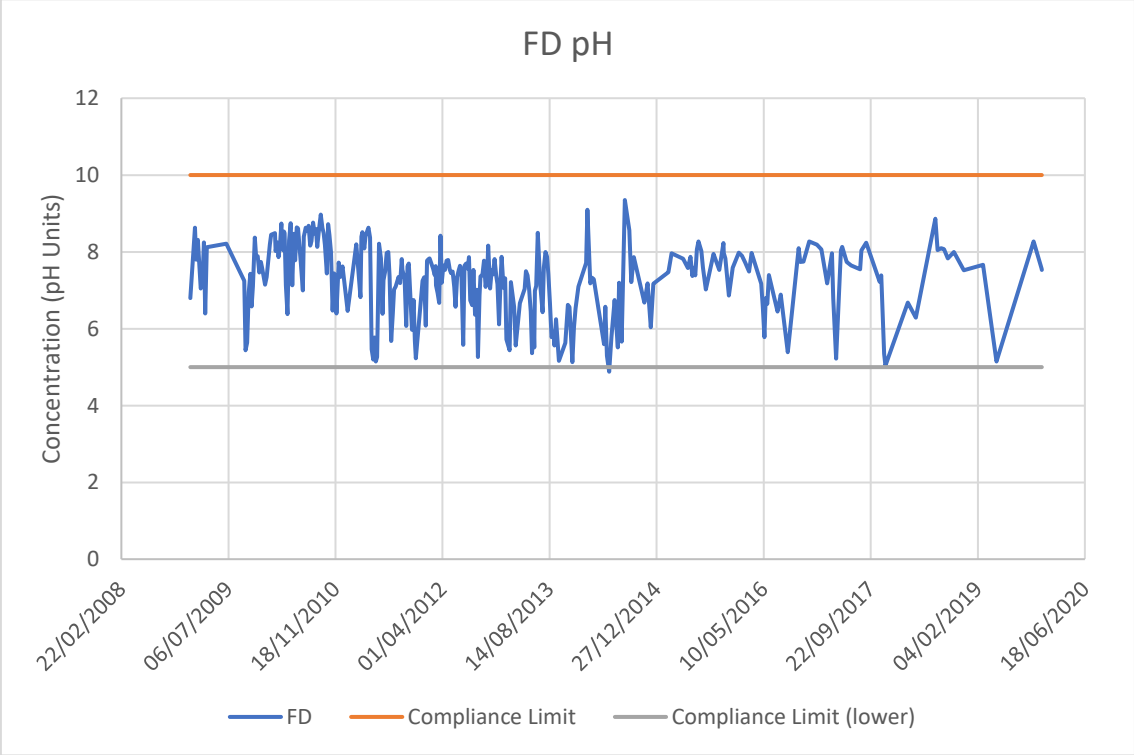
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Table 4: Final Discharge Quality Summary

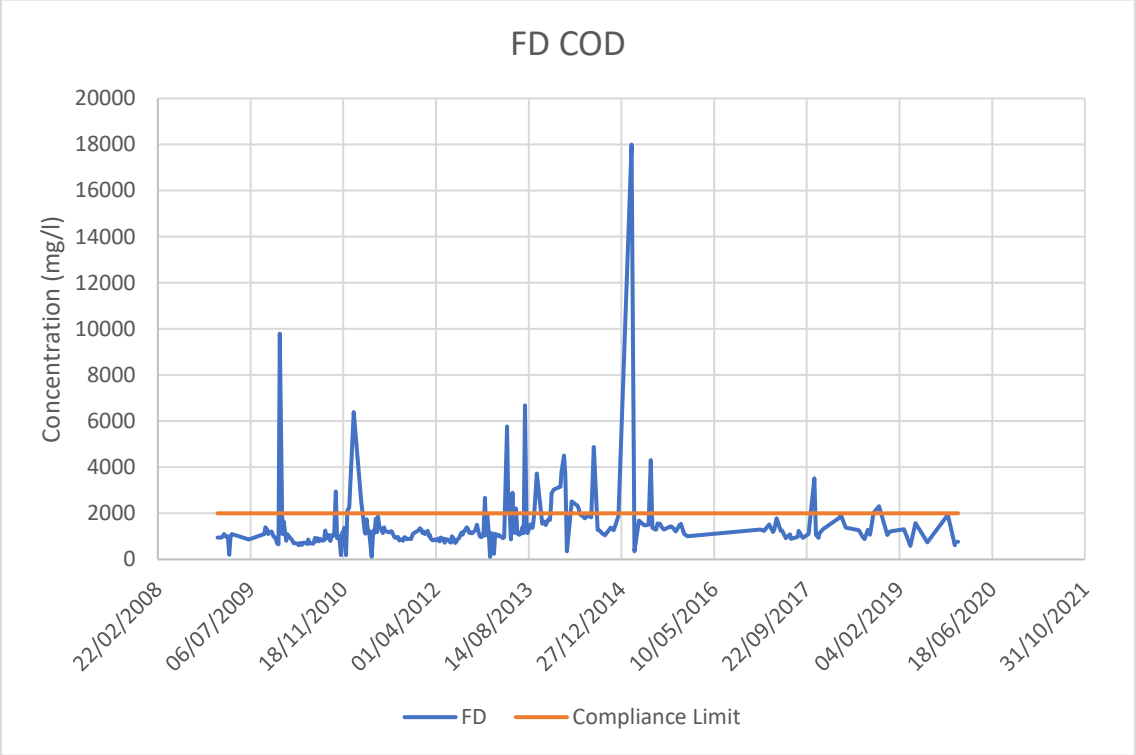
Final Discharge	Ammoniacal Nitrogen	pH	COD	Suspended Solids	Chromium	Copper	Lead	Nickel	Zinc	Nitrate as N	Nitrite as N	Alkalinity
	mg/l	pH Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Date / Compliance Limit	**50**	**>5<10**	**2000**	**500**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**
28/02/2019	0.791	7.66	1310	543						765	0.0152	587
04/04/2019	53.9		590								20.2	585
02/05/2019	11.7	5.15	1580	880						755	0.349	85
04/07/2019	0.641		747		0.0385	0.0314	0.00303	0.149	0.096		0.28	357
29/08/2019				550								
22/10/2019	0.541	8.27	1930									550
29/11/2019	0.368	7.56	621	331						433	0.429	190
30/11/2019	0.321	7.53	732	352						434	0.432	190
17/12/2019	0.589		762		0.0455	0.0289	0.00512	0.114	0.101		0.0222	93.3
min	0.321	5.15	590.00	331.00	0.04	0.03	0.00	0.11	0.10	433.00	0.02	85
max	53.9	8.27	1930.00	880.00	0.05	0.03	0.01	0.15	0.10	765.00	20.20	587
average	8.6064	7.23	1034.00	531.20	0.04	0.03	0.00	0.13	0.10	596.80	3.10	329.7
count	8	5	8	5	2	2	2	2	2	4	7	8

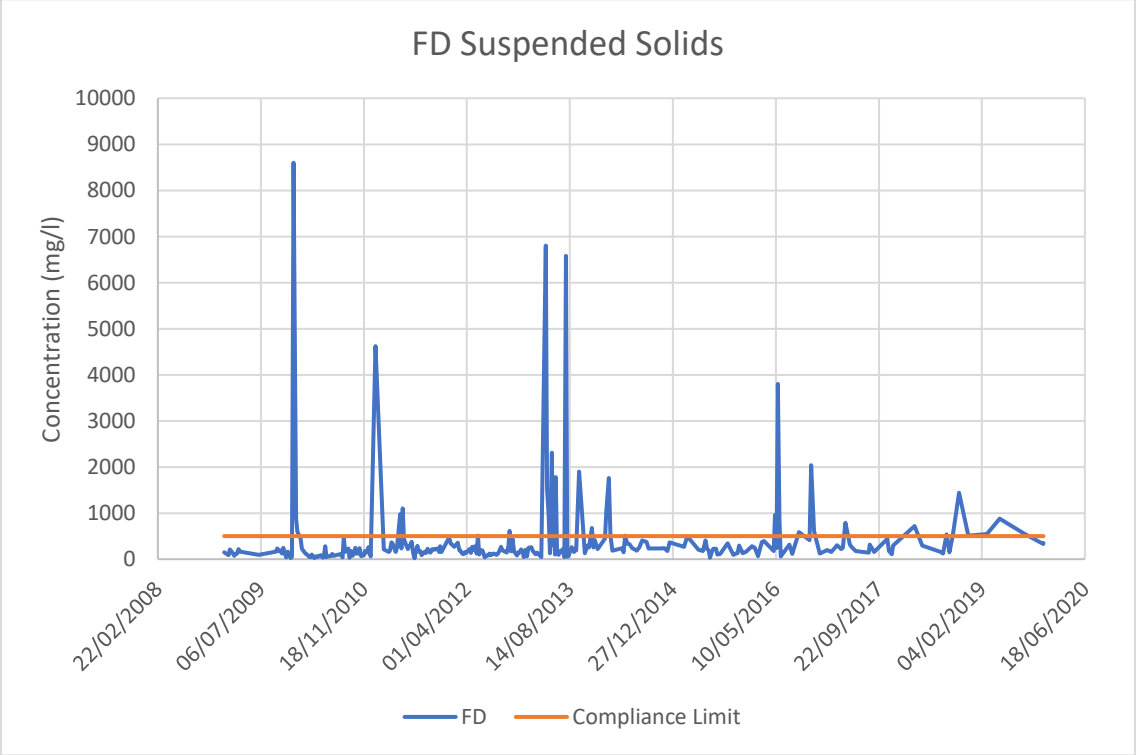
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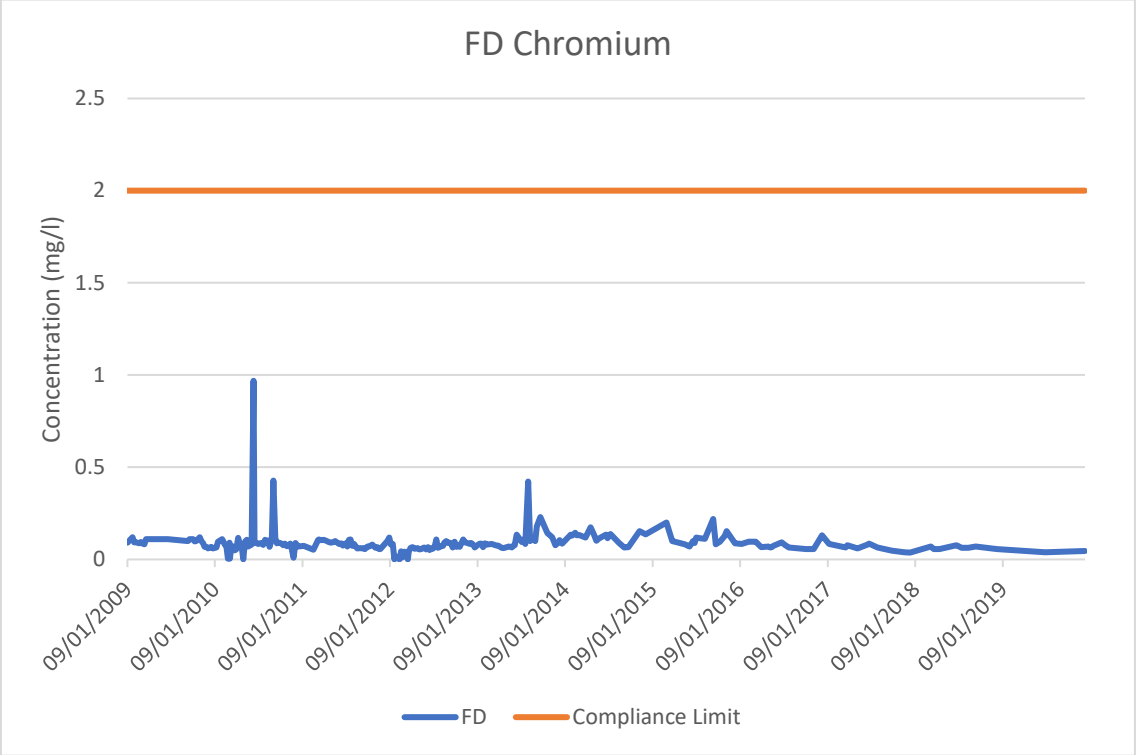


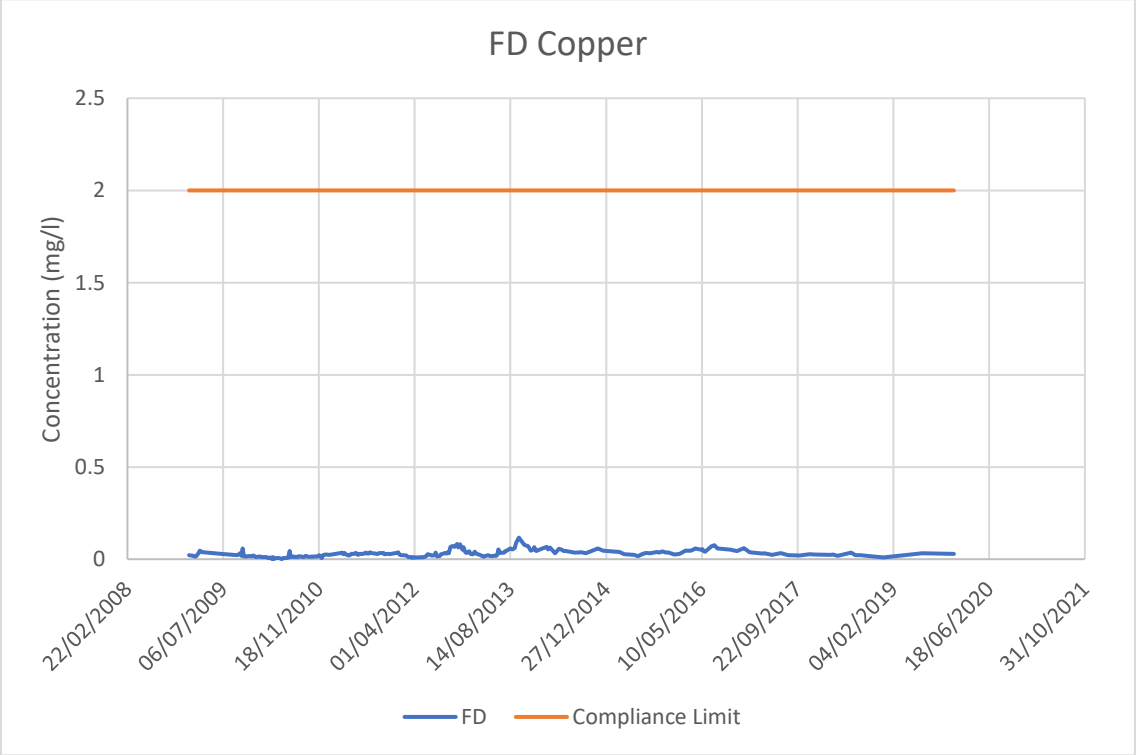
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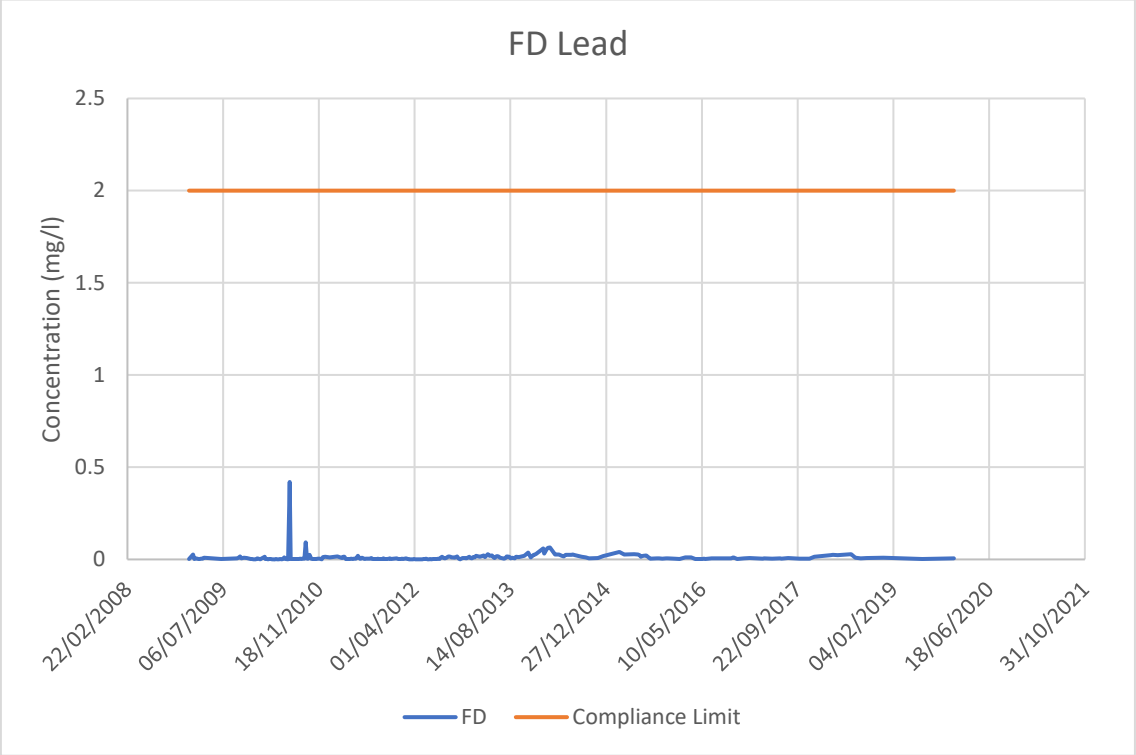


