

Caulmert Limited

Engineering, Environmental & Planning
Consultancy Services

Brookhill Landfill Site

Flintshire County Council Waste Management Services

Annual Monitoring Review 2016

Prepared by:

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2231.EMP.01 Environmental Monitoring Plan

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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 2016 to 31st December 2016.
- 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 2015 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 1.5km 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, approx 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 15° 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 recently 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 2231.EMP.01. Appendix 1 contains a landfill gas monitoring data summary table, and methane and carbon dioxide data from all boreholes is displayed in time-series graphs. The time-series graphs display methane and carbon dioxide concentrations in the perimeter boreholes recorded between January 2009 and December 2015. The 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 2016 and 31st December 2016 is summarised in Appendix 1.
- 3.2.2 Landfill gas quality is relatively similar throughout the site. Methane concentration was on average 44.5%, varying between 0.3% (at GV 13) and 60.2% (at GV37). Most boreholes (except e.g. GV13 and GV36) had sufficient levels of methane and low O₂, making them suitable for extraction.
- 3.2.3 Fifteen new gas extraction wells were installed at the site in September/October 2015. Initial monitoring data for these wells, GV35 – GV49, are included in Appendix 1. During this review period they had methane concentrations and oxygen levels similar to the other boreholes around the site.

3.3 Trace Gas Monitoring

- 3.3.1 Annual trace gas monitoring was carried out by Envirodat Air Quality and Environmental Consultants on 6th of May 2016 (see report included in Appendix 1). The sample point was

described as Inlet Line to Utilisation Plant. The ambient temperature was 19 °C and the atmospheric pressure, 996 mb.

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 average for this location):

- Methane 46.6 % v/v
- Carbon dioxide 36.1 % v/v
- Oxygen 0.0 % 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, 5 were detected. These were carbon disulphide, ethanol (acetaldehyde), hydrogen sulphide, methanal (formaldehyde), and toluene.

3.3.5 Of these, 4 exceeded their Environmental Assessment Levels (EALs¹). Those were carbon disulphide (short and long term EAL), hydrogen sulphide (short and long term EAL), methanal (formaldehyde) (short and long term EAL), and toluene (long term EAL).

3.4 Engine and Flare Emission Monitoring

3.4.1 Monitoring of the emissions from the flare and landfill gas engine was carried out on the 6th of May 2016. Engine and flare exhausts were both sampled for oxides of nitrogen (as NO₂), 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 NO₂ for both the flare and engine were below their respective compliance limits. The CO concentration at the engine was above the emissions limit value (1500 mg(N)m⁻³) with a concentration of 1648 mg(N)m⁻³ and a ± 65 estimate of uncertainty. VOC concentration at the engine was also above the emission limit value (1750 mg(N)m⁻³) with a concentration of 1835 mg(N)m⁻³ and a ± 65 estimate of uncertainty.

3.4.3 The concentrations of CO and VOC were below the emissions limit at the flare.

¹ Environment Agency, August 2016, Risk assessments for specific activities: environmental permits: Environmental Assessment Levels for Air (for the protection of human health).

3.5 Perimeter Boreholes

Methane

- 3.5.1 All perimeter gas boreholes had methane concentrations below their respective EP limits during 2016.
- 3.5.2 Methane concentrations have remained below 1.0 % in locations BH1, BH3, BH6, BH7, BH10, BH11, BH12, BH13, BH14, BH15, BH16, BH17, BH20, BH21, BH23, BH24 and BH25 throughout the 2009 – 2016 period, and no methane has been recorded in 2013, 2014, 2015 or 2016 in BH4 or BH5.
- 3.5.3 Methane concentrations in BH8 and BH9 have remained relatively stable since late 2013. This trend continued in 2016 at BH8, however, the methane concentration in BH9 displayed an increasing trend throughout the year. The concentration increase is not considered to be significant, but should continue to be monitored closely and will be included in the first Quarterly Review of 2017.

Carbon Dioxide

- 3.5.4 Carbon dioxide was recorded in all perimeter boreholes, but remained below the relevant EP limits throughout the review period in all monitoring points. A slight increase in concentration was observed at BH9, corresponding with the increase in methane noted. BH11, BH13 and BH15 also showed a slight increase in carbon dioxide concentration over 2016. Concentrations at BH23 and BH25 increased slightly from September 2016 to December 2016. No overall increases in CO₂ were noted in any other boreholes around the site.

4.0 GROUNDWATER

4.1 Introduction

4.1.1 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), GW2.1 and GW3.1 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 2231.EMP.01.

4.1.2 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

4.1.3 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.

4.2 Groundwater Levels

4.2.1 Groundwater levels were recorded monthly during the review period. The results show a similar seasonal trend to that noted in 2015, with seasonal decrease in water level within groundwater monitoring points from March to September, before a steady increase through the remainder of 2016. This fluctuation was particularly pronounced in GW1 and GW1.1A, GW4.1, GW5A and GW7.

4.3 Groundwater Quality

4.3.1 Monthly groundwater sampling was undertaken at groundwater points GW1-GW8, as per the schedule outlined above. In March, June, September and December samples were analysed for the quarterly suite. Tables 1 and 2 in Appendix 2 summarise monthly and quarterly monitoring data from 2016. Time-series graphs for all parameters between 2009 and 2016 are also included in Appendix 2.

4.3.2 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

4.3.3 The groundwater EP limit for ammoniacal nitrogen (1.7 mg/l) was exceeded in GW2A throughout 2016. The groundwater EP limit was also exceeded in GW3A and GW4 for the majority of the review period.

4.3.4 Concentrations in GW3A were lower than in 2015 with a maximum of 114 mg/l and an average of 40 mg/l (compared to 132 mg/l and 60 mg/l respectively). Concentrations in GW4 were, on average, 26 mg/l. Concentrations in GW2A were similar to that recorded in 2015, with an average of 9 mg/l.

4.3.5 Average concentrations within the remaining groundwater boreholes ranged between 0.2 mg/l in GW6 and 17 mg/l in GW8.

4.3.6 As in the 2015 review, GW3A consistently contained the highest concentrations of ammoniacal nitrogen of the groundwater locations.

Chloride

4.3.7 The chloride EP limit (60 mg/l) was exceeded in GW2A, GW3A and GW4 throughout 2016. Highest chloride concentrations were detected in GW3A, with a maximum of 247 mg/l and an average of 164 mg/l. This shows an improvement compared to the 2015 maximum of 390 mg/l and average of 187 mg/l.

4.3.8 Average chloride concentrations in GW2A and GW4 were 115 mg/l and 52 mg/l respectively, both lower than the average concentrations in 2015 of 124 mg/l and 113 mg/l respectively.

- 4.3.9 In GW1, GW.1.1, GW5A, GW6, GW7 and GW8 the average chloride concentrations were 125 mg/l, 252 mg/l, 48 mg/l, 32 mg/l, 139 mg/l and 138 mg/l respectively, reflecting the presence of off-site sources around the site.

Zinc

- 4.3.10 Similarly to 2015, the trigger level for zinc (0.254 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2016. A graph in Appendix 2 shows that this trigger level was not exceeded on any occasion between January 2009 and December 2016.

Nickel

- 4.3.11 The trigger level for nickel (0.15 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2016. The graph in Appendix 2 shows that nickel concentrations in these locations have been below the trigger level since July 2010.

Toluene

- 4.3.12 Toluene was detected once in location GW4 only. The concentration in GW4 detected on the 13th of October 2016 was 0.148 mg/l, which exceeds the trigger limit for this location of 0.004 mg/l. The concentration was below the detection limit in the subsequent visit reflecting that this was an isolated, potentially anomalous result.

Xylenes

- 4.3.13 No xylenes were detected in boreholes GW2A, GW3A and GW4, or any of the other groundwater monitoring points between January 2009 and December 2016.

Annual Suite

- 4.3.14 No benzene, ethylbenzene, m,p-xylene, o-xylene, BTEX, xylenes or toluene was detected in any of the groundwater boreholes as part of the annual suite.

5.0 LEACHATE

5.1 Introduction

5.1.1 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.

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

5.1.3 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, BOD, COD, TOC and TON.

5.1.4 Samples collected from the leachate chambers in December 2016 were also analyzed 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.

5.1.5 Well locations are shown on Drawing Number 2231.EMP.01.

5.2 Leachate Levels

5.2.1 Leachate levels were recorded monthly during the review period. Table 1 and graphs displaying leachate head (in metres above cell base) can be found in Appendix 3. 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 3.

5.2.2 Table S4.1 in the EP requires that leachate levels must not exceed 2 m above the base of each cell. This trigger level was discussed in the Leachate Management Plan. Following an assessment of the lowest achievable leachate levels for each landfill cell, new EP limits were proposed for Cells 2, 3, 4 and 5. These levels, detailed in Table 1 below, were agreed in a meeting between Alison Soper of the Environment Agency and representatives from Flintshire County Council Waste Management Services (then AD Waste Ltd) and Caulmert on the 17th of September 2009.

Table 1: Leachate Level EP Limits

Landfill Cell	Monitoring Points	Revised EP Limit (m)
Cell 1	LC1B & R1	2.0
Cell 2	LC2B & R2	3.0
Cell 3	LC3 & R3	5.5
Cell 4	LC4B & R4	3.0
Cell 5	LC5 & R5	3.0
Cell 6	LC6B & R6	2.0

5.2.3 Leachate levels recorded during 2016 are summarised in Table 2 below.

Table 2: Leachate Head Data (exceedances highlighted in yellow)

Landfill Cell	Monitoring Point	Leachate Head (m above cell base)			Trigger Limit
		Minimum	Maximum	Average	
Cell 1	BK LC 1B	-0.63	1.93	1.59	2.0
	BK R1	1.79	2.14	2.02	
Cell 2	BK LC 2B	0.65	0.89	0.77	3.0
	BK R2	0.56	2.11	1.46	
Cell 3	BK R3*	0.85	1.12	1.03	5.5
Cell 4	BK LC 4B*	0.62	1.21	0.95	3.0
	BK R4	2.16	2.62	2.35	
Cell 5	BK R5	2.96	4.31	3.95	3.0
Cell 6	BK LC 6B	0.74	0.93	0.84	2.0
	BK R6	0.31	0.74	0.50	

5.2.4 Leachate levels remained below the EP limits in locations LC1B, LC2B, R2, R3, LC4B, R4, LC6B and R6 throughout the review period. Exceedances of the EP limits were recorded in R1 and R5.

5.2.5 The leachate level within R1 exceeded the trigger limit of 2.0 m above cell base on nine occasions during 2016, between March and December. The average leachate level within R1 was slightly above the trigger level, at 2.02 m.

5.2.6 The leachate level within R5 exceeded the trigger limit of 3.0 m above cell base throughout the review period. However, a decreasing trend was noted, from 4.31 m in July to within compliance, 2.96 m in December.

5.3 Leachate Quality

5.3.1 A summary of the leachate quarterly quality analysis from 2016 is shown in Table 2 in Appendix 3 along with graphs showing trends in leachate quality between January 2009 and December 2016. Annual suite analysis data is included in Table 3 in Appendix 3.

- 5.3.2 Average ammoniacal nitrogen concentration in the leachate 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 as it appears that leachate strength at the site has plateaued since then, with average ammoniacal nitrogen concentrations in 2013, 2014, 2015 and 2016 at 2089 mg/l, 2205 mg/l, 2008 mg/l and 2301 mg/l respectively.
- 5.3.3 Average chloride concentration in the leachate in 2016 were 2984 mg/l similar to those in 2015 (2772 mg/l). 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.
- 5.3.4 In general, although fluctuating, the majority of the quarterly parameters within the leachate have remained at approximately the same average concentration between January 2009 and December 2016. No significant overall increasing or decreasing trends are observed in the time-series graphs in Appendix 3.

Annual Suite

- 5.3.5 No free cyanide was detected in the leachate chambers. Total cyanide was recorded in LC3 – LC6, were concentrations ranged between <0.05 mg/l in LC1B, LC3 and LC4B and 0.12 mg/l in LC5 and LC6.
- 5.3.6 No mercury was detected in the leachate chambers. Metals cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, nickel and zinc were generally low in concentration.
- 5.3.7 Mineral oil concentrations ranged between 0.0339 mg/l in LC1B and 0.753 mg/l in LC2B.
- 5.3.8 Of the hazardous substances analysed during December, a total of 40 were detected in the leachate. Leachate quality tables are presented in Appendix 3.

5.4 Emissions to sewer

- 5.4.1 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).
- 5.4.2 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

- 5.4.3 The ammoniacal nitrogen discharge consent limit (50 mg/l) was exceeded once in 2016, with a maximum concentration of 59 mg/l recorded on the 30th of June 2016. All other concentrations were below the consent limit, giving an annual average of 9.8 mg/l. This is an improvement compared with the 2015 average of 17.6 mg/l.

Chemical Oxygen Demand (COD)

- 5.4.4 COD exceeded the discharge consent limit of 2000 mg/l three times during 2016. The maximum concentration recorded was 4160 mg/l on the 20th of May. The average concentration was below the discharge consent limit, 1622 mg/l.

Suspended Solids

- 5.4.5 The suspended solids discharge consent limit (500 mg/l) was exceeded six times during this review period, with concentrations ranging between 59 mg/l and 3800 mg/l. The average was also above the discharge consent limit, at 646 mg/l.

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 2231.EMP.01.

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 Surface water samples are analysed on a monthly basis for:

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

6.1.4 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 point².

6.1.5 A table displaying a summary of the laboratory analysis of the surface water samples from P2, P4 and SW2 collected during 2016 is presented in Appendix 4. Time-series graphs for all parameters between January 2009 and December 2016 are also included in Appendix 4.

6.2 Surface Water Quality

Ammoniacal Nitrogen

6.2.1 P2 was sampled only 3 times in 2016, in January, March and April. The EP for ammoniacal nitrogen (1.6 mg/l) was exceeded once in January at 5.07 mg/l. The average concentration in P2 was 2.2 mg/l, which is slightly lower than the average recorded in 2015 (2.3 mg/l).

6.2.2 The average ammoniacal nitrogen concentration in P4 in 2016 was 5.0 mg/l which is slightly lower than that recorded in 2015, 8.7 mg/l.

6.2.3 The average ammoniacal nitrogen concentration in SW2 during 2016 was 0.7 mg/l which is the same as that recorded in 2015.

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

Chemical Oxygen Demand (COD)

- 6.2.4 COD in P2 has displayed a decreasing trend since a peak of 10,700 mg/l in November 2010. The concentration decreased to below the trigger level in December 2012, for the first time since October 2010 but then peaked in October 2013 at 4,100 mg/l (possibly due to low water in P2). In 2014 COD, concentrations in P2 exceeded the EP permit level of 100 mg/l on each occasion, with average COD concentration of 315 mg/l. In 2015, COD concentrations in P2 exceeded the EP permit level on 3 out of 4 occasions, with an average of 227 mg/l. In 2016, COD concentrations in P2 exceeded the EP permit level on 2 out of 3 occasions, with an average of 239 mg/l.
- 6.2.5 COD in P4 ranged between 78 mg/l and 169 mg/l, while COD in SW2 ranged between 59 mg/l and 99 mg/l which generally lower than the results obtained in 2015 at these locations.

Chloride

- 6.2.6 As in 2015, chloride concentrations in P2 remained below the EP limit of 250 mg/l during 2016, and ranged from 83 mg/l to 121 mg/l.
- 6.2.7 Concentrations varied between 52 mg/l and 77 mg/l in P4 and 79 mg/l and 260 mg/l in SW2.

pH

- 6.2.8 pH has remained between 5 and 9 in all locations since January 2009.

Suspended Solids

- 6.2.9 Suspended solid concentrations in P2 exceeded the EP limit of 100 mg/l on two occasions in 2016. The maximum concentration was 370 mg/l, recorded in April. This suspended solids concentration corresponds with the elevated COD concentration detected in P2.
- 6.2.10 Concentrations within P4 and SW2 have fluctuated between January 2009 and December 2016. Average concentrations in these locations during 2016 were 34 mg/l and 31 mg/l respectively.

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 was undertaken by Enitial on the 27th of July 2016, the report is enclosed in Appendix 2.

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-16	Jun-16	Sep-16	Dec-16	Permit Level
Dust Concentration (mg/m ² /day)					
Location 1: Site perimeter	22	37	26	51	200
Location 2: Industrial estate	35	14	37	207	200
Location 3: Oaks farm	30	24	51	62	200

- 7.3.2 Dust emissions were compliant with the 200mg/m²/day EP limit during the first three quarters of 2016 at Locations 1, 2 and 3. Dust emissions were also compliant in December at Location 1 and Location 3; however the concentration at Location 2 exceeded the permit level. This is uncharacteristic of the Site and is likely an anomaly as the sample was observed to contain an algal bloom.

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 generally improved in 2016. The noted improvement in the performance of the plant is believed to result from better management

of the plant operation. 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 2016 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;	15083
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.	10
Landfill gas:	Normalised cubic metres/year:
Combustion in flares;	55,437
Combustion in gas engines;	148,855
Other methods of gas utilisation.	0

9.0 PERFORMANCE PARAMETERS

9.1 Introduction

- 9.1.1 The performance parameters at Brookhill during the period 1st of January and the 31st of December 2016 are presented in 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	142.851	MWh of Electricity

- 9.1.2 It should be noted that 1572.408 MWh of energy was exported from the site during the same time period.

10.0 SUMMARY

10.1 Landfill gas

- 10.1.1 Landfill gas in most in-waste boreholes was of good quality for utilisation, with methane concentrations typically above 20% (44.5% on average) and low oxygen. 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.
- 10.1.2 Annual trace gas monitoring was carried out by Envirodat Air Quality and Environmental Consultants on 6th of May 2016. Of the 28 trace gases, 5 were detected. Of these, 4 exceeded their Environmental Assessment Levels (EALs). Those were carbon disulphide (short and long term EAL), hydrogen sulphide (short and long term EAL), methanal (formaldehyde) (short and long term EAL), and toluene (long term EAL).
- 10.1.3 Monitoring of the emissions from the flare and landfill gas engine was carried out on the 6th of May 2016. Concentrations of NO₂ for both the flare and engine were below their respective compliance limits. CO and VOC concentrations at the flare were below their respective compliance limits. The CO and VOC concentrations at the engine were however above their respective compliance limits.
- 10.1.4 Landfill gas concentration was 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 EP trigger levels during 2016. Likewise, none of the boreholes exceeded their respective carbon dioxide EP limits in 2016.

10.2 Groundwater

- 10.2.1 As in 2015, 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 2016. This fluctuation was particularly pronounced in GW1 and GW1.1A, GW4.1, GW5A and GW7.
- 10.2.2 The EP limit for ammoniacal nitrogen of 1.7 mg/l was exceeded in locations GW2A, GW3A and on occasion at GW4 during 2016.
- 10.2.3 The chloride EP limit (60 mg/l) was exceeded in GW2A, GW3A and GW4 throughout 2016.
- 10.2.4 Zinc and Nickel concentrations remained below the trigger limits in GW2A, GW3 and GW4 throughout 2016. As previously, no xylene, cyanide, mercury or mineral oil was detected in any of the samples. Toluene was detected once in GW4 in 2016.

10.3 Leachate

- 10.3.1 Leachate levels were below the EP limits throughout the year in all locations except R1 and R5.
- 10.3.2 Leachate samples were analysed quarterly. Leachate quality in LC1B - LC6B during this review period was similar to that during 2015. Average ammoniacal nitrogen concentration across the leachate wells appears to have stabilised at concentrations similar to those recorded in 2015, which is consistent with the interpretation of peak leachate strength having been reached in 2011/2012 and leachate strength now decreasing.
- 10.3.3 The chemical analysis of the Final Discharge (FD) from the leachate treatment plant indicates that the efficiency of the leachate treatment plant improved through 2016. This reflects the improvements made to the operation and infrastructure of the plant.

10.4 Surface Water

- 10.4.1 The ammoniacal nitrogen concentration at P2 exceeded the EP limit (1.6 mg/l) once in 2016. The average ammoniacal nitrogen concentration in P2 during 2015 was lower than that reported in 2015. Concentrations of chloride remained steady in 2016. COD concentrations exceeded the 100 mg/l trigger level on two sampling occasions. Suspended solids concentrations exceeded the trigger level of 100 mg/l on two occasions which may have been the result of low water level at this location during sampling.
- 10.4.2 The surface water quality within P4 and SW4 remained similar to that in 2015.

10.5 Fugitive emissions to air

- 10.5.1 Fugitive emissions to air were monitored by way of an FID Walkover survey completed in July. The report is enclosed in Appendix 2.

10.6 Dust

- 10.6.1 Dust emissions were compliant with the 200mg/m²/day EP limit during the first three quarters of 2016 at Locations 1, 2 and 3. Dust emissions were also compliant in December at Location 1 and Location 3; however the concentration at Location 2 exceeded the permit level. This is uncharacteristic of the Site and is likely an anomaly as the sample was observed to contain an algal bloom.

DRAWINGS

Drawing 2231.EMP.01

Environmental Monitoring Plan

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- NOTES
1. SURVEY INFORMATION PROVIDED BY SOUTH STAFFS SURVEYS. TITLE: UPDATE SURVEY, REF: 4839a.dwg. DATE: 07.08.2015.
- LEGEND
- GAS BOREHOLE
 - GAS EXTRACTION WELL
 - GROUND WATER MONITORING BOREHOLE
 - LEACHATE WELL
 - SURFACE WATER MONITORING POINT
 - COAL VENT
 - LEACHATE MONITORING POINT

REV	MODIFICATIONS	BY	CH	AP	DATE
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FLINTSHIRE COUNTY
COUNCIL WASTE
MANAGEMENT SERVICES

BROOKHILL LANDFILL SITE

ENVIRONMENTAL
MONITORING PLAN

DRAWN BY	RWG	DATE	01.03.2016
CHECKED BY	JM	SCALE @ A1	1:750
APPROVED BY	JM	ISSUE	Fn
		REVISION	-

DRAWING NUMBER
2231.EMP.01



APPENDIX 1

Perimeter Landfill Gas Monitoring Summary Table

Landfill Gas Time-Series Graphs

In Waste Gas Monitoring Summary Table

Trace Gas Report

MCerts Report

FID Survey Report

APPENDIX 1 – LANDFILL GAS

Table 1: In-Waste Landfill Gas

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
B+C	Min	43.6	35.4	0.2	1	0
	Max	50.2	37.0	0.9	14	19
	Ave	48.0	36.6	0.5	8	6
	Count	12	12	12	12	12
Flare	Min	44.3	33.6	0.3	3	0
	Max	51.6	38.9	0.8	12	13
	Ave	49.1	36.7	0.5	9	7
	Count	21	21	21	21	21
GV / LC3.1 + LC3	Min	39.9	32.6	0.8	1	0
	Max	48.6	37.2	1.5	11	9
	Ave	44.7	34.9	1.2	6	6
	Count	12	12	12	12	12
GV 2.1	Min	46.9	36.6	0.1	5	0
	Max	49.6	38.9	0.9	12	13
	Ave	48.4	37.6	0.5	7	6
	Count	12	12	12	12	12
GV 2.2 + LC2B	Min	45.8	32.5	1.0	3	0
	Max	48.5	36.5	1.2	11	12
	Ave	46.9	35.2	1.1	7	7
	Count	12	12	12	12	12
GV 22	Min	46.0	34.0	0.8	2	3
	Max	47.8	36.9	1.3	10	10
	Ave	47.0	35.8	1.0	6	8
	Count	12	12	12	12	12
GV 26	Min	50.0	34.9	0.1	2	0
	Max	52.4	39.8	0.8	12	10
	Ave	50.9	36.7	0.3	7	6
	Count	12	12	12	12	12
GV 26 + 27	Min	50.0	34.6	0.2	3	3
	Max	54.6	38.6	0.9	12	21
	Ave	51.0	36.7	0.5	8	7
	Count	12	12	12	12	12
GV 28 + 29	Min	49.9	31.1	0.2	2	0
	Max	51.9	37.9	0.6	10	17
	Ave	50.6	36.3	0.4	7	7
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
GV 35	Min	16.8	22.4	0.4	2	0
	Max	49.2	34.5	1.9	14	9
	Ave	31.2	27.7	1.2	7	5
	Count	12	12	12	12	12
GV 36	Min	14.8	18.6	2.5	2	0
	Max	38.9	25.4	4.9	11	10
	Ave	21.6	22.0	3.7	7	6
	Count	12	12	12	12	12
GV 37	Min	25.6	22.6	0.0	1	0
	Max	60.2	37.4	1.4	10	11
	Ave	43.1	31.8	0.5	6	5
	Count	12	12	12	12	12
GV 38	Min	43.3	30.8	0.2	3	0
	Max	49.2	35.9	1.3	12	10
	Ave	46.1	33.5	0.9	7	6
	Count	12	12	12	12	12
GV 39	Min	42.3	30.6	0.3	2	0
	Max	47.1	37.2	1.8	12	17
	Ave	46.1	34.5	1.2	8	5
	Count	12	12	12	12	12
GV 40	Min	42.9	29.9	0.4	3	0
	Max	46.2	37.0	1.1	14	9
	Ave	45.2	35.3	0.9	7	4
	Count	12	12	12	12	12
GV 41	Min	41.2	32.5	1.0	3	0
	Max	46.3	37.0	1.4	10	28
	Ave	44.7	35.5	1.1	6	6
	Count	12	12	12	12	12
GV 42	Min	29.6	26.9	0.6	4	2
	Max	42.6	36.5	1.5	16	9
	Ave	38.0	32.7	1.2	10	5
	Count	12	12	12	12	12
GV 43	Min	37.9	29.9	0.3	3	0
	Max	47.0	38.1	1.5	15	16
	Ave	44.8	35.8	1.1	9	8
	Count	12	12	12	12	12
GV 44	Min	30.2	24.5	0.2	1	0
	Max	42.5	36.2	1.4	14	12
	Ave	38.9	32.2	0.9	8	5
	Count	12	12	12	12	12
GV 45	Min	44.0	28.9	0.3	4	0
	Max	47.2	38.9	1.2	17	17
	Ave	45.9	35.9	0.9	9	6
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
GV 46	Min	46.4	36.5	0.2	2	0
	Max	49.0	40.0	0.5	18	11
	Ave	48.1	38.8	0.4	9	6
	Count	12	12	12	12	12
GV 47	Min	42.1	33.6	0.6	5	0
	Max	46.9	37.0	1.2	11	83
	Ave	45.5	35.9	1.0	8	13
	Count	12	12	12	12	12
GV 48	Min	57.9	38.0	0.0	4	4
	Max	60.1	41.3	0.5	9	27
	Ave	59.6	39.7	0.2	7	10
	Count	12	12	12	12	12
GV 49	Min	31.2	27.8	1.0	2	3
	Max	46.9	35.9	3.0	12	15
	Ave	43.5	33.4	1.4	7	7
	Count	12	12	12	12	12
GV B	Min	42.6	34.9	0.2	4	2
	Max	50.5	39.2	0.8	11	12
	Ave	47.7	36.7	0.4	9	7
	Count	12	12	12	12	12
GV C	Min	46.5	35.9	0.1	0	0
	Max	49.8	37.8	0.6	14	10
	Ave	47.9	37.0	0.4	8	5
	Count	12	12	12	12	12
GV 1	Min	21.8	22.6	1.2	3	0
	Max	34.5	27.9	3.0	10	9
	Ave	27.7	25.7	2.0	7	4
	Count	12	12	12	12	12
GV 10	Min	37.6	19.9	1.1	1	0
	Max	44.5	35.9	2.0	17	14
	Ave	41.2	30.8	1.4	7	7
	Count	12	12	12	12	12
GV 11	Min	29.9	24.5	0.3	0	0
	Max	45.9	34.5	1.4	14	11
	Ave	39.7	28.9	1.0	7	6
	Count	12	12	12	12	12
GV 12	Min	48.6	33.2	0.2	2	0
	Max	52.2	38.2	0.6	13	12
	Ave	50.5	35.7	0.4	7	5
	Count	12	12	12	12	12
GV 12 + R3	Min	49.8	32.6	0.1	5	0
	Max	51.0	36.5	0.6	78	22
	Ave	50.3	34.8	0.4	14	7
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
GV 13	Min	0.3	1.1	0.4	0	0
	Max	51.6	37.0	20.0	13	10
	Ave	22.0	16.0	11.7	5	5
	Count	12	12	12	12	12
GV 14	Min	42.3	35.9	0.2	2	0
	Max	50.2	38.7	0.8	10	37
	Ave	48.7	37.3	0.4	7	8
	Count	12	12	12	12	12
GV 15	Min	49.0	33.8	0.3	5	0
	Max	55.3	39.9	0.8	911	32
	Ave	50.9	36.9	0.5	85	9
	Count	12	12	12	12	12
GV 16	Min	27.9	30.4	0.2	3	0
	Max	53.0	40.2	3.0	11	12
	Ave	43.8	35.4	1.5	7	7
	Count	12	12	12	12	12
GV 17	Min	36.9	32.1	2.0	3	3
	Max	45.0	36.3	4.2	13	11
	Ave	40.2	34.3	2.6	9	8
	Count	12	12	12	12	12
GV 17 + LC4	Min	33.6	31.8	2.3	3	5
	Max	46.3	36.0	4.0	10	11
	Ave	40.6	33.9	2.9	8	8
	Count	12	12	12	12	12
GV 18	Min	45.0	33.6	0.2	0	0
	Max	56.3	38.9	0.5	17	52
	Ave	50.8	37.2	0.4	7	9
	Count	12	12	12	12	12
GV 23	Min	49.5	35.1	0.2	1	0
	Max	58.9	39.9	0.5	11	46
	Ave	52.2	36.8	0.4	7	11
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
GV 24	Min	48.7	35.6	0.3	4	0
	Max	56.4	38.9	0.6	12	11
	Ave	52.0	36.9	0.4	7	5
	Count	12	12	12	12	12
GV 25	Min	39.6	33.8	0.2	5	0
	Max	53.9	38.0	1.4	11	11
	Ave	46.2	35.9	0.7	8	5
	Count	12	12	12	12	12
GV 26	Min	50.0	34.9	0.1	2	0
	Max	52.4	39.8	0.8	12	10
	Ave	50.9	36.7	0.3	7	6
	Count	12	12	12	12	12
GV 26 + 27 Manifold	Min	50	34.6	0.2	3	3
	Max	54.6	38.6	0.9	12	21
	Ave	51.0	36.7	0.5	7.5	7.1
	Count	12	12	12	12	12
GV 27	Min	48.2	34.2	0.3	5	2
	Max	55.9	42.1	0.7	25	30
	Ave	51.2	37.2	0.5	9	10
	Count	12	12	12	12	12
GV 28	Min	48.9	35.8	0.1	3	2
	Max	51.4	38.4	0.6	11	10
	Ave	50.7	36.6	0.3	7	8
	Count	12	12	12	12	12
GV 28 + 29 MAN	Min	49.9	31.1	0.2	2	0
	Max	51.9	37.9	0.6	10	17
	Ave	50.6	36.3	0.4	7	7
	Count	12	12	12	12	12
GV 29	Min	49.5	34.8	0.1	4	0
	Max	52.3	37.4	0.7	15	26
	Ave	50.5	36.3	0.4	9	7
	Count	12	12	12	12	12
GV 3	Min	50.0	33.2	0.2	5	3
	Max	58.9	38.6	0.6	11	12
	Ave	52.7	36.1	0.4	7	6
	Count	12	12	12	12	12
GV 30	Min	43.3	29.6	0.5	0	3
	Max	48.5	37.5	1.3	76	11
	Ave	46.1	35.6	1.1	13	7
	Count	12	12	12	12	12
GV 31	Min	44.5	30.1	1.0	0	4
	Max	47.1	36.2	1.3	12	16
	Ave	45.8	35.2	1.1	7	9
	Count	12	12	12	12	12
GV 32	Min	44.9	26.4	1.0	2	0
	Max	46.5	36.1	1.2	14	12
	Ave	45.7	34.0	1.1	7	7
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
GV 33	Min	44.8	29.9	0.8	5	2
	Max	48.9	37.0	1.2	12	45
	Ave	45.9	34.9	1.1	8	11
	Count	12	12	12	12	12
GV 34	Min	44.8	25.6	1.0	4	5
	Max	47.6	37.0	1.4	12	9
	Ave	45.8	34.4	1.1	8	7
	Count	12	12	12	12	12
GV 4	Min	40.1	34.9	0.2	4	2
	Max	46.8	37.1	1.2	16	10
	Ave	45.0	36.1	0.9	9	7
	Count	12	12	12	12	12
GV 6	Min	44.3	32.9	0.4	6	0
	Max	46.9	37.0	1.2	14	8
	Ave	45.6	35.2	0.9	10	6
	Count	12	12	12	12	12
GV 7	Min	23.6	21.9	2.0	5	0
	Max	31.9	29.9	3.0	14	9
	Ave	27.9	26.1	2.5	9	6
	Count	12	12	12	12	12
GV 8	Min	31.7	23.6	1.1	4	0
	Max	42.3	33.6	3.0	9	8
	Ave	36.9	28.6	2.0	7	5
	Count	12	12	12	12	12
GV 9	Min	45.2	32.6	0.0	3	0
	Max	49.2	38.2	0.8	14	9
	Ave	48.0	36.0	0.4	7	5
	Count	12	12	12	12	12
GV A	Min	24.9	19.8	4.9	5	0
	Max	34.5	29.9	11.3	12	7
	Ave	29.5	24.9	7.2	9	3
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
LC 1B	Min	29.9	33.0	1.9	0	0
	Max	37.5	36.8	3.2	11	13
	Ave	35.7	35.2	2.5	5	6
	Count	12	12	12	12	12
LC 2B	Min	44.7	30.8	1.0	2	3
	Max	49.0	36.0	1.4	13	14
	Ave	46.8	34.8	1.2	7	9
	Count	12	12	12	12	12
LC 2R	Min	46.9	33.8	0.2	4	2
	Max	50.2	37.9	1.2	23	9
	Ave	48.4	36.5	0.7	8	5
	Count	12	12	12	12	12
LC 3	Min	39.9	31.5	1.4	1	3
	Max	46.2	36.3	2.9	9	69
	Ave	44.0	34.3	2.4	6	17
	Count	12	12	12	12	12
LC 3.1	Min	40.1	32.6	0.8	2	0
	Max	48.6	37.2	1.5	14	10
	Ave	44.8	35.0	1.2	7	6
	Count	12	12	12	12	12
LC 4	Min	32.7	28.9	2.6	2	4
	Max	46.9	36.0	3.9	9	11
	Ave	40.7	33.5	3.2	5	9
	Count	12	12	12	12	12
LC 4B	Min	22.8	24.4	1.1	3	0
	Max	48.6	37.0	3.6	18	14
	Ave	45.1	34.9	1.4	9	7
	Count	12	12	12	12	12
LC 5	Min	44.2	31.7	0.3	4	2
	Max	48.3	36.2	3.3	9	11
	Ave	46.8	33.8	2.5	6	7
	Count	12	12	12	12	12
LC 6	Min	43.9	31.6	1.9	1	2
	Max	50.2	35.9	3.9	10	11
	Ave	46.4	34.0	2.7	6	8
	Count	12	12	12	12	12
LC 6B	Min	50.2	30.9	0.3	4	4
	Max	52.2	37.9	1.9	10	23
	Ave	51.0	35.9	0.7	7	11
	Count	12	12	12	12	12
PW 1	Min	0.5	0.0	12.9	3	4
	Max	1.9	0.5	17.9	14	12
	Ave	1.0	0.2	15.3	9	8
	Count	12	12	12	12	12

APPENDIX 1 – LANDFILL GAS

Location	Data	Methane	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide
		%	%	%	ppm	ppm
PW 2	Min	29.9	15.6	2.6	5	2
	Max	34.9	20.0	4.0	14	9
	Ave	32.7	18.2	3.4	8	7
	Count	12	12	12	12	12
PW 3	Min	25.4	18.9	2.1	1	5
	Max	34.9	20.8	6.2	9	910
	Ave	31.1	19.8	4.1	6	84
	Count	12	12	12	12	12
PW 4	Min	44.6	30.2	0.3	1	4
	Max	47.2	36.5	1.3	8	15
	Ave	45.9	34.6	0.9	6	7
	Count	12	12	12	12	12
PW 5	Min	19.0	20.3	0.8	0	1
	Max	34.5	26.9	1.7	12	14
	Ave	27.4	24.0	1.3	8	8
	Count	12	12	12	12	12
PW 6	Min	24.1	20.9	1.5	2	4
	Max	34.5	26.9	2.9	10	16
	Ave	29.3	24.1	2.2	8	9
	Count	12	12	12	12	12
R 1	Min	44.6	30.6	0.6	3	4
	Max	47.6	36.3	1.2	44	12
	Ave	46.3	34.2	1.0	9	9
	Count	12	12	12	12	12
R 1 + R 1B	Min	46.8	32.6	0.6	4	4
	Max	48.9	36.9	0.9	8	19
	Ave	48.1	34.9	0.7	6	10
	Count	12	12	12	12	12
R 1B	Min	48.5	33.9	0.2	5	2
	Max	50.2	38.0	0.8	9	19
	Ave	49.3	36.1	0.5	7	9
	Count	12	12	12	12	12
R 2B	Min	48.7	33.9	0.2	3	2
	Max	51.2	38.0	0.8	11	21
	Ave	49.7	36.3	0.4	7	7
	Count	12	12	12	12	12
R 3	Min	48.9	31.6	0.0	1	0
	Max	52.3	36.0	0.7	11	10
	Ave	50.1	34.1	0.5	7	4
	Count	12	12	12	12	12
R 4B	Min	35.3	29.3	0.2	2	0
	Max	49.8	36.9	3.9	9	19
	Ave	43.7	34.1	2.3	6	7
	Count	12	12	12	12	12
R 6B	Min	46.6	31.2	0.2	4	4
	Max	51.2	38.6	0.6	14	9
	Ave	49.7	35.0	0.3	8	7
	Count	12	12	12	12	12

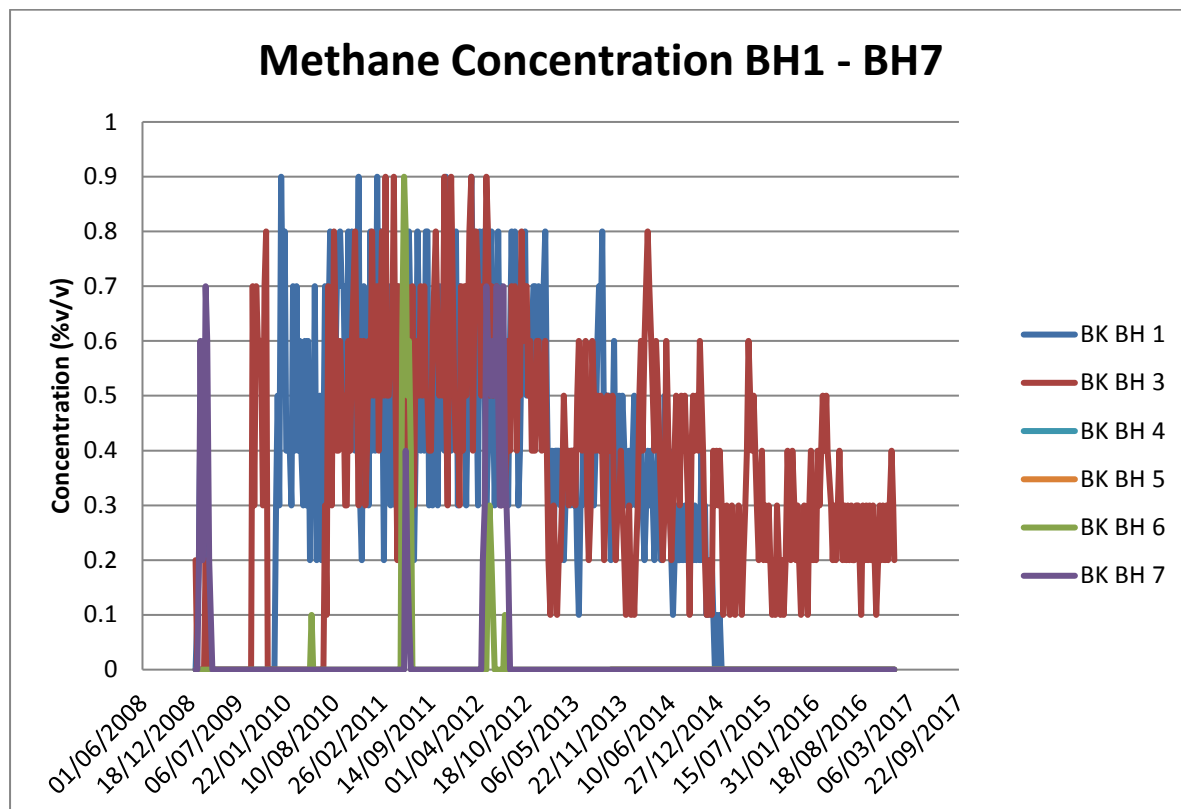
APPENDIX 1 – LANDFILL GAS
Table 2: Perimeter Landfill Gas (% v/v)

Location	Data	CH4 (%v/v)	Trigger (%v/v)	CO2 (%v/v)	Trigger (%v/v)
BK BH 1	Min	0.00	1	1.00	8.8
	Max	0.00		3.00	
	Average	0.00		1.57	
	Count	52		52	
BK BH 3	Min	0.10	1	0.70	3.1
	Max	0.50		2.10	
	Average	0.27		1.29	
	Count	52		52	
BK BH 4	Min	0.00	1	0.60	5.1
	Max	0.00		1.60	
	Average	0.00		1.23	
	Count	52		52	
BK BH 5	Min	0.00	1	0.40	1.5
	Max	0.00		1.40	
	Average	0.00		0.79	
	Count	52		52	
BK BH 6	Min	0.00	1	0.50	1.5
	Max	0.00		1.20	
	Average	0.00		0.77	
	Count	52		52	
BK BH 7	Min	0.00	1	0.60	10
	Max	0.00		2.60	
	Average	0.00		1.42	
	Count	52		52	
BK BH 8	Min	27.40	32.2	0.80	3.6
	Max	30.10		1.90	
	Average	28.66		1.35	
	Count	52		52	
BK BH 9	Min	26.10	29.6	0.40	10.4
	Max	28.60		2.60	
	Average	27.48		1.59	
	Count	52		52	
BK BH 10	Min	0.00	1	0.80	3.9
	Max	0.00		2.30	
	Average	0.00		1.50	
	Count	52		52	
BK BH 11	Min	0.00	1	0.50	6.5
	Max	0.00		3.00	
	Average	0.00		1.91	
	Count	52		52	
BK BH 12	Min	0.00	1	1.00	6.6
	Max	0.00		2.00	
	Average	0.00		1.45	
	Count	52		52	
BK BH 13	Min	0.00	1	0.60	9.4
	Max	0.00		2.90	
	Average	0.00		1.61	
	Count	52		52	