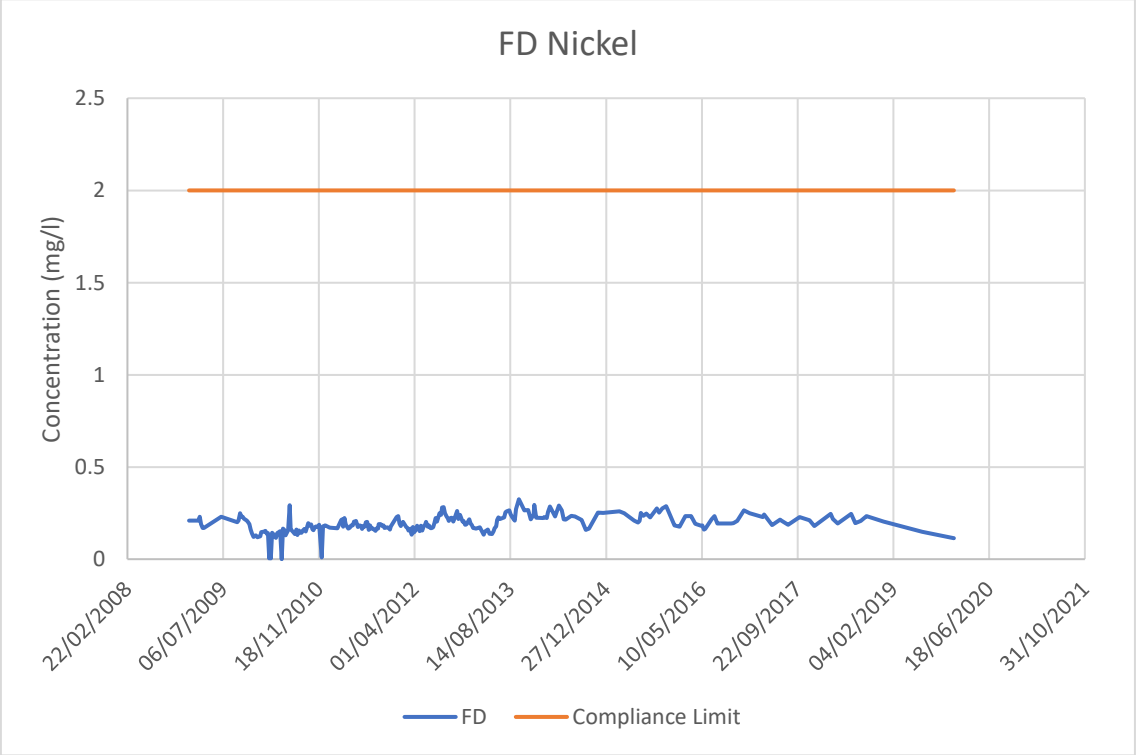
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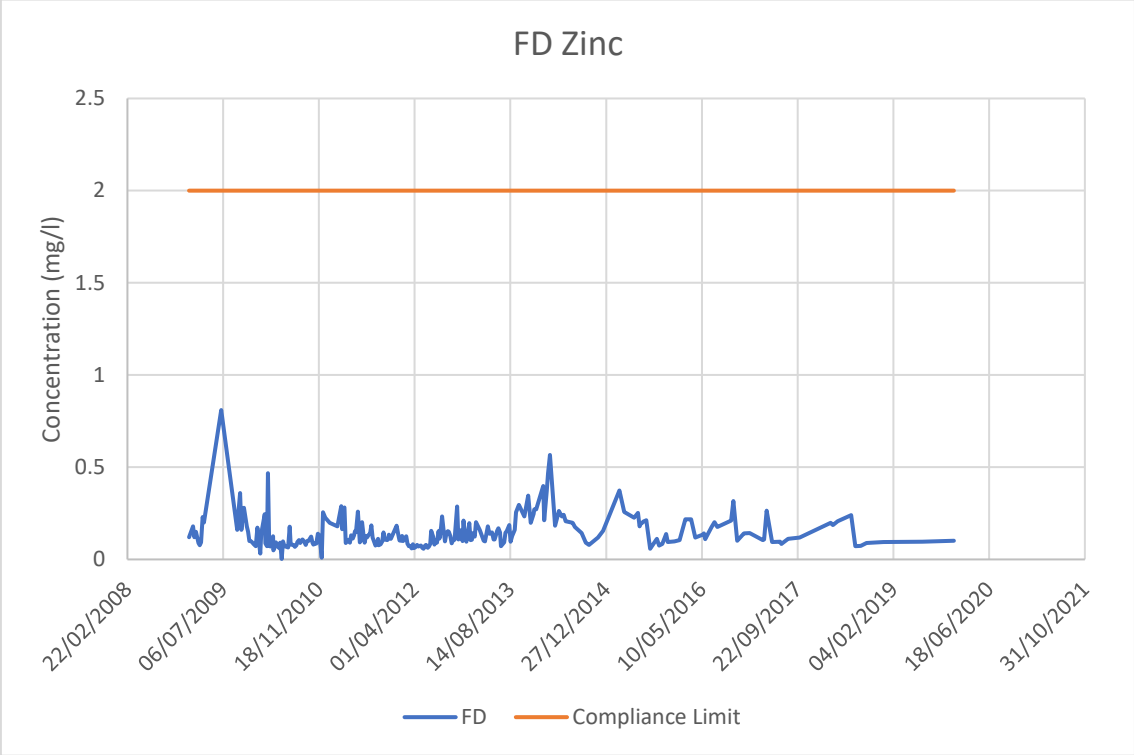


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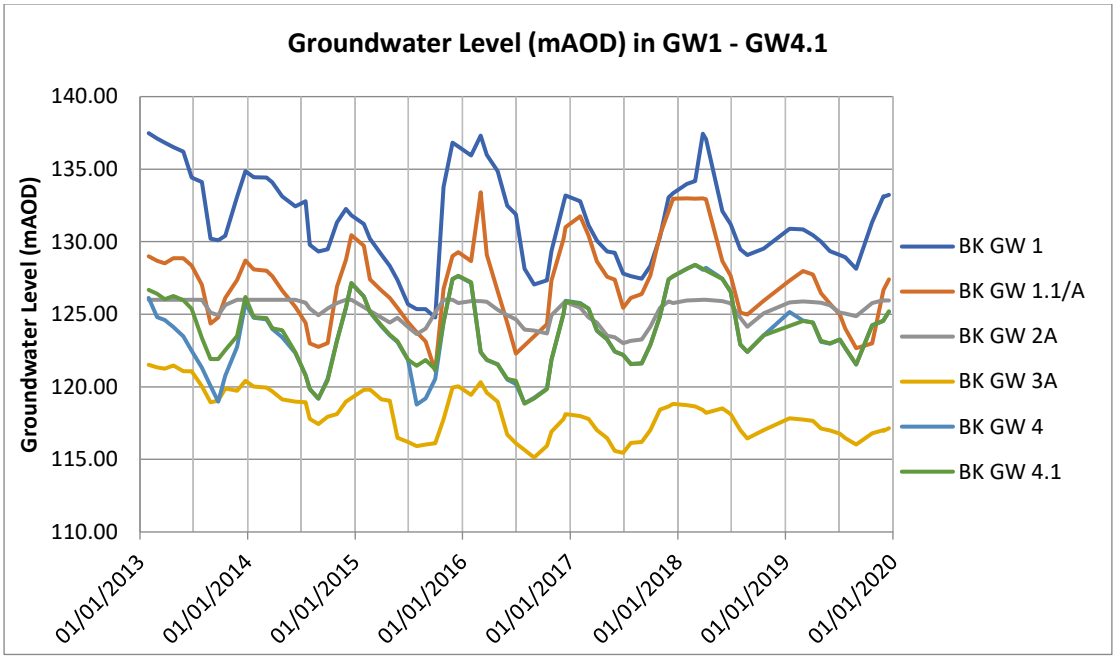
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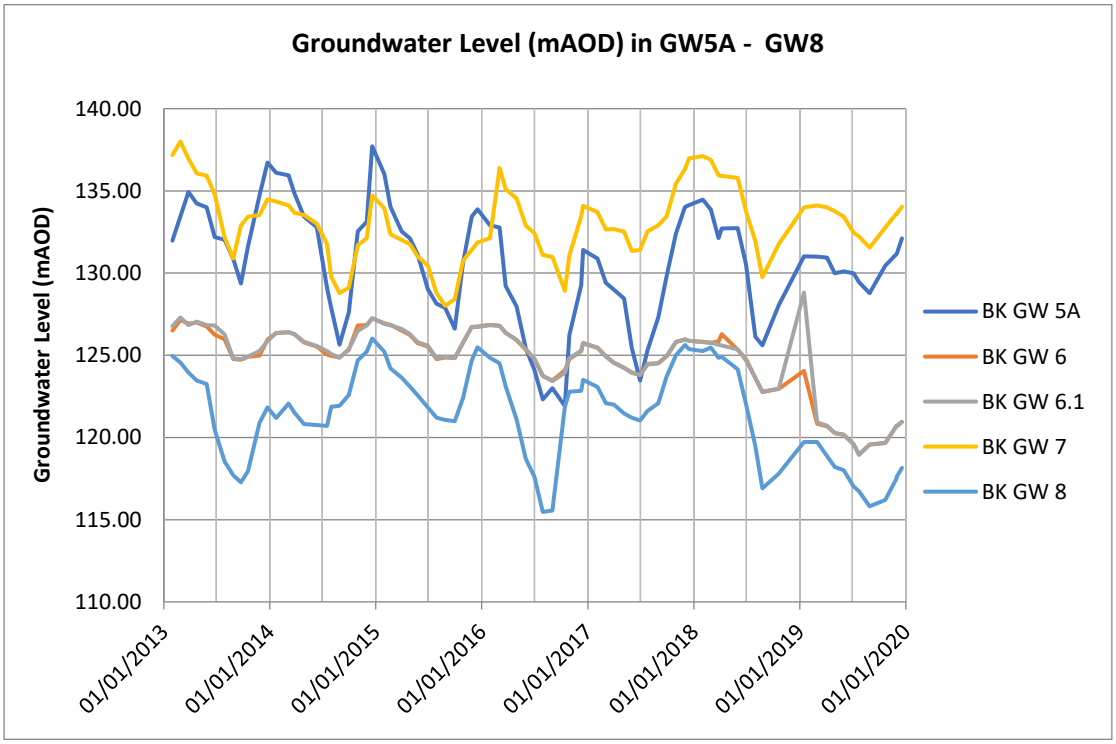
APPENDIX 3

Groundwater Level and Quality Summary Tables and Time-Series Graphs

APPENDIX 3 - GROUNDWATER



Graph 1A: Groundwater level as metres above Ordnance Datum (2009-2019)



Graph 1B: Groundwater level as metres above Ordnance Datum (2009-2019)

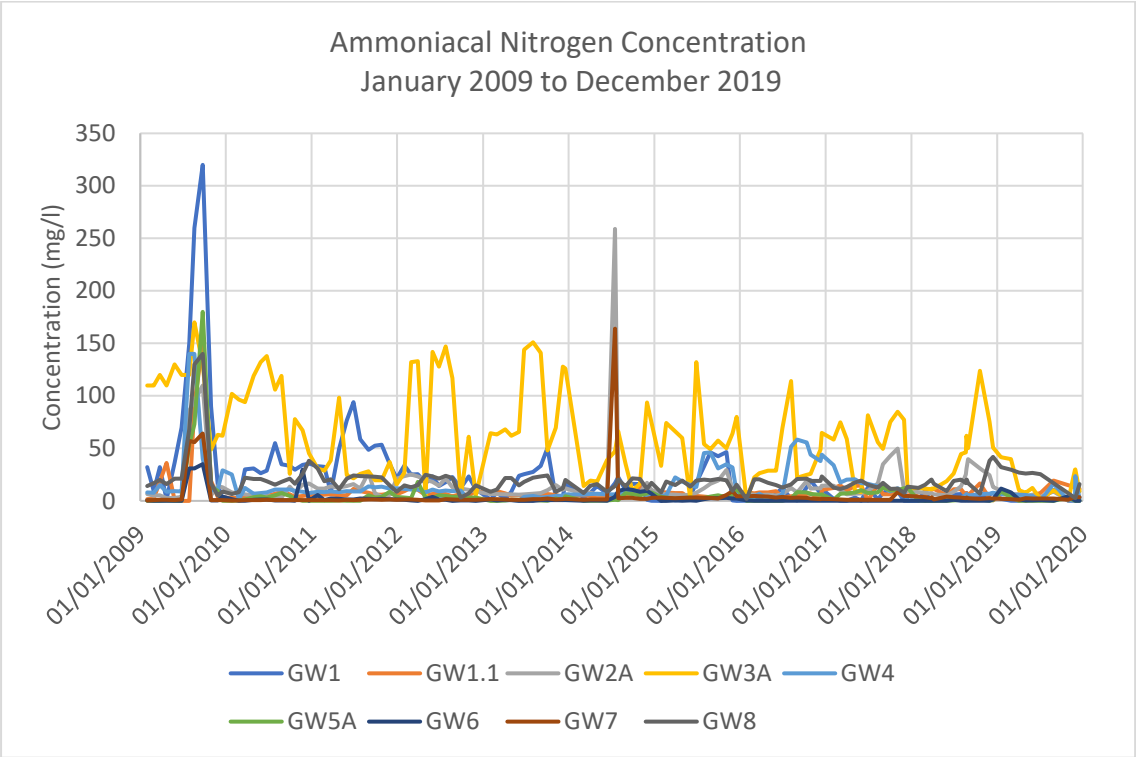
APPENDIX 3 - GROUNDWATER

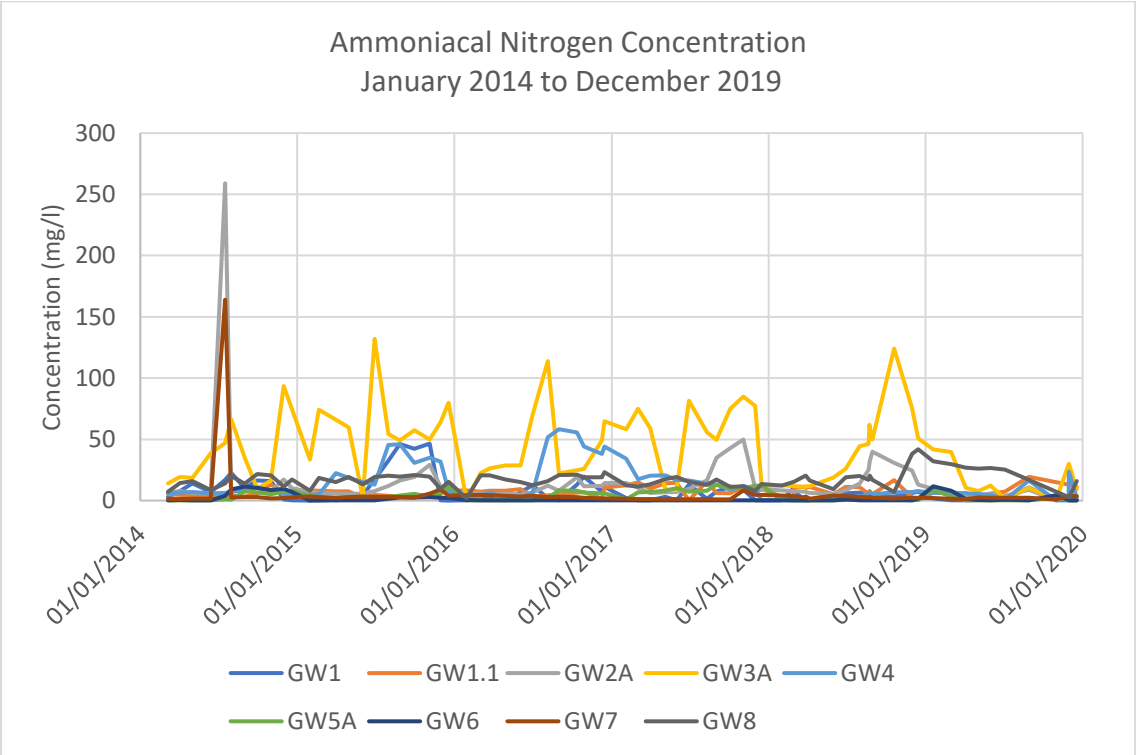
Table 1: Groundwater Quality (Monthly) 2018