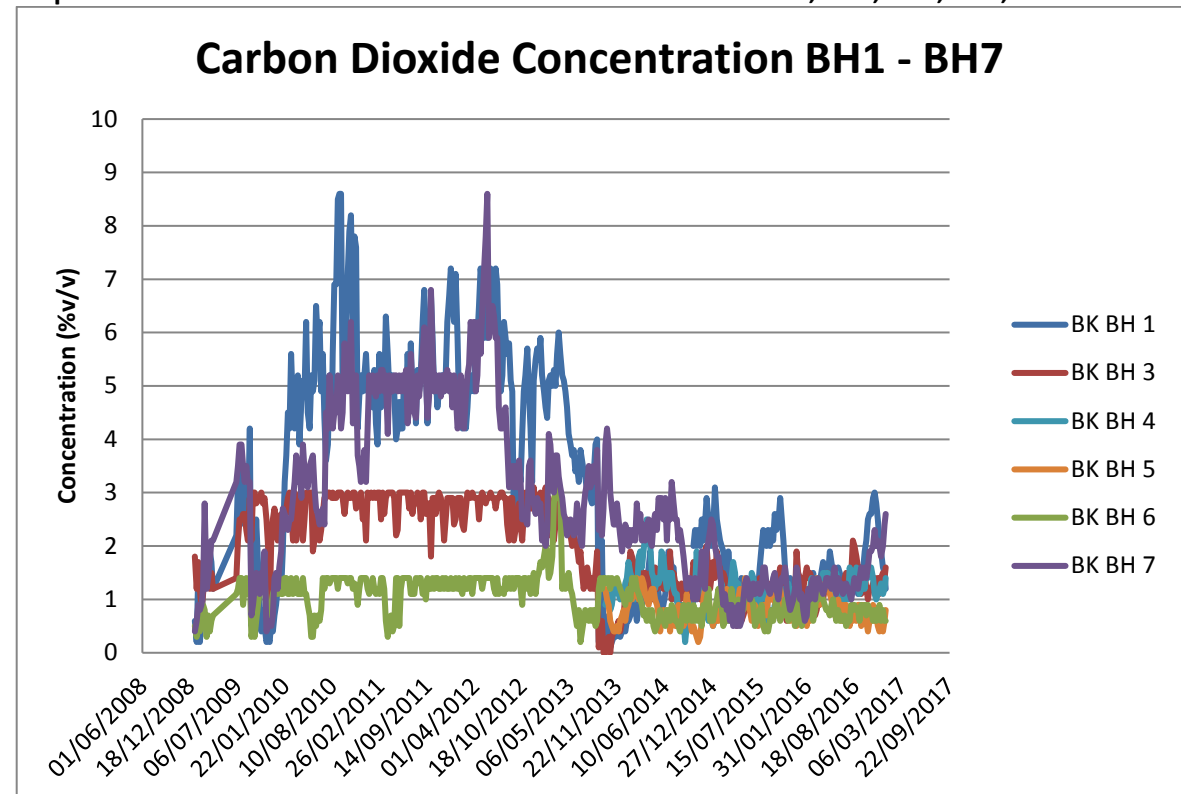
APPENDIX 1 – LANDFILL GAS

Location	Data	CH4 (%v/v)	Trigger (%v/v)	CO2 (%v/v)	Trigger (%v/v)
BK BH 14	Min	0.00	1	0.50	3.5
	Max	0.00		2.00	
	Average	0.00		1.32	
	Count	52		52	
BK BH 15	Min	0.00	1	0.60	17.6
	Max	0.00		2.30	
	Average	0.00		1.53	
	Count	52		52	
BK BH 16	Min	0.00	1	1.00	11.4
	Max	0.00		3.00	
	Average	0.00		1.79	
	Count	52		52	
BK BH 17	Min	0.10	1	0.90	12.9
	Max	0.40		3.60	
	Average	0.28		2.14	
	Count	52		52	
BK BH 18	Min	0.10	6.8	0.90	21.2
	Max	0.60		3.50	
	Average	0.28		2.11	
	Count	52		52	
BK BH 19	Min	0.00	1	0.90	11.2
	Max	0.00		4.30	
	Average	0.00		2.30	
	Count	52		52	
BK BH 20	Min	0.10	1	0.50	17.6
	Max	0.80		3.90	
	Average	0.27		2.39	
	Count	52		52	
BK BH 21	Min	0.10	1	1.00	11.4
	Max	0.70		2.30	
	Average	0.31		1.50	
	Count	52		52	
BK BH 23	Min	0.00	1	1.00	7.3
	Max	0.00		2.90	
	Average	0.00		1.61	
	Count	52		52	
BK BH 24	Min	0.00	1	0.60	1.5
	Max	0.00		1.20	
	Average	0.00		0.79	
	Count	52		52	
BK BH 25	Min	0.00	1	0.60	9.9
	Max	0.00		2.60	
	Average	0.00		1.42	
	Count	52		52	

APPENDIX 1 – LANDFILL GAS

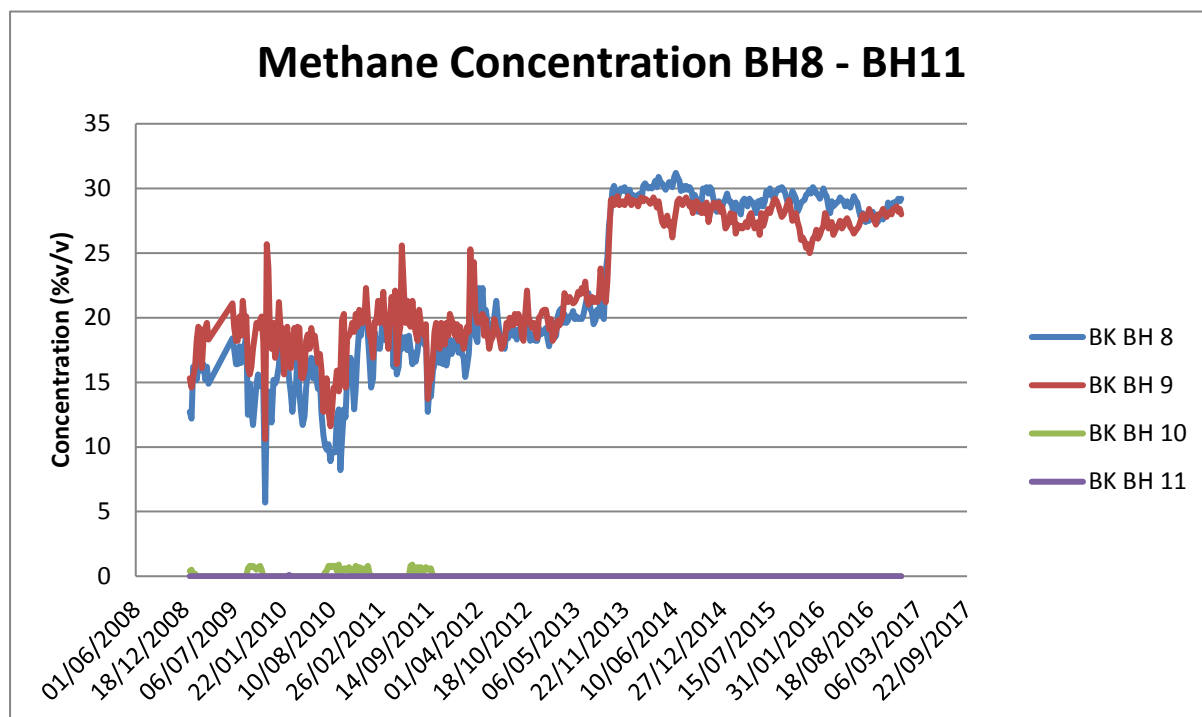


Graph 1a: Perimeter Landfill Gas - Methane concentration in BH1, BH3, BH4, BH5, BH6 and BH7

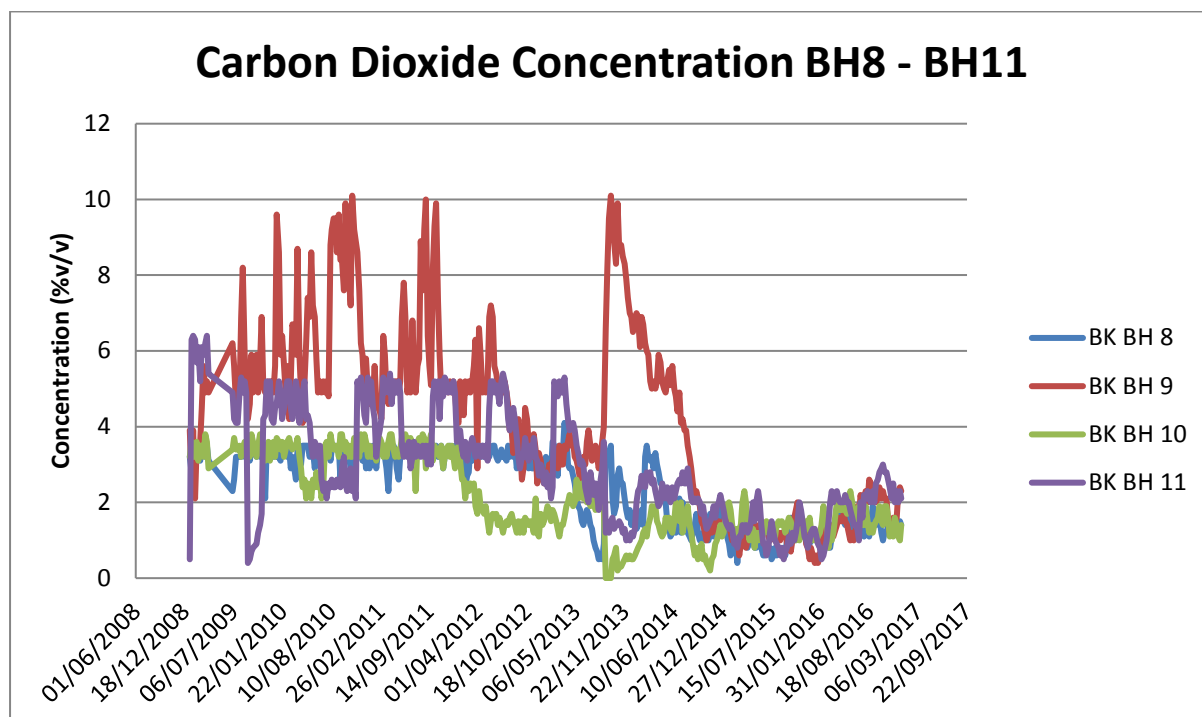


Graph 1b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH1, BH3, BH4, BH5, BH6 and BH7

APPENDIX 1 – LANDFILL GAS

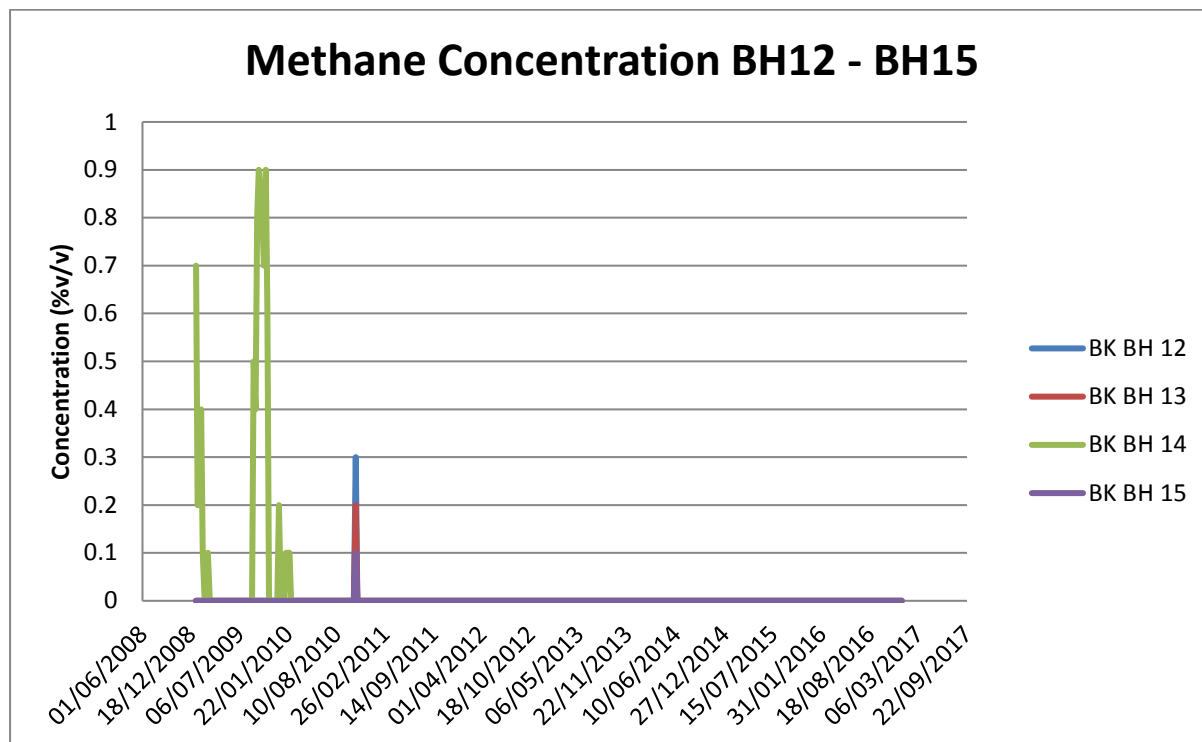


Graph 2a: Perimeter Landfill Gas - Methane concentration in BH08, BH09, BH10 and BH11

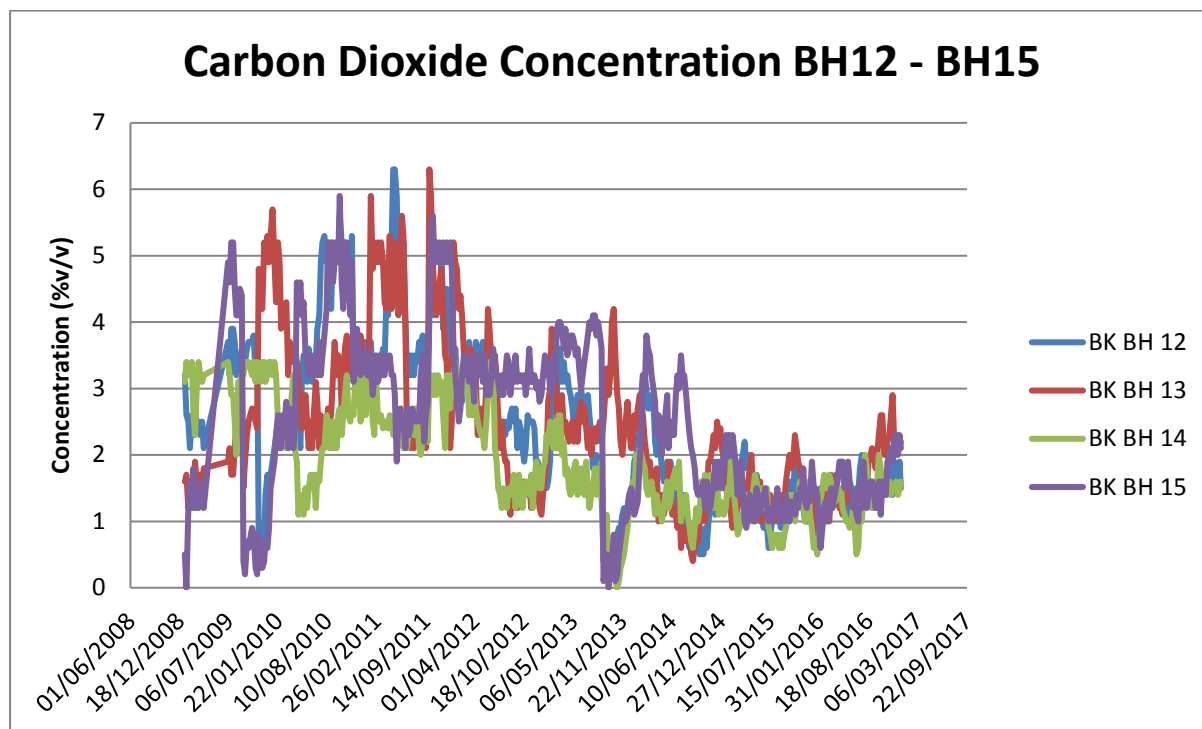


Graph 2b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH08, BH09, BH10 and BH11

APPENDIX 1 – LANDFILL GAS

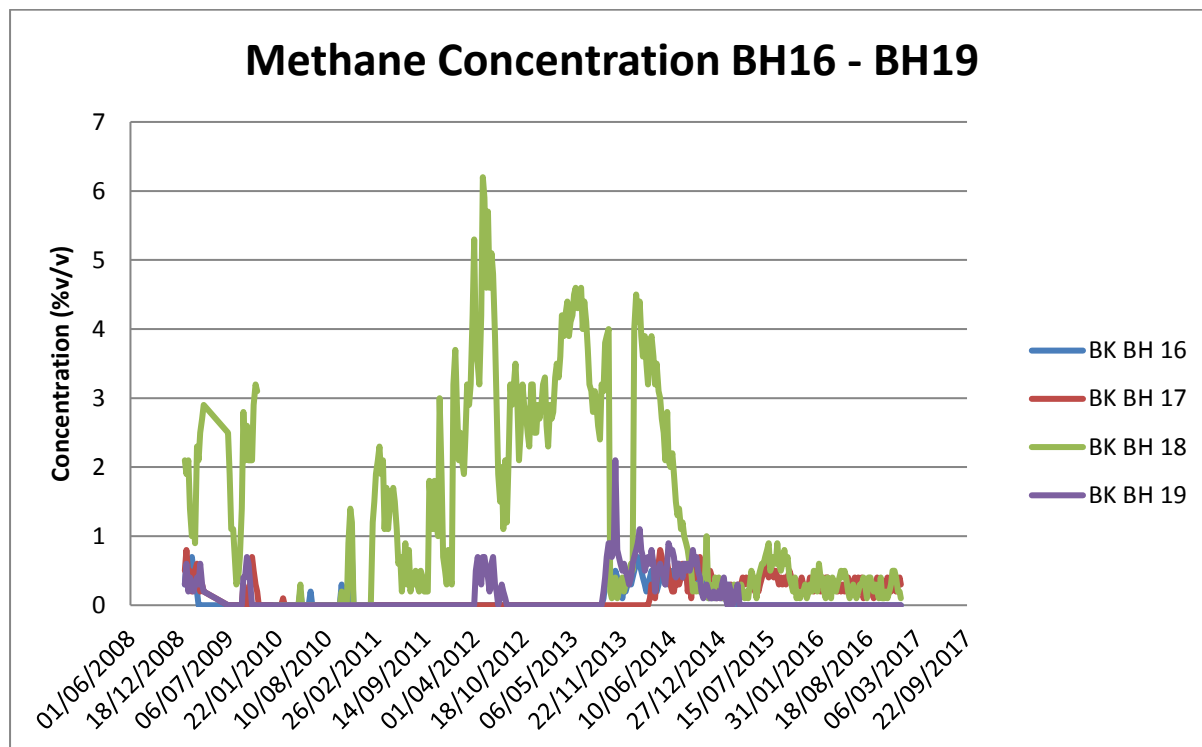


Graph 3a: Perimeter Landfill Gas - Methane concentration in BH12, BH13, BH14 and BH15

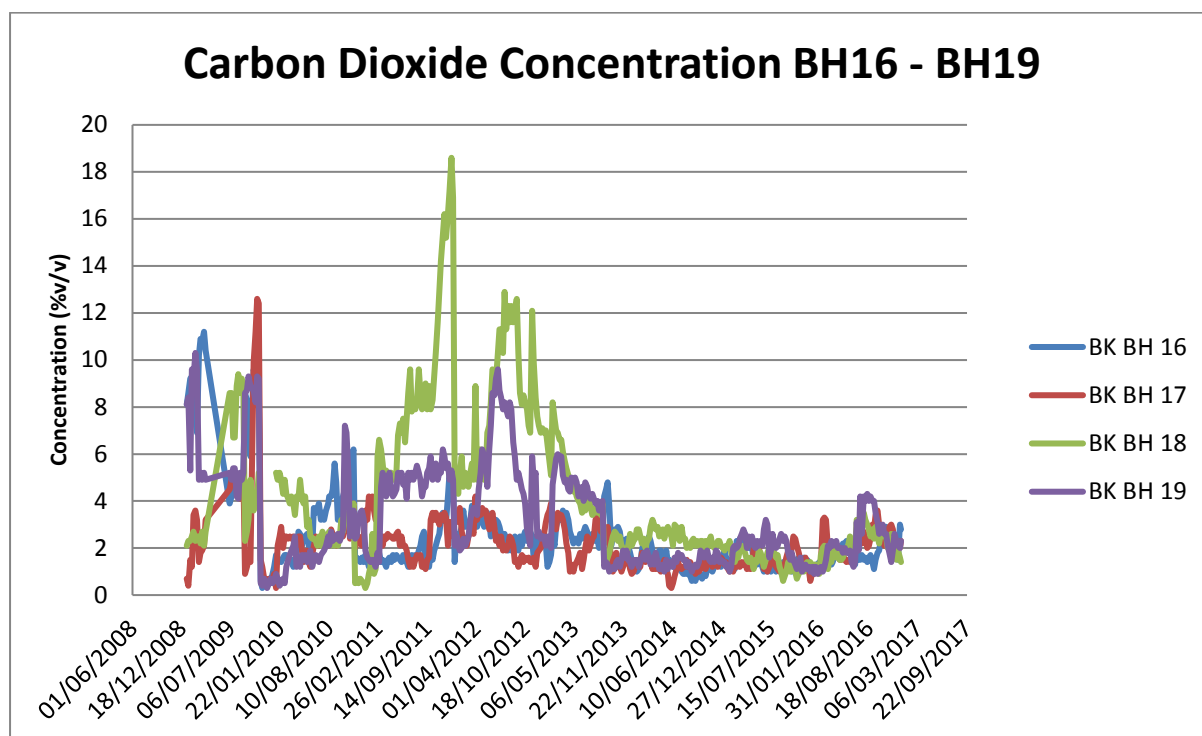


Graph 3b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH12, BH13, BH14 and BH15

APPENDIX 1 – LANDFILL GAS

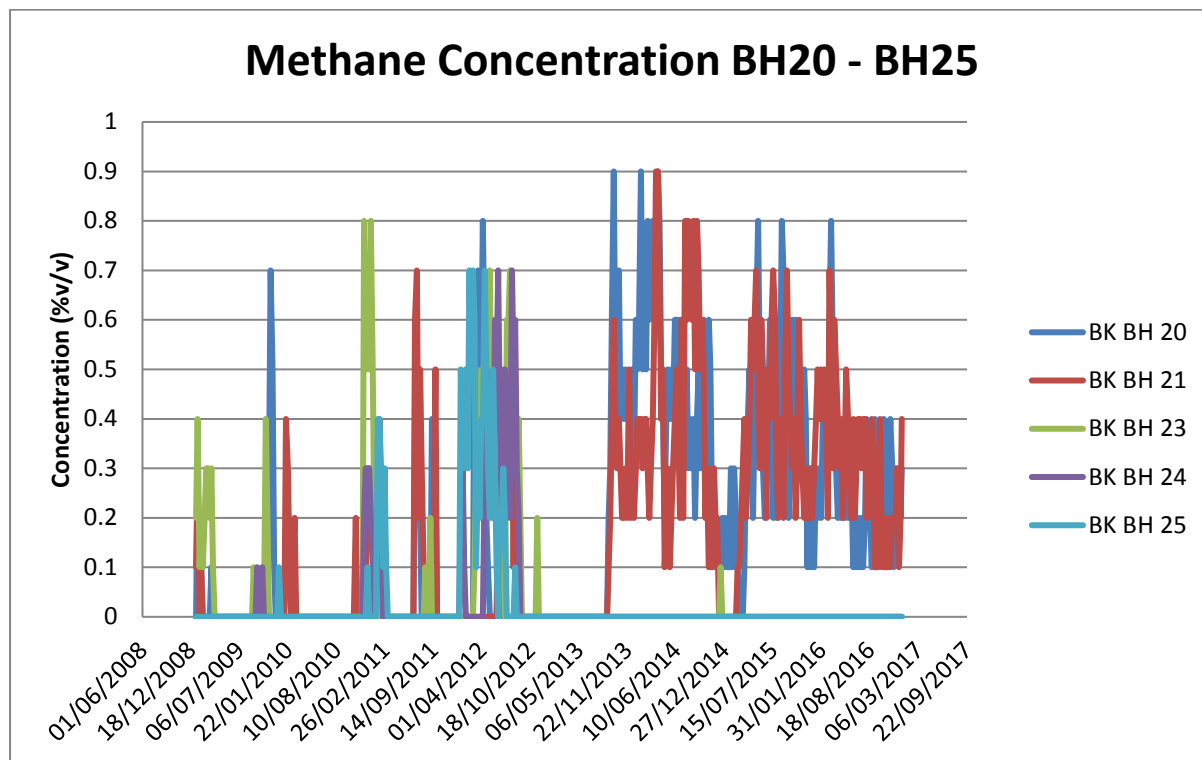


Graph 4a: Perimeter Landfill Gas - Methane concentration in BH16, BH17, BH18 and BH19

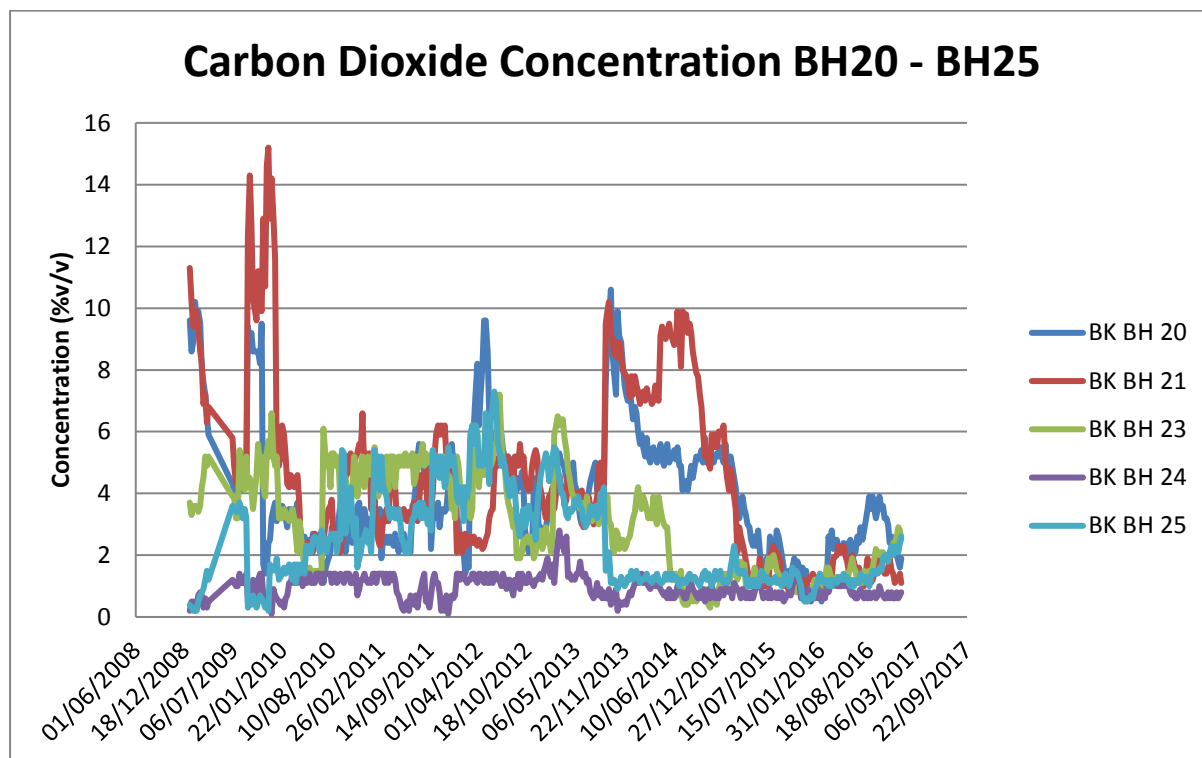


Graph 4b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH16, BH17, BH18 and BH19

APPENDIX 1 – LANDFILL GAS



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 and Flare Stack Located at Brookhill Landfill Site, Buckley.**

Part 1: Executive Summary

Permit Number: BV7273

Operator: Flintshire County Council

Installation: Brookhill Landfill Site (Engine & Flare)



4251

Monitoring dates: 6th May 2016

Job Number: **R16221**

Version: 1

Address: **Flintshire County Council**

Alltami Depot

Mold Road - Alltami

Flintshire, CH7 6LG

Monitoring Organisation: **EnviroDat Ltd**

Address: Science & Technology Centre

Earley Gate

Whiteknights Road

Reading RG6 6BZ

Date of Report: 1st June 2016

Report Approved By: David Littlewood

MCERTS Registration Number: MM 06 772 (Level II, TE1, 2, 3 & 4)

Function: Operations Manager (Team Leader)

Signed:

CONTENTS

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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 and flare stacks. This work forms part of the annual compliance test. The pollutants monitored within the engine and flare emissions, as required under permit BV7273 are summarised below:

Substances to be monitored	Emission Point Identification	Emission Point Identification
	Engine	Flare Stack
Oxides of Nitrogen (as NO ₂)	✓	✓
Carbon Monoxide	✓	✓
Volatile Organic Compounds (VOCs)	✓	✓
Oxygen (for correction)	✓	✓
Moisture (for correction)	✓	✓
Special requirements	None requested	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)	650	265	±17	mg(N)m ⁻³	101.3kPa, 273K, dry gas, 5% Oxygen	06/05/2016	10:22-11:22	BS EN 14792	A	At 44% MCR
	Carbon Monoxide	1500	1648	±65	mg(N)m ⁻³				BS EN 15058	A	
	Volatile Organic Compounds (VOCs as carbon)	1750	1835	±57	mg(N)m ⁻³				BS EN 12619	A	
	Moisture	-	12.3	n/a	%	101.3kPa, 273K, dry gas			BS EN 14790	A	
	Oxygen	-	7.36	±0.45	%				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).

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
Flare Stack	Oxides of Nitrogen (as NO ₂)	150	86.2	±3.2	mg(N)m ⁻³	101.3kPa, 273K, dry gas, 3% Oxygen	06/05/2016	12:51-13:51	BS EN 14792	A	At 60% MCR
	Carbon Monoxide	50	17.1	±2.7	mg(N)m ⁻³				BS EN 15058	A	
	Volatile Organic Compounds (VOCs as carbon)	10	4.4	±0.3	mg(N)m ⁻³				BS EN 12619	A	
	Moisture	-	7.8	n/a	%	101.3kPa, 273K, dry gas			BS EN 14790	A	
	Oxygen	-	13.22	±0.63	%				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	06/05/2016	Combustion	Continuous	Landfill Gas	N/A	None	Producing 500kWe (44% MCR)	N/A	N/A	N/A	N/A
Flare Stack	06/05/2016	Combustion	Continuous	Landfill Gas	N/A	None	Burning 600m ³ /hr (60% 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
Flare Stack	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 Engineers:

Team Leader, David Littlewood – Mcerts Level II (TE1, 2, 3 & 4)	MM06 772
Assistant, Dean Kyle – Mcerts Level I	MM12 1188

2.1.2 Monitoring organisation method details

2.1.2.1 Standard Reference Conditions

All pollutant concentrations measured have been expressed at standard reference conditions of 273K, 101.3kPa, dry gas and 5% O₂ for the engine and 3% O₂ for the flare.

2.1.2.2 NO_x (as NO₂)

A sample of the duct gas was passed via a short high temperature, titanium probe and down a heated PTFE line to a gas conditioner used to remove moisture. The conditioned (dry) gas then passed to a Horiba PG250 analyser, which, following specific pre-treatment of the NO_x within the sample, measured the concentration of NO_x (as NO₂) by chemiluminescent detector, in accordance with EnviroDat Ltd. documented procedure SP14792, which implements the requirements of the standard reference method (SRM) BSEN14792. The detector and sampling system was checked prior to, and immediately following, testing to ensure operational conformity. This involved ensuring the absence of sample egress or air ingress, span and zero gas checks and system response times as necessary. All raw data was logged at 60-second intervals via a Grant Instruments Squirrel Datalogger and these are presented in Appendix II. An estimate of the uncertainty associated with the monitoring is also presented, as Appendix III.

2.1.2.3 CO

A sample of the duct gas was passed via a short high temperature, titanium probe and down a heated PTFE line to a gas conditioner used to remove moisture. The conditioned (dry) gas then passed to a Horiba PG250 analyser, which measured the concentration of CO by non-dispersive infrared (NDIR) detector, in accordance with EnviroDat Ltd. documented procedure SP15058 which implements the requirements of the SRM BSEN15058. The detector and sampling system was checked prior to, and immediately following, testing to ensure operational conformity. This involved ensuring the absence of sample egress or air ingress, span and zero gas checks and system response times as necessary. All raw data was logged at 60-second intervals via a Grant Instruments Squirrel Datalogger and these raw data are presented in Appendix II. An estimate of the uncertainty associated with the monitoring is also presented, as Appendix III.

2.1.2.4 Total VOCs

VOC sampling was performed using a Signal 3010HM analyser that measures by use of a heated flame ionisation detector (FID) in accordance with SP12619, which implements the requirements of the SRM BSEN12619:2013. The VOC analyser was positioned prior to the gas conditioner and measured the sample gas 'hot and wet.' The result was subsequently corrected to dry values. The detector and sampling system was checked prior to, and immediately following, testing to ensure operational conformity. This involved ensuring the absence of sample egress or air ingress, span and zero gas checks and system response times as necessary. All raw data was logged at 60-second intervals via a Grant Instruments Squirrel Datalogger and these raw data are presented in Appendix II. An estimate of the uncertainty associated with the monitoring is also presented, as Appendix III.

2.1.2.5 O₂

A sample of the duct gas was passed via a short high temperature, titanium probe and down a heated PTFE line to a gas conditioner used to remove moisture. The conditioned (dry) gas then passed to a Horiba PG250 analyser, which measured the concentration of O₂ by was measured by a zirconia cell, as detailed in documented procedure SP14789, which implements the requirements of the SRM BSEN14789. The detector and sampling system was checked prior to, and immediately following, testing to ensure operational conformity. This involved ensuring the absence of sample egress or air ingress, span and zero gas checks and system response times as necessary. All raw data was logged at 60-second intervals via a Grant Instruments Squirrel Datalogger and the raw data are presented in Appendix II. An estimate of the uncertainty associated with the monitoring is also presented, as Appendix III.

Determination of oxygen is essential for adjusting the prescribed pollutants to reference oxygen levels as detailed in the sites permit. This was performed in the following manner:

$$\text{Conc}_{\text{ref}} = \text{Conc}_{\text{meas}} \times \frac{(20.95 - \text{O}_{2\text{ref}})}{(20.95 - \text{O}_{2\text{meas}})}$$

Whereby, Conc_{ref} was the concentration at reference conditions and $\text{Conc}_{\text{meas}}$ was the measured concentration, $\text{O}_{2\text{ref}}$ is the oxygen reference conditions and $\text{O}_{2\text{meas}}$ is the measured oxygen value.

2.1.2.6 Moisture

Moisture levels in the stack were determined gravimetrically to the requirements of BSEN14790, which implements the requirements of the SRM BSEN14790. The equipment consisted of an Apex Instruments USEPA Method Five apparatus. This consisted of a heated probe, heated filter and impinger bucket, connected to the sampling console. The console contained a calibrated dry gas meter. The data obtained from this system combined with the gravimetric increases allowed water content to be calculated. The moisture correction factor was calculated in the following manner:

$$\frac{(100 - [\text{H}_2\text{O}]_{\text{reference}})}{(100 - [\text{H}_2\text{O}]_{\text{measured}})}$$

This correction factor is only applied to the VOC result and was not applied to the combustion gases as the sample train for combustion gases uses a gas conditioner to remove moisture and introduces dried gas to the analyser. The raw data relating to the moisture test is presented as Appendix IV.

2.1.3 Monitoring organisation equipment and gas check list references

EQUIPMENT			
Item	Reference	Calibration Due	PAT Due
Portable Gas Analyser	PGA#02	25-Jan-17	Oct-16
Flame Ionisation Detector Analyser	FID#02	19-Apr-17	Oct-16
Gas Conditioner	COND#02	07-Mar-17	Oct-16
Data Logger	DL#05	04-Nov-16	-
Digital Barometer	DB#15	27-Feb-17	-
Digital Barometer	DB#17	05-Feb-17	
Balance	BAL#03	03-Apr-17	-
Heated Line ¹	HL#03B	04-Jan-17	-
Heated Line ²	HL#05	04-Jan-17	-
Heated Line Controller ¹	HLC#06	04-Jan-17	Oct-16
Heated Line Controller ²	HLC#04	04-Jan-17	Oct-16
Heated Filter Holder	HFH#01	31-Jan-17	Oct-16
'Apex' Kit	APEX#03	See each item	Oct-16
Dry Gas Meter ('Apex')	DGM#06	03-Sep-16	-
Timepiece ¹ ('Apex')	TP#12	03-Sep-16	-
Timepiece ²	TP#08	22-Dec-16	-
Thermocouple ¹	TC#28	08-Oct-16	-
Thermocouple ² ('Apex' Dogleg Exit)	TC#20	03-Sep-16	-
Thermocouple ³ ('Apex' Dry Gas Meter)	TC#30	03-Sep-16	-
Thermocouple ⁴	TC#43	08-Oct-16	-
Thermocouple Reader ('Apex') ¹	TCR#12	03-Sep-16	-
Thermocouple Reader ²	TCR#09	08-Oct-16	-
Flow meter ¹	FM05	21-Dec-16	-

Flow meter ²	FM08	21-Dec-16	-
Transformer ¹	-	-	Oct-16
Transformer ²	-	-	Oct-16
Cable Reel/Splitter ¹	-	-	Oct-16
Cable Reel/Splitter ²	-	-	Oct-16

GAS CYLINDERS			
	Certificate No.	Level (ppm)	Validity
'Zero' Gas (%) ¹	D909084	99.999%	-
'Zero' Gas (%) ²	N10000018	8.11% O ₂ in N ₂	-
Carbon Monoxide Span Gas ¹	VCD116940	1158	09-Jul-16
Nitrogen Dioxide Span Gas ¹	VCD116940	264	09-Jul-16
Oxygen Span Gas (%) ¹	11787910	7.94	01-Jul-16
VOC Span Gas ¹	11787910	565	01-Jul-16
Carbon Monoxide Span Gas ²	VCD115689	184.1	13-Dec-16
Nitrogen Dioxide Span Gas ²	VCD115689	85.7	13-Dec-16
Oxygen Span Gas (%) ²	7700651	8.01	07-May-17
VOC Span Gas ²	7700651	7.94	07-May-17

2.2 Appendix II: Emission Point Reference Data & Results

2.2.1 Photograph of Sampling Location on Engine



Engine sampled from 3 inch BSP port on vertical section of approx. 0.4m diameter stack. Accessed via permanent platform.

2.2.2 Photograph of Sampling Location on Flare



Flare sampled from flanged port on vertical section of approx. 1.5m diameter stack. Accessed via Aluminium Tower Scaffolding erected by PASMA Trained staff.

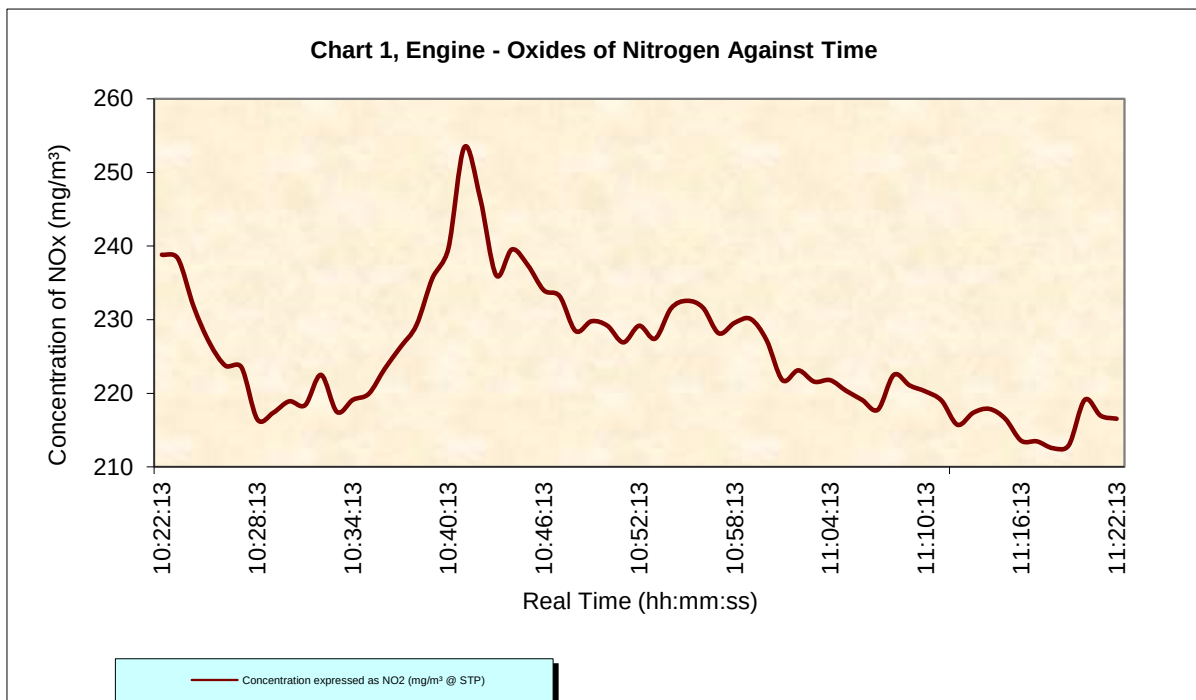
2.2.3 Homogeneity testing

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
Flare Stack	N/A – Due to the health & safety implications of working on a live flare, homogeneity assumed and single point sampling acceptable.

2.2.4 Gas analyser site measurements and calibrations

The data in Charts 1 to 6 and Tables 1 & 2 are expressed in mgm^{-3} @ STP and is uncorrected for O_2 . In addition, VOC results are expressed as methane 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 Tables 3 & 4.



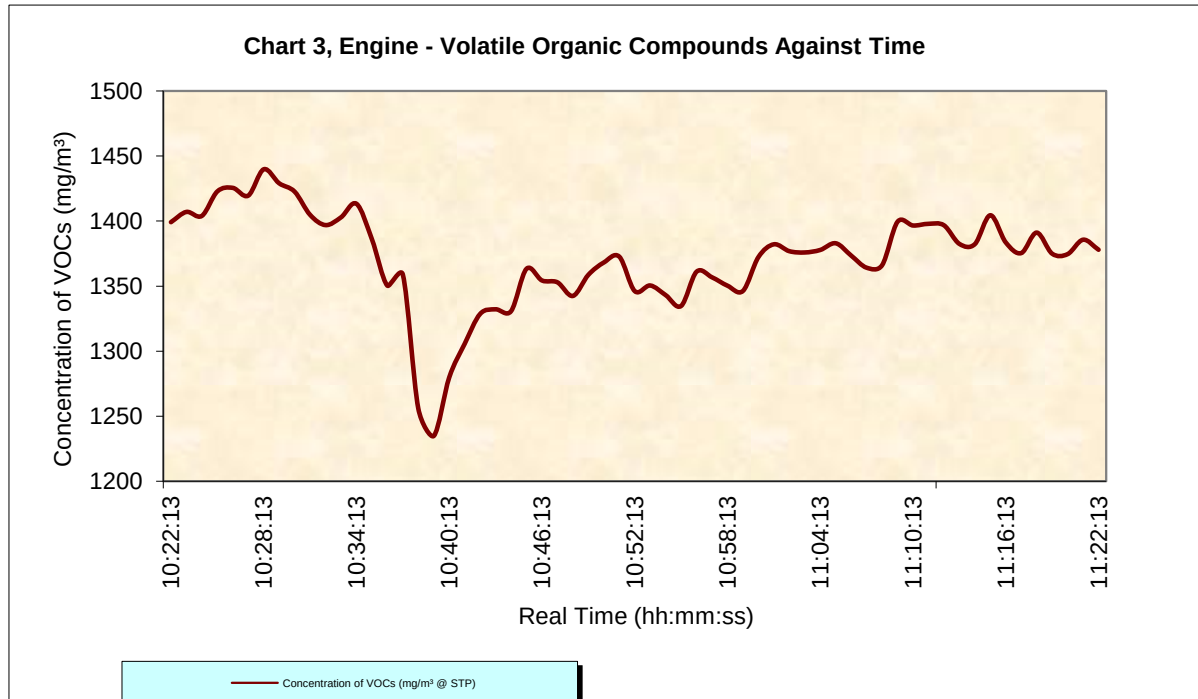
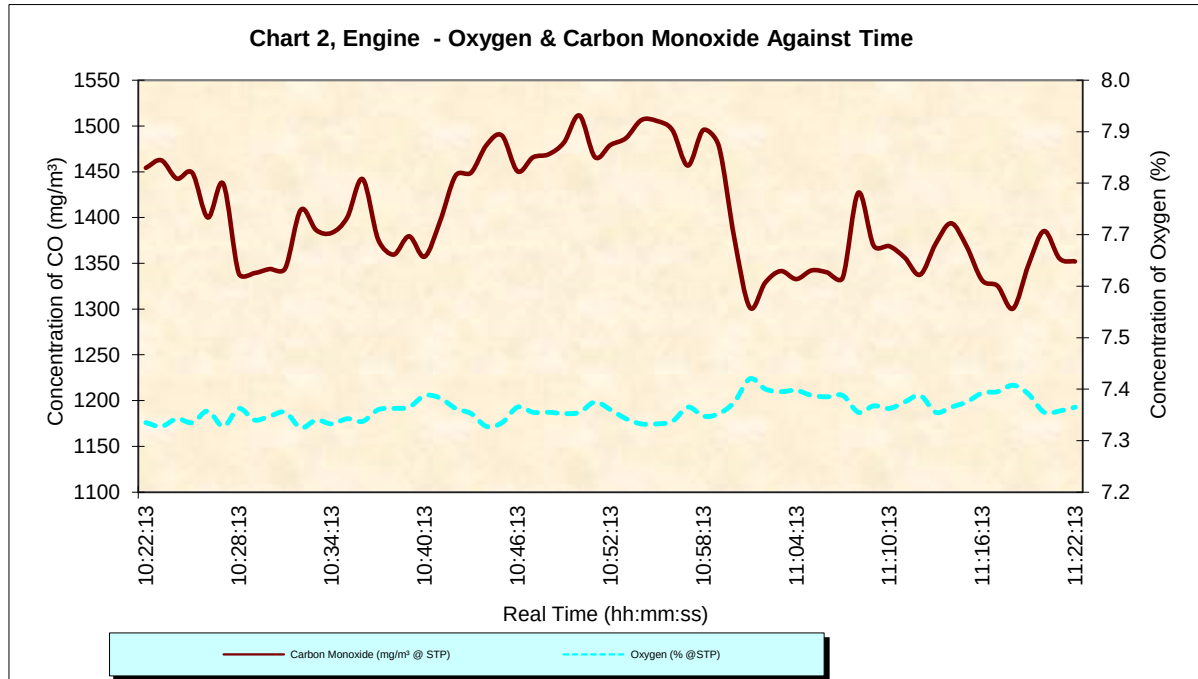


Chart 4, Flare- Oxides of Nitrogen Against Time

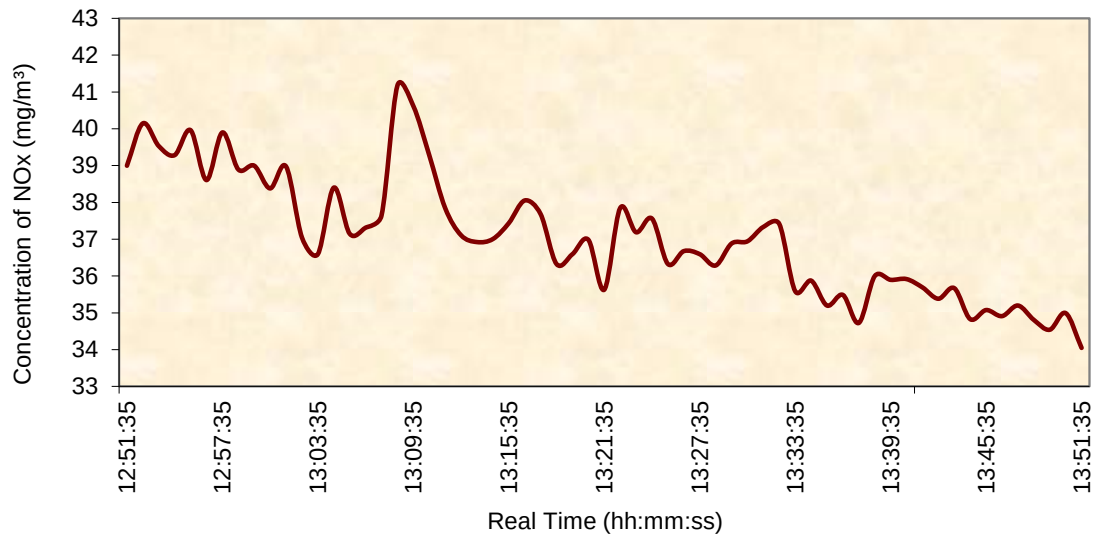
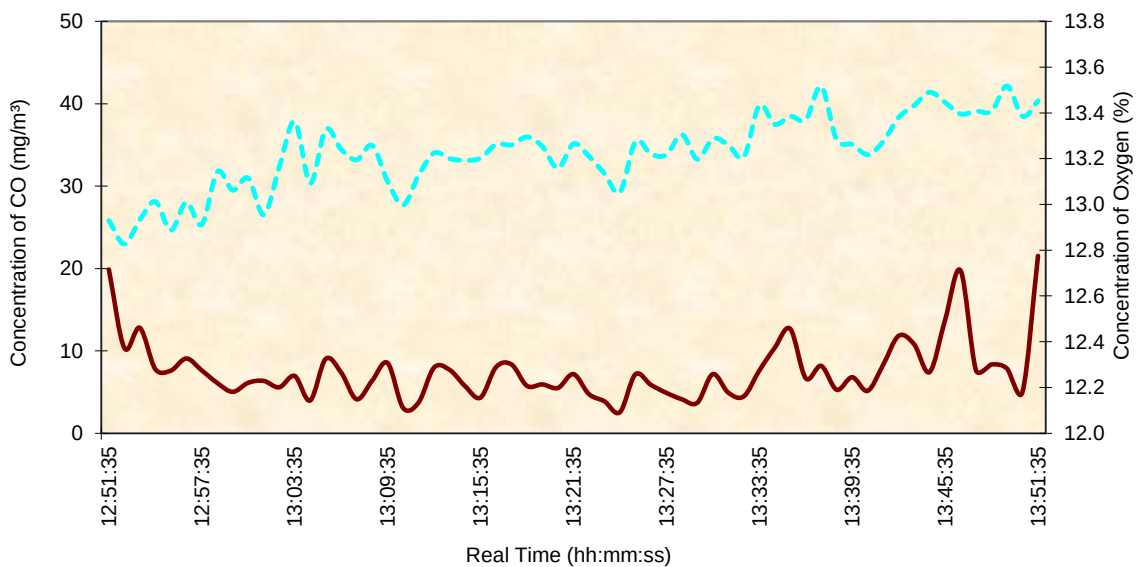
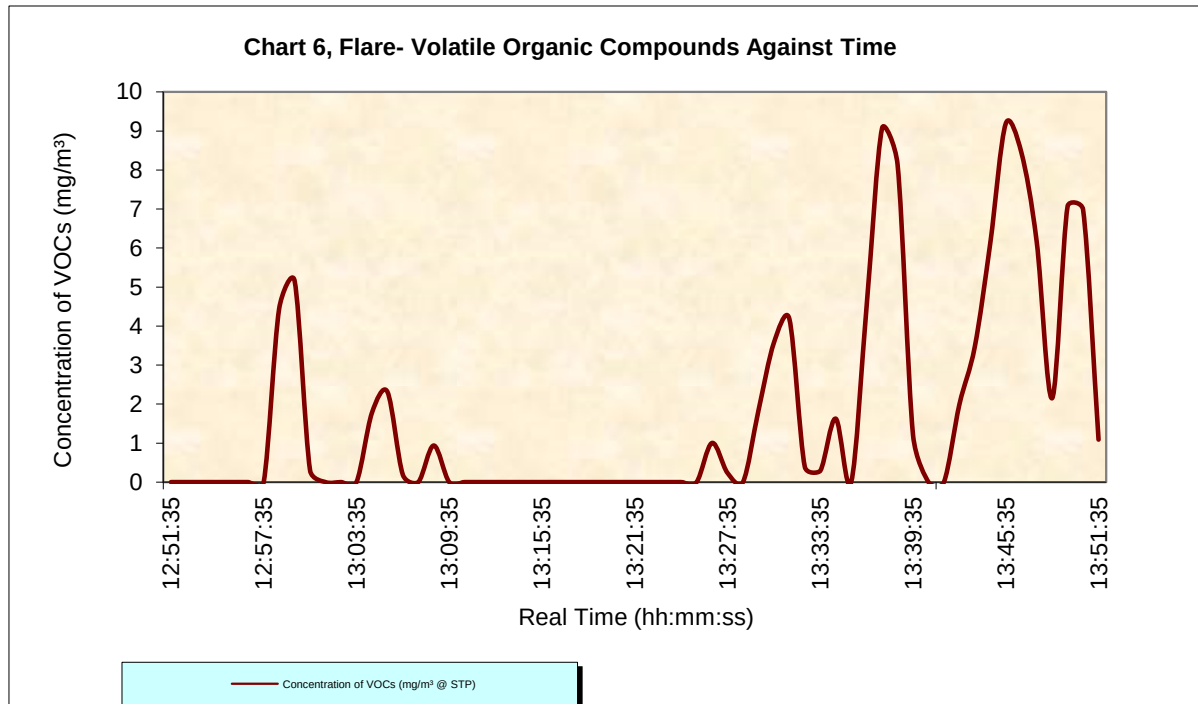


Chart 5, Flare- Oxygen & Carbon Monoxide Against Time



**Table 1 – Engine, Raw Data**

Time	Oxygen (%)	VOC (mgC/m³)	CO (mg/m³)	Nox (mg/m³)	Comment
10:22:13	7.3	1399.2	1454.3	238.8	
10:23:13	7.3	1407.1	1462.5	238.3	
10:24:13	7.3	1404.0	1442.5	231.7	
10:25:13	7.3	1422.8	1448.8	226.8	
10:26:13	7.4	1425.5	1400.0	223.7	
10:27:13	7.3	1419.6	1436.8	223.5	
10:28:13	7.4	1439.8	1339.0	216.4	
10:29:13	7.3	1429.1	1339.3	217.4	
10:30:13	7.3	1422.6	1343.8	218.9	
10:31:13	7.4	1404.8	1344.5	218.4	
10:32:13	7.3	1396.9	1408.3	222.5	
10:33:13	7.3	1402.9	1386.3	217.5	
10:34:13	7.3	1413.3	1383.3	219.1	
10:35:13	7.3	1386.0	1400.0	219.9	
10:36:13	7.3	1350.3	1442.0	223.3	
10:37:13	7.4	1358.8	1376.0	226.3	
10:38:13	7.4	1255.8	1359.5	229.3	
10:39:13	7.4	1234.8	1379.5	235.6	
10:40:13	7.4	1279.8	1357.3	239.7	
10:41:13	7.4	1305.6	1396.0	253.4	
10:42:13	7.4	1328.6	1445.8	246.5	
10:43:13	7.4	1332.2	1449.0	236.1	
10:44:13	7.3	1330.7	1479.3	239.5	

Time	Oxygen (%)	VOC (mgC/m ³)	CO (mg/m ³)	Nox (mg/m ³)	Comment
10:45:13	7.3	1363.3	1489.5	237.4	
10:46:13	7.4	1354.3	1450.5	234.0	
10:47:13	7.4	1352.9	1465.8	233.2	
10:48:13	7.4	1342.4	1469.0	228.5	
10:49:13	7.4	1358.7	1482.0	229.8	
10:50:13	7.4	1368.2	1511.5	229.2	
10:51:13	7.4	1372.7	1466.0	226.9	
10:52:13	7.4	1346.1	1479.3	229.2	
10:53:13	7.3	1350.5	1486.8	227.4	
10:54:13	7.3	1343.1	1506.5	231.5	
10:55:13	7.3	1334.7	1505.5	232.6	
10:56:13	7.3	1361.1	1495.5	231.6	
10:57:13	7.4	1356.8	1456.8	228.2	
10:58:13	7.3	1350.3	1495.8	229.6	
10:59:13	7.4	1346.3	1478.0	230.1	
11:00:13	7.4	1372.3	1377.5	227.2	
11:01:13	7.4	1382.1	1301.8	221.8	
11:02:13	7.4	1376.8	1329.0	223.1	
11:03:13	7.4	1375.9	1341.5	221.6	
11:04:13	7.4	1377.8	1332.8	221.8	
11:05:13	7.4	1382.9	1342.3	220.3	
11:06:13	7.4	1373.5	1340.0	219.1	
11:07:13	7.4	1364.1	1334.3	217.8	
11:08:13	7.4	1366.1	1427.0	222.5	
11:09:13	7.4	1399.5	1369.3	221.1	
11:10:13	7.4	1396.6	1368.8	220.2	
11:11:13	7.4	1397.9	1356.3	219.0	
11:12:13	7.4	1396.8	1337.5	215.7	
11:13:13	7.4	1382.5	1371.3	217.4	
11:14:13	7.4	1382.3	1393.8	217.9	
11:15:13	7.4	1404.5	1368.5	216.5	
11:16:13	7.4	1383.6	1331.5	213.6	
11:17:13	7.4	1375.4	1325.3	213.5	
11:18:13	7.4	1391.1	1300.5	212.5	
11:19:13	7.4	1374.9	1348.5	213.0	
11:20:13	7.4	1374.6	1385.3	219.1	
11:21:13	7.4	1385.7	1355.3	217.0	
11:22:13	7.4	1378.0	1352.0	216.5	

Table 2 – Flare, Raw Data

Time	Oxygen (%)	VOC (mgC/m ³)	CO (mg/m ³)	Nox (mg/m ³)	Comment
12:51:35	12.9	0.0	19.9	39.0	
12:52:35	12.8	0.0	10.4	40.1	
12:53:35	12.9	0.0	12.8	39.5	
12:54:35	13.0	0.0	7.8	39.3	
12:55:35	12.9	0.0	7.6	40.0	
12:56:35	13.0	0.0	9.1	38.6	
12:57:35	12.9	0.0	7.6	39.9	
12:58:35	13.1	4.4	6.1	38.9	
12:59:35	13.1	5.2	5.0	39.0	
13:00:35	13.1	0.3	6.1	38.4	
13:01:35	13.0	0.0	6.4	39.0	
13:02:35	13.2	0.0	5.6	37.0	
13:03:35	13.4	0.0	7.0	36.6	
13:04:35	13.1	1.8	4.0	38.4	
13:05:35	13.3	2.3	9.0	37.1	
13:06:35	13.2	0.2	7.4	37.3	
13:07:35	13.2	0.0	4.1	37.6	
13:08:35	13.3	0.9	6.4	41.2	
13:09:35	13.1	0.0	8.5	40.6	
13:10:35	13.0	0.0	3.1	39.3	
13:11:35	13.1	0.0	3.7	37.8	
13:12:35	13.2	0.0	8.0	37.1	
13:13:35	13.2	0.0	7.7	36.9	
13:14:35	13.2	0.0	5.7	37.0	
13:15:35	13.2	0.0	4.3	37.4	
13:16:35	13.3	0.0	8.0	38.1	
13:17:35	13.3	0.0	8.4	37.7	
13:18:35	13.3	0.0	5.8	36.3	
13:19:35	13.3	0.0	5.9	36.6	
13:20:35	13.2	0.0	5.5	37.0	
13:21:35	13.3	0.0	7.2	35.6	
13:22:35	13.2	0.0	4.8	37.8	
13:23:35	13.1	0.0	3.9	37.2	
13:24:35	13.1	0.0	2.6	37.6	
13:25:35	13.3	0.0	7.2	36.3	
13:26:35	13.2	1.0	5.9	36.7	
13:27:35	13.2	0.2	4.9	36.6	
13:28:35	13.3	0.0	4.1	36.3	
13:29:35	13.2	1.8	3.7	36.9	
13:30:35	13.3	3.6	7.2	36.9	
13:31:35	13.3	4.2	4.9	37.3	
13:32:35	13.2	0.4	4.5	37.4	
13:33:35	13.4	0.3	7.6	35.6	
13:34:35	13.4	1.6	10.4	35.9	
13:35:35	13.4	0.0	12.7	35.2	

Time	Oxygen (%)	VOC (mgC/m ³)	CO (mg/m ³)	Nox (mg/m ³)	Comment
13:36:35	13.4	4.5	6.7	35.5	
13:37:35	13.5	9.1	8.2	34.7	
13:38:35	13.3	8.1	5.3	36.0	
13:39:35	13.3	1.2	6.8	35.9	
13:40:35	13.2	0.0	5.2	35.9	
13:41:35	13.3	0.0	8.3	35.7	
13:42:35	13.4	2.0	11.8	35.4	
13:43:35	13.4	3.5	10.8	35.7	
13:44:35	13.5	6.1	7.4	34.8	
13:45:35	13.4	9.2	13.8	35.1	
13:46:35	13.4	8.5	19.8	34.9	
13:47:35	13.4	6.2	7.6	35.2	
13:48:35	13.4	2.2	8.4	34.8	
13:49:35	13.5	7.1	7.9	34.5	
13:50:35	13.4	7.0	5.0	35.0	
13:51:35	13.5	1.1	21.5	34.0	

Table 3 – 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.	D909084			Scrubbed Air/ N10000018
Span Gas	Cylinder No.	VCD116940	VCD116940	VC1981886	VC1981886
	Certified Value	264	1158	7.43	800
Zero Check	Value	0.4	2	0	0
<2 x repeatability (Yes/No)		YES	YES	YES	YES
Down Line Zero & Span Check					
Zero Gas	Value	0.4	1	0.08	0
	<2% of span	YES	YES	YES	YES
Span Gas	Value	263.7	1158	7.42	803
	Within 2% of span	YES	YES	YES	YES
Post Sampling Drift Check					
Zero Gas	Value	4.9	6	0.03	0
	Drift (%)	1.7	0.4	0.7	0.0
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required
Span Gas	Value	259.8	1149	7.41	799
	Drift (%)	1.5	0.8	0.1	0.5
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required

Table 4 – Flare, Analyser Calibration Data

ANALYSER CALIBRATION DATA					
Pre Sampling Check					
		NO (ppm)	CO (ppm)	O2 (%)	VOC's (ppm)
Range		100	200	25	10
Zero Gas	Cylinder No.	D909084			Scrubbed Air/ N10000018
Span Gas	Cylinder No.	VCD115689	VCD115690	7700651	7700651
	Certified Value	85.7	184.1	8.01	7.94
Zero Check	Value	0.3	0.8	-0.01	0
<2 x repeatability (Yes/No)		YES	YES	YES	YES
Down Line Zero & Span Check					
Zero Gas	Value	0.8	0.4	0.07	0.02
	<2% of span	YES	YES	YES	YES
Span Gas	Value	85.6	184.2	8	7.97
	Within 2% of span	YES	YES	YES	YES
Post Sampling Drift Check					
Zero Gas	Value	0.2	-1.4	0.07	-0.12
	Drift (%)	0.7	1.0	0.0	1.8
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required
Span Gas	Value	85.6	182.4	8.11	7.97
	Drift (%)	0.0	1.0	1.4	0.0
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required

2.3 Appendix III: Uncertainty Calculation

2.3.1 Engine, Uncertainties

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 _{rit}	2.37
Drift			U _{odr}	7.22
volume or pressure flow dependence			U _{spres}	0.06
atmosphseric pressure dependence			U _{apres}	0.00
ambient temperature dependence			U _{temp}	0.69
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}	1.04
losses in the line (leak)			U _{leak}	2.60
Uncertainty of calibration gas			U _{calib}	2.60
NOx Measurement uncertainty		Result	225.56	mg/m ³
Combined uncertainty			8.55	mg/m ³
Expanded uncertainty	k = 2		17.11	mg/m ³
Uncertainty corrected to std conds			17.11	mg.m-3 (corrected)
Expanded uncertainty		expressed with a level of confidence of 95%	2.63 % ELV	
Expanded uncertainty		expressed with a level of confidence of 95%	17.11 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 _{odr}	22.54
volume or pressure flow dependence			U _{spres}	0.00
atmospheric pressure dependence			U _{apres}	0.00
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}	16.21
Uncertainty of calibration gas			U _{calib}	16.21
CO Measurement uncertainty		Result	1404.09	mg/m ³
Combined uncertainty			32.73	mg/m ³
Expanded uncertainty	k = 2		65.46	mg/m ³
Uncertainty corrected to std conds			65.46	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%		4.36 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%		65.46 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 _{odr}	17.27
volume or pressure flow dependence			U _{spres}	0.00
atmosphseric pressure dependence			U _{apres}	0.00
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}	15.83
Uncertainty of calibration gas			U _{calib}	15.83
VOC Measurement uncertainty		Result	1371.14	mg/m ³
Combined uncertainty			28.54	mg/m ³
Expanded uncertainty	k = 2		57.08	mg/m ³
Uncertainty corrected to std conds			57.08	mg.m-3 (corrected)
Expanded uncertainty		expressed with a level of confidence of 95%	3.26 % ELV	
Expanded uncertainty		expressed with a level of confidence of 95%	57.08 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_{odr}	0.11
volume or pressure flow dependence			U_{spres}	0.00
atmospheric pressure dependence			U_{apres}	0.00
ambient temperature dependence			U_{temp}	0.10
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	7.36	%vol
Combined uncertainty			0.23	%vol
% of value			3.07	%
Expanded uncertainty		expressed with a level of confidence of 95%	6.15 % of value	
Expanded uncertainty		expressed with a level of confidence of 95%	0.45 % vol	

2.3.2 Flare, Uncertainties

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}	0.47
Drift			U _{odr}	1.40
volume or pressure flow dependence			U _{spres}	0.01
atmospheric pressure dependence			U _{apres}	0.00
ambient temperature dependence			U _{temp}	0.00
NH3 (20 mg/m3)			U _{interf}	0.14
CO2 (15%)			-	0.02
H2O (30%)			-	0.01
Error in logger voltage			-	0.10
Dependence on voltage			U _{vdt}	0.03
Converter efficiency			U _{ceff}	0.17
losses in the line (leak)			U _{leak}	0.43
Uncertainty of calibration gas			U _{calib}	0.43
NOx Measurement uncertainty		Result	37.11	mg/m ³
Combined uncertainty			1.62	mg/m ³
Expanded uncertainty	k = 2		3.24	mg/m ³
Uncertainty corrected to std conds			3.24	mg.m-3 (corrected)
Expanded uncertainty	expressed with a level of confidence of 95%		2.16 % ELV	
Expanded uncertainty	expressed with a level of confidence of 95%		3.24 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}	0.58
Drift			u _{odr}	1.20
volume or pressure flow dependence			u _{spres}	0.00
atmosphseric pressure dependence			u _{apres}	0.00
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			-	0.20
losses in the line (leak)			u _{leak}	0.08
Uncertainty of calibration gas			u _{calib}	0.08
CO Measurement uncertainty		Result	7.36	mg/m ³
Combined uncertainty			1.35	mg/m ³
Expanded uncertainty	k = 2		2.71	mg/m ³
Uncertainty corrected to std conds			2.71	mg.m-3 (corrected)
Expanded uncertainty		expressed with a level of confidence of 95%	5.42 % ELV	
Expanded uncertainty		expressed with a level of confidence of 95%	2.71 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}	0.04
Drift			U _{odr}	0.10
volume or pressure flow dependence			U _{spres}	0.00
atmospheric pressure dependence			U _{apres}	0.00
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			-	0.01
Dependence on voltage			U _{vdt}	0.03
losses in the line (leak)			U _{leak}	0.02
Uncertainty of calibration gas			U _{calib}	0.02
VOC Measurement uncertainty		Result	1.75	mg/m ³
Combined uncertainty			0.16	mg/m ³
Expanded uncertainty	k =	2	0.31	mg/m ³
Uncertainty corrected to std conds			0.31	mg.m-3 (corrected)
Expanded uncertainty		expressed with a level of confidence of 95%	3.14 % ELV	
Expanded uncertainty		expressed with a level of confidence of 95%	0.31 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}	0.15
Drift			U_{odr}	0.15
volume or pressure flow dependence			U_{spres}	0.00
atmospheric pressure dependence			U_{apres}	0.00
ambient temperature dependence			U_{temp}	0.00
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}	0.15
Error in Logger voltage			-	0.03
Uncertainty of calibration gas			U_{calib}	0.15
O2 Measurement uncertainty		Result	13.22	%vol
Combined uncertainty			0.31	%vol
% of value			2.38	%
Expanded uncertainty		expressed with a level of confidence of 95%	4.76 % of value	
Expanded uncertainty		expressed with a level of confidence of 95%	0.63 % vol	

2.4 Appendix IV: Moisture Calculations

2.4.1 Engine, Moisture

Test No	T1		Site	Flintshire CC		
Date	6-5-16			Brookhill		
pbar (mbar)	996		Stack	Engine		
pbar (mmHg)	747		Job Number:	R16221		
Nozzle Diameter (mm)	n/a		Site Team:	DL + DK		
Temp of Meter (in)/(out) deg. C	21		Data Entered By:	DL		
ΔH_{ave} (mmHg)	10.0					
DGM Cal Factor (Y)	0.9706					
Start Volume Reading	0.0000	m ³		Start time	10:22	hr:min
End Volume Reading	0.5095	m ³		End time	11:22	hr:min
Volume Sampled	0.4945	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)	785.2	787.9	551.0	728.4	DK	
Final Weight of Impingers plus absorber (g)	827.3	790.2	551.2	734.7	DK	
Weight Gain (g)	42.1	2.3	0.2	6.3		
Total Weight Gain (1+2+3+4) (g)	50.9					
Gas Volume of water at 0 °C (l)	63.37					
Gas Meter volume at 0 °C (l)	451.94					
Moisture content of Gases (%)	12.3					

2.4.2 Flare, Moisture

Test No	T2		Site	Flintshire CC		
Date	6-5-16			Brookhill		
pbar (mbar)	992		Stack	Flare		
pbar (mmHg)	744		Job Number:	R16221		
Nozzle Diameter (mm)	n/a		Site Team:	DL + DK		
Temp of Meter (in)/(out) deg. C	21		Data Entered By:	DL		
ΔH_{ave} (mmH ₂ O)	10.0		Enter Data into coloured cells only			
DGM Cal Factor (Y)	0.9706					
Start Volume Reading	0.0000	m ³	Start time	12:51	hr:min	
End Volume Reading	0.4881	m ³	End time	13:51	hr:min	
Volume Sampled	0.4737	m ³	Total time	01:00	hr:min	
IMPINGER	1	2	3	4	Initials of Analyst	
Absorber Solution (Type):	H ₂ O	H ₂ O	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)	827.3	790.2	551.2	734.7	DK	
Final Weight of Impingers plus absorber (g)	850.4	791.2	551.3	739.8	DK	
Weight Gain (g)	23.1	1.0	0.1	5.1		
Total Weight Gain (1+2+3+4) (g)	29.3					
Gas Volume of water at 0 °C (l)	36.48					
Gas Meter volume at 0 °C (l)	431.22					
Moisture content of Gases (%)	7.8					



4251

ANALYSIS OF THE TRACE LANDFILL GAS

AT

Brookhill Landfill Site

Brookhill Way
Pinfold Industrial Estate
Buckley
Flintshire, CH37 3PL

Commissioned by: Phil Mulhall

Of

Waste Management Service

Flintshire County Council
Alltami Depot
Mold Road - Alltami
Flintshire, CH7 6LG

Date of Survey:

6th May 2016

Compiled By:

David Littlewood
Operations Manager

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6th May 2016

Compiled By:

Mr David Littlewood
Operations Manager
Mcerts Level II (TE1, 2, 3 & 4)

Signed:



Dated:

1st June 2016

CONTENTS

- 1.** INTRODUCTION
- 2.** PLANT DESCRIPTION
- 3.** SAMPLING PROCEDURES
- 4.** RESULTS
- 5.** DISCUSSION & CONCLUSION

APPENDICES:

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

1. INTRODUCTION

- 1.1 EnviroDat Limited was commissioned by Phil Mulhall, 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 6th May 2016.
- 1.2 The sampling was conducted in response to permit requirements (Permit No. BV7273 Var. 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 CHP plant. Samples of the fuel gas were taken from a feed system for trace gas analysis after the gas booster.

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 Scientific Analysis Laboratories Ltd (SAL 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 SAL Ltd.
- 3.4 Arsenic was sampled onto an activated charcoal sorbent tube prior to analysis by inductively coupled plasma/optical emission spectrometry (ICP/OES), in accordance with EA recommendations and SPTGN04. The results are presented in Appendix B. The analytical component of the work was conducted at SAL Ltd.
- 3.5 Hydrogen sulphide was sampled into a Tedlar bag with analysis by GC/MS (by SAL Ltd) in accordance with SPTGN04. The results are presented in Appendix B.
- 3.6 Siloxanes sampling was effected 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 results are presented in Appendix D. The analysis was carried out at SAL Ltd.

4. RESULTS

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

5. DISCUSSION AND CONCLUSION

- 5.1 The aim of the survey was to measure trace components from the landfill gas at Brookhill LFS.
- 5.2 The levels of trace components within the landfill are of a range and magnitude not dissimilar to what would be expected and can be regarded as comparable with biogenic gas of this nature from other sources.

APPENDIX A

Site Information & Preliminary Gas Measurements

TABLE A: Site Information & Preliminary Gas Measurements

Sample Position Details			
Date	06/05/2016	Site	Flintshire County Council Brookhill LFS
Ambient Temperature	19°C	Atmospheric Pressure	996mbar
Monitoring Organisation (s)	EnviroDat Ltd	Analytical Laboratory	SAL
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	18°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*	46.6	%	-
Carbon Dioxide*	36.1	%	-
Oxygen*	0.0	%	-
Nitrogen*	17.3	%	Assumed to be balance of gas
Hydrogen Sulphide*	-	ppmv	Not required
Carbon Monoxide*	-	ppmv	

Notes: * Raw result obtained from client

APPENDIX B

Trace Gas Results

TABLE B: Trace Gas Results

Trace Gases - Test 1							
	Test Duration	Flow Rate	Flowmeter	Volume	Ambient T	Barometric P	Volume
	(min)	(ml/min)	CAL Factor	(l as sampled)	(°C)	(kPa)	(l @ STP)
VOC	5	50	1.074	0.27	19	99.6	0.25
Aldehydes	20	200	0.997	3.99	19	99.6	3.67
Arsenic	60	200	0.997	11.96	19	99.6	11.00
Compound	Mass of TG (ng)	LoD of TG (ng)	Concentration		Units	Analysis Notes (See below)	Analysis UKAS Accredited (Y/N)
1, 1 - dichloroethane		10	< 41		µg/m3	-	Y
1, 2 - dichloroethane		10	< 41		µg/m3	-	N
1, 1 - dichloroethene		10	< 41		µg/m3	-	Y
1, 2 - dichloroethene		30	< 122		µg/m3	-	Y
1, 3 - butadiene		10	< 41		µg/m3	-	Y
1 - butanethiol		10	< 41		µg/m3	-	Y
1 - pentene		10	< 41		µg/m3	-	Y
1 - propanethiol		10	< 41		µg/m3	-	Y
2 - butoxyl ethanol		10	< 41		µg/m3	-	N
Arsenic (as As)		1000	< 91		µg/m3	-	Y
Benzene		10	< 41		µg/m3	-	Y
Butyric acid		10	< 41		µg/m3	-	N
Carbon disulphide	230	10	932		µg/m3	a	N
Chloroethane		30	< 122		µg/m3	-	N
Chloroethene (vinyl chloride)		10	< 41		µg/m3	-	Y
Dimethyl disulphide		10	< 41		µg/m3	-	N
Dimethyl sulphide		10	< 41		µg/m3	-	Y
Ethanal (acetaldehyde)	500	100	136		µg/m3	-	Y
Ethanethiol		10	< 41		µg/m3	-	N
Ethyl butyrate		25	< 101		µg/m3	-	N
Furan (1,4-epoxy-1,3 butadiene)		10	< 41		µg/m3	-	N
Methanal (formaldehyde)	1800	100	491		µg/m3	a	Y
Methanethiol		30	< 122		µg/m3	-	N
Styrene		10	< 41		µg/m3	-	N
Tetrachloromethane		10	< 41		µg/m3	-	Y
Toluene	960	10	3890		µg/m3	c	N
Trichloroethene		9	< 36		µg/m2	-	Y
Compound	Concentration in ppm	LOD of TG (ppm)	Concentration		Units	Analysis Notes (See below)	Analysis UKAS Accredited (Y/N)
Hydrogen sulphide	530	10	804464		µg/m3	-	N

*H2S value is equivalent to 530 ppm, values in heighlighted box are expressed as ppm and not ng

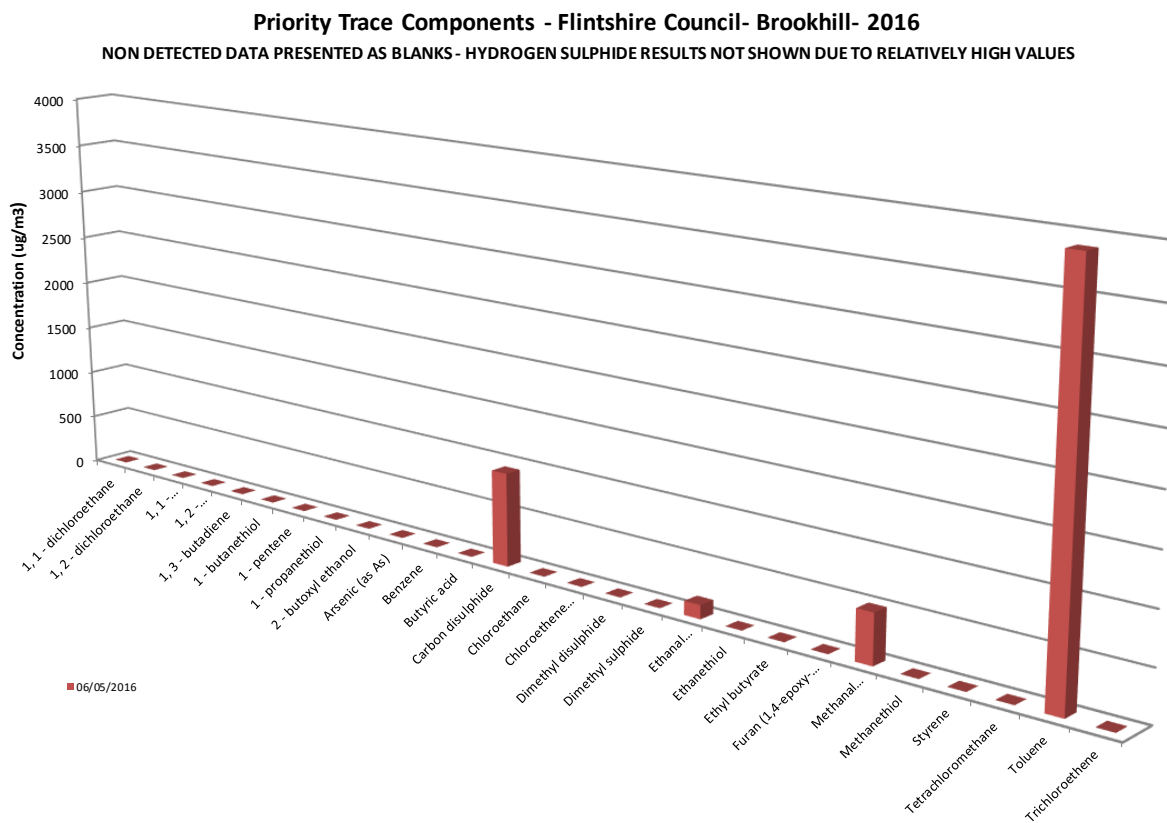
(a) – Results have been blank corrected
(b) – Results should be considered a minimum due to detector saturation
(c) – Results should be viewed with caution due to being outside of the instrument calibration range

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	1
Date	06/05/2016
Site	Flintshire CC Brookhill
Stack	Fuel Line
Reference Conditions - Oxygen (%)	n/a
- Temperature (°C)	0
- Pressure (kPa)	101.3
Job Number	R16221
Site Team	DL, DK
Test Conducted By	DL, DK
Data Entered By	DL

Test Start Time	09:20
Test End Time	09:40
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)	99.6
Ambient Temperature (°C)	18
Flowmeter Calibration Factor (f)	0.997
Stack Oxygen Level (%)	n/a
Volume Sampled @ Reference Conditions	3.68

Primary Tube Reference Identification Number	5896803433
Security Tube Reference Identification Number	5896803361
Blank Tube Reference Identification Numbers	5896803420/5896803432
Mass of Siloxane on Primary Tube (ug)	106
Mass of Siloxane on Security Tube (ug)	< 6
Breakthrough (Reject if > 5%)	Accepted
Total Mass of Siloxane in Sample (ug)	112

Siloxane Concentration (mg/m ³ @ STP and Ref O ₂)	30.45
--	-------

TABLE D(ii): Siloxane/Silicon Congener Breakdown

Siloxane	Siloxane Concentration (mg/m ³ @ STP)	Organic Silicon Concentration (mg/m ³ @ STP)
Decamethylcyclopentasiloxane	9.25	3.50
Decamethyltetrasiloxane	< 0.54	< 0.20
Hexamethylcyclotrisiloxane	0.54	0.21
Hexamethyldisiloxane	2.18	0.75
Octamethylcyclotetrasiloxane	17.40	6.59
Octamethyltrisiloxane	< 0.54	< 0.19
Total Siloxane Concentration:	30.45	
Total Silicon Concentration:		11.45

Annual FID Survey Report

Brookhill Landfill Site

July 2016

Approval Sheet

Customer: TerraConsult

Site: Brookhill Landfill Site

Project title: Annual FID Survey

Project Manager: D Higgins

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Issue	Status	Date	Prepared By	Signature	Date
1	Final	28/07/2016	C Keightley	C Keightley	28/07/2016
			Approved By	Signature	Date
			D Higgins		28/07/2016

Foreword

enital has used its best endeavours, experience and expertise to provide a meaningful, accurate and relevant representation of the works carried out. The works were based on a defined programme and scope of works and terms and conditions agreed with the Client.

The findings discussed in this document relating to information provided by the Client relate only to those to which we have had access. No attempt has been made to validate any data or information provided. It is acknowledged that certain aspects may be superseded or rendered irrelevant by information in documentation to which we have not accessed.

enital cannot accept responsibility to any parties whatsoever, following the issue of this report, for any matters arising which may be considered outside the agreed scope of works.

This report is issued solely to the Client. enital does not accept any responsibility to any third parties to whom this report may be circulated, in part or in full, and any such parties rely on the contents at their own risk.

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Appendix

- A. Annual FID Survey Results
- B. Annual FID Survey Plans

1.0 Introduction

1.1 Brief

enital were commissioned by TerraConsult to undertake a Surface Emissions Phase 1 (Annual FID Walkover) Survey at their Brookhill Landfill Site in July 2016. Brookhill Landfill Site is situated off Brookhill Way, in Buckley, Flintshire at NGR SJ278656. The site is no longer accepting waste inputs and the site has been permanently capped and restored.

1.2 Desk Study

A desktop study was undertaken prior to the Annual FID Survey by collecting information supplied by Flintshire County Council in the form of drawings of capping areas and up to date topography. One zone was identified as requiring Annual FID Surveying.

2.0 Survey Summary

2.1 Annual FID Survey

The Annual FID Survey was undertaken on 27 July 2016 and included the capped and restored areas of the landfill site as indicated on the plan contained in Appendix B. A Gas-Tec Flame Ionisation Detector device was used to undertake the survey which measures hydrocarbons in parts per million by volume (ppm) on a scale of 0 to 10,000.

The capped areas of the landfill site were surveyed on lines at 50m intervals for permanent capping as detailed in the Environment Agency Guidance on Monitoring Landfill Gas Surface Emissions LFTGN 07 (EA Guidance) and at a distance of not exceeding 5cm from the surface where possible. In addition, all known infrastructure was surveyed which included all gas extraction and leachate wells and associated installations. Any distinctive features were also surveyed which generally include surface fissures, stressed vegetation, interfaces between caps, edges and side-slopes.

3.0 Results Summary

3.1 Annual FID Survey Results

A full set of Annual FID Survey results are presented in Appendix A along with plans showing the location of all survey transects and infrastructure in Appendix B.

The table below summarises infrastructure and features where a significant elevated hydrocarbon reading was recorded (100ppm for a surface emission and 1,000ppm for emissions from infrastructure) along with details of the point of emission.

Zone	Reference	Concentration in ppm	Comments
Z1	R1B	5,000	From top of well

4.0 Field Log

4.1 Weather Conditions and Meteorological Data

Meteorological data was recorded from on site observations and local weather station data. The table below details conditions and observations made during the survey.

Date / Time Period	Weather Conditions	Ground Conditions	Temperature (°C)	Atmospheric Pressure (mbar)	Wind Direction / Speed (mph)
27/07/2016 08:00	Light cloud	Wet	15	1014	NW / 12
27/07/2016 11:00	Light cloud	Wet	17	1015	NNW / 11

4.2 Site Personnel and Equipment

The table below details the personnel on site during the survey and the equipment type used including serial number and calibration expiry details.