Sample Description	Limit (GW2A, GW3A, GW4)	GW1			GW1.1			GW2A			GW3A			GW4		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Ammoniacal Nitrogen	1.7	0.20	10.60	1.51	0.20	19.40	8.84	0.20	9.50	5.05	0.60	41.70	17.54	0.35	23.60	6.65
Chloride	60	28.10	222.00	78.46	38.80	298.00	198.76	51.20	129.00	103.44	55.30	149.00	123.09	2.60	170.00	54.14
Conductivity @ 20 deg.C	N/A	0.58	3.30	2.49	1.52	1.71	1.61	0.58	1.54	1.22	0.92	2.00	1.54	0.11	2.58	1.20
Dissolved Oxygen	N/A	0.30	10.60	5.45	0.30	4.68	2.10	0.30	11.10	4.18	0.30	9.93	3.95	0.30	11.10	4.73
pH	N/A	6.56	7.87	7.44	6.45	7.60	6.94	6.43	8.08	7.35	6.91	8.41	7.63	6.40	7.73	7.02

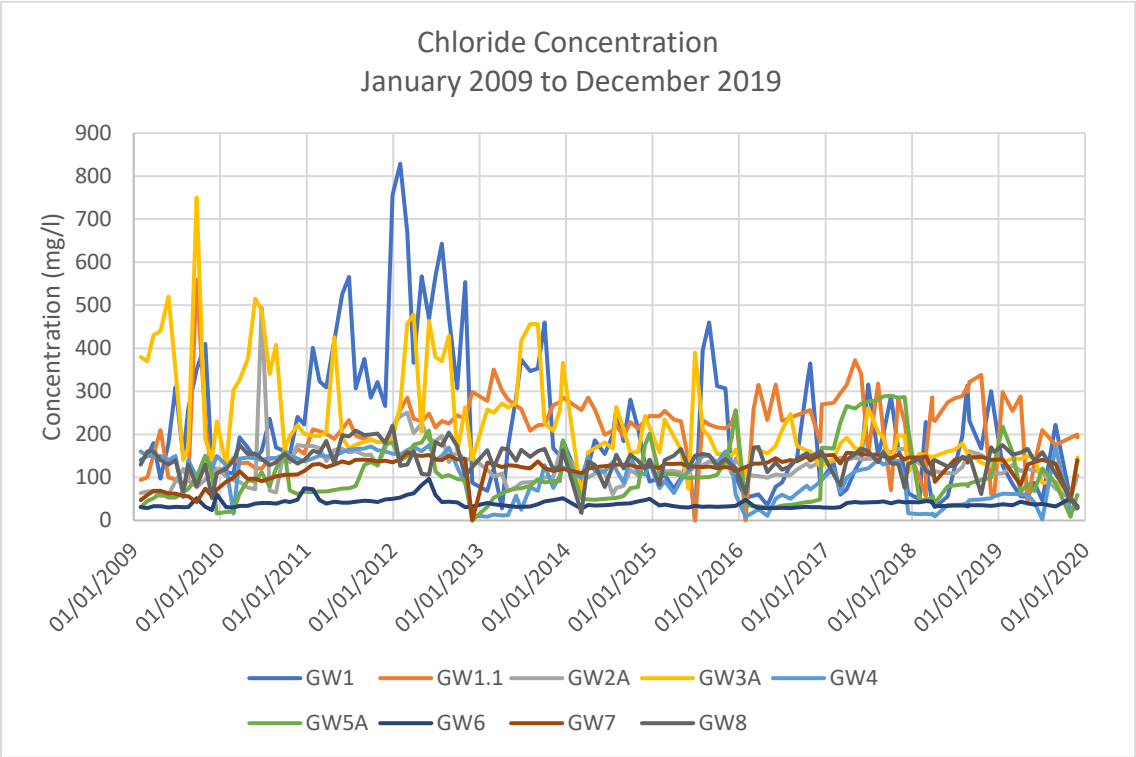
Sample Description	GW5A			GW6			GW7			GW8		
	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Ammoniacal Nitrogen	0.20	8.93	1.53	0.20	11.70	2.55	0.89	3.77	2.38	2.48	32.20	20.50
Chloride	8.60	218.00	93.03	32.70	51.00	38.09	44.70	142.00	119.56	29.00	175.00	124.10
Conductivity @ 20 deg.C	0.44	1.41	0.85	0.72	1.00	0.80	0.60	0.75	0.70	1.16	2.28	1.56
Dissolved Oxygen	3.95	11.70	6.96	1.14	10.20	4.30	0.86	9.65	3.61	0.30	11.20	2.90
pH	6.37	7.52	6.78	5.49	8.30	7.38	7.25	8.24	7.63	6.80	8.37	7.35