Date	Personnel	Instrument Type	Instrument Serial Number	Calibration Due
27/07/2016	A Moore	Gas-Tec FID	250215 0001	03/09/2016

Appendix A

Annual FID Survey Results

Brookhill Landfill Site
Surface Emissions Survey - July 2016
Initial Walkover / FID Survey - Transects

Zone	Transect Ref	Date	Location			Concentration in ppmv	Comments
			Start - End	Easting	Northing		
Z1	Transect 1	27/07/2016	North	327780	365779	0	
			South	327780	365505		
Z1	Transect 2	27/07/2016	North	327830	365762	0	
			South	327830	365493		
Z1	Transect 3	27/07/2016	North	327880	365751	0	
			South	327880	365492		
Z1	Transect 4	27/07/2016	North	327930	365677	0	
			South	327930	365551		
Z1	Cap Edge	27/07/2016	North	See Plan		0	
			South				

Brookhill Landfill Site
Surface Emissions Survey - July 2016
Initial Walkover / FID Survey - Infrastructure

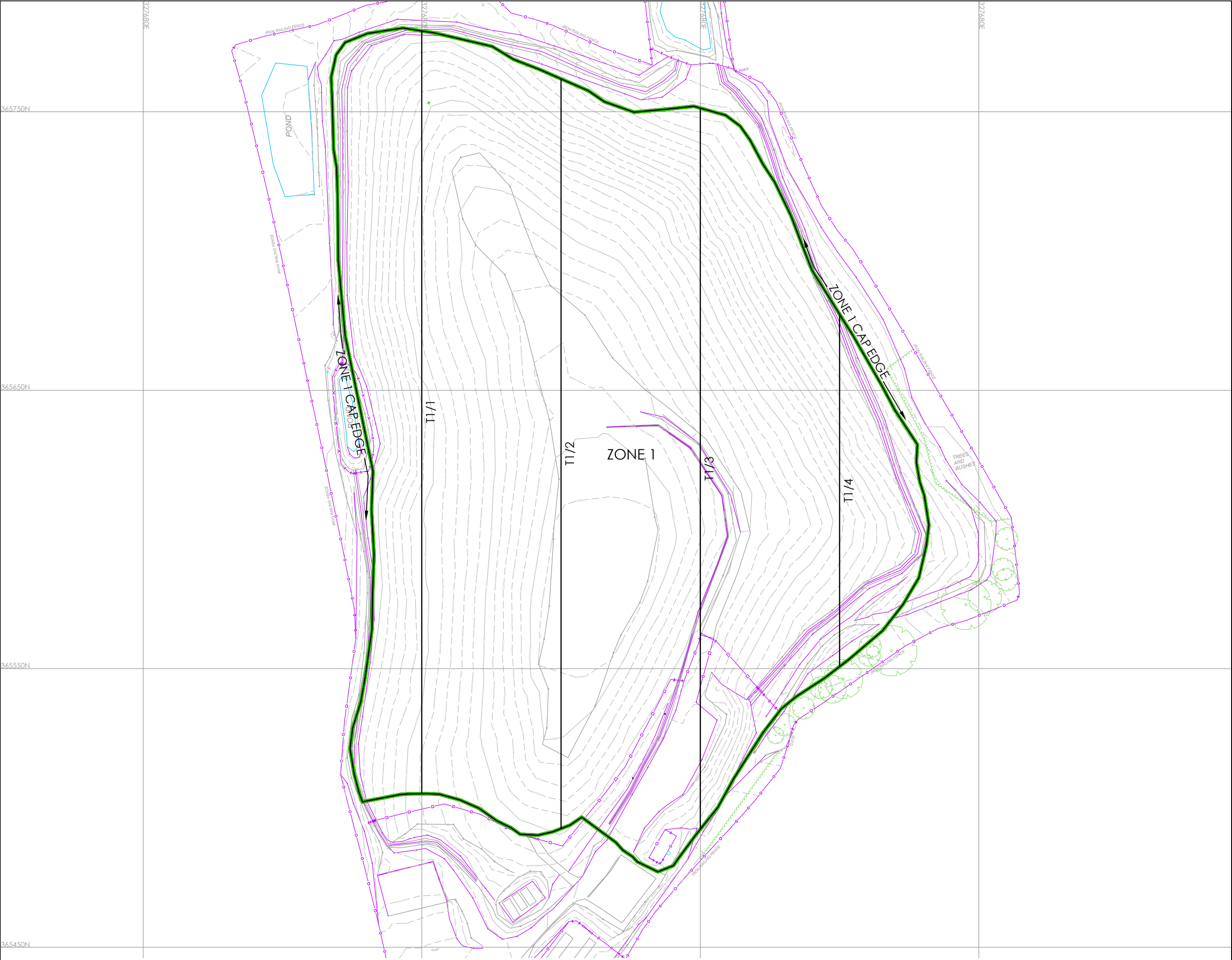
Zone	Feature Ref	Date	Location		Concentration in ppmv	Valve Position	Comments
			Easting	Northing			
Z1	CV	27/07/2016	327923	365550	0	-	
Z1	CV	27/07/2016	327923	365550	0	-	
Z1	CV	27/07/2016	327941	365565	0	-	
Z1	CV	27/07/2016	327941	365565	0	-	
Z1	GW	27/07/2016	327950	365592	0	-	
Z1	GW	27/07/2016	327928	365584	0	-	
Z1	GW	27/07/2016	327904	365629	0	-	
Z1	GW	27/07/2016	327884	365648	0	-	
Z1	GW	27/07/2016	327895	365617	0	-	
Z1	GW	27/07/2016	327910	365594	0	-	
Z1	GW	27/07/2016	327889	365587	0	-	
Z1	GW	27/07/2016	327876	365557	0	-	
Z1	GW	27/07/2016	327854	365527	0	-	
Z1	GW	27/07/2016	327832	365516	0	-	
Z1	GW	27/07/2016	327840	365539	0	-	
Z1	GW	27/07/2016	327804	365508	0	-	
Z1	GW	27/07/2016	327794	365549	0	-	
Z1	GW	27/07/2016	327790	365579	0	-	
Z1	GW	27/07/2016	327825	365572	0	-	
Z1	GW	27/07/2016	327855	365560	0	-	
Z1	GW	27/07/2016	327863	365600	0	-	
Z1	GW	27/07/2016	327864	365649	0	-	
Z1	GW	27/07/2016	327848	365615	0	-	
Z1	GW	27/07/2016	327841	365586	0	-	
Z1	GW	27/07/2016	327834	365648	0	-	
Z1	GW	27/07/2016	327826	365600	0	-	
Z1	GW	27/07/2016	327818	365631	0	-	
Z1	GW	27/07/2016	327799	365638	0	-	
Z1	GW	27/07/2016	327792	365600	0	-	
Z1	GW	27/07/2016	327770	365639	0	-	
Z1	GW	27/07/2016	327774	365728	0	-	
Z1	GW	27/07/2016	327784	365676	0	-	
Z1	GW	27/07/2016	327812	365660	0	-	
Z1	GW	27/07/2016	327813	365674	0	-	
Z1	GW	27/07/2016	327828	365674	0	-	
Z1	GW	27/07/2016	327824	365685	0	-	
Z1	GW	27/07/2016	327859	365682	0	-	
Z1	GW	27/07/2016	327866	365651	10	-	Gap in well chamber
Z1	GW	27/07/2016	327874	365656	0	-	
Z1	GW	27/07/2016	327882	365651	0	-	
Z1	GW	27/07/2016	327897	365655	0	-	
Z1	GW	27/07/2016	327862	365709	0	-	
Z1	GW	27/07/2016	327851	365710	0	-	
Z1	GW	27/07/2016	327850	365729	0	-	

Brookhill Landfill Site
Surface Emissions Survey - July 2016
Initial Walkover / FID Survey - Infrastructure

Zone	Feature Ref	Date	Location		Concentration in ppmv	Valve Position	Comments
			Easting	Northing			
Z1	GW	27/07/2016	327828	365704	0	-	
Z1	GW	27/07/2016	327822	365748	0	-	
Z1	GW	27/07/2016	327792	365740	0	-	
Z1	GW	27/07/2016	327781	365752	0	-	
Z1	GW10	27/07/2016	327889	365709	0	-	
Z1	GW11	27/07/2016	327907	365678	0	-	
Z1	GW2	27/07/2016	327777	365701	0	-	
Z1	GW2/2	27/07/2016	327828	365673	0	-	
Z1	GW21	27/07/2016	327881	365539	0	-	
Z1	GW6	27/07/2016	327810	365719	0	-	
Z1	GW7	27/07/2016	327823	365754	0	-	
Z1	GW8	27/07/2016	327850	365734	0	-	
Z1	GWLC1	27/07/2016	327881	365718	0	100	
Z1	IC	27/07/2016	327844	365492	0	-	
Z1	IC	27/07/2016	327887	365545	0	-	
Z1	IC	27/07/2016	327783	365753	0	-	
Z1	KOP	27/07/2016	327869	365484	0	-	
Z1	LC	27/07/2016	327855	365485	0	-	
Z1	LC	27/07/2016	327856	365511	0	-	
Z1	LC	27/07/2016	327867	365534	0	-	
Z1	LC1B	27/07/2016	327851	365712	0	-	
Z1	LC2B	27/07/2016	327821	365680	0	100	
Z1	LC6B	27/07/2016	327820	365537	0	50	
Z1	LW	27/07/2016	327912	365593	0	-	
Z1	LW	27/07/2016	327893	365598	0	-	
Z1	LW	27/07/2016	327898	365605	0	-	
Z1	LW	27/07/2016	327897	365658	0	-	
Z1	LW5	27/07/2016	327829	365554	500	0	From top of well
Z1	LW6	27/07/2016	327807	365528	0	0	
Z1	LW913	27/07/2016	327882	365720	0	0	
Z1	MANIFOLD	27/07/2016	327887	365704	0	-	
Z1	MANIFOLD	27/07/2016	327821	365752	0	-	
Z1	MANIFOLD	27/07/2016	327765	365729	0	-	
Z1	R1	27/07/2016	327802	365726	0	-	
Z1	R1B	27/07/2016	327804	365724	5,000	50	From top of well
Z1	R2	27/07/2016	327820	365659	0	-	
Z1	R2B	27/07/2016	327822	365660	0	-	
Z1	R4	27/07/2016	327892	365598	0	-	
Z1	R4B	27/07/2016	327900	365597	0	100	
Z1	R5	27/07/2016	327843	365572	0	-	
Z1	R6	27/07/2016	327817	365515	1	-	Ambient levels
Z1	R6B	27/07/2016	327823	365520	0	100	

Appendix B

Annual FID Survey Plans



LEGEND

- Indicative Extent of FID Walkover Survey
- FID Survey Lines (at 50m and 25m centres dependant on cap type)
- Feature Location and Reference

NOTE: DRAWING SUPPLIED BY FLINTSHIRE CC POSITIONED AND ROTATED TO LOCAL GRID - CONVERTED TO OSG81936 GRID USING SITE FEATURES TO DETERMINE LOCATION IN GOOGLE EARTH. CONFIDENCE IN ACCURACY ASSUMED TO BE WITHIN 3m

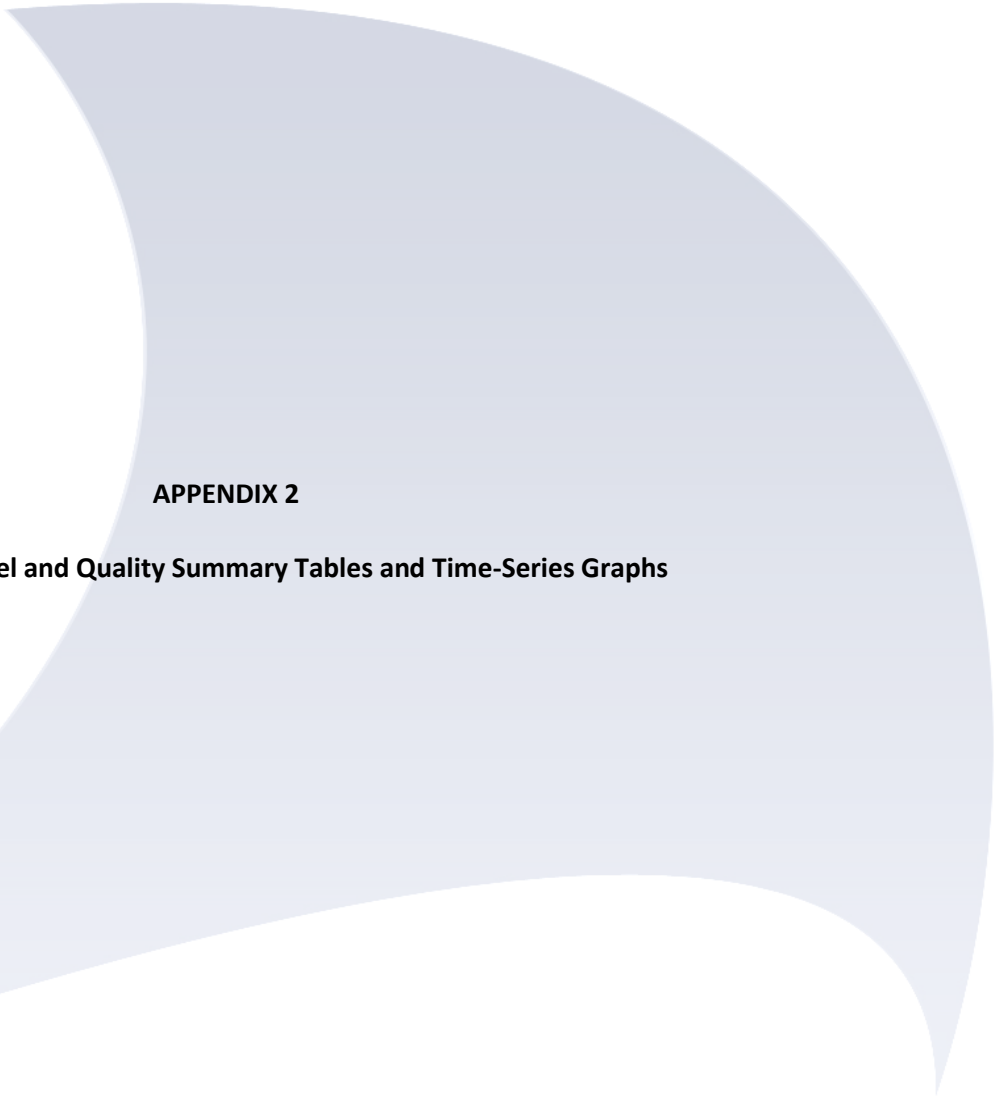
TERRACONSULT

BROOKHILL LANDFILL SITE

ANNUAL FID SURVEY PLAN
TRANSECTS PLAN (1 of 2)
JULY 2016

DRAWN BY	CK	DATE	28/07/2016
APPROVED BY		SCALE @ A3	1:1250
DRAWING No	2016/BRO/01	STATUS	FINAL

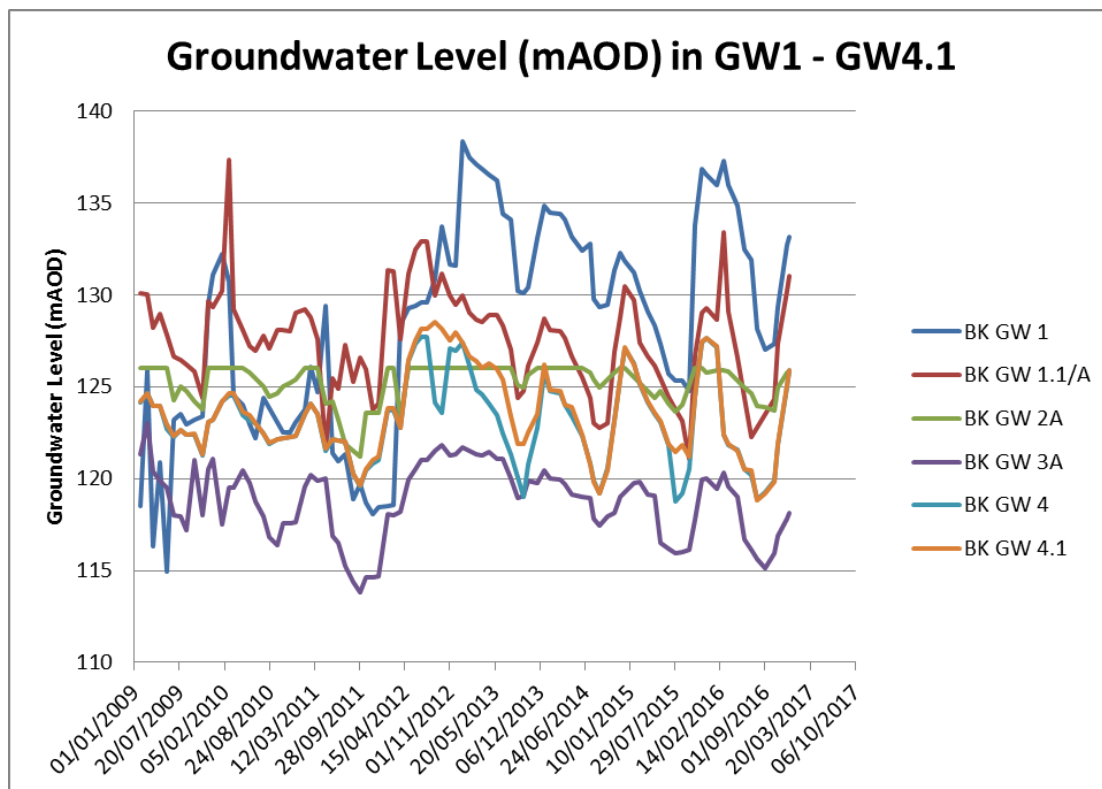
enitl
Enterprise Drive
Four Ashes
Wolverhampton
WV10 7DE
tel +44 (0) 1902 798798
fax +44 (0) 1902 798711
www.enitl.co.uk



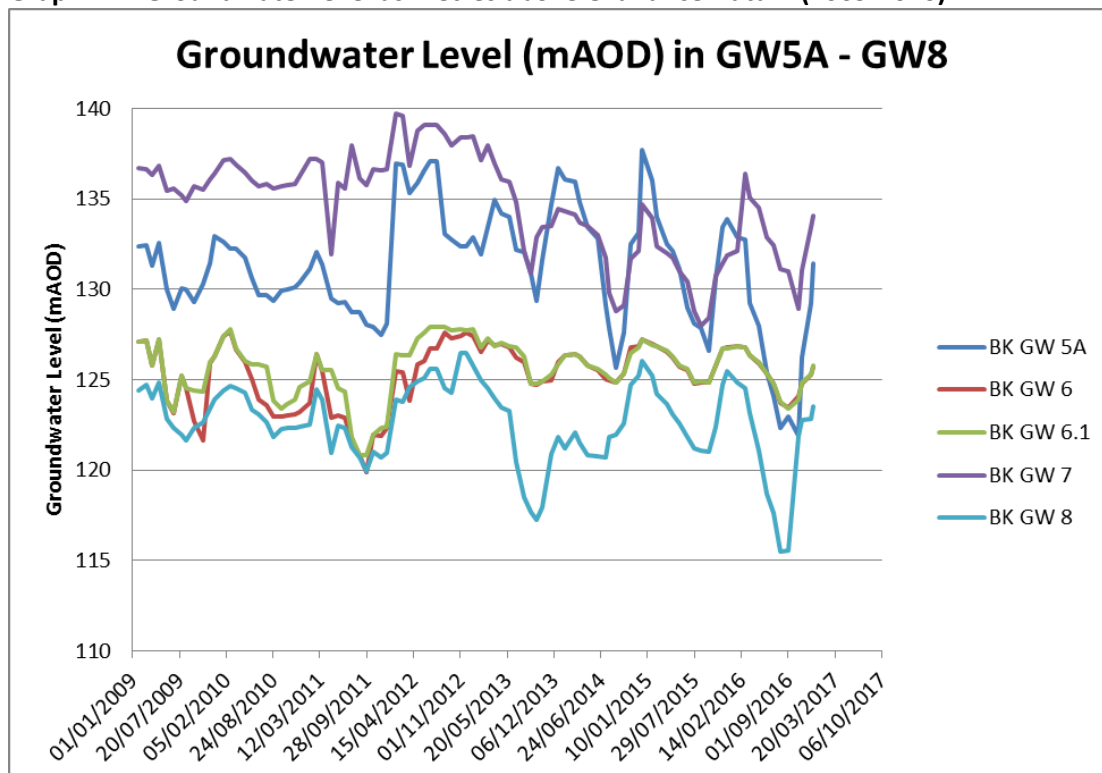
APPENDIX 2

Groundwater Level and Quality Summary Tables and Time-Series Graphs

APPENDIX 2 - GROUNDWATER



Graph 1A: Groundwater level as metres above Ordnance Datum (2009-2016)



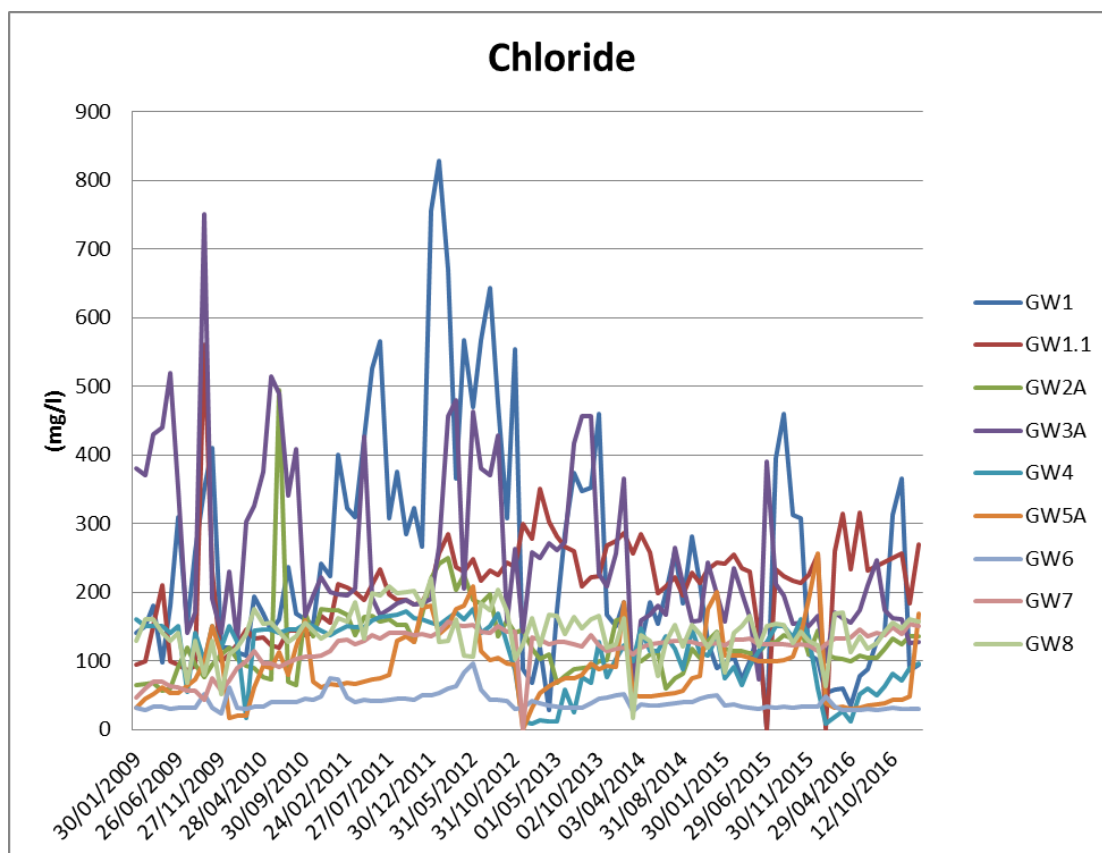
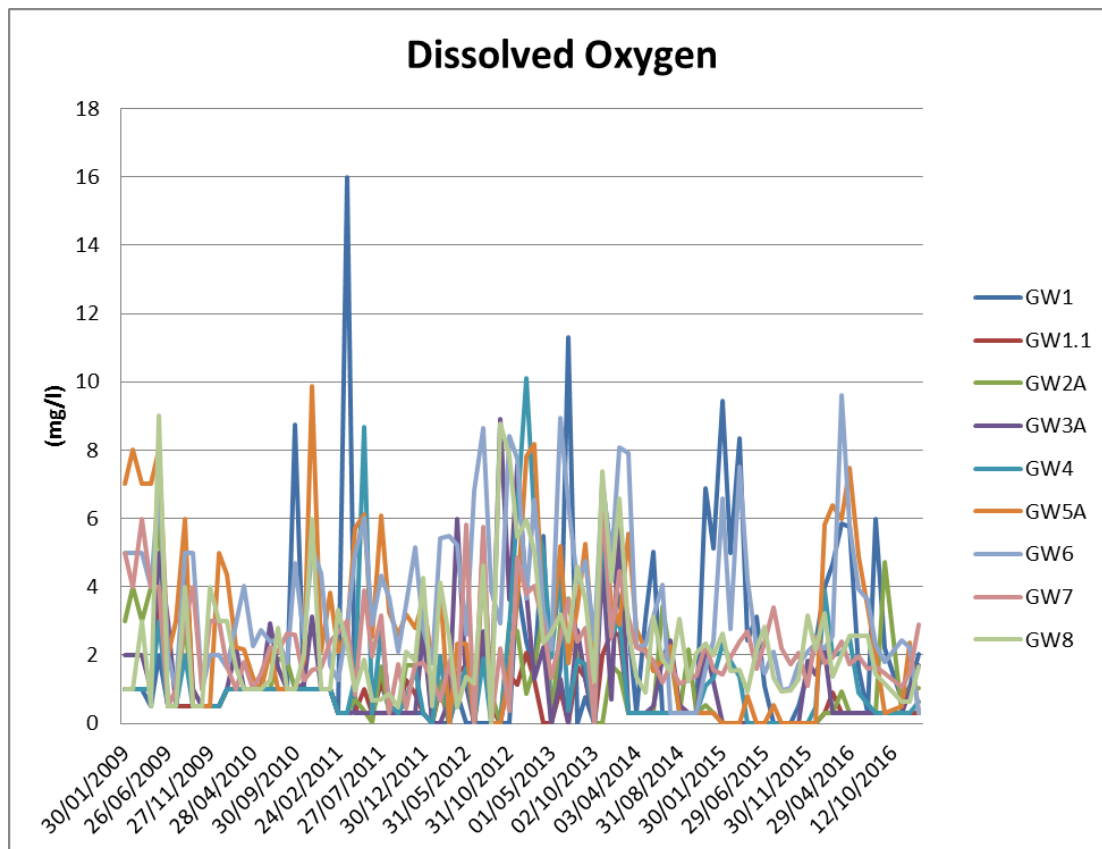
Graph 1B: Groundwater level as metres above Ordnance Datum (2009-2016)

APPENDIX 2 - GROUNDWATER

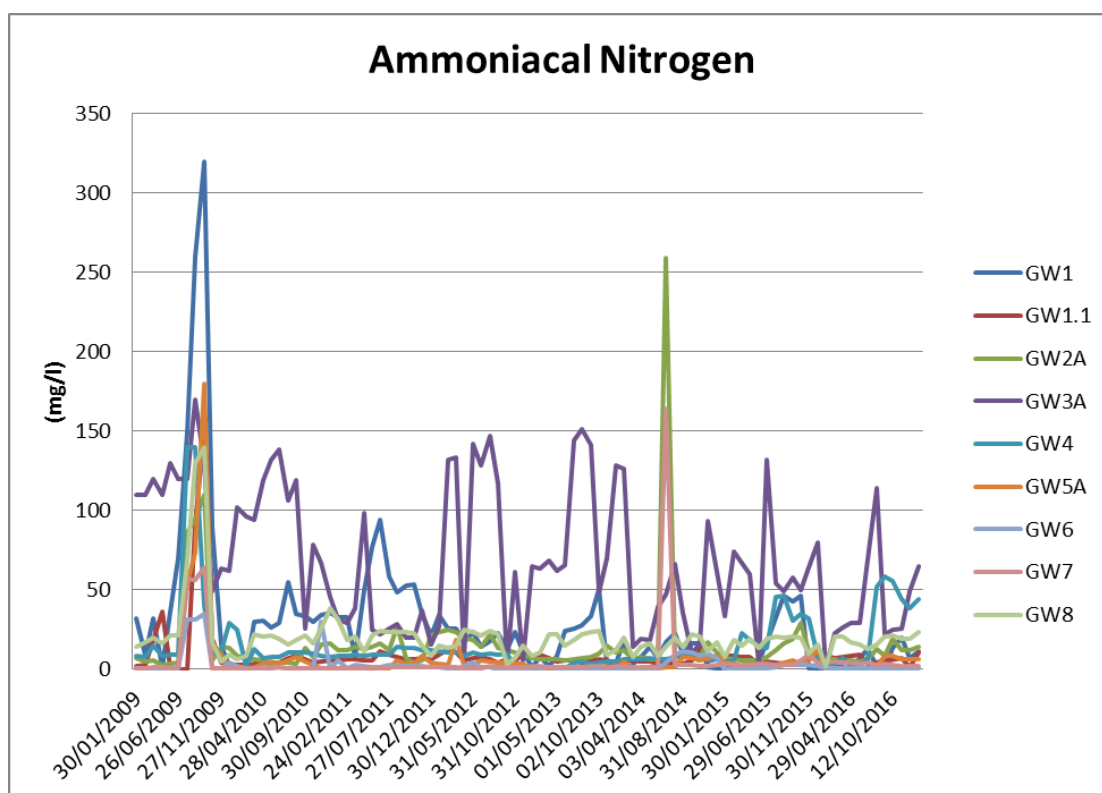
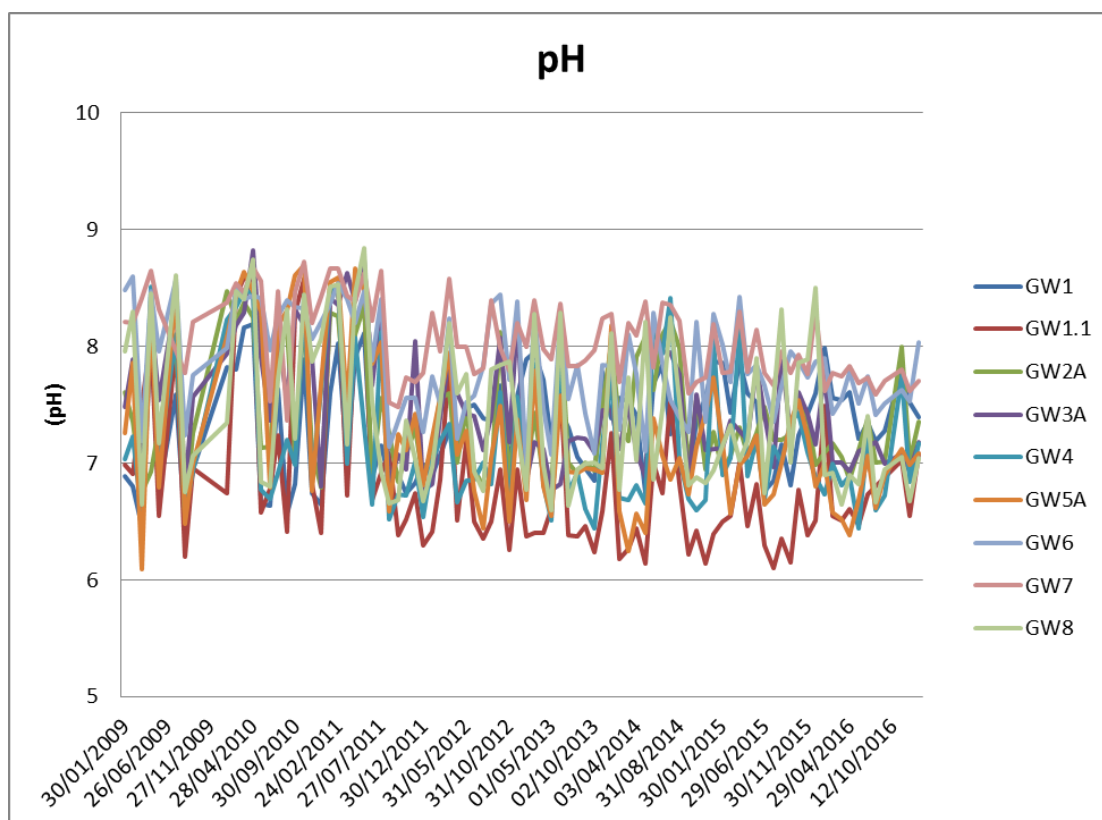
Table 1: Groundwater Quality (Monthly) 2016

Location	Parameter	Ammoniacal N	Chloride	Conductivity	Dissolved Oxygen	pH
	Units	mg/l as N	mg/l	mS/cm	mg/l	pH Units
GW1	Minimum	<0.2	35	2.28	<0.3	7.19
	Maximum	19.6	365	3.83	6.0	7.99
	Average	6.4	125	3.01	3.1	7.49
GW1.1	Minimum	1.6	183	1.39	<0.3	6.47
	Maximum	10.6	316	2.06	0.9	7.49
	Average	7.0	252	1.72	0.4	6.78
GW2A	Trigger	1.7	60	N/A	N/A	N/A
	Minimum	5.0	100	1.18	<0.3	6.86
	Maximum	19.1	136	1.45	4.7	8.00
	Average	9.4	115	1.31	0.9	7.18
GW3A	Trigger	1.7	60	N/A	N/A	N/A
	Minimum	0.7	100	1.47	<0.3	6.93
	Maximum	114.0	247	3.05	2.1	7.77
	Average	39.7	164	1.86	0.7	7.12
GW4	Trigger	1.7	60	N/A	N/A	N/A
	Minimum	<0.2	9	0.17	<0.3	6.44
	Maximum	58.3	96	0.93	3.9	7.74
	Average	26.1	52	0.56	1.2	6.92
GW5A	Minimum	<0.2	29	0.55	<0.3	6.38
	Maximum	8.3	169	1.16	7.5	7.12
	Average	3.2	48	0.71	3.6	6.81
GW6	Minimum	<0.2	29	0.66	<0.3	7.41
	Maximum	0.5	48	0.88	9.6	8.03
	Average	0.2	32	0.72	3.3	7.64
GW7	Minimum	1.7	124	0.70	1.1	7.59
	Maximum	4.8	154	0.76	2.9	7.83
	Average	3.2	139	0.73	1.8	7.71
GW8	Minimum	1.8	63	0.74	0.6	6.64
	Maximum	23.3	171	1.54	3.2	7.40
	Average	17.2	138	1.27	1.7	6.90

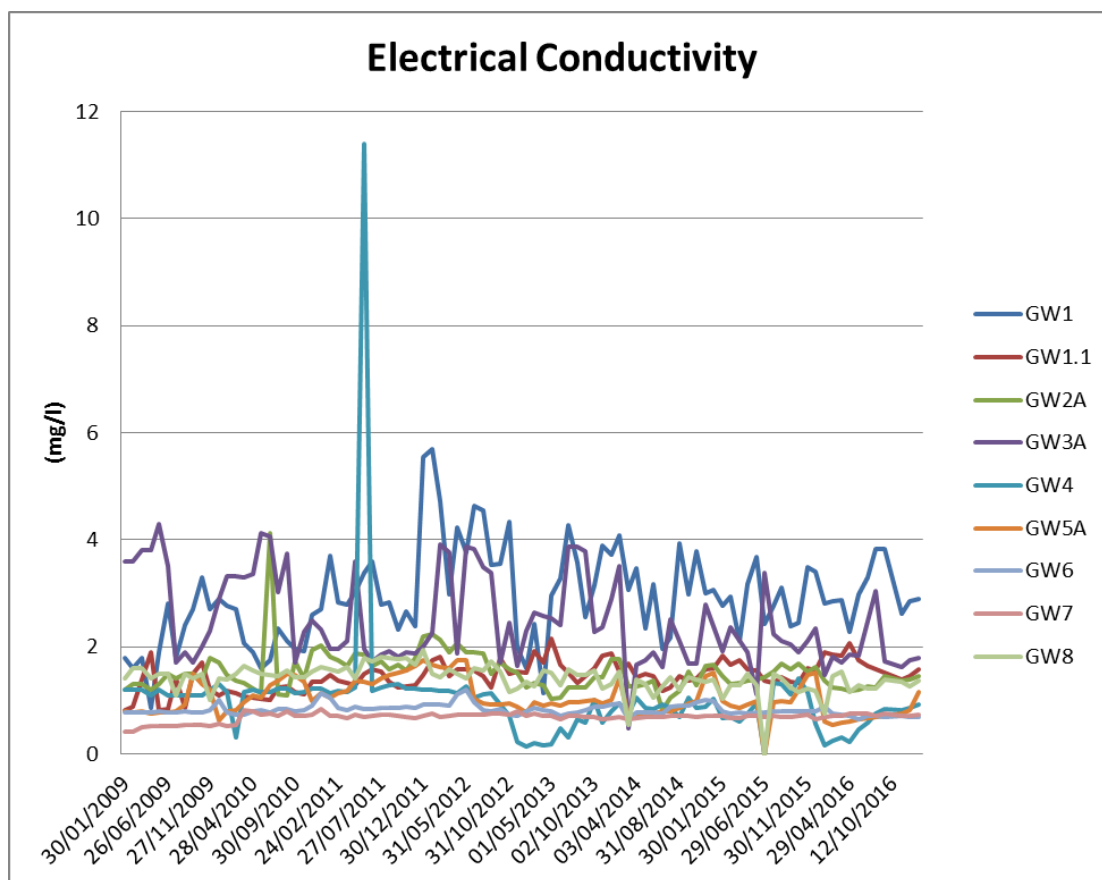
APPENDIX 2 - GROUNDWATER



APPENDIX 2 - GROUNDWATER



APPENDIX 2 - GROUNDWATER



APPENDIX 2 - GROUNDWATER

Table 2: Groundwater Quality (Quarterly)

Location	Parameter	Alkalinity, Total as CaCO3	Cadmium (diss.filt)	Calcium (diss.filt)	Chromium (diss.filt)	COD, unfiltered
	Units	mg/l	mg/l	mg/l	mg/l	mg/l
GW1	Minimum	760	<0.00008	655	<0.0012	122
	Maximum	1120	<0.0001	761	0.03040	320
	Average	993	<0.00009	698	0.01098	198
GW1.1	Minimum	170	<0.00008	121	<0.0012	68
	Maximum	290	0.0002	171	0.00768	468
	Average	218	0.0001	141	0.00394	192
GW2A	Minimum	384	<0.00008	148	<0.0012	34
	Maximum	660	<0.0001	189	0.01550	64
	Average	532	<0.00009	167	0.00637	49
GW3A	Minimum	475	<0.00008	147	<0.0012	70
	Maximum	880	0.0001	182	0.02930	101
	Average	688	0.0001	163	0.01085	88
GW4	Minimum	125	<0.00008	28	<0.0012	60
	Maximum	405	<0.0001	65	0.00796	308
	Average	286	<0.00009	51	0.00345	142
GW5A	Minimum	85	0.0001	66	<0.0012	9
	Maximum	350	0.0002	121	0.00403	64
	Average	190	0.0002	84	0.00240	35
GW6	Minimum	286	<0.00008	84	<0.0012	10
	Maximum	310	<0.0001	90	0.00729	49
	Average	297	<0.00009	88	0.00360	21
GW7	Minimum	200	<0.00008	20	<0.0012	19
	Maximum	215	<0.0001	25	0.00521	42
	Average	206	<0.00009	22	0.00288	30
GW8	Minimum	435	<0.00008	84	<0.0012	32
	Maximum	530	<0.0001	111	0.01430	62
	Average	493	<0.00009	102	0.00670	47

APPENDIX 2 - GROUNDWATER

Location	Parameter	Copper (diss.filt)	Iron (diss.filt)	Lead (diss.filt)	Magnesium (diss.filt)	Manganese (diss.filt)
	Units	mg/l	mg/l	mg/l	mg/l	mg/l
GW1	Minimum	0.00214	0.027	<0.0001	61.2	0.82
	Maximum	0.01310	0.696	0.00020	87.4	2.04
	Average	0.00770	0.283	0.00012	76.0	1.27
GW1.1	Minimum	<0.00085	21.900	<0.0001	51.8	9.10
	Maximum	0.00169	38.500	0.00043	59.9	10.90
	Average	0.00106	30.200	0.00017	56.2	9.88
GW2A	Minimum	<0.00085	0.032	<0.0001	35.3	5.52
	Maximum	0.00087	5.310	0.00027	48.0	7.77
	Average	0.00086	2.291	0.00013	41.6	6.51
GW3A	Minimum	<0.00085	0.047	0.00005	46.8	1.00
	Maximum	0.00402	21.200	0.00049	68.9	2.92
	Average	0.00178	5.898	0.00019	57.4	1.56
GW4	Minimum	<0.00085	0.180	<0.0001	6.3	0.45
	Maximum	0.00089	7.820	0.00078	20.6	1.43
	Average	0.00086	2.925	0.00029	15.2	1.06
GW5A	Minimum	<0.00085	<0.019	<0.0001	11.0	0.01
	Maximum	0.00268	2.980	0.00010	43.0	1.39
	Average	0.00152	0.766	0.00007	22.4	0.39
GW6	Minimum	0.00283	<0.019	<0.0001	26.5	0.00
	Maximum	0.00328	<0.019	0.00021	29.5	0.01
	Average	0.00299	<0.019	0.00011	27.9	0.00
GW7	Minimum	<0.00085	<0.019	<0.0001	30.6	0.13
	Maximum	<0.00085	<0.019	0.00028	35.5	0.20
	Average	<0.00085	<0.019	0.00014	33.2	0.17
GW8	Minimum	<0.00085	0.035	<0.0001	30.6	0.36
	Maximum	0.00096	0.788	0.00030	40.2	0.55
	Average	0.00089	0.229	0.00013	37.1	0.48

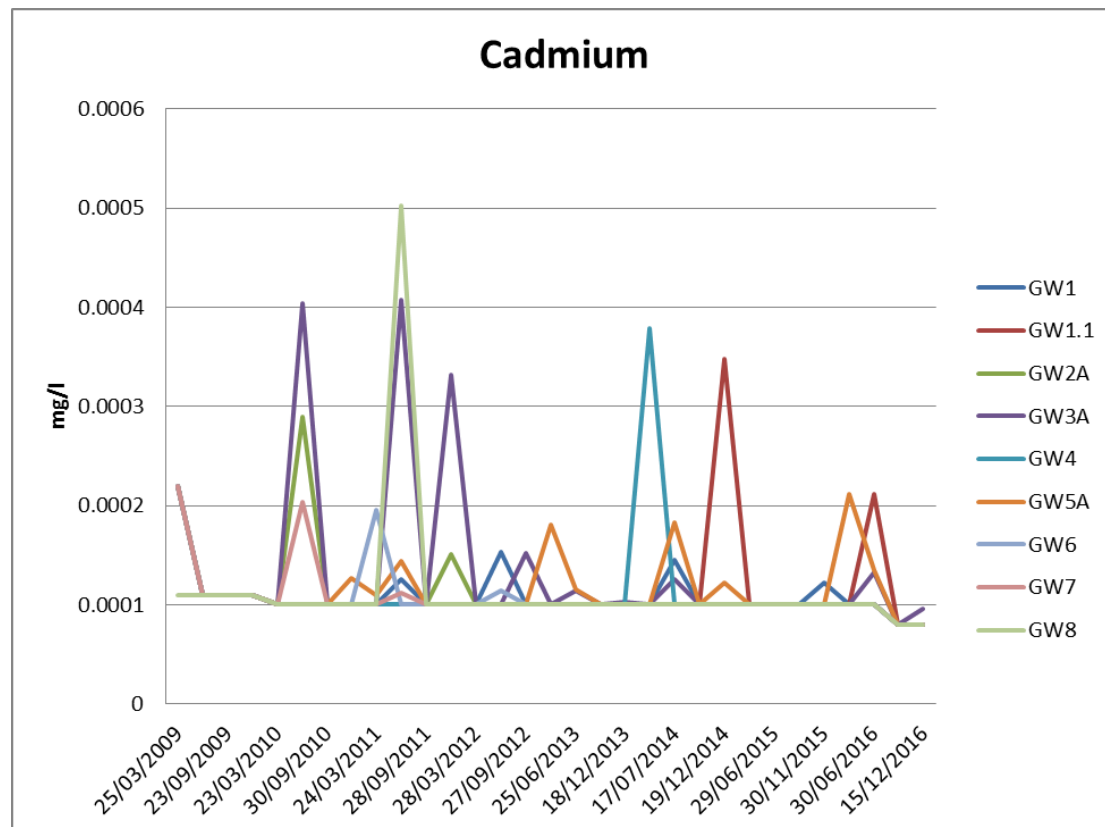
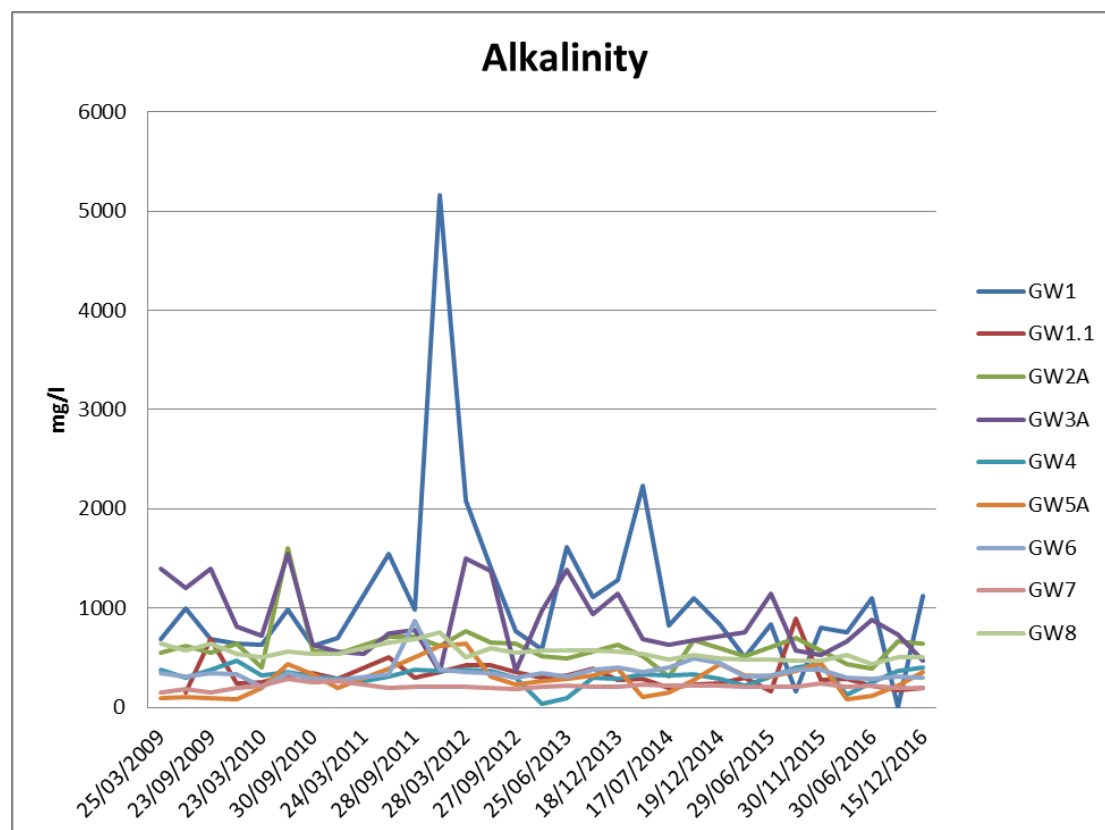
APPENDIX 2 - GROUNDWATER

Location	Parameter	Nickel (diss.filt)	Organic Carbon, Total	Potassium (diss.filt)	Sodium (diss.filt)	Sulphate
	Units	mg/l	mg/l	mg/l	mg/l	mg/l
GW1	Minimum	0.0072	32.3	122.0	45.2	504
	Maximum	0.0564	47.7	163.0	164.0	1990
	Average	0.0258	41.5	144.0	90.9	1299
GW1.1	Minimum	0.0245	8.3	18.4	91.5	292
	Maximum	0.0707	19.3	26.1	120.0	462
	Average	0.0528	14.8	22.1	101.9	351
GW2A	Minimum	0.0153	7.3	28.2	52.8	128
	Maximum	0.0360	13.6	32.3	79.6	169
	Average	0.0237	9.8	30.9	67.3	153
GW3A	Minimum	0.0242	14.1	26.6	110.0	109
	Maximum	0.0643	34.7	49.4	161.0	460
	Average	0.0413	21.3	38.6	135.0	273
GW4	Minimum	0.0050	8.8	10.5	14.6	<2
	Maximum	0.0141	29.3	28.3	45.6	4
	Average	0.0103	16.3	20.5	32.7	2
GW5A	Minimum	0.0072	<3	7.6	39.1	139
	Maximum	0.0329	6.7	19.8	77.2	189
	Average	0.0239	4.4	12.0	52.1	164
GW6	Minimum	0.0012	4.5	15.8	17.1	78
	Maximum	0.0026	6.5	19.5	20.6	79
	Average	0.0019	5.3	18.0	19.3	79
GW7	Minimum	0.0010	3.2	20.5	60.9	<2
	Maximum	0.0014	4.8	24.5	73.9	2
	Average	0.0012	4.0	21.8	67.0	2
GW8	Minimum	0.0278	9.3	31.1	102.0	115
	Maximum	0.0434	13.9	40.6	122.0	135
	Average	0.0357	11.4	36.4	114.5	123

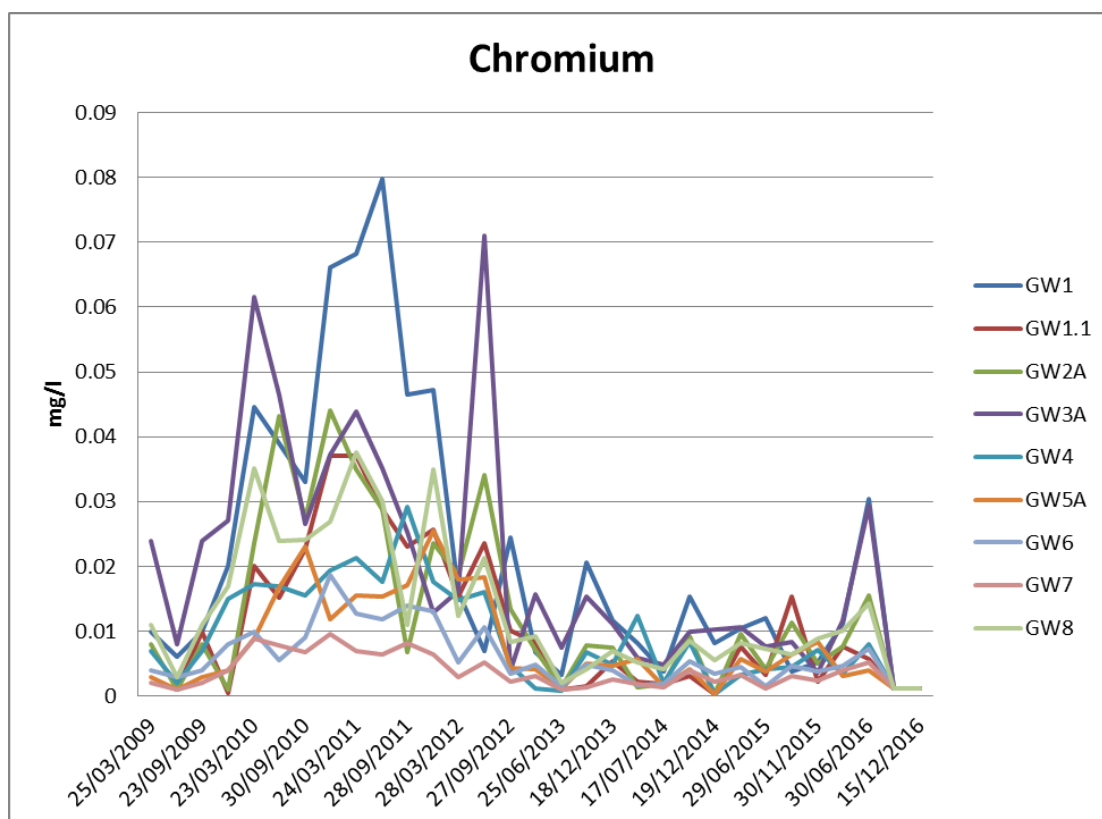
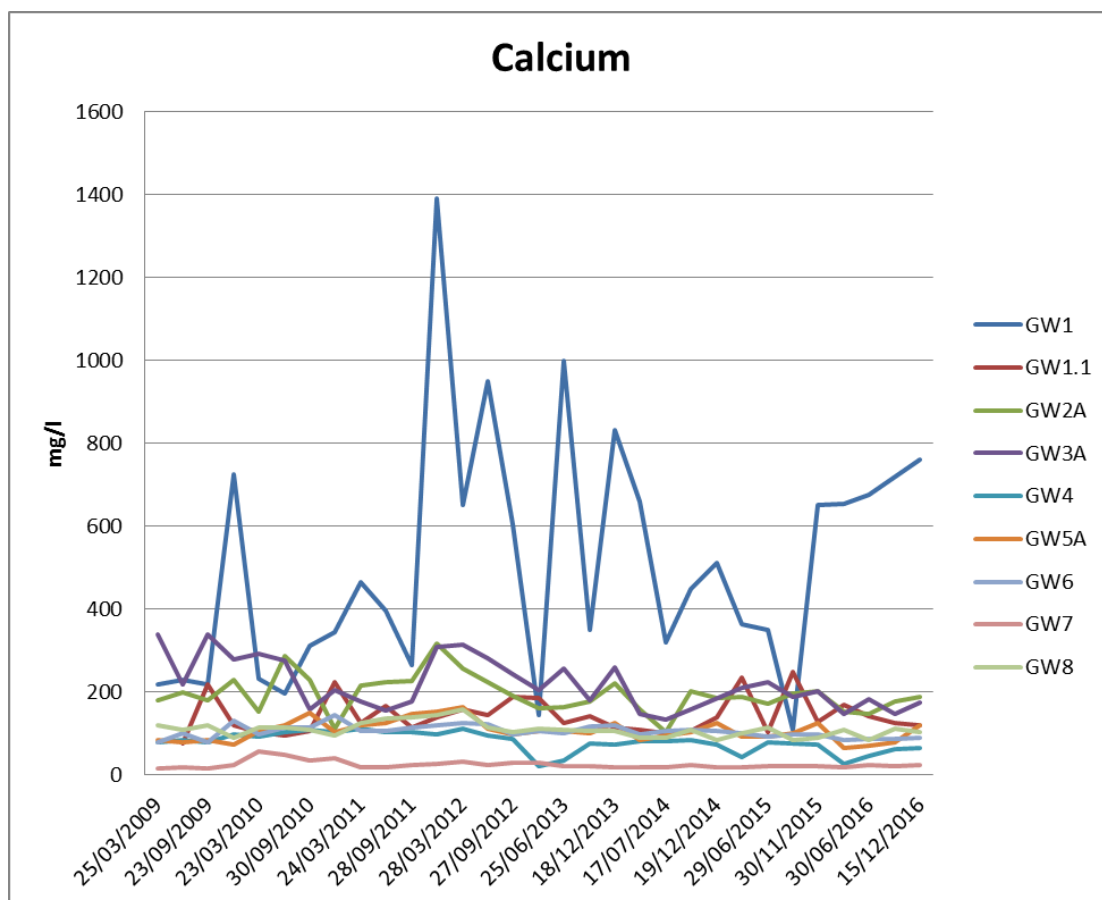
APPENDIX 2 - GROUNDWATER

Location	Parameter	Sum of detected Xylenes	Toluene	Total Oxidised Nitrogen as N	Zinc (diss.filt)
	Units	mg/l	mg/l	mg/l	mg/l
GW1	Minimum	<0.001	<0.001	0.77	0.01650
	Maximum	<0.001	<0.004	26.40	0.06580
	Average	<0.001	<0.003	8.93	0.03140
GW1.1	Minimum	<0.001	<0.001	<0.3	0.00651
	Maximum	<0.001	<0.004	7.40	0.04680
	Average	<0.001	<0.003	2.08	0.01746
GW2A	Minimum	<0.001	<0.001	<0.3	0.00214
	Maximum	<0.001	<0.004	2.51	0.00638
	Average	<0.001	<0.003	0.80	0.00417
GW3A	Minimum	<0.001	<0.001	<0.3	<0.0013
	Maximum	<0.001	<0.004	26.40	0.00933
	Average	<0.001	<0.003	10.79	0.00605
GW4	Minimum	<0.001	<0.004	<0.3	0.00195
	Maximum	<0.001	0.148	5.15	0.00423
	Average	<0.001	0.040	1.51	0.00294
GW5A	Minimum	<0.001	<0.001	<0.3	0.00240
	Maximum	<0.001	<0.004	24.50	0.03170
	Average	<0.001	<0.003	8.36	0.01700
GW6	Minimum	<0.001	<0.001	2.91	0.00222
	Maximum	<0.001	<0.004	25.80	0.00694
	Average	<0.001	<0.003	16.70	0.00385
GW7	Minimum	<0.001	<0.001	<0.3	0.00094
	Maximum	<0.001	<0.004	0.61	0.00455
	Average	<0.001	<0.003	0.38	0.00212
GW8	Minimum	<0.001	<0.001	0.36	0.00317
	Maximum	<0.001	<0.004	13.40	0.01020
	Average	<0.001	<0.003	6.86	0.00573

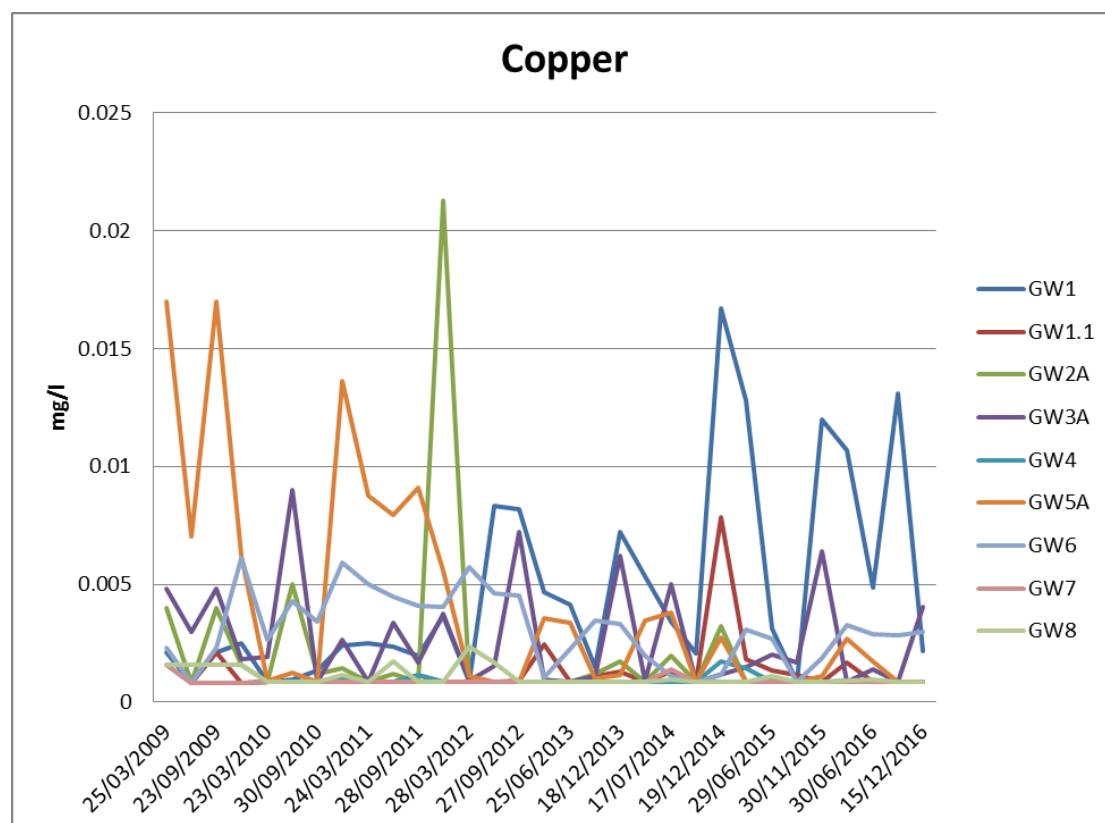
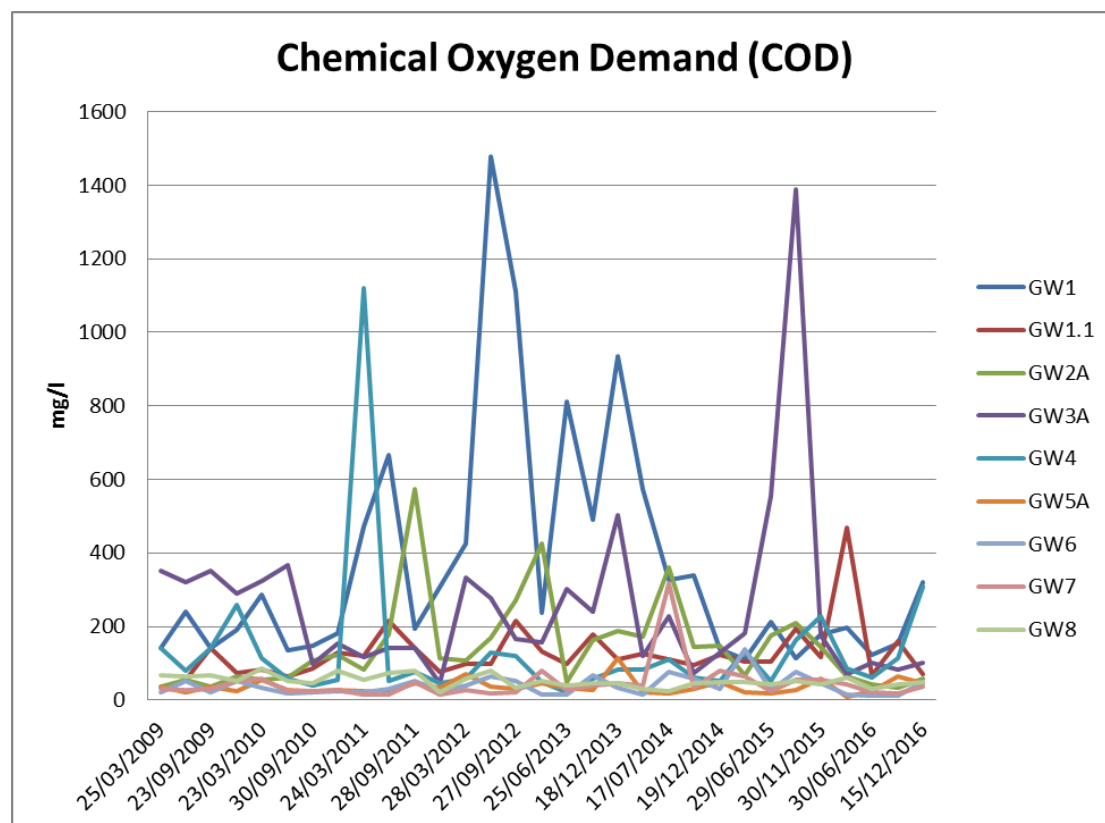
APPENDIX 2 - GROUNDWATER



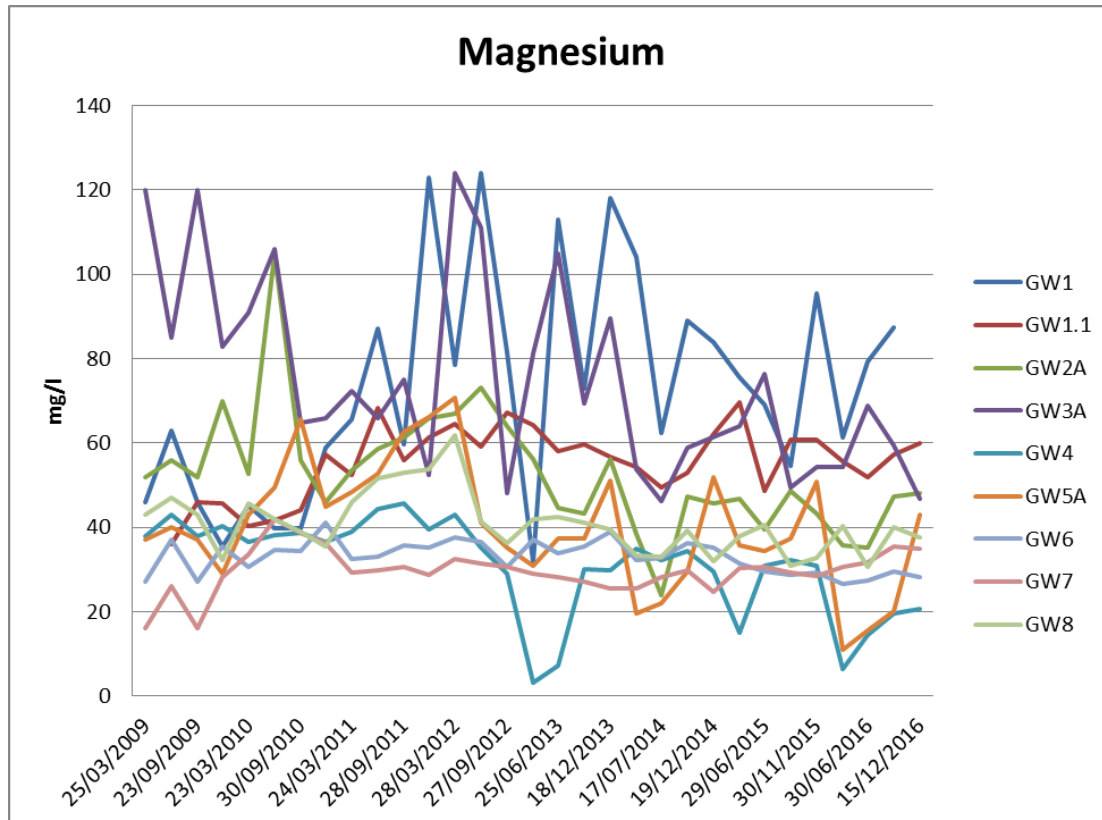
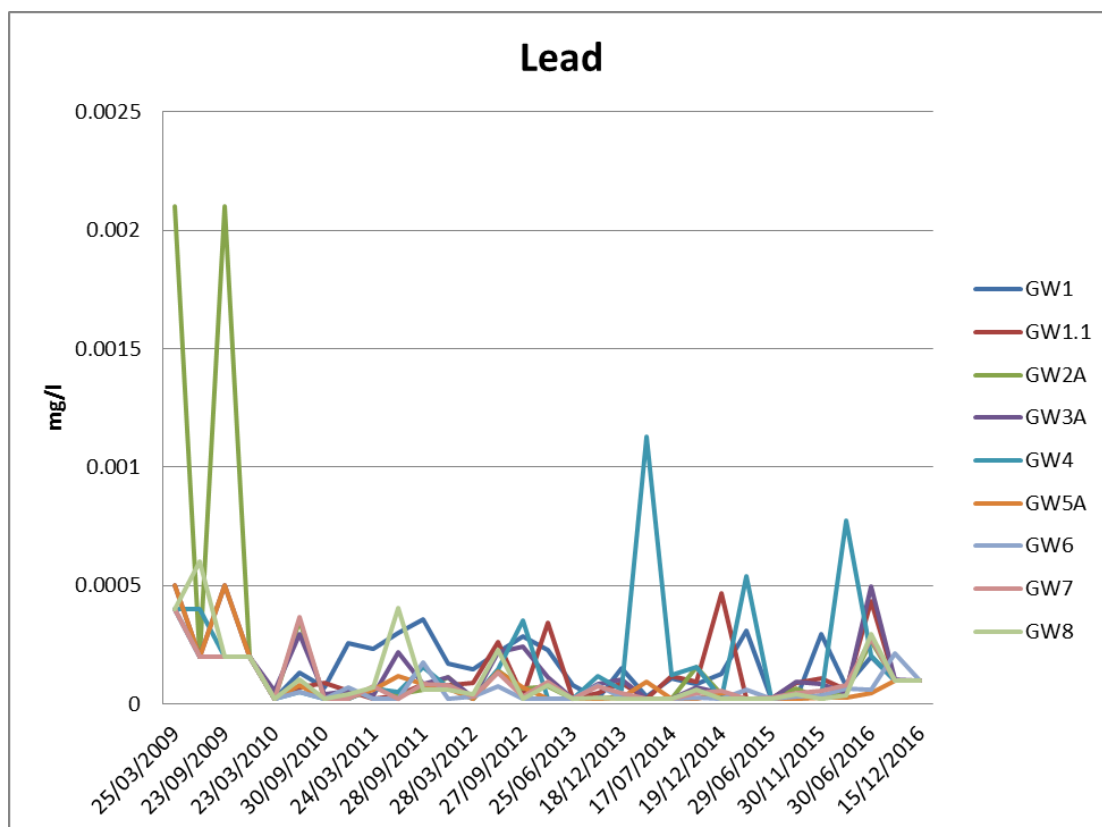
APPENDIX 2 - GROUNDWATER



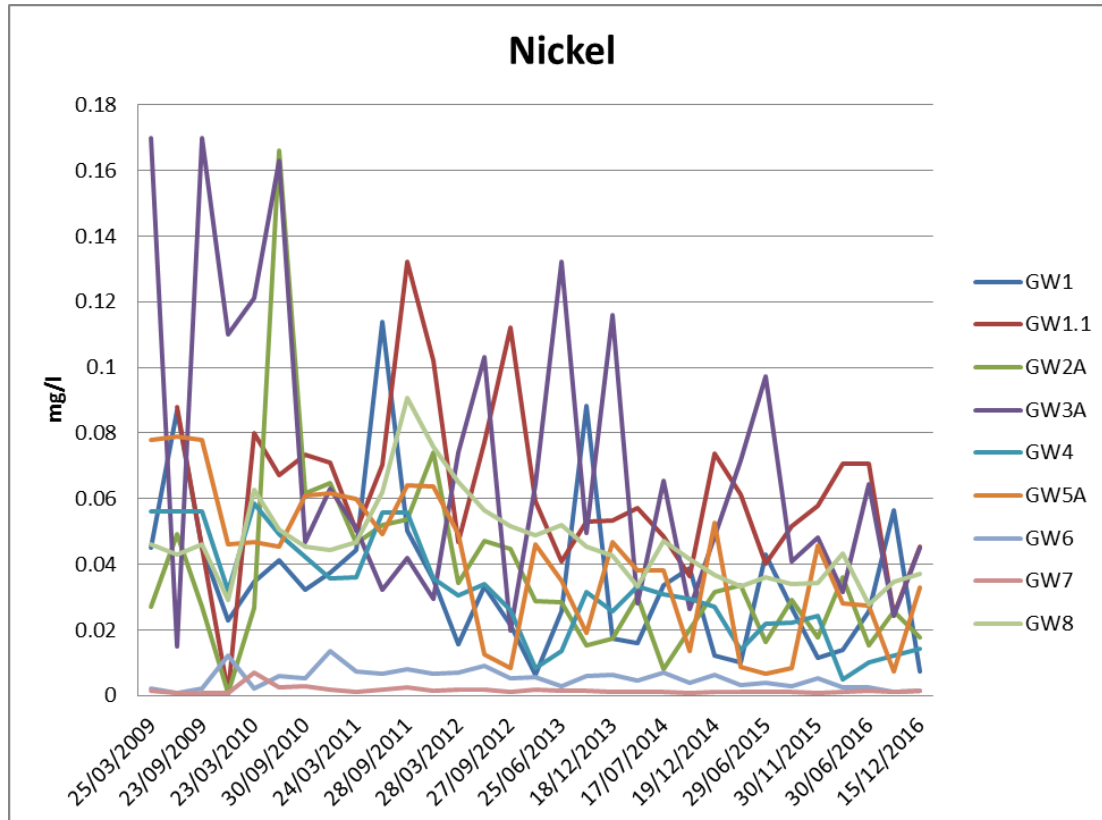
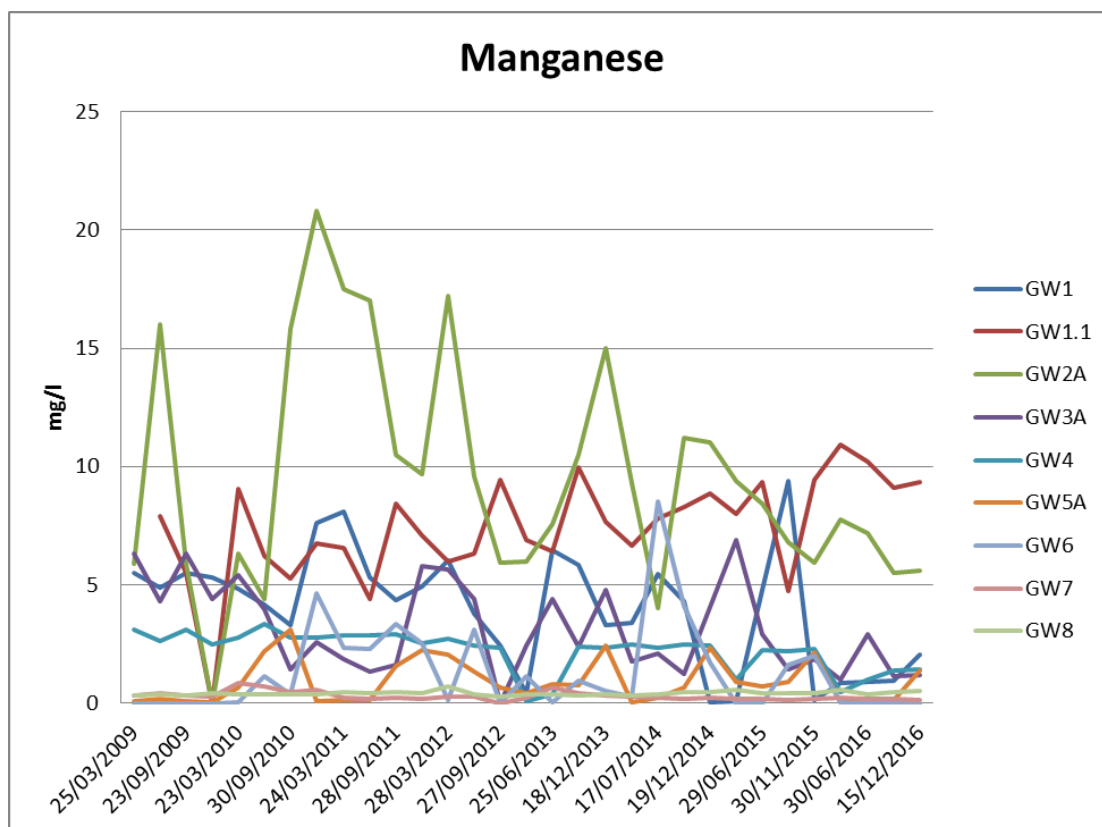
APPENDIX 2 - GROUNDWATER



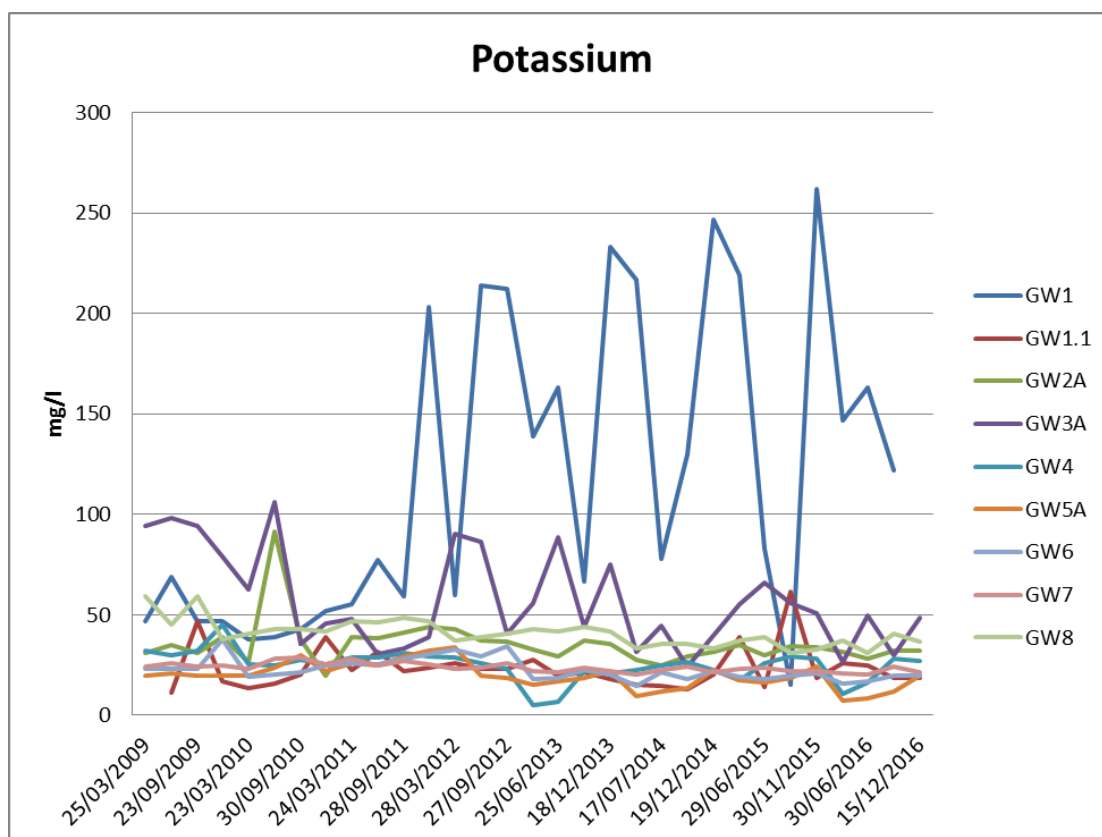
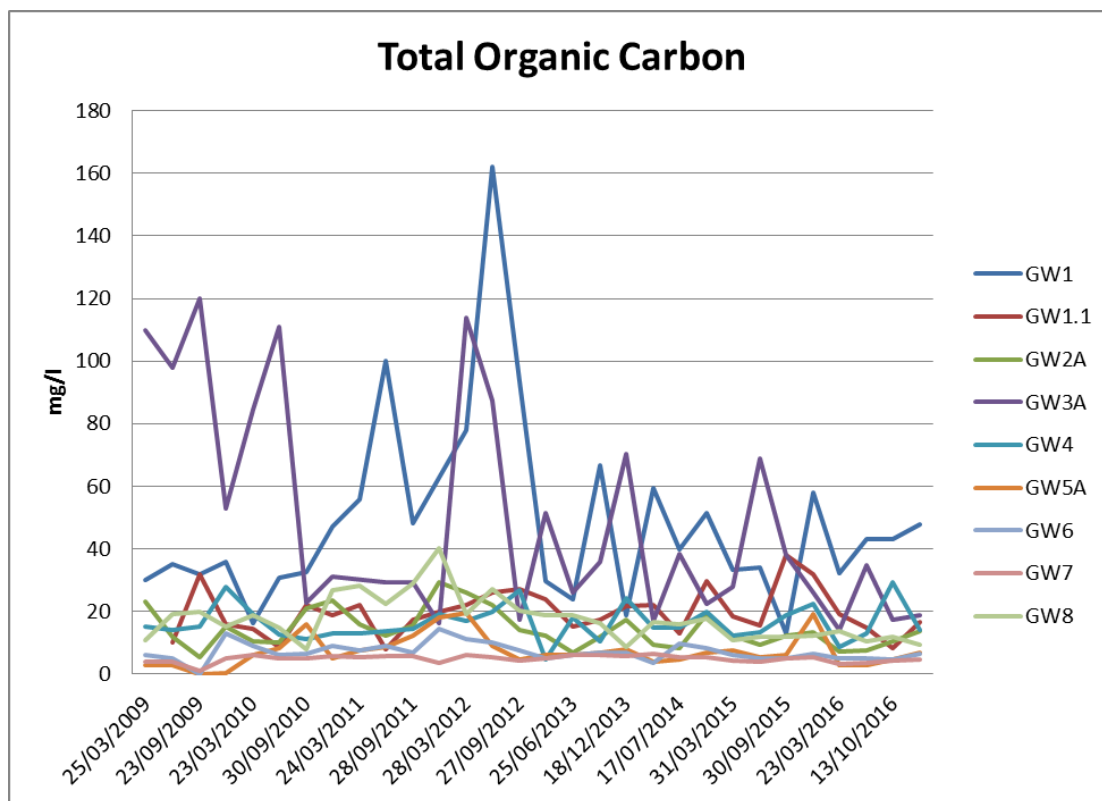
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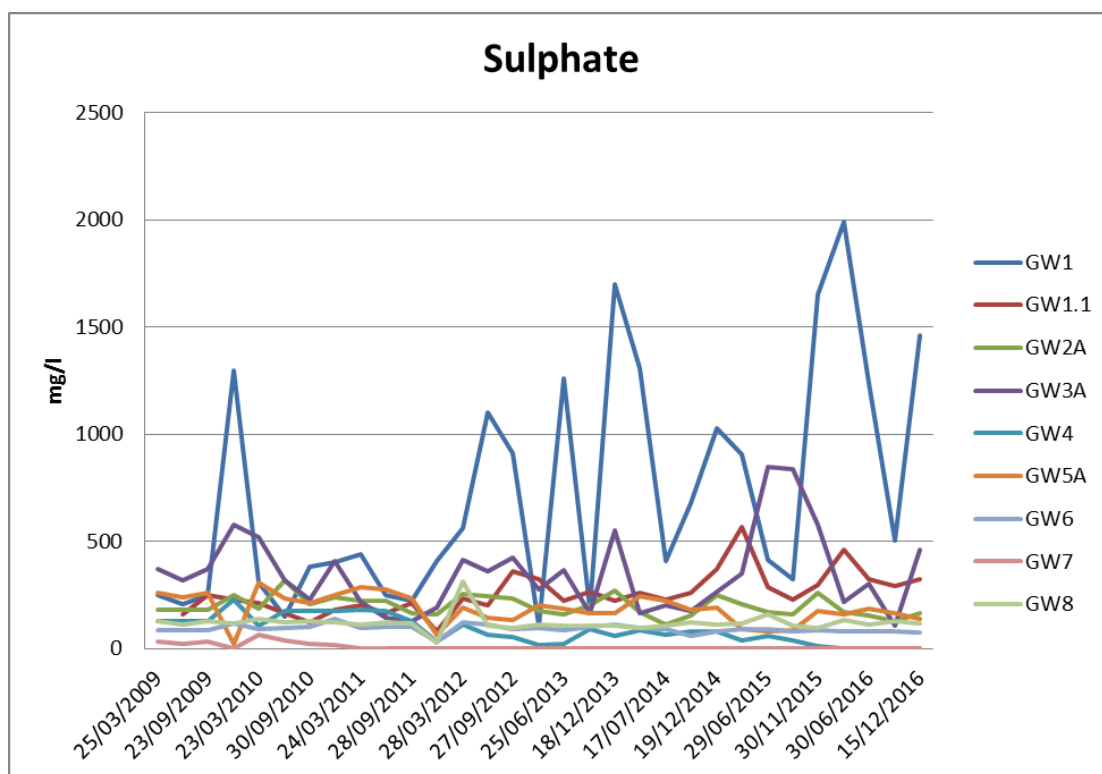
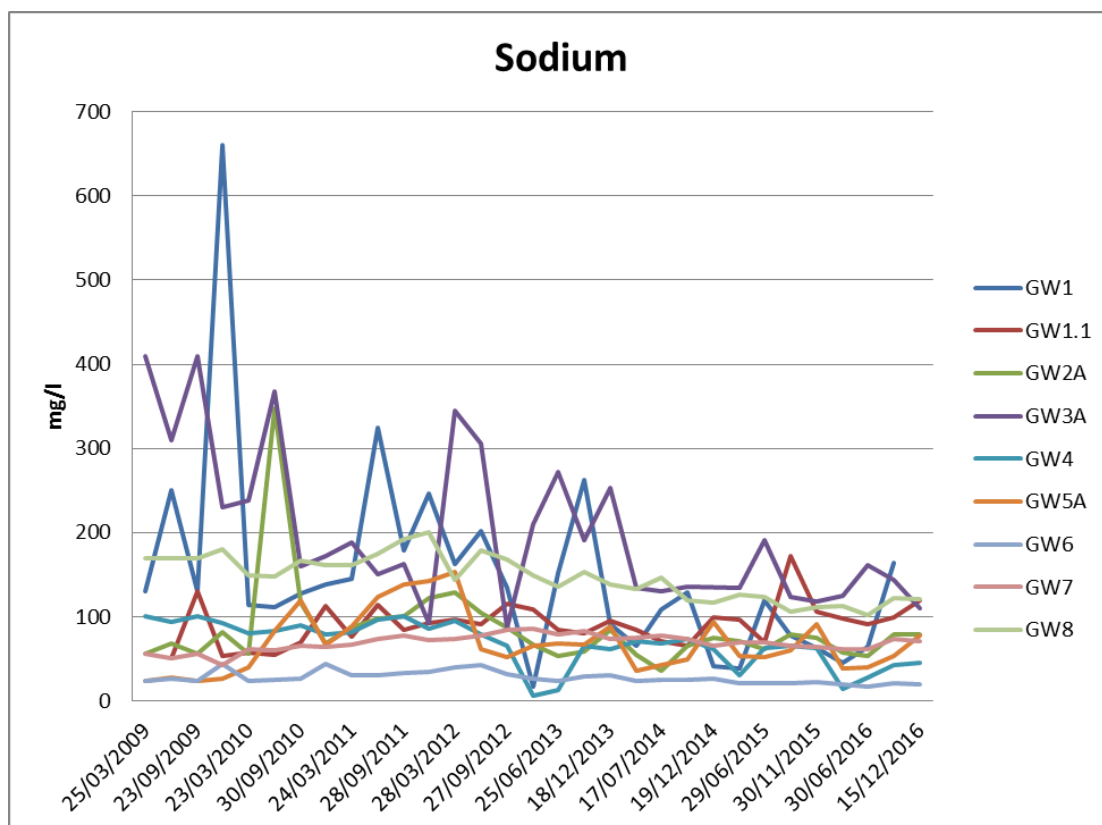
APPENDIX 2 - GROUNDWATER



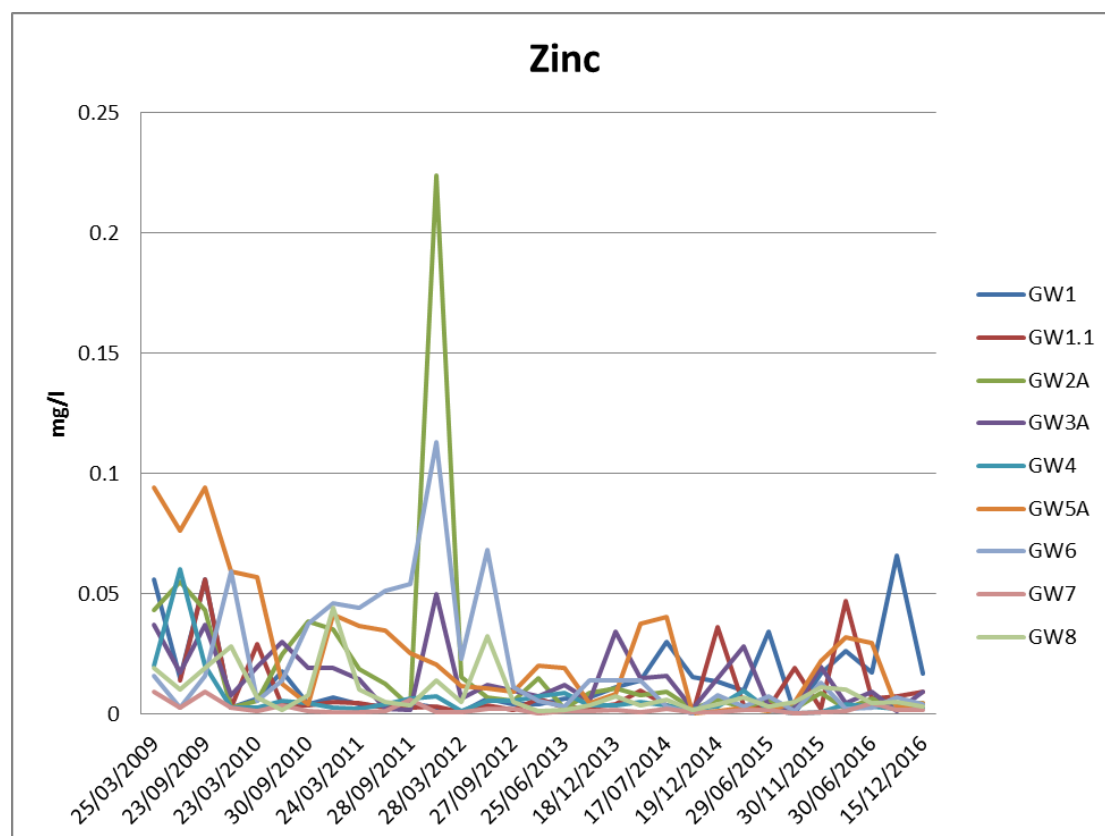
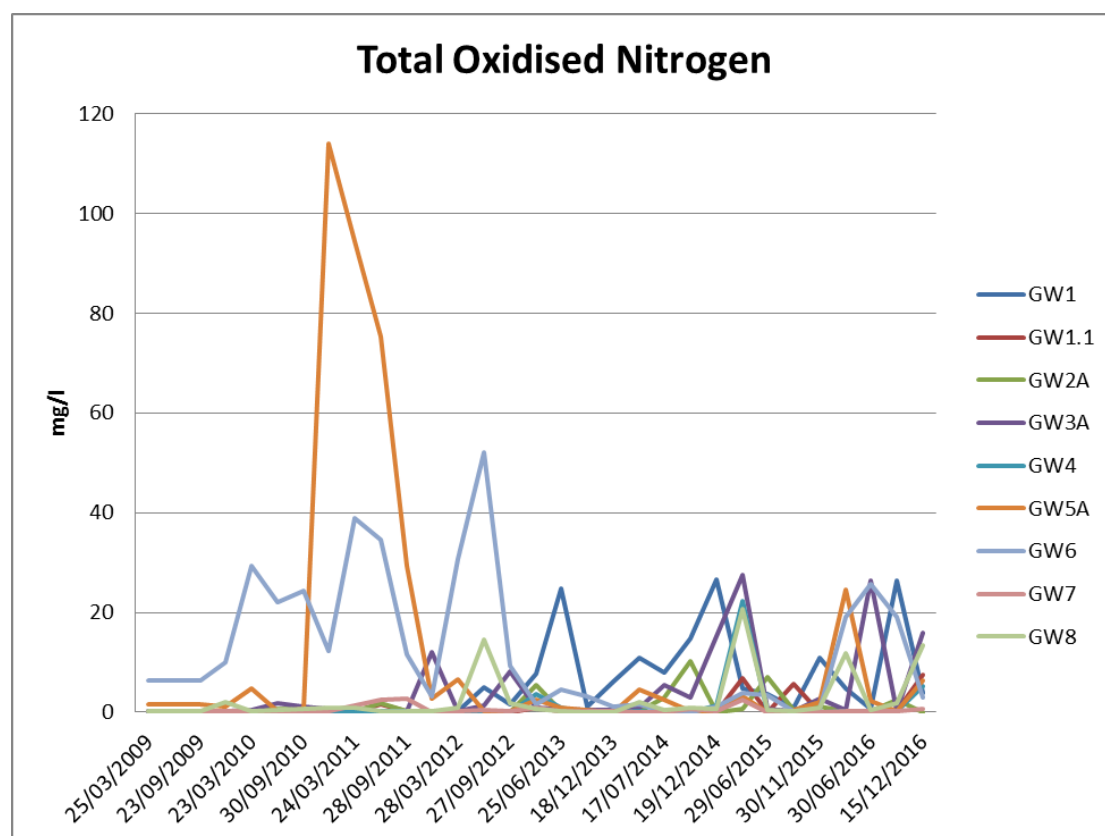
APPENDIX 2 - GROUNDWATER



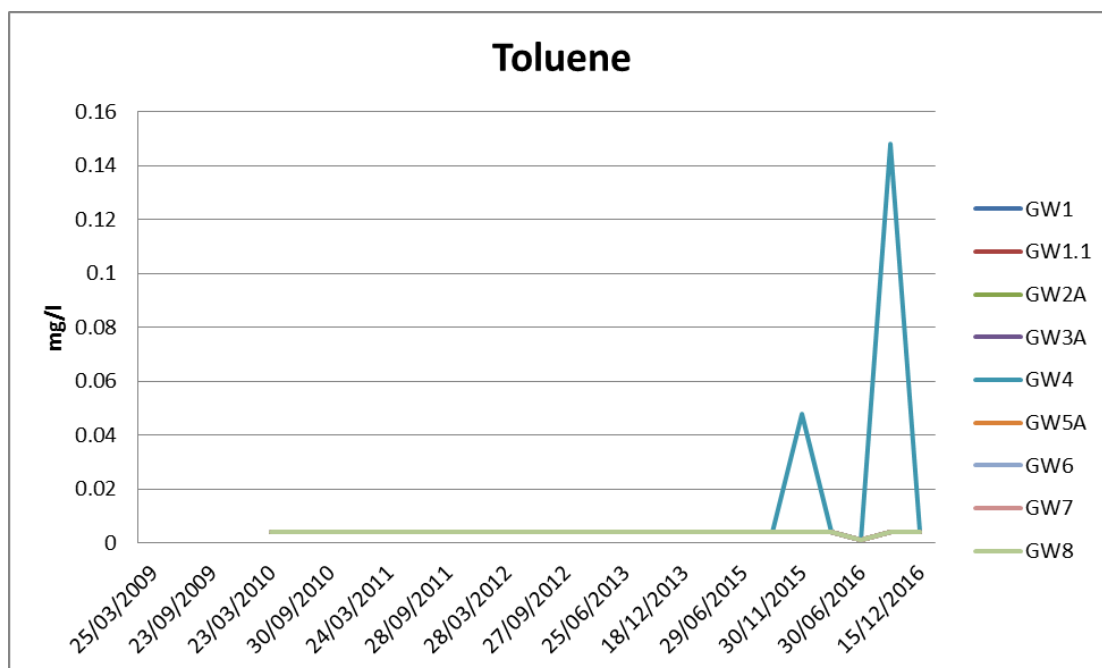
APPENDIX 2 - GROUNDWATER



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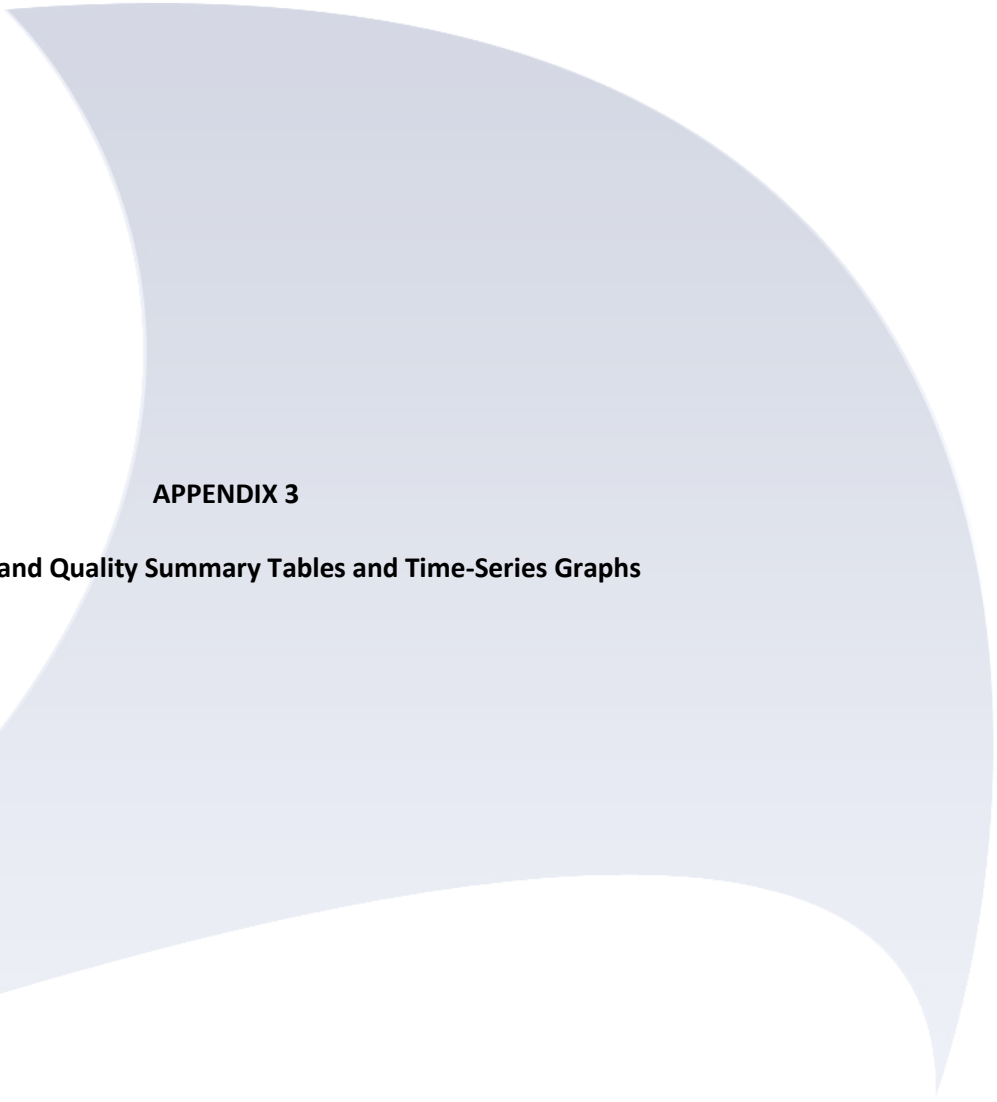
APPENDIX 2 - GROUNDWATER