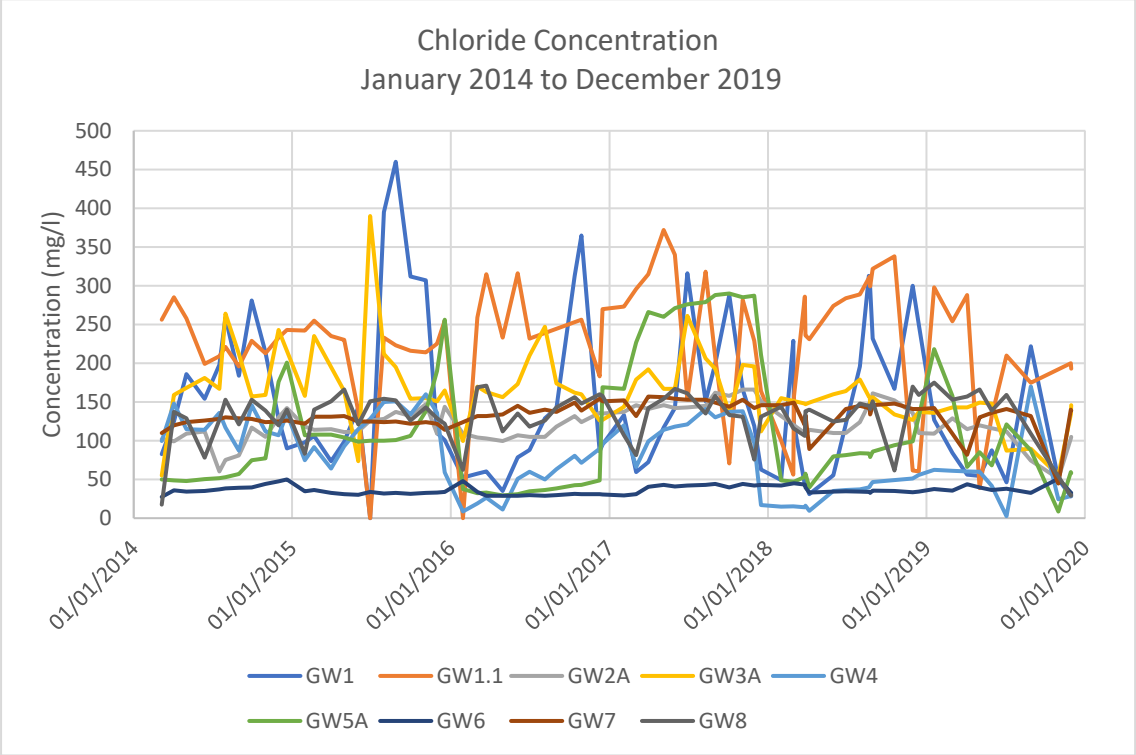
APPENDIX 3 - GROUNDWATER



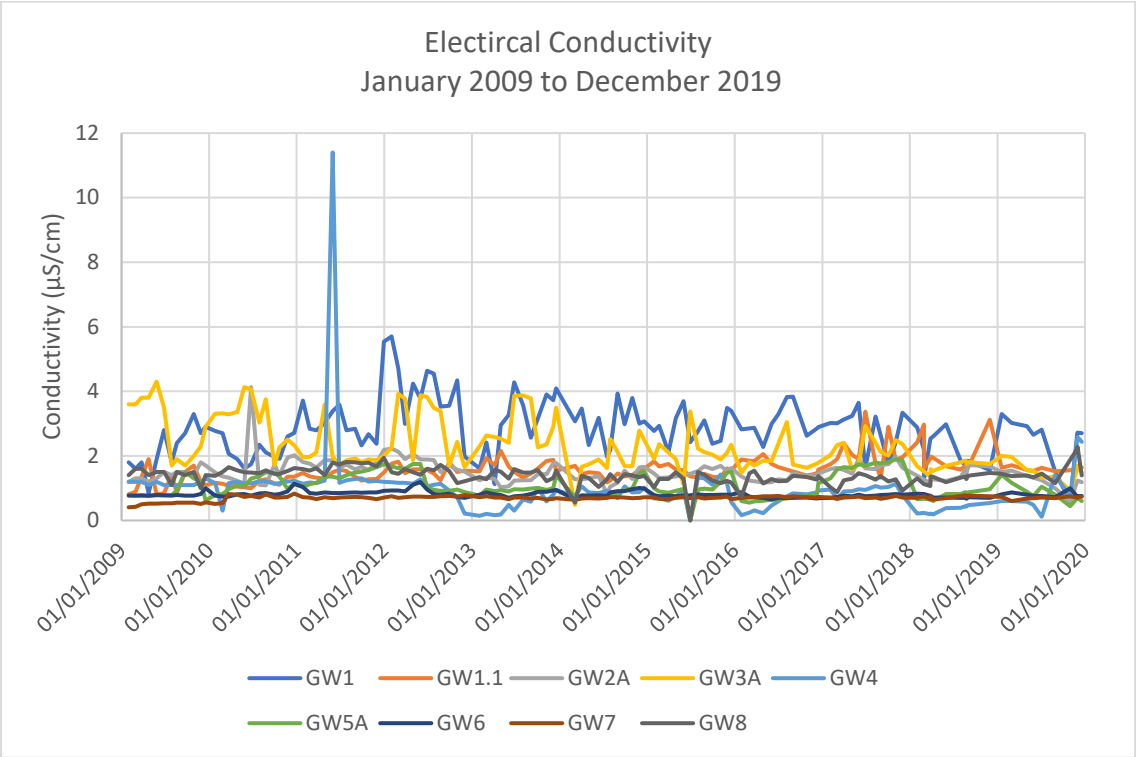


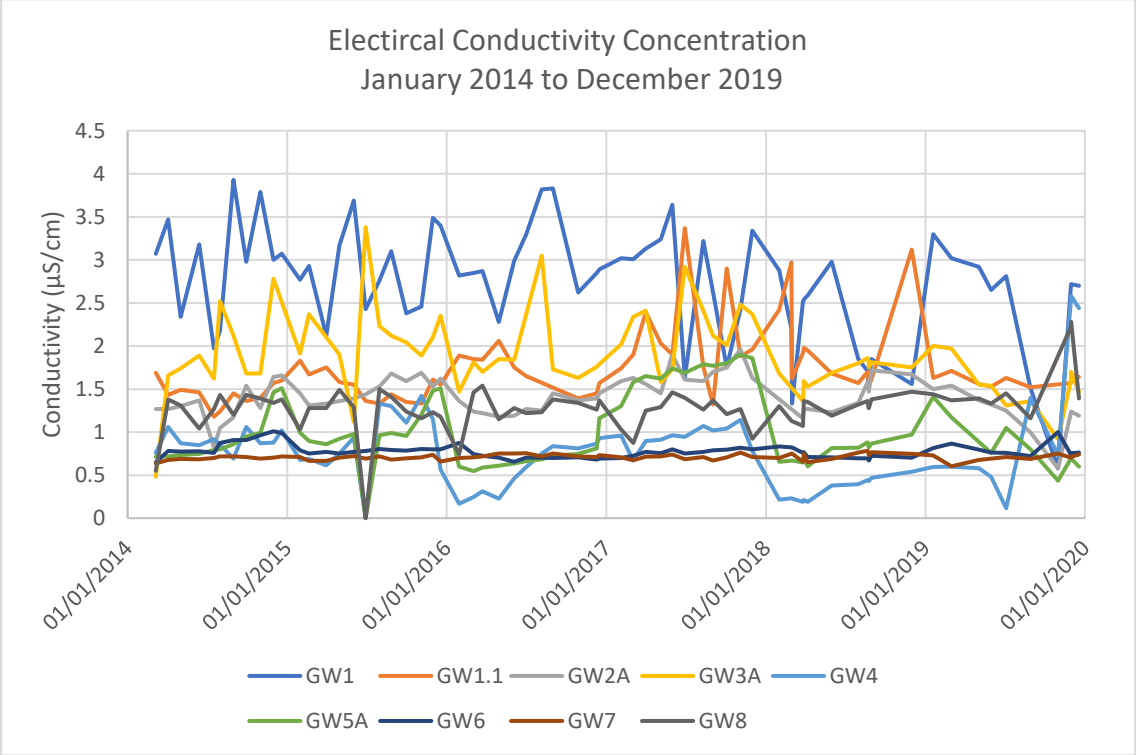
APPENDIX 3 - GROUNDWATER



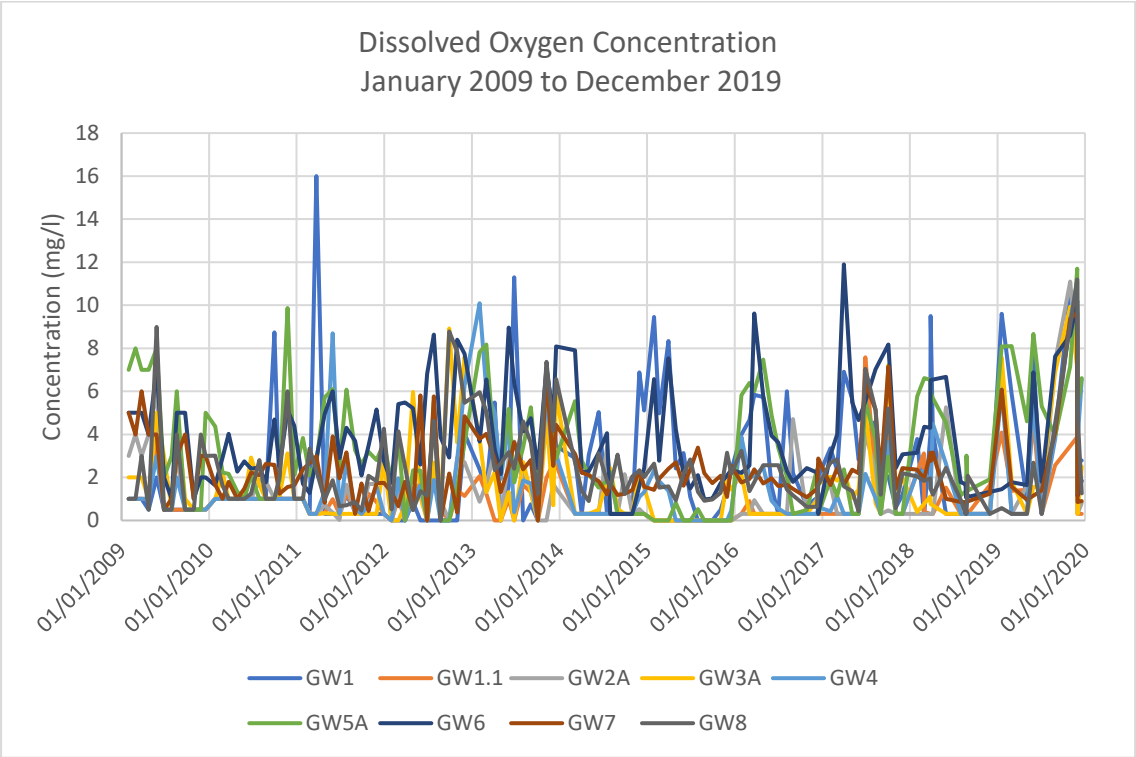


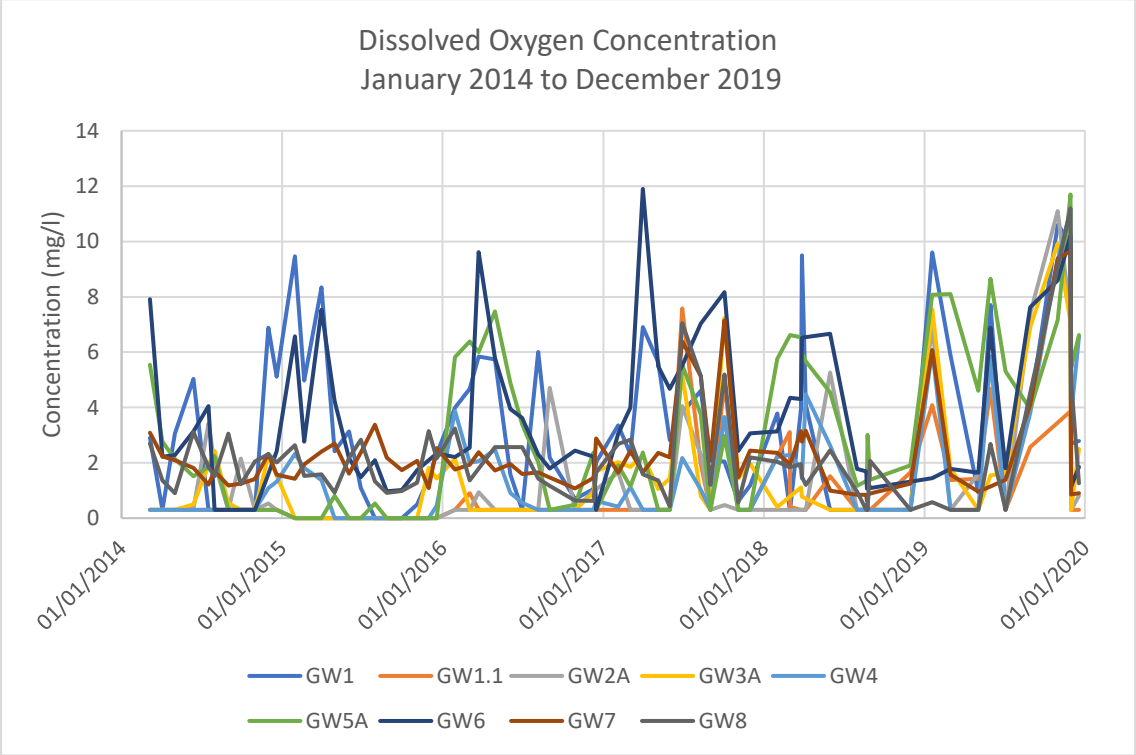
APPENDIX 3 - GROUNDWATER



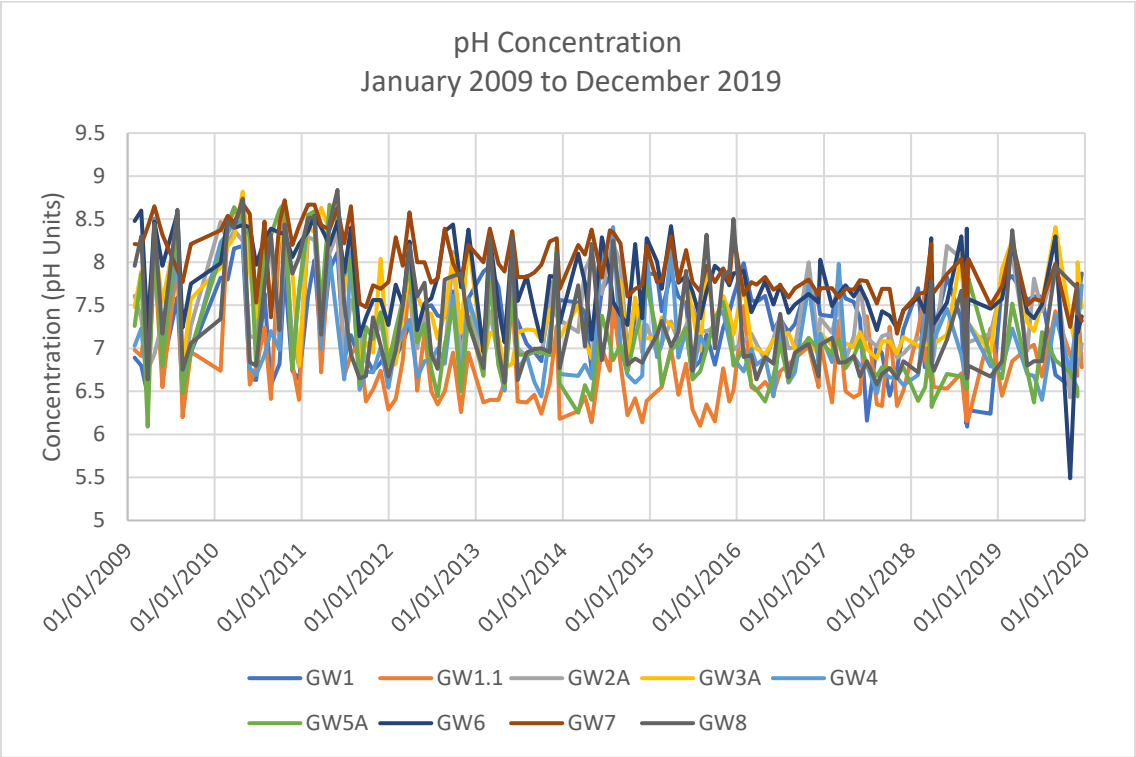


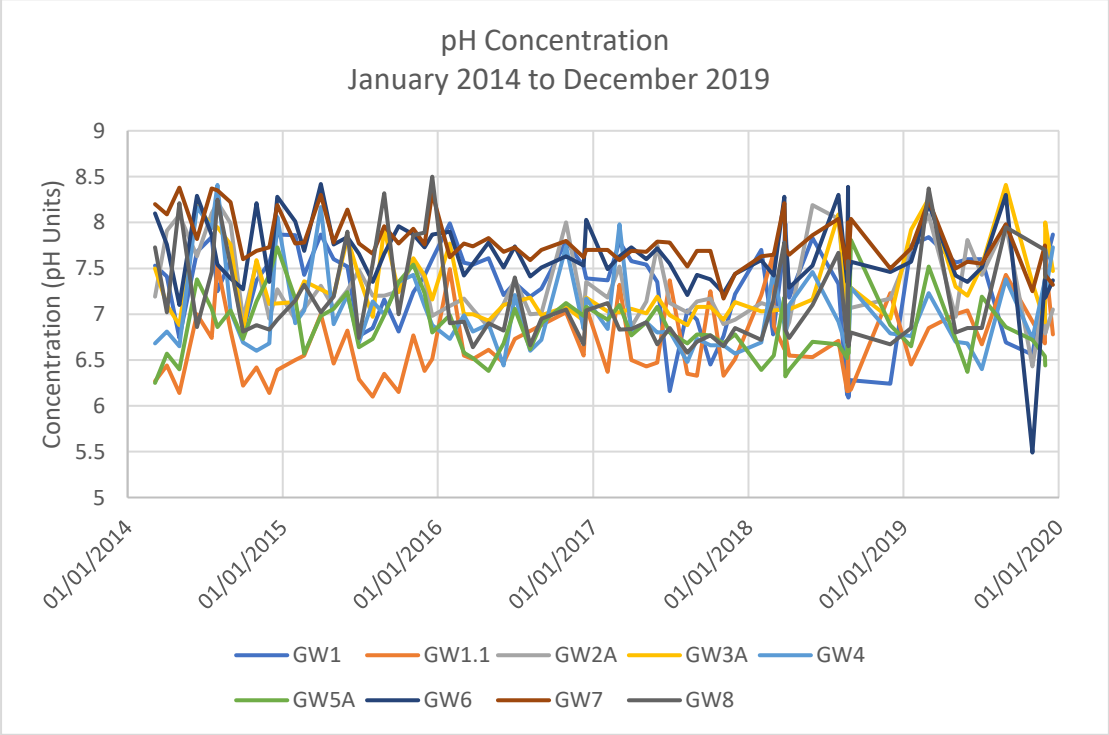
APPENDIX 3 - GROUNDWATER





APPENDIX 3 - GROUNDWATER





APPENDIX 2 - GROUNDWATER

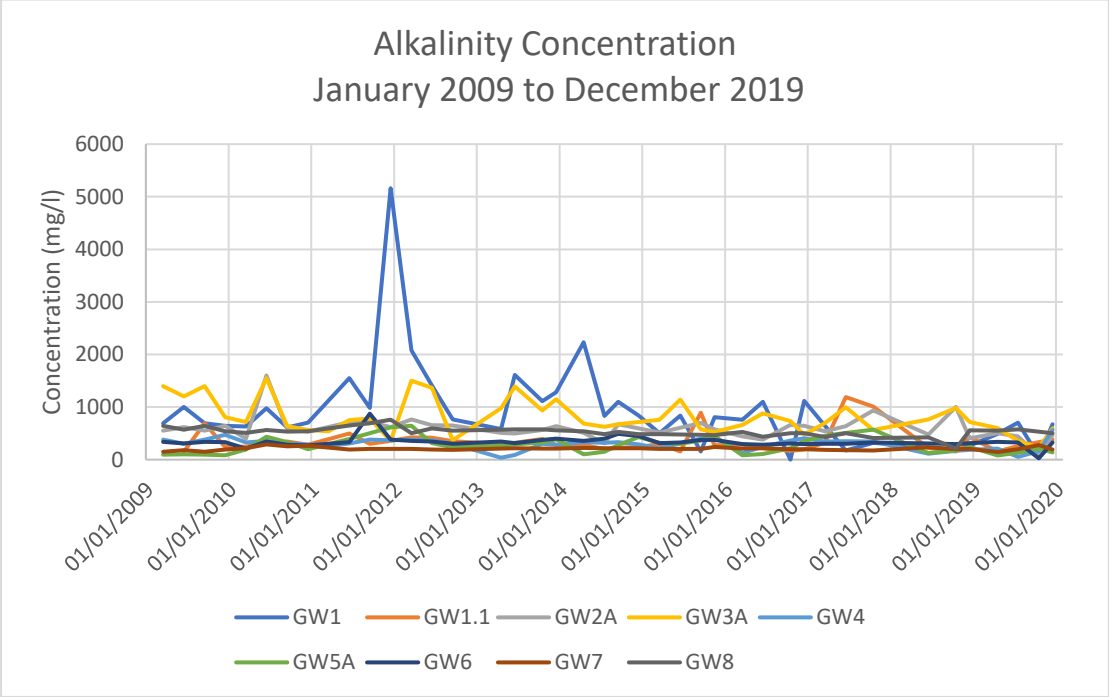
Table 2: Groundwater Quality (Quarterly)

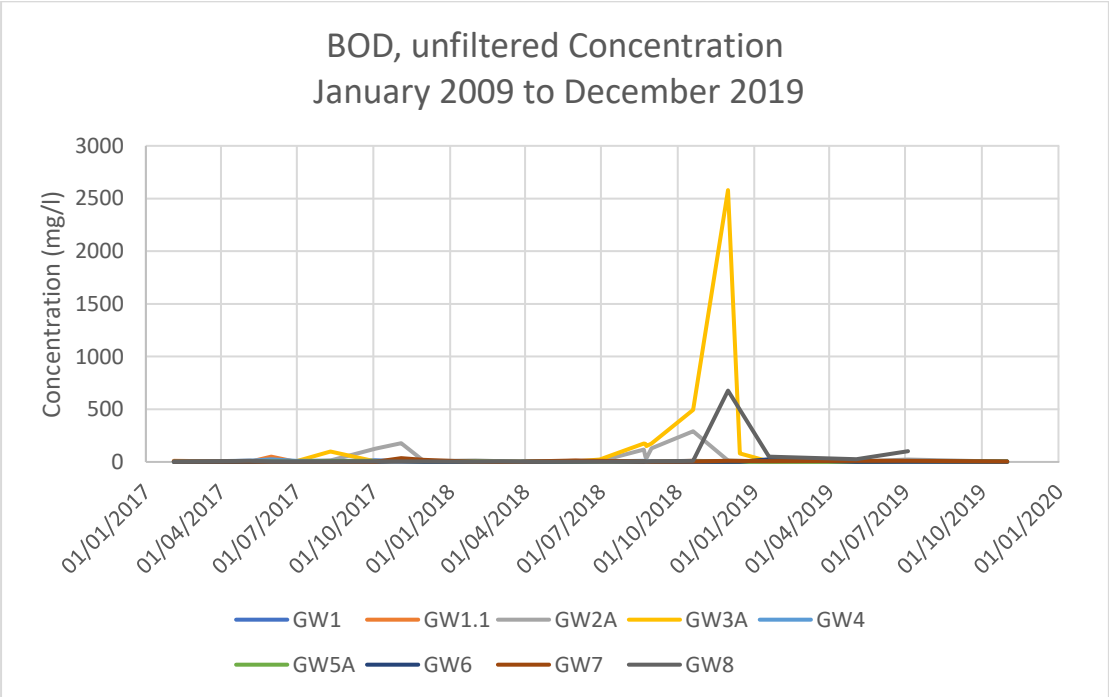
Sample Description		GW1			GW1.1			GW2A			GW3A			GW4		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity (mg/l)		60	705	482.5	157	382	266.7	60	500	367.8	230	598	445.2	50.2	565	247.3
BOD, unfiltered (mg/l)		1	3.4	1.6	3.5	9.76	7.58	1.67	21.3	7.618	1	7.14	4.4	3	9.35	5.6
Cadmium (mg/l)		0.00008	0.0005	0	0.00008	0.0005	0	0.00008	0.0005	0	0.00008	0.0005	0	0.00008	0.0005	0
Calcium (mg/l)		54.8	653	494.2	141	212	178.7	56.7	185	141.92	89.6	180	143.4	17.1	569	188.7
Chemical Oxygen Demand (COD) (mg/l)		72.3	147	104.43	108	116	112	64	128	88.3	13.9	113	79.63	94.7	243	187.23
Chromium (mg/l)		0.001	0.003	0.0015	0.001	0.0059	0.0026	0.001	0.003	0.0015	0.001	0.003	0.0015	0.001	0.00488	0.0026
Copper (mg/l)		0.0003	0.0136	0.0088	0.0003	0.0117	0.0041	0.0003	0.00702	0.00198	0.0003	0.0177	0.00508	0.00165	0.013	0.006688
Iron (mg/l)		0.019	0.052	0.0286	26.1	43.3	36.6	0.019	4.73	1.3476	0.019	4.61	1.847	0.019	8.13	2.6632
Lead (mg/l)		0.0002	0.00204	0.00066	0.0002	0.0192	0.00653	0.0002	0.00662	0.0018	0.0002	0.0234	0.006	0.0002	0.0173	0.0047
Magnesium (mg/l)		26	69	55.8	54.8	60.2	56.7	27	44.9	38.5	36.8	55.2	45.65	1.6	55.6	26.28
Manganese (mg/l)		0.0111	0.429	0.13358	6.87	8.44	7.477	0.075	5.96	4.2112	0.0655	0.966	0.49062	0.015	1.29	0.3769
Nickel (mg/l)	Limit							0.15			0.15			0.15		
	Values	0.0007	0.00933	0.00564	0.0187	0.0543	0.03543	0.000786	0.0378	0.0187965	0.000968	0.0289	0.013492	0.00244	0.0188	0.009218
Potassium (mg/l)		32.3	10.7	140	105.92	20	31.2	26.2	10.9	32.7	26.95	11	46.5	27.4	4.61	120
Sodium (mg/l)		64.6	28.2	47.3	36.82	88.6	115	103.53	29	64.9	54.2	51.4	130	91.25	2.8	29.6
Toluene (mg/l)	Limit							0.004			0.004			0.004		
	Values	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
Total Oxidised Nitrogen (TON) (mg/l)		0.641	7.13	2.8983	0.1	0.1	0.1	0.1	0.658	0.29	0.468	5.63	2.2027	0.1	0.724	0.42
Zinc (mg/l)	Limit							0.254			0.254			0.254		
	Values	0.0272	0.106	0.05248	0.001	0.041	0.0146	0.00181	0.0314	0.016358	0.00663	0.0475	0.024232	0.0047	0.0412	0.0191
m,p-Xylene (mg/l)	Limit							0.011			0.011			0.011		
	Values	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