APPENDIX 2 - GROUNDWATER

Table 3: Groundwater Quality (Annual) (Detected hazardous substances are highlighted)

Sample Description		GW1	GW1.1	GW2A	GW3A	GW4	GW5A	GW6	GW7	GW8
Date Sampled		15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016	15/12/2016
TPH Criteria Working Group (TPH CWG)										
Benzene	mg/l	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Ethylbenzene	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
m,p-Xylene	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
o-Xylene	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Sum of detected BTEX	mg/l	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028
Sum of detected Xylenes	mg/l	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011
Toluene	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004



APPENDIX 3

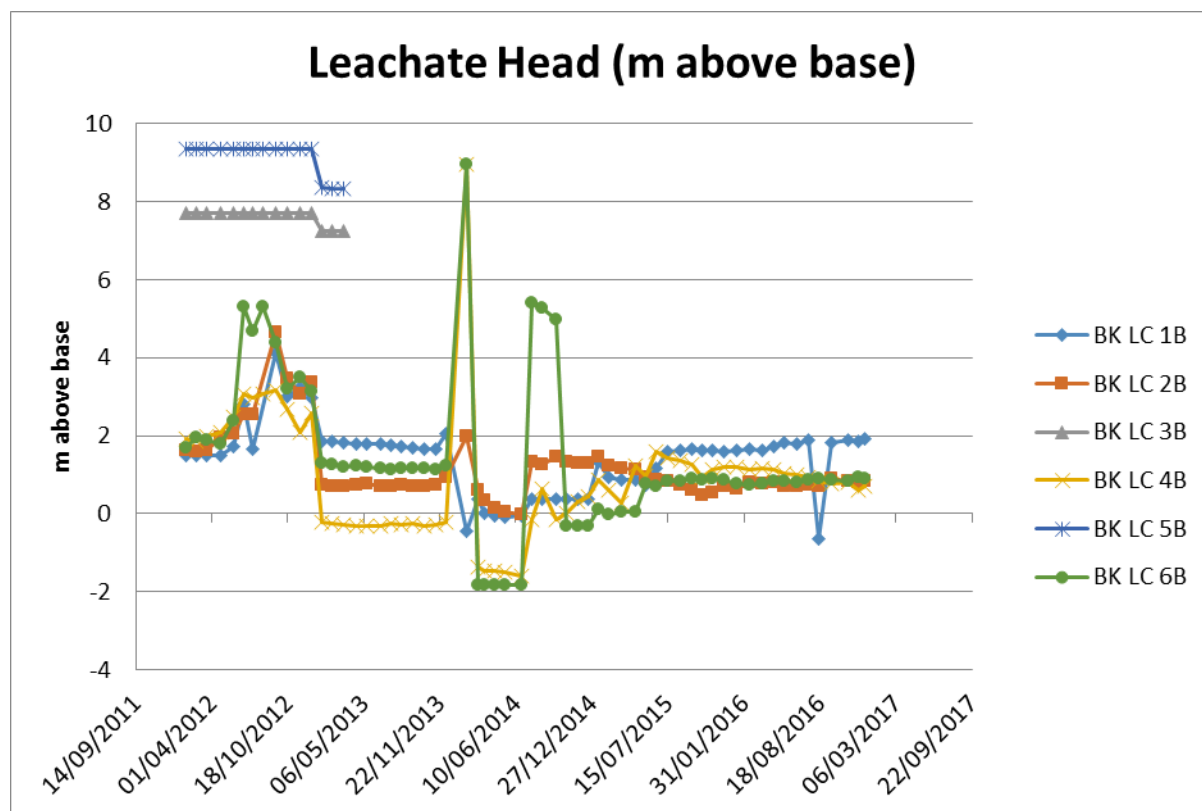
Leachate Level and Quality Summary Tables and Time-Series Graphs

APPENDIX 3 - LEACHATE

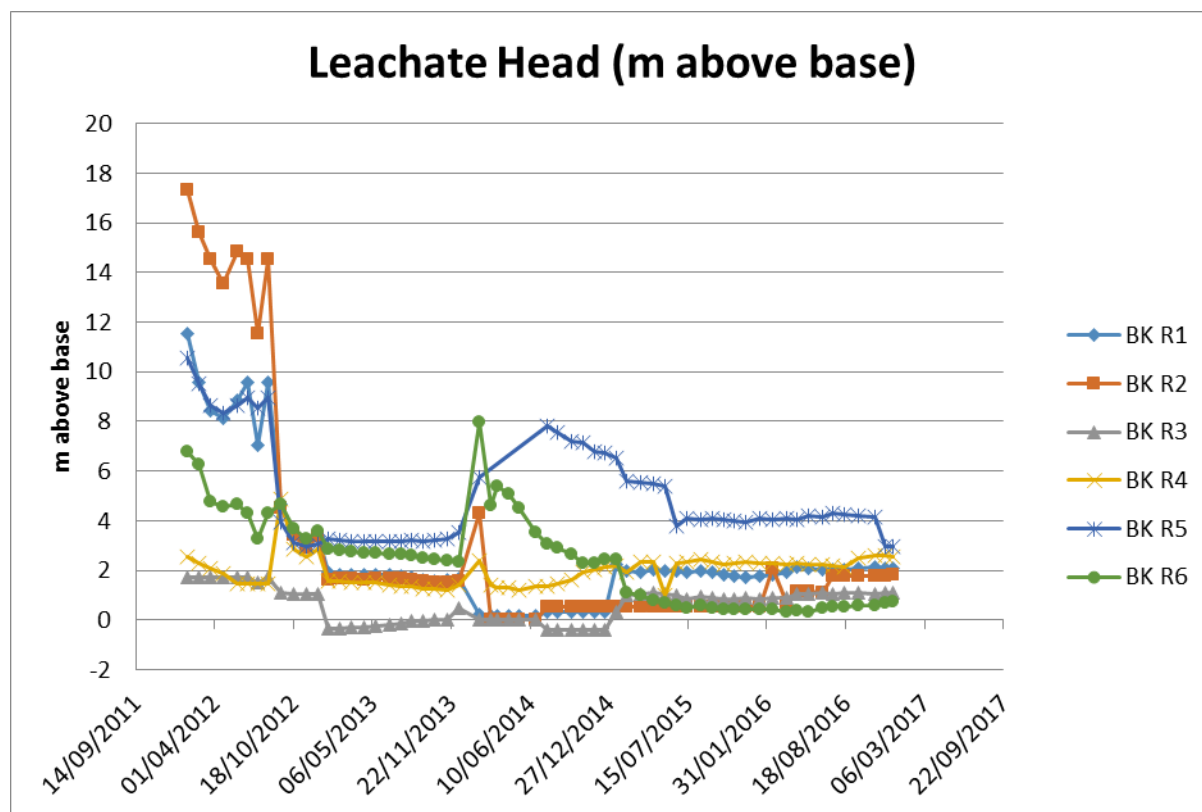
Table 1: Leachate Levels

Landfill Cell	Monitoring Point	Leachate Head (m above cell base)			Trigger Limit
		Minimum	Maximum	Average	
Cell 1	BK LC 1B	-0.63	1.93	1.59	2.0
	BK R1	1.79	2.14	2.02	
Cell 2	BK LC 2B	0.65	0.89	0.77	3.0
	BK R2	0.56	2.11	1.46	
Cell 3	BK R3*	0.85	1.12	1.03	5.5
Cell 4	BK LC 4B*	0.62	1.21	0.95	3.0
	BK R4	2.16	2.62	2.35	
Cell 5	BK R5	2.96	4.31	3.95	3.0
Cell 6	BK LC 6B	0.74	0.93	0.84	2.0
	BK R6	0.31	0.74	0.50	

APPENDIX 3 - LEACHATE

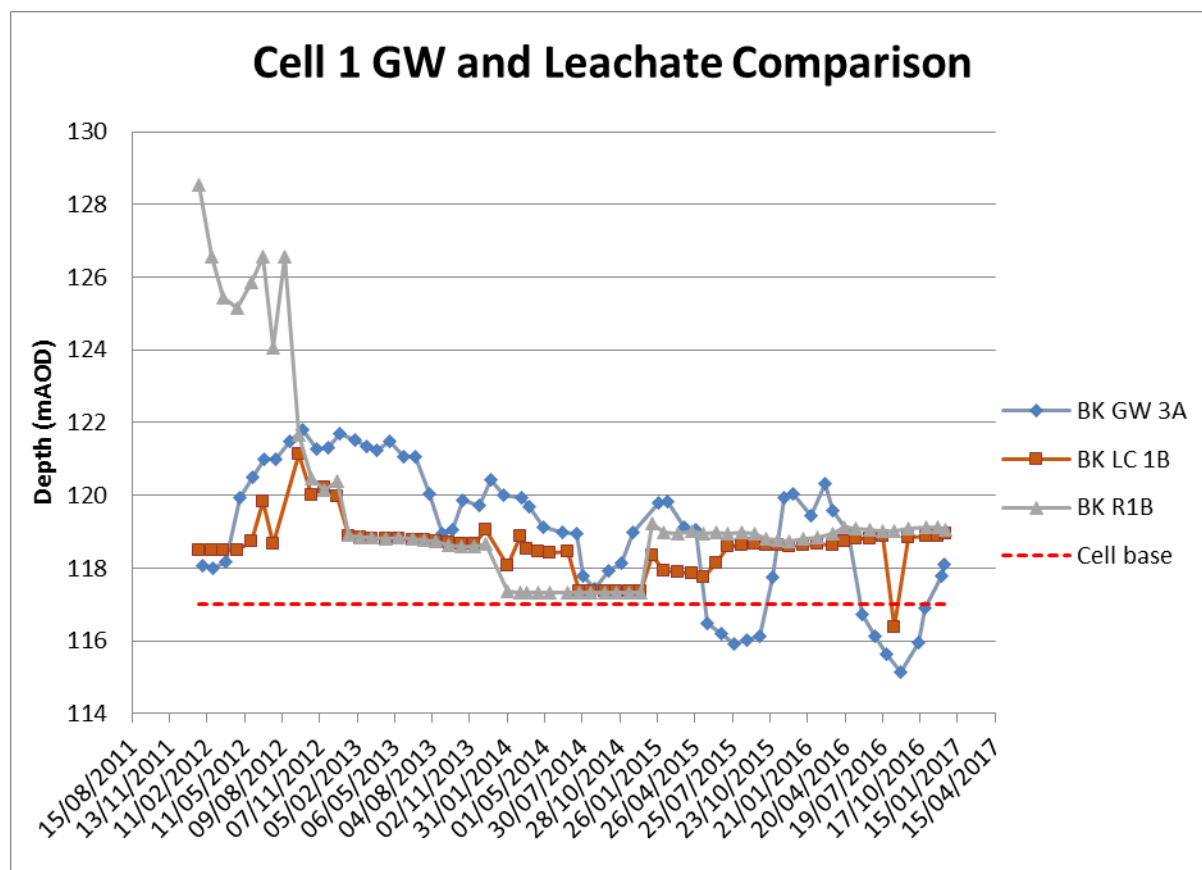


Graph 1: Leachate Levels as m above cell base at LC Series Wells

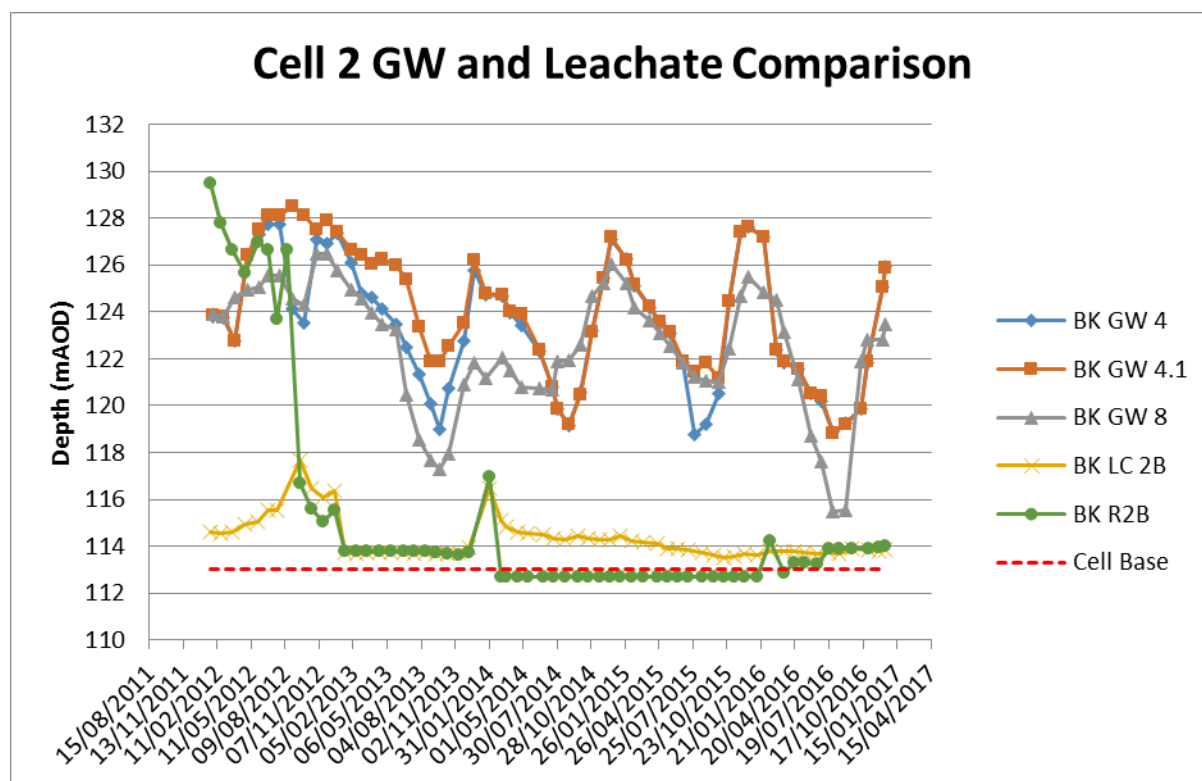


Graph 2: Leachate Levels as m above cell base at Remote Leachate Monitoring Points

APPENDIX 3 - LEACHATE

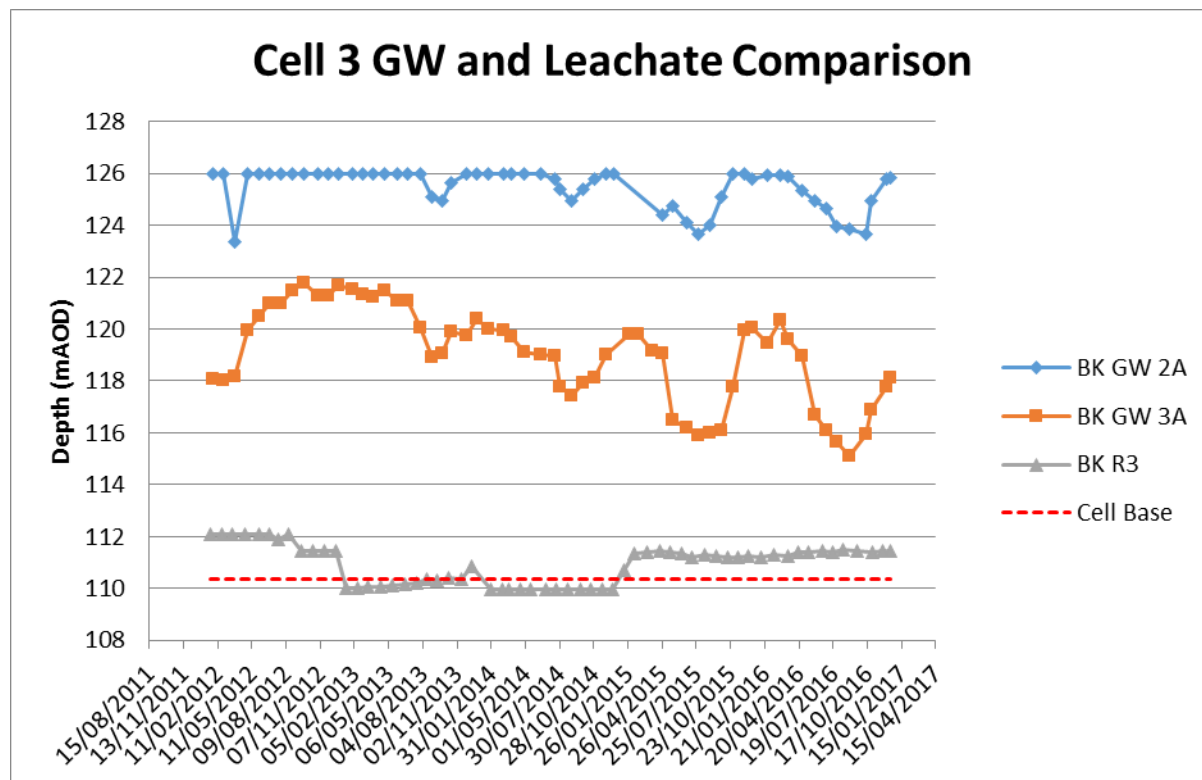


Graph 3: Groundwater and Leachate level comparison in Cell 1

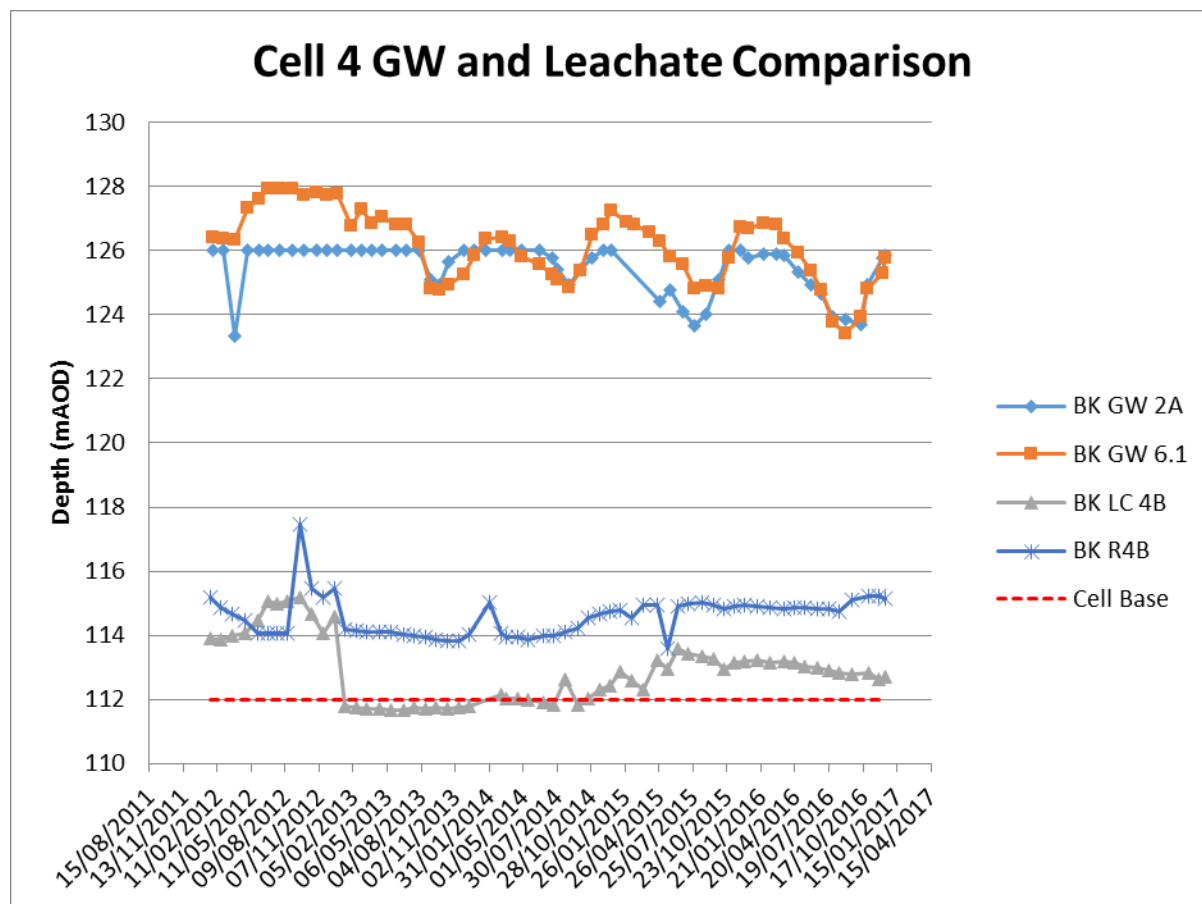


Graph 4: Groundwater and Leachate level comparison in Cell 2

APPENDIX 3 - LEACHATE

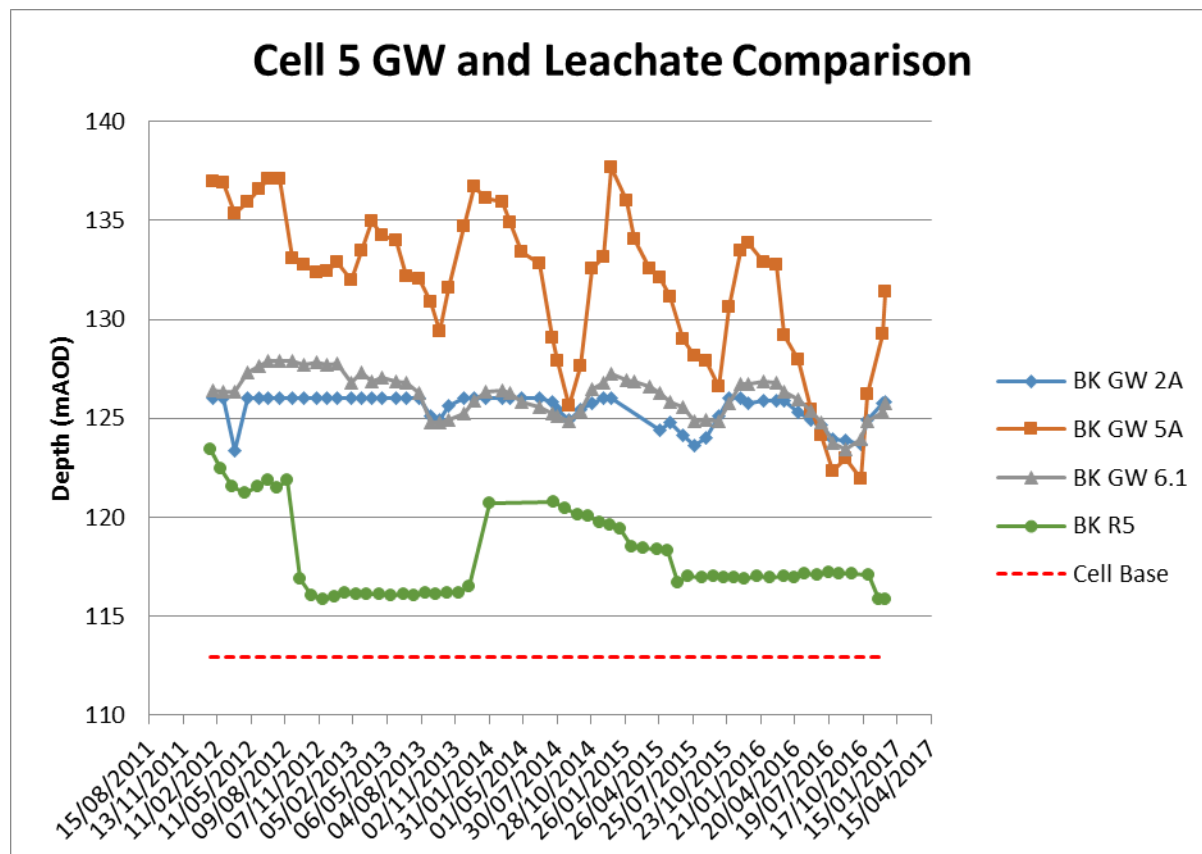


Graph 5: Groundwater and Leachate level comparison in Cell 3

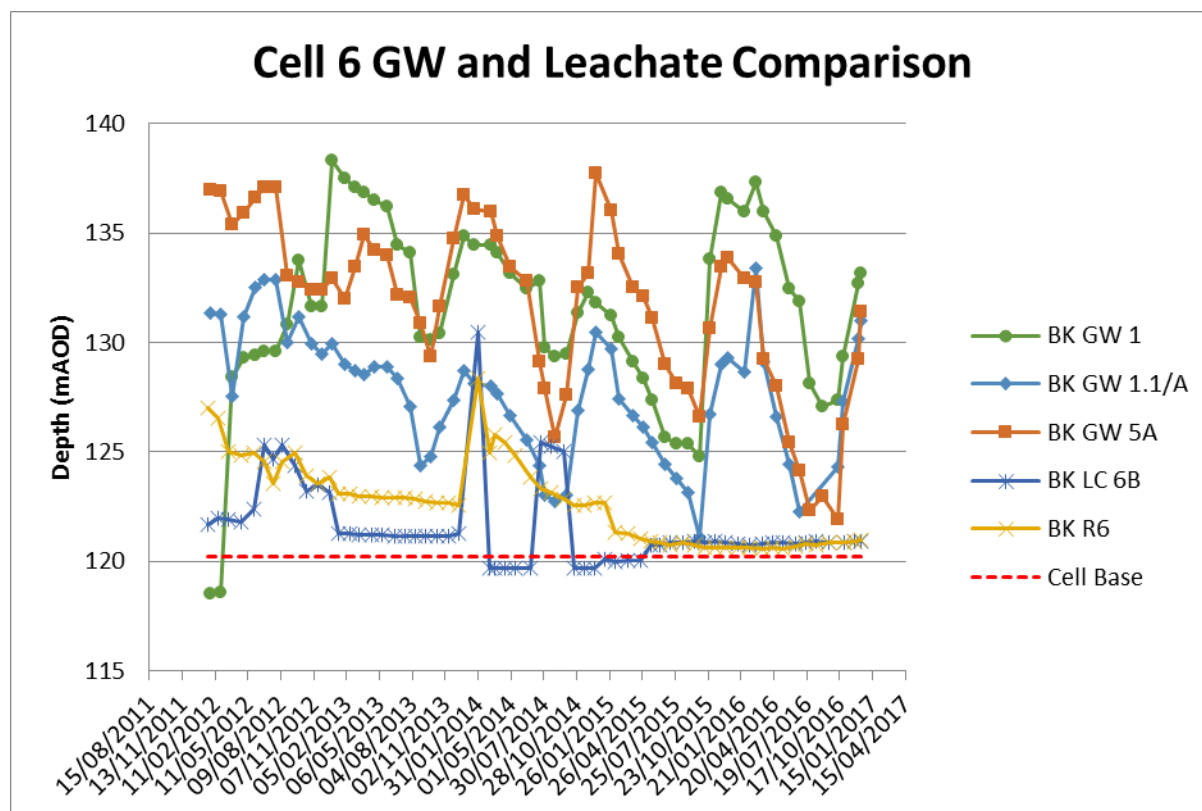


Graph 6: Groundwater and Leachate level comparison in Cell 4

APPENDIX 3 - LEACHATE



Graph 7: Groundwater and Leachate level comparison in Cell 5



Graph 8: Groundwater and Leachate level comparison in Cell 6

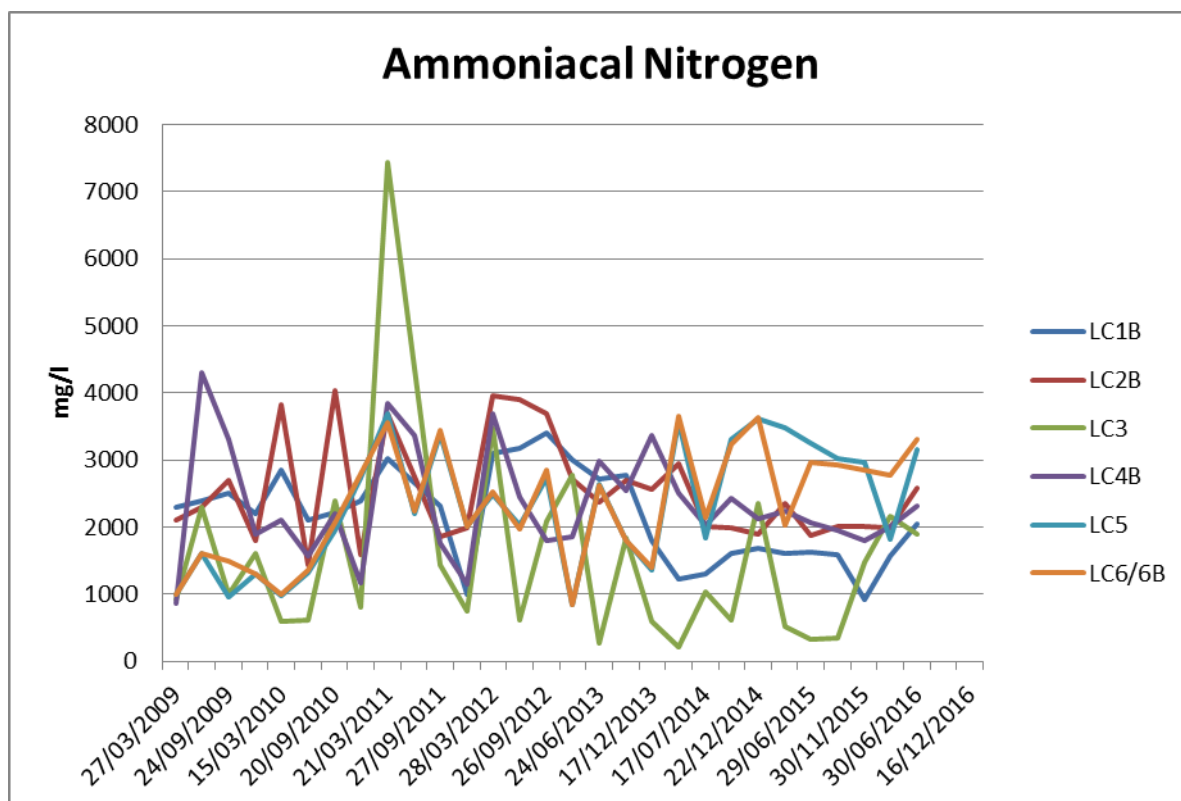
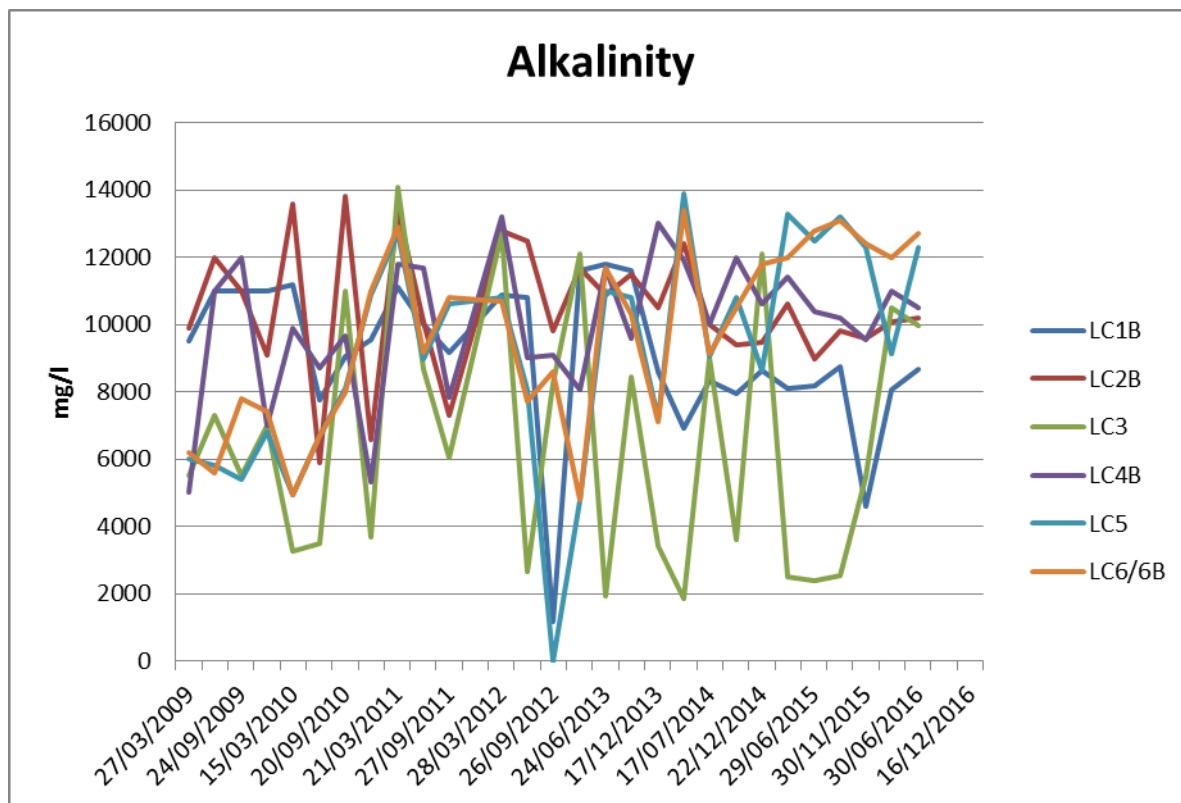
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Table 2: Leachate Quality Summary - Quarterly Suite

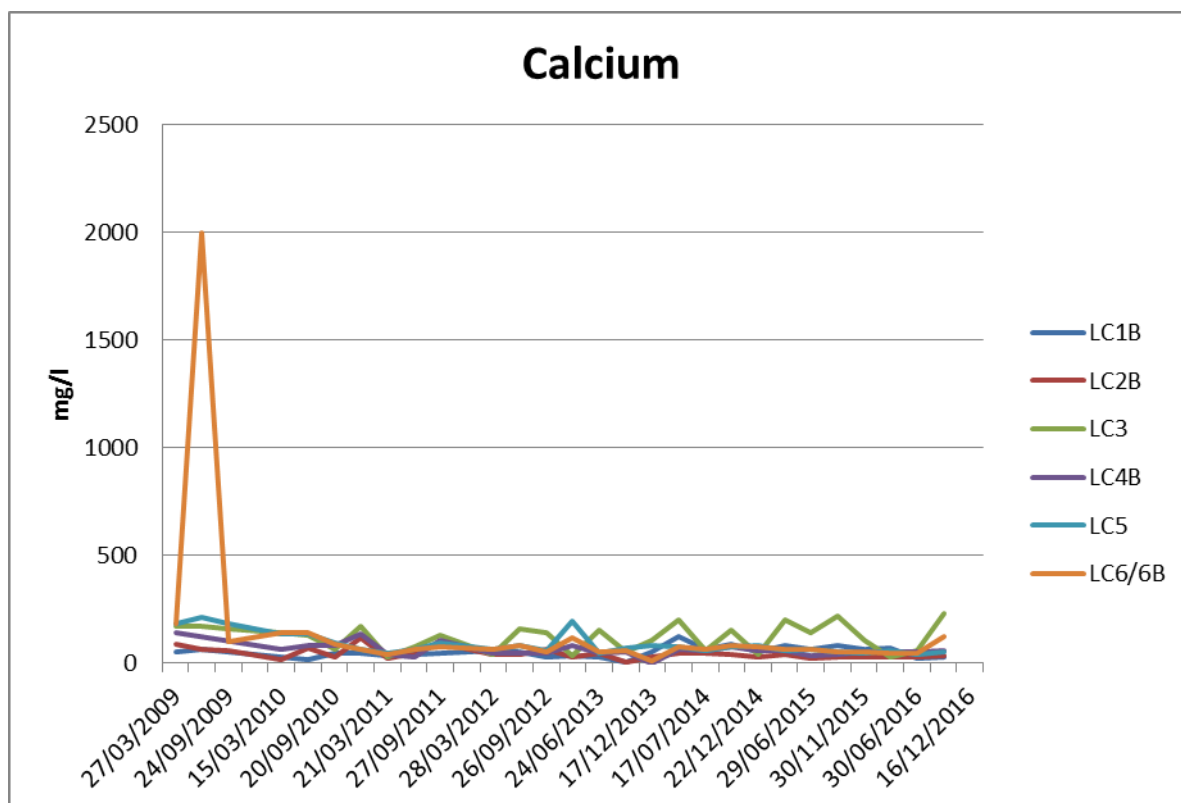
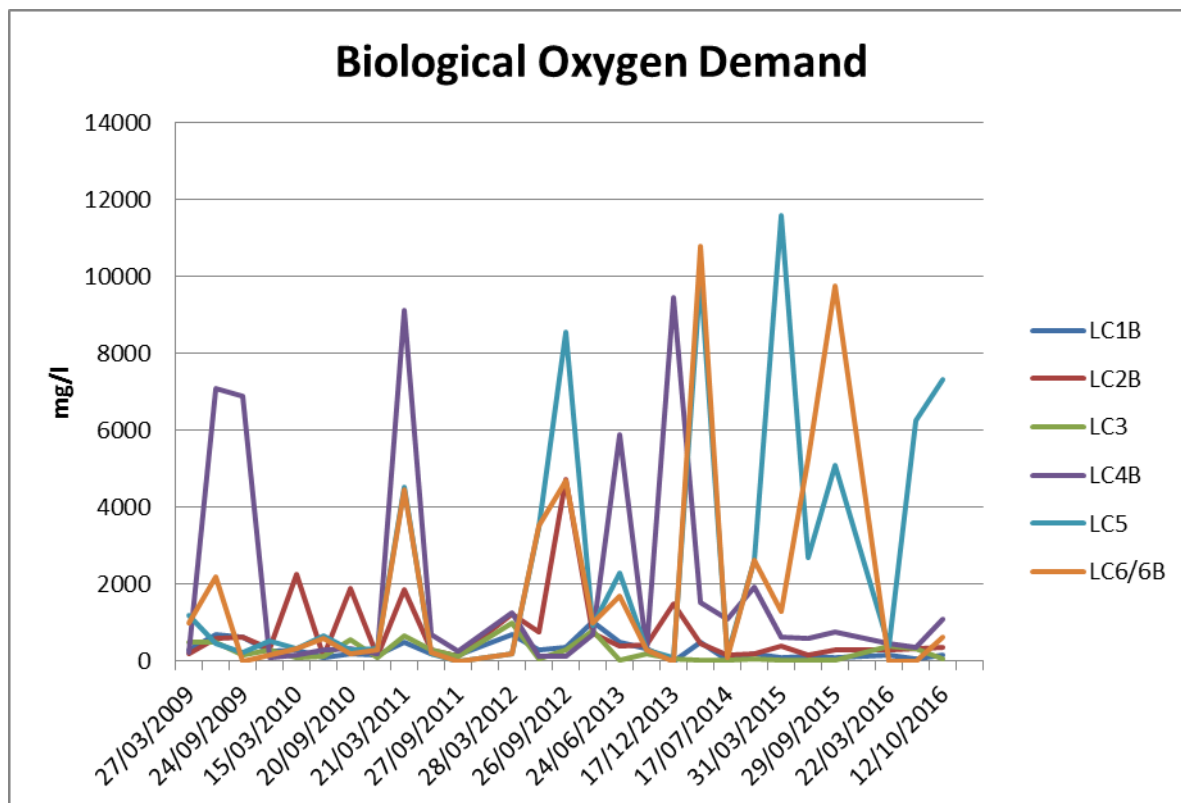
Location	Parameter	Alkalinity	Ammoniacal	BOD	Calcium	COD	Chloride
	Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
LC 1B	Minimum	8060	1570	146	22	2390	2140
	Maximum	8680	2050	151	67	3240	2220
	Average	8370	1810	149	40	2687	2187
LC 2B	Minimum	10100	1980	292	28	3730	2510
	Maximum	10200	2580	348	34	4240	2640
	Average	10150	2280	318	30	3937	2567
LC 3	Minimum	9950	1890	<50	29	761	1440
	Maximum	10500	2170	402	231	4350	3540
	Average	10225	2030	262	105	3107	2507
LC 4B	Minimum	10500	2010	340	50	3690	3790
	Maximum	11000	2320	1070	59	6650	4810
	Average	10750	2165	616	53	4850	4233
LC 5	Minimum	9140	1810	387	38	4320	3330
	Maximum	12300	3150	7320	58	21200	3820
	Average	10720	2480	4656	49	13040	3527
LC 6B	Minimum	12000	2780	624	44	2560	1660
	Maximum	12700	3300	>2700	122	17700	3520
	Average	12350	3040	1978	70	11253	2887

Location	Parameter	Magnesium	pH	Potassium	Sodium	Sulphate	TOC	TON
	Units	mg/l	-	mg/l	mg/l	mg/l	mg/l	mg/l
LC 1B	Minimum	82	7.82	742	1420	5	889	<0.4
	Maximum	89	8.11	925	1550	5	899	<6
	Average	85	7.97	841	1493	5	894	<3
LC 2B	Minimum	63	7.81	679	1270	17	120	<0.4
	Maximum	83	8.13	966	1790	<50	1200	<6
	Average	75	7.97	832	1563	39	660	<4
LC 3	Minimum	69	7.73	274	1050	<10	1180	<0.4
	Maximum	99	7.98	832	2230	<40	1450	<6
	Average	81	7.89	570	1643	21	1315	2.63
LC 4B	Minimum	68	8.04	683	2480	6	1210	<0.4
	Maximum	73	8.26	1070	3460	<100	1360	<6
	Average	70	8.13	831	2917	49	1285	4.13
LC 5	Minimum	51	8.01	739	2300	56	1320	<0.4
	Maximum	87	8.22	1050	2700	<100	4360	<6
	Average	65	8.12	844	2533	85	2840	4.13
LC 6B	Minimum	67	7.58	406	1480	21	4750	<0.4
	Maximum	69	8.19	902	2760	<100	5710	<6
	Average	68	7.96	714	2287	54	5230	3.13