APPENDIX 2 - GROUNDWATER

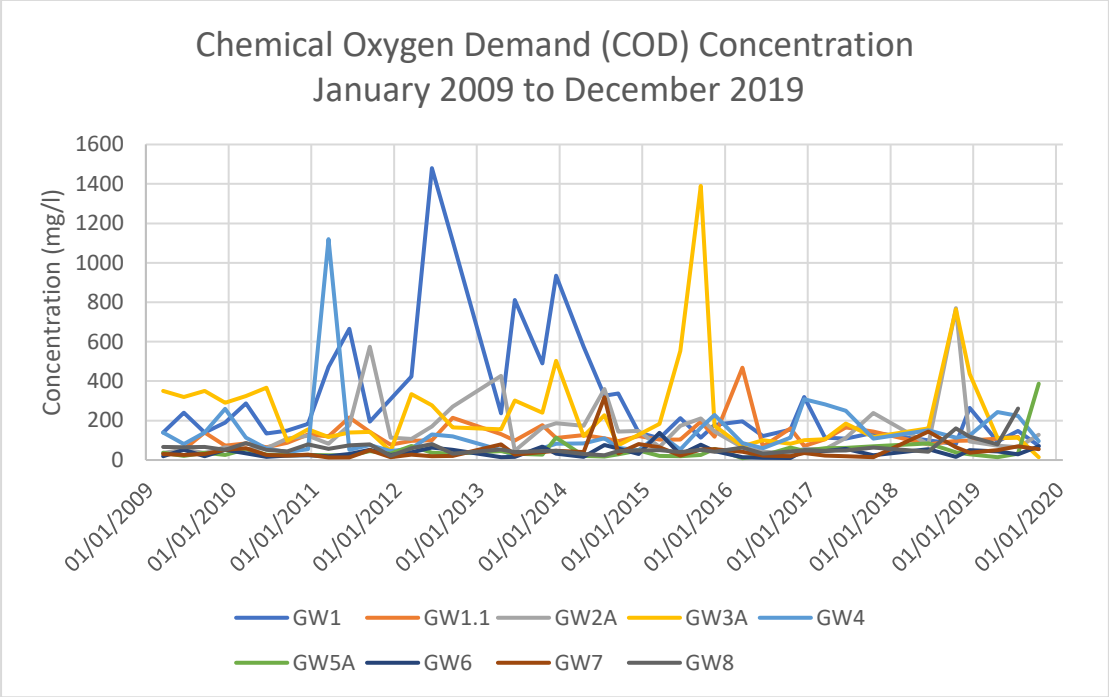
Sample Description	GW5A			GW6			GW7			GW8		
	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Alkalinity (mg/l)	80	210	140	25	340	253.8	145	275	202.5	500	575	541.7
BOD, unfiltered (mg/l)	1	4.16	2.7	1	25	7.7	4.3	10.2	7.95	25	101	58.7
Cadmium (mg/l)	0.00008	0.000626	0	0.00008	0.00269	0	0.00008	0.0005	0	0.00008	0.0005	0
Calcium (mg/l)	68.7	104	86.48	88.2	116	101.52	24.4	78.4	40.48	101	110	105.7
Chemical Oxygen Demand (COD) (mg/l)	14.9	387	144.67	28.8	68.8	46.93	49.8	69.2	57.93	78.7	261	169.85
Chromium (mg/l)	0.001	0.003	0.0015	0.001	0.003	0.0015	0.001	0.003	0.0015	0.001	0.003	0.0017
Copper (mg/l)	0.000747	0.00739	0.0039668	0.00157	0.0102	0.004588	0.0003	0.0069	0.00196	0.0003	0.00338	0.00145
Iron (mg/l)	0.019	0.246	0.077	0.019	0.0307	0.022	0.019	0.16	0.0786	0.201	0.43	0.3097
Lead (mg/l)	0.0002	0.00167	0.00057	0.0002	0.0056	0.00156	0.0002	0.00321	0.00095	0.0002	0.00436	0.00166
Magnesium (mg/l)	9.22	22.5	15.505	31.2	36.6	33.05	17.6	31.6	26.65	35.9	39.9	37.93
Manganese (mg/l)	0.0186	2.35	0.62535	0.901	7.38	3.7778	0.19	1.74	0.614	0.478	0.515	0.5013
Nickel (mg/l)	0.00127	0.0469	0.028542	0.00286	0.0883	0.02647	0.000954	0.0102	0.0043035	0.0206	0.0241	0.022
Potassium (mg/l)	7.06	11.5	9.328	20.3	24.8	21.95	11.4	26.1	19.75	34.5	38.4	36.73
Sodium (mg/l)	10.9	76.6	44.15	19.5	68.5	32.55	44.2	73	61.4	111	113	112
Toluene (mg/l)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Total Oxidised Nitrogen (TON) (mg/l)	0.1	17.8	8.94	5.68	14.3	8.91	0.1	2.95	1.06	0.1	0.1	0.1
Zinc (mg/l)	0.0106	0.0788	0.04088	0.0164	0.167	0.06455	0.00388	0.0295	0.016802	0.001	0.0171	0.0076
m,p-Xylene (mg/l)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

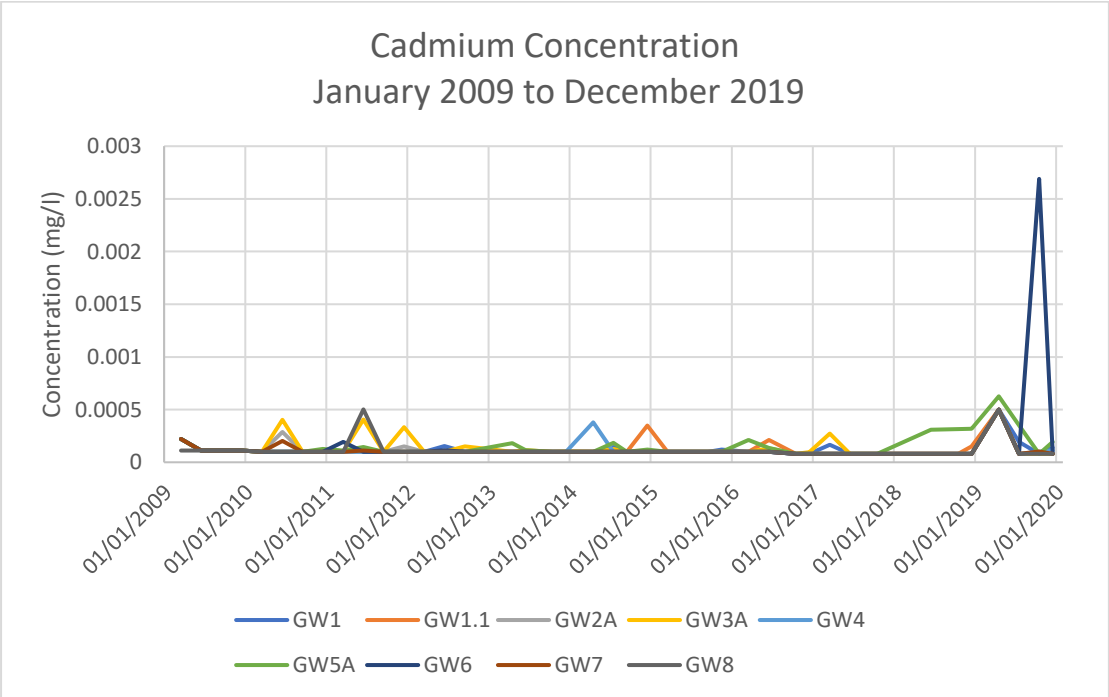
APPENDIX 3 - GROUNDWATER



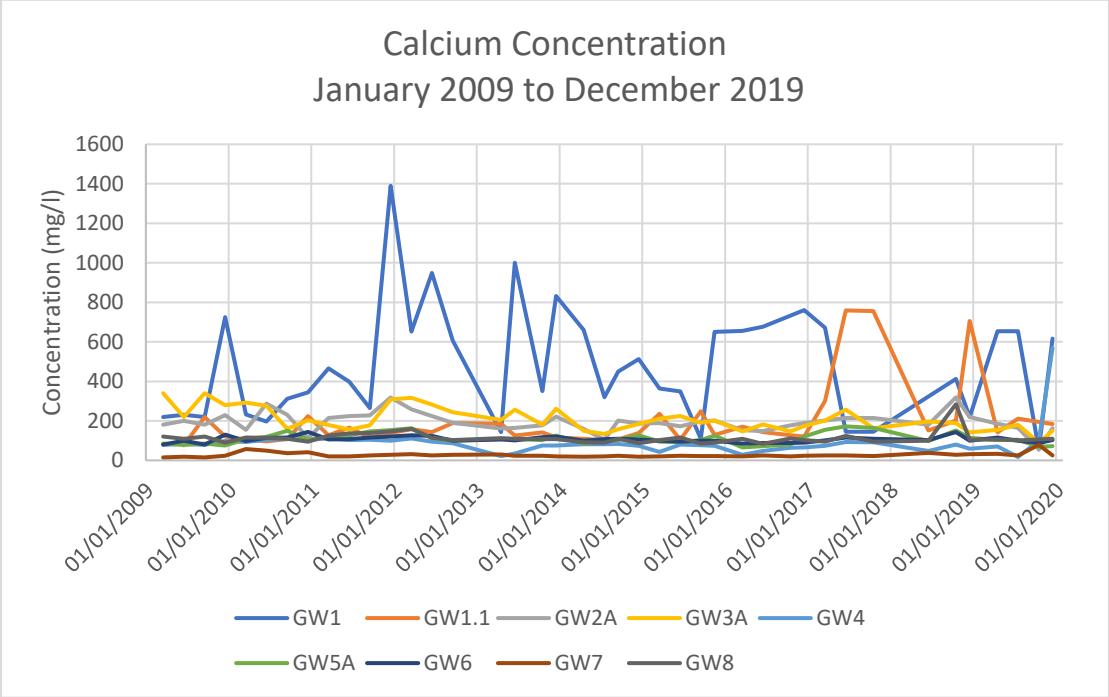


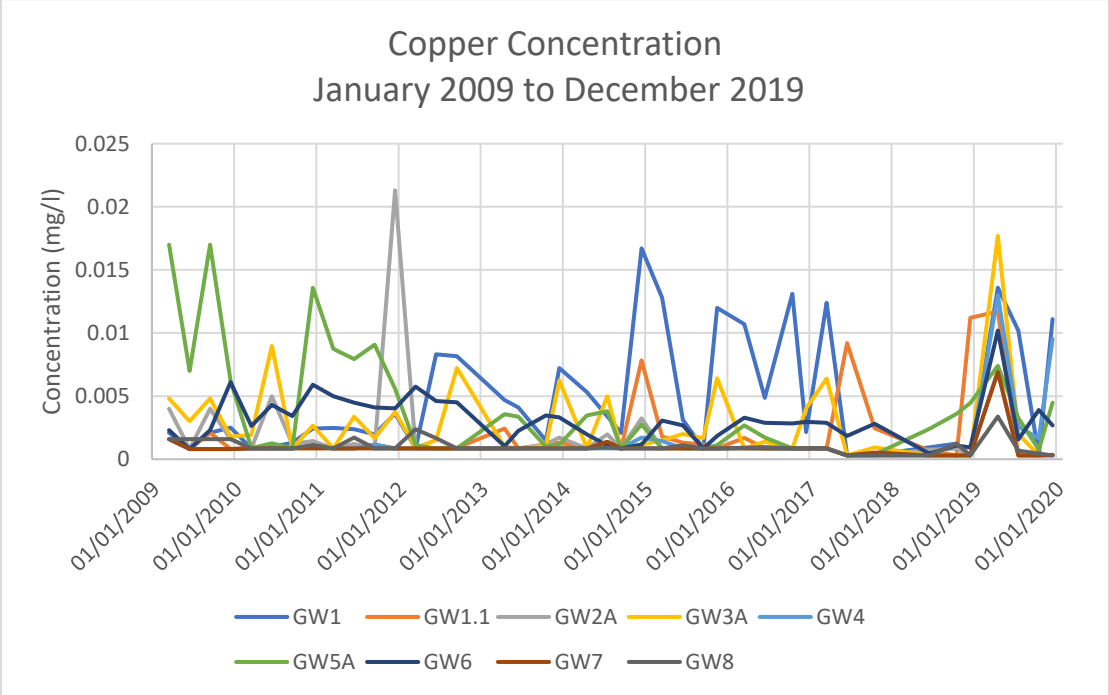
APPENDIX 3 - GROUNDWATER



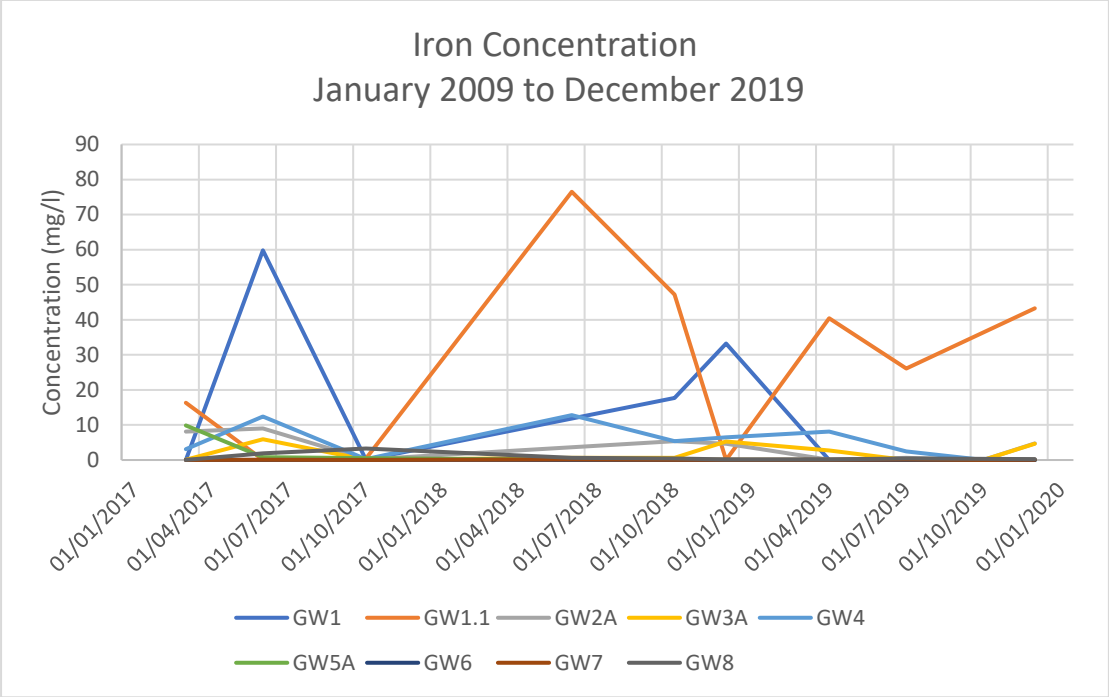


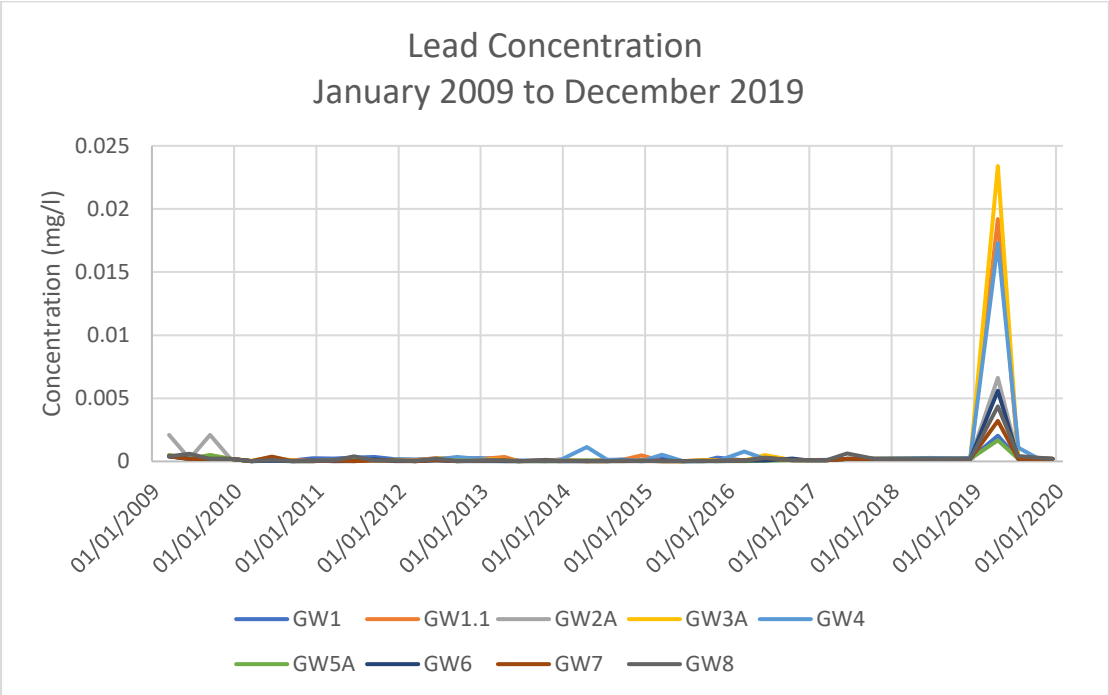
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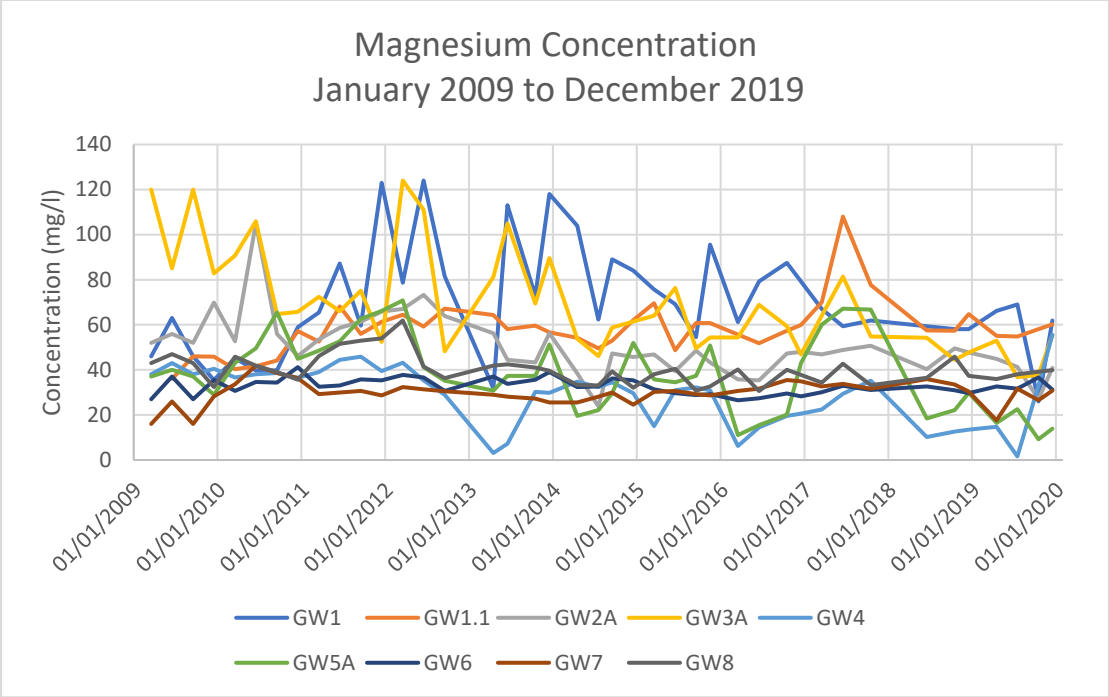


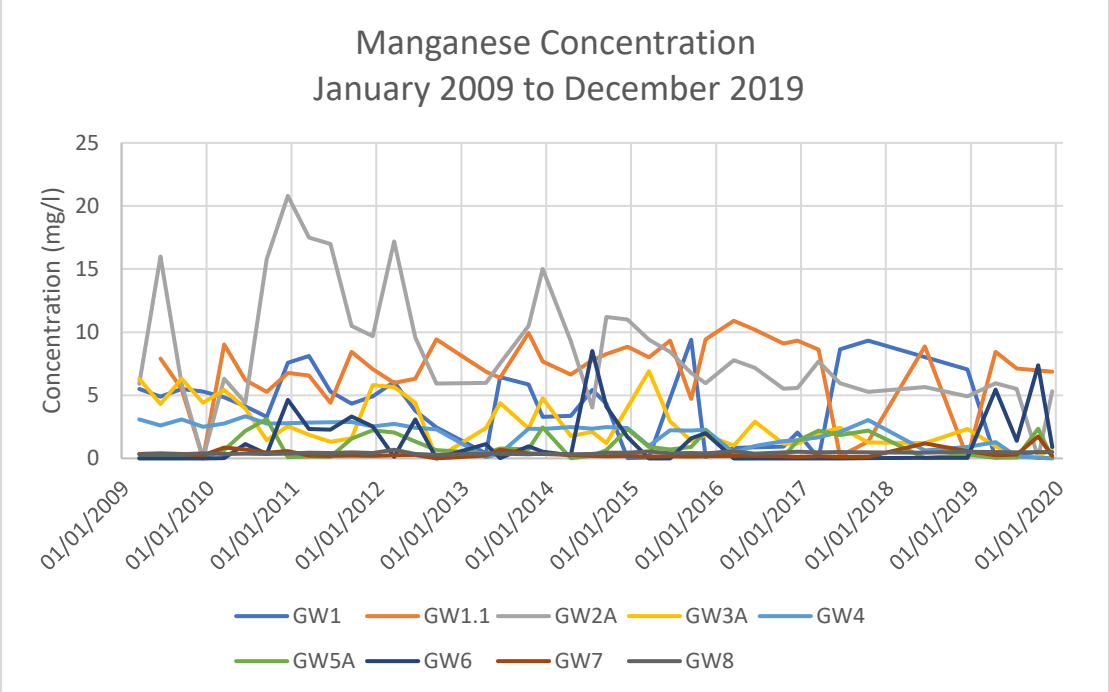
APPENDIX 3 - GROUNDWATER



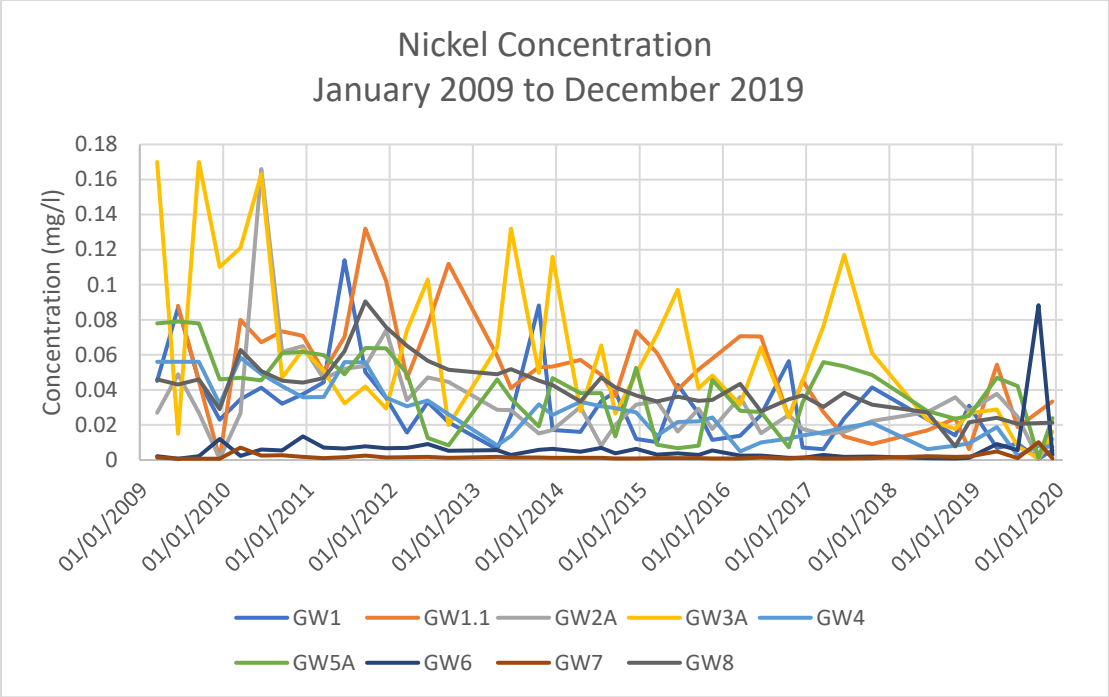


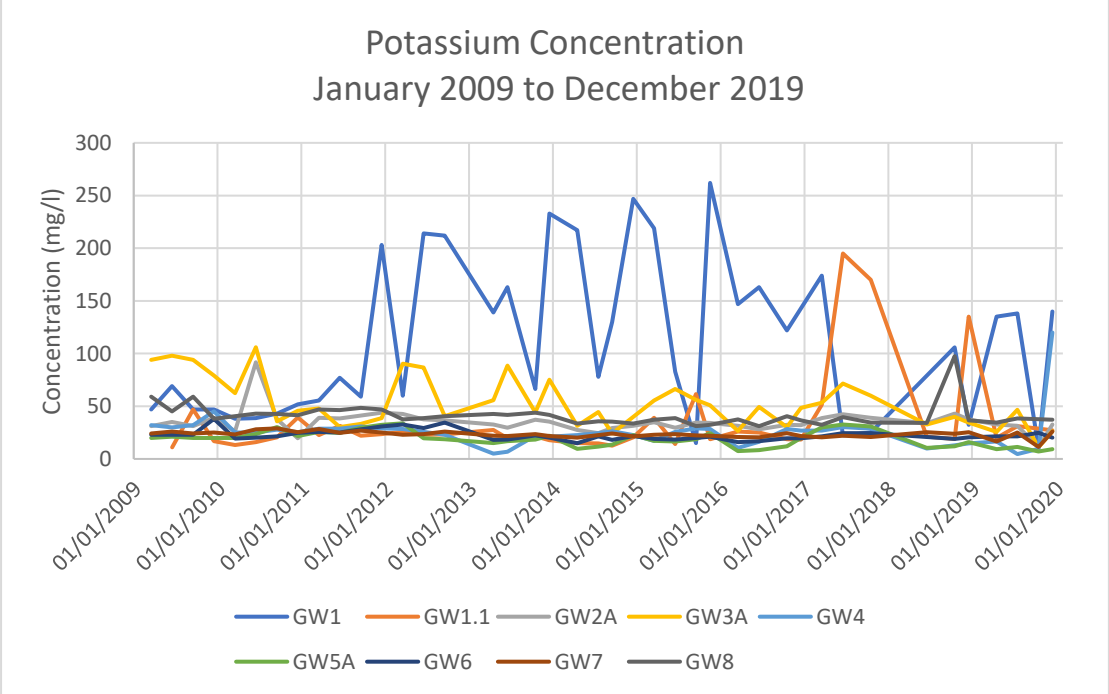
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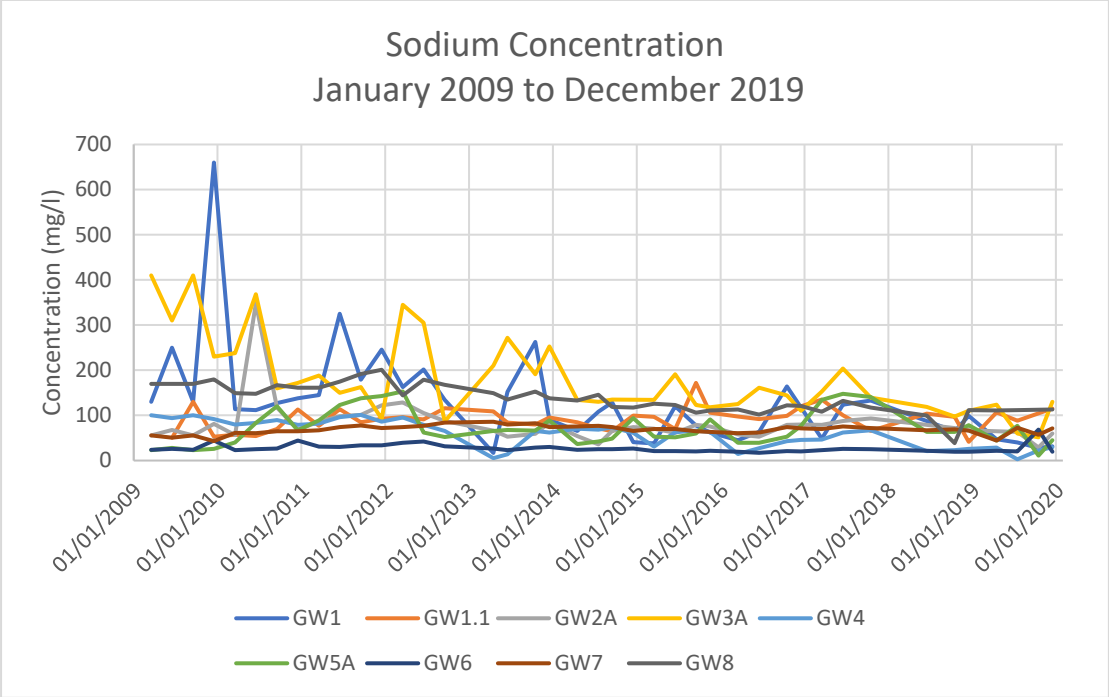