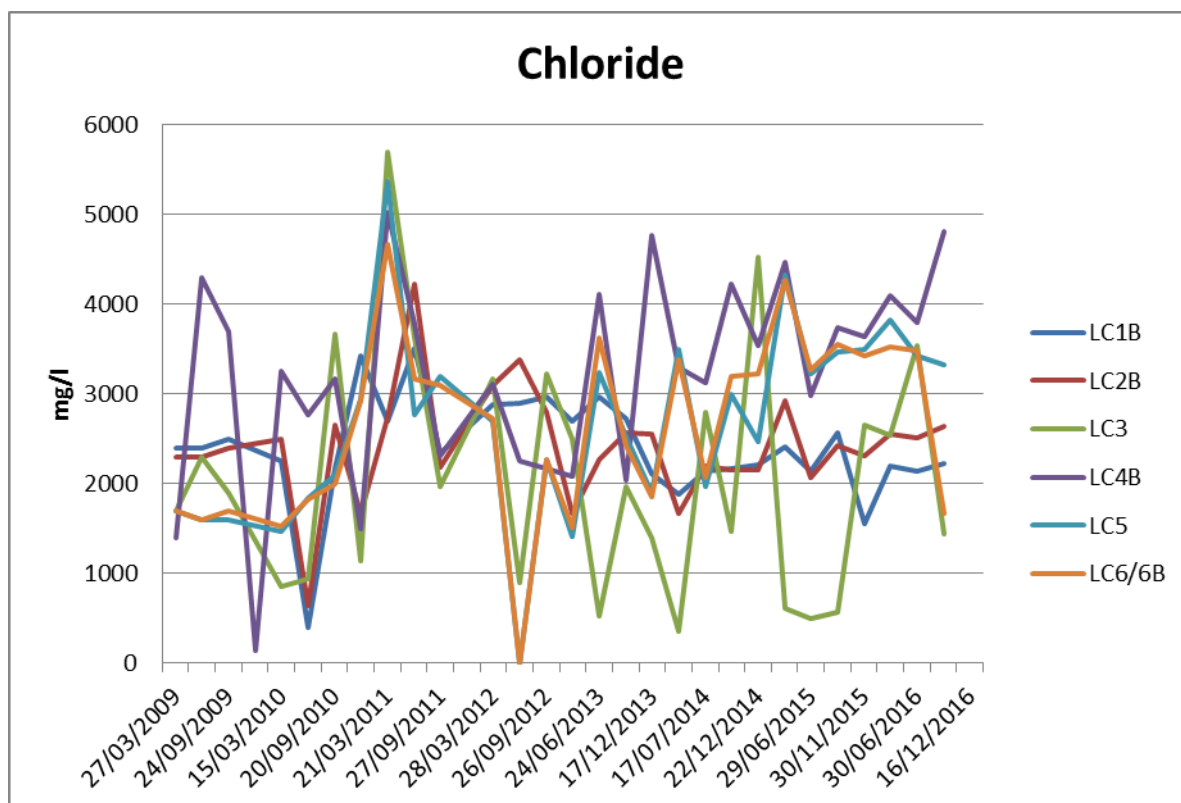
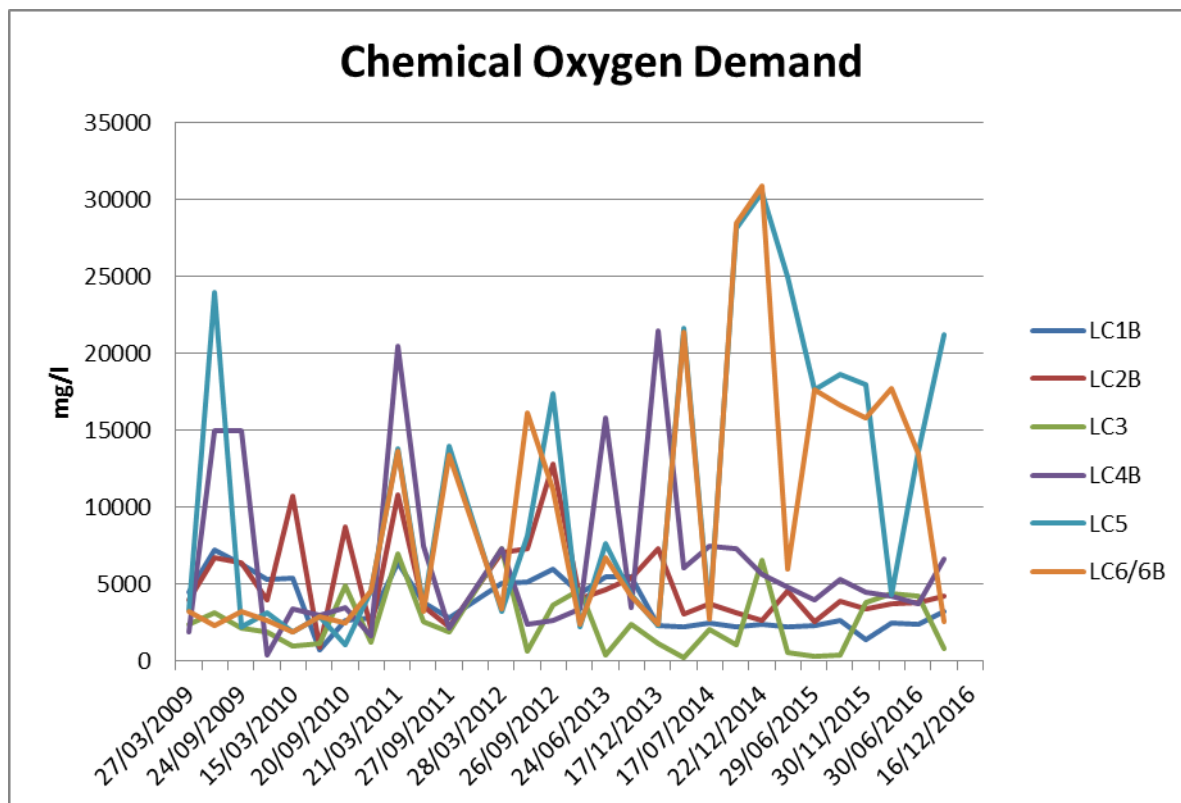
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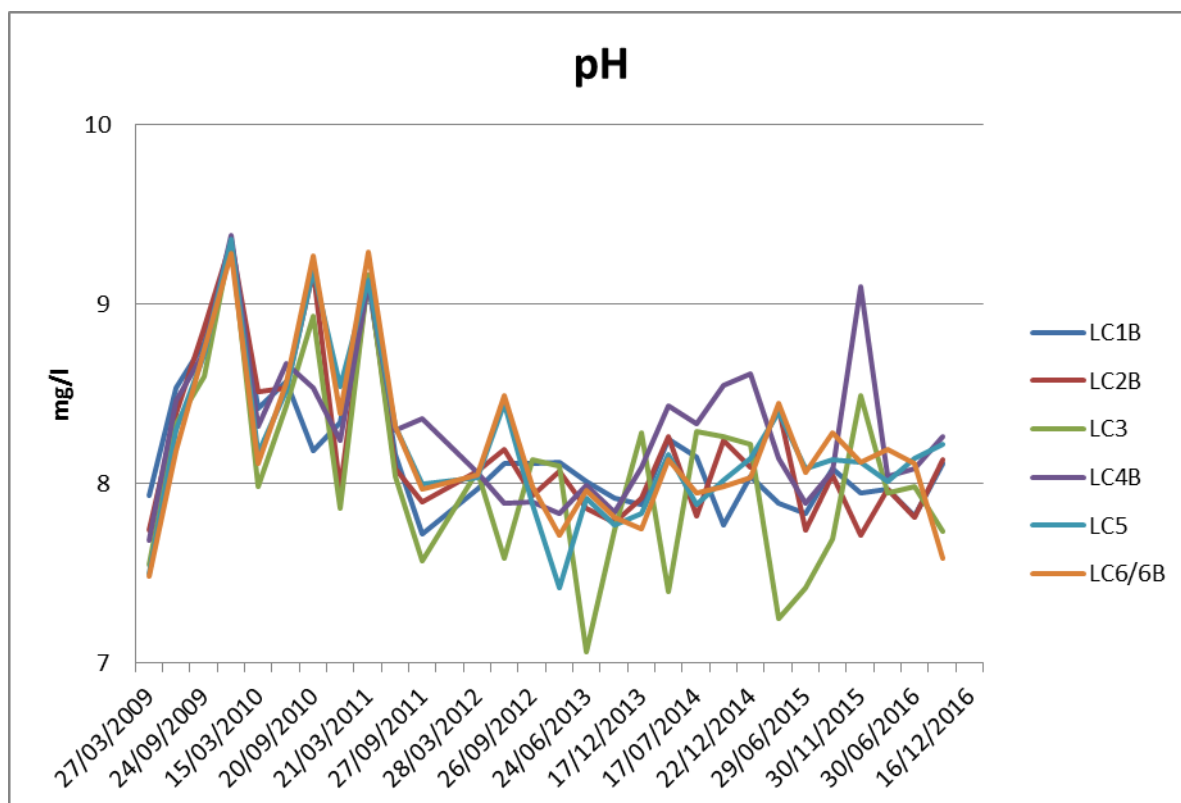
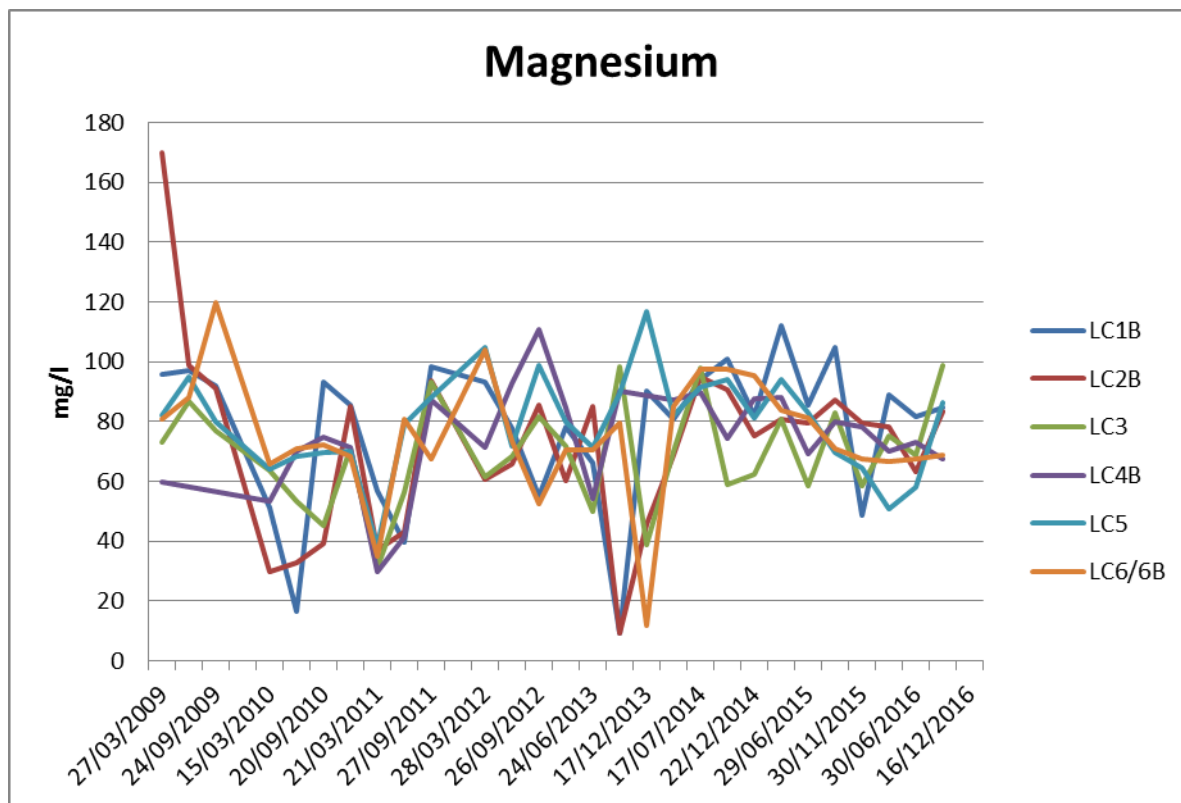
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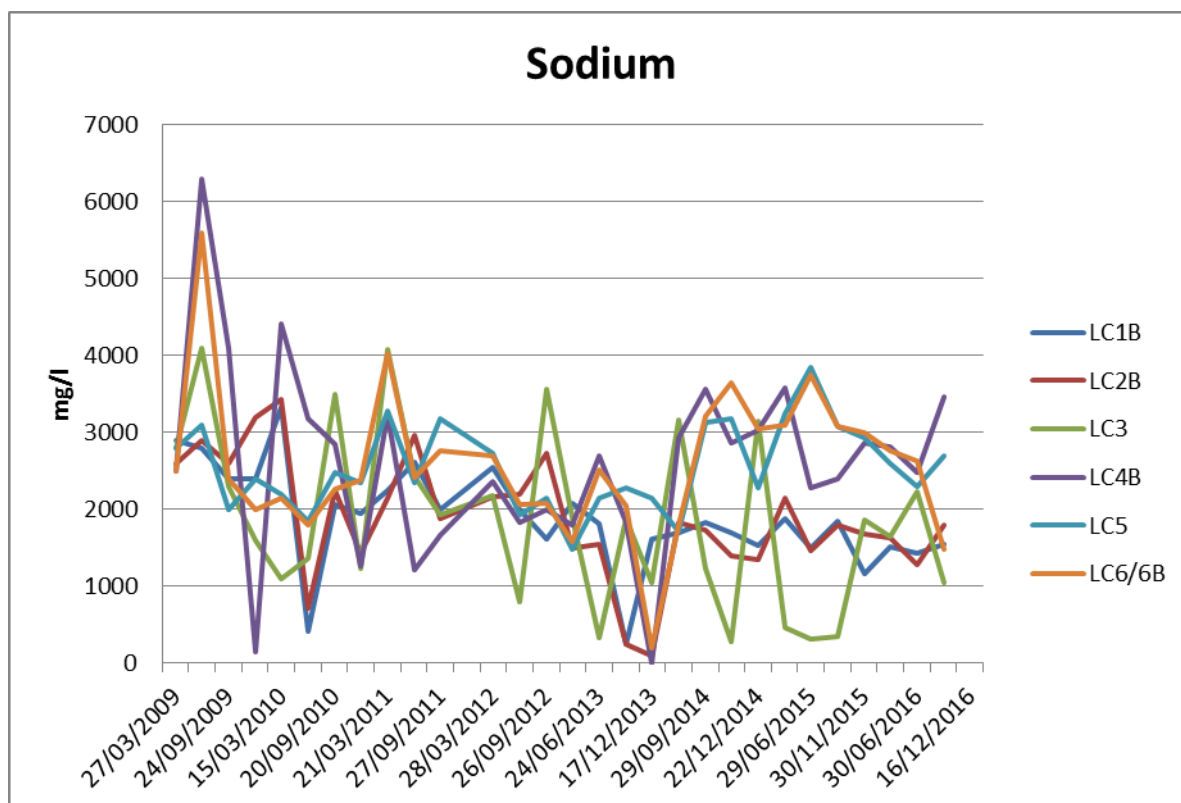
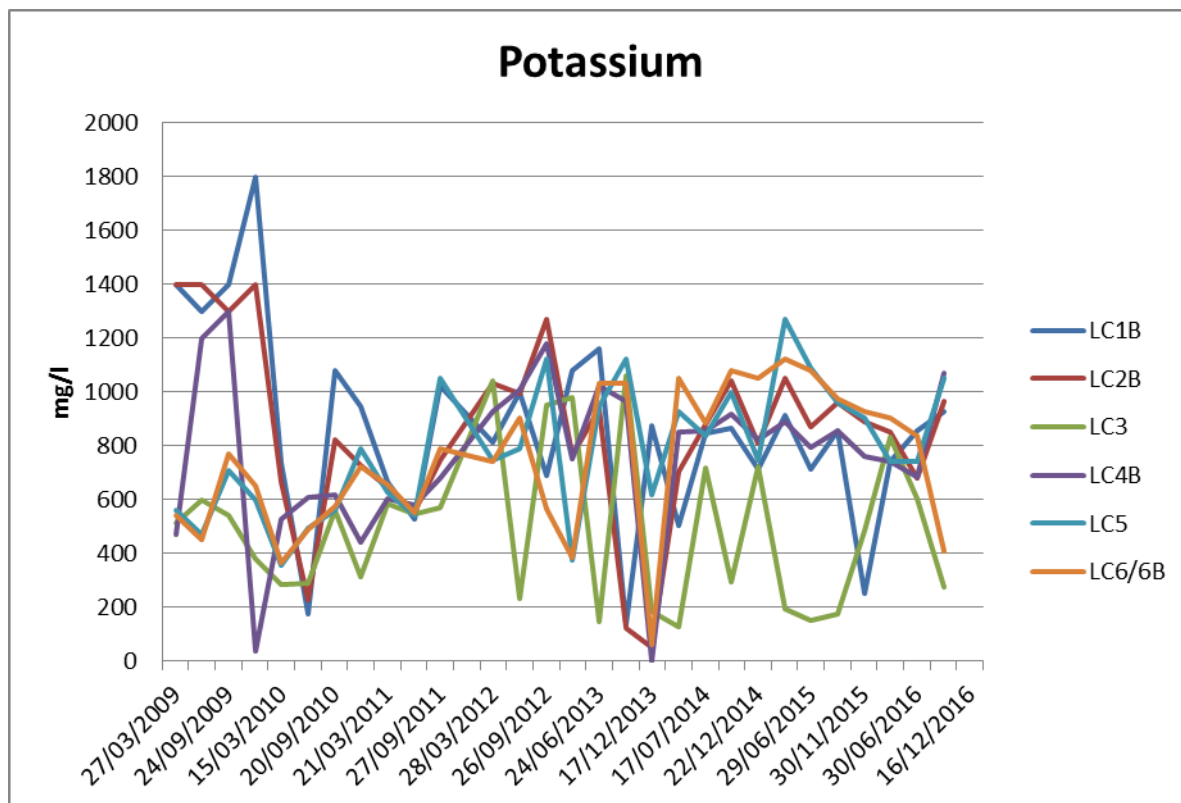
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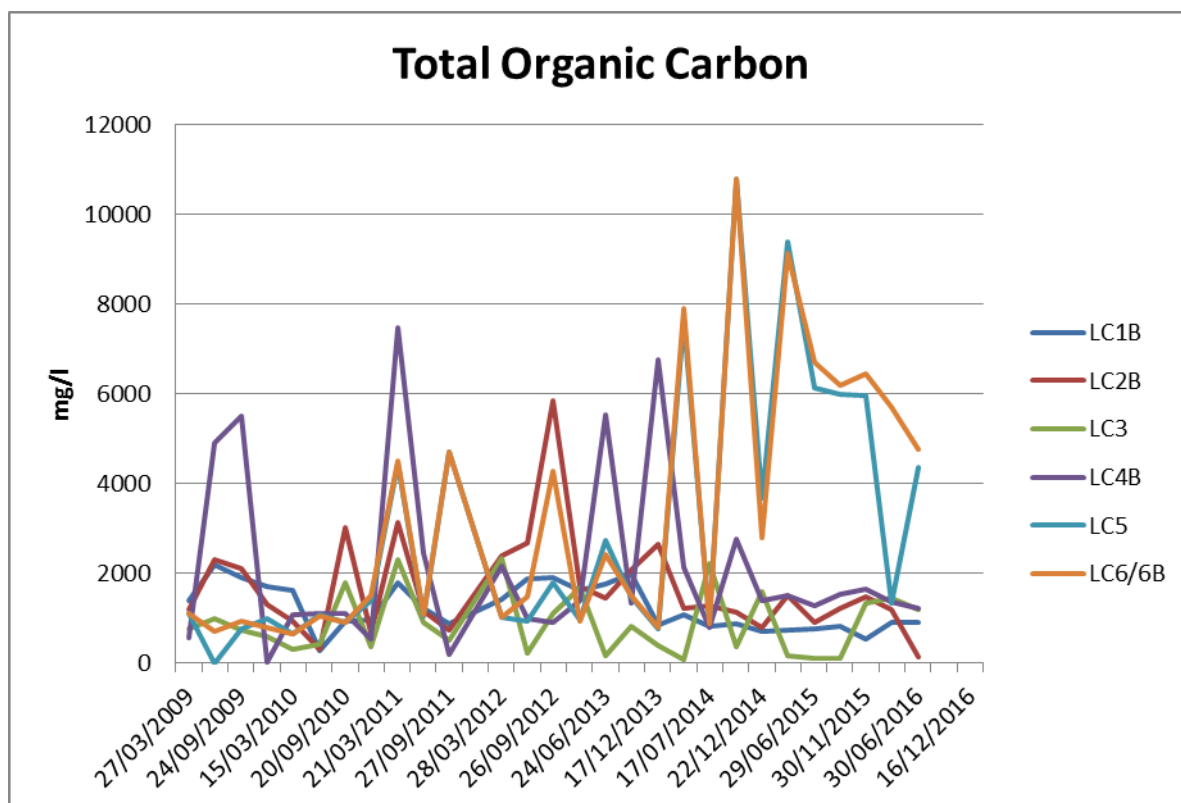
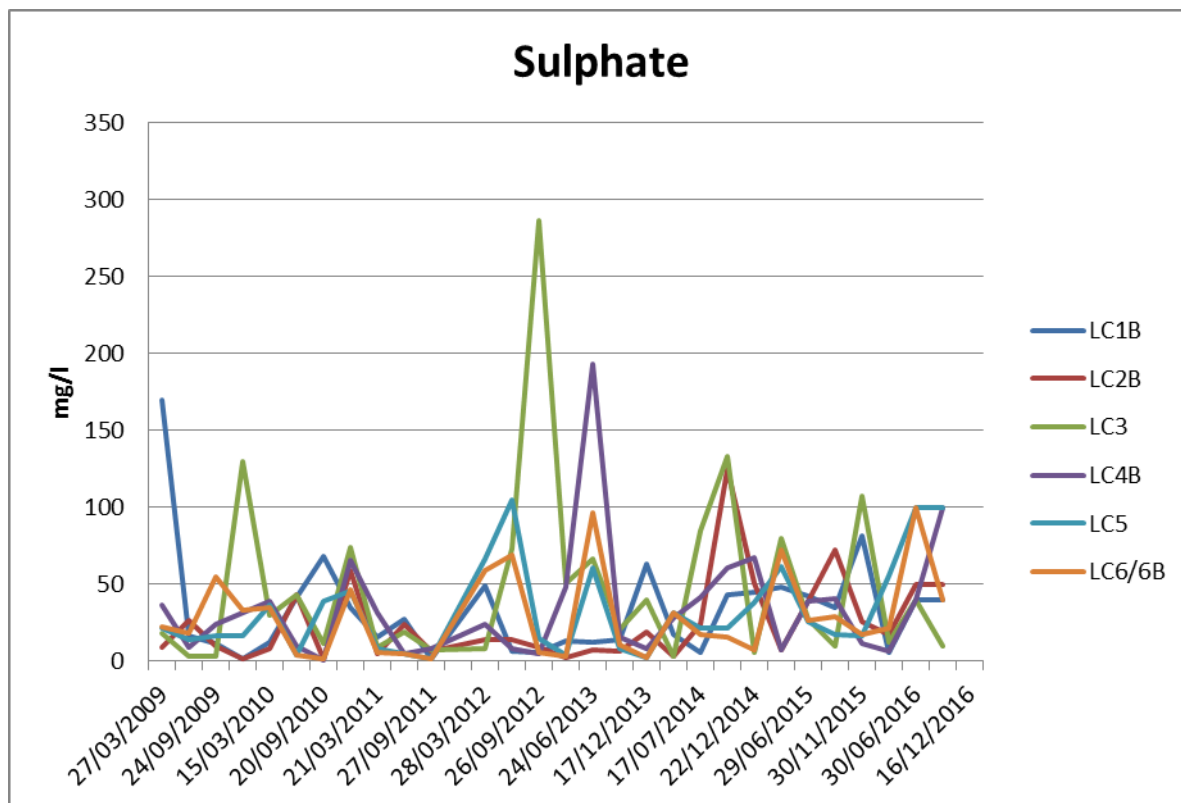
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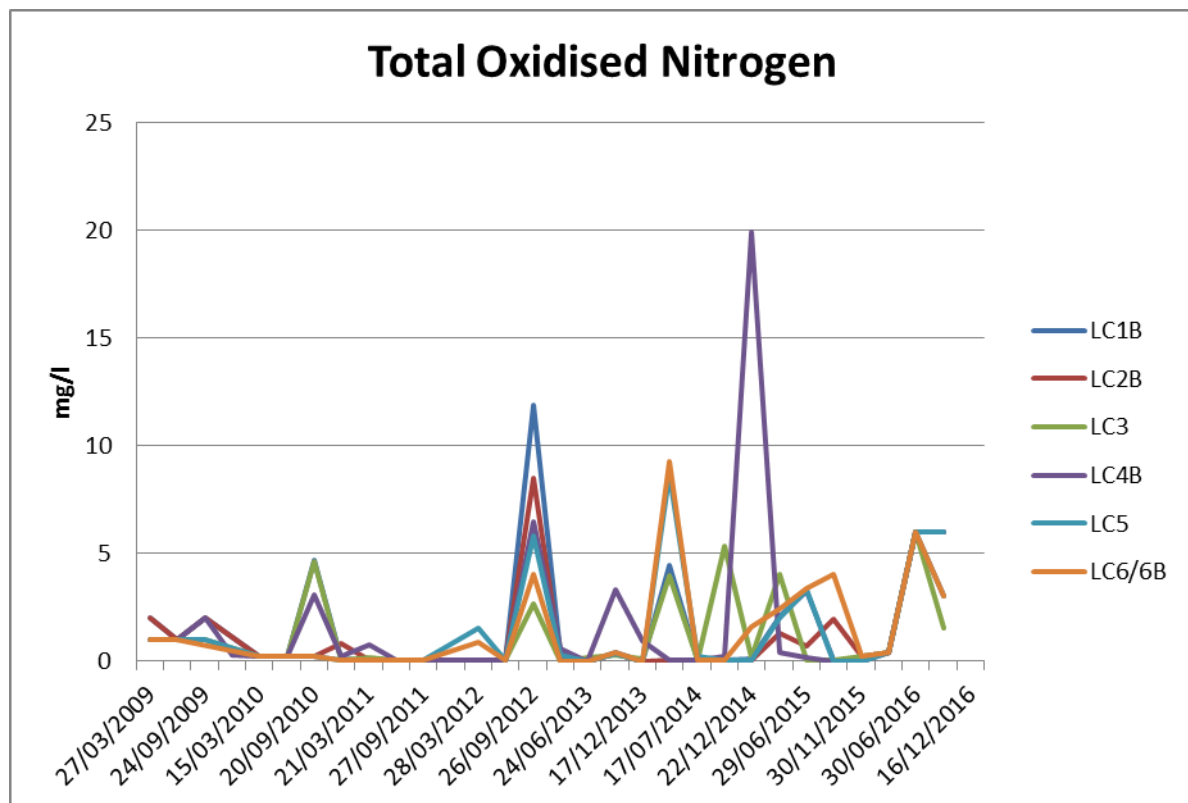
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APPENDIX 3 - LEACHATE



APPENDIX 3 - LEACHATE



APPENDIX 3 - LEACHATE**Table 3: Leachate Annual Suite**

Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
Inorganics							
Cyanide, Free	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cyanide, Total	mg/l	<0.05	0.053	<0.05	<0.05	0.118	0.12
Filtered (Dissolved) Metals							
Cadmium (diss.filt)	mg/l	<0.00008	0.000131	<0.00008	<0.00008	<0.00008	<0.00008
Chromium (diss.filt)	mg/l	0.0549	0.135	0.0654	0.0956	0.187	0.183
Copper (diss.filt)	mg/l	0.271	0.0941	0.0966	0.0722	0.387	0.0231
Iron (diss.filt)	mg/l	9.27	8.41	12.2	12.4	4.73	4.36
Lead (diss.filt)	mg/l	0.00414	0.00421	0.00259	0.00419	0.0117	0.00486
Manganese (diss.filt)	mg/l	0.564	0.17	0.307	0.376	0.337	0.341
Mercury (diss.filt)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	-	-
Nickel (diss.filt)	mg/l	0.198	0.367	0.243	0.28	0.334	0.312
Zinc (diss.filt)	mg/l	0.341	0.103	0.163	0.181	0.249	0.104
Mineral Oil / Oils & Greases							
Mineral oil >C10 C40 (aq)	mg/l	0.0339	0.753	0.0165	0.212	0.0947	0.126
Semi-Volatile Organic Compounds (SVOCs)							
1,2,4-Trichlorobenzene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
1,2-Dichlorobenzene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
1,3-Dichlorobenzene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
1,4-Dichlorobenzene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,5-Trichlorophenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4,6-Trichlorophenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dichlorophenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2,4-Dimethylphenol (aq)	mg/l	<0.008	0.00874	<0.008	<0.008	0.0992	0.107
2,4-Dinitrotoluene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008

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Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
2,6-Dinitrotoluene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2-Chloronaphthalene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2-Chlorophenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2-Methylnaphthalene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2-Methylphenol (aq)	mg/l	<0.008	0.0322	<0.008	<0.008	0.0589	0.0613
2-Nitroaniline (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
2-Nitrophenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
3-Nitroaniline (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
4-Bromophenylphenylether (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
4-Chloro-3-methylphenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
4-Chloroaniline (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
4-Chlorophenylphenylether (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
4-Methylphenol (aq)	mg/l	<0.008	0.0116	<0.008	<0.008	5.46	4.54
4-Nitroaniline (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
4-Nitrophenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Azobenzene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Benzo(k)fluoranthene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
bis(2-Chloroethoxy)methane (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
bis(2-Chloroethyl)ether (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
bis(2-Ethylhexyl) phthalate (aq)	mg/l	<0.016	0.0738	<0.016	0.0336	0.155	0.188
Butylbenzyl phthalate (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Carbazole (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Dibenzofuran (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Diethyl phthalate (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Dimethyl phthalate (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Hexachlorobenzene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Hexachlorobutadiene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008

APPENDIX 3 - LEACHATE

Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
Hexachlorocyclopentadiene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Hexachloroethane (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Isophorone (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
n-Dibutyl phthalate (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
n-Dioctyl phthalate (aq)	mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Nitrobenzene (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
n-Nitroso-n-dipropylamine (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Pentachlorophenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Phenol (aq)	mg/l	<0.008	<0.008	<0.008	<0.008	6.13	5.13
Total SVOC TIC	mg/l	0.325	30	4.28	14.9	64.1	83
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	0.00268	0.0236	<0.001	0.0127	0.0124	0.0138
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

APPENDIX 3 - LEACHATE

Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
1,3,5-Trichlorobenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trimethylbenzene	mg/l	0.00142	0.00545	0.00224	0.00325	0.00249	0.00276
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	<0.001	<0.001	<0.001	<0.001	0.00407	<0.001
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-Chlorotoluene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-iso-Propyltoluene	mg/l	0.00146	0.0426	0.00992	0.0233	0.00991	0.0109
Benzene	mg/l	0.0014	0.00335	0.00132	0.00242	0.00824	0.00448
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
Carbon disulphide	mg/l	<0.001	<0.001	<0.001	<0.001	0.00282	0.00184
Carbontetrachloride	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene	mg/l	0.00114	0.00244	<0.001	0.00173	0.00687	0.00772
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	<0.001	0.00777	0.00864
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
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

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Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
Ethylbenzene	mg/l	0.0021	0.0498	<0.001	0.023	0.0219	0.0253
Hexachlorobutadiene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isopropylbenzene	mg/l	<0.001	0.00179	<0.001	0.00107	<0.001	0.00102
m,p-Xylene	mg/l	0.00486	0.0986	0.00319	0.0462	0.0539	0.0606
Methyl tertiary butyl ether (MTBE)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Naphthalene	mg/l	0.00187	0.0116	0.0083	0.00785	0.0153	0.0113
n-Butylbenzene	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
o-Xylene	mg/l	0.00539	0.0315	0.0118	0.017	0.0231	0.0262
Propylbenzene	mg/l	<0.001	0.00249	<0.001	0.00141	0.00106	0.00122
sec-Butylbenzene	mg/l	<0.001	0.00106	<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	0.00125	0.0285	<0.001	0.0139	0.0404	0.0438
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	0.00112	<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	<0.001	<0.001	0.001
Combined Pesticides / Herbicides							
Aldrin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
alpha-Hexachlorocyclohexane (HCH / Lindane)	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Azinphos-ethyl	mg/l	0.00101	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Azinphos-methyl	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
beta-Hexachlorocyclohexane (HCH / Lindane)	mg/l	<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

APPENDIX 3 - LEACHATE

Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
Chlorfenvinphos	mg/l	<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
Chlorpyrifos	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chlorpyrifos methyl	mg/l	<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
Diazinon	mg/l	<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
Dieldrin	mg/l	<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
Disulfoton	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Endosulphan I	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Endosulphan II	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Endosulphan sulphate	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Endrin	mg/l	<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
Etrimphos	mg/l	<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
Fenthion	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
gamma-Hexachlorocyclohexane (HCH / Lindane)	mg/l	<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
Heptachlor epoxide	mg/l	<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
Isodrin	mg/l	<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
Methyl parathion	mg/l	<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

APPENDIX 3 - LEACHATE

Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
o,p-DDE	mg/l	<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
o,p-Methoxychlor	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
o,p-TDE (DDD)	mg/l	<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
p,p-DDT	mg/l	<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
p,p-TDE (DDD)	mg/l	<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
Pendimethalin	mg/l	<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
Permethrin II	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Phosalone	mg/l	<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
Propetamphos	mg/l	<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
Tecnazene	mg/l	<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
Trans-chlordane	mg/l	<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
Triallate	mg/l	<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
Trifluralin	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Miscellaneous Organics							
Dibutyl tin	mg/l	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Tetrabutyl tin	mg/l	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006	<0.00006
Tributyl tin	mg/l	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003

APPENDIX 3 - LEACHATE

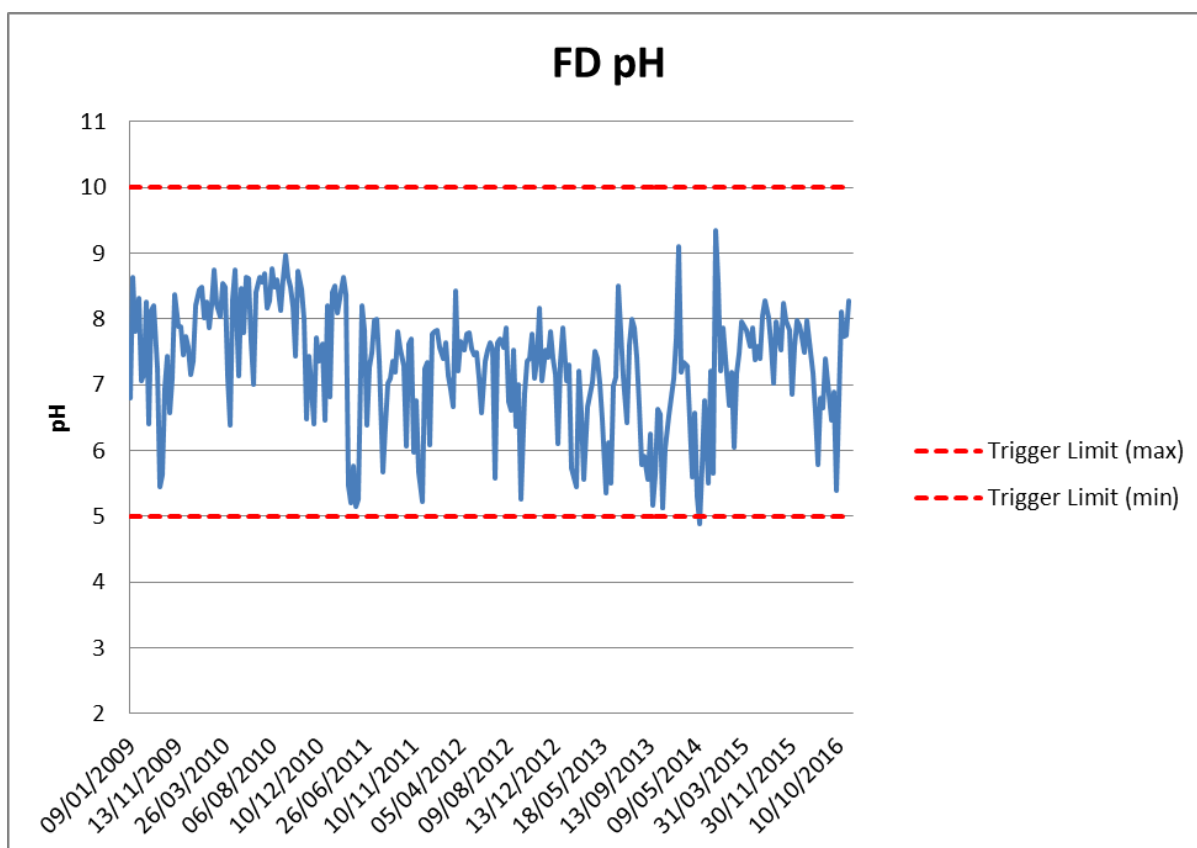
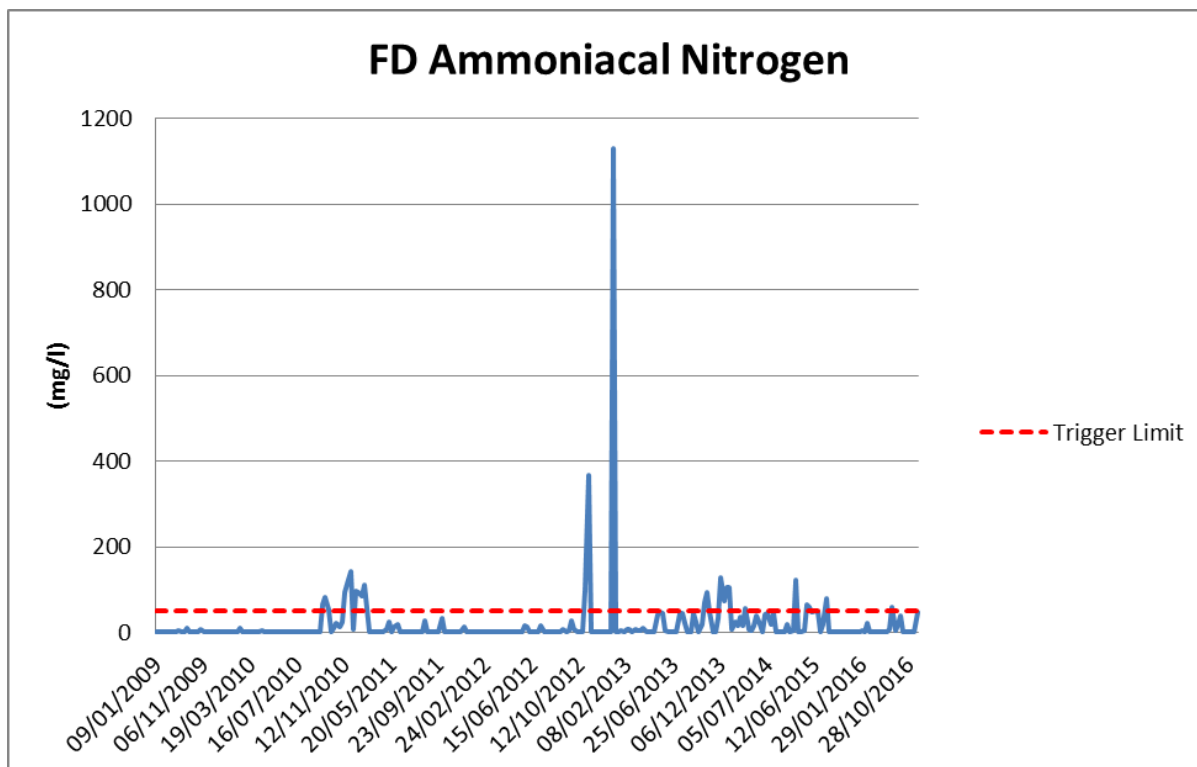
Parameters	Units	LC1B	LC2B	LC3	LC4B	LC5	LC6
Triphenyl tin	mg/l	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
TICS							
Benzeneacetic acid	mg/l	-	-	-	-	13.3	18.4
Benzenecarboxylic acid	mg/l	-	-	-	-	5.69	4.65
Benzenepropanoic acid	mg/l	-	-	-	-	4.61	5.12
Butylbenzenesulfonamide	mg/l	-	0.362	-	0.644	-	-
Ethylheptanoic acid	mg/l	-	-	-	-	1.14	1.48
Methyl(methylethyl)Cyclohexenol	mg/l	-	0.629	-	-	-	-
Methylbenzenepropanoic acid	mg/l	-	-	-	-	3.01	4.05
mixed hydrocarbons	mg/l	0.0915	6.33	0.524	0.228	2.53	4.78
Phenol(methylethylidene)bis-	mg/l	-	12.3	0.319	8.51	16	22.1
Tertbutylbenzoic acid	mg/l	-	0.349	-	0.164	-	-
Tertbutylhydroxyphenylpropionic acid	mg/l	-	1.62	0.289	0.498	1.88	2.37
Tertbutylphenol	mg/l	-	0.43	-	0.355	1.45	2.54
Trimethylbicycloheptanone	mg/l	-	-	-	0.156	-	-
trimethylhexanoic acid	mg/l	0.234	7.96	3.15	3.48	14.4	17.4

APPENDIX 3 - LEACHATE

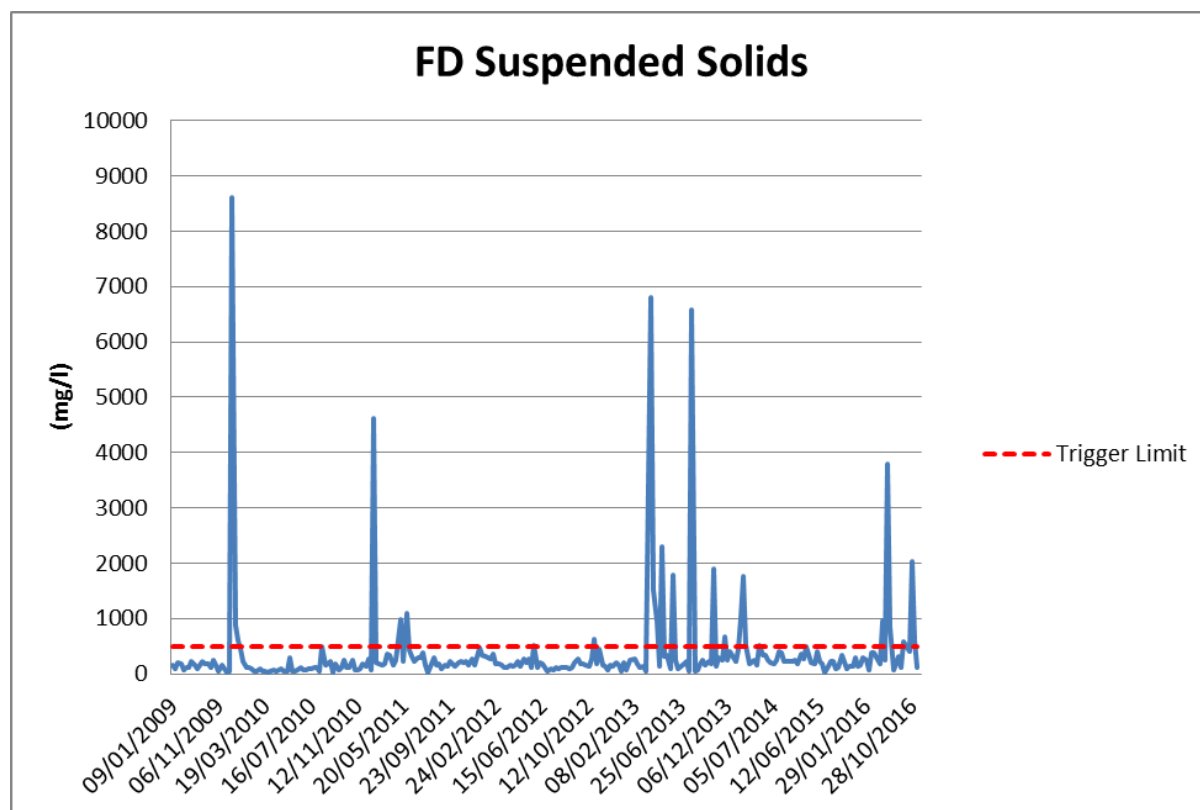
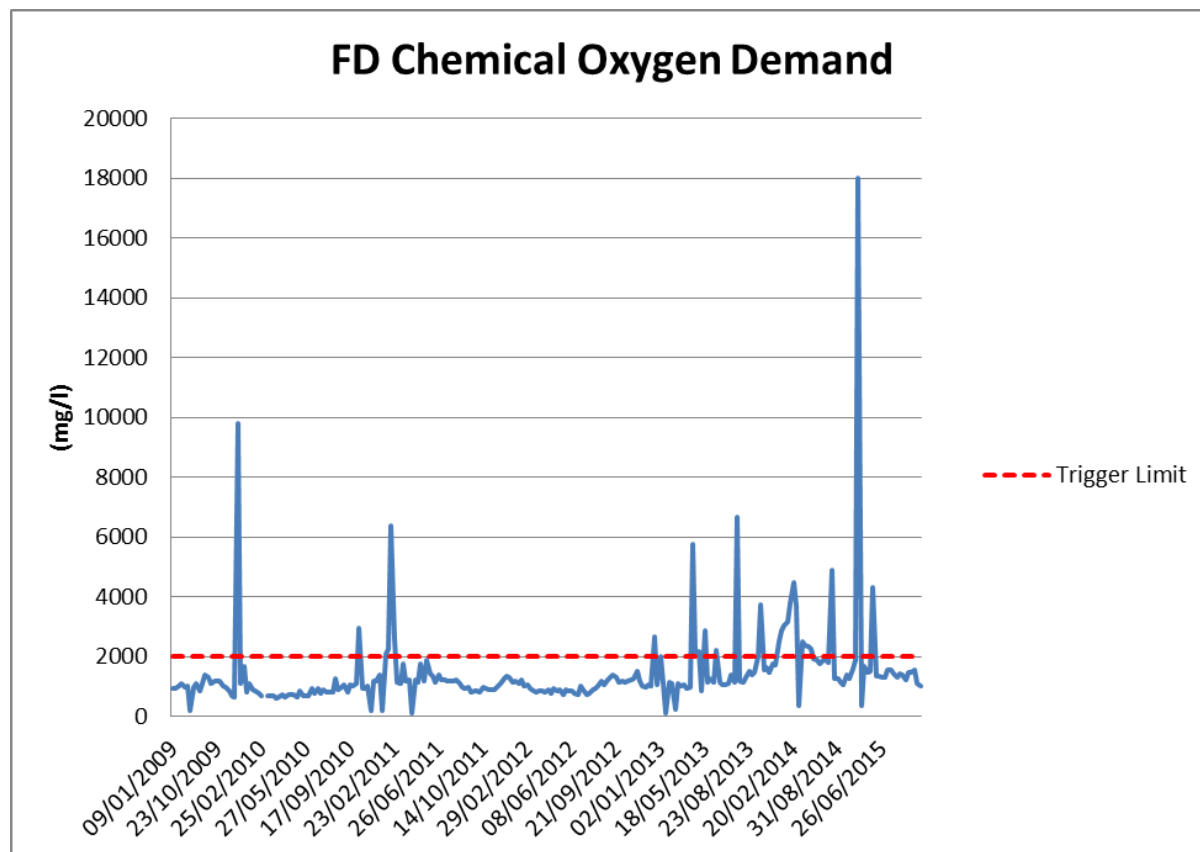
Table 4: Final Discharge Quality Summary

Final Discharge	Ammoniacal Nitrogen	pH	COD	Suspended Solids	Chromium	Copper	Lead	Nickel	Zinc	Nitrate as N	Nitrite as N	Alkalinity
Date / Trigger	mg/l	pH Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	50	>5<10	2000	500	2	2	2	2	2	-	-	-
15/01/2016	0.3	8.0	1140	283	0.085	0.028	0.003	0.18	0.10	1030	<0.25	465
29/01/2016	<4	7.9	1110	246	-	-	-	-	-	975	0.2	433
13/02/2016	0.6	7.7	1070	63	0.097	0.046	0.011	0.23	0.22	1020	0.1	190
03/03/2016	21.2	7.5	1450	375	-	-	-	-	-	997	9.3	735
14/03/2016	0.5	8.0	1370	390	0.097	0.046	0.011	0.23	0.22	1080	1.3	720
05/04/2016	0.6	-	995	-	0.067	0.059	0.003	0.19	0.12	-	<0.152	270
29/04/2016	0.4	7.2	856	176	-	-	-	-	-	895	<0.152	210
06/05/2016	0.3	6.6	1650	955	0.070	0.051	0.002	0.18	0.13	875	<0.1	115
13/05/2016	0.7	5.8	935	238	0.064	0.056	0.002	0.18	0.13	735	0.2	40
20/05/2016	0.6	6.8	4160	3800	0.067	0.043	0.004	0.16	0.14	874	0.6	390
27/05/2016	1.5	6.7	1400	850	0.074	0.041	0.002	0.16	0.11	916	0.5	200
03/06/2016	8.4	7.4	870	59	-	-	-	-	-	902	4.7	280
30/06/2016	59.0	-	1160	-	0.092	0.070	0.006	0.22	0.18	-	0.6	198
14/07/2016	5.6	6.5	1440	316	0.079	0.076	0.006	0.23	0.20	818	0.6	165
29/07/2016	18.7	6.9	1160	116	0.064	0.058	0.005	0.19	0.18	866	1.0	264
30/08/2016	40.3	5.4	1660	590	-	-	-	-	-	827	0.7	85
10/10/2016	<2	-	3000	-	0.056	0.052	0.006	0.19	0.21	-	0.0	94
21/10/2016	<1	8.1	1480	412	0.057	0.048	0.011	0.20	0.32	906	<0.0152	725
28/10/2016	2.1	7.7	4070	2040	-	-	-	-	-	1080	1.0	1050
11/11/2016	0.4	7.8	1650	605	0.057	0.044	0.003	0.21	0.10	1080	<0.0152	420
09/12/2016	0.9	8.3	1140	121	-	-	-	-	-	1110	0.3	635
15/12/2016	46.2	-	1910	-	0.131	0.060	0.006	0.27	0.14	-	1.9	1190
Minimum	<1	5.4	856	59	0.056	0.028	0.002	0.16	0.10	735.0	<0.0152	40.0
Maximum	59.0	8.3	4160	3800	0.131	0.076	0.011	0.27	0.32	1110.0	9.3	1190.0
Average	9.8	7.2	1622	646	0.077	0.052	0.005	0.20	0.17	943.7	1.0	403.3
Count	22	18	22	18	15	15	15	15	15	18	22	22

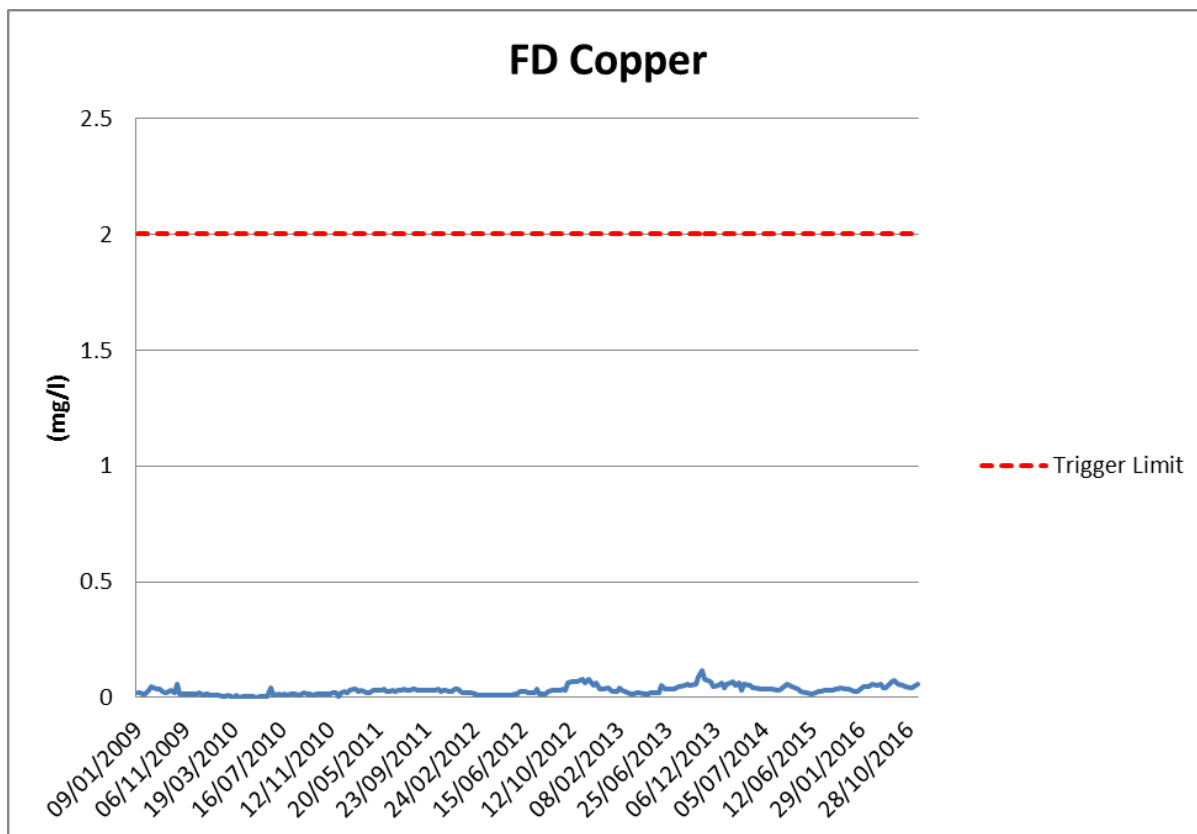
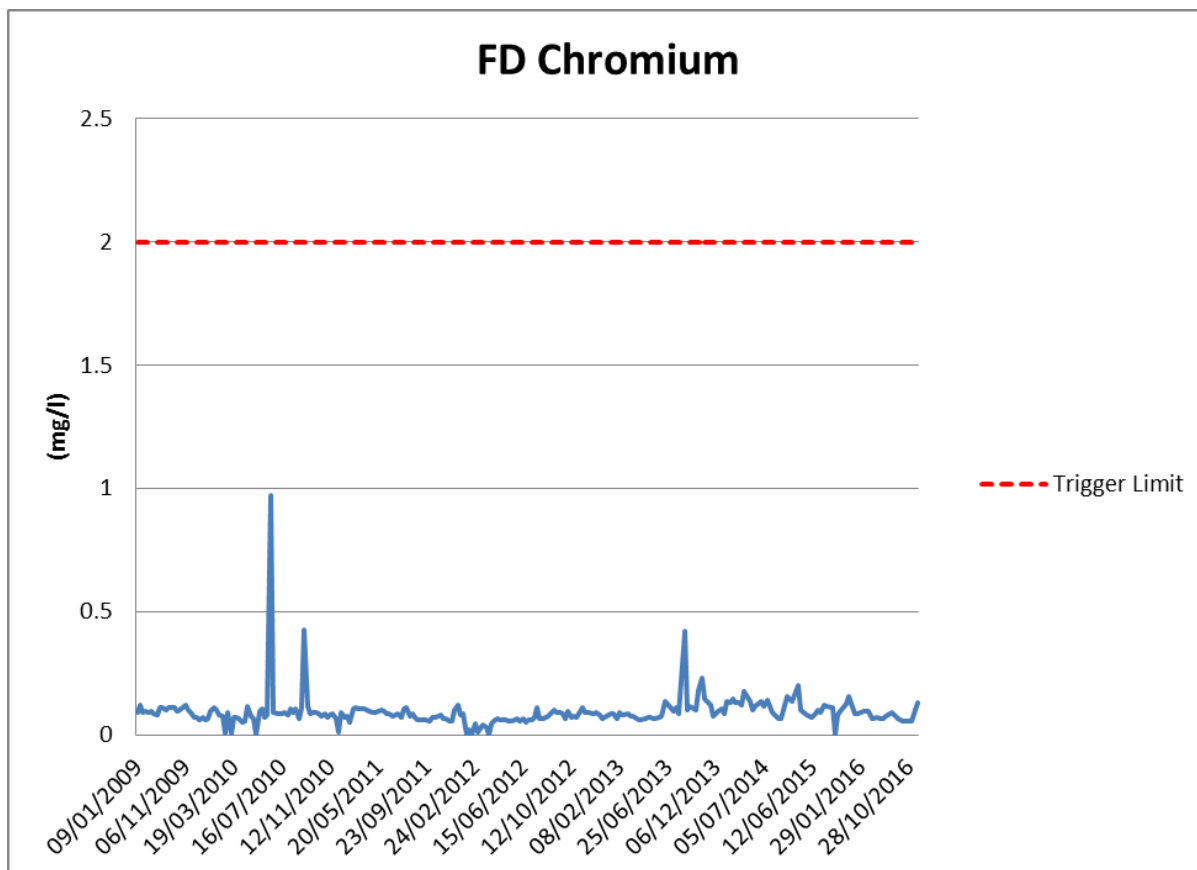
APPENDIX 3 - LEACHATE



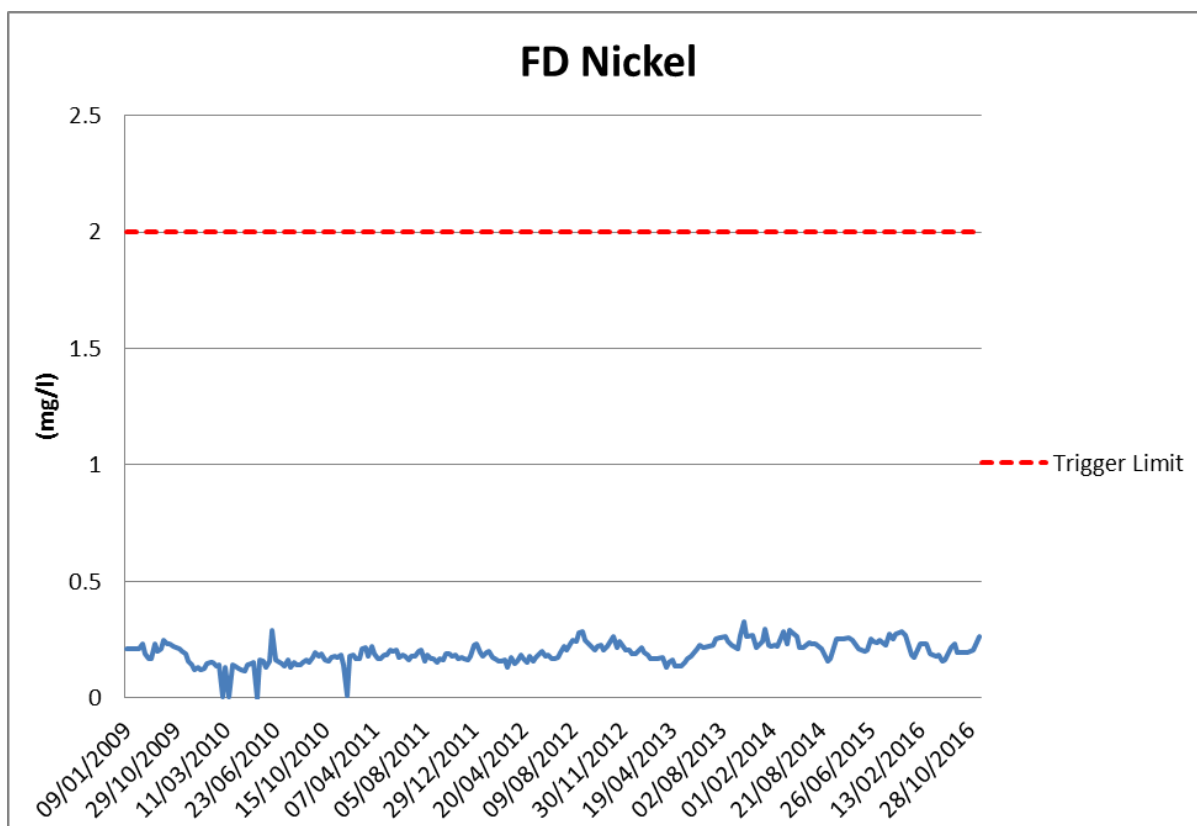
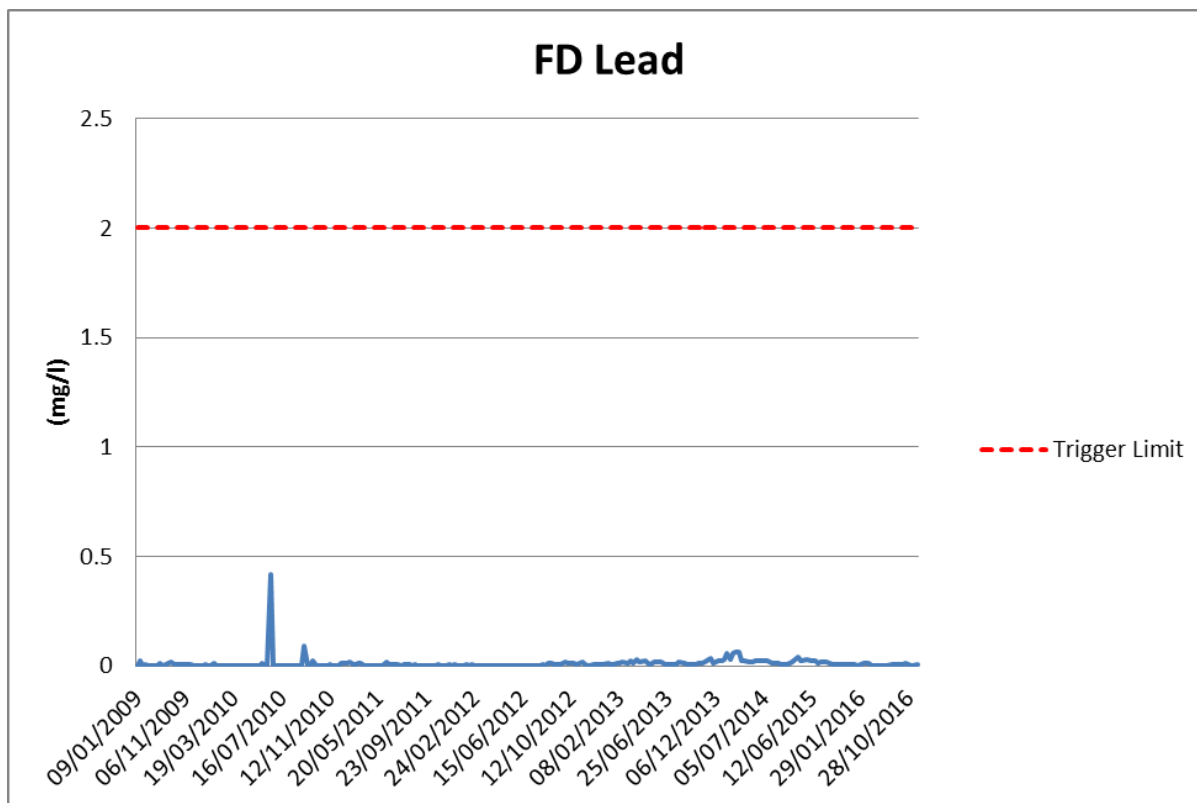
APPENDIX 3 - LEACHATE



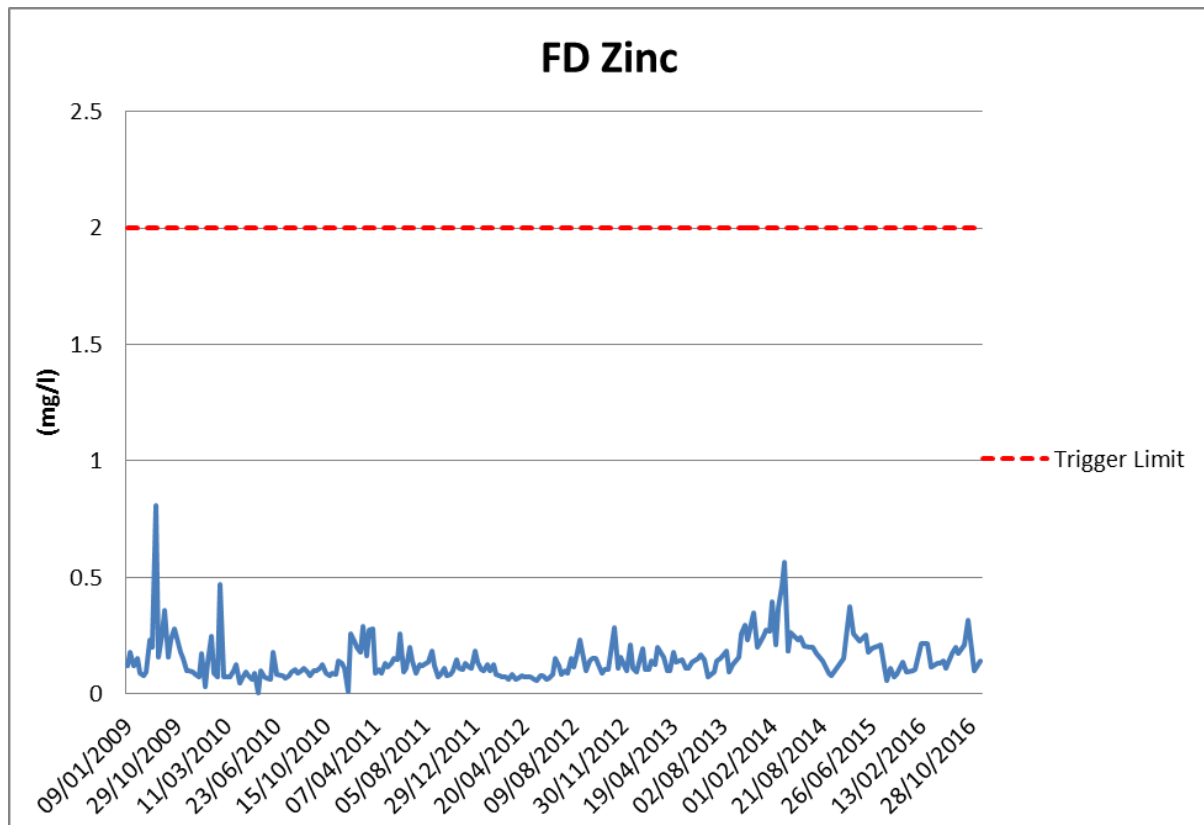
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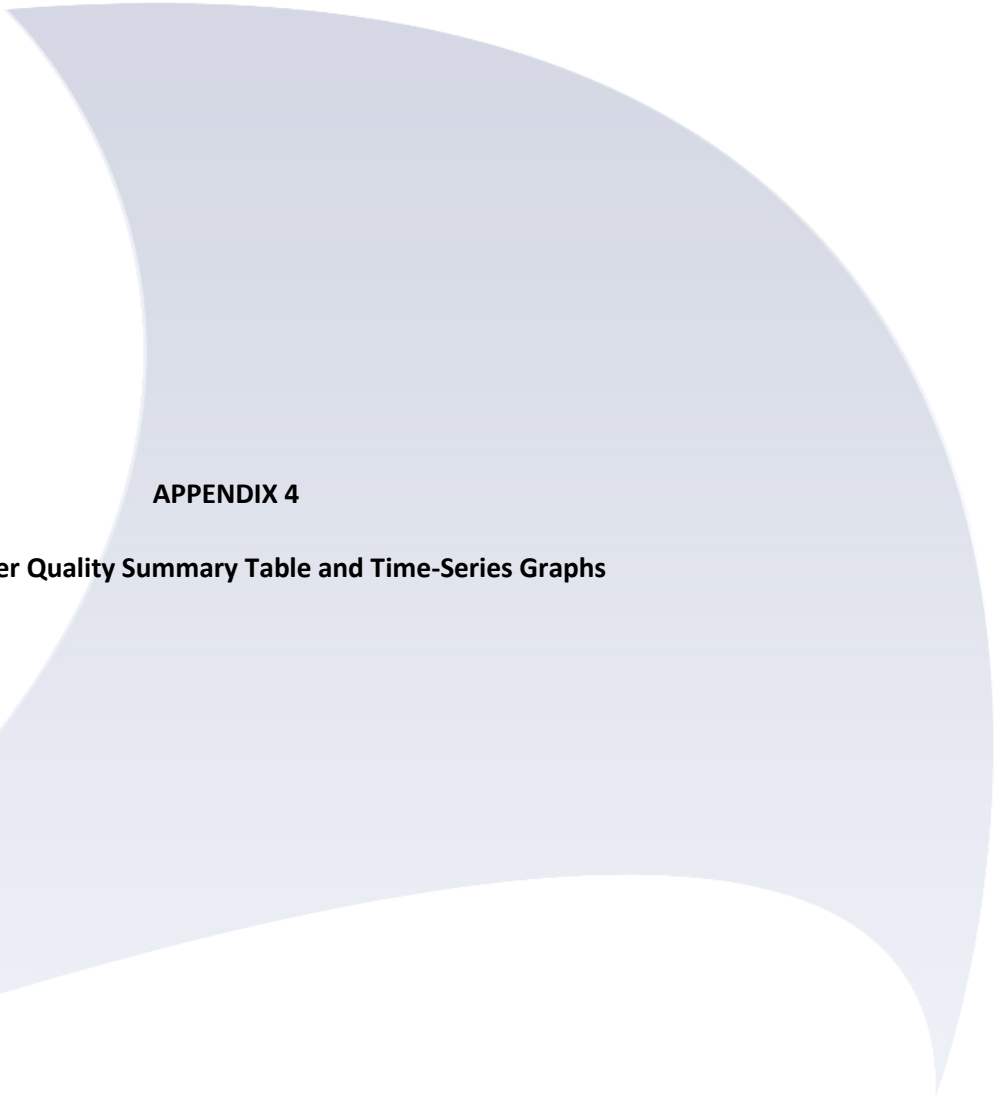


APPENDIX 3 - LEACHATE



APPENDIX 3 - LEACHATE





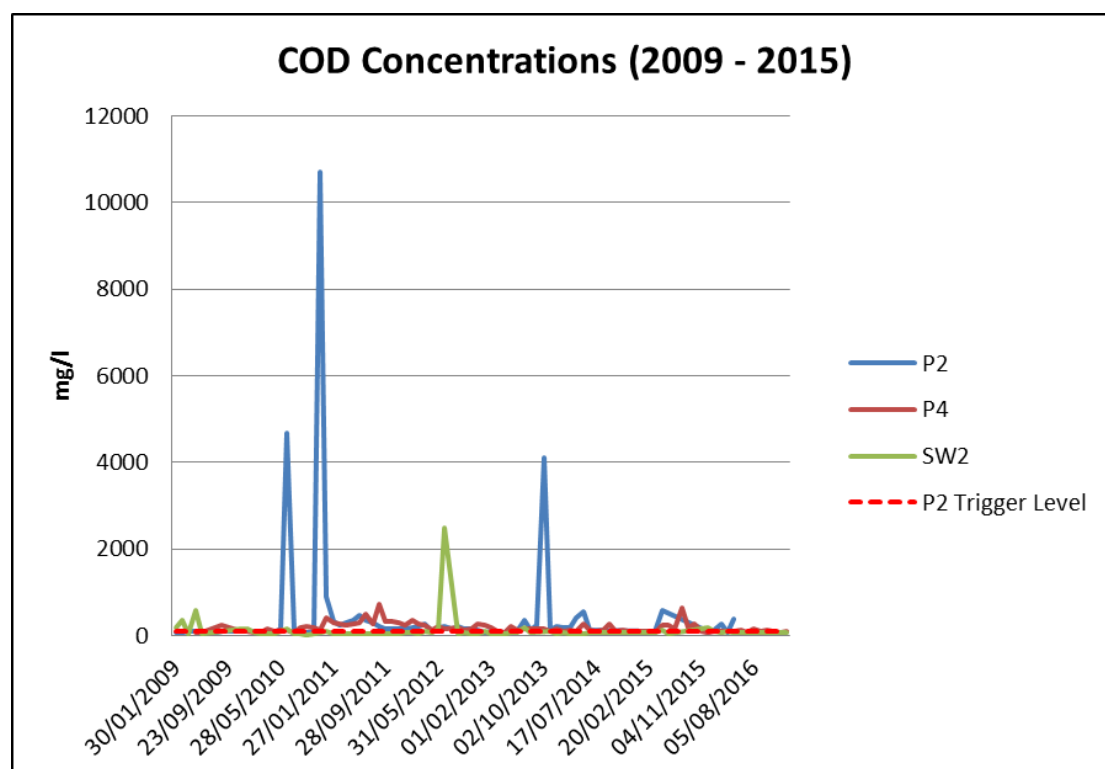
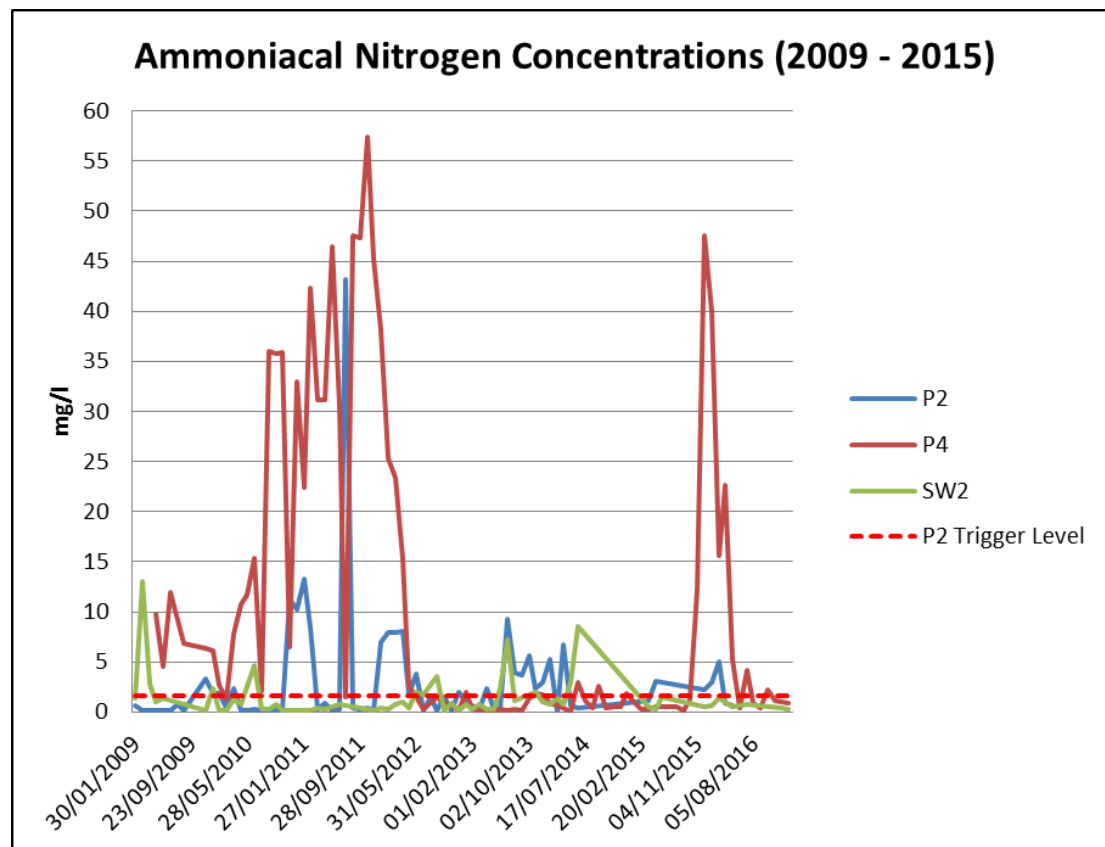
APPENDIX 4

Surface Water Quality Summary Table and Time-Series Graphs

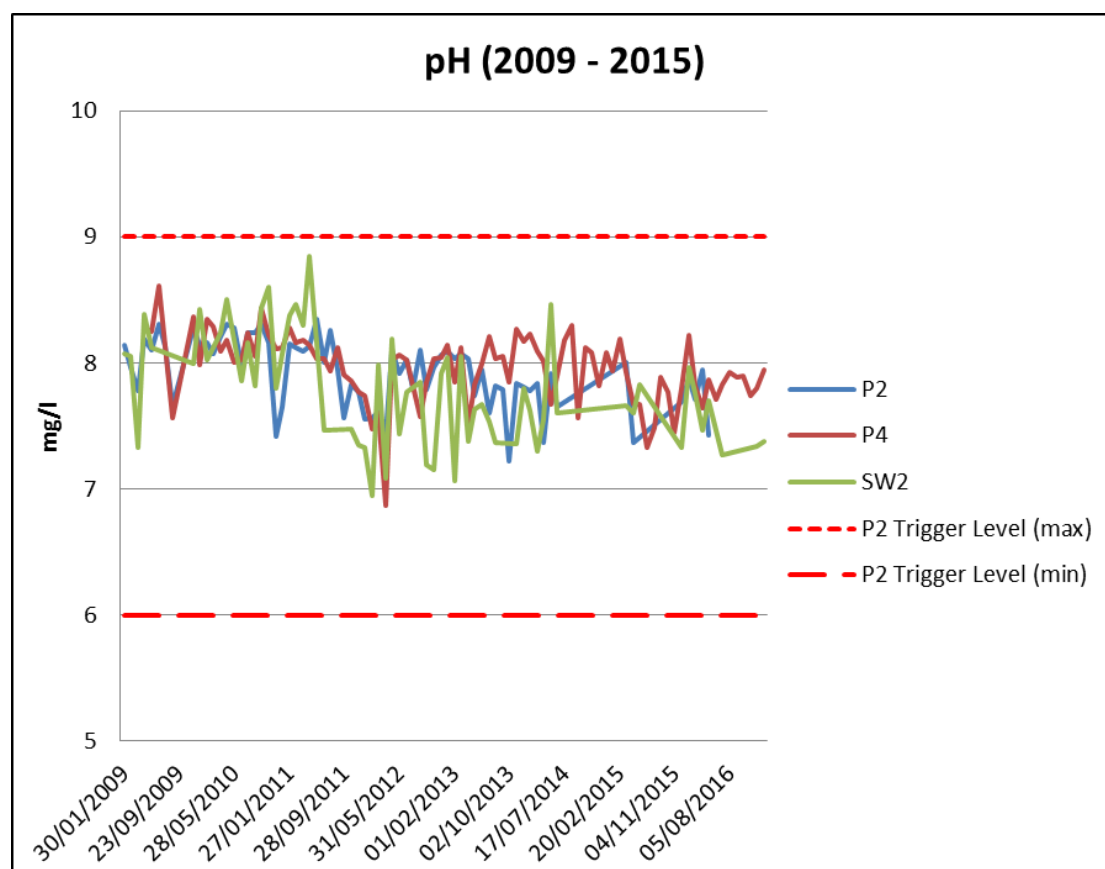
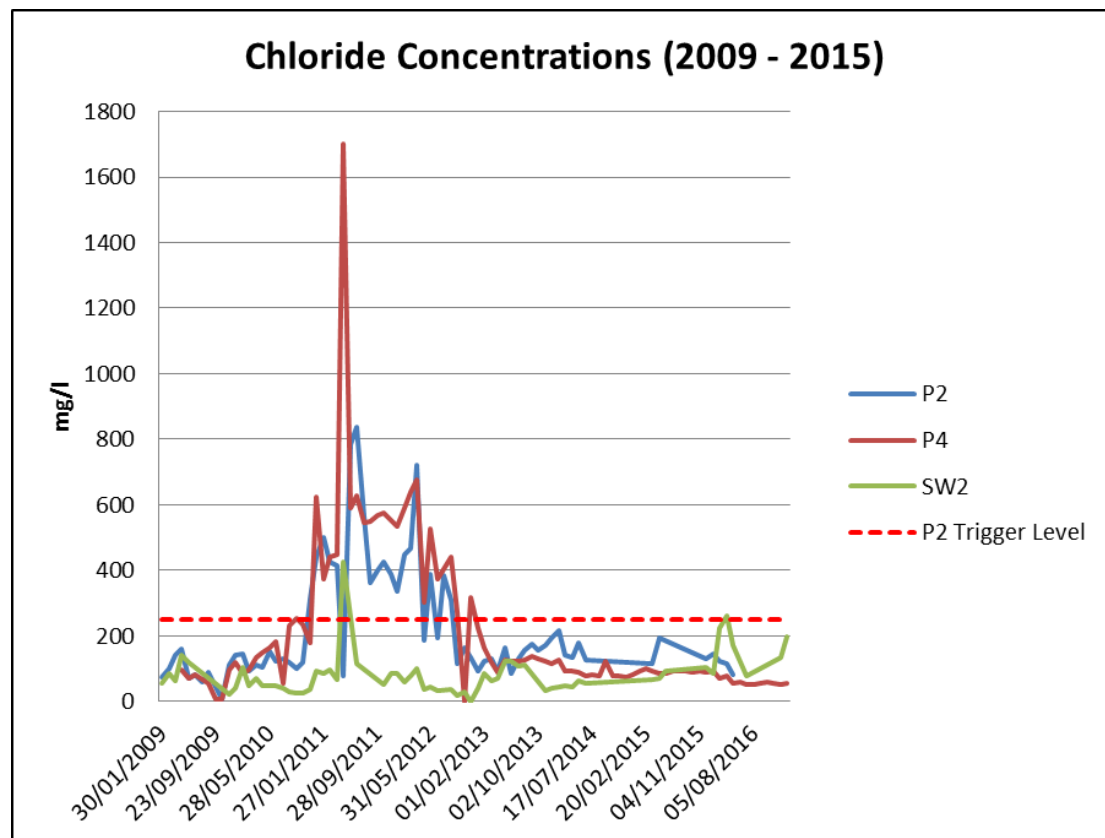
APPENDIX 4**Table 1: Monthly Surface Water Quality (2016)**

Location	Parameter	Ammoniacal Nitrogen	Chloride	COD	pH	Suspended solids
	Units	mg/l	mg/l	mg/l	-	mg/l
P2	EP Limit	1.6	250	100	>6 < 9	100
	Minimum	0.6	83	77	7.4	5
	Maximum	5.1	121	385	8.0	370
	Average	2.2	106	239	7.7	194
P4	Minimum	0.4	52	78	7.6	3
	Maximum	22.7	77	169	8.0	133
	Average	5.0	59	106	7.8	34
SW2	Minimum	0.3	79	59	7.3	17
	Maximum	1.4	260	99	7.8	56
	Average	0.7	177	73	7.5	31

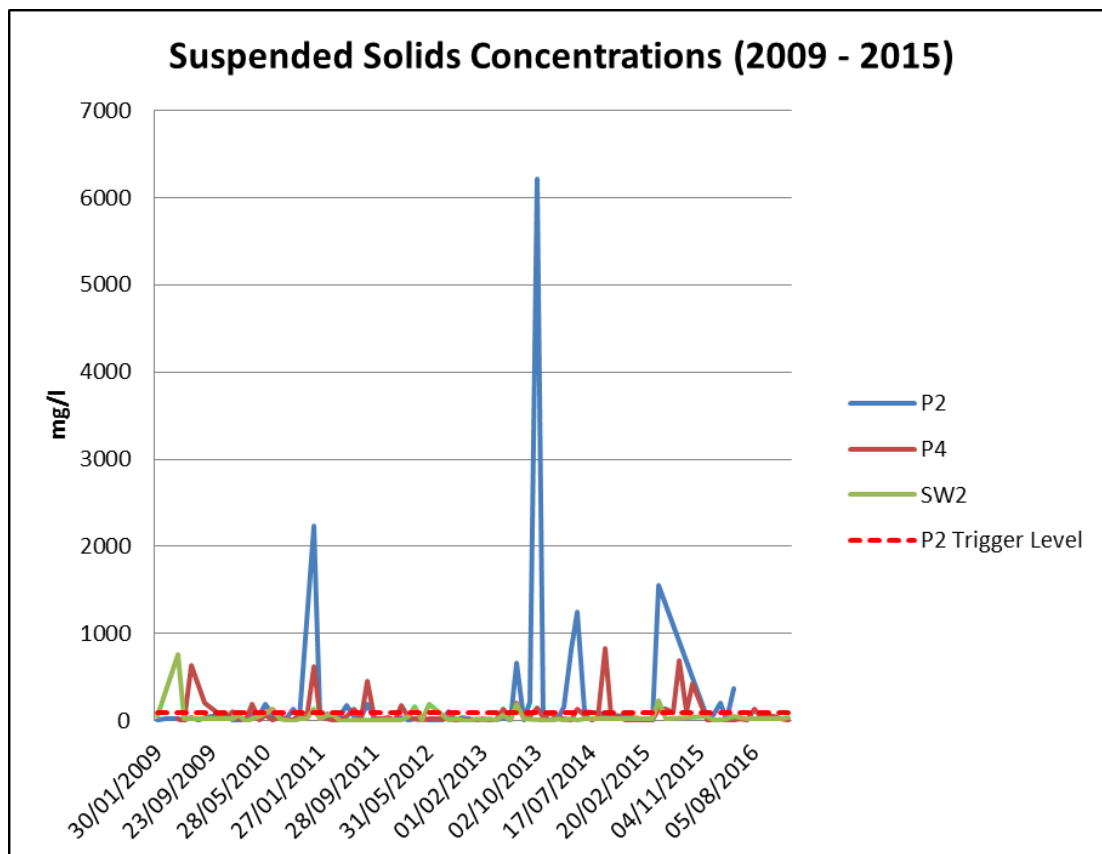
APPENDIX 4

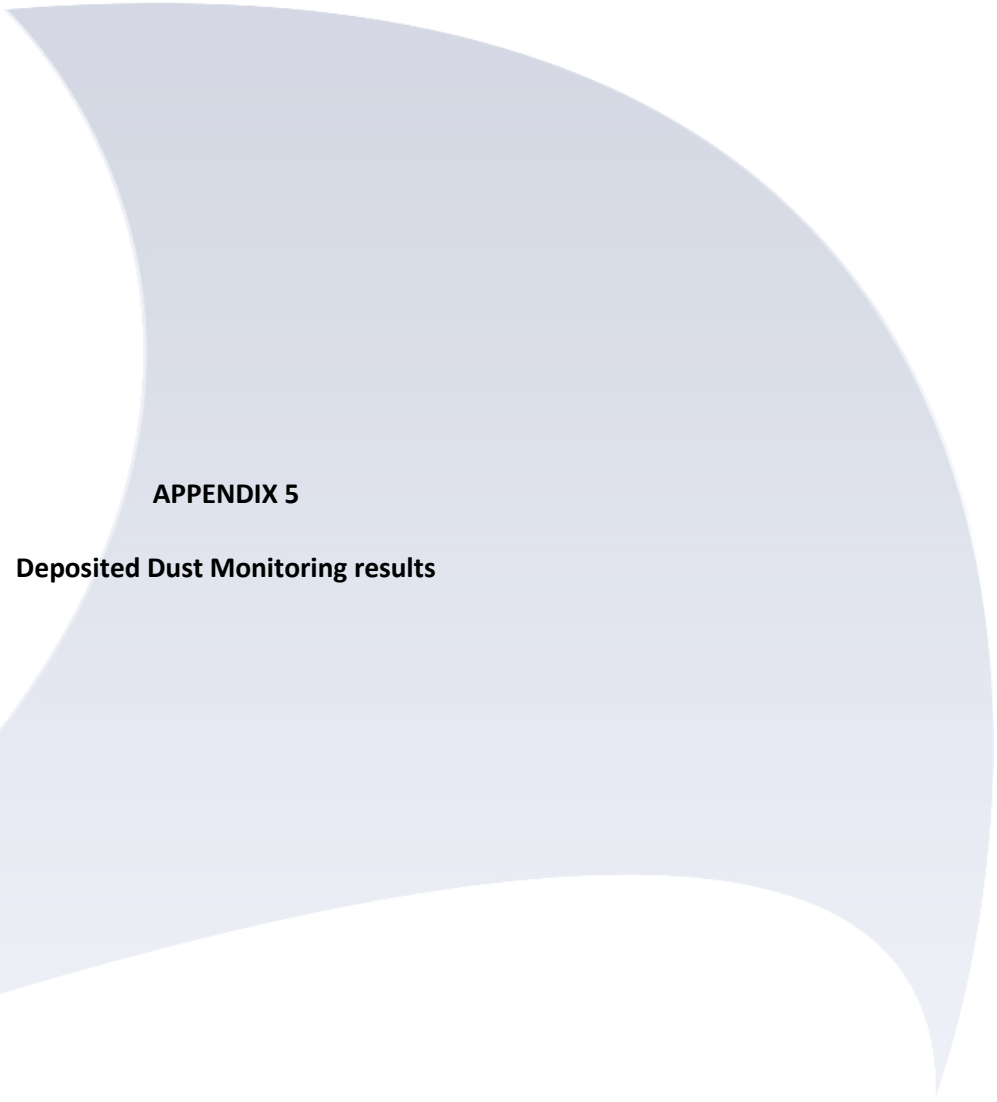


APPENDIX 4



APPENDIX 4





APPENDIX 5

Deposited Dust Monitoring results

Flintshire County Council Deposited Dust Monitoring

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

From: 09/12/2016 To: 09/01/2017
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	220	64	51
Location 2	80	260	207
Location 3	420	78	62

Comments:

- Dust analysis carried out by SAL Laboratories, Manchester
- Algal deposits in sample giving probably giving rise to higher suspended solids value and hence greater "gross dust deposition" value.

Location 1: Site Operations - located opposite "new" transfer pad

Location 2: Industrial Estate Boundary - located on perimeter near leachate treatment plant

Location 3: Oaks Farm



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