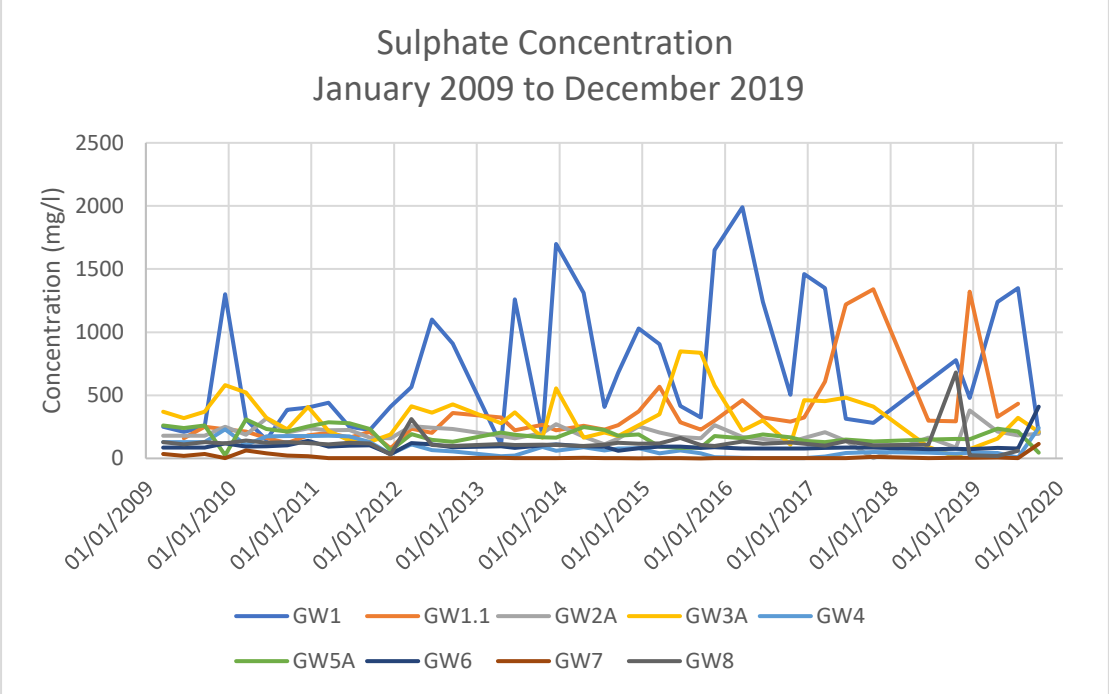
APPENDIX 3 - GROUNDWATER



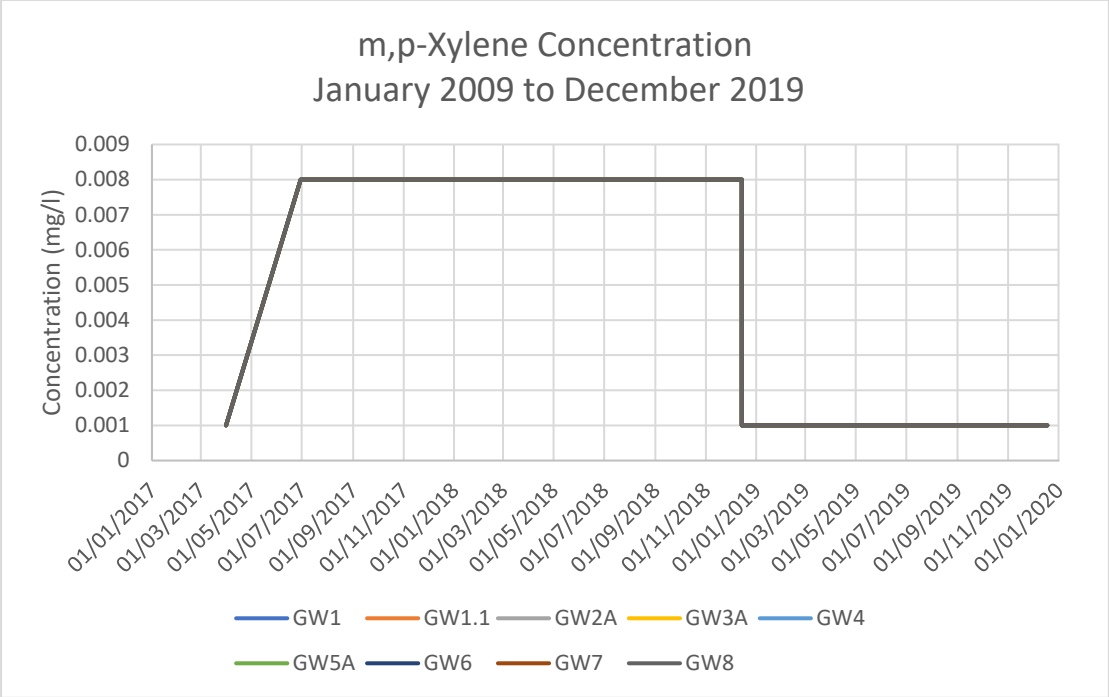


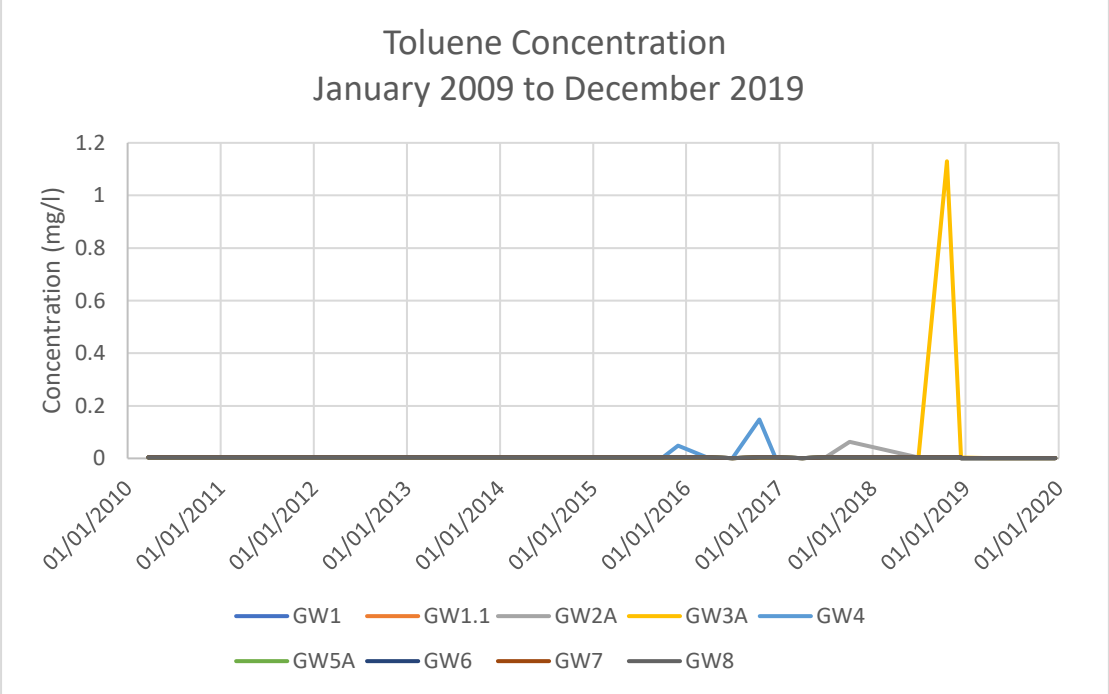
APPENDIX 3 - GROUNDWATER



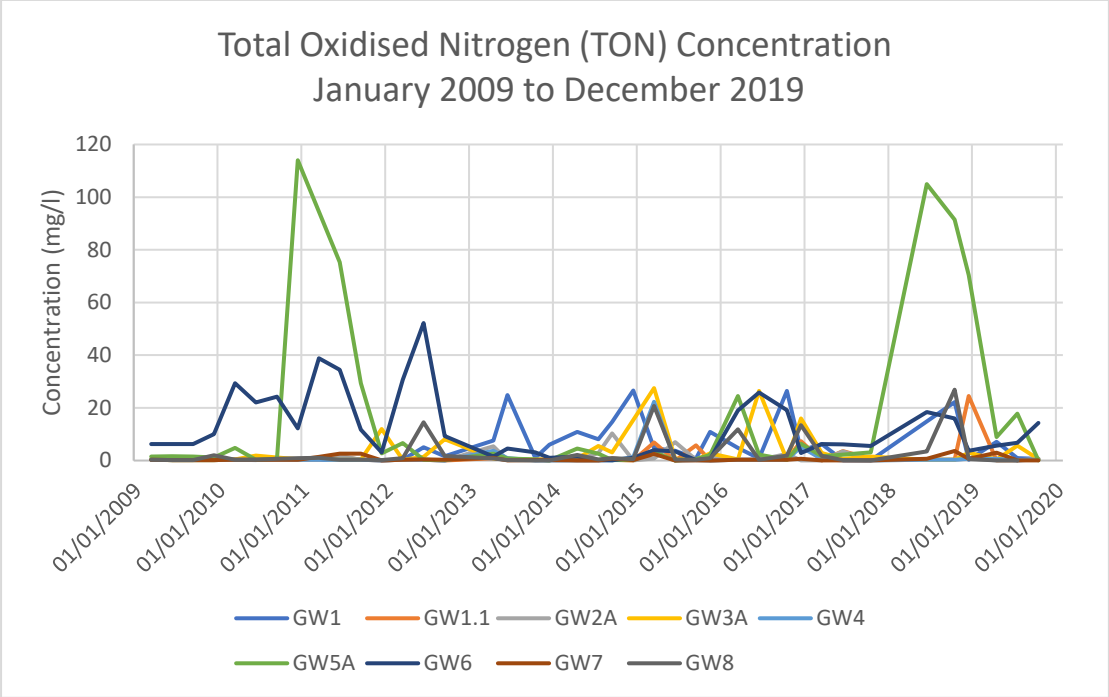


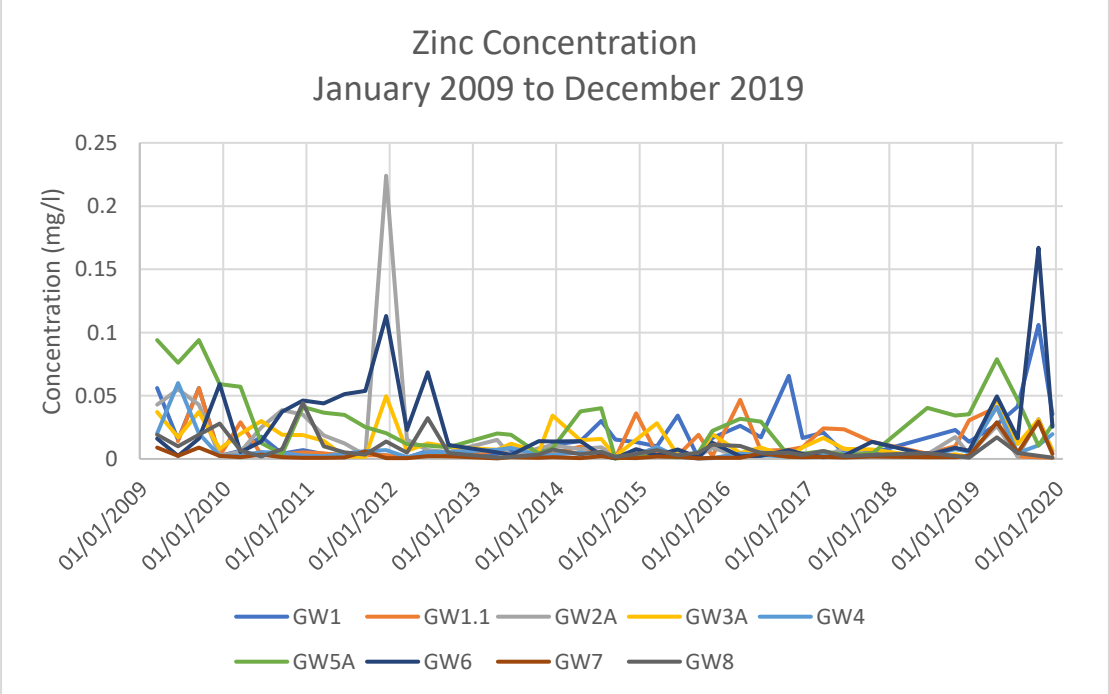
APPENDIX 3 - GROUNDWATER





APPENDIX 3 - GROUNDWATER





APPENDIX 2 - GROUNDWATER

Table 3: Groundwater Quality (Hazardous Suite). Detected hazardous substances are highlighted

Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Inorganics										
Cyanide, Free	mg/l	<0.05	<0.05	<0.05	<0.05	0.18	0.23	<0.05	<0.05	<0.05
Cyanide, Total	mg/l	<0.05	<0.05	<0.05	<0.05	4.33	4.12	<0.05	<0.05	0.09
Filtered (Dissolved) Metals										
Cadmium (diss.filt)	mg/l	<0.00008	0.000138	<0.00008	<0.00008	0.000114	0.000195	<0.00008	<0.00008	<0.00008
Chromium (diss.filt)	mg/l	<0.001	<0.001	<0.001	<0.001	0.00362	<0.001	<0.001	<0.001	<0.001
Copper (diss.filt)	mg/l	<0.0003	0.0111	<0.0003	<0.0003	0.00952	0.00447	0.00269	0.000336	<0.0003
Iron (Dis.Filt)	mg/l	43.3	0.0244	4.73	4.61	0.0237	<0.019	0.0192	0.0346	0.298
Lead (diss.filt)	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (diss.filt)	mg/l	6.87	0.0111	5.32	0.798	0.015	0.0186	0.901	0.19	0.515
Mercury (diss.filt)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Nickel (diss.filt)	mg/l	0.0333	0.00568	0.012	0.0162	0.0075	0.0239	0.00286	0.000954	0.0213
Zinc (diss.filt)	mg/l	<0.001	0.0354	0.00612	0.00663	0.0197	0.0273	0.0254	0.00388	<0.001
Mineral Oil / Oils & Greases										
Mineral oil >C10 C40 (aq)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Semi-Volatile Organic Compounds (SVOCs)										
1,2,4-Trichlorobenzene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichlorobenzene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichlorobenzene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4,5-Trichlorophenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4,6-Trichlorophenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dichlorophenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dimethylphenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dinitrotoluene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,6-Dinitrotoluene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
2-Chloronaphthalene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Chlorophenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Methylnaphthalene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Methylphenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Nitroaniline (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Nitrophenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3-Nitroaniline (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Bromophenylphenylether (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Chloro-3-methylphenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Chloroaniline (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Chlorophenylphenylether (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Methylphenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Nitroaniline (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Nitrophenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Acenaphthene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Acenaphthylene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Anthracene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Azobenzene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(a)anthracene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(a)pyrene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(b)fluoranthene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(g,h,i)perylene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(k)fluoranthene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-Chloroethoxy)methane (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-Chloroethyl)ether (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-Ethylhexyl) phthalate (aq)	mg/l	<0.008	<0.002	<0.008	<0.002	<0.002	<0.002	<0.002	<0.002	0.00279
Butylbenzyl phthalate (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Carbazole (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chrysene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenzo(a,h)anthracene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibenzofuran (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diethyl phthalate (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dimethyl phthalate (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoranthene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluorene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorobenzene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorobutadiene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorocyclopentadiene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachloroethane (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Indeno(1,2,3-cd)pyrene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isophorone (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphthalene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Dibutyl phthalate (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Dioctyl phthalate (aq)	mg/l	<0.02	<0.005	<0.02	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrobenzene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Nitroso-n-dipropylamine (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pentachlorophenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenanthrene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phenol (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pyrene (aq)	mg/l	<0.004	<0.001	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Volatile Organic Compounds (VOCs)										
1,1,1,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2,2-Tetrachloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
1,1,2-Trichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3-Trichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trimethylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dibromo-3-chloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dibromoethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trimethylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2,2-Dichloropropane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Bromofluorobenzene**	%	94.8	94.3	93.4	95.2	94.8	94.6	95.4	95.8	95.6
4-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-iso-Propyltoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromodichloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Bromoform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbon disulphide	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbontetrachloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,2-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
cis-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromochloromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromofluoromethane**	%	119	117	116	108	117	117	117	116	118
Dibromomethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichlorodifluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dichloromethane	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ethylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorobutadiene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isopropylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
m,p-Xylene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methyl tertiary butyl ether (MTBE)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphthalene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
o-Xylene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Propylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
sec-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Styrene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
tert-Amyl methyl ether (TAME)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

APPENDIX 2 - GROUNDWATER

Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
tert-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tetrachloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene-d8**	%	98	98.2	99.6	99.4	99.1	98.7	99.4	99.4	99.5
trans-1,2-Dichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
trans-1,3-Dichloropropene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Trichlorofluoromethane	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vinyl chloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Combined Pesticides / Herbicides										
Aldrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
alpha-HCH	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Atrazine	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Azinphos ethyl	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Azinphos methyl	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
beta-HCH	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Carbophenothion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorfenvinphos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorothalonil	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorpyriphos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorpyriphos-methyl	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
cis-Chlordane	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Diazinon	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Dichlorvos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Dieldrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Dimethoate	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Disulfoton	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001

APPENDIX 2 - GROUNDWATER

Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Endosulphan I	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Endosulphan II	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Endosulphan Sulphate	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Endrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Ethion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Etrimphos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Fenitrothion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Fenthion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
gamma-HCH (Lindane)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Heptachlor	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Heptachlor epoxide	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Hexachlorobenzene	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Isodrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Malathion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Methyl Parathion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Mevinphos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
o,p'-DDD (TDE)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
o,p'-DDE	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
o,p'-DDT	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
p,p'-DDD (TDE)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
p,p'-DDE	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
p,p'-DDT	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
p,p'-Methoxychlor	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Parathion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Pendimethalin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Permethrin I	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Permethrin II	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001

APPENDIX 2 - GROUNDWATER

Sample Description	Units	GW1.1	GW1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Phosalone	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Pirimiphos-methyl	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Propetamphos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Quintozene (PCNB)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Simazine	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Tecnazene	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Telodrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
trans-Chlordane	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Triadimefon	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Triallate	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Triazophos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Trifluralin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Miscellaneous Organics										
Dibutyl tin	mg/l	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Surrogate	%	71.5	114	97.1	80	104	116	119	93.9	111
Tetrabutyl tin	mg/l	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002	<0.000002
Tributyl tin	mg/l	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001
Triphenyl tin	mg/l	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001

APPENDIX 4

Surface Water Quality Summary Table and Time-Series Graphs

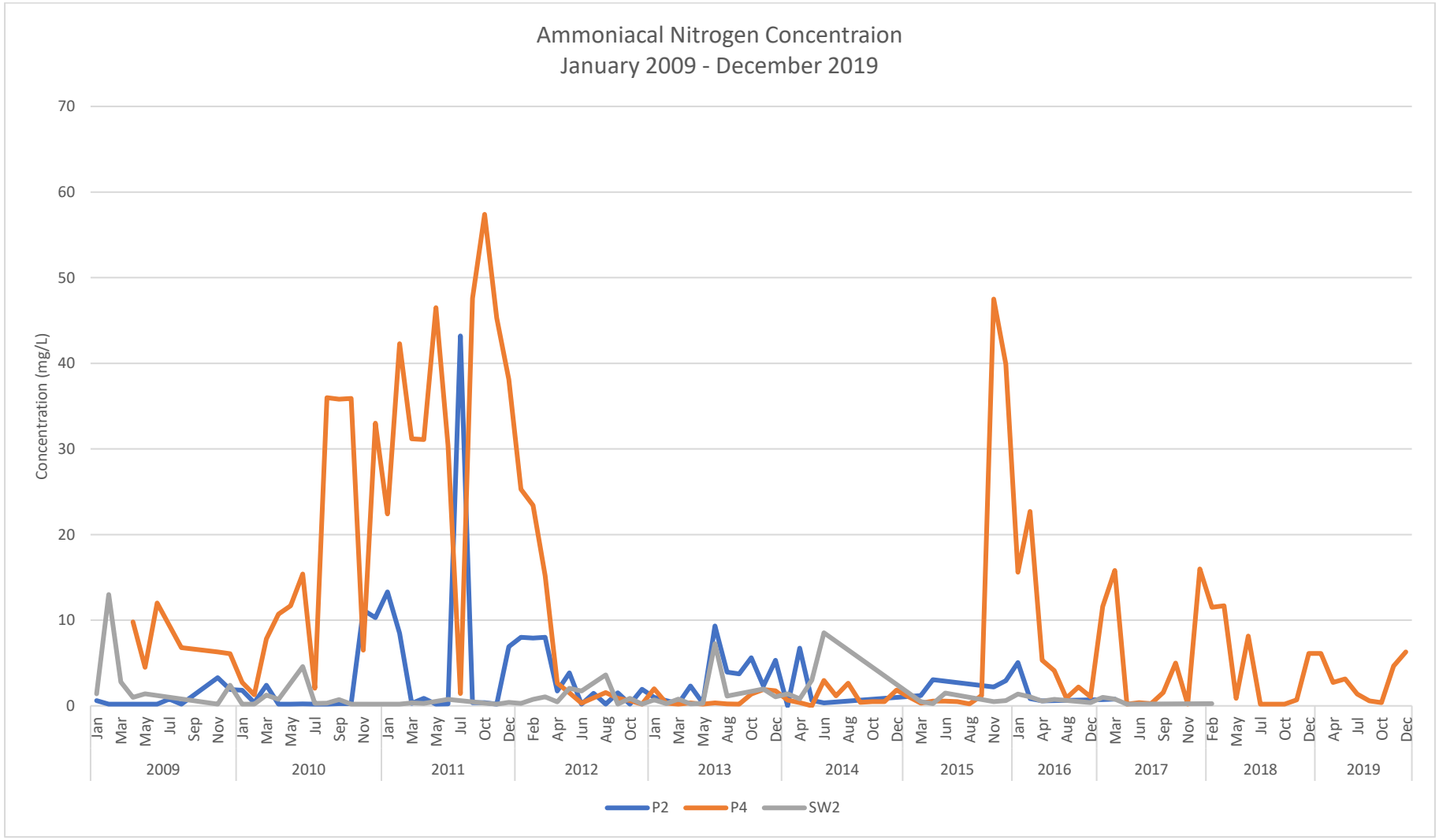
APPENDIX 4

Table 1: Monthly Surface Water Quality (2019)

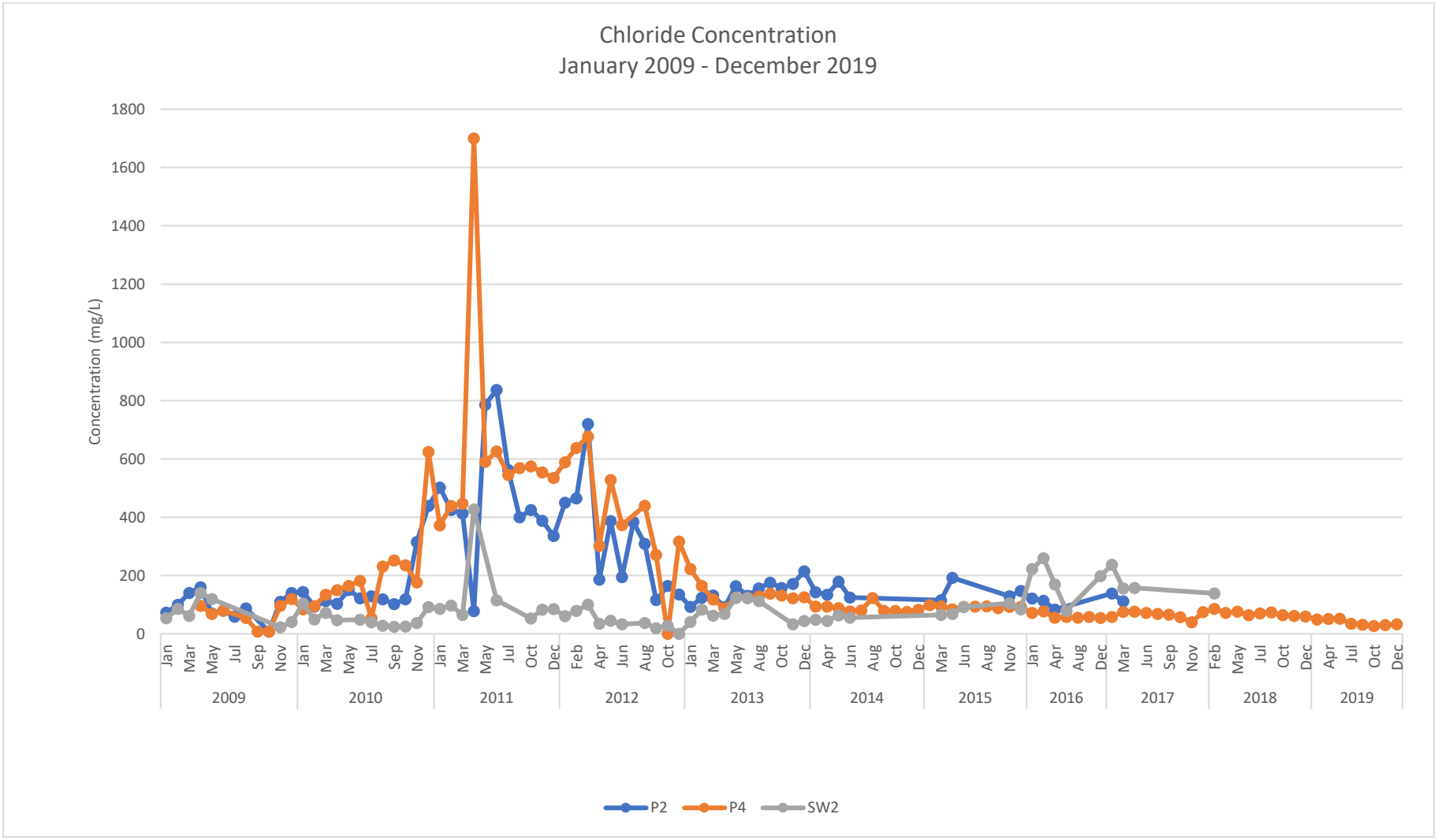
Location	Ammoniacal Nitrogen as NH			Chloride			COD, unfiltered			pH			Suspended solids, Total		
	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
EP Limit	**1.6**			**250**			**100**			**>6 < 9**			**100**		
P4	0.37	6.31	3.09	26.90	52.00	39.09	65.00	121.00	80.03	7.58	8.16	7.94	2.00	53.00	20.73

APPENDIX 4

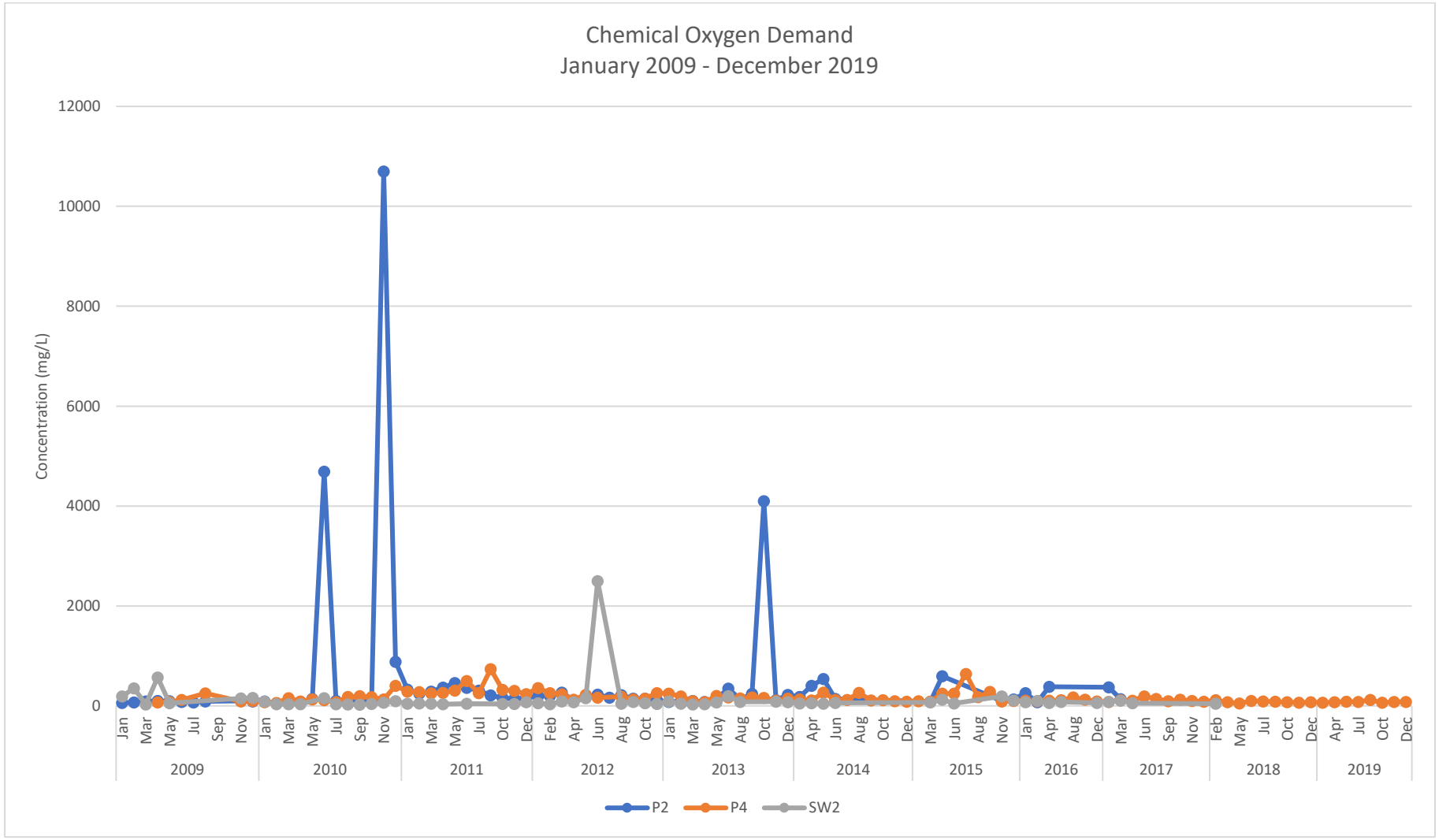
Time Series Graphs



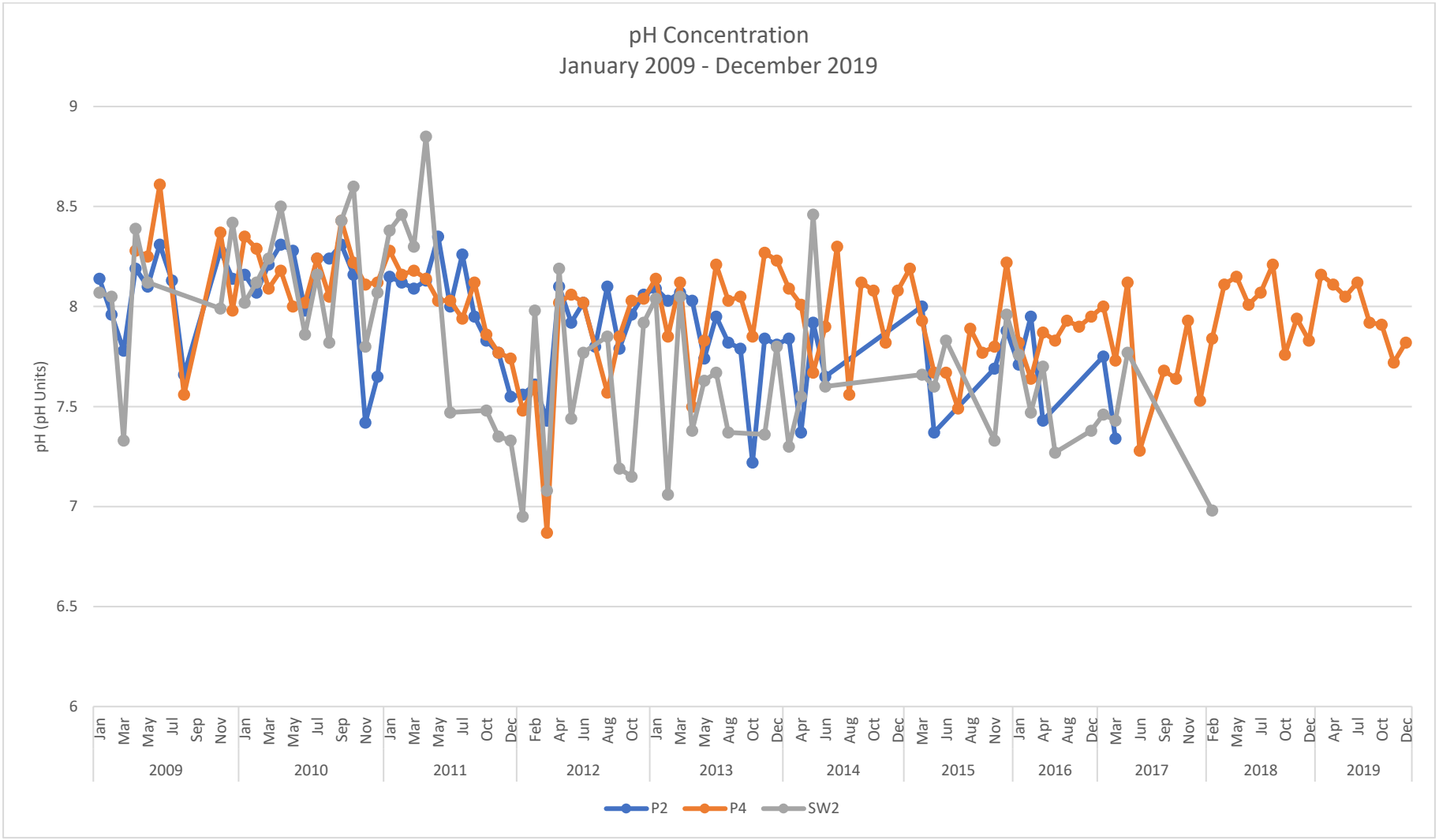
APPENDIX 4


Chloride Concentration
January 2009 - December 2019
Concentration (mg/L)
1800
1600
1400
1200
1000
800
600
400
200
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
P2
P4
SW2

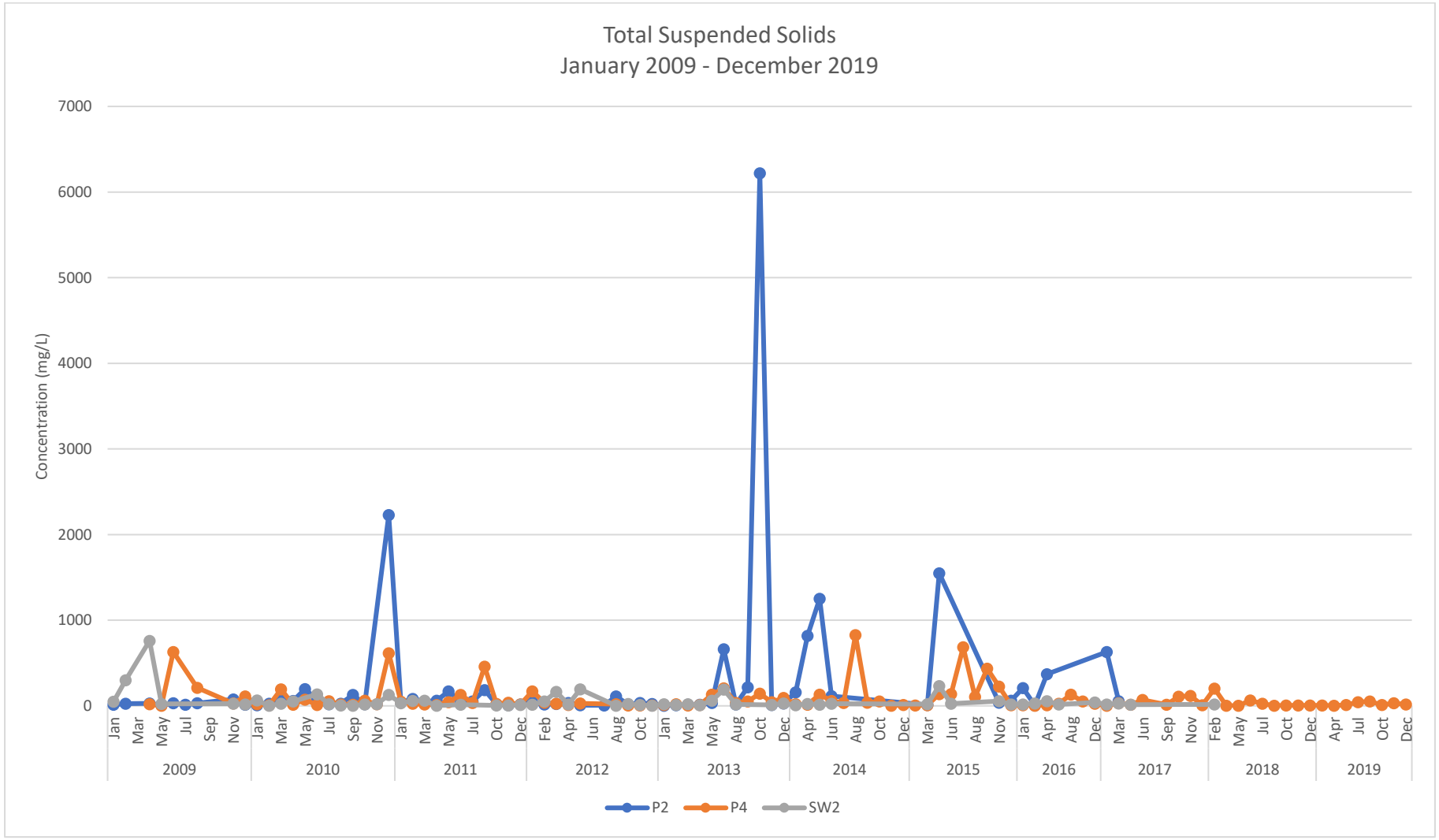
APPENDIX 4


Chemical Oxygen Demand
January 2009 - December 2019
Concentration (mg/L)
12000
10000
8000
6000
4000
2000
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
P2
P4
SW2

APPENDIX 4


pH Concentration
January 2009 - December 2019
pH (pH Units)
9
8.5
8
7.5
7
6.5
6
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
P2
P4
SW2

APPENDIX 4


Total Suspended Solids
January 2009 - December 2019
Concentration (mg/L)
7000
6000
5000
4000
3000
2000
1000
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
P2
P4
SW2

APPENDIX 5

Deposited Dust Monitoring results

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge duing the period of:

From: 04/03/2019 To: 04/04/2019
No. of days 31

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3

Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1	500	<10	<7.97
Location 2	2900	<10	<7.97
Location 3	1800	<10	<7.97

Comments:

►Dust analysis carried out by Concept Life Sciences Laboratories, Manchester

Location 2 location changed to access issues with new fencing surrounding LTP. Dust gauge now located near to electricity meter house.

Location 1: Site Operations - located opposite "new" transfer pad
Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house
Location 3: Oaks Farm

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge duing the period of:

From: 03/06/2019 To: 03/07/2019
No. of days 30

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3

Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1		24	19.76
Location 2		<5	<4.12
Location 3		5	4.12

Comments:

►Dust analysis carried out by DETS

Location 2 location changed to access issues with fencing surrounding LTP. Dust gauge now located near to electricity meter house.

Location 1: Site Operations - located opposite "new" transfer pad
Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house
Location 3: Oaks Farm

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge duing the period of:

From: 02/09/2019 To: 09/10/2019
No. of days 37

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3

Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1		45	30.04
Location 2		15	10.01
Location 3		130	86.78

Comments:

►Dust analysis carried out by DETS

Location 2 location changed due to access issues with fencing surrounding LTP. Dust gauge now located near to electricity meter house.

Location 1: Site Operations - located opposite "new" transfer pad
Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house
Location 3: Oaks Farm

Flintshire County Council Deposited Dust Monitoring

Analysis of matter collected in atmospheric deposit gauge duing the period of:

From: 06/12/2019 To: 07/01/2020
No. of days 32

Collector: MW

Gauge Bowl No. Location 1 OES1
Location 2 OES2
Location 3 OES3

Factor (mg deposit to mg/m2) 24.7

Monitoring Location	Sample Volume (ml)	Total Suspended Solids (mg/l)	mg/m2/day
Location 1	2880	<10	<7.72
Location 2	3380	<10	<7.72
Location 3	3540	14.9	11.50

Comments:

►Dust analysis carried out by i2 analyitcal

Location 2 location changed due to access issues with fencing surrounding LTP. Dust gauge located near to electricity meter house.

Location 1: Site Operations - located opposite transfer pad
Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house
Location 3: Oaks Farm (near road)

Caulmert
engineering environmental planning

Registered Office: InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672666
Fax: 01248 672601
Email: contact@caulmert.com
Web: www.caulmert.